Appendix 2-A

Hydrogen Production Process - Electrolyzer Design

PROJECT NUJIO'QONIK
Hydrogen Production Process - Electrolyzer Design

August 2023

Prepared for:

Prepared by:

Stantec Consulting Ltd.

File: 121417575

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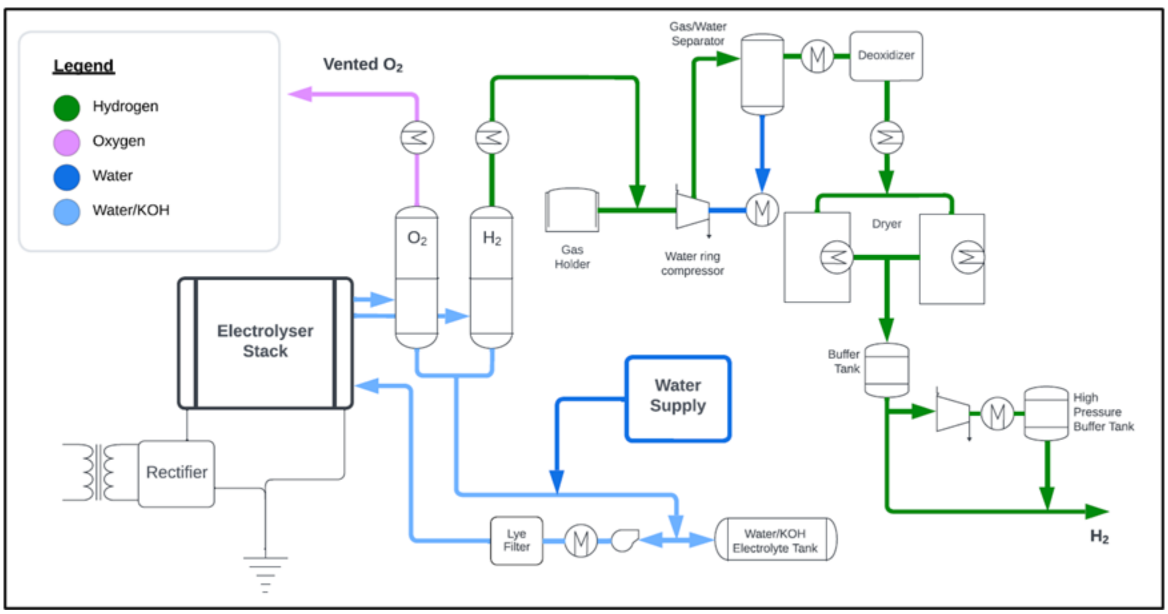
1.0 Alkaline

Alkaline is the most developed technology and growing interest in green hydrogen is boosting further development. Where the established alkaline technology was mainly atmospheric, pressurized systems have also entered the market. Pressurized systems require less compression, which is generally needed for most applications. Pressurized systems are also better equipped to respond to changes in power input (e.g., from renewable energy). This gives pressurized alkaline the advantage to still compete with other technologies such as PEM when combined with renewable energy.

Alkaline systems require a larger balance of plant in comparison to other technologies; this is due to the requirement for separation of the water / potassium hydroxide (KOH) mixtures and recirculating of the electrolyte. A mixing pipe is also installed between the node and cathode water / gas separator to balance hydroxide ion charges; this prevents the operation of the stack with a differential pressure (as seen in PEM systems). A typical process flow diagram for an alkaline electrolyzer is shown in Figure 1.1.



Note: O_2 = oxygen; H_2 = hydrogen; KOH = potassium hydroxide

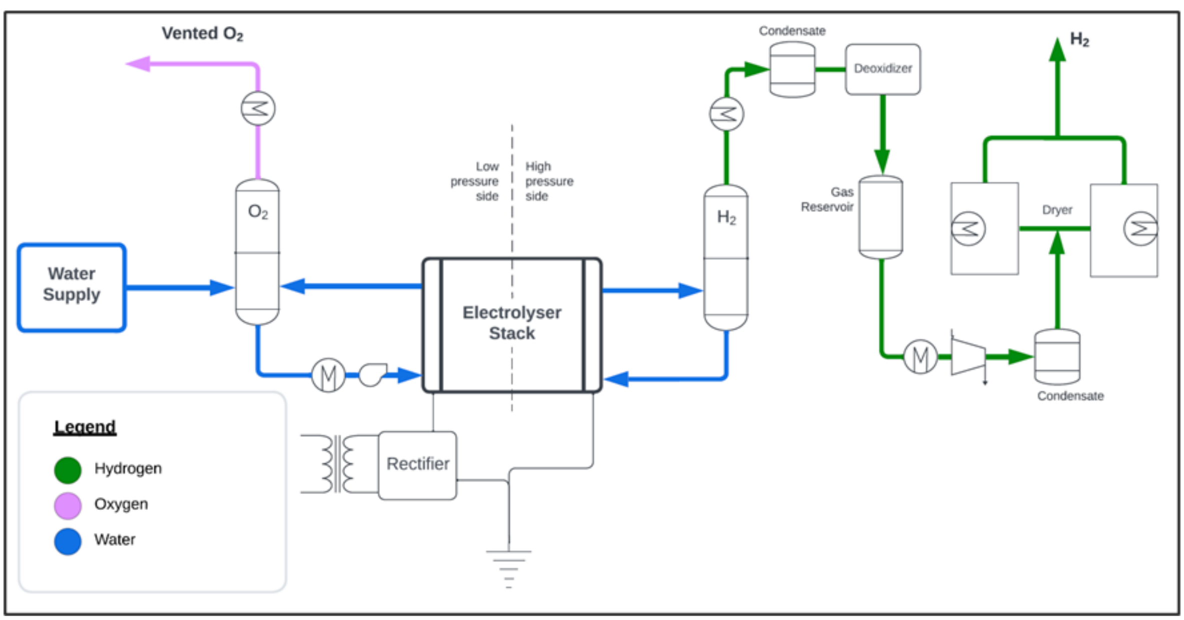
Figure 1.1 Typical Process Flow Diagram for an Alkaline Electrolyzer

2.0 Proton Exchange Membrane

PEM systems have seen much development over the last decade and have an established position in the electrolyzer market. PEM is known for its ability to ramp up and down quickly, making it a suitable technology to follow changes in power input from renewable energy.

PEM electrolyzers use thin perfluorosulfonic acid membranes that are chemically and mechanically robust, allowing higher operating temperatures and pressures achieving higher efficiencies. This allows PEM electrolyzers to be run at high differential pressures, with the hydrogen production at 70 bar and oxygen at atmospheric. The acidic environment, high voltages, and oxygen evolution at the anode creates a harsh environment within the electrolyzer, leading to high-cost noble metal material usage to prevent corrosion. PEM stacks are more compact than alkaline but are more susceptible to damage from water impurities such as iron, copper, chromium, and sodium.

PEM systems are simple in design, with circulation pumps and heat exchangers used on the anode (oxygen) side of the electrolyzer. A gas-separator, de-oxygenation component to remove remnant oxygen, gas dryer, and a final compressor step are required on the cathode side. PEM systems are also flexible in their design and can be operated as an atmospheric, differential, or balanced pressurized unit (although high differential pressures increase system costs and lower efficiencies due to the thicker membranes required and potential risk of hydrogen permeating the oxygen side of the electrolyzer). A typical process flow diagram for a PEM electrolyzer is shown in Figure 2.1.

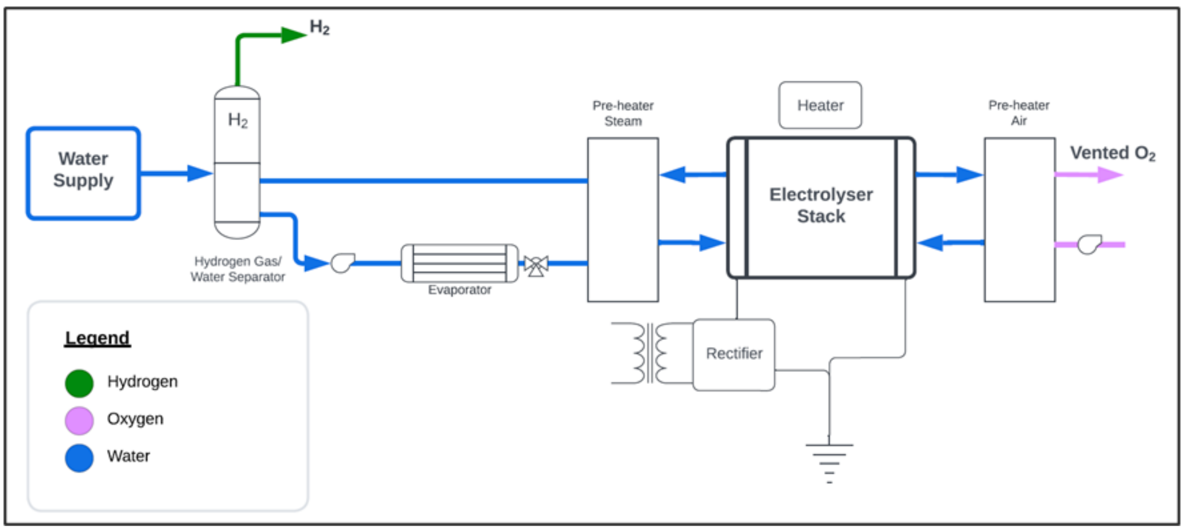


Note: O_2 = oxygen; H_2 = hydrogen

Figure 2.1 Typical Process Flow Diagram for a PEM Electrolyzer

3.0 Solid Oxide Electrolysis

The SOE technology is mainly recognized for high operating temperatures (500°C to 900°C), high efficiencies (>90%), and the use of steam instead of liquid water. The technology is commercially available but is still far behind alkaline and PEM in terms of scale and maturity. A unique advantage of SOE is its capability to directly form syngas using co-electrolysis of steam and carbon dioxide, and to produce a mixture of hydrogen and nitrogen with co-electrolysis of steam and air. The latter is advantageous combined with ammonia production, saving costs on air separation units to produce nitrogen and the possibility to use waste heat for steam production. SOE is also capable of operating in reverse, acting as a fuel cell. A typical process flow diagram for an SOE electrolyzer is shown in Figure 3.1.

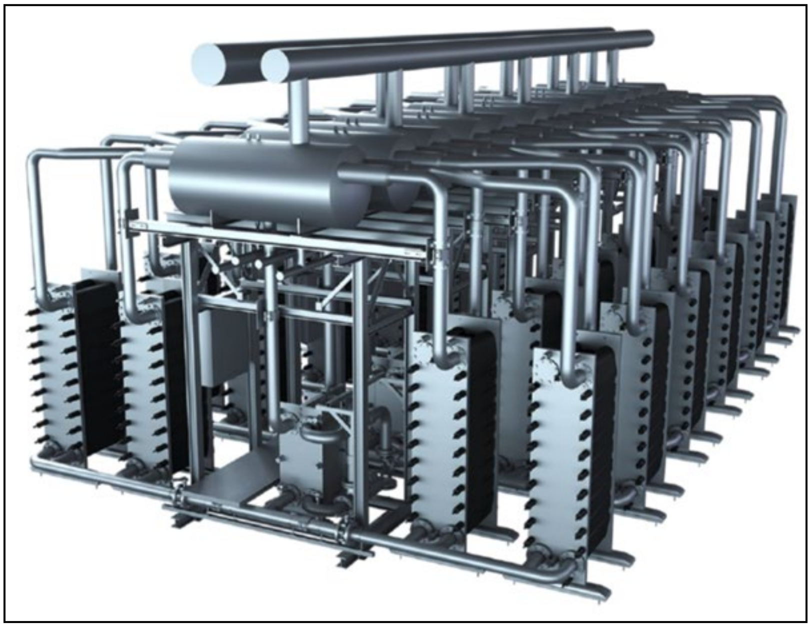


Note: O_2 = oxygen; H_2 = hydrogen

Figure 3.1 Typical Process Flow Diagram for an SOE Electrolyzer

4.0 Siemens Energy, PEM

If the Project selects a Siemens Energy's PEM electrolyzer, the model would likely be the Silyzer 300 (Figure 4.1). The full stack array of a single electrolyzer consists of 24 stacks and has a 17.5 MW plant power demand. Silyzer 300's modular design makes unique use of scaling effects. The full stack plant provides an efficiency of more than 75.5% and can produce approximately 335 kg/hr.



Source: Seimens Energy

Figure 4.1 Siemens Energy's PEM Silyzer 300 Module Array

5.0 Bloom Energy, Solid Oxide Electrolyzer Cell

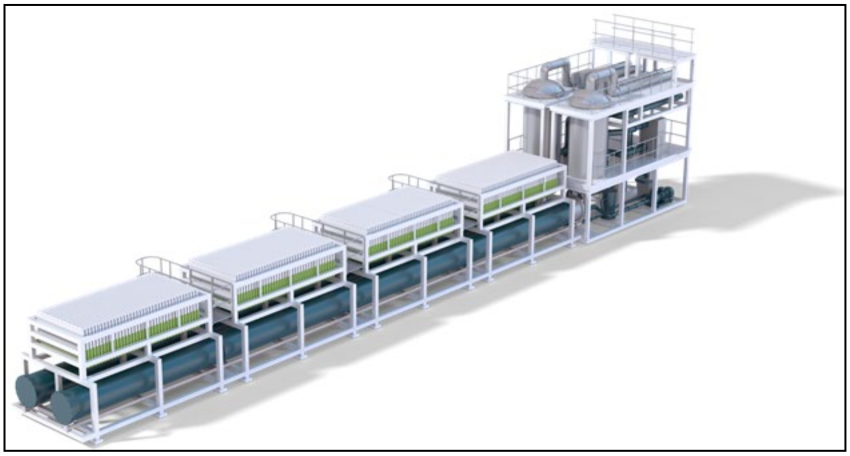
The SOEC electrolyzer being considered by the Project is the Bloom Energy SOEC (Figure 5.1). Multiple stacks of metal plates and cells are assembled into a single electrolyzer module. Each module consumes 100 kW of electricity and functions independently. Multiple individual electrolyzer modules and ancillary equipment combine to form a Bloom SOEC, in this case, at a 25 MW scale per block. A 25 MW building block can be multiplied as many times as needed to meet the capacity requirements of the facility and the stack solution offers up to four levels to get 100 MW in the same footprint. The SOEC offers the ability to grow the installation in 25 MW increments and then improve to meet the Project's final demand requirements. Multiple 25 MW blocks will supply the Project's requirement for 50 MW for the Port au Port wind farm and can be scaled for the Codroy wind farm and future expansion.

Source: Bloom Energy

Figure 5.1 Bloom Energy Example Image of Electrolyzer SOEC Plant

6.0 ThyssenKrupp, Alkaline

The ThyssenKrupp alkaline technology is being considered as an alternative by the Project. Single alkaline elements are stacked in a 20 MW electrolyzer unit, as shown in Figure 6.1. A 20 MW module can produce approximately 4,000 m³/hr of hydrogen. The prefabricated alkaline units can be easily transported, installed, and interconnected to obtain the desired plant capacity, up to several hundred megawatts or even gigawatts as a modularized solution for large-scale green hydrogen production.



