Biophysical Impact Assessment High Displacement Renewable Energy Project

Final Report
Sanikiluaq, NU
Project # TAV1989301

Prepared for:

Nunavut Nukkiksautiit Corporation
Iqaluit, NU

25-May-22

Biophysical Impact Assessment High Displacement Renewable Energy Project

Sanikiluaq, NU

Project # TAV1989301

Prepared for:
Nunavut Nukkiksautiit Corporation
Iqaluit, NU

Prepared by:
Wood Environment and Infrastructure Solutions

25-May-22

Table of Contents

List of Figures

List of Tables

List of Appendices

List of Acronyms

AGL	above ground level
AMZ	Air Management Zone
AQMS	Air Quality Management System
ARU	autonomous recording unit
ASL	above sea level
ATV	all-terrain vehicle
BESS	Battery Energy Storage System
BIA	Biophysical Impact Assessment
CAAQ	Canadian Ambient Air Quality Standards
CCME	Canadian Council of Ministers of the Environment
CESCC	Canadian Endangered Species Conservation Council
CERRC	Clean Energy for Rural and Remote Communities
cm	Centimetres
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSD	Census Subdivision
CWS	Canadian Wildlife Service
ECC	Environmental Components of Concern
ECCC	Environment and Climate Change Canada
EMP	Environmental Management Plan
EPP	Environmental Protection Plan
FEED	Front End Engineering and Design
GHG	Greenhouse Gas
GLO	Ground-level ozone
ha	hectare
IAAC	Impact Assessment Act of Canada
IBA	Important Bird Area
IPCC	Intergovernmental Panel on Climate Change
km	kilometres
km/h	kilometres per hour
kV	kilovolt
kW	kilowatt
kWh	kilowatt per hour
L	litres
m	metres
m/s	metres per second
MBCA	Migratory Birds Convention Act
MET	meteorological evaluation tower
mg/L	milligrams per litre
MPa	megaPascals
NAWCC	North American Wetlands Conservation Council
NIRB	Nunavut Impact Review Board
NL	Newfoundland and Labrador
NNC	Nunavut Nukkiksautiit Corporation
NO_2	Nitrogen dioxide
NRCan	Natural Resources Canada
NU	Nunavut

NuPPA	Nunavut Planning and Project Assessment Act
NWB	Nunavut Water Board
OBBA	Ontario Breeding Bird Atlas
PM	Particulate Matter
PPD	Petroleum Products Division
QBDC	Qikiqtaaluk Business Development Corporation, a subsidiary of QC
QC	Qikiqtaaluk Corporation
QEC	Qulliq Energy Corporation
QIA	Qikiqtani Inuit Association
RSZ	rotor-swept zone
SAR	Species at Risk
SARA	Species at Risk Act
SARPR	Species at Risk Public Registry
SOCC	Species of Conservation Concern
SO_2	Sulphur dioxide
StatCan	Statistics Canada
TC	Transport Canada
UTM	Universal Transverse Mercator
VEC	Valued Environmental Components
VOCs	Volatile organic compounds
°C	degrees Celsius

1.0 Introduction

Sanikiluaq is a small community located in the Belcher Islands of the Hudson Bay. Like all communities in Nunavut (NU), Sanikiluaq has no access to the North American electrical grid, is not connected to the piped natural gas network and has no access to a back-up grid. The community independently produces electricity using one diesel power plant with three generators. Being wholly dependent on fossil fuel, the community consumes approximately 3.6 million litres of diesel fuel annually for heating, transportation, and electricity.

The Sanikiluaq High Displacement Renewable Energy Demonstration Project (the 'Project') is a wind energy and storage platform tailored for deployment in the remote Hamlet of Sanikiluaq. The project aims to provide clean, affordable, and reliable energy to the community and to reduce diesel reliance for electricity production in the community by at least 50%. The Project will integrate up to ten turbines, e+ micro controller and a containerized Battery Energy Storage System (BESS) within Sanikiluaq's diesel grid to achieve high diesel displacement.

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (Wood) was retained by the Qikiqtaaluk Corporation (QC) to provide environmental consulting services to complete a Biophysical Impact Assessment (BIA) in support of the Nunavut Impact Review Board (NIRB) screening process. The NIRB is Nunavut's environmental assessment agency, with responsibilities for assessing the potential impacts of proposed projects before any required permits, licences and approvals can be granted under the Standard Impact Statement Guidelines.

1.1 Background

The Sanikiluaq High Displacement Renewable Energy Demonstration Project is a wind energy and storage project. The preliminary design is based on 1,000 kW (1 MW) wind energy combined with 500 kWh of battery energy storage. Several supporting studies and activities were completed over the past five years to support the project, specifically:

- The "Potential for Wind Energy in Nunavut Communities" report, produced by Qulliq Energy Corporation (QEC) in 2016, which identified Sanikiluaq as the most appropriate community to focus a small wind project using 100 kW wind turbines;
- QBDC subsequently initiated a project to advance a wind resource assessment in Sanikiluaq and was awarded funding from Polar Knowledge Canada and Bullfrog Power to procure and install a meteorological evaluation tower (MET), which has collected wind measurements at the Project Site since 2017; and
- A bankable Wind Resource Assessment (Zephyr North 2020) was completed by Zephyr North based on the MET data collected.

The project aims to provide clean, affordable, and reliable energy to the community while assuring local ownership, job creation, and a local economic boost. A primary goal of the project is to reduce diesel reliance for electricity production in the community by at least 50%. That goal is expected to be exceeded, especially in the winter months.

1.2 Proponent

The Nunavut Nukkiksautiit Corporation (NNC) is a subsidiary company of the Qikiqtaaluk Corporation (QC) which is a wholly owned Inuit birthright development corporation created by the Qikiqtani Inuit Association (QIA). QIA is the not-for-profit Designated Inuit Organization established under Article 39 of the Nunavut Agreement representing approximately 14,000 Inuit in the Qikiqtani Region of NU. Qikiqtani includes thirteen communities from Grise Fiord (High Arctic) down to Sanikiluaq (Hudson Bay). NNC supports Qikiqtani communities in pursuing clean energy projects, it is the first 100% Inuit-owned renewable energy developer in Nunavut.

Contact information for the Proponent:

Nunavut Nukkiksautiit Corporation
PO Box 1228, Iqaluit, NU X0A 0H0
Heather Shilton, Project Manager
Email: hshilton@qcorp.ca

1.3 National and Regional Considerations

Combustion of fossil fuels generates harmful pollutants such as sulphur dioxide (SO_2), oxides of nitrogen (NO_x), mercury, volatile organic compounds (VOCs) as well as GHG emissions. These contribute to climate change and directly impact human and environmental health. To address these concerns, under the Paris Agreement the Canadian Government is committed to reducing Canada's total GHG emissions by 30% below 2005 levels by 2030, and that 90% of Canada's electricity be provided by non-emitting sources. To achieve this target, the Canadian Government has, and continues to, implement measures to increase the share of renewable energy in the overall energy mix and to promote, as well as accelerate, technology development and deployment. Natural Resources Canada has implemented the Clean Energy for Rural and Remote Communities (CERRC) program to support projects across Canada to reduce the reliance on diesel fuel for heat and power in rural and remote communities.

1.3.1 Justification for the Project

The wind turbines will generate an anticipated 3.8 GWh of energy annually. This can displace 2.8 GWh of electricity generation from diesel fuel with clean, non-emitting renewable power, while generating community ownership of the system leading to revenue generation and other economic benefits. The project will demonstrate a unique approach to renewable energy development in the North, using proven technologies to support the clean energy transition in Nunavut.

The project will integrate an innovative hybrid system with Sanikiluaq's diesel grid to achieve high diesel displacement. The project will be delivered through a regional-community ownership structure and will be a model for transitioning Canada's remote, diesel dependent communities to sustainable clean energy systems.

The project, implementation will generate valuable knowledge on multiple aspects of renewable energy deployment in remote Arctic climates:

- capabilities for diesel grid -interconnection, microgrid control and penetration;
- deployment and operations in a remote community; and
- a regional-community ownership model with financial, environmental, and social benefits.

The proposed project will employ up to 10 turbines, each rated between 100 - 300 kW. This can displace more than 50% of the diesel fuel used for electricity generation. In turn, decreased fuel delivery activities and onsite storage will reduce the chances for accidental releases that can contaminate surface water, groundwater, and terrestrial habitat.

1.4 Regulatory Environment

NNC and QC will work together to engage the appropriate regulatory authorities, agencies, community, and local authorities/groups.

In addition to the BIA and an Environmental Management Plan (EMP), the NNC will apply for required regulatory authorizations/permits such as:

- Municipality of Sanikiluaq: Land Use and Development Permit;
- Nunavut Planning Commission (NPC) authorization;
- Nunavut Impact Review Board (NIRB) authorization;
- Transport Canada and NavCan Permits;
- Qulliq Energy Corp Power Purchasing Agreement; and,
- Nunavut Water Board (NWB) Water Licence (if required)

The Impact Assessment Act (IAA 2019) does not apply in NU as per Section 7 of NuPPA:

> *(7) The Canadian Environmental Assessment Act, 2012 does not apply in respect of the designated area. (Designated area is defined in NuPPA as: the area that consists of the Nunavut Settlement Area and the Outer Land Fast Ice Zone)*

The construction, operation, and maintenance of the Project will be undertaken in accordance with all applicable legislation, regulatory approvals, and relevant guidelines.

1.5 Structure of the Document

The activities and results of the assessment are presented as follows:

Section 1.0	Provides the need and justification for the Project, proponent information and the regulatory structure.
Section 2.0	Provides a description of the Project, including phases and activities.
Section 3.0	Describes the scope of the BIA, methodology, as well as the temporal and spatial boundaries.
Section 4.0	Describes the existing geophysical, biological and atmospheric environmental setting of the Study Area.
Section 5.0	Describes the potential interactions between Project activities and environmental components, describes mitigation measures and potential residual environmental effects.
Section 6.0	Describes other undertakings in the Project area.
Section 7.0	Describes the effects of the environment on the Project.
Section 8.0	Conclusion
Section 9.0	List of Supporting Documents.

2.0 Project Description

The Project is a wind energy and storage platform tailored for deployment in the remote Hamlet of Sanikiluaq. The recommended project configuration consists of 1,000 kW wind energy combined with 500 kWh of battery energy storage. The preliminary design is expected to reduce diesel reliance for electricity generation in the community by at least 50%, and with the current sizing, that goal is expected to be exceeded, especially in the winter months. As such, early analysis is ongoing to determine any potential to use excess electricity to generate heat locally for community buildings, or if there may be an opportunity to integrate additional storage technologies into the facility.

The Project will be owned in partnership with the Hamlet of Sanikiluaq. This partnership may be established through a joint venture agreement between a Nunavut Nukkiksautiit Corporation (NNC)-led holding company and the Hamlet, or through the establishment of some form of community enhancement fund to be administered by local individuals within the community. Regardless of structure, a portion of dividends/profit will be shared directly with the community.

2.1 Project Location

The Belcher Islands are situated in southeastern Hudson Bay, approximately 170 kilometres (km) west of Richmond Gulf, Quebec (Figure 2.1). The islands are topographically low-lying and barren, comprised of nearly a hundred islands that are predominantly rounded and undulating to flat. There are four large islands, another 14 islands that are 9 - 29 km long, and many smaller islands located mainly to the south (Jackson, G.D. 2013). Sanikiluaq is located just south of western Eskimo Harbour on northwestern Flaherty Island - the largest of the Belcher Islands.

The Project will integrate up to ten turbines, located entirely on municipal land located approximately 4.5 km south of the Sanikiluaq Airport. Table 2.1 provides the coordinates for each potential turbine in the array, and locations are illustrated in Figure 2.2. The exact number and locations of the turbines will depend on turbine models / supply available pre-construction.

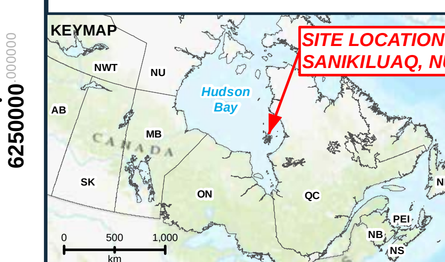
Table 2.1 UTM Geographical Coordinates

Turbine Name	UTM	
	Easting	Northing
T1	608915.97	6263116.05
T2	608959.97	6263000.05
T3	608999.97	6262890.05
T4	609009.97	6262770.05
T5	608991.97	6262520.05
T6	608977.97	6262396.05
T7	608965.97	6262272.05
T8	608974.97	6262148.05
T9	608930.97	6261993.05
T10	608924.97	6261868.05

Note: NAD 83 CSRS, UTM Zone 17 North

LEGEND:

Proposed Wind Project Location



CLIENT:

QIKIQTAALUK BUSINESS DEVELOPMENT CORPORATION

wood.

TITLE:

PROJECT LOCATION

PROJECT:

SANIKILUAQ WIND PROJECT

PROJECT NO:	DATE:
TAV1989301	NOVEMBER 2021
REV NO: 0	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 17 N

FIGURE:

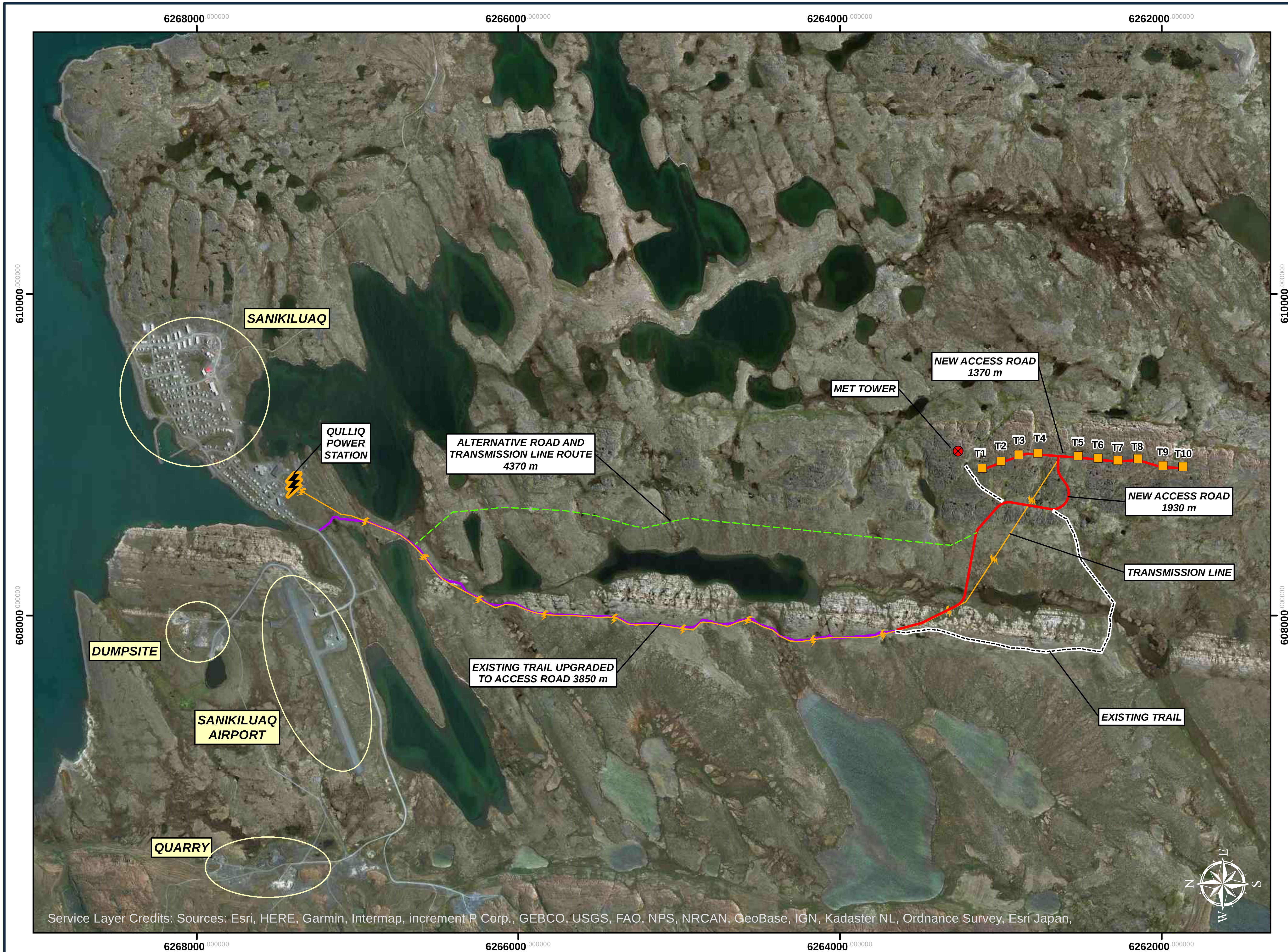
FIGURE 2.1

SCALE: 1:1,500,000

0 12.5 25 50

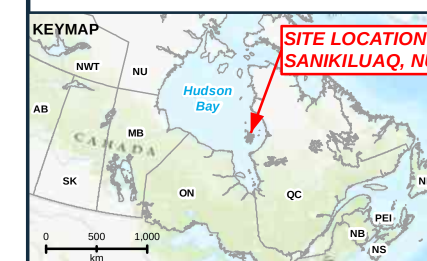
Kilometres

Path: G:\5300 PROJECTS\2019\TAV1989301 Qikiqtaaluk Business Development\GIS\MXD\TAV1989301_FIG_2_1_ProjectLocation.mxd User: candace.macdonald Date: 11/26/2021



LEGEND:

- MET Tower
- Proposed Wind Turbine Locations
- Qulliq Power Station
- Alternative Road and Transmission Line Route
- Existing Trail
- Existing Trail Upgraded to Access Road
- New Access Road
- New Transmission Line



CLIENT:

QIKIQTAALUK BUSINESS DEVELOPMENT CORPORATION

wood.