Source: ThyssenKrupp Nucera

Figure 6.1 ThyssenKrupp Nucera's 20 MW Alkaline Electrolyzer

Appendix 2-B

Ammonia Production Process – Ammonia Unit Design

Stantec

PROJECT NUJIO'QONIK
Ammonia Production Process – Ammonia Unit Design

August 2023

Prepared for:

world energy GH2

Prepared by:

Stantec Consulting Ltd.

File: 121417575

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1.0 KBR

KBR's Advanced Ammonia Process integrates the chosen electrolyzer technology with an ammonia synthesis loop using KBR's ammonia synthesis technology (Figure 1.1). KBR offers a standard 6,000 metric tonnes per day (mtpd) capacity ammonia plant package that includes steam-methane reforming integrated with an ammonia synthesis loop, with a 210 m x 120 m plant footprint.

Figure 1.1 KBR's Horizontal Ammonia Synthesis Converter

The ammonia synthesis loop uses a magnetite-based catalyst in a horizontal ammonia synthesis converter, with either two or three beds and with intercoolers between the beds. In addition to the standard magnetite-based converter, KBR's Advanced Ammonia Process technology is a proprietary ammonia synthesis loop that operates at a lower synthesis loop pressure and uses ruthenium on a graphite carbon base as its catalyst.

In addition to traditional steam-methane reforming-based ammonia production, KBR offers a green ammonia plant package that integrates electrolysis arrays with hydrogen compression and storage, nitrogen production and storage, and ammonia synthesis, refrigeration and storage. Available capacities range from <200 mtpd up to 6,000 mtpd.

2.0 Topsoe

Topsoe™ S-300 ammonia converter baskets are radial flow converters (Figure 2.1) that include three catalyst beds and are available with or without a feed-effluent heat exchanger. This ammonia synthesis process uses iron-based catalysts. Topsoe offers traditional ammonia production via steam-methane reforming at capacities up to 3,500 mtpd as well as patented integrated green ammonia system packages that pair SOEC electrolyzers with an ammonia synthesis loop.

Figure 2.1 TOPSOE™ S-300 Ammonia Converter

3.0 ThyssenKrup

ThyssunKrup offer a package in which its own proprietary alkaline-water electrolysis technology is paired with its low-pressure Uhde® ammonia synthesis loop technology (Figure 3.1). The ammonia synthesis technology uses three radial-type magnetite-based catalyst beds with a heat exchanger between the catalyst beds. ThyssenKrup offers small-scale (50 mtpd capacity) modules, which includes the water electrolyzer arrays as well as the ammonia synthesis loop in one package. In addition, ThyssenKrup offers adapted solutions designed to pair its Uhde® ammonia synthesis technology with various feedstocks for ammonia production, including hydrogen. Standard ammonia production plants via steam-methane reforming are produced by ThyssenKrup at capacities of up to 5,000 mtpd.

There will be onsite storage of green hydrogen, used to buffer between the electrolyzer and ammonia units, for conversion to green ammonia within the plant's premises. Hydrogen and ammonia can be stored in various methods, with options available for both above-ground and below ground. The Project will use above-ground storage for both hydrogen and ammonia.

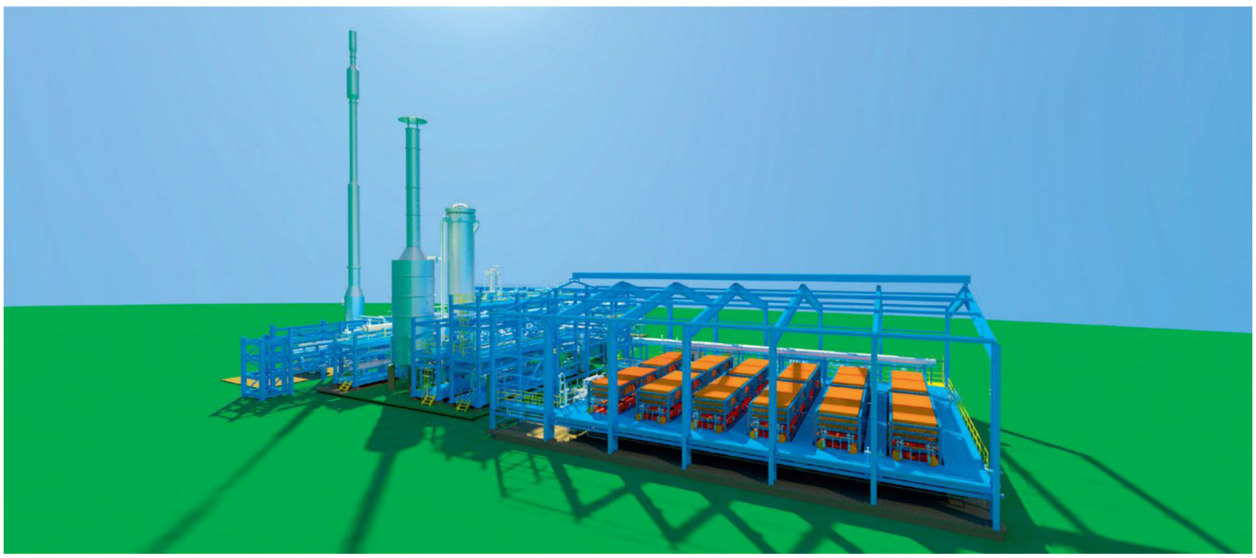

Figure 3.1 Uhde® Ammonia Synthesis by ThyssenKrup

4.0 Power Storage Facilities

4.1 Thermal Battery Storage

The Project is investigating storing power through a heat battery developed by Rondo Energy Inc. The Rondo Heat Battery (RHB) is a drop-in replacement for fossil-fired boilers and converts intermittent wind and solar power into a supply of continuous industrial heat and power. A visual flow diagram of the process is shown in Figure 4.1. The RHB uses electric heating elements, like those in a toaster or oven, to turn power when it is available into high-temperature heat. Integrating the RHB with a steam turbine converts intermittent renewables into a baseload electricity supply to control grid energy and demand charges, enhance resiliency, and satisfy heat loads.

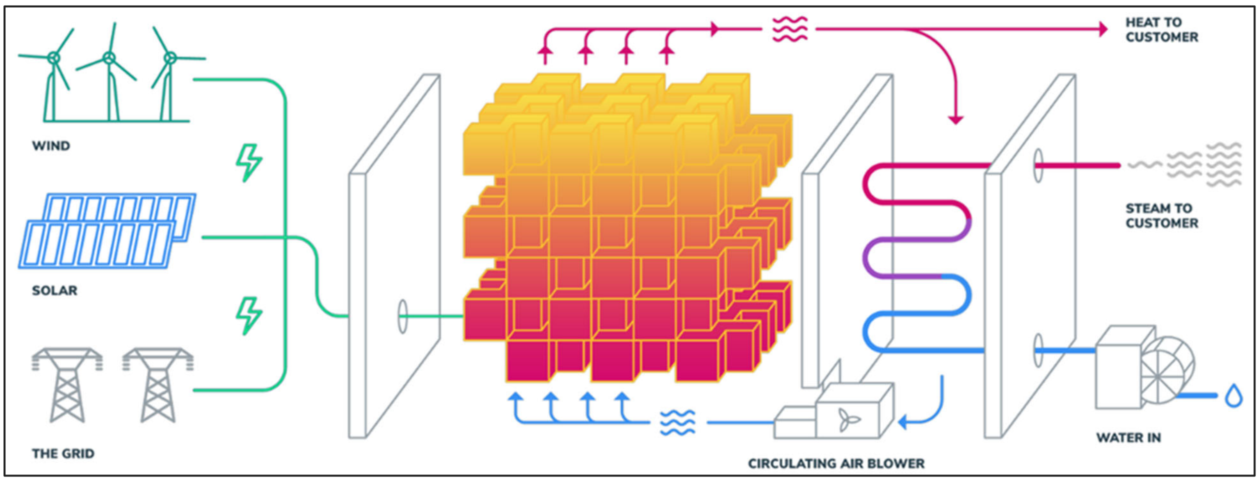

Figure 4.1 Thermal Storage Process

Electrical heaters (Joule heaters) convert electrical energy into heat at 100% efficiency, and interact smoothly with grid and off-grid generation. When power is available, the electrical heaters glow brightly and warm objects around them rapidly. Thousands of tons of brick are heated directly by this thermal radiation and store energy for hours or days with low loss (less than 1% per day).

Power and heat are delivered whenever it is needed, on demand, start-stop or continuously. When power and heat are wanted, air flows up through the brick stack and is superheated to over 1,000°C. The heat delivery rate is adjusted easily by changing air flow. Heat at the outlet is delivered at exactly the desired temperature via automated Artificial Intelligence patented controls. The air is eventually recycled back through the system, reducing heat loss and maximizing efficiency. Heat is delivered as superheated air or as superheated steam. RHBs delivers heat at the exact temperature and pressure to meet facility demands. The heat battery easily integrates into existing infrastructure.

The RHB comes in two models – the RHB100 and RHB300 – ready to be deployed and are scalable (Figure 4.2). The technical specifications of the RHB are included in Table 4.1.

Figure 4.2 RHB100 (left) and RHB300 (right)

Table 4.1 Rondo Heat Battery Technical Specifications

Parameter	RHB100	RHB300
Typical daily output	160 MWh | 545 MMBTU	480 MWh | 1,630 MMBTU
Depth of Discharge	100%	100%
Max. Discharge Rate	Typical 7 MWth Configurable up to 10 MWac	Typical 20 MWth Configurable up to 30 MWac
Energy Storage Capacity	130MWh	340 MWh
Typical Charge Rate	Typical 0 to 20 MWac Configurable up to 0 to 30 MWac	Typical 0 to 70 MWac Configurable up to 0 to 100 MWac
Number of Cycles	Unlimited, 40 years	Unlimited, 40 years
Round Trip Efficiency	> 98%	> 98%
Typical Connections Electrical – 3-phase	4,160 V	20 to 24 kV
Temperate Range	80°C to 1,500°C	80°C to 1,500°C
Dimensions	40(L) / 30(W) / 30(H) in feet 13(L) / 10(W) / 10(HJ) in metres	100(L) / 30(W) / 30(H) in feet 30(L) / 10(W) / 10(HJ) in metres

Note:
MWh = Megawatt-hour; MMBTU = Million British Thermal Units; MWth = thermal megawatt
kV = kilovolt; MWac = Mega-Watt, Alternating Current; L = length
W = width; °C = degree Celsius; H = Height
HJ =

4.2 Battery Energy Storage

Battery storage is particularly relevant to support the grid balance is it creates the ability to store power at times of excess and release it at times of deficit and high demand, which is critical to balancing supply and demand for the Project. Lithium-ion battery storage currently dominates the market, as it is the most commercially favourable form of energy storage to date. Lithium-ion battery storage has greater efficiency and flexibility, faster response times, and lower costs overall than most other storage systems.

In the charging phase, the battery converts electrical energy supplied by an external source into chemical energy: a reaction occurs which causes lithium ions to migrate to the anode. During discharge, the opposite happens, allowing a current to circulate. The main technical parameters of a battery are:

- The maximum amount of energy storage, in kWh or MWh
- The maximum power that the battery can supply (i.e., the instantaneous magnitude, expressed in kW or MW)
- The degree of decay in the above parameters (linked to the battery lifetime), in number of charge / discharge cycles

For the Project, it is estimated that a battery system set-up of around [160 MW / 250 MWh] would suffice to manage the intermittent production of the wind farm.

4.3 Renewable Diesel or Bio-Diesel Power Generator

The Project also has the option to include a renewable diesel generator to provide baseline power to maintain turn-down operations at the ammonia plant, protect the solid-oxide-electrolyzer from total shutdown, and sustain the operational instruments. The generator, estimated at a net required 50 MW capacity, will provide sufficient power to support the above mentioned needs during periods of low wind power production. The renewable diesel will have a low carbon intensity at less than 17 grams carbon dioxide per megajoule (gCO_2/MJ) (conventional diesel has a carbon intensity of over 100 gCO_2/MJ) and a stack height of 3.7 m (12 feet). The diesel generator will likely be designed similar to a peaker plant to provide maximum flexibility as the load demand fluctuates.

4.4 Salt Cavern Compressed Air Energy Storage

The Project has been evaluating storing power through CAES in salt caverns in the vicinity of the hydrogen / ammonia plant's location. The salt caverns under consideration are approximately 26 km south from of Town of Stephenville. TriplePoint Resources Ltd., based in St.-John's, NL, owns the Fischell's Brook Salt Dome mineral rights (NL's only known salt dome), a total of 226 km² of mineral licenses prospective for salt on the west coast of the Island of Newfoundland. TriplePoint Resources Ltd. intends to build, own, and operate a multi-cavern storage facility. Hydrogen and/or power can be stored in the salt cavern.

CAES is a way to store electrical power for later use using compressed air. At utility scale, energy generated during periods of low energy demand (off-peak) can be released to meet higher demand (peak load) periods. CAES is a proven technology, with several plants up and running for multiple years. In a CAES plant, ambient air or another gas is compressed and stored under pressure in an underground cavern. When electricity is required for the production of hydrogen, the pressurized air is heated and expanded in an expansion turbine driving a generator for power production.

CAES (and hydrogen) can be produced and injected into the caverns quickly and removed quickly, which will support emergent or peak needs for air to power, or as subsistence for wind to electrolyzer generation or other utility requirements. The TriplePoint caverns will be large enough to allow for the continuous generation of products that typically lowers the cost of operation and production. In addition, the caverns can deliver stored energy quickly to service variable load demands making it an efficient "battery" for a wind to hydrogen project. Use of the caverns could the Project to operate with reduced or no pressure spheres at surface. This reduces both the Project footprint and the ecological and environmental effects to the land base. Although caverns are initially expensive to wash, they have lower ongoing costs of maintenance, especially for hydrogen storage, and substantially longer lifecycles with less operational risk compared to pressure spheres.

Hydrostor, founded in 2010 and head quartered in Toronto, Ontario, has developed the Advanced Compressed Air Energy Storage (A-CAES) technology, which builds upon traditional CAES by using thermal storage for heat generated during compression and offers siting flexibility due to the hard rock caverns optionality. A-CAES can be deployed at utility scale while offering similar power flexibility rates as flywheels or Lithium-ion battery energy storage systems. The process from air compression to energy storage of the A-CAES technology is shown in Figure 4.3.

A-CAES is comprised of the following steps:

1. Compression: Off peak or renewable electricity powers a compressor, which produces heated, compressed air
2. Heat Exchanger: Heat is extracted from the air and captured by the thermal management system for reuse
3. Air Pump: Air is pumped down the shaft into a water filled cavern
4. Water Displacement: Compressed air forces water up the shaft to the surface reservoir
5. Fully Charged State: Once the reservoir is filled the plant is ready to provide electricity on demand

The Fischell Brook salt dome is a subterranean high density, zero permeability salt deposit large enough to allow for the creation of more than 10 large caverns, with an opportunity to wash additional smaller volume caverns. The larger caverns can individually store up to 1 million m^3 or more of compressed air or green hydrogen safely. TriplePoint is planning to develop caverns that will vary in size from 500,000 m^3 to 1 million m^3. The company's initial cavern developed will likely be approximately 500,000 m^3, with future caverns developed to suit project requirements for CAES and hydrogen. Caverns in the Fischell Brook salt dome are estimated to be able to provide approximately 500 MW and 8 to 14 hours of storage per cavern, which would be more than sufficient for the Project to manage intermittent wind energy production.

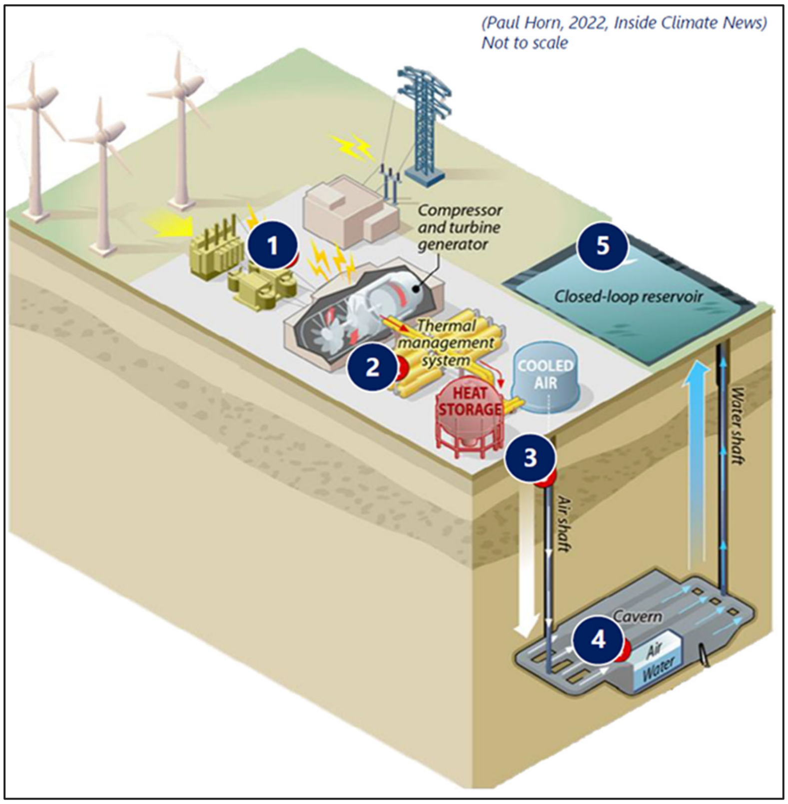

Figure 4.3 Hydrostor's Advanced Compressed Air Energy Storage Process

4.5 Electrical Infrastructure

Based on preliminary design, some Project-related electrical infrastructure may be located within approximately 1.7 km of the end of the runway for the Stephenville International Airport. Standard mitigation measures will be in place to reduce the risks of potential electromagnetic noise (EMN) interference with airport operations and other potential conflicts with local aviation (e.g., transmission line collision risk).

Appendix 2-C

Transportation Impact Study and Traffic Management Plan

PROJECT NUJIO'QONIK
Transportation Impact Study and Traffic Management Plan

August 2023

Prepared for:

Prepared by:

Stantec Consulting Ltd.

File: 121417575

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Ray Lei, M.Sc., EIT.

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Rodney Blanchard, CTech, CPT

Mirhoseini, Arash

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Arash Mirhoseini, M.Sc., P.Eng., PMP.

Flower, Peter

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Peter Flower, P.Eng.

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1.0 Introduction

World Energy GH2 (WEGH2) is proposing Project Nujio'qonik (the Project). The Project involves the development, construction, operation and maintenance, and eventual decommissioning and rehabilitation of one of the first Canadian, commercial-scale, "green hydrogen" and ammonia production plants powered by renewable wind energy. Located on the western coast of the island of Newfoundland, Newfoundland and Labrador (NL), the Project will have a maximum production of up to approximately 206,000 tonnes of green hydrogen (equivalent to approximately 1.17 megatonnes (Mt) of ammonia) per year. The hydrogen produced by the Project will be converted into ammonia and exported to international markets by ship. The hydrogen / ammonia plant and associated storage and export facilities will be located at the Port of Stephenville (in the Town of Stephenville, NL) on a privately-owned brownfield site and at an adjacent existing marine terminal, both of which are zoned for industrial purposes.

Renewable energy from two approximately 1,000 megawatt (MW) / 1 gigawatt (GW) onshore wind farms on the western coast of Newfoundland will be used to power the hydrogen and ammonia production processes. These wind farms (referred to herein as the "Port au Port area wind farm" and the "Codroy area wind farm") will include up to 328 turbines and collectively produce approximately 2,000 MW / 2 GW of renewable electricity. The Port au Port wind farm will include up to 164 wind turbines, with up to 171 sites that are being studied for the EIS, on the Port au Port Peninsula, NL and adjacently on the Newfoundland "mainland" (i.e., northeast of the isthmus at Port au Port). The Codroy wind farm will also consist of up to 164 wind turbines located on Crown land in the Anguille Mountains of the Codroy Valley, NL. The modelling and assessment work is based on preliminary layouts for both wind farm sites (i.e., 171 potential turbine locations at the Port au Port wind farm and 143 potential turbine locations at Codroy wind farm). Final wind farm layouts will be dependent on results of the wind campaign and more detailed field investigations. Once the layout and number of turbines are finalized, the results of models will be reviewed and updated as required.

The Project is subject to provincial environmental assessment (EA) requirements under the NL *Environmental Protection Act* and associated *Environmental Assessment Regulations* (EA Regulations). This document is the Transportation Impact Study and Traffic Management Plan, prepared in support of an Environmental Impact Statement (EIS) and required under section 7.2.4 of the EIS Guidelines.

1.1 Project Transportation Overview and Location

The locations of the Project sites are shown in Figure 1.1 and the locations of turbines are illustrated in Figure 1.2 and Figure 1.3.

Materials, equipment, and components for construction and commissioning of the Project, will be delivered by ship to the Port of Stephenville and be stored at laydown areas before being distributed to the appropriate construction site. Two alternative landing sites have also been defined/planned for the Port au Port peninsula to accommodate direct landing of large equipment. This may include specialized heavy equipment, transmission line materials, large wind turbine components, and components for the hydrogen/ammonia plant and ship-loading system. Distribution of components during construction will include:

- Use of existing or upgraded roads at the Port to transport components / materials to the hydrogen/ammonia plant site.
- Use of barges to transport wind farm and transmission line / transformer materials and equipment to the wind farm on the Port au Port Peninsula using the proposed marine landing sites
- Use of the local and private road network to transport wind farm and transmission line / transformer materials and equipment to the portion of the Port au Port Wind Farm located on the east side of Port au Port Bay.
- Use of the local road network and the TransCanada Highway (Route 1) to transport wind farm and transmission line / transformer materials and equipment to the Codroy Wind Farm site.

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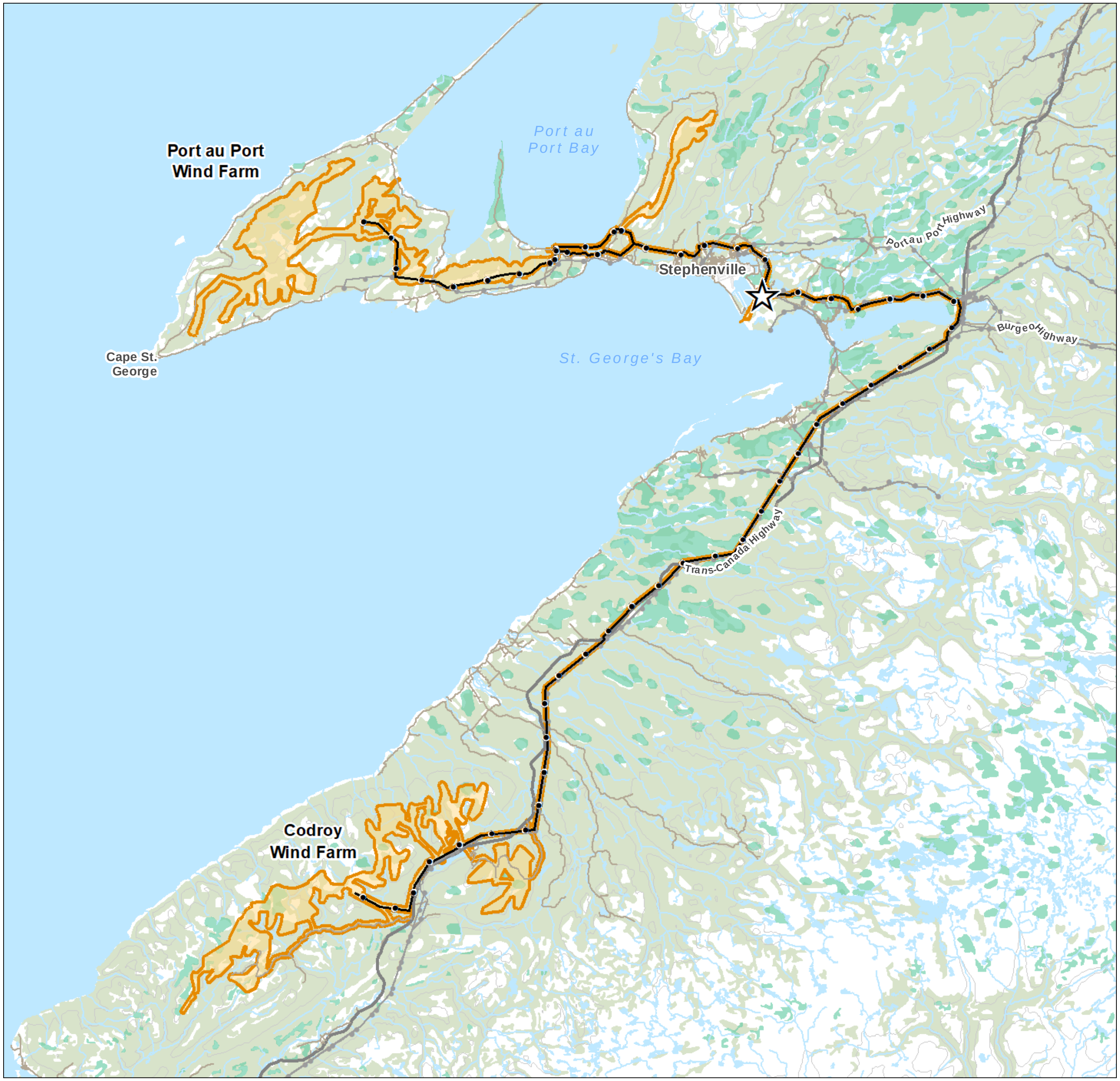

Stantec

Proposed Project Features

- Hydrogen / Ammonia Plant Location
- Transmission Line 230 kV
- Project Area

Other Features

- Transmission Line, Existing
- Trans-Canada Highway
- Road
- Contour (100 m)
- Watercourse
- Waterbody
- Wetland
- Forested Area

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Notes

1. Coordinate System: NAD 1983 CSRS UTM Zone 21N
2. Data Sources: World Energy GH2, NRCan CanVec, OpenStreetMap
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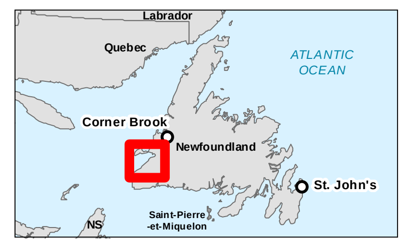

Project Location
Stephenville
NL

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Client/Project
World Energy GH2
Project Nujio'qonik

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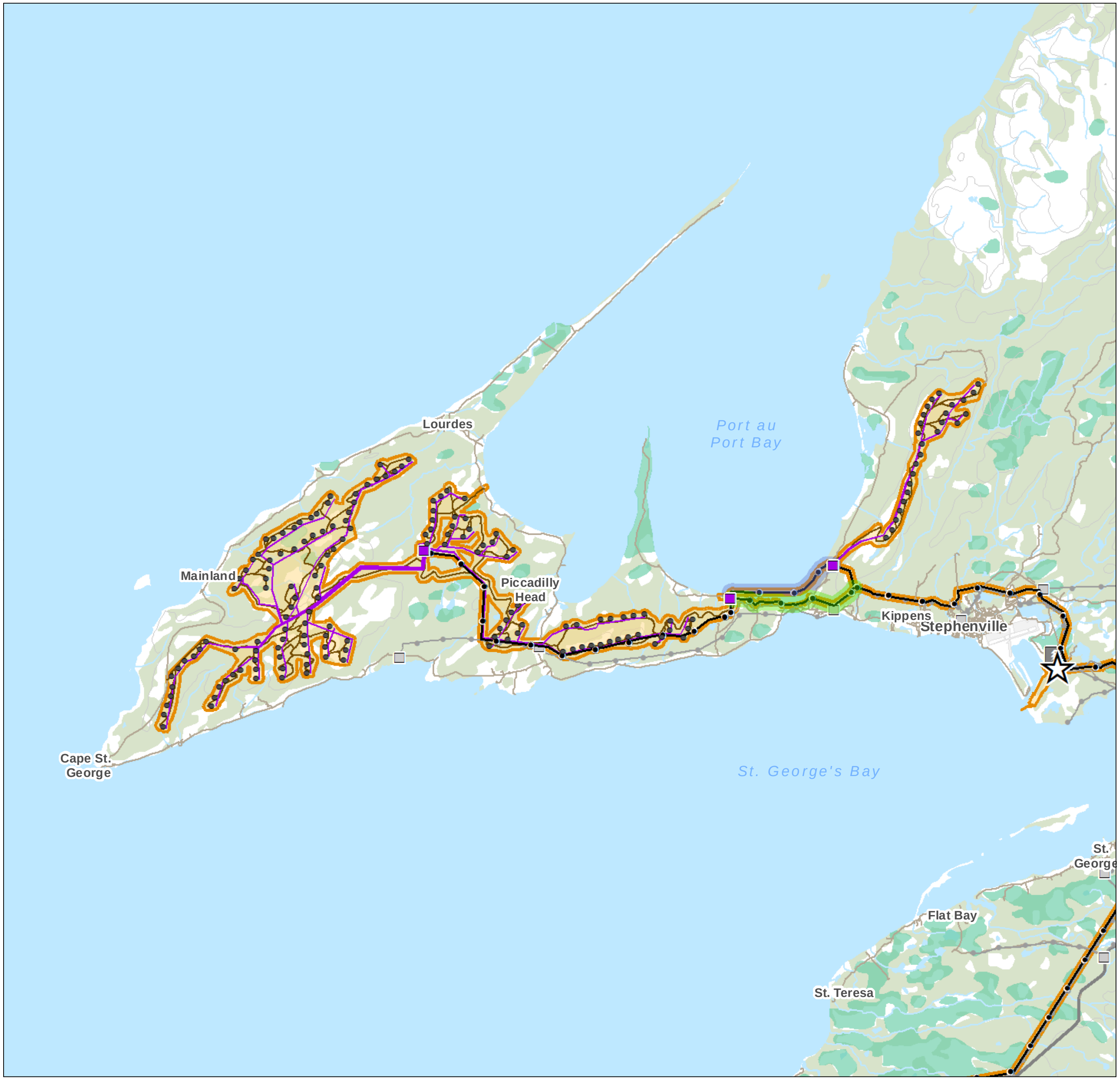
Figure No.
1.1

Proposed Project Features (All Areas)



Stantec

Proposed Project Features

- Turbine Location
- Substation
- Hydrogen / Ammonia Plant Location
- Transmission Line 230 kV

Port au Port Interconnection

- Proposed Route
- Alternate Route
- Collector Line
- Access Road
- Project Area

Other Features

- Substation, Existing
- Electrical Generation, Existing
- Transmission Line, Existing
- Trans-Canada Highway
- Road
- Contour (100 m)
- Watercourse
- Waterbody
- Wetland
- Forested Area

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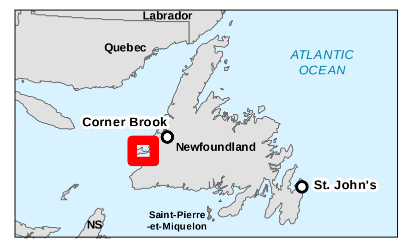

Project Location
Stephenville
NL

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Project Nujio'qonik

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Figure No.
1.2

Proposed Project Features (Port au Port Wind Farm)

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Stantec

Proposed Project Features

- Turbine Location
- Substation
- Transmission Line 230 kV
- Collector Line
- Access Road
- Project Area

Other Features

- Transmission Line, Existing
- Trans-Canada Highway
- Road
- Resource Road / Trail
- Contour (100 m)
- Watercourse
- Waterbody
- Wetland
- Forested Area

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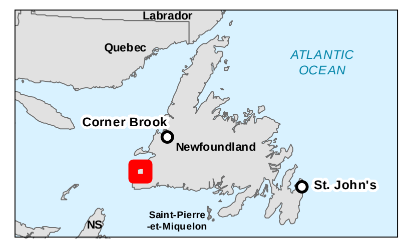

Project Location
Stephenville
NL

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Project Nujio'qonik

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Figure No.
1.3

Proposed Project Features (Codroy Wind Farm)

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1.2 Scope of the Study

A Transportation Impact Study (TIS) has been developed in consideration of the section 7.2.4 of the final EIS Guidelines. This study focuses on the potential effects of transporting oversized and overweight Project materials and equipment over existing roadways during construction, operation, maintenance, modification, and decommissioning, and rehabilitation phases of the Project. The marine transportation of project materials is not considered in this study.