TITLE:

SITE PLAN

PROJECT:

SANIKILUAQ WIND PROJECT

PROJECT NO:	DATE:
TAV1989301	JANUARY 2022
REV NO: 1	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 17 N

FIGURE:

FIGURE 2.2

SCALE: 1:22,500

0 250 500 1,000
Metres

Path: G:\5300 PROJECTS\2019\TAV1989301 Qikiqtaaluk Business Development\GIS\MXD\TAV1989301_FIG_2_2_SitePlan.mxd User: candace.macdonald Date: 1/26/2022

2.2 Estimated Capacity of Wind Farm

2.2.1 Nominal Capacity

The Project will be implemented in one stage. This stage will consist of the installation of up to ten wind turbines (T1, T2, T3, T4, T5, T6, T7, T8, T9, and T10) with a capacity of 100 kW to 300 kW each, generating a total of 1000 kW of electrical wind power. There may be fewer than 10 turbines if supply/pricing make the higher rated 300 kW a more suitable model during the construction phase. These turbines range from 50 – 60 m hub height with a 24 – 36 m rotor diameter. Both options have tilt-up towers, a cut-out wind speed of 25 metres per second (m/s) and a survival wind speed rated at 70 m/s.

2.2.2 Expected Annual Energy Production

The expected annual energy production of this Project is approximately 3.8 GWh.

2.3 Construction Schedule

The estimated construction schedule is depicted in Table 2.2.

Table 2.2 Proposed Construction Schedule

30 MW of Wind Power	Date
BIA Completed	December 2021
Preliminary Front End Engineering and Design (FEED)	November 2021
Grubbing and Access Road Construction	July – September 2022
Wind Turbine Site Foundation Construction	September 2022
Wind Turbine Assembly and Erection	July – August 2023
Transmission Line	August 2023
Substation Upgrade	July – October 2023
Wind Site Electrical (Collector System and E-House Install)	September 2023
Commissioning of Wind Turbines and Substation	October 2023

2.4 Alternatives to the Project

Transitioning to wind-based power is inherently more sustainable than continued reliance on traditional fossil fuels and protects the environment from greenhouse gas emissions and accidental releases of petroleum products during transportation and storage.

The Sanikiluaq site was selected by NNC based on community feedback and preliminary work conducted prior to the FEED study. Factors considered for site selection include, but are not limited to:

- 4 km radius from the airport (as per Transport Canada requirements);
- Existing roads, trails, or other infrastructure;
- Restricted zones; and
- Environmentally sensitive areas.

The selected site for the Sanikiluaq project has pre-existing trails to and from the community which allow for easier road development and is clear of the 4 km radius from the airport. Additionally, this location is not in any restricted zones or environmentally sensitive areas. The existing onsite MET that was erected in 2017 confirmed the resource opportunity of the site and demonstrates the location is viable for the wind development.

2.5 Project Planning and Preparation

Figure 2.2 depicts the infrastructure locations within the footprint upon completion of the Project. To optimize the Project layout several surveys were required. These include a meteorological survey, environmental surveys, and a geotechnical survey.

2.5.1 Meteorological Survey

The purpose of a meteorological survey is to evaluate exact wind conditions prior to the construction of a wind project. For this Project, a 34-m MET was installed on March 28, 2017, on a ridge with an elevation of approximately 77 m above sea level (ASL). The tower was sited approximately 4.5 km south of Sanikiluaq Airport to adhere to Transport Canada (TC) requirements. Airport authorities, NavCan and TC, have a ceiling height restriction for any tower within 4 km of the airport runway centre which requires an official survey.

The MET is equipped with two wind speed sensors, or anemometers, at each of 20 and 34 m above ground level (AGL). Wind direction sensors were installed at 33 m and a temperature sensor installed at 2 m AGL. Although data collection is ongoing, the measurements used were collected from March 28, 2017 to March 1, 2020 (Zephyr North, 2020). The wind measurements from the airport weather station operated by ECCC were also used for correlating and projecting the site measurements to long term. The airport weather station has a wind speed and direction sensor on a 10 m tower located across the runway from the airport terminal. The station also measures temperature, relative humidity, and other parameters.

The MET reported an average wind speed of 8.5 m/s at 34 m AGL and estimated to be 8.8 m/s at the proposed hub height of 50 metres (Zephyr North, 2020). The winds are generally from the west spreading from the northwest to southwest and are strongest in the fall.

2.5.2 Environmental Surveys

To fully understand the environmental constraints of a Project, several environmental surveys were conducted. These include:

- General site walkthroughs;
- Bird surveys;
- Vegetation / rare plant surveys; and
- Aquatic and wetland surveys.

Flora and fauna species at risk (SAR) surveys were integrated in the wetland, vegetation, bird, and wildlife surveys. These surveys were conducted by the personnel indicated in Table 2.3.

The results of these surveys allowed optimization of the layout of the Project by minimizing impacts to Valued Environmental Components (VECs) through avoidance where possible. In addition, they provide the Proponent with information regarding the necessary mitigation measures.

Table 2.3 Surveys Conducted, Personnel Qualifications and Survey Periods

Survey	Personnel and Qualifications	Survey Period
Wetlands / Vegetation	Christina Brodribb, BAEM, R.T.(Ag)	Aug 2021
Avian Species Inventory and Behaviour Assessment	Maureen Cameron, M.Sc.	Dec 2019
	Silas Novalinga	Dec 2019, Feb 2020, May – July 2021, Sept – Oct 2021
	Charlie Takatak	Feb 2020

2.5.3 Geotechnical Survey

A desktop geotechnical survey was completed as part of the planning process to assess the general subsurface conditions (Tetra Tech, 2020) within the Project Footprint. The purpose of geotechnical investigation was to determine engineering recommendations for designing the earthworks and foundations for structures to prevent human and material damage due to earthquakes, foundation cracks, shifts in permafrost and other potential effects of the environment on the Project.

The information reviewed indicated that bedrock is exposed at the site and suitable for the proposed Project. The top 2 m - 3 m may be highly fractured due to frost-shattering; jointed and weathered; and considered less competent. Below that, the bedrock is assumed to be more competent with published uniaxial compressive strengths ranging from 100 megaPascals (MPa) to >250 MPa and described as very strong to extremely strong.

Grouted rock-socketed steel pipe piles encased in a concrete pier or tied to a steel foundation base (if the use of steel is more feasible than concrete) have been recommended for the wind turbine foundations. Grouted rock-socketed piles are considered the least susceptible foundation type to the effects of climate change. With competent bedrock anticipated at 2 m to 3 m below ground surface, potential seepage and sloughing through highly fractured and weathered near surface rock might make it difficult for local contractors to install grouted rock-socketed steel pipe piles; especially when the piles are installed during the thawing seasons. Special measures will need to be taken for the installation to be feasible and less problematic in this case.

A rock anchored pier or footing on bedrock system is also considered an acceptable foundation for the wind turbines if suitable installation equipment for the anchors is readily available in Sanikiluaq and construction is planned in the summer when temperatures are suitable for concrete works. The proposed battery storage units can be placed on a concrete pad cast directly on exposed competent bedrock or on a granular fill pad.

2.6 Construction Phase

Front end engineering and design has been completed and will be updated as specific equipment is procured. Access road construction will commence the construction phase, followed by electrical line and foundation installation. Turbine and BESS delivery will begin in July 2023 and be completed by October 2023. The proposed turbines are planned to be commissioned and operational by November 2023.

The total construction process will entail:

- grubbing and access road/laydown areas construction;
- construction of turbine foundations;
- installation of collector lines between and from turbines to substation;
- substation upgrade and BESS installation;
- installation of turbines;
- testing and commissioning of turbines; and
- removal of all temporary works and restoration of the Site.

Generally, construction activities will avoid environmentally sensitive areas, dwellings, and buildings to minimize the effect of noise, shadow flicker, potential tower or blade failure, and ice throw, and the site is far enough from the hamlet such that no other developments are nearby. Additionally, collector, road, and turbine locations will avoid disturbing existing services and utilities. While there are no existing detailed setback requirements in NU for wind developments, all federal standards will be complied with.

All electrical installations and materials will be compliant with the Canadian Electrical Code.

All construction activities outlined below will be addressed in a Project Environmental Protection Plan (EPP).

2.6.1 Access Road/Laydown Areas Construction

The proposed locations for all access roads were chosen by design to minimize environmental impacts. All-season, unpaved access roads will be required to access each turbine location from existing public roads during the construction, operation, and decommissioning phases of the Project.

The initial construction activities will involve grubbing and access road construction beginning in July 2022.

Existing roads will be prioritized for the development of the single lane (4 metre wide) access road. Passing points will be provided at a minimum spacing of 500 metres, and turnarounds shall be provided at all dead ends where reversing more than 200 metres is required or is not practical. Standard road intersection geometry will be adequate for turbine component shipments up to 12 m (40 ft), however additional clearances for blade swing may be required for the larger machine options. Road design speeds are as follows:

- Main Roads: 50 km/h
- Site Access Road: 30 km/h
- Turn Around: 10 km/h

Access road construction will consist of the following:

- Land will be grubbed by a qualified contractor using typical construction equipment. Grubbed material may be removed for disposal in a borrow pit or distributed on site.
- Borrow material will be used to build the roads to grade.
- Granular "A" gravel will be spread on the surface of the road. The road surface will then be compacted to provide smooth, erosion-resistant, safe surfaces.

Laydown areas will prioritize the use of existing cleared areas (or their expansion). In addition, ditching and cross drainage will be constructed as appropriate.

Existing pits and quarries will be used if adequate supply, quality, cost, and availability is acceptable. Specifically, pit and quarry development shall consider:

- Proximity to areas where materials are required for use;
- Availability of multiple types of materials in one location (if practical);
- Maintaining minimum buffer to creeks and natural drainage courses, as well as main roads (to control dust and act as safety barrier); and
- Use of previously disturbed areas.

2.6.2 Turbine Foundations

The turbine layout is based on the wind resource assessment, energy modelling, land ownership considerations, and natural features. Locations will be refined based on access, collector arrangement, geotechnical conditions, and avoidance of low-lying areas and depressions that could have drainage issues.

The foundation designs will depend on site-specific subsurface conditions. Acceptable foundation design types include rock anchored steel frame for free-standing monopole towers and rock anchors for guyed towers. The top of rock anchored foundations will be at or near grade to avoid the requirement of a tower pedestal and burial of the cap so that free access to the rock anchor heads is available without excavation. The foundations will be on bedrock or lean concrete fill cast directly on bedrock. Loose surface rocks will be scaled and removed, and fractured rock may require treatment, such as grouting, or removal to meet design parameters.

2.6.3 Interconnection Cabling

The collector cabling will generally be run along the access trail directly between turbines. Routing will be housed in a raceway mounted to the rock at a nominal clearance. Separate cabling will be run directly from each turbine to the collector station, without daisy chaining or using junction boxes. A fibre optic cable is routed with the collector power cabling.

The layout and design standards shall be in accordance with the Energy Electrical Design Basis Memorandum (Frobisher, 2021). Layout will adhere to all constraints, lands, and right-of-way requirements and consider topography and difficult construction areas. The collector routing will avoid road crossings.

Transmission Lines

The transmission line from the collector station transformer to the interconnection at Sanikiluaq will follow the access road where possible to minimize the project footprint except where a more direct routing will result in significant cost savings. Key transmission layout design parameters are presented in Table 2.4 below.

Table 2.4 Transmission Layout Design Key Parameters

Horizontal road clearances	5.0 m
Ruling span	55.0 m
Cascade failure protection distance	10 – 12 spans

Overhead pole mounted hook-stick operated disconnect switches will be provided at each end of the line.

The current aerial overhead distribution system within the hamlet consists of two radial feeders operating at 5 kV class and are of standard utility construction. It is planned that an overhead aerial line will be constructed from the wind site to a new wind system substation located adjacent to the existing QEC powerhouse. This site will operate at 15 kV class and connect via power transformer T4 and T5 respectively. The total distance is estimated at 5 kilometres and will be rated to transfer up to 1.2 MVA @ 0.8 Power

Factor (1,000 kW), with a ruling span of 55 metres. The following are the general specifications for the transmission line:

- Class 3, CCA treated wooden poles, with standard Douglas fir crossarms or equivalent;
- Conductor spacing will be asymmetrical or flat regular with typical loading sag;
- Poles will be installed with tri-anchor type rock socket piles, due to the amount of rock excavation required regular excavation would be cost prohibitive;
- Built to current utility distribution engineering standard practice, with wind and ice loading as per CAN/CSA C22.3 NO. 1-15 (R2020) – "Overhead systems";
- Allowance for communication space on overhead system to accommodate optical fiber plant attachments;
- An anti-cascading dead-end structure will be placed approximately every 10 to 11 spans;
- Storm guying will be placed as required;
- Insulators will be specified with extra creepage to accommodate for high salt contamination levels;
- Interconnection point at each end will consist of a typical cable riser arrangement with station class switches for isolation of the 1000 KVA pad-mount type transformers (T4 & T5);
- The routing of the distribution line feeder will be determined by the civil scope and follow the access road routing to ensure ready access and aid in construction activities. A standard road easement/right-of-way will be determined during layout and survey activities.

Interconnection

The project interconnection will be at the existing diesel generating station. All equipment except the transmission system step-down transformer will be contained in a modular building installed on a braced steel pile foundation.

The building will contain 5 kV switchgear, overall micro-grid control system, communications system, station service transformer and switchboard, step load bank controller, boiler dump load, and room for diesel plant office space expansion as required. The building transformer will be installed adjacent to the diesel plant with the existing yard expanded as required to compensate for the footprint.

Substation (Town Site)

The intent is to construct a 5 kV class, air insulated modular substation (E House) adjacent to QEC plant to meet the following requirements of the wind system:

- House 5 kV switchgear lineup, 600-volt MCC, and station service ancillaries
- Interconnect QEC, BESS, and the wind system at the 5 kV level
- House the Microgrid controller master terminal unit (MTU), Supervisory Control & Data Acquisition (SCADA) Historian and Workstations, Human Machine Interface (HMI), and process control/corporate network support infrastructure
- Electric Boiler (dump load) controller and supply connection point (via 600-volt MCC)
- Auxiliary load bank connection point (via 600-volt MCC)

The project team will endeavour to align with QEC technical specifications should they differ from the proposal, provided it remains up to code and is safe to operate.

Wind Site Plant

The wind site plant will consist of a modular, E-house style building located adjacent to the turbine tower structures and will house all controls associated with the wind turbine units. It will contain the following units:

- 600 V or 480 V (dependant on turbine output voltage) switchboard lineup and station service ancillaries.
- Interconnection point to the distribution system via Transformer T5 and main incomer breaker 52-6.
- Microgrid controller remote terminal unit (RTU), HMI, and process control/corporate network support infrastructure.
- Engineering workstation for equipment control logic and software updates.

The wind site plant will have a redundant, secure DC supply rated at 24 V for breaker, protection & control, and network equipment supply which will be sized in accordance with IEEE standard 485 and have an 8–12-hour outage supply rating. The system will be prefabricated, pre-commissioned, and shipped to site to reduce site works as much as possible.

The entire system will follow the Canadian Electrical Code.

2.6.4 BESS Installation

The BESS will be supplied in modified standard 20-foot shipping containers and installed on pre-cast concrete sleepers on a gravel pad with appropriate allowances for possible vertical movements of +/-0.15 m. The BESS will also be installed adjacent to the diesel plant and interconnection building with the existing yard expanded as required to compensate for the footprint.

The BESS will consist of a compact, plug-and-play microgrid and battery energy storage solution built for utility grade grid applications. Built for the environment, the solution will have DC protection, battery monitoring, HVAC, and fire protection in a fully enclosed building.

The BESS will be connected to the wind system substation 5 kV bus via transformer T6 to allow matching of the BESS output voltage to the 5 kV system, while providing electromagnetic compatibility (EMC) filtering and isolation.

2.6.5 Turbine Installation

Wind turbines components will arrive via Sea Lift in shipping containers in 2023. Turbine components will be delivered to site with standard transport trailer trucks, and the towers will be erected with a tilt-up design that will not require a heavy lift crane. It will be the responsibility of the turbine supplier to schedule, deliver and obtain appropriate transportation and safety permits.

2.6.6 Turbine Commissioning

The final activity of the Construction Phase consists of testing prior to start-up and physical adjustments to the turbines.

2.7 Operation Phase

The operational life span of the turbines is rated as 20 years, during which maintenance activities will be required from time to time. Operation of the wind farm will commence when the required approvals and authorizations are in place to supply energy into the grid.

2.7.1 Road Maintenance

During the operation of the proposed wind farm, the access roadways will be maintained at a level suitable to boom truck-sized vehicles, but on a level below that required for heavy cranes. Re-grading and rolling of the access road may periodically be required, and ditches along the road will need to be regularly maintained as well.

2.8 Decommissioning Phase

Nearing the end of the 20-year operational life span of the turbines, decisions will be made regarding continuing operations of the wind park with new or refurbished turbines and/or other equipment or dismantling the operation and returning the site to its original condition using modern technologies to accomplish this objective.

Decommissioning of the wind farm would require de-installation and removal of all physical components and machinery from the Site. The access roads would remain if the Hamlet so desired. The collector lines, power line and substation would be removed. The transmission line will also be removed if it was no longer required for other purposes. Concrete turbine pads and building foundations will be removed to a reasonable depth and re-claimed unless the Hamlet wishes to use them as they are. The equipment used for the deconstruction would be essentially the same as for the construction (e.g., transport equipment, earth moving equipment and trucks to transport waste materials). Any areas disturbed by Project activities will be revegetated with a collection of native vegetation to prevent erosion.

3.0 Approach and Methodology

3.1 Scope of the Project and Assessment

The Project is not under the jurisdiction of Impact Assessment Agency of Canada (IAAC) thus the scope of the BIA has been completed in accordance with the requirements of the NPC and the NIRB. The NPC is responsible for the development, implementation and monitoring of direct resource use and development in the Nunavut Settlement Area (NPC website, 2022). Upon review of a Project proposal, the NPC will determine if a Project conforms with approved land use plans, and if screening by the NIRB is required.

Screening by the NIRB will determine whether proposed projects require a full environmental review, or whether they should proceed without further assessment. Full environmental reviews may be required for projects using untested technologies, where significant public concern exists, or for major development projects with the potential to significantly impact the environment. Should screening by the NIRB be required, authorizing agencies are prohibited from issuing licences, permits and approvals for a project until the NIRB's screening is complete (NIRB website, 2022).

The assessment addresses the biophysical environment and potential interactions with project activities and the potential effects. Socio-economic components are addressed in a separate report.

3.2 Methodology of Biophysical Impact Assessment

To facilitate the review of project activities, an understanding of the environment within which the activities will occur, or potentially have an influence on, was developed from a review of existing information, discussions with non-governmental representatives with expertise in biological resources, and field surveys. Potential positive and negative interactions between Project activities and the biophysical environment were identified. If negative interactions are anticipated and potential effects are a concern, methods for mitigating the effects are proposed.

The impact assessment includes the following series of steps:

- Describing the project and establishing environmental baseline conditions.
- Scoping and establishing the boundaries of the assessment.
- Identification of project-environment interactions.
- Assessing the potential environmental effects of the project, including residual effects.
- Identifying potential mitigation measures to eliminate or minimize potential adverse effects.

For the purpose of this BIA, the interactions (effects) between Project activities and the biophysical environment are examined to select a defined set of Valued Ecosystem Components (VECs) that will be assessed.

The significance of potential interactions and the likelihood of the interactions are also considered. Possible measures to mitigate impacts are identified and, where residual impacts are identified, measures to compensate have been considered. Impact of malfunctions and accidents are also included in the evaluation of the environmental effects.

Issues scoping is an important part in the VEC identification process. The issues scoping process for this assessment included: review of past, relevant environmental and scientific reports and the study team's professional judgment.

3.3 Temporal and Spatial Boundaries of the Project

To evaluate impacts, physical and biological properties must be determined both temporally and spatially. The effects of a specific project activity on a VEC may differ in both space and time from the effect of any other activity. Some project activities may have long-term consequences, while others will be of short duration.

Temporal project bounding for the proposed Project includes the short-term clearing and construction activities (approximately 2 years) as well as the long-term operation of the wind energy facility (turbine lifetime 20 years) and its decommissioning. There is some temporal variability, since a refurbishment of the turbines at the end of their regular lifetime is likely, which could increase the lifetime of the wind facility. In addition, the duration of the effects will probably vary with the VEC and the Project activity.

For the purposes of this BIA, the temporal bounds for the Project have been categorized into three stages:

1. Construction Period.
2. Operations and Maintenance.
3. Decommissioning/Refurbishment.

The spatial boundaries for assessing potential effects are typically established by determining the spatial extent of an effect of a Project component or activity. The physical components of the Project are as illustrated on Figure 2.1.

The physical (spatial) boundaries of the Project (Study Area) may vary depending on the individual VEC. For example, the Project boundaries for endangered plant species will be restricted to the footprint of lay-down areas, access roads and ancillary structures.

Scientific and technical knowledge and professional experience were used to develop the temporal and spatial boundaries.

3.4 Approach to Determination of Significance

To determine the significance of an environmental effect, thresholds were defined for each VEC. These thresholds constitute a measure or standard beyond which residual environmental effects (those remaining after implementation of mitigation and controls) would be significant. Thresholds are quantitative, where possible, and based on applicable regulatory criteria or standards, policies and guidelines, stakeholder input and / or professional judgement.

The determination of the significance of potential effects consists of the following steps:

- determine whether the environmental effect is adverse;
- determine whether the adverse environmental effect is significant; and
- determine whether the significant environmental effect is likely.

The assessment will determine whether the residual environmental effects of the Project are significant or non-significant after application of mitigation measures.

For the purposes of the BIA, an effect will be defined as the change effected on a VEC(s) because of Project activities. Effects will be categorized as either negative (adverse) or positive. Any adverse effects will be determined to be significant or non-significant in consideration of assessment criteria listed above. The Assessment will focus on those interactions between the VECs and Project activities, which are likely.

3.5 Other Undertakings – Cumulative Effects

The effects assessment identifies other planned and reasonably foreseeable activities that could overlap in time and space with the proposed wind project construction and operation. Where such overlap is recognized, the potential for cumulative effects and requirements for mitigation measures is discussed. The significance levels of the residual adverse effects, if any, is determined applying the methodology criteria presented above.

4.0 Environmental Setting

The environmental setting of the Study Area includes a description of those components of the environment potentially affected by the proposed Project, or those which may influence or place constraints on the execution of Project-related activities.

The environmental setting is presented to allow assessment of the potential impacts of the proposed Project. Description of the setting includes an overview of geophysical, biological and atmospheric characteristics, as well as identification of designated areas and other critical habitat features within the Study Area (Figure 4.1).

4.1 Geophysical Environment

The Belcher Islands are situated in southeastern Hudson Bay, about 170 km west of Richmond Gulf, Quebec. The landscape is topographically low-lying and barren, comprised of nearly a hundred islands that are predominantly rounded and undulating to flat. Sanikiluaq is located just south of western Eskimo Harbour on northwestern Flaherty Island - the largest of the Belcher islands. The elevation ranges from 2 to 31 m ASL (Google Earth, 2021).

Information regarding surface and subsurface geology outlined in the following subsections was extracted from a geotechnical report completed during the project planning phase (Tetra Tech, 2020).

4.1.1 Soil and Soil Quality

The Project site is located along an exposed north-south trending bedrock ridge which consists mostly of basalt with some pyroclastic tuffs, minor sedimentary rocks, and a possible late mafic intrusion. The bedrock ridge includes patches of surficial material comprised of weathered rock up to boulder size, colluvium and organics, and infilled north-south trending elongated depressions (lineaments). The north-south trending depression at the southeast side of the ridge is a drainage path that includes a chain of small ponds possibly of thermokarst origin. Low-lying areas may contain perennially frozen ice-rich organic material.

Belcher Islands are located in Hudson Bay, within the Qikiqtani (Baffin) Region of NU, part of the Southern Arctic Ecozone according to the Ecological Classification System described in the National Ecological Framework for Canada (ESWG 1995). Groundcover in this Ecozone typically consists of dwarf birch, willow, ericaceous shrubs, cotton grass, lichen, and moss. Poorly-drained sites may have tussocks of sedge, cottongrass, and sphagnum moss.

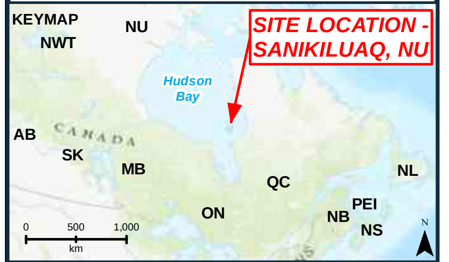
4.1.2 Bedrock Geology

The Belcher Islands are made up of Middle Paleoproterozoic metasedimentary and metavolcanic rocks of the Belcher Group, forming a series of anticlines and synclines (Jackson 2013). These rocks form an anticline on Flaherty Island, upon which Sanikiluaq is situated. The south side of the community where the project site is located is shown to rest mostly on massive basalt, with some pyroclastic tuff, intrusions, iron formation, and gabbro mainly of the Eskimo Formation.

The massive basaltic bedrock, anticipated to be covering most of the proposed project site, is considered very strong to extremely strong. It is anticipated that the uniaxial compressive strength of the rock mass onsite will be influenced by weathering and structural discontinuities (joints, faults, cleavage zones etc.). The exposed rock surfaces down to a depth of about 2 m to 3 m may be highly fractured, with discoloration and crumbly rock texture present in small, loose rock fragments surrounding jointed areas of the bedrock. Where vegetation may be present above fractures in the rock surface, infilling of the fractures with soil and organic material may be present.

LEGEND:
- Watercourse Crossing
- Survey Point
- MET Tower
- Proposed Wind Turbine Locations
- Qulliq Power Station
- Survey Track
- Access Road (Preliminary Location)
- Existing Trail
- Site Road (Preliminary Location)
- Transmission Line (Preliminary Location)
- Watercourse
- Waterbody
- Wetlands
- Watershed Divide

U/S = UPSTREAM
D/S = DOWNSTREAM



CLIENT:
QIKIQTAALUK BUSINESS DEVELOPMENT CORPORATION

TITLE:
ENVIRONMENTAL SETTING

PROJECT:
SANIKILUAQ WIND PROJECT

PROJECT NO: TAV1989301	DATE: MARCH 2022
REV NO: 3	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 17 N

FIGURE:
FIGURE 4.1

SCALE: 1:8,500

0 100 200 400
Metres

4.1.3 Permafrost

The Permafrost Map of Canada identifies Sanikiluaq as being in an area of extensive discontinuous permafrost (50% to 90% of land area) with little to no ice content (up to 10%). The active layer in Sanikiluaq is anticipated to range from about 2 m to 3 m in thickness, although thicker active layers could be present in the Project site since bedrock is exposed to the ground surface.

It is anticipated that the mean annual ground temperature below a depth of about 6 m is probably in the order of about -1°C to -2°C for undisturbed sites, and may be even warmer near water bodies, at disturbed sites, or at sites near active thermokarst processes.

There is potential for an increase in permafrost creep in ice-rich soils through climate change that could reduce the bearing resistance of the soils and possibly a thickening of the active layer. For shallow or deep foundations, a consequence could be increased settlement due to creeping or thawing of the permafrost and increased seasonal movements due to a thicker active layer. Such movements will not necessarily be uniform across the Project site, and there could be some significant differential movements even in a short distance as a result of thaw settlement or seasonal thawing and refreezing of high-ice content zones in the soil.

4.1.4 Hydrogeology/Groundwater

The arctic climate and presence of permafrost does not allow access to groundwater. Climate change effects are increasing causing lower precipitation levels and damage to infrastructure (such as breakage of buried pipes in shifting permafrost). A water treatment facility sources surface water from Sanikiluaq Lake and distributes it via water trucks (Water Canada, 2021; NWB, 2015). Buildings / residents have individual indoor water tanks to receive water distributed by truck. Each building / home is equipped with a reverse osmosis system since there have been reports of high sodium levels, possibly a result of saltwater intrusion to the surface water (Nunvut Tunngavik, 2020). In 2016, Sanikiluaq residents were advised to not drink the water due to sodium levels. Boil water advisories due to the presence of total coliform bacteria are issued occasionally as well (Nunavut Department of Health, 2016).

4.1.5 Sub-surface Resources

The Belcher Islands host NU's second and fourth largest carving stone producers, the active Qullisajaniavvik quarry and the abandoned Aqituniavvik quarry, respectfully (Beauregard and Ell, 2015). Excellent-quality artisan marble, locally referred to as 'argillite', is a competent, soft to medium-soft rock that Sanikiluaq carvers can shape and polish by hand. The deposit is well exposed, with only minor amounts of debris generated because most stone is suitable for carving. Sanikiluaq's Qullisajaniavvik quarry has reserves of at least 30 000 tonnes of artisan marble. Granular materials for construction are quarried as well (NWB, 2015).

4.1.6 Surface Hydrology and Water Quality

The hydrology of Sanikiluaq is highly influenced by seasonal changes in the climate. The high spring freshet flow occurs in late May to June, as the cumulative snow and ice over the winter melts. Flows decrease as the summer progresses into July and August. The hamlet of Sanikiluaq uses trucked drinking water distribution and waste collection services (Hayward, 2020). The Water Supply Facility draws freshwater from Sanikiluaq Lake to the south of the community. The proposed access road is located along a local watershed divide, primarily on exposed bedrock, which drains northeast to Sanikiluaq Lake. The construction of the access road will not require blasting. Water is treated and transferred to municipal trucks for distribution within the community. The sewage disposal facility consists of a natural ditch, located 2.9 km west of the hamlet, where the effluent is discharged from the lagoon to a wetland and then into the marine environment (NWB, 2015).

4.2 Biological Environment

Information in the following sections was gathered from desktop review and field surveys. Additionally, professional opinions and perspectives were obtained regarding the biological environment from the following:

Contact	Affiliation	Topics Discussed
Randi Mulder	NatureServe Canada: NU	Potential bats and regional wildlife habitat
Joel Heath	Arctic Eider Society	Avian resources
Jean-Francois Dufour	Canadian Wildlife Service	Avian and wildlife resources

4.2.1 Species at Risk

Biological Species at Risk (SAR) (i.e., endangered, threatened, and of special concern) are of particular concern due to potential disturbance resulting from Project development.

The federal SARA was established in June 2003 as a component of a three-part national strategy for the protection of wildlife SAR, which also includes commitments under the Accord for the Protection of Species at Risk and activities under the Habitat Stewardship Program for Species at Risk. The listing process begins with a species assessment that is conducted by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Based on a status report, species specialist subcommittees assess and assign the status of a wildlife species believed to be at some degree of risk. SARA uses the COSEWIC scientific assessment when making the listing decision. Once a species is added to Schedule 1, it benefits from all the legal protection afforded and the mandatory recovery planning required under SARA. The Act provides federal legislation to prevent wildlife species from becoming extinct and to provide for their recovery. Under the Act, an ongoing process of monitoring, assessment, response, recovery, and evaluation will be undertaken to improve the species status and ecosystem. The prohibitions and offences portions of the Act came into effect in June 2004. The status of species protected under SARA can be found at the Species at Risk Public Registry (SARPR) online at https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html.

COSEWIC and SARA categorize SAR into three main groups according to their assessed status:

- Endangered: A wildlife species facing imminent extirpation or extinction.
- Threatened: A wildlife species likely to become endangered if limiting factors are not reversed.
- Special Concern: A wildlife species that may become a threatened or an endangered species through a combination of biological characteristics and identified threats.

Species at risk are governed territorially by the Nunavut Wildlife Act, via the Nunavut Wildlife Management Board. There are currently no species listed by Nunavut legislation that may intersect with the Project footprint, as discussed with James Elliot of the Nunavut Department of Environment's Land Use Planning.

The BIA has compiled information regarding the habitat within the Project area, specifically within the proposed Project footprint. Available information on the known occurrence of floral and faunal SAR in the Project area was compiled and reviewed to determine their presence relative to the proposed infrastructure. Each of the following subsections that describe avifauna (birds and bats), terrestrial fauna and vegetation reference COSEWIC and SARPR databases in addition to other references specific to those components. Literature and information sources were limited due to the remoteness of Belcher Islands. Representatives for NatureServe Canada and the Nunavut Conservation Data Centre were contacted in October 2021 and were unable to provide a data report for the Region. However, some general information was provided regarding wildlife ranges in the territory.

A list of SAR occurring in Nunavut with potential to occur within or near the project area is provided below (Table 4.1).