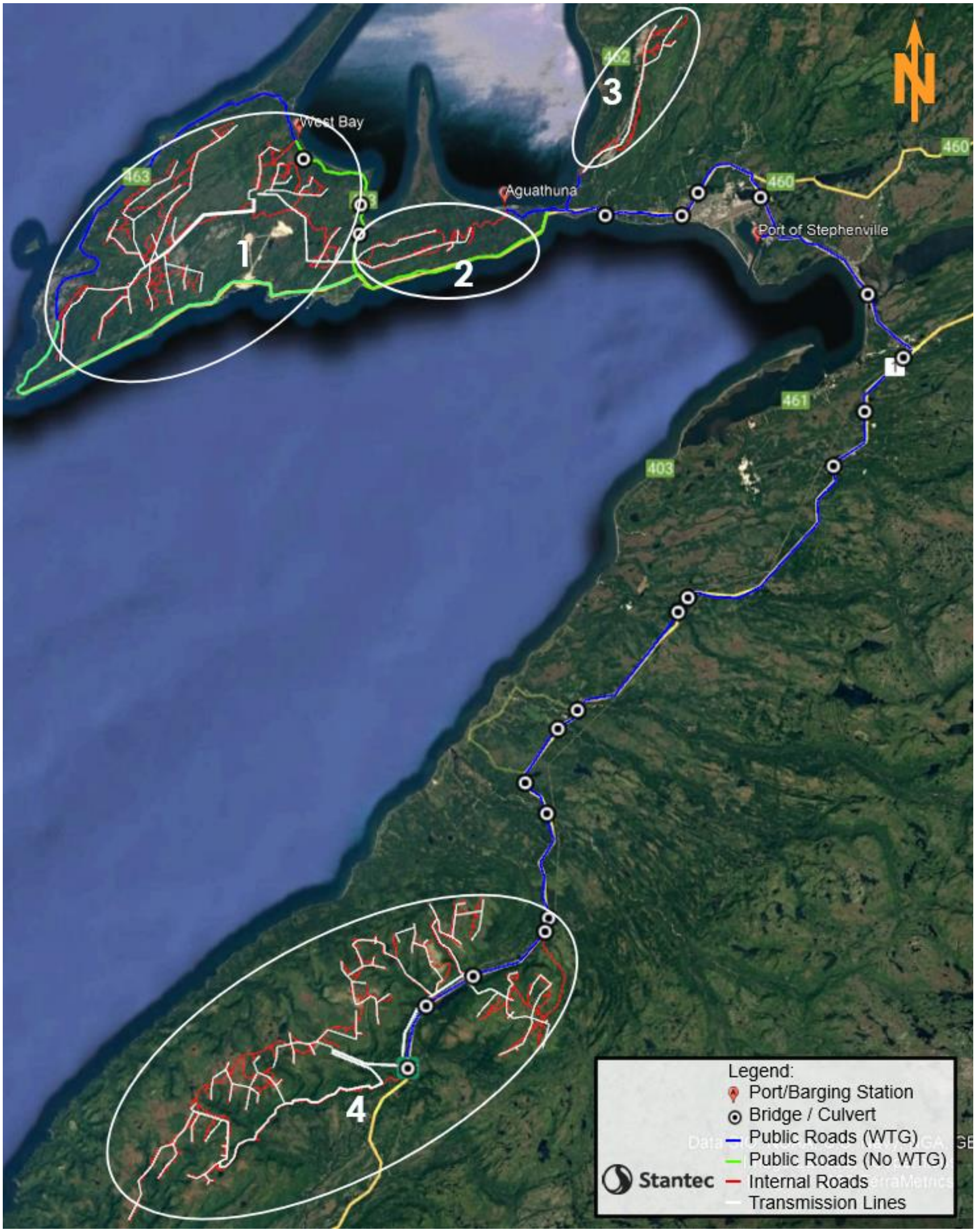
Among all phases of the Project, it is identified that the construction phase represents the worst-case scenario since oversized and overweight Project materials and equipment will be transported to the site during the construction period. It is also important to note that components for the construction of hydrogen/ammonia plant will be transported from the laydown areas at the Port of Stephenville to the adjacent construction site using the road network at the port and Harbour Drive, which is also used for delivery of oversized and overweight Project materials and equipment. Therefore, this study focuses on the impact of transporting oversized and overweight Project materials and equipment during the construction phase of the wind farms. In addition, a Traffic Management Plan and Swipe Path Analysis was conducted to confirm the site accessibility during the transporting of oversized and overweight Project materials and equipment or components. The TIS is focused on the following components:

- Existing infrastructure (i.e., roads) will be used to transport oversized and overweight Project materials and equipment during the construction phase of the wind farms.
- Traffic volume analysis for the proposed routes to be used for Project-related transportation.
- Mitigation measures including planned infrastructure to support barging component from the port or laydown areas to one of two landing sites.

As detailed below, the approach to this study has been developed based on both data provided by the client and NL government, and publicly available information.

2.0 Road Infrastructure

This section of the report discusses the existing road infrastructure that will be used during all phases of the Project. For the convenience of traffic analysis, the wind farms are generally divided into four areas. Area 1 is located on the west side of the Port au Port peninsula, west of Route 463. Area 2 is located on the east side of the Port au Port peninsula, east of Route 463. Area 3 is located on the north of Stephenville, nearby the Route 462. Area 4 is located near the Codroy Pond and on both sides of the Trans-Canada Highway (Route 1). The existing road infrastructures that will be used during construction, operation, maintenance, modification, decommissioning and rehabilitation phases of the Project are shown in Figure 2.1.



Source: Google Earth

Figure 2.1 Road Infrastructure

2.1 Port / Barging Stations

As previously noted, materials, equipment, and components, including oversized and overweight components, will be brought to the Port of Stephenville by ship, stored at the port itself or at additional laydown area secured/available at the Stephenville airport and distributed to the appropriate construction site. To reduce disruptions to local traffic flow on the Port au Port peninsula when necessary, and to manage the effort of transporting oversized and overweight project materials and equipment, Project materials and equipment may also be barged from the Port of Stephenville to two locations on the peninsula: West Bay and Aguathuna.

These two sites will provide landing locations for barges with turbine components and supporting materials and infrastructure. For Area 1, turbine components and supporting materials, infrastructure, and equipment can be barged to both the West Bay and Aguathuna sites and transported by land to the construction site. For Area 2, components barged to Aguathuna will be transported to the construction sites in Area 2.

For Areas 3 (Port au Port East turbine sites) and 4 (Codroy Wind Farm), components, materials, and components will be delivered to the construction sites by road from the Port of Stephenville.

2.2 Highways

Construction materials, equipment, and components for the wind farms and supporting infrastructure will be transported to Areas 1 to 4 using the local road network (Table 2.1). These routes will also be used to transport Project personnel to the construction sites.

Table 2.1 Highway Information

Road	Classification	Speed limit (km/h)	Number of Lanes	Area*
Route 1	Provincial Highway	100	2 / 3 / 4	4
Route 460	Regional Road	60	2	1 2 3 4
Route 462	Regional Road	50	2	3
Route 463	Regional Road	60	2	1
Route 490	Regional Road	80	2	1 2 3 4
Main Street/Aguathuna Road	Local Road	50	2	2
Harbour Drive	Local Road	50	2	1 2 3 4
Note: *see Figure 2.1 for Areas defined for the purpose of the TIS				

As shown in Figure 2.1, the delivery routes of oversized and overweight components for each Area of the Project are highlighted in blue as further described as follows:

- For Area 1, for delivery of components starting from West Bay, the trucks will cross Route 463 to access the internal roads leading to the sites for wind turbine installation. Alternatively, some trucks can turn right on Route 463 and transport the turbine components to the southwest portion of Area 1 if the internal road network has accessibility issues. For delivery of components starting from Aguathuna, the trucks will cross Aguathuna Road to access internal roads in Area 2 and then cross Route 463 to access Area 1 sites for wind turbine installation. About 8% of Area 1 turbine components will be shipped from Aguathuna since 10 proposed turbine sites are located relatively closer to it.
- For Area 2, shipments from Aguathuna will cross Aguathuna Road to access the internal roads.
- For Area 3, trucks departing from Port of Stephenville will leave the port through Harbour Drive and turn left to Route 490, then turn left to Route 460, and finally turn right to Route 462 to access the Port au Port East site.
- For Area 4, trucks will start from Port of Stephenville, leave the port through Harbour Drive, turn right to Route 490, and finally turn right onto Route 1 to access the Codroy Wind Farm. .

The delivery routes of other construction materials for each Area of the Project are highlighted in blue or green depend on whether the route overlaps with the delivery routes of turbine components or not:

- For Area 1, trucks departing from Port of Stephenville will leave the port through Harbour Drive and turn left to Route 490, then turn left to Route 460. Trucks will turn right to Route 463 to access the rest of the Area 1. Alternatively, some trucks will continue drive on Route 460 until reach the southwest portion of the Area 1 site.
- For Area 2, trucks departing from Port of Stephenville will leave the port through Harbour Drive and turn left to Route 490, then turn left to Route 460, finally access the Area 2 site through Aguathuna Road.
- For Area 3, the route is the same as the delivery routes of oversized and overweight components.
- For Area 4, the route is the same as the delivery routes of oversized and overweight components.

A truck swept path analysis has been completed as part of this assessment and is discussed in a later section of this report.

2.3 Bridges and Culverts

Bridges and large diameter culverts that exist on the transportation routes are listed in Table 2.2. The location of bridges and culverts can be found on Figure 2.1. There are no existing bridges or large diameter culverts along the routes from West Bay to Area 1, or from Aguathuna to Area 2.

Table 2.2 Bridges and Culverts Information

ID	Road	Structure Name	Structure Type	Year Built	Design Load Code
West Bay to Area 2					
1	Route 463	Harry's River Multi-Plate	Culvert (Steel)	1974	N/A
2	Route 463	Piccadilly Slant Multi-Plate	Culvert (Steel)	1975	N/A
3	Route 463	Piccadilly Multi-Plate	Culvert (Steel)	1974	N/A
Port of Stephenville to Area 3					
4	Route 490	Noel's Pond Multi-Plate	Culvert (Steel)	1983	N/A
5	Route 460	Blanche Brook Bridge	Bridge (Conc.)	1980	MS200
6	Route 460	Gadons Brook Bridge	Bridge (Conc.)	1995	CS-600
7	Route 460	Romaines River Bridge	Bridge (Conc.)	1955	Unknown
Port of Stephenville to Area 4					
8	Route 490	Main Gut Bridge	Bridge (Conc.)	1973	HS 20-44
9	Route 1	Little Barachois Brook Bridge	Bridge (Conc.)	2021	CL-625
10	Route 1	First Dribble Pond Culvert	Culvert (Steel)	1964	N/A
11	Route 1	Flat Bay Brook Bridge	Bridge (Conc.)	2009	CL-625
12	Route 1	Fischell's Brook Bridge	Bridge (Conc.)	2010	CL-625
13	Route 1	Little Fischell's River Multi-Plate	Culvert (Steel)	1982	N/A
14	Route 1	Robinson's River Bridge	Bridge (Conc.)	2012	CL-625
15	Route 1	Middle Barachois River Bridge	Bridge (Conc.)	2011	N/A
16	Route 1	Little Crabbes River	Culvert (Steel)	1968	N/A
17	Route 1	Crabbe's River Bridge	Bridge (Conc.)	1994	CS-600
18	Route 1	Highlands River Bridge (River BK.)	Bridge (Conc.)	2006	CL-625
19	Route 1	Bald Mountain Brook Bridge	Bridge (Conc.)	1961	HS 20-44
20	Route 1	Codroy Pond CNR Overpass	Arch Culvert (Steel)	2006	N/A
21	Route 1	Morris Brook Bridge	Bridge (Conc.)	1955	HS 20-44
22	Route 1	North Branch CNR Overpass	Culvert (Steel)	1997	N/A

2.4 Internal Roads

In addition to the existing road infrastructures, a series of internal/project roads will be constructed to be used throughout the life of the Project including transport the materials, equipment, and components to and around the wind farm sites and to support on-going maintenance. As shown in Figure 2.1, the internal roads highlighted in red will be used to connect the barge landing sites or public roads to the turbine locations. The internal roads will be designed and constructed to accommodate the weight, size and turning movements of the trucks and equipment.

3.0 Traffic Analysis

This section discusses the potential traffic impact of transporting oversized and overweight Project materials, equipment, and components over existing roadways. The peak daily trips generated by the Project will be estimated based on the site trips planned during the construction phase, when the majority of oversized / overweight cargo will occur.

3.1 Annual Average Daily Traffic Volume

The locations and annual average daily traffic (AADT) volumes of selected intersections provided by the NL Department of Transportation and Infrastructure are listed in Table 3.1. The location of the data collection points and AADT of each segment are illustrated in Figure 3.1. No growth rate was applied to the AADTs.

Table 3.1 Intersections with AADT Data

Intersection	Legs	2013 AADT	Heavy Vehicle (HV)%
Route 1 and Route 490	North (Corner Brook)	1,537	28.32%
	West (Stephenville)	1,079	12.82%
	South (Channel - P.A.B)	2,166	29.51%
Route 1 and Route 403	North (Corner Brook)	2,039	26.46%
	West (Flat Bay)	333	3.61%
	South (Channel - P.A.B)	1,737	27.86%
Route 1 and Route 404	North (Corner Brook)	1,619	37.39%
	West (Robinsons)	338	4.92%
	South (Channel - P.A.B)	1,144	28.64%
Route 1 and Route 404	North (Corner Brook)	1,244	29.13%
	West (Jeffrey's)	194	4.49%
	South (Channel - P.A.B)	1,295	25.55%
Route 1 and Route 405	North (Corner Brook)	1,173	10.62%
	West (St. Davids)	218	4.15%
	South (Channel - P.A.B)	908	23.38%
Route 460 - Boswarlos - Stephenville	West (Boswarlos)	8,169	27.19%
	South (Route 460)	2,566	8.08%
	East (Stephenville)	1,683	39.76%
Route 490 and Seal Cove Road	North (Stephenville Crossing)	1,154	13.80%
	West (Stephenville)	3,858	7.24%
	East (Route 1)	2,789	12.69%
Romaines River Bridge	-	1,200	Not Available
Main Gut Bridge	-	3,858	Not Available

Table 3.1 Intersections with AADT Data

Intersection	Legs	2013 AADT	Heavy Vehicle (HV)%
Crabbe's River Bridge	-	2,081	Not Available
Morris Brook Bridge	-	2,871	Not Available

Source: Google Earth

Figure 3.1 AADT Locations

The maximum AADT recorded in the road network is 8,169. This was recorded on the west side of the Port au Port isthmus. The capacity of a two-lane highway is 1,700 vehicles per hour (veh/h) for each direction of travel (Transportation Research Board, 2000). To determine the peak hour volume at each travelling direction, it is assumed that the peak hour volume is 10% of the AADT and traffics are evenly distributed in two directions. The result peak hour volume at each travelling direction is about 410 veh/h, which is well below the default capacity of 1,700 veh/h for a two-lane highway road.

3.2 Trip Estimation

It is expected that the turbine installation will generate the highest traffic volumes which mainly include turbine component delivery trips, construction material delivery trips, and trips generated by construction staff and other personnel. It is expected that the site trips will be limited to a few weekly maintenance and site visit trips after sites become fully operational.

3.2.1 Turbine Delivery Trips

It is assumed that up to 3 turbines will be shipped to construction sites per week during the construction phase. The construction of each wind farm will not be conducted simultaneously. Construction crews will finish one area then move on to the next. It is estimated that each turbine comprised 12 to14 components/shipments to transport to a wind farm site. The number of turbine component delivery trips per day results from the above assumptions is up to 6 deliveries per day. The number of round trips per day and days of delivery are provided in Table 3.2.

Table 3.2 Estimated Turbine Delivery Round Trips

Areas	Number of Turbines	Number of Components	Daily Delivery Round Trips	Days of Turbine Delivery
Area 1	121	1,694	6	282
Area 2	24	336	6	56
Area 3	26	364	6	61
Area 4	143	2,002	6	334
Total	314	4,396	N/A[1]	733

3.2.2 Construction Material Delivery Trips

In addition to turbine delivery trips, other construction materials such as transmission line and transformer station components and materials will be shipped from Stephenville to each site. It was estimated that up to 30 construction material delivery round trips will be made per day.

[1] The delivery to the different areas will happen sequentially.

3.2.3 Personnels Trips

During the construction phase of the Project, it is estimated that approximately 400 workers will be residing in accommodations camps. Staff will be based in Stephenville and Codroy during construction of Port au Port site and Codroy site respectively, and shuttles will be provided for their commute. It is estimated that 10 shuttles are required to transport the staff back and forth between accommodations camps and project sites. In addition, it is assumed that 5 personal trips from Stephenville and 5 personal trips from the nearest ferry (i.e., Port aux Basques) to the Project sites will be made by contractors, inspectors, surveyors, and supervisors.

3.2.4 Overall Estimated Future Trips

The overall estimated peak daily round trips during the turbine installation phase are shown in Table 3.3.

Table 3.3 Estimated Peak Future Round Trips per Day during Turbine Installation

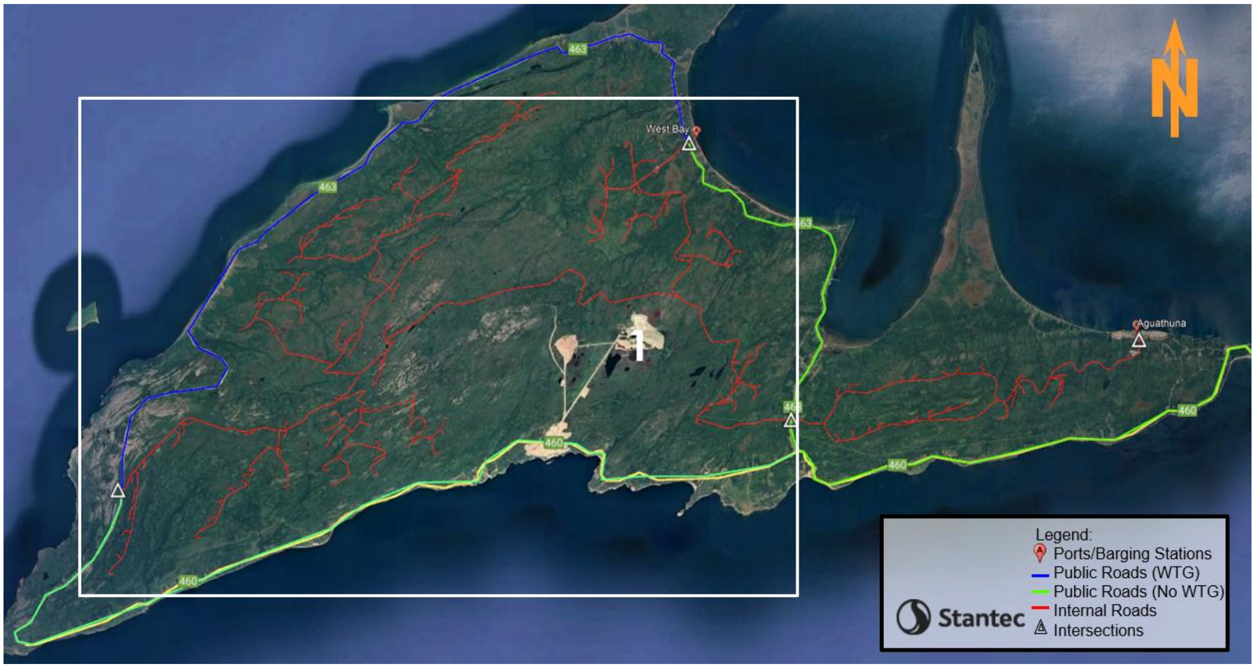
From\To	Area 1	Area 2	Area 3	Area 4
Port of Stephenville	45	45	51	41
West Bay	6	0	0	0
Aguathuna	0	6	0	0
Codroy	0	0	0	10
Port aux Basques	5	5	5	5
Total	56	56	56	56

3.3 Traffic Impact for Area 1

As shown in Figure 3.2, the Area 1 site is located on the west side of Route 463. Oversized and overweight components can be barged to both the West Bay and Aguathuna sites and transported by land to the construction site. For shipments starting from West Bay, the trucks will cross Route 463 to access the internal roads leading to the sites for wind turbine installation. Alternatively, some trucks can turn right on Route 463 and transport the equipment to the southwest portion of Area 1. The number of turbine components that will be delivered through the alternative route is not yet determined. It will be estimated based on the travel time and accessibility from the West Bay site to each individual turbine location. For shipments starting from Aguathuna site, the trucks will cross Aguathuna Road to access internal roads in Area 2 and then cross Route 463 to access Area 1 sites for wind turbine installation. Ten (10) out of 121 turbines in Area 1 are located relatively closer to the Aguathuna site. It is estimated that up to 6 round trips will take place between barging stations and wind farm site in one day during the construction season.

When trucks are making turns at the intersections or crossing a major highway, traffic will need to be stopped for up to 5 minutes to allow a truck to pass. Two traffic controller persons will be needed for each crossing location during this process. This issue will be further discussed and monitored as part of the Traffic Management Plan (Stantec 2023). Considering the traffic volume on Route 463 is fairly low, it is not expected that this process to be a cause for congestion at the crossing point.

For the delivery of other construction materials and transportation of workers, up to 50 daily round trips will be added to the road network which will not bring noticeable impact to the road network and is within the design capacity of the road network.



Source: Google Earth

Figure 3.2 Wind Farm Area 1

3.4 Traffic Impact for Area 2

As shown in Figure 3.3, Area 2 is located on the east side of Route 463. The turbine components can be barged to the Aguathuna landing site and then will be transported to the internal roads of the wind farm. Trucks need to cross Aguathuna Road when bringing material and equipment from landing site to the wind farm site.

For the delivery of oversized and overweight components, it is estimated that 6 round trips will be made between the landing site and wind farm in one day during the construction season. When trucks are crossing Aguathuna Road, traffic will need to be stopped for up to 5 minutes to allow a truck to pass. Two traffic controller persons will be needed for each intersection. This issue will be further discussed and monitored as part of the Traffic Management Plan (Stantec 2023). Considering the traffic volume on Aguathuna road are low, it is not expected to cause congestion at the crossing point.

For the delivery of other construction materials and transportation of workers, up to 50 daily round trips will be added to the road network which will not bring noticeable impact to the road network.

Source: Google Earth

Figure 3.3 Wind Farm Area 2

3.5 Traffic Impact for Area 3

As shown in Figure 3.4, Area 3 includes turbines on the east side of Port au Port Bay and is located to the north of Stephenville. Materials, equipment, and components will be delivered by road to Area 3 from the Port of Stephenville. The delivery route is highlighted in blue. Trucks will use Routes 490, 460, and 462. This route is selected to avoid passing through the residential areas of Stephenville and Kippens to the extent possible.

For the delivery of oversized and overweight components, it is estimated that 6 round trips per day will be made between the Port of Stephenville and Port au Port East site during the construction season. When trucks are making turns at the intersections, traffic will need to be stopped for up to 5 minutes to allow a truck to pass. An approved traffic management plan with appropriate traffic control will be needed for each intersection. It is worthy to note that Romaine's River Bridge is undergoing replacement and is expected to be completed in 2024. The old bridge is going to remain in place and may be able to sustain the loads required for transportation of select Project-related oversized and overweight equipment.

For the delivery of other construction materials and transportation of workers, up to 50 daily round trips will be added to the road network which will not bring noticeable impact to the road network and is within the design capacity of the road network.

Source: Google Earth

Figure 3.4 Wind Farm Area 3

3.6 Traffic Impact for Area 4

As shown in Figure 3.6, the Codroy Wind Farm is within Area 4 which is south of Stephenville. Materials, equipment, and components will be delivered by road to Area 4 from the Port of Stephenville. Trucks will start from Port of Stephenville, leave the port through Harbour Drive, turn right to Route 490, and finally turn right onto Route 1 to access the Codroy Wind Farm.

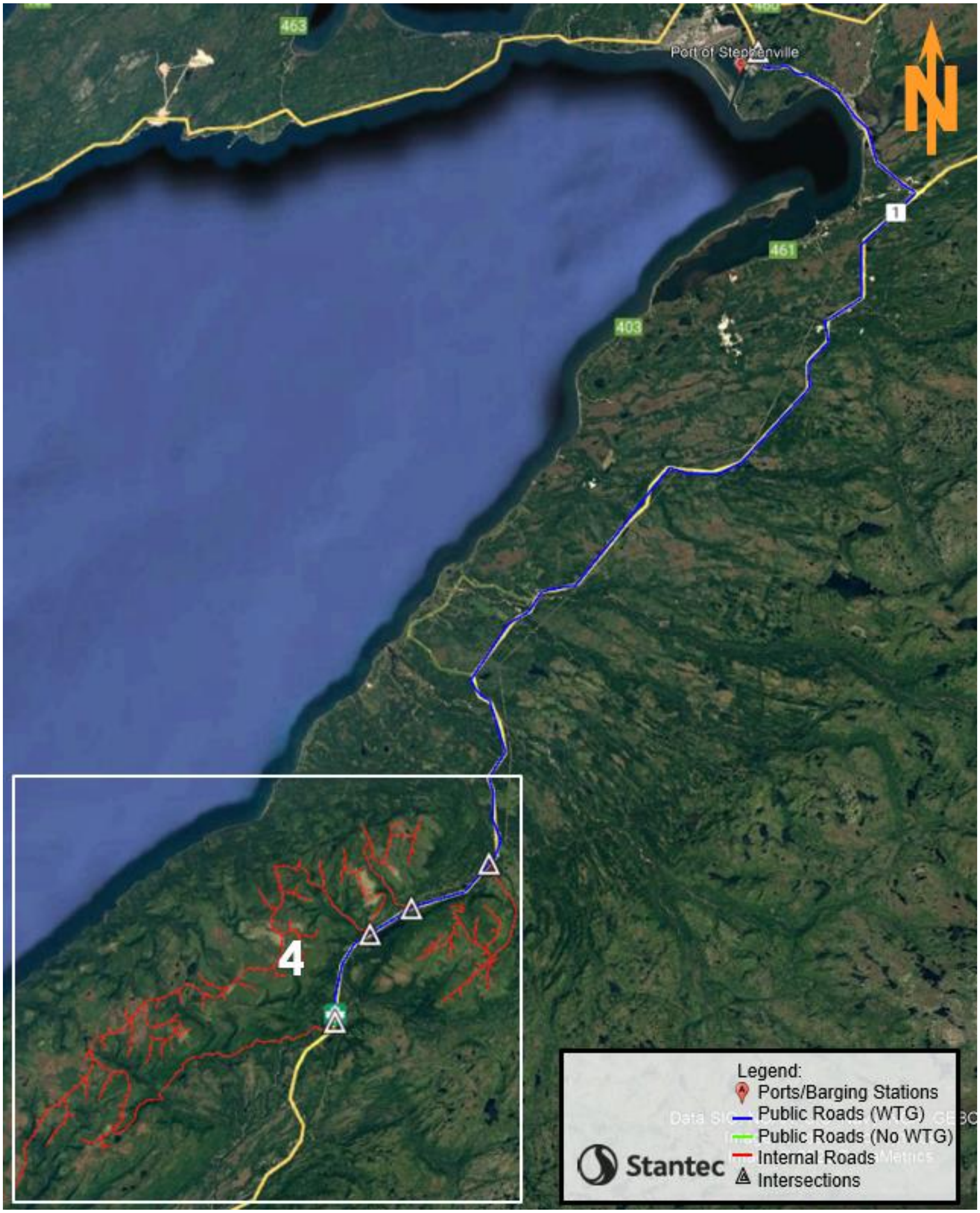
For the delivery of oversized and overweight components, It is estimated that 6 round trips will be made between the Port of Stephenville and Area 4 in one day during the construction season. When trucks are making turns at the intersections, traffic will need to be stopped for up to 5 minutes to allow a truck to pass. Two traffic controller persons will be needed for each intersection.