Table 4.1 Federal Status of Species at Risk occurring in Nunavut with potential to occur within or near the Project footprint

Common Name	Scientific Name	COSEWIC Status	SARA Status – Schedule 1
Avian Species			
Barn Swallow	*Hirundo rustica*	Special Concern	Threatened
Buff-breasted Sandpiper	*Tryngites subruficollis*	Special Concern	Special Concern
Common Nighthawk	*Chordeiles minor*	Special Concern	Threatened
Eskimo Curlew	*Numenius borealis*	Endangered	Endangered
Harlequin Duck	*Histrionicus histrionicus*	Special Concern	Special Concern
Horned Grebe (Western Population)	*Podiceps auritus*	Special Concern	Special Concern
Ivory Gull	*Tringa flavipes*	Endangered	Endangered
Olive-Sided Flycatcher	*Contopus cooperi*	Special Concern	Threatened
Peregrine Falcon	*Falco peregrinus tundrius*	Not at Risk	Special Concern
Red Knot (islandica subspecies)	*Calidris canutus islandica*	Not at Risk	Special Concern
Red Knot (rufa subspecies)	*Calidris canutus rufa*	Endangered	Endangered
Red-Necked Phalarope	*Phalaropus lobatus*	Special Concern	Special Concern
Ross's Gull	*Rhodostethia rosea*	Endangered	Threatened
Rusty Blackbird	*Euphagus carolinus*	Special Concern	Special Concern
Short-Eared Owl	*Asio flammeus*	Threatened	Special Concern
Mammalian Species			
Grizzly Bear	*Ursus arctos*	Special Concern	Special Concern
Barren-ground Caribou (Dolphin and Union Population)	*Rangifer tarandus*	Endangered	Special Concern
Peary Caribou	*Rangifer tarandus pearyi*	Threatened	Endangered
Polar Bear	*Ursus maritimus*	Special Concern	Special Concern
Wolverine (Western Population)	*Gulo gulo*	Special Concern	Special Concern
Moss Species			
Porsild's Bryum	*Haplodontium macrocarpum*	Threatened	Threatened
Vascular Plant Species			
Felt-leaf Willow[1]	*Salix alaxensis*	Special Concern	Special Concern

1 Listed under SARA as Special Concern in Saskatchewan but listed as a SAR of Special Concern in Nunavut by NIRB. Not expected to occur in the Project area or Sanikiluaq in general as it is outside of the reported species range

4.2.2 Birds, Bats and Terrestrial Fauna

Fauna of greatest concern in context of the Project are avian and bat populations, since these groups have potential to interact with the turbines. For birds and bats, the primary potential negative effect of wind farms is displacement due to disturbance, along with habitat loss, collision, and barrier effects. Displacement occurs during both the construction and operations phases of wind farms as a result of physical barriers (i.e., turbines); visual, noise and vibration impacts; as well as repeated vehicle movements related to maintenance (Drewitt and Langston, 2006). The pattern and scale of disturbance depends upon the species, life cycle stage, availability of alternate habitats, and siting of the wind turbines with respect to important habitat areas. Fatalities due to collision are also of concern, although mortality due to wind turbines is lower than other sources such as predation by household cats and collisions with anthropogenic structures such as windows, vehicles, and towers (Zimmerling et al., 2013; Blancher, 2013). Zimmerling et al. (2013) reported that mortality rates of birds at wind farms in Canada (8.4 birds per turbine per year) were not sufficient to cause population-level effects. Nonetheless, it is recognized that prior to wind farm construction, proper consideration must be given to ensure that important habitats and migration corridors are avoided to the extent possible.

4.2.2.1 Important Bird Areas (IBAs)

Areas of particular importance to the survival of bird species may be given the designation of Important Bird Area (IBA). The IBA program is coordinated by BirdLife International and administered in Canada by Nature Canada and Birds Canada (IBA, 2021). The criteria used to identify important habitat are internationally standardized, and are based on the presence of SAR, species with restricted range, habitats holding representative species assemblages, or a congregation of a significant proportion of a species' population during one or more seasons. These criteria are used to identify sites of national and international importance.

A review of the IBA database showed that the nearest is the North Belcher Islands IBA (ID#: NU031), which is located approximately 60 km northwest of the Project area (IBA, 2021). The North Belcher Islands IBA, indicated on Figure 4.2, includes portions of three large islands (Split Island, Johnson Island, and Laddie Island) as well as numerous smaller islands. The smaller islands are predominantly low-lying and composed of exposed bedrock, cobble, and gravel (IBA, 2021). However, some islands north of Laddie Island have higher slopes and are sparsely vegetated. The area meets IBA designation criteria because it supports a significant Hudson Bay Common Eider (*Somateria mollissima sedentaria*) colony. The colony represents over 2.5% of the estimated population for ssp. *sedentaria*, with 243 nests recorded during a survey in 1997 (IBA, 2021). The Hudson Bay Common Eider are non-migratory, wintering at polynyas around the Belcher Islands and along shore leads elsewhere in southern Hudson Bay. The IBA also supports other colonial nesting birds including the Arctic Tern (*Sterna paradisaea*), Glaucous Gull *(Larus hyperboreus)*, and Herring Gull (*Larus argentatus*).

Two other IBAs are designated on the islands of southern Hudson Bay: South Flaherty Islands IBA (ID#: NU100) and the Salikuit Islands IBA (ID: NU032).

The South Flaherty Islands are an archipelago of approximately 300 islands located at the southwestern tip of the Belcher Islands. They are comprised of low-lying islands scoured by glaciation, rough islands with a steep slope, or gravel and cobble (IBA, 2021). The site supports numerous polynyas that occur mainly near the most prominent island in the area, Agiaraalluk. The IBA supports a large population of nesting and wintering Hudson Bay Common Eider population, with an estimated 50% or more wintering in the area annually. The area is also thought to be important for moulting sea ducks.

The Salikuit Islands are located approximately 80 km east of the Project area, between the Belcher Islands and Quebec. They contain an archipelago of 103 islands that are predominantly small (< 50 ha) and low-lying with exposed bedrock, cobble beaches, and sparse vegetation (IBA, 2021). The islands are believed to support approximately 2.5% of the nesting Hudson Bay Common Eider population. The IBA also supports colonies of Arctic Tern, Glaucous Gull and Herring Gull.

4.2.2.2 Polynyas and Leads

Polynyas are large areas of open water that occur within thick pack ice of polar oceans (Martin, 2019). They are critical habitat features for polar wildlife, as they provide reliable access to food sources and air that are otherwise unavailable in winter (Gilchrist and Robertson, 2000). The strong tidal currents of Hudson Bay result in numerous recurring polynyas that form annually among the Belcher Islands. These polynyas are relatively small, with most < 10 ha in size and < 15 m deep (Gilchrist and Robertson, 2000). Another source of open water are leads, which are long features that exist at the edges of ice floes (Martin, 2019). In contrast to polynyas, leads are transient and not restricted to a specific location. Leads surrounding the Belcher Islands occur along land fast ice edges in winter and are driven predominantly by wind (Gilchrist and Robertson, 2000). The polynyas and leads of Belcher Islands and western Quebec are the only permanent areas of open water in southeast Hudson Bay in winter. Consequently, overwintering marine mammal and bird species are restricted to, and rely heavily upon, these areas. The largest congregations of wildlife are present from February to March, which is the period of maximum ice coverage in the region (Gilchrist and Robertson, 2000).

Most of the Hudson Bay Common Eider population winters at open-water areas surrounding the Belcher Islands. Gilchrist and Robertson (2000) conducted a survey of ten polynyas among the Belcher Islands and recorded a total of eight bird species and seven mammal species using polynyas and leads in February and March. Birds may travel among polynyas in winter, which could increase risk of collision with turbines in the Project area. However, movement patterns of birds among the Belcher Island polynyas have not been studied extensively. A list of species observed by Gilchrist and Robertson (2000) during their polynya survey is presented in Table 1 in Appendix A. Figure 4.2 illustrates the locations of the IBAs and polynyas in relation to the Project site.

4.2.2.3 Local and Migratory Birds

Most migratory birds are protected under the federal *Migratory Birds Convention Act* (MBCA); exceptions include game birds (grouse, quail, pheasants), raptors (hawks, owls, eagles, falcons), corvids (crows and jays), and certain fish-eating species including cormorants and kingfishers. Under this Act, no person shall disturb, destroy or take a nest, egg, nest shelter, or nest box of a migratory bird without a permit.

Most species that breed in NU are migratory, spending the winter months in warmer, southerly climates. Others are adapted to cold climates and may be present year-round, moving exclusively between habitats at a local scale. Migrants typically arrive in the territory between late April and mid-June and depart between mid-July and early October. Migratory routes are dependent upon several factors including origin, species, and weather patterns. In NU, snowmelt often extends into late spring, resulting in short avian breeding seasons. According to ECCC’s general avoidance guidelines for migratory birds, the Project area is in breeding zone D7. In this zone, the regional nesting period for which most birds protected under the MBCA breed extends from early May to mid-August (ECCC, 2021). It is recognized that some avian species occurring in the region may nest outside this period, including waterfowl, corvids, and raptors. Although precise breeding dates for these species are not available for the Belcher Islands, few species in NU breed prior to early May because snowmelt typically determines timing of nest initiation.

In addition to the SAR databases previously described, the following additional resources were reviewed:

- Important Bird Areas of Canada (IBA, 2021);
- Birds of Nunavut (Richards and Gaston, 2018); and

- Birds of Qikiqtait area, Belcher Islands, Nunavut (Arctic Eider Society, 2021).

The available sources provided a high-level assessment of the species that have been reported near Sanikiluaq and on the Belcher Islands; however, no low-level information was available for the Project area. Once the above sources were consulted, all bird species that could potentially occur in the Project area were compiled in a species list (Table 2 in Appendix A). A total of 83 bird species have been reported on the Belcher Islands archipelago, including one SARA-listed Endangered Species, the Red Knot (*Calidris canutus rufa*), and four SARA-listed species of Special Concern including the Short-eared Owl (*Asio flammeus*), Peregrine Falcon (*Falco peregrinus*), Red-necked Phalarope (*Phalaropus lobatus*), and Harlequin Duck (*Histrionicus histrionicus*). These SAR are further discussed in the following subsection.

4.2.2.4 Bird Species at Risk

For the territory of NU, SARA lists 15 species under Schedule 1 (Table 3 in Appendix A). This includes three species listed as Endangered; four species as Threatened; and eight as Special Concern. Of these species, a total of five have been recorded on the Belcher Islands, including the following:

- Red Knot (rufa subspecies): Endangered
- Short-eared Owl: Special Concern
- Peregrine Falcon: Special Concern
- Harlequin Duck: Special Concern
- Red-necked Phalarope: Special Concern

The Red Knot (*rufa* subspecies) is a migratory shorebird that breeds in the high arctic and winters in South America and the gulf coasts of US and Mexico (Baker et al., 2020). During fall migration, an estimated 23% of the *rufa* Red Knot population stages on the mud flats of southern James Bay to feed on invertebrates (MacDonald et al., 2021). Therefore, though there are no records of Red Knots breeding on the Belcher Islands and few reported sightings, this species likely passes through or near the area on migration. Red Knot migration through the subarctic typically occurs from late May to early June and late July to early September (Baker et al., 2020; MacDonald et al., 2021). Though breeding is unlikely, this species may occur in the Project area during migration.

The Short-eared Owl is a nomadic bird that breeds in grassland, tundra, and wetland habitats across Canada, and winters from southern Canada to northern Mexico (ECCC, 2011). This species nests on the ground in dry areas (e.g., knolls or hummocks) concealed amongst grasses and shrubs (Richards and Gaston, 2018). Short-eared Owls are believed to disperse annually to follow surges in small mammal populations (e.g., lemmings, voles), resulting in a patchy and irregular distribution of individuals across their range. It is generally observed in southern NU from May to October; however, there are few records of this species occurring on Belcher Islands, and breeding has not been confirmed in the region (Manning, 1976; Arctic Eider Society, 2021). This species is unlikely to frequent the Project area, though suitable breeding habitat is present.

The Red-necked Phalarope is a small shorebird that breeds in wetlands and near lakes, rivers and streams in the low Arctic and subarctic (COSEWIC, 2015). It typically nests in habitats immediately adjacent (< 20 m) to water with large amounts of moss, graminoids, and sedges (Richard and Gaston, 2018). Red-necked Phalaropes winter in Central and South America, where they are typically found in pelagic environments near large upwellings of plankton (Richards and Gaston, 2018). It is a common nesting species on Belcher Islands, most often found in small lakes (Government of Nunavut, 2010). Birds arrive to NU in mid-May to early June, and typically depart by late June to early July (females) or shortly thereafter (males and juveniles) (Richards and Gaston, 2018). This species may occur and breed within the Project area in summer.

The Peregrine Falcon (*tundrius* subspecies) is a large falcon that typically breeds north of the treeline in Canada, United States, and Greenland, and winters predominantly in Central and South America (Richards and Gaston, 2018). This species nests in small depressions on cliffs and rocky outcrops adjacent to open habitats. It should be noted that although still SARA-listed as a SOCC, COSEWIC has recently re-evaluated the *tundrius* subspecies as "Not at Risk", reflecting recent population increases (COSEWIC, 2017). As such, COSEWIC recommended delisting the species from Schedule 1. Peregrine Falcons usually arrive to NU in late May to early June and depart on fall migration in mid-September to early October (Richards and Gaston 2018). They are observed widely in the Belcher Islands, though breeding pairs are absent from areas without cliffs or rocky outcrops (Arctic Eider Society, 2021). This species may occur within the Project area in summer but is unlikely to breed, as no suitable nesting habitat is present.

The Harlequin Duck is a small sea duck that has small, isolated breeding populations on Baffin Island, NU, and northern New Brunswick and Labrador, as well as northern Quebec where it nests on the ground near rivers and streams along the east coast of Hudson Bay (Mallory et al., 2008). Harlequin Ducks winter in the ocean predominantly in Greenland, with smaller populations existing in New England and Atlantic Canada (Richards and Gaston, 2018). They are generally rare in NU, with few records on Belcher Islands and no recorded breeding activity (Arctic Eider Society, 2021). This species is unlikely to breed in the Project area but may occur offshore when open water is available (i.e., late spring, summer, early fall).

4.2.2.5 Avian and Wildlife Field Surveys

Since birds have the potential to be impacted by wind turbines throughout the annual cycle, baseline field surveys for the BIA targeted wintering, breeding, and migratory birds in the Project area. The survey program was developed in consultation with ECCC-CWS and following their guidance documents for assessing birds at proposed wind energy sites (EC, 2007a; EC, 2007b). Baseline bird surveys were initiated in December 2019 by a birder with over 20 years of field experience. Subsequent surveys were conducted by a local waterfowl hunter with knowledge of avian species occurring on Belcher Islands, having survey training in Winter 2019 and Spring 2021. Surveys consisted of four seasonal components: spring migration (four surveys in May to early June), peak breeding season (two surveys in June to early July), autumn migration (six surveys in August to end of October), and winter resident surveys (two surveys in December and February).

Due to the COVID-19 pandemic, surveyors experienced in breeding bird assessment were unable to travel to the Project area in 2021. Therefore, breeding bird surveys have been postponed until late-June to early July 2022. Breeding bird surveys will consist of 10-minute point counts at 15 locations within the Project area, including five within the proposed turbine footprint and 10 along the proposed transmission line and access road. At each survey location, all species within 100 m of the observer will be identified visually and/or by their characteristic songs and call notes. The surveyor will record all species detected, including the number of individuals, distance category (0-50m, 50-100m, 100+m), flight height and direction, and breeding evidence using codes employed in the Ontario Breeding Bird Atlas (OBBA, 2021). Additional bird species detected between point count locations will be noted, including numbers and any observed breeding evidence. Surveys will begin in the early morning and will be completed within 6 hours of sunrise. All surveys will be conducted under favourable weather conditions. Results of these surveys will be detailed in a supplementary report, to be issued in August 2022.

Surveys for winter residents and migrants (spring and fall) consisted of stationary watch counts. Each survey was approximately six hours in length, with the observer recording all species, counts, flight directions and heights of birds within and/or passing through the Project area. During the initial survey in December 2019, an additional survey transect was completed that extended along the length of the Study Area, including the proposed transmission line and access road and along the turbine footprint to the southern extent of the Project Area. The stationary observation point, located at the MET (Figure 4.2), afforded a clear view of the Project Footprint. The migration surveys were conducted at an approximately weekly frequency. All surveys were conducted under weather conditions favourable to the survey (i.e., no sustained precipitation and relatively low winds (< 40 km/h).

Table A-1 (Appendix A) summarizes the results of the bird surveys at the Project area. Winter resident bird surveys were conducted on 17 December 2019 and 19 February 2021. The surveys focused on Hudson Bay Common Eider since this species uses polynyas to the northwest and southeast of the Project site. However, no Common Eiders were observed during either survey. The only avian species observed during winter watch counts was Common Raven. Most individuals were observed flying north within the 0-60 m height range.

Incidental observations during winter surveys included Arctic Fox (*Vulpes pagopus*) and Polar Bear (*Ursus maritimus*) tracks as well as an Arctic Fox sighting.

Spring migration surveys were conducted weekly over 4 dates between 25 May and 17 June 2021. A total of six confirmed species were observed during the surveys, as well as three additional groups that could not be identified to species level. Of the six confirmed species, four are known to breed on Belcher Islands and two are migratory. The most observed species included Canada Goose (*Branta canadensis*) and Snow Goose (*Anser caerulescens*). An active Canada Goose nest was observed near the MET on 3 June 2021. Birds travelled predominantly to the north (36%), northeast (43%), and northwest (20%). All birds were observed flying in the 0-60 m height range, which is within the rotor-swept zone (RSZ) of the turbines.

Fall migration surveys were conducted approximately weekly over 6 dates between 2 September and 28 October 2021. A total of three species were observed during the surveys, as well as one additional group that could not be identified to species level. Of the three confirmed species, two are known to breed on the Belcher Islands and one is migratory. The most observed species included Canada Goose and Snow Goose. Birds travelled predominantly to the south (58%), southwest (22%), and southeast (13%). Most (98%) birds were observed flying in the 0-60 m height range (i.e., within the RSZ), with the remaining birds (2%) observed on the ground. No birds were observed flying in the 60+ m height range.

No SAR were observed during any field survey at the Project site.

4.2.2.6 Time-lapse Photography and Acoustic Monitoring

Automated data collection was employed at the Project site from May to October 2021. Data collection techniques included time-lapse photography and acoustic monitoring. Time-lapse photography was conducted using two Link-S 12MP (SpyPoint) trail cameras deployed at the MET (Figure 4.2), which is located approximately 180 m from the proposed T1 location. Each camera was programmed to take a photograph every 15 minutes, 20 hours per day (3 am to 11 pm) with the aim of obtaining a standardized index of birds and other incidental wildlife (e.g., mammals) passing through the area. The cameras were mounted facing south toward the proposed turbine footprint, slightly offset from one another to obtain a wider field of view. It should be noted that there are limitations to this technology, including a relatively poor ability to detect and identify smaller-bodied birds (e.g., passerines and shorebirds) at a distance. As such, the cameras were intended to provide information on passage of larger-bodied birds (e.g., geese and other waterfowl) as a supplement to ongoing field surveys. Photographs were reviewed by experienced personnel and identified to the lowest possible taxonomic order.

The cameras were deployed from 12 May to 28 October 2021. However, due to technical issues, no photographs were collected from 12 May to 17 June and 8 September to 28 October 2021. A total of 13,382 photographs were collected during the survey period. Birds or mammals were visible in eight photographs. A total of 10 birds were identified, though nine were recorded at a far distance that did not permit identification to species nor genus. Though not identifiable to species, one gull was recorded on 18 June 2021. Incidental observations included an Arctic Fox on 24 June 2021.

Acoustic monitoring was conducted using a SongMeter SM4 (Wildlife Acoustics, Inc) autonomous recording unit (ARU) equipped with a built-in weatherproof microphone. The objective of acoustic monitoring was to supplement field studies by automatically collecting flight calls of both diurnal and nocturnal migrants, as well as songs and other vocalizations of birds potentially breeding in the area. Nocturnal migrants were of particular interest, as these species cannot typically be sampled using visual surveys. Many migrating birds are known to give calls during migration flights, and although these flight calls are relatively simple (typically just a single “chip” note), in most cases they are distinctive enough to allow identification to species (Evans, 2000). The ARU was programmed on a 25% duty cycle (15 minutes on, 45 minutes off) to monitor the acoustic environment throughout the day and night. The acoustic data were then subsampled to simulate an in-person survey. Specific methodologies and results of passive acoustic monitoring for birds will be detailed in a forthcoming supplementary report, scheduled to be issued in August 2022.

4.2.2.7 Bats

There is limited information available on the status of bats in NU. In addition to the SAR databases previously described, the following additional resources were reviewed:

- Wild Species 2015 Report (Canadian Endangered Species Conservation Council (CESCC), 2017); and
- Birds and Mammals of Nunavut (Manning, 1976).

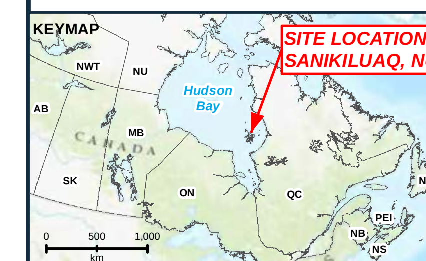
There are two species of bats that have been recorded in the territory, including the Little Brown Myotis (*Myotis lucifugus)* and Hoary Bat *(Lasiurus cinereus)*. The Hoary Bat is a widespread migratory bat species, ranging throughout North America from Alaska to South America. This species typically roosts in the foliage of tall trees, though in rare occasion it may roost in buildings, caves, and tree cavities (Willis and Brigham, 2005). Nunavut is at the northern limit of the Hoary Bat’s range, with only two recorded sightings at Arviat and Southhampton Island (Anand-Wheeler, 2014; Hitchcock, 1943). As such, Hoary Bats are considered rare migrants to the territory.

The Little Brown Myotis is a small bat that may migrate short distances between seasons. It typically roosts in trees, buildings, and rocky crevices in summer, and hibernates in caves, buildings, or abandoned mines in winter. Nunavut is at the northern limit of their range, with only a few unconfirmed reports in the southwestern portion of the territory (COSEWIC, 2013). According to the Wild Species 2015 report (CESCC, 2017) and published information on the mammals of NU (Manning, 1976), it does not occur in the territory.

It is unlikely that Hoary Bats or Little Brown Myotis occurs within the Project area since there are no records of these species on the Belcher Islands and there is no suitable roosting habitat present. While the NU division of NatureServe’s Conservation Data Centre is in transition and a data report could not be issued, the Acting Coordinator confirmed that there have been no reports of bat sightings in the Belcher Islands (R. Mulder, pers comm, 2021). Mitigation measures protecting birds will also protect any vagrant bats that may occur in the Project area during the Project’s lifetime. Therefore, bats will be omitted from further assessment in the BIA.

LEGEND:

- Polynyas
- Cameras and ARU Location
- Important Bird Area (IBA)



CLIENT:

QIKIQTAALUK BUSINESS DEVELOPMENT CORPORATION

wood.

TITLE:

BIRD HABITAT AND FIELD SURVEY LOCATIONS

PROJECT:

SANIKILUAQ WIND PROJECT

PROJECT NO:	DATE:
TAV1989301	NOVEMBER 2021
REV NO: 0	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 17 N

FIGURE: FIGURE 4.2

SCALE: 1:650,000

0 5 10 20
Kilometres

Path: G:\5300 PROJECTS\2019\TAV1989301 Qikiqtaaluk Business Development\GIS\MXD\TAV1989301_FIG_4_2_BirdHabitatAndSurveyLocations.mxd User: candace.macdonald Date: 11/26/2021

4.2.3 Wetland Resources and Vegetation

Both collectively and as individual units, wetland resources serve a variety of important ecological functions. Wetlands function in the maintenance of surface and groundwater resources and quality, as well as in the provision of wildlife habitat. The value of wetlands to society and their ecological value are derived from their biological productivity and biodiversity.

Wetlands are generally characterized by hydrophytic vegetation and can vary from a closed peat bog to an open water body dominated by submergent vegetation. Sanikiluaq is located in the Sub-Arctic region, where the active layer of soil that thaws above the permafrost is very shallow and during the summer, wetlands appear all over the landscape (CWF, 2012). Almost all arctic wetlands are associated with permafrost, strongly influencing their development. The most predominant and widespread wetland types of the Low Arctic Region are fens and bogs (Tarnocai & Zoltai, 1988). Wetlands in this area are typically composed of willows, sedges, grasses, and mosses, where upland habitat is typically characterized by berries, white heather, grasses, and lichens (Hayward, 2020). By providing natural flood control, points of recharge and discharge of groundwater, acting as filters, and by trapping silt, wetlands play an important role in the hydrological cycle and generally enhance the water regime. Since they provide habitat for a wide variety of plants and animals, they may be highly productive and often exceed adjacent uplands in their standing crops, productivity, and biodiversity. In the past, wetlands have been viewed mainly in terms of development, such as agricultural land or peat resources. However, their ecological value is now more clearly understood.

Ecological wetland values may include sustenance for waterfowl; sources of fish production; storage and slow release of water; erosion protection; and areas of aesthetic or recreational enjoyment.

4.2.3.1 Wetland Regulation

The purpose of the Federal Policy on Wetland Conservation policy is the sustainable management of wetland resources (both for wildlife and humans) and is underpinned by a commitment to "no net loss of wetland function". This policy has been strongly applied and several specific guidance documents are available, including:

- The Federal Policy on Wetland Conservation (EC, 1991);
- Implementing "No Net Loss" Goals To Conserve Wetlands In Canada (North American Wetlands Conservation Council (NAWCC), 1992);
- Wetland Evaluation Guide (Bond *et al*., 1992);
- The Federal Policy on Wetland Conservation; Implementation Guide for Federal Land Managers (EC, 1996);
- Wetlands Environmental Assessment Guideline (Milko, 1998);
- Wetlands and Government (NAWCC, 1999); and

- Wetland Mitigation in Canada (NAWCC, 2000).

Two main concepts of the guidance include the wetland "mitigation sequence" and the principle of "no net loss of wetland function". These are briefly described below.

4.2.3.2 Wetland Identification and Delineation

A wetland survey was conducted by an experienced field biologist from August 18 – 21, 2021. A total of five (5) wetlands were delineated and assessed along the preferred access road (Table 4.2 and Figure 4.1). A representative vegetation plot was established within each wetland. Six additional wetland crossings were noted along the proposed alternative route but were not delineated.

The wetland type determination was based on the presence of vegetation and hydrology indicators. Shallow soil layers above the permafrost limits the use of soil as a viable wetland indicator. The wetland boundary in proximity to the road crossing was collected using Avenza maps. The boundaries of Wetlands 3 and 5 were partially delineated in the field and extended based on the assessment of aerial images. For each wetland, a 1m x 1m quadrat was marked. All identifiable species within the quadrat were noted along with the approximate percent cover of each species.

Wetland areas were predominantly characterized by ground shrubs and graminoids (mostly Carex sp.) with lesser amounts of forbs, moss, and lichen.

Table 4.2 Wetland Summary

Wetland	Coordinates		Type	Survey Area Size (ha)	Landscape Position	Water Flow Path	Landform
	Easting	Northing					
WL1	608484	6267369	Snowpatch Fen	0.93	Terrene Riparian	Throughflow	Peatland
WL2	608617	6267159	Lowland Polygon Fen	0.72	Terrene Riparian	Throughflow	Peatland
WL3	607864	6264348	Lowland Polygon Fen	7.13	Terrene Riparian	Throughflow	Peatland
WL4	608029	6262532	Lowland Polygon Fen	4.94	Terrene Riparian	Throughflow	Peatland
WL5	608456	6266692	Lowland Polygon Fen	9.54	Terrene Riparian	Throughflow	Peatland

- **Wetland 1**
  Wetland 1 is a gently sloping riparian Snowpatch fen surrounding a small, permanent watercourse that is braided at crossing (Photo 1-3, Appendix B). The dominant vegetation included Arctic Willow (*Salix arctica*), Baltic Rush (*Juncus baltica*), Fragile-Seed Sedge (*Carex membranacea*), Alpine Blueberry (*Vaccinium uliginosum*) and Tall Cotton-Grass (*Eriophorum angustifolium*).

- **Wetland 2**
  Wetland 2 is a flat, lowland polygon fen surrounding a watercourse (Photo 4, Appendix B). The dominant vegetation included Leafy Tussock Sedge (*Carex aquatilis*), Fragile-Seed Sedge, Arctic Willow, Tall Cotton-Grass and Baltic Rush.

- **Wetland 3**
  Wetland 3 is a flat, lowland polygon fen surrounding a braided watercourse (Photo 5, Appendix B). Several small pools of standing water were present. The dominant vegetation included Fragile-Seed Sedge, Northern Willow (*Salix arctophila*), Tall Cotton-Grass, and an unidentified *Carex* sp.

- **Wetland 4**
  Wetland 4 is a flat, lowland polygon fen surrounding a braided watercourse (Photo 6, Appendix B). Patterns of small pools were present throughout the fen. The dominant vegetation species included Net-Veined Willow (*Salix reticulata*), Alpine Blueberry, Yellow Marsh Saxifrage (*Saxifraga hirculus*), Curly Sedge (*Carex rupestris*) and an unidentified *Carex* sp.

- **Wetland 5**
  Wetland 5 is a flat, lowland polygon fen surrounding open water (Photo 7 & 8, Appendix B). The wetland is hummocky, consisting of 40-80 cm of peat, with pockets of standing water. The dominant vegetation species included Fragile-Seed Sedge, Curly Sedge, Tall Cotton-Grass, Alpine Blueberry, Leafy Tussock Sedge, Northern Willow, and Black Torpedoberry (*Arctous alpinus*).

Six (6) wetlands were observed along the proposed alternative access route but were not delineated due to scope constraints (Figure 4.1, Table 4.3). Photos of the wetlands are provided in Appendix B (Photos 9 -14). The preferred route was chosen based on fewer wetland and watercourse crossings.

Table 4.3 Alternative Road Wetland Crossings

Wetland	Coordinates		Landform
	Easting	Northing	
AWL1	608743	6266227	Peatland
AWL2	608774	6266007	Peatland
AWL3	608809	6265688	Peatland
AWL4	609066	6265288	Peatland
AWL5	608727	6264544	Peatland
AWL6	608781	6263873	Peatland

4.2.4 Terrestrial Environment

Sanikiluaq is in the Subarctic region of Canada. It is a comparatively low latitude site that is characterized by slightly higher precipitation and average summer air temperatures (Hayward, 2020). The landscape is predominantly barren and rocky tundra, with a short growing season comprised of mainly mosses, sedges, grasses, and flowering plants. Vegetation in this region is low growing to avoid wind and ice scouring, growing close together in clumps or mats (Aiken et. al. 2007).

4.2.4.1 Vegetation

A vegetation survey was conducted within the Study Area in parallel with wetland delineations, the locations were chosen to be representative of the general site habitat. Six (6) 1 x 1 m vegetation plots were assessed along the access road, and ten (10) were assessed at each turbine location. Species were identified and relative percent cover was recorded. Flowering plants were in bloom during this survey.

All 10 turbine sites are in upland habitat. The vegetation is predominantly comprised of *Alectoria* sp., Leafy Tussock Sedge, *Cetraria nivalis*, Broad-Leaf Fireweed (*Chamaenerion latifolium*), Crowberry (*Empetrum nigrum*), Lichen sp., Alpine Blueberry, and Northern Mountain-Cranberry (*Vaccinium vitis-idaea*).

The six vegetation plots along the access road were dominated by Curly Sedge, *Cetraria* sp., White - Mountain Avens, Crowberry, Lichen sp., Arctic Wintergreen, Arctic Willow, Alpine Blueberry, and Northern Mountain-Cranberry.

4.2.4.2 Flora Species at Risk

No plant SAR were observed during the field surveys. There is one plant SAR that is known to occur in the area, a moss, Porsild's Bryum (*Haplodontium macrocarpum*), which is listed as threatened under SARA. Felt Leaf Willow (*Salix alaxensis*) of special concern, is outside the range of Sanikiluaq and not expected to occur in or near the Project area.

4.2.5 Aquatic Resources

Project activities will take place in proximity to lake, stream and wetland habitats located south of Sanikiluaq. The existing trail to be upgraded to an access road and ten turbine sites are located adjacent to watercourses that are likely to support several small fishes – including minnow species and Arctic Char parr (*Salvelinus alpinus*). Wood field staff conducted aquatic habitat assessments on watercourse crossings within the Site footprint and determined that the habitat is suitable to support fish communities. Fish community assessments were not conducted. Watercourse crossings and characteristics are provided in Table 4.4. Water quality parameters were collected at representative project crossings as well as selected upstream and downstream locations. Arctic charr and Lake Whitefish (*Coregonus clupeaformis*) play an important role as sustenance for Sanikiluarmiut and are harvested from the freshwater lakes near the community. Although culturally and economically significant species are present in areas surrounding the Project site, no aquatic SAR are expected to use the watercourses within the Project area.

The main watercourse within the Project area generally flows north towards Sanikiluaq Lake, with established access roads/trails along either side of the stream channel. The majority of stream substrate was observed as gravel and cobble bottom, with some fines and sediments. Undercut banks and overhanging and submerged vegetation was limited, and depths were shallow at the time of sampling. Flows may vary throughout the year with greatest variation occurring in late spring and early summer as ice melts.

Aquatic Species at Risk

Fish community assessments were not completed at watercourse crossings. Desktop studies were conducted, including review of SARPR, COSEWIC, and the Nunavut Wildlife Act. There are no freshwater aquatic fish species in Nunavut listed under SARA. No SAR fish are expected to use the watercourses within the Project area as detailed in Section 4.2.1.

Table 4.4 Watercourse Crossings

Watercourse	Coordinates		Wetted Width (m)	Left Bank Height (cm)	Right Bank Height (cm)	pH	Conductivity (µS)	Temperature (°C)	Flow (m/s)	Avg Depth (cm)
	Easting	Northing								
WC1 Crossing	608484	6267369	7.05	30	8	8.81	1061	9.3	0.56	6
WC1 U/S (Upstream)	608492	0267268	5.56	35	75	--	--	--	--	9
WC1 D/S (Downstream)	608548	6267445	40	--	--	--	--	--	--	11
WC2 Crossing	608617	6267159	6.2	--	--	8.88	956	8.7	--	12
WC3 Crossing	607864	6264348	0.6	12	10	8.65	1195	9.2	--	3
WC3 U/S	607820	6264338	na	--	--	--	--	--	--	--
WC3 D/S1	607952	6264392	0.7	--	--	--	--	--	--	8
WC3 D/S2	--		--*	--	--	--	--	--	--	--
WC4A	608029	6262532	1.25	15	20	8.83	1430	10.3	0.27	37
WC4A U/S	608009	6262433	1.02	30	20	--	--	--	0.38	16
WC4A D/S	608057	6262629	4.25	25	20	--	--	--	--	8
WC4B	608095	6262517	0.45	10	5	8.78	242	11.9	--	30
WC4B U/S	608085	6262417	--	--	--	8.87	350	15.3	--	--
WC4B D/S	608122	6262612	15	--	--	--	--	--	--	--
WC5**	608456	6266692	--	--	--	--	--	--	--	--

* -- not applicable

** Large wetland, most of wetland is hummocks with open water between.

4.3 Atmospheric Environment

4.3.1 Climatology

ECCC does not provide historical datasets for the Sanikiluaq region. World Weather Online, however, reports average temperatures ranging from -24°C in February to 10°C in August during the 2009 – 2020 period in Sanikiluaq (World Weather Online, 2021). Rainfall is typically highest in July (averaging 98 mm) and snowfall in November (averaging 25.2 cm). The data presented by Climatedata.ca, supported by ECCC, reports that the annual average temperature was -5.2°C for the period of 1951-1980; -4.4°C for 1981-2010. It is predicted that, under a high emissions scenario, that annual average temperature will rise to -2.1°C between 2021 and 2050 (ClimateData.ca, 2021).