Although the route between Port of Stephenville and Area 4 is considerably longer than the other routes, and the travelling speed of the transport vehicle is lower than the posted speed on Route 1, the majority of sections of Route 1 have more than one lane in each direction which may reduce the impact of the transport vehicle to the general traffic. It is recommended to have escort vehicles to warn the traveling public or other motorists and schedule the delivery to avoid the ferry traffics between Stephenville and Port aux Basques. Figure 3.5 illustrates time windows of ferry traffics between Stephenville and Port aux Basques according to the Port aux Basques ferry summer schedule (Marine Atlantic, 2023).

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Traffics from Stephenville to Port aux Basques					Wed. ONLY																			
Traffics from Port aux Basques and Stephenville	Wed. Only																							Wed. Only

Figure 3.5 Time Windows of Ferry Traffic between Stephenville and Port aux Basques

For the delivery of other construction materials and transportation of workers, up to 45 daily round trips will be added to the road network which will not bring noticeable impact to the road network.



Source: Google Earth

Figure 3.6 Wind Farm Area 4

4.0 Transport Methods

For Areas 1 and 2, it has been assumed that oversized and overweight equipment and materials will arrive via barging and landing at both West Bay and Aguathuna. From there they will be transported to the adjacent development site. For Areas 3 and 4 have been assumed that oversized and overweight equipment and materials will arrive at the Port of Stephenville. Area 3 is approximately 25 km in length using the existing road network and Area 4 is approximately 120 km in length from the Port of Stephenville. The alignment assessments were conducted along these routes, between the Port of Stephenville and the wind turbines.

There are several horizontal and vertical alignment elements that were assessed to confirm if the transporter vehicle has the appropriate clearances for height and width. 90-degree turns were reviewed to determine if the maneuver can be made and if not, what modifications would be required, such as clearing, additional extra roadway and shoulder width, property encroachment, relocation of infrastructure, lengthening of culverts, and other potential temporary upgrades. The vertical clearances were assessed at the underpass structures and overhead utility locations that the transporter vehicle will pass under.

For the assessment of the horizontal clearances, Stantec used AutoCAD and Civil3D software with the specialized add-on software AutoTURN, that mimics the travel path of the design vehicle to verify wheel paths and overhang boundaries for specified movements. Without the aid of detailed profile information for the roads and ramps identified, there were limitations in being able to accurately determine if there are any significant limitations along the travel route, however, based on Google Street View and NLDTI's Bridge Inventory List, vertical clearance assessments were made, and recommendations provided that are beneficial to the overall route assessment. The assessment included a summary of challenges or problem areas along the route and provided recommendations for mitigation. More refined assessments should be conducted once the equipment and transporter vehicle loads and dimensions are finalized.

4.1 Transporter Vehicle Description

Swept path assessments (using AutoTURN) for each of the key intersections and potential pinch points along the route were undertaken. An 82.0-metre-long wind farm transporter vehicle was used for the route assessment, starting at the Port / Barging Stations and ending at the corresponding wind turbine areas. Figure 4.1 illustrates the vehicle template for the 82-metre-long wind farm truck and trailer assembly. For this assessment, the return route was not assessed. It is anticipated that the overall trailer length is reduced on the return trip to that of a standard tractor trailer, thus being able to navigate the geometry at roadway and interchange locations, with no challenges or pinch points.

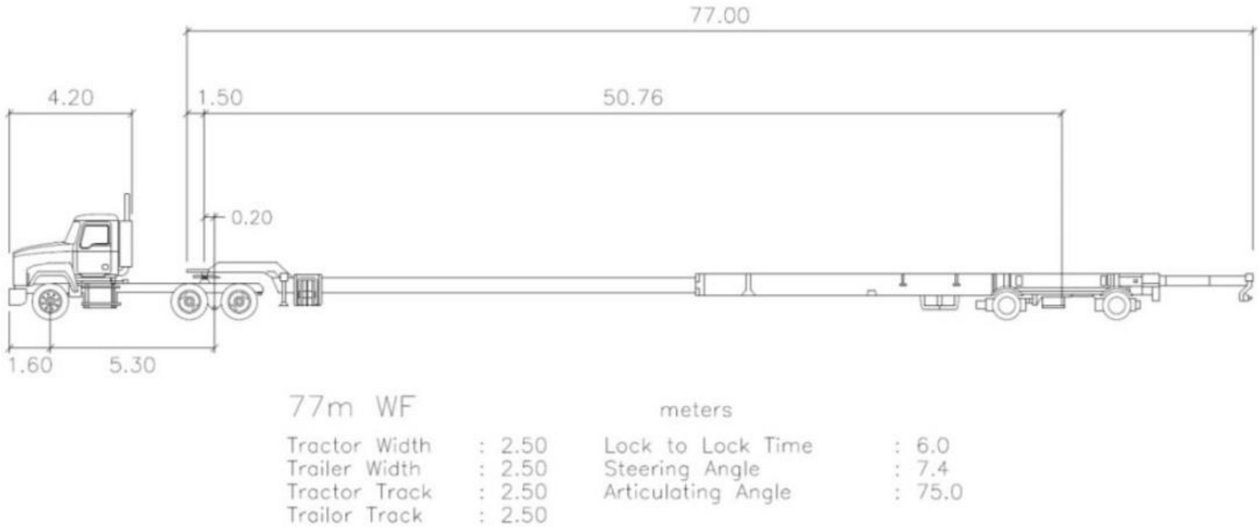


Figure 4.1 82 m Wind Farm Transporter Vehicle (77 m Blade)

It is also anticipated that other transporter vehicles will be used to facilitate transporting the other wind farm components, including generators, transformers, and turbines. It is anticipated that the vehicles used for this equipment will be via a 53-foot-long tractor trailer assembly and larger, similar to the float trailer illustrated in Figure 4.2, with the float trailer and truck having additional axles to distribute the heavy loads. Since these vehicles are of standard length, an assessment of the horizontal clearances was not conducted, as it does not exceed the footprint of the longer transport vehicle for the wind farm blades. As the vehicle loads and dimensions of the equipment and components have not been fully defined, the vertical clearances and structural load capacities of the bridges, overpasses and culverts will need to be assessed once they are known.

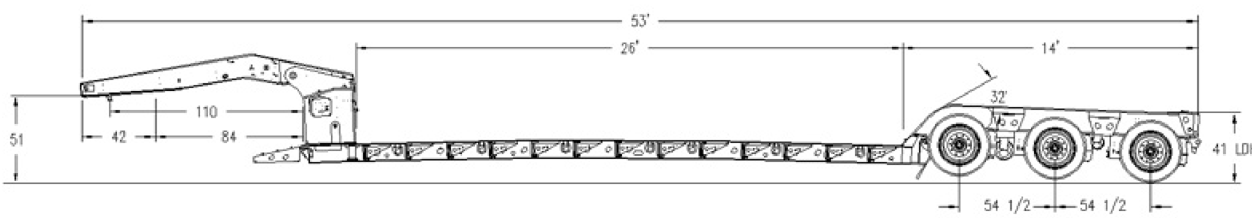


Figure 4.2 53 Foot Gooseneck Float Trailer (Imperial Measurements)

Figure 4.3 illustrates a typical style of transport unit for the various configurations of components for heavy and oversized loads. It is anticipated that 2 or 3 different trailer configurations for heavy loads (towers, blades, and transformers) will be equipped with a steerable rear unit. Table 4.1 provides a summary of the preliminary components per turbine.

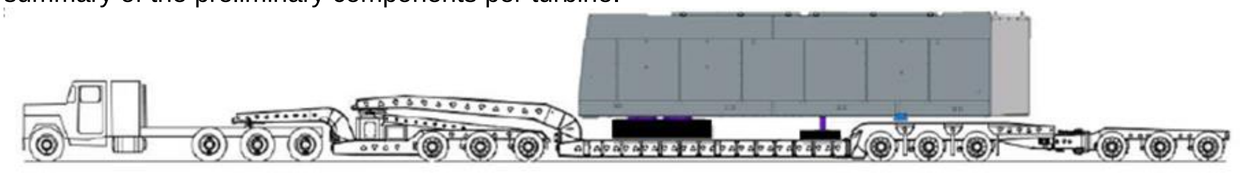


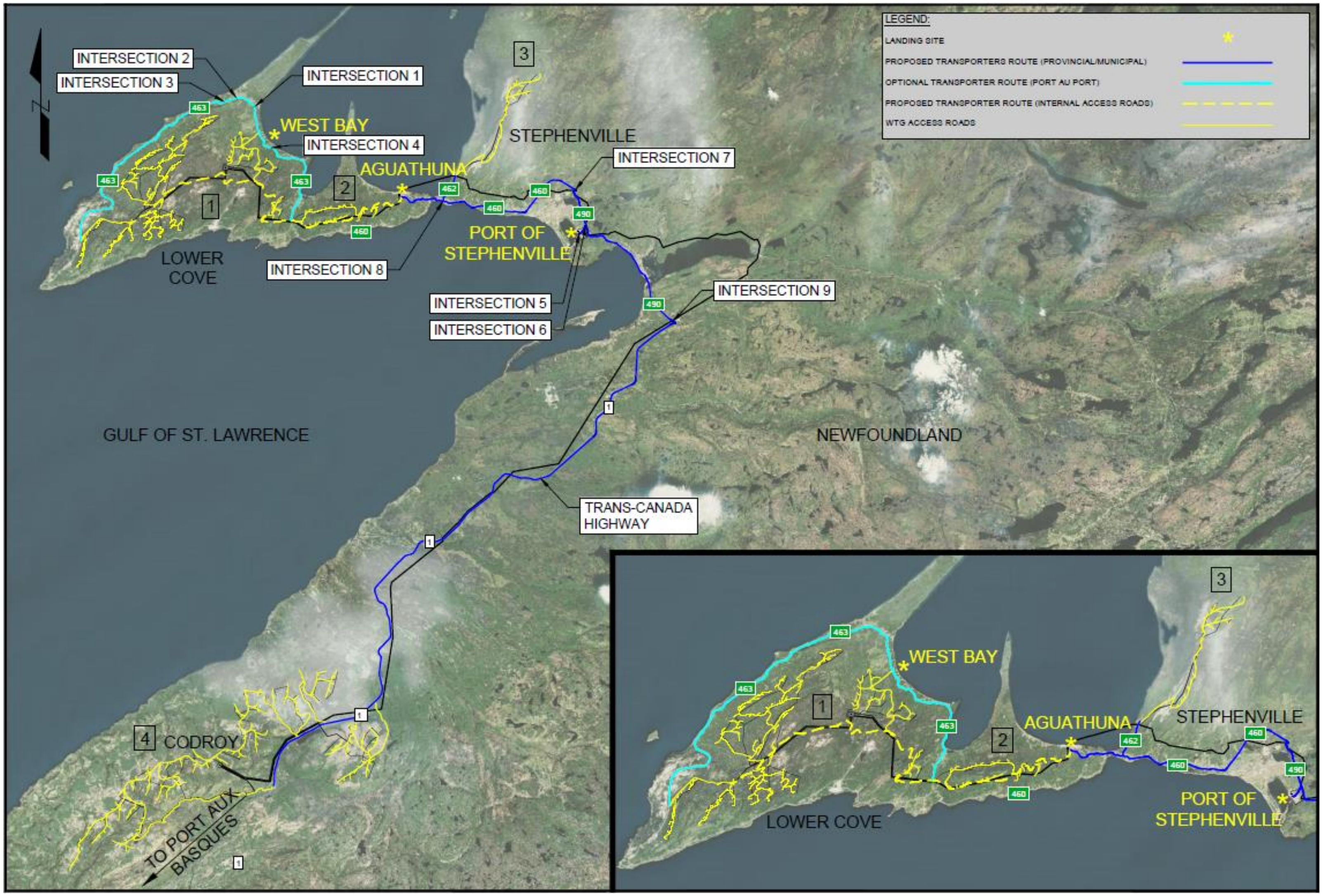
Figure 4.3 Typical Transporter Vehicle Unit

Table 4.1 Preliminary Breakdown of Transport Unit Components Per Wind Turbine

Component	Weight	Dimensions	Assumptions
1x Nacelle	60 to 85 tonnes	15 m x 4.5 m x 4.5 m	Assuming shipped in 'empty' configuration
1x Drivetrain	80 to 100 tonnes	7.5 m x 3 m x 3 m	
1x Hub	50 to 60 tonnes	5 m x 4.5 m 4.3 m	
3x Blades	20 to 30 tonnes	L = 70 m to 90 m Dia. 4.5 m x 3.0 m	
4 to 5x Tower Sections	50 to 90 tonnes	L = 20 to 30 m Dia. 4 m to 5 m	
3x loads of smaller components	< 20 tonnes	varies	

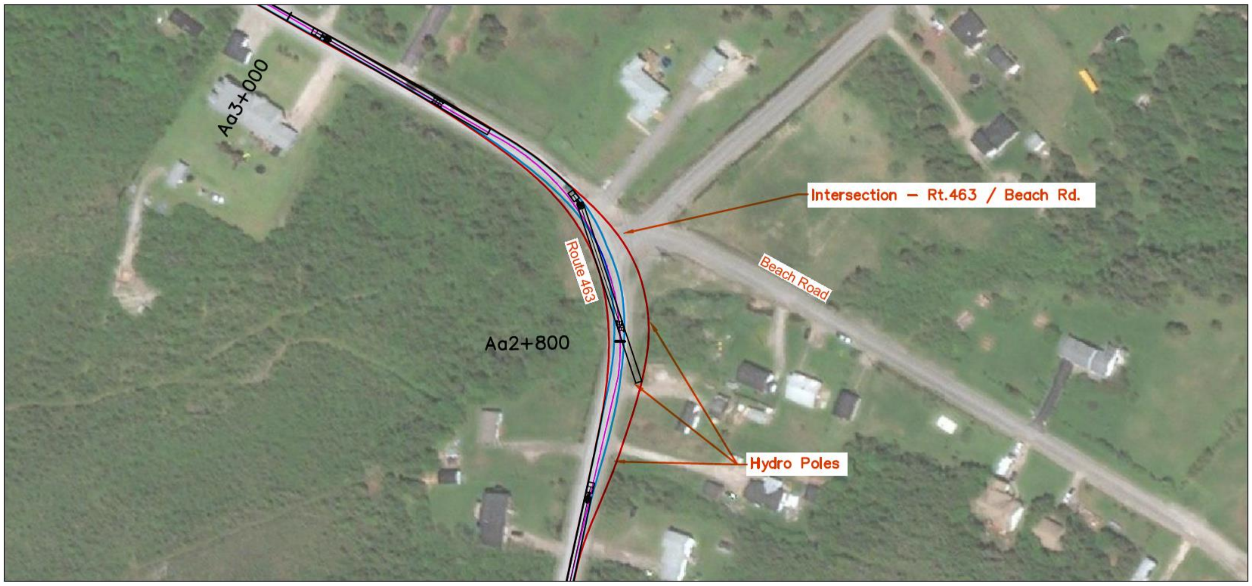
Based on the methods and transporter vehicle specifications identified in the sections above, a horizontal clearance assessment through a swept path analysis was performed. The analysis used the methods and transporter vehicle specifications identified in Section 4 and as described in Figure 4.1. Based on the analysis, nine (9) intersections were identified that pose potential turn movement conflicts along the described routing. The figures below illustrate the required path and the table in this section summarizes the locations with proposed mitigation measures for the required movements.