4.3.2 Ambient Air Quality

Air quality is influenced by the concentrations of air contaminants in the atmosphere. Air contaminants are emitted by both natural and anthropogenic sources and are transported, dispersed, or concentrated by meteorological and topographical conditions. Air contaminants eventually settle or are washed out of the atmosphere by rain and are deposited on vegetation, livestock, soil, water surfaces, and other objects. In some cases, contaminants may be redistributed into the atmosphere by wind. Since there are no major industries in the region of Belcher Islands, most of the releases are from fuel combustion during heating and mobile vehicle use. Although there is little information about the air quality of NU, Sanikiluaq is located just west of Quebec where three Air Management Zones (AMZ) collect data using 46 air quality stations (Canadian Council of Ministers of the Environment (CCME), 2021).

In October 2012, most federal jurisdictions, excluding Quebec, had agreed to implement an Air Quality Management System (AQMS). AQMS is a holistic and standardized approach for improving air quality in Canada. The AQMS is supported by the CCME and includes the new Canadian Ambient Air Quality Standards (CAAQS) for outdoor air quality management across Canada. The CAAQs consider particulate matter (PM), ground-level ozone (GLO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and VOCs. Although Quebec does not participate in the AQMS, it was reported that CAAQs were achieved in all three of its AMZ since reporting began in 2015 (CCME, 2021).

4.3.3 Wind Resources

According to the Canadian Wind Atlas, the mean windspeed at the site of the Study Area, located in Quadrangle 44, is 8.12 m/s at 50 m AGL ranging from 7.24 m/s in the summer and 9.02 m/s in the winter (Canadian Wind Atlas, 2018). Wind speed, direction, and other meteorological data were collected at the proposed project site using a 34 m tower. Data for the three-year period of March 28th, 2017, up to and including March 1st, 2020, was provided by Zephyr North (Zephyr North 2020). The average measured wind speed was 8.5 m/s at 34 m and estimated to be 8.8 m/s at the proposed 50 m hub height by Zephyr North (Zephyr North 2020). The wind rose prepared by Zephyr North is presented in Figure 4.3, and the wind speed distribution is presented in Figure 4.4.

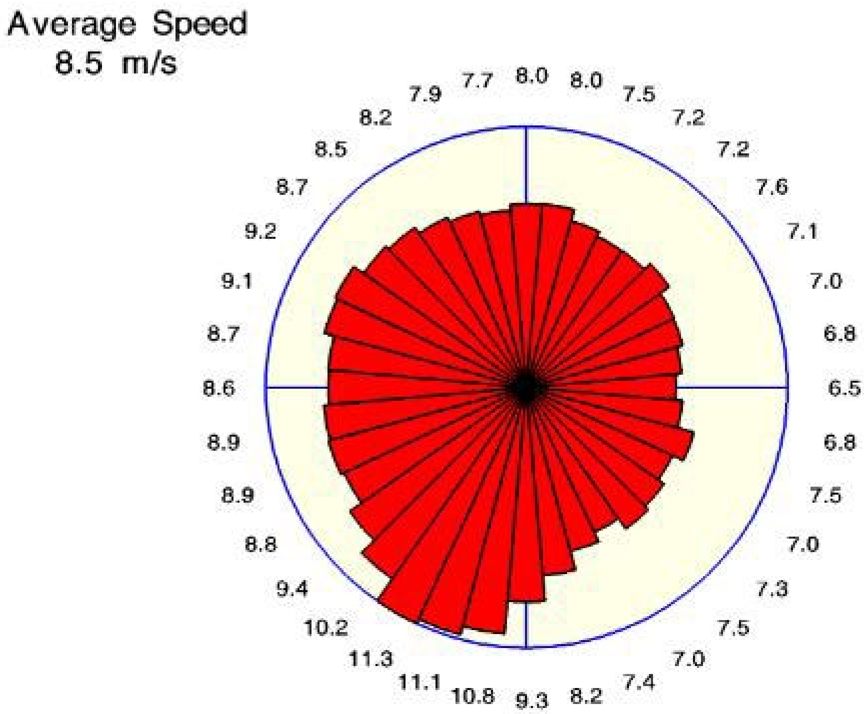


Figure 4.3 Wind Rose for Proposed Project Site (Zephyr North 2020)

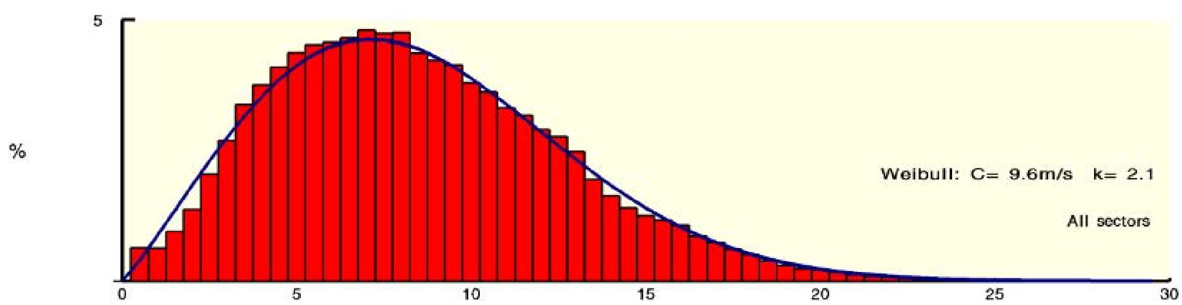


Figure 4.4 Wind Speed Distribution for Proposed Project Site (Zephyr North 2020)

4.3.4 Safety Issues

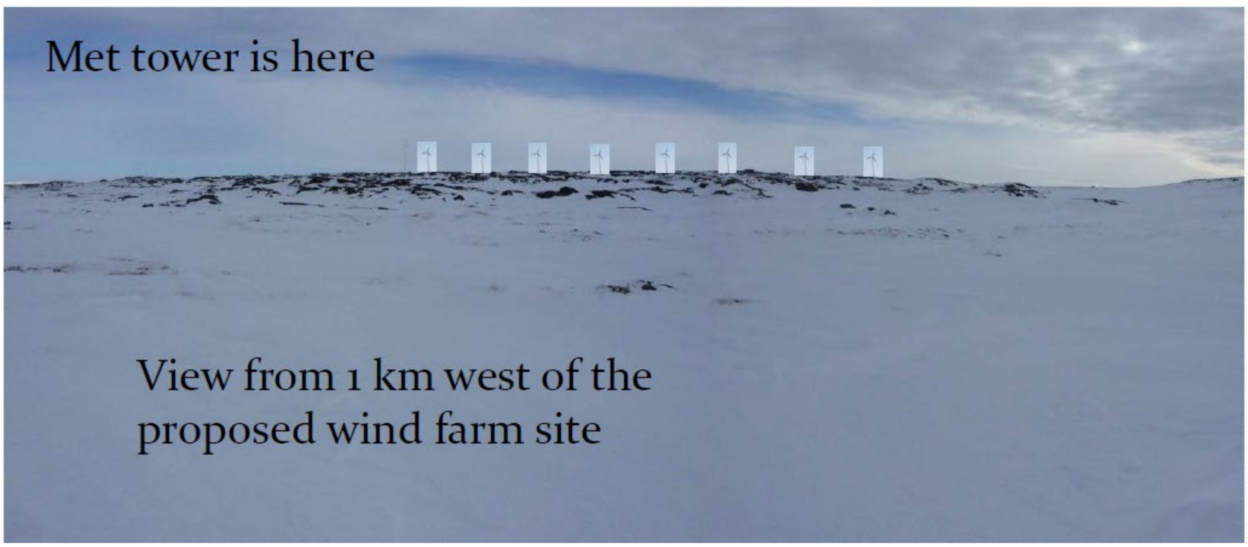
There are several potential safety issues for both the public and onsite workers, the Site being rugged, rocky terrain. The potential hazards from the construction and decommissioning phases are limited to the contractors, as the public will be prevented from accessing the Site. The exception to this would involve the transportation of materials to and from the Site which extends the spatial boundaries to include public roads. Any special permits required for the delivery of turbine components using overweight or non-compliant trucking configurations will be obtained. Access to the Site will not be restricted outside of construction phases and other critical activities.

The potential hazards from the operation phase include maintenance activities, the potential formation of ice on the turbine blades (ice-throw), and the potential for breakage of turbines or turbine blades. Maintenance hazards are limited to workers, but the other scenarios pose a risk to anyone that may be near the Site. Structural failure of the turbines and rotors is a rare event but can be caused by material fatigue, rotor over-speed, poor maintenance or lightning strikes.

The Project Area has an appropriate setback from any residential area and the potential for interaction with the public is minimal. Shadow flicker and noise is not a concern given the distance from the populated area of the Hamlet.

4.3.5 Visual Landscape

The Project site is largely underdeveloped and sited approximately 4.5 km from the populated area of the Hamlet. The illustration below approximates the impact to the visual landscape for this Project from the west where the existing trail ends.



Source: Pinard, 2017

5.0 Impact Assessment

5.1 Project Environment Interactions

The planning, construction, operation, maintenance, and decommissioning phases of the proposed Project will have the potential to affect the geophysical, biological, and atmospheric environments. This section will describe potential interactions between the Project and the environmental components. The BIA was conducted in the following stepwise fashion:

- Identification of VEC's and potential interactions with Project activities;
- Prediction and assessment of Project-related environmental impacts;
- Identification of mitigation measures (avoidance, mitigation, offsetting); and,
- Determination of the residual effects and their level of impact/significance after the implementation of mitigation measures.

This process, detailed in Section 3 was followed to ensure that interactions between the Project components and the environment were adequately described, that the likely environmental effects are identified and properly assessed, and that the significance of any residual effect is determined.

The analysis of the identified environmental components of concern (ECCs) and the list of VECs within the Study Area's spatial and temporal bounds are presented in Table 5.1. VECs were identified based on potential public concerns related to environmental, social, cultural, economic, or aesthetic values as well as the scientific concerns of the professional community. These VECs and pathways were further analysed against potential interactions with Project components resulting in a summary of potential environmental impacts and those VEC's that underwent detailed assessment.

Table 5.1 Issues Scoping: Summary of VEC Selection and Pathway Analysis

Environment/ Resources	Environmental Components of Concern (ECC)	Pathway		ECC Avoided During Site Selection		VEC		Interactions with Project Activities/Components and Possible Pathways	Rationale for Inclusion/Exclusion as Valued Environmental Component (VEC)
		Yes	No	Yes	No	Yes	No		
Geophysical Environment	Soil and Soil Quality	X			X		X	Construction: clearing, spills Operations: spills	Excluded: Surface is primarily exposed bedrock. Included with Accidents and Malfunctions VEC
	Geology: permafrost	X			X		X		Excluded: Included in Effects of the Environment on the Project
	Seismicity	X			X		X	Operations: Seismic activity could affect structural integrity of turbine towers	Excluded: Belcher Islands is not an active seismic region
	Hydrogeology/Groundwater	X			X		X	Construction: installation of foundations and spills	Excluded: no blasting is required, groundwater not accessible for drinking water. Included with other VEC – Surface Water Quality
	Surface Water Quality (potable water supply)	X			X	X		Construction: clearing, spills Operations: spills	Included. Construction of the access roads has potential to alter surface water quality flowing to Sanikiluaq Lake (e.g. increased sedimentation). Potential impacts and mitigation measures have been included with Aquatic Environment mitigation measures.
	Sub-surface Resources		X		X		X	Construction	Excluded: Project will not interact with local argillite quarries. Will have no significant impact on gravel quarries.
Aquatic Environment	Fish Habitat	X			X	X		Construction: clearing and installation of aerial cables	Included. Construction of the access roads and installation of poles to support aerial cables has potential for harmful alteration, disruption, or destruction of fish habitat as well as impact to local fisheries activities.
	Surface Hydrology	X			X	X		Construction: clearing	Included. Construction of the access roads has potential for alteration of surface hydrology within the local watershed boundaries.

Environment/ Resources	Environmental Components of Concern (ECC)	Pathway		ECC Avoided During Site Selection		VEC		Interactions with Project Activities/Components and Possible Pathways	Rationale for Inclusion/Exclusion as Valued Environmental Component (VEC)
		Yes	No	Yes	No	Yes	No		
	Surface Water Quality	X			X	X		Construction/decom: Clearing, ground disturbance, and const. related activity for the access road may generate site run-off or accidental fuel or chemical spills. Operations: transformer and equipment toxic leaks and spills.	Included: Surface water quality within the watershed is addressed in the wetlands and fish habitat VECs
Terrestrial Environment	Habitat	X			X		X	Construction: clearing and grubbing, excavation	Excluded: Habitat is addressed within Fauna and Species at Risk VECs, below
	Fauna • Mammals • Local and Migratory Birds • Bats	 X X X			 X X X	 X 	 X X	Construction/decom: noise, visual impacts and the presence of humans (workers in the area), habitat loss by clearing and grubbing, excavation, equipment: silt run-off, infilling; fuel spills. Operations: collisions with turbines, lights, barrier effect, toxic leaks and spills, habitat destruction	Included: Birds are protected by regulation. Some minor project interaction with terrestrial mammals. Excluded: No records of bats on the Belcher Islands and no suitable roosting habitat on Project site.
	Species-at-Risk • Flora Species-at-Risk • Fauna Species-at-Risk	 X	 X 	 X 	 X	 X	 X 	Construction/decom: noise, visual impacts and the presence of humans (workers in the area), habitat loss by clearing and grubbing, excavation, equipment: silt run-off, infilling; fuel spills. Operations: collisions with turbines, lights, barrier effect, toxic leaks and spills, habitat destruction	Fauna SAR included: Protected by statute/regulation. If a species is Endangered, effects on individuals may be considered significant.
	Designated Areas and Other Critical Habitat Areas • National Wildlife Areas / Migratory Bird Sanctuaries	X		X			X	Construction/decom: noise, visual impacts and the presence of humans (workers in the area), habitat loss by clearing and grubbing, excavation, equipment: silt run-off, infilling; fuel spills. Operations: collisions with turbines, lights, barrier effect, toxic leaks and spills, habitat destruction	Excluded: Avoided during site selection.

Environment/ Resources	Environmental Components of Concern (ECC)	Pathway		ECC Avoided During Site Selection		VEC		Interactions with Project Activities/Components and Possible Pathways	Rationale for Inclusion/Exclusion as Valued Environmental Component (VEC)
		Yes	No	Yes	No	Yes	No		
	Wetlands	X			X	X		Construction/decom: Clearing, ground disturbance, and const. related activity for the access road may generate site run-off or accidental fuel or chemical spills. Operations: transformer and equipment toxic leaks and spills.	Included: Along the access road, potential exists for erosion/ sedimentation or accidental spills to enter the nearby wetland during construction.
Atmospheric Environment	Air Quality • Ambient air	X			X	X		Construction/decom: Dust from construction and transport equipment, construction of turbines, transformers: air emissions (exhaust fumes, leaks, vapour), dust.	Included: Protected by statute/regulation (SO_2, NO_x, PM etc). Minor quantities will be produced for short time during construction of project.
	Climatology	X			X	X		Construction/decom: Emissions (exhaust fumes, leaks, vapour) from construction and transport equipment	Included: Potential to increase beneficial effects of sustainable resources, such as reduction of GHG production and carbon footprint

5.2 Effects, Mitigation, and Residual Effects

The importance of effects after mitigation measures (residual effects) are determined using the definitions of level of impact established in the Environmental Impact Statement Guidelines for Screenings of Inland Wind Farms under the Canadian Environmental Assessment Act Guidelines (NRCan, 2003) (Table 5.2).

Residual effects refer to those environmental effects predicted to remain after the successful application of all proposed mitigation measures. The predicted residual effects were evaluated for the Project construction and operation phases as well as for potential accidents and unplanned events.

The significance of the residual effects was evaluated for each VEC. For adverse impacts, significance was determined based on the following criteria:

- magnitude;
- geographic extent;
- timing, duration, and frequency;
- reversibility; and,
- ecological context.

Where an adverse environmental effect was identified, mitigation was proposed. Where possible, mitigation measures will be incorporated into the Project design and implementation to eliminate or reduce potential adverse effects. Mitigation at the receptor end was considered if avoidance and mitigation at the source of the effect was deemed not feasible or not sufficiently effective.

Table 5.2 Definitions of Level of Impact after Mitigation Measures (Residual Effects)

Level	Definition
High	Potential impact could threaten sustainability of the resource and should be considered a management concern. Research, monitoring and/or recovery initiatives should be considered.
Medium	Potential impact could result in a decline in 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.
Low	Potential impact may result in slight decline in resource in Study Area during life of the project. Regional management actions such as research, monitoring and/or recovery initiatives would not normally be required.
Minimal	Potential impact may result in slight decline in resource in Study Area during construction phase but should return to baseline levels.