The results of the swept path analysis for the route are provided below, including an overall map of the routes and the specific locations with zoomed in images (Figure 4.4 to 4.13) and provides a summary of the assessment in Table 4-1. It is anticipated that, with the exception of the Trans-Canada Highway, a number of the routes will require lane closures in order for the transporter vehicle to maneuver along the provincially designated and local roadways.



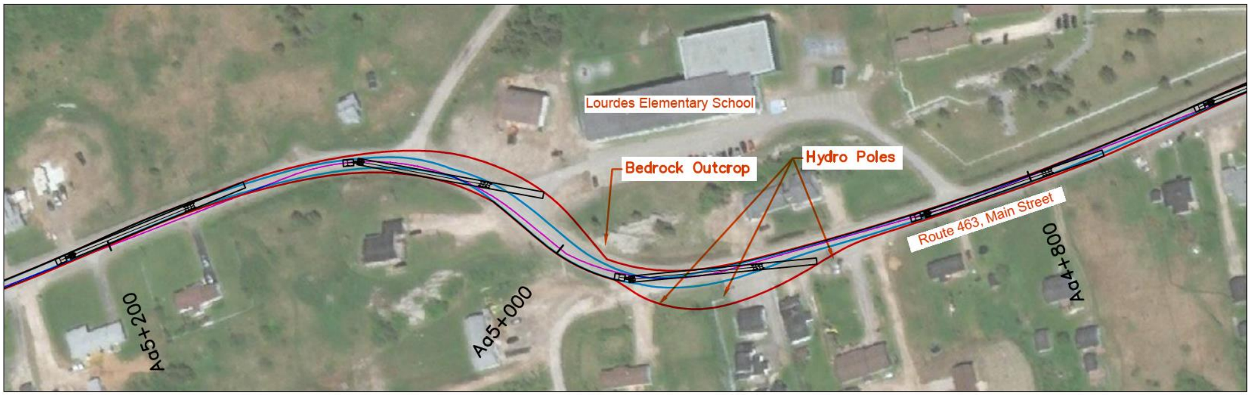
Source: Google Maps

Figure 4.4 Overall Route Plan Illustrating Conflict Locations



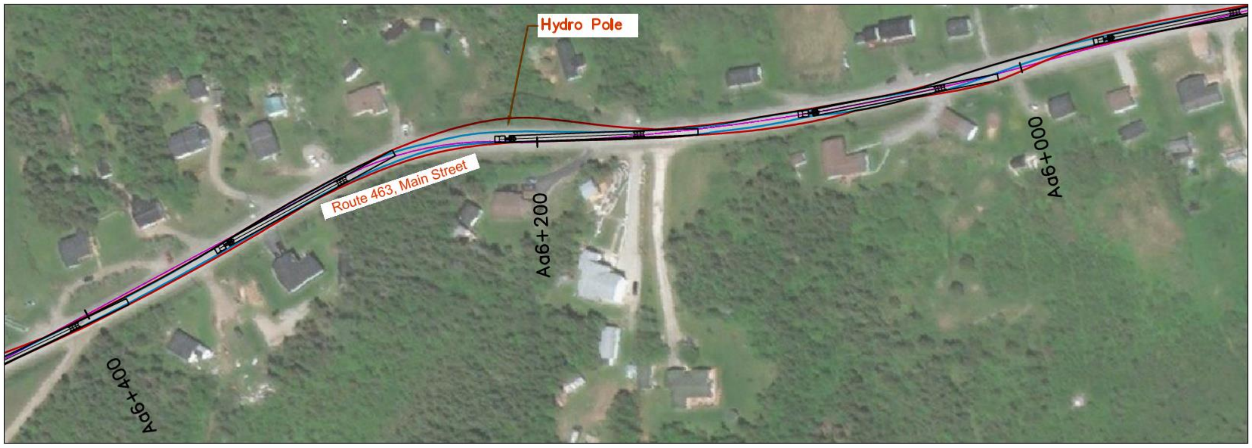
Source: Google Maps

Figure 4.5 Intersection 1



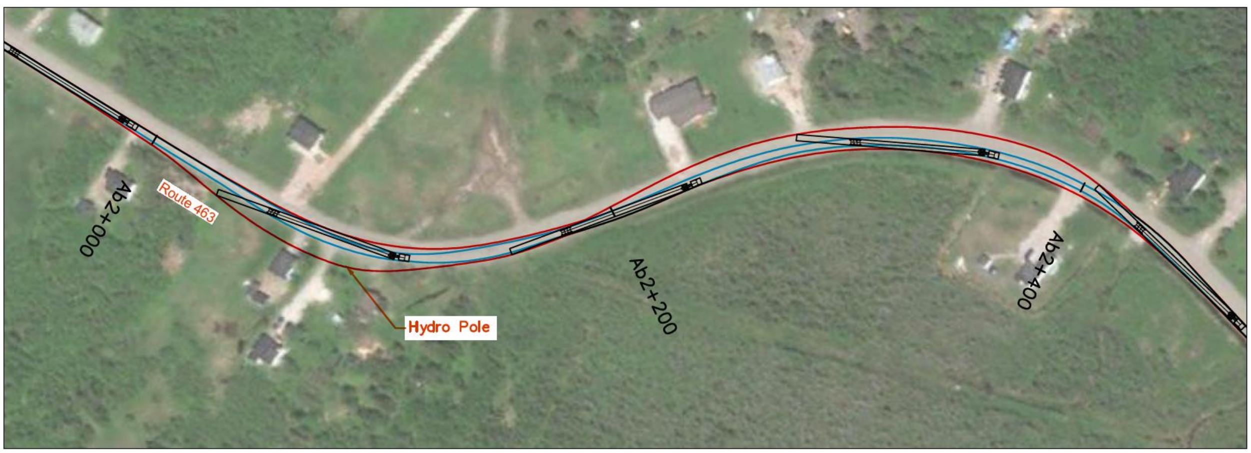
Source: Google Maps

Figure 4.6 Intersection 2



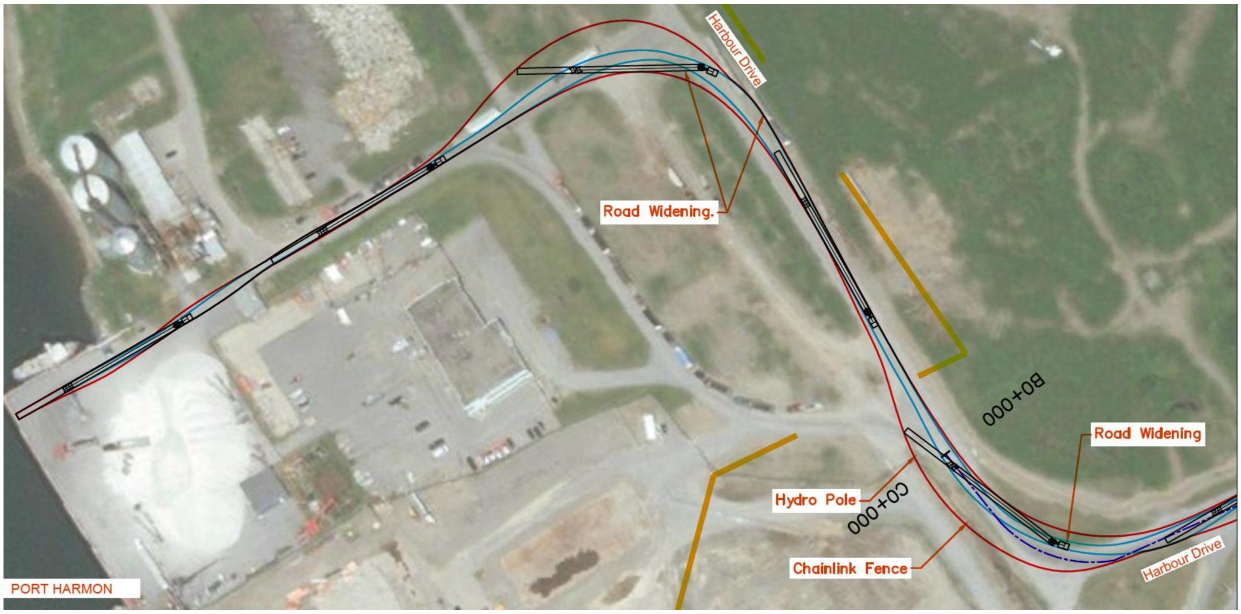
Source: Google Maps

Figure 4.7 Intersection 3



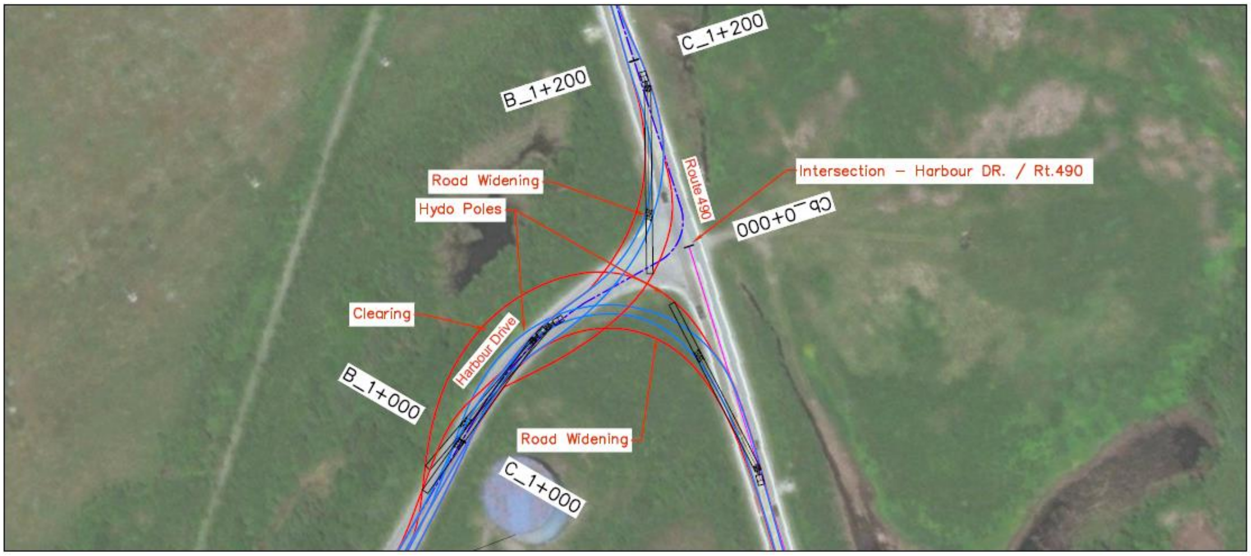
Source: Google Maps

Figure 4.8 Intersection 4



Source: Google Maps

Figure 4.9 Intersection 5

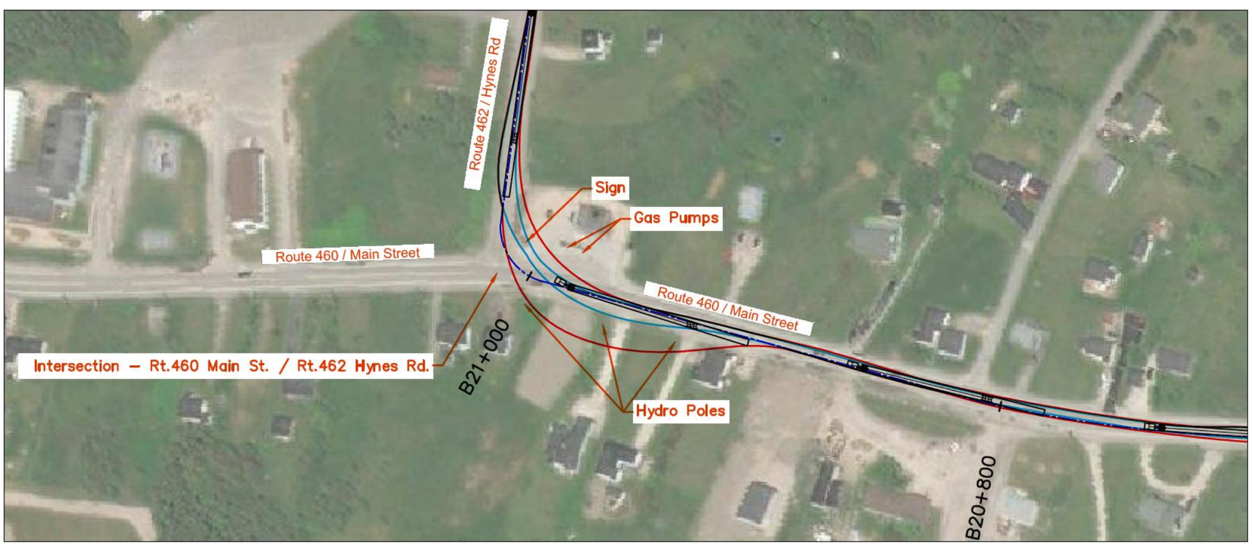


Source: Google Maps

Figure 4.10 Intersection 6

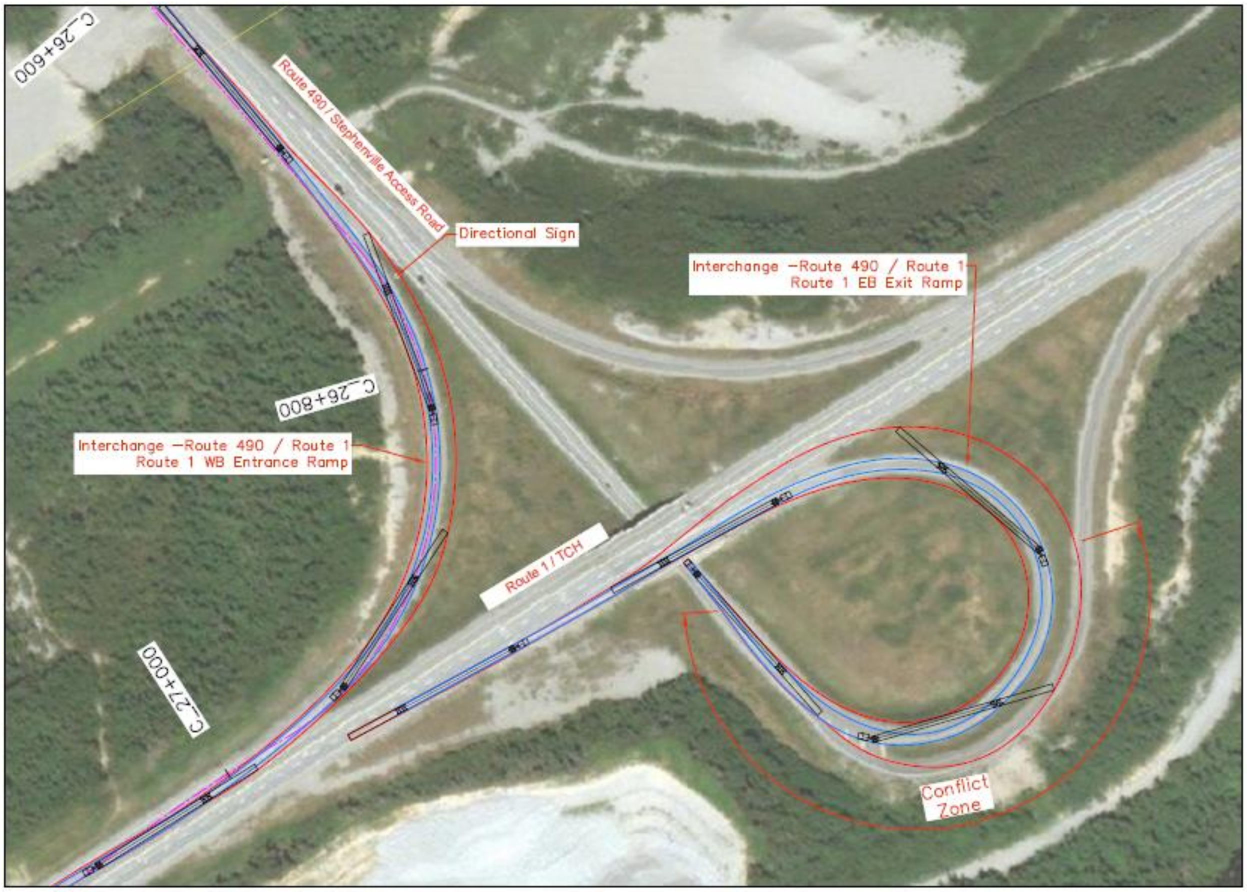
Source: Google Maps

Figure 4.11 Intersection 7



Source: Google Maps

Figure 4.12 Intersection 8



Source: Google Maps

Figure 4.13 Intersection 9

Table 4.2 Summary of Swept Path Assessment

Figure No.	Wind Farm Site	Location	Comment
4-5	Area 1 (optional)	Route 463 (Main St.) at Beach Road, Port au Port	Hydro poles located on west side of RTE 463. *This route would be optional should the transport vehicle use the existing public roadway vs. utilizing internal access roads at Area 1.
4-6	Area 1 (optional)	Route 463 (Main St.), Port au Port	Hydro poles located on south side of RTE 463 and large bedrock outcrop. * This route would be optional should the transport vehicle use the existing public roadway vs. utilizing internal access roads at Area 1.
4-7	Area 1 (optional)	Route 463 (Main St.), Port au Port	Hydro pole located on north side of RTE 463. *This route would be optional should the transport vehicle use the existing public roadway vs. utilizing internal access roads at Area 1.
4-8	Area 1 / 2 (optional)	Route 463, Port au Port	Hydro pole located on south side of RTE 463. *This route would be optional should the transport vehicle use the existing public roadway vs. utilizing internal access roads at Areas 1 and 2.
4-9	Port Exit, Area 4	Offloading to Harbour Drive	Roadway widening work within the port access roads, hydro poles and overhead lines crossing. It should be noted that a finalized swept path analysis should be completed as part of the overall logistics of offloading at the Port to the laydown area to minimize impact to the existing infrastructure and need for roadway widening where feasible.
4-10	Port Exit, Area 4	Harbour Drive and Route 490	Minor clearing and widening work at intersection.
4-11	Port Exit Area 4	Route 490 / Minnesota Drive / Route 460 westbound and eastbound	Clearing and widening work at intersection approaches. Temporary removal of signage (regulatory, warning and wayfinding). Hydro pole impacts and overhead lines crossing.
4-12	Area 3	Intersection Route 460 (Main St) and Route 462 (Hynes Rd)	Widening work at intersection through encroachment onto residential and commercial properties (Western Petroleum), including temporary removal of commercial signage. Hydro pole impacts and overhead lines crossing.
4-13	Area 4	Route 490 / Trans-Canada Highway Interchange (RTE 1)	Temporary removal of regulatory, warning and wayfinding signage. A traffic management plan is needed to mitigate the impact to the conflict zone. Minor clearing and widening work at intersection may be required.

Note:

* Transporter vehicle movements will need to be accompanied by pilot vehicles and include an appropriate traffic management plan acceptable to NLTI Provincial requirements (Traffic Control Manual, latest edition).

4.2 Site Access Roadway Upgrades

The swept path analysis indicates that site-specific intersection upgrades are required to accommodate the identified transporter vehicle. Tree clearing, temporary widening, signage and hydro poles will require modification or removal at the identified intersections in order to accommodate the transporter vehicle. The site-specific upgrades would be assessed in further detail through a comprehensive route analysis and agreed to with NLDTI and WEGH2 through the permitting process, prior to commencing work.

Each of the vehicle access and egress points to the site(s) and the internal access road network should be designed to accommodate the swept path requirements of the largest transporter vehicle.

Along the routes, there are several smaller diameter culverts with varying depths of cover. Of less concern are the culverts under Route 1, however, under the other roadways, many of the small diameter culverts have minimal cover and may require further assessment on a case-by-case basis, depending on the loads, dimensions and axel configurations of the final transporter vehicle and float trailers.

Speed reductions along the routing will be required during the construction phase to provide a safer environment for all roadway users, particularly along the Trans-Canada Highway (Route 1), where the reduction should be from 100 km/h to 70 km/h. This would need to be discussed and agreed to by NLDTI.

4.3 Vertical Clearance Assessment

Based on the transporter vehicle described in in Figure 4.1, there are no apparent clearance limitations at any of the underpass structures along the routes. There are also multiple locations along the route where there are overhead utilities (e.g., power, communication). Without any survey information available, it is assumed that the heights of the overhead utilities exceed the minimum roadway clearance requirements for arterial and collector roadways of 5.03 metres.

Based on the transporter vehicles defined in Figures 4.1 to 4.3, the ground clearance at structure locations will need to be assessed to ensure the trailer does not bottom out. Based on the condition and standard of the Trans-Canada Highway (Route 1), and it being subjected to oversize and overweight vehicles and loads in the past, it is not anticipated that ground clearance will be cause for concern, however, an assessment is recommended once more information is known on the dimensions of the transporter vehicles.

4.4 Hydro Conflicts

Utility poles and transmission lines along the roadside will potentially be impacted, during the transporting of oversized and overweight equipment or components. Scenarios such as those shown in Figures 4.14 and 4.15 should be inspected and evaluated to determine the appropriate mitigation method(s) required during transportation and construction. The specific occurrences of scenarios shown in Figures 4.14 and 4.15 will be further reviewed during detailed design of the Project.

Figure 4.14 Example of Crossing at an Existing Public Road to WTG Site (Ex. Crossing between Route 463 and Internal Road from West Bay Barging Station to the Wind Farm Site)

Figure 4.15 Example of Trucks Driving under Overhead Wires (Route 490 near Newfoundland T'Railway)

4.5 Load Rating Requirements