Environmental concerns are primarily related to the removal of minor amounts of vegetation during construction, operation, and decommissioning. Any removal of vegetation can alter or destroy existing or potential wildlife habitat, as well as impact watercourse ecology and surface water and potable water resources essential to the community of Sanikiluaq. In addition, noise disturbance to wildlife as a result of activity in the area may occur.

Recommended mitigation measures are provided in this section that will minimize the potential environmental effects of vegetation clearing during construction, operation, and decommissioning. The Proponent will ensure all required permits and approvals from federal, territorial, and municipal agencies are acquired for the area of work prior to the start of activities. The impact assessments described through Section 5.0 are summarized in Table 6.1.

Table 6.1 Summary of Construction Phase Environmental Impacts, Mitigation Measures and Residual Effects

Project Activity	Valued Environmental Component	Impact	Mitigation Measures	Residual Environmental Effects	Level of Residual Impact
Project related traffic and equipment operation	Air Quality	• Formation of dust and exhaust fumes • Dust created from soil depleted of vegetation and from gravel access roads	• If possible, schedule activities when weather conditions (winds) are favourable. • Equipment should be kept in good running order • Use water as dust suppressant. • The exits of the construction sites will be equipped with effective dirt traps. • Impose and enforce speed limits on access roads. • Do not load trucks with soil above the freeboard. • Minimize drop heights when loading trucks. • During operation allow vegetation disturbed in the lay down areas to grow back.	No residual effects expected.	Minimal
	Birds	• Mortality due to vehicle collisions • Avoidance and changes to movement caused by noise, visual impacts, and human presence • Disturbance of normal behaviour during foraging and breeding • Habitat degradation from invasive species •	• Vehicles will yield the right-of-way to wildlife • Do not harass or disturb wildlife. • All personnel will report notable wildlife sightings (dangerous, injured, dead, or SAR) to the Construction Manager. • The Construction Manager will initiate any reasonable action to reduce the chance of disruption or injury to reported wildlife. • Should disruption or injury to wildlife occur, the Construction Manager will contact the on-call Conservation Officer in Sanikiluaq at (867) 266-8098. • If encountered, dead animals will be removed and disposed of as soon as possible. • Handling of bird carcasses will be conducted in accordance with MBCA scientific permits. • If found, carcasses of SARA-listed species will be sent to the Edmonton CWS office with suitable permitting as advised by CWS. • If an injured or dead bird is encountered, personnel will record the following information: date and time, injury sustained, cause of injury, and species. • Native plant regeneration will be promoted to allow natural revegetation. • Inspect and clean imported equipment for invasive species. • Inspect borrow areas for presence of invasive species prior to use. • Dust abatement and prevention measures shall be implemented.	No residual effects expected	Minimal
			• Notify landowners and the public of construction activities schedule.	No residual effects expected	Minimal

Project Activity	Valued Environmental Component	Impact	Mitigation Measures	Residual Environmental Effects	Level of Residual Impact
	Local Traffic	• Increased traffic including possible damage to roads and interference with traffic flows. • Damage or injury as a result of traffic accidents • Noise disturbance	• Complaint registry to be developed for traffic, noise and other Project concerns. • Limit traffic to regular working hours. • The routing of truck traffic through the hamlet will be controlled during all activities. • Repairs to public roads to be implemented should the need arise. • All Project vehicles will be properly maintained and muffled to reduce noise emissions. • The Contractor will make daily inspections of tires, brakes, lights, mirrors, fluids, hydraulic and fuel systems on machinery, and leaks will be repaired immediately. If parts are not immediately available, equipment will be removed from service until repaired. All leaks will be reported to the Government of Nunavut Department of Environment and the Canadian Coast Guard at 1-800-565-1633. • A protective buffer zone will be established for wetlands and watercourses where construction equipment will not enter. • Erosion control measures are to be implemented and maintained • All staging areas will be located 100 m outside any wetland/watercourse.		
Clearing, Grubbing and Excavation	Air Quality	• Formation of dust and exhaust fumes	• Minimize air emissions through proper planning. • All heavy construction equipment will be equipped to reduce air emissions. • Water will be applied as a dust suppressant as needed to prevent fugitive emissions. • The speed limit will be reduced. • Idling of vehicles will be limited. • Do not load trucks with soil above the freeboard. • Minimize drop heights when loading trucks. • Disturbed soil will be stabilized as soon as possible.	No significant effects expected	Minimal
	Birds Terrestrial Fauna	• Potential mortality of adults, young and eggs from collisions, or nest destruction • Killing of individuals during land clearing activity • Avoidance and changes to migratory movement caused by noise, visual impacts, and human presence	• See measures for project related traffic and equipment operation. • Clearing and grubbing will be restricted to areas necessary to carry out the Project. • A nest search will be conducted prior to clearing and grubbing activities occurring within the regional avian nesting period (1 May to 15 August). Any active nests will be protected with a species-appropriate buffer until the young have vacated the nest. For species that re-use nests for multiple years (e.g., some raptors), vacant nests will be relocated outside the clearing/grubbing zone.	No significant effects expected	Minimal

Project Activity	Valued Environmental Component	Impact	Mitigation Measures	Residual Environmental Effects	Level of Residual Impact
		• Loss, fragmentation, or degradation of breeding, feeding, and resting habitat • Respiratory health effects from dust • Changes to the water regime by erosion and runoff • Habitat degradation by invasive species • Exposure to toxic chemicals	• Native plant regeneration will be promoted in any areas that are cleared but not built upon (i.e., roadside ditches, temporary laydown areas, etc.). • Use native plants or no vegetation around turbines. • Materials cleared from the sites (brush, soil, etc.) should not be dumped into otherwise unaffected land. • All construction equipment should have appropriate noise-muffling equipment installed and in good working order. • Keep work area clean of food scraps and garbage and transport waste to an approved landfill on a regular basis. • Maintain appropriate spill response equipment. • Vehicles will yield the right-of-way to wildlife • Do not harass or disturb wildlife. • Alterations to existing natural drainage patterns will be minimized • For construction activities required during the sensitive nesting season the following measures will be implemented: - Clearing activities will be scheduled in consideration of critical habitat features (e.g., wetland areas) identified during the pre-construction field survey. - The proponent will instruct the management team and contractors on the MBCA, the importance of habitat, the significance of the nesting period, and measures to be implemented to minimize any disturbance to birds/nests. - Construction workers will be informed of the potential for SAR to be present and will be instructed on measures to take if a SAR is observed. - If a migratory bird nest is discovered within the active work zone, work in the area should cease until CWS is contacted for guidance. A buffer of an appropriate size may be required until young have fledged from the area.		
	Fish and Fish Habitat Surface Water Quality	• Impacts to water flow and drainage within local watershed boundaries • Loss of fish habitat • Reduced species diversity	• Environmentally sensitive areas (i.e., wetlands and watercourse) will be staked out prior to work operations so that these areas are protected. • A buffer zone will be established on each side of a wetland/watercourse. • Activity to be limited within watercourse and wetland buffer zones.	No significant effects expected	Minimal

Project Activity	Valued Environmental Component	Impact	Mitigation Measures	Residual Environmental Effects	Level of Residual Impact
	Wetland	• Degradation of water quality and watershed health • Impacts to potable water supply	• Implement erosion/sedimentation mitigation measures of wetlands/watercourses when necessary. • No waste or debris into wetlands/watercourses or buffer zone. • No heavy equipment or motorized vehicles will enter wetlands/watercourses. • Work to be completed in shortest duration possible. • The on-site POL storage container shall be located on level terrain, at least 100 m from any water body or wetland. • No POL storage will occur in sensitive areas (e.g., near wetlands, watercourses, or wells) or associated buffer zone. • Fuelling must be done at least 50 m from a wetland or waterbody. • Servicing of equipment will not be allowed within 100 m of a wetland, watercourse, or drainage ditch. • Culverts shall be appropriately sized to accommodate peak flow volumes and maintain aquatic connectivity of watercourses. • Due to the nature of the bedrock, bridges should be placed to protect aquatic habitat where culverts are not a viable option. • Standard methodology and construction practices should be followed for culvert/bridge installations to mitigate potential impacts. • No chemicals will be used to wash equipment.		

Project Activity	Valued Environmental Component	Impact	Mitigation Measures	Residual Environmental Effects	Level of Residual Impact
Building Construction and Turbine Assembly	Air Quality Birds Terrestrial Fauna Fish and Fish Habitat Surface Water Wetland	• Formation of dust and exhaust fumes • Avoidance and changes to migratory movement caused by noise, visual impacts, and human presence. • Reduction of quality and quantity of habitat • Loss, fragmentation, or degradation of breeding, feeding, and resting habitat. • Changes to the water regime by erosion and runoff • Habitat degradation by invasive species • Impacts to water flow and drainage • Reduced species diversity • Toxic effects from chemicals substances	• See mitigation measures for clearing, grubbing and excavation. • Minimize area disturbed. • Use access roads for equipment movement. • Place and maintain proper erosion/sedimentation measures. • During foundation laying, form oil may be used sparingly to allow forms to separate from concrete following curing. • Washing of chutes on-site will occur at a designated location. • No chemicals will be used in the washing of concrete trucks or forms on-site. • Poles will be placed no closer than 15 m from any watercourse, and wetlands will be avoided where possible. If a watercourse or wetland cannot be spanned, untreated poles (wood, fibreglass or steel) will be used.	No significant effects expected	Minimal
Accidents and Malfunctions	Air Quality Birds Terrestrial Fauna Fish and Fish Habitat Surface Water Local Traffic	• Potential hydrocarbon contamination of soil and water. • Potential adverse effects to flora and fauna as a result of exposure to toxic substances. • Damage or injury as a result of traffic accidents	• Replace hazardous materials with less harmful ones when possible • Incorporate preventative and response measures into construction practices • Provide environmental awareness training • Maintain appropriate spill response equipment • Report all spills to applicable authorities, including the GN 24-hour spill report line at 867- 920-8130) • Inspect equipment to ensure equipment and vehicles have no obvious leaks • Do not refuel vehicles on-site • Store all hazardous materials outside of a 30 m buffer around wetlands and watercourses • Maintain and update and inventory of hazardous materials on-site. • Train workers to adhere to safe driving rules in order to prevent traffic accidents • Public notification of an increase in construction traffic. • Report all incidents of injured or dead wildlife to the on-call Conservation Officer in Sanikiluaq at (867) 266-8098.	No significant effects expected	Minimal

Table 6.2 Summary of Operation Phase Impacts, Mitigation Measures and Residual Effects

Project Activities	Environmental Components Subject to Impacts	Impacts	Mitigation Measures	Residual Environmental Effects	Level of Residual Impact
Wind Turbine Operation and Maintenance	Birds	• Direct mortality or injury from collisions with turbines • Disturbance and avoidance of potential breeding habitat due to human presence • Noise may interfere with feeding, migration, and breeding • Interference with movement due to barrier effect (avoidance of turbines) • Fire	• Control visits to the area by both workers and public • Keep workers from entering undisturbed habitat areas where no work is done • Encourage public to refrain from visiting access roads during breeding season (early May – mid-August) • Prevent perching and nesting on turbines • If guywire use is required, determine appropriate mitigation measures to increase visibility for birds to minimize strikes. • Do not create areas of high prey density during habitat restoration and maintenance • Use native plants or no vegetation around turbines • Use the minimum allowable amount of lighting (i.e., minimum intensity and number of flashes per minute), using white colour aviation lighting in accordance with Transport Canada Guidelines • Use LED lights, as they emit no light during the "off phase" of the flash • Avoid or shield strong lights such as sodium vapour lights • Implement post-construction monitoring program	Reduction in population density for birds disturbed by turbines (birds can return to preconstruction levels when wind farm is decommissioned); Limited mortality and injury of birds due to collisions; None expected for: barrier and fire	Low
	Visual Landscape	• Turbines in the natural landscape • Strong steady lighting may cause "skyglow" • Glare • Negative impressions caused by "untidy" turbine arrangement, garbage, leaks from nacelles, idle turbines or turbines with parts missing	• Create aesthetic balance in the design • Use light grey colour, non-reflective, not shiny steel • Arrange turbines in clusters • Minimize lighting on the turbines • Minimize project footprint, implement erosion control and dust abatement • Repair turbines as soon as it is safe and practicable to do so. • Clean turbines • Remove excess materials and litter • Avoid posting commercial signs	Residual effects are likely despite mitigation measures	Low

Road and Power Lines Operation and Maintenance	Birds Terrestrial Fauna	• Direct mortality or injury from collisions with overhead power lines. • Electrocution from powerlines • Disturbance and avoidance of potential breeding habitat due to human presence • Noise may interfere with feeding, migration, and breeding	• See mitigation measures for wind turbine operation.	Small number of mortalities potentially every year for the lifetime of the wind farm	Low
	Fish and Fish Habitat Surface Water Quality	• Impacts to water flow and drainage • Loss of fish habitat • Toxic effects from chemicals substances	• See mitigation measures for clearing, grubbing and excavation in Construction Phase.	Impacts are expected to be low for all factors	Low
Accidents and Malfunctions	Air Quality Birds Terrestrial Fauna Fish and Fish Habitat Surface Water Local Traffic	• Potential hydrocarbon contamination of soil and water. • Potential adverse effects to flora and fauna as a result of exposure to toxic substances. • Icing and breakage • Fire • Damage or injury as a result of traffic accidents	• The mitigation for spills and traffic accidents for the construction phase is sufficient for the operation phase. • Workers will be trained on the hazards of ice build up on tall structures • Warning signals or flags should be set up to warn of potential ice issues • If those measures are not heeded other options must be investigated • A safety set-back of at least 290 m will mitigate most effects of breakage. • Staff should wear protective equipment when on-site	No significant effects expected	Minimal

6.0 Other Undertakings in the Area

A review of other undertakings in the area that may potentially act in combination with the biophysical impacts of the proposed Project was completed. Other undertakings in the area may include existing, approved or under construction land uses or other developments. These other undertakings in the area are described below in context of their potential to act in combination with the environmental effects of the proposed Project.

Existing land uses in the local area include:

- residential and commercial land use in the hamlet of Sanikiluaq;
- the Quilliq Power Station to the southwest of the hamlet; and
- the municipal dump, quarry, and the Sanikiluaq airport are located to the west of the hamlet.

Planned or proposed Federal infrastructure projects for Sanikiluaq are related to capacity building, drinking water, and solid waste management. The Integrated Community Sustainability Plan outlines various network infrastructure plans for the Hamlet. Due to existing demand, it is anticipated that additional residential, commercial, and industrial land development will occur over time (GN, 2022). Proposed or ongoing municipal construction has been outlined by the Government of Nunavut for 2021-2022 and includes the following:

- construction of new municipal buildings;
- a new co-op hotel;
- upgrades to the existing wastewater treatment facility;
- the proposed relocation of the existing petroleum tank farm; and
- the proposed establishment of an alternate drinking water source within the Hamlet's municipal boundaries (Government of Nunavut 2022).

There are no other known approved or under construction undertakings in the Project area that are expected to act in combination with the biophysical effects of the proposed Project.

The potential effects from other undertaking in the area within context of the Project could include:

- atmospheric emissions from land uses and road network, including dust during construction activities, and TSP, CO, CO_2, NO_2, SO_2, and VOCs emitted as part of equipment and vehicle exhaust, with noise emissions from construction and operation of existing and future undertakings;
- reduced surface water quality from land uses and linear developments (e.g., sedimentation, spills, increased stormwater runoff), which could also affect fish and fish habitat;
- direct loss of flora, habitat alterations from changes in local hydrology, water quality, introduction of non-native plants, and increased fragmentation of terrestrial environment;
- reduction of wetland habitats through removal, and indirectly through changes to wetland quality and function, as well as adverse effects from changes to adjacent habitats; and
- direct loss of wildlife and avifauna from collisions with vehicles and indirect effects via habitat alterations and introduction of non-native species, as well as increased fragmentation of terrestrial habitat.

It is not anticipated that residual adverse effects from the proposed Project will substantially contribute to existing adverse effects from other undertakings. Other future undertakings are anticipated to implement similar mitigation measures for environmental protection as those outlined in this document. This will further reduce potential for future other undertakings in the area to contribute additional adverse effects.

7.0 Effects of the Environment on the Project

Several environmental factors could have adverse effects on the Project, especially extreme weather events and global climate change in the Arctic region. These effects have been considered during the Project design phase.

7.1 Extreme Weather

Severe weather events could potentially damage wind turbines due to conditions exceeding the operational design of the wind turbines. High winds, extreme temperatures, and icing on blades all have the potential to shut down wind turbines, thus not producing energy and revenue. Cold climate turbine technology will be a major consideration in the selection of the turbine model..

For reference, Figure 7.1 shows the percentage of the year at, or above a given temperature in Sanikiluaq (based on wind monitoring data).