The legally allowable gross vehicle mass and dimensions are given in the Vehicle Regulations, under the *Highway Traffic Act*. which can be accessed on the Government of Newfoundland Labrador website on the *Overweight and Over Dimensional Special Permits* page (Overweight and Over Dimensional Special Permits - Digital Government and Service NL). This page also provides a link to apply for a special permit to operate vehicles not in conformance with the weights and dimensions set out in the regulation.

Oversize Permits are required for a vehicle that exceeds either an overall width of 4.27 metres, an overall height of 4.5 metres or a length with overhangs of front overhang of 3.1 metres and rear overhang of 5.5 metres and an overall length of 30 metres.

Over-mass/Oversize Permits are issued for vehicles that exceed the axle group or gross masses prescribed under the Act. Maximum mass of 64,000 kg while the axle weight, axle spacing, tire sizes and number of tires are also reviewed and may result in an excessive overweight permit being required. The maximum mass permitted corresponds closely to the design vehicle used in the province and prescribed in the *Canadian Highway Bridge Design Code* (CSA S6:19). This is the CL-625-ONT truck with axle loads as illustrated in Figure 4.7. It has an overall gross weight of 625 kilonewtons (63,710 kg) and interaxle spacings and axle groupings less than what is legally allowed, for conservatism and safety.

NLDTI's Design Branch review Over-mass/Oversize Permit applications and determine if current infrastructure can accommodate the vehicles. The Branch evaluates the truck loads against available load ratings (or structural evaluation) or against the design vehicle at the time of construction. To help evaluate the likelihood of Over-mass permits being allowed along the proposed route, a list of bridge structures (bridges, retaining walls and culverts over 3 m in diameter) has been assembled by Stantec and is presented in Table 2.2. The provided information is available in the bridge database system of the province. The location of the structures, along with the conflicting movement intersections, is shown on a map of the proposed route in Appendix A.

As noted in the bridge list in Table 2.2**,** the year of construction of the major structures range between 1955 and 2021 with most dating from the 1970's. Of the 29 structures along the route, five have been evaluated to the CL-625-ONT vehicle in accordance with section 14 of the *Canadian Highway Bridge Design Code*. Once the final routing is accepted and with the owner's approval, it is recommended that structural evaluations for the project transport loads be completed.

Figure 4.16 shows the CL-625 design load and the Newfoundland Special Heavy Truck live load.

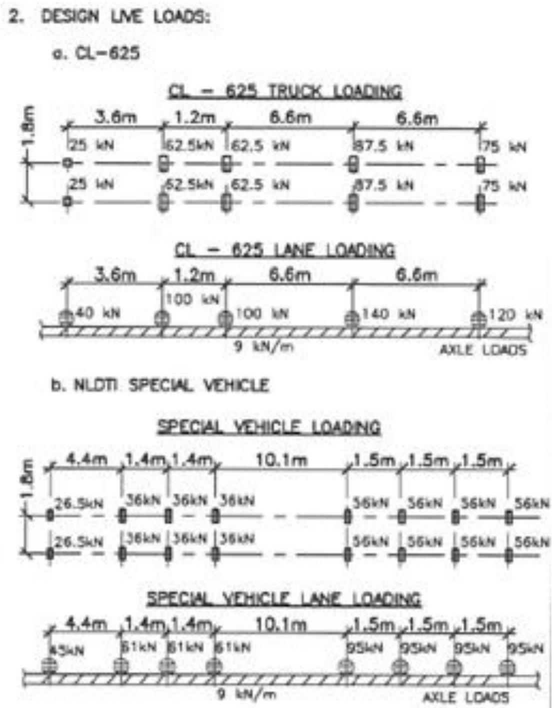


Figure 4.16 CL-625 design load and the Newfoundland Special Heavy Truck live load

In stakeholder discussions with the NLDTI Design Branch, they have stated that vehicle configurations can be submitted to the Permits office for pre-approval. They have also stated that for overlength vehicles, a comprehensive Traffic Management Plan including vehicle configuration approval or completed load evaluation calculations, if deemed necessary, shall also be submitted to NLDTI.

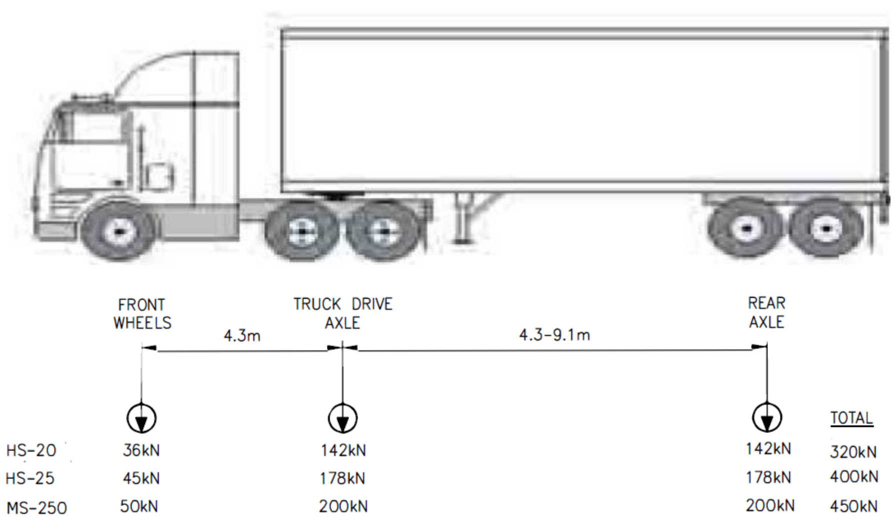


Figure 4.17 HS-20, HS-25 and MS-250 Truck Loadings

5.0 Conclusions and Recommendations

The conclusions and recommendations of the TIS and TMP are:

Once the equipment and transporter vehicles have been finalized for all delivery components, WEGH2 will proceed with the following next steps.

1. A comprehensive Traffic Management Plan to provide detailed information on the proposed routes, schedule, component & equipment dimensions and weights, traffic controls & private escorts, structures, overhead obstructions, significant turns including communication protocols, emergency vehicles plans, breakdown plans and environmental constraints.
2. Detailed load rating assessments and calculations to be conducted on the structures and large diameter culverts identified in this report.
3. Permit applications to be completed and submitted to proper authorities.
4. Detailed route analysis (horizontal and vertical) to be completed:
    a. Horizontal clearance: provide recommendations to upgrade the road to permit the transporter vehicle to pass. Include clearing, roadway and shoulder widening, traffic control (temporary lane closures, flaggers, etc.).
    b. Vertical clearances: provide recommendations on any potential challenges including overpass/underpass clearances and utility line clearances.
5. Early confirmation of equipment and transporter vehicle dimensions and loadings to allow adequate time to conduct structural load ratings and permit applications.
6. Early coordination with Newfoundland Power and NL Hydroon the requirements of temporary relocation of hydro poles and overhead wires.
7. Any shallow buried small diameter culverts that would not be included as part of the bridge inventory (< 3 m dia.) should be assessed prior transport of WTG components and equipment.
8. Among all phases of the Project, it is identified that the construction phase represents the worst-case scenario since oversized and overweight Project materials and equipment will be transported to the site during the construction period.
9. Components for the construction of hydrogen/ammonia plant will be transported from the laydown areas at the Port of Stephenville to the adjacent construction site using the road network and Harbour Drive, which is also used for delivery of oversized and overweight Project materials and equipment.
10. On average, 6 daily round trips will be made to deliver overweight and oversized equipment from barging stations / ports to wind farm sites and 30 round trips will be made to deliver other construction materials from Port of Stephenville to wind farms per day.
11. When shipping the turbine components, the transport vehicles will need to cross the public road and/or make turns when travelling between barging stations and wind farm sites. Up to 5 minutes are needed to allow vehicles to cross. Two traffic controller persons are needed for each intersection.

12. When transporting the turbine components to Area 3 by road, the Project vehicles will pass through a section of developed area within Stephenville and Kippens. It is recommended to complete a swept path analysis for the transport vehicle and to coordinate the delivery of the components during late night or at off-peak times.
13. When shipping the turbine components to Area 4, the travelling speed of the transport vehicle is much lower than the posted speed. It is recommended to have escort vehicles to warn the traveling public and to schedule the delivery to avoid the ferry traffics between Stephenville and Port aux Basques.
14. In terms of construction-related vehicles during the construction season, the impact to current traffic operation is low.

6.0 References

Marine Atlantic. 2023. Passenger Ferry Schedule. Available online at: https://www.marineatlantic.ca/sailing-information/schedule

Transportation Research Board. 2000. Highway Capacity Manual 2000. Prepared for the National Research Board. Available online at: https://sjnavarro.files.wordpress.com/2008/08/highway_capacital_manual.pdf