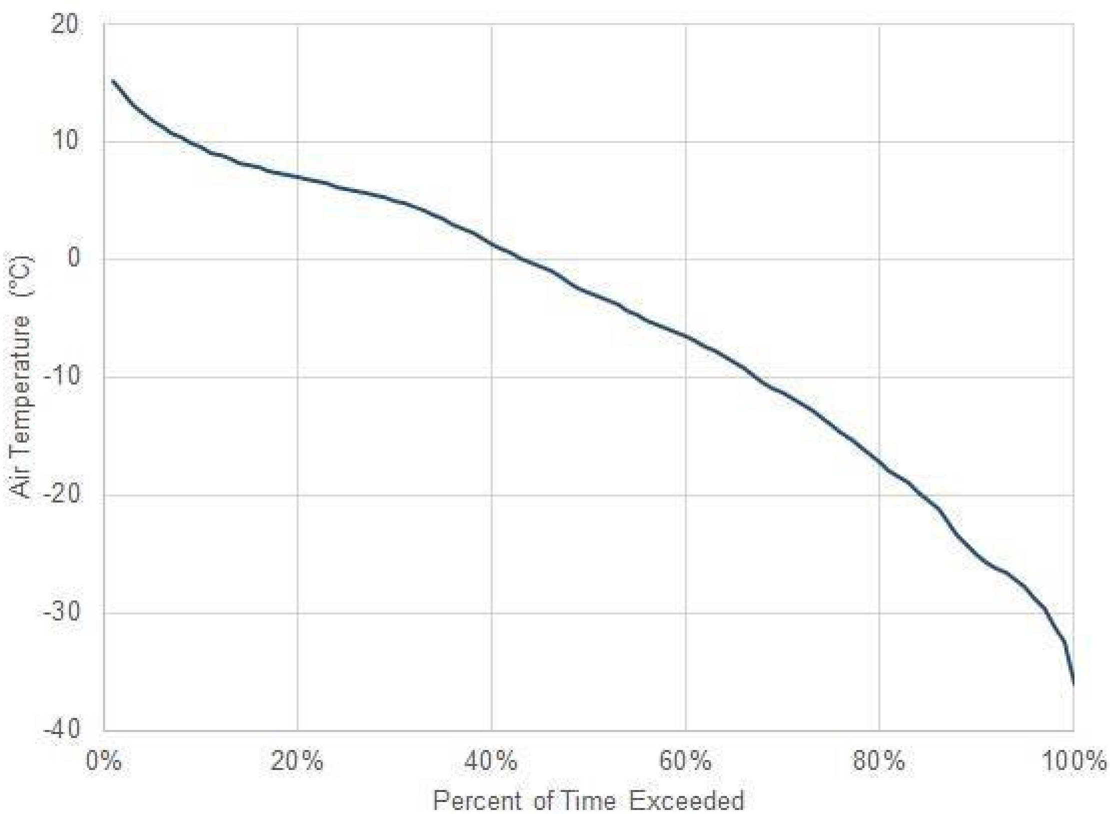


Figure 7.1 Temperature as Percent of Time (Growler, 2021)

Several manufacturers have developed infrastructure components specifically designed for deployment in Arctic climates. The capacity and supplier will continue to be refined as suppliers and technologies are assessed.

7.2 Global Climate Change

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate which can be attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (Government of Canada, 2010b). Emissions of GHGs (including CO_2, methane (CH_4), nitrous oxide (N_2O), ozone (O_3), sulphur hexafluoride (SF_6), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), and chlorofluorocarbons (CFCs)) released into the atmosphere primarily through anthropogenic activities such as the burning of fossil fuels are contributing to global climate change (Government of Canada, 2010b).

The Intergovernmental Panel on Climate Change (IPCC) is an international organization of the world's leading climate scientists and is affiliated with the United Nations. According to the IPCC, human activities have already resulted in an overall global warming of 1.0°C and is forecasted to reach 1.5 between 2030 and 2052 should it continue to increase at the current rate (IPCC, 2018).

The increase in average temperatures is projected to be accompanied by an increase in severe weather events and a rise in sea levels. Severe weather events include flood, drought and storms, and the rise in sea levels will increase the number and severity (height) of storm surges, the wave energy and erosion (Lemmen *et al.*, 2008).

7.2.1 Permafrost

There is potential for an increase in permafrost creep in ice-rich soils through climate change that could reduce the bearing resistance of the soils and possibly a thickening of the active layer (Tetra Tech, 2020). For shallow or deep foundations, a consequence could be increased settlement due to creeping or thawing of the permafrost and increased seasonal movements due to a thicker active layer. Such movements will not necessarily be uniform across the Project site, and there could be some significant differential movements even in a short distance as a result of thaw settlement or seasonal thawing and refreezing of high-ice content zones in the soil.

These consequences would ordinarily be considered relatively "major" due to the possible magnitude of annual movements, up to 200 mm or more. Shallow foundations are recommended for the battery storage and should be expected to require regular and ongoing maintenance, entailing future relevelling and additional fill placement. However, in the case of deep foundations founded in bedrock (grouted rock-socketed steel pipe piles), the consequences of movements in the weathered bedrock would be reduced by founding piles in competent bedrock, below the depth of fractured, frost-shattered, friable, or ice-bearing bedrock.

8.0 Conclusion

This Biophysical Impact Assessment report addresses the environmental effects of the construction, operation, and decommissioning Project phases. The information to date has shown that no significant adverse residual impacts on the VECs identified are likely.

The generation of electricity from renewable resources such as wind is in accordance with federal and territorial strategies since it contributes to the reduction of GHG emissions and air pollutants. The Sanikiluaq High Displacement Renewable Energy, if approved, could displace more than 50% of the diesel fuel used for electricity generation at the Hamlet and generate valuable knowledge on multiple aspects of renewable energy deployment in remote Arctic climates.

9.0 List of Supporting Documents

Anand-Wheeler, I. 2014. Terrestrial mammals of Nunavut. Volume 5 of Field Guides of Nunavut Series. Inhabit Media Incorporated. 107 pp.

Arctic Eider Society. 2021. Bird species list for Qikigtait area, Belcher Islands, Nunavut (Draft). 22 pp.

Baker, A., P. Gonzalez, R. I. G. Morrison, and B. A. Harrington. 2020. Red Knot (*Calidris can*utus), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

Beanlands, Gordon E., and Peter N. Duinker, 1983: An Ecological Framework of Environmental Impact Assessment in Canada. Institute for Resource and Environmental Studies, Dalhousie University, Halifax, and Federal Environmental Assessment Review Office, Hull, Canada, 132 pp.

Beauregard, M.A. and Ell, J. 2015: Nunavut Carving Stone Deposit Evaluation Program: 2013 and 2014 fieldwork in the Kitikmeot Region, Belcher Islands, Hall Peninsula and Repulse Bay, Nunavut; in Summary of Activities 2014, Canada-Nunavut Geoscience Office, p. 163–174. Accessible: https://m.cngo.ca/wp-content/uploads/Summary-of-Activities-2014-P18.pdf

Blancher, P. 2013. Estimated number of birds killed by house cats (*Felis catus*) in Canada. Avian Conservation and Ecology, 8(2).

Canadian Council of Ministers of the Environment (CCME). 1999. Water Quality Guidelines for the Protection of Aquatic Life.

Canadian Council of Ministers of the Environment (CCME). Air Quality Report. Accessed 2021: https://ccme.ca/en/air-quality-report

Canadian Endangered Species Conservation Council (CESCC). 2017. Wild Species 2015: General Status of Species in Canada (Report Database). Available at: https://www.wildspecies.ca/reports. Accessed 27 Oct 21.

Canadian Wind Atlas. 2018. Quadrangle 44. Accessed 2021: http://www.windatlas.ca/nav-en.php?no=28&field=E1&height=50&season=ANU

CBC News. 2021. New MLA will have to continue advocating for infrastructure in Sanikiluaq, says outgoing MLA. October 22, 2021. https://www.cbc.ca/news/canada/north/sanikiluaq-infrastructure-1.6220081

CBC News. 2016. Sanikiluaq residents warned not to drink tap water – even if boiled. Accessed 2021: https://www.cbc.ca/news/canada/north/sanikiluaq-advisory-tap-water-sodium-1.3650378

ClimateData.ca. 2021. Sanikiluaq, NU. Accessible: https://climatedata.ca/explore/location/?loc=OAOKW&location-select-temperature=tx_max&location-select-precipitation=rx1day&location-select-other=frost_days

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2017. COSEWIC assessment and status report on the Peregrine Falcon *Falco peregrinus pealei* subspecies – *Falco peregrinus pealei anatum/tundrius* – *Falco peregrinus anatum/tundrius*) in Canada 2017. Ottawa. xviii + 108 pp. Available: https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/peregrine-falcon-2017.html.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2015. COSEWIC Assessment and Status Report on the Red-necked Phalarope *Phalaropus l*obatus in Canada. Ottawa. X + 52 pp.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2013. COSEWIC Assessment and Status Report on the Little Brown Myotis *Myotis lucifugus*, Northern Myotis *Myotis septentrionalis*, and Tri-colored Bat *Perimyotis subflavus* in Canada. Ottawa. xxiv + 93 pp.

Drewitt, A.L. and R.H.W. Langston, 2006. Assessing the impact of wind farms on birds. Ibis 148 (1):19-42.

Environment Canada (EC). 1991. The Federal Policy on Wetland Conservation. Government of Canada. 14 pp.

Environment Canada (EC). 1996. The Federal Policy on Wetland Conservation: Implementation Guide for Federal Land Managers. Environment Canada. Ottawa, Ontario.

Environment Canada (EC). 2007a. Wind Turbines and Birds: A Guidance Document for Environmental Assessment. Environment Canada – Canadian Wildlife Service. 46pp

Environment Canada (EC). 2007b. Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds. Environment Canada – Canadian Wildlife Service. 33pp.

Environment and Climate Change Canada (ECCC). 2011. Species Profile: Short-eared Owl. Species at Risk Act Public Registry. Updated 29 Nov 2011. Accessed 25 Oct, 2021.

Environment and Climate Change Canada (ECCC). 2017. Species profile: Peregrine Falcon *tundrius* subspecies (*Falco peregrinus tundrius*). Species at Risk Act Public Registry. Updated 02 Feb 2021. Accessed 25 Oct, 2021.

Environment and Climate Change Canada (ECCC). 2021. General nesting periods of migratory birds. Available at: https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods.html. Accessed 25 October, 2021.

Evans, W.R. 2000. Applications of Acoustic Bird Monitoring for the Wind Power Industry. National Avian Wild Power Planning Meeting III. 12 pp.

Gilchrist, G.H., Roberston, G.J. 2000. Observations of Marine Birds and Mammals Wintering at Polynas and Ice Edges in the Belcher Islands, Nunavut, Canada. Arctic. 53(1): 61-68.

Government of Nunavut. 2022. ICSP Toolkit, Infrastructure Plan for Sanikiluaq 2021/2022. Available at: toolkit.buildingnunavut.com. Accessed 28 March 2022.

Government of Nunavut, Department of Environment. 2011. Environmental Guideline for Ambient Air Quality. October 2011 revision of January 2002.

Government of Nunavut. 2010. Nunavut Coastal Resource Inventory – Sanikiluaq. Department of Environment, Fisheries and Sealing Division, Government of Nunavut, Iqaluit, NU. 117 pp.

Growler Energy, Nunavut Nukkiksautiit Corporation, Landsvirkjun Power, 2021. Sanikiluaq Wind Energy + BESS Project – FEED Report. Document No. SAN-PDG-RP-001

Hayward, J. L. 2020. Fate and Transport of Determinants of Antimicrobial Resistance in Variably Saturated Terrestrial Environments. Published April 2020.

Hitchcock, H.B. 1943. Hoary Bat, *Lasiurus cinereus*, at Southampton Island, NWT. Canadian Field-Naturalist 57: 86.

Important Bird Areas (IBA). 2021. Important Bird Areas in Canada. Available at: http://www.ibacanada.ca. Accessed 25 October 2019.

Intergovernmental Panel on Climate Change (IPCC). 2018. IPCC, 2018: Summary for Policymakers. World Meteorological Organization, Geneva, Switzerland. Accessible: https://www.ipcc.ch/sr15/chapter/spm/

Jackson, G. D., 2013. Geology, Belcher Islands, Nunavut; Geological Survey of Canada, Open File 4923, map at 1:125 000 and report. Doi:10.4095/292434.

Lemmen, D.S., Warren, F.J., Lacroix, J., and Bush, E. (editors). 2008. From Impacts to Adaptation: Canada in a Changing Climate 2007. Government of Canada. Ottawa, Ontario. 448 p.

Macdonald, A.J., Smith, P.A., Friis, C.A., Lyons, J.E., Nol, E. 2021. Stopover Ecology of Red Knots in Southwestern James Bay during Southbound Migration. Journal of Wildlife Management. 85(5): 932-944.

Mallory, M.L., Fontaine, A.J., Akearok, J.A., Gilchrist, G,H. 2008. Harlequin Ducks in Nunavut. Waterbirds, 31(2): 5-18.

Manning, T.H. 1976. Birds and Mammals of the Belcher, Sleeper, Ottawa and King George Islands, Northwest Territories. Occasional Paper No. 28. Ottawa: Canadian Wildlife Service. 42 pp.

Martin, S. 2019. Sea Ice Dynamics. Encyclopedia of Ocean Sciences (Third Edition), p 187-199. Academic Press. Editors: Cochran, J.K., Bokuniewicz, H.J., Yager, P.Y.

Milko, R. 1998. Wetlands Environmental Assessment Guideline. Published by Environment Canada. Cat. No. CW66-174/1998.

Mitiq.com. Accessible http://www.mitiq.com/sanikiluaq-inuit-artists.htm.

Natural Resources Canada (NRCan). 2003. Wind Power Production Incentive - Environmental Impact Statement Guidelines for Screenings of Inland Wind Farms under the Canadian Environmental Assessment Act Guidelines.

Mandate | Nunavut Impact Review Board (nirb.ca) Accessed on December 9, 2021.

North American Wetlands Conservation Council (Canada) (NAWCC). 1992. NO NET LOSS. Implementing "No Net Loss" Goals To Conserve Wetlands In Canada. Issues Paper, No. 1992 -2.

North American Wetlands Conservation Council (Canada) (NAWCC). 1999. Wetlands and Government. Policy and Legislation for Wetland Conservation in Canada. Issues Paper, No. 1999 -1.

North American Wetlands Conservation Council (Canada) (NAWCC). 2000. Wetland Mitigation In Canada. A Framework For Application. Issues Paper, No. 2000 -1.

Nunavut Department of Community and Government Services. 2021. Sealift Services. Accessible: https://www.gov.nu.ca/information/sealift-services

Nunavut Department of Health. 2016. Boil Advisory for Sanikiluaq. November 4, 2016. Accessed 2021: https://www.gov.nu.ca/health/news/boil-water-advisory-sanikiluaq-0.

Nunavut Impact Review Board. (https://www.nirb.ca/content/projects-requiring-assessment). Accessed on March 28, 2022.

Nunavut Planning Commission (https://www.nunavut.ca/about-commission). Accessed on March 10, 2022.

Nunavut Water Board (NWB). 2015. NWB Renewal Licence No. 3BM-SAN1520. May 14, 2015. Accessed 2021: https://www.gov.nu.ca/sites/default/files/sanikiluaq_water_license.pdf

Ontario Breeding Bird Atlas (OBBA). 2021. Instructions for General Atlassing. 16 pp. Available: https://www.birdsontario.org/wp-content/uploads/Instructions-for-General-Atlassing-2021-04-07-download.pdf. Accessed 29 October, 2021.

Pinard, JP. 2017. Sanikiluaq Wind Project Study Highlights. June 2017.

Qulliq Energy Corporation (QEC). 2016. Potential for Wind Energy in Nunavut Communities. March 15, 2016. Accessible: https://www.qec.nu.ca/sites/default/files/potential_for_wind_energy_in_nunavut_communities_2016_report_0.pdf.

Richards, J.M., and A.J. Gaston (Eds.). 2018. Birds of Nunavut (2 Volumes). UBC Press, Vancouver, BC. 861 pp.

Statistics Canada (StatCan). 2021. Census Profile, 2016 Census. Sanikiluaq, Hamlet, NU. Available at: https://www12.statcan.gc.ca/censusrecensement/2016/dppd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=6204001&Geo2=PR&Code2=62&SearchText=Sanikiluaq&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=6204001&TABID=1&type=0

Tarnocai, C., and S.C. Zoltai. 1988. Wetlands of Arctic Canada. 29-30 p.

Tetra Tech Canada Inc. 2020. Desktop Geotechnical Evaluation for Proposed Wind Farm and Battery Storage, Sanikiluaq, NU. May 15, 2020. File 704-ENG.EARC03189-01. Edmonton, Canada.

Water Canada. 2020. Arctic Water. March 12, 2020. Accessed 2021: https://www.watercanada.net/feature/arctic-water/

Willis, C.K.R., Brigham, M.R. 2005. Physiological and Ecological Aspects of Roost Selection by Reproductive Female Hoary Bats (*Laciurus cinereus*). Journal of Mammology. 86(1):85-94.

World Weather Online. 2021. Sanikiluaq Climate Weather Averages. Accessible: https://www.worldweatheronline.com/sanikiluaq-weather-averages/nunavut/ca.aspx

Zimmerling, J. R., A. C. Pomeroy, M. V. d'Entremont, and C. M. Francis. 2013. Canadian estimate of bird mortality due to collisions and direct habitat loss associated with wind turbine development. Available: Ace-Eco 8:10 http://dx.doi.org/10.5751/ACE-00609-080210