newfoundland labrador hydro

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September 7, 2022

VIA EMAIL

[redacted]

Re: Your request for access to information under Part II of the *Access to Information and Protection of Privacy Act*, 2015 (File #: PB/742/2022)

On August 9, 2022, we received your request for access to the following records/information:

> *Please supply any studies or analysis completed by Newfounldand and Labrador Hydro regarding wind energy on the West Coast of the island. I am looking for studies of analysis completed between July 1st 2020 and July 30 2022.*

On August 19, 2022, you updated the request to include 2 studies outside of the date range as Hydro had no records responsive from 2020-2022.

I am pleased to inform you that your request for access to these records has been granted in part. Access to remaining records, and/or information contained within the records, has been refused in accordance with the following exceptions to disclosure as specified in the *Access to Information and Protection of Privacy Act* (the "Act"):

> **Section 29(1)(a):**The head of a public body may refuse to disclose to an applicant information that would reveal advice, proposals, recommendations, analyses or policy options developed by or for a public body or minister;
>
> **Section 35(1)(d):** The head of a public body may refuse to disclose to an applicant information which could reasonably be expected to disclose information, the disclosure of which could reasonably be expected to result in the premature disclosure of a proposal or project or in significant loss or gain to a third party;
>
> **Section 35(1)(g):** The head of a public body may refuse to disclose to an applicant information which could reasonably be expected to disclose information, the disclosure of which could reasonably be expected to prejudice the financial or economic interest of the government of the province or a public body;

Section 39(1)(a)(ii): The head of a public body shall refuse to disclose to an applicant informationthat would reveal commercial, financial, labour relations, scientific or technical information of a third party;
(b) that is supplied, implicitly or explicitly, in confidence; and
(c)(i) the disclosure of which could reasonably be expected to harm significantly the competitive position or interfere significantly with the negotiating position of the third party;

Section 40(1): The head of a public body shall refuse to disclose personal information to an applicant where the disclosure would be an unreasonable invasion of a third party's personal privacy.

Please see Appendix A attached hereto for two documents responsive to your request:

1. Solas Energy Consulting Inc. Wind Capex Report
2. Review of Solas Energy Report on Resource Assessment and Capital Cost

Please note the following pages are withheld in full under section 29(1)(a), 35(1)(d) and (g), and 39(1)(a)(ii), (b), and (c)(i) of the Act:
Solas Energy Consulting Inc. Wind Capex Report pages 6, 8, and 17-22
Review of Solas Energy Report on Resource Assessment and Capital Cost pages 13, 23, 25, 33-39, 42, 70-75, 82-84, 87-91, and 97-101.

In keeping with our standard practice, it is our intention to post this letter on the Newfoundland and Labrador Hydro website.

Please be advised that you may ask the Information and Privacy Commissioner to review the processing of your access request, as set out in section 42 of the Access to Information and Protection of Privacy Act, 2015 (the Act) (a copy of this section has been enclosed for your reference). A request to the Commissioner must be made in writing within 15 business days of the date of this letter or within a longer period that may be allowed by the Commissioner.

The appeal may be addressed to the Information and Privacy Commissioner as follows:

Office of the Information and Privacy Commissioner
2 Canada Drive
P. O. Box 13004, Stn. A
St. John's, NL. A1B 3V8

Telephone: (709) 729-6309
Toll-Free: 1-877-729-6309
Email: commissioner@oipc.nl.ca

You may also appeal directly to the Supreme Court within 15 business days after you receive the decision of the public body, pursuant to section 52 of the Act (a copy of this section has been enclosed for your reference).

If you have any further questions, please contact me by telephone at (709) 725-4859 or by email at cassandrahearn@nlh.nl.ca

Sincerely,

Cassandra Hearn

Cassandra Hearn
Access & Privacy Officer

Access or correction complaint

42. (1) A person who makes a request under this Act for access to a record or for correction of personal information may file a complaint with the commissioner respecting a decision, act or failure to act of the head of the public body that relates to the request.

(2) A complaint under subsection (1) shall be filed in writing not later than 15 business days

(a) after the applicant is notified of the decision of the head of the public body, or the date of the act or failure to act; or

(b) after the date the head of the public body is considered to have refused the request under subsection 16 (2).

(3) A third party informed under section 19 of a decision of the head of a public body to grant access to a record or part of a record in response to a request may file a complaint with the commissioner respecting that decision.

(4) A complaint under subsection (3) shall be filed in writing not later than 15 business days after the third party is informed of the decision of the head of the public body.

(5) The commissioner may allow a longer time period for the filing of a complaint under this section.

(6) A person or third party who has appealed directly to the Trial Division under subsection 52 (1) or 53 (1) shall not file a complaint with the commissioner.

(7) The commissioner shall refuse to investigate a complaint where an appeal has been commenced in the Trial Division.

(8) A complaint shall not be filed under this section with respect to

(a) a request that is disregarded under section 21 ;

(b) a decision respecting an extension of time under section 23 ;

(c) a variation of a procedure under section 24 ; or

(d) an estimate of costs or a decision not to waive a cost under section 26 .

(9) The commissioner shall provide a copy of the complaint to the head of the public body concerned.

Direct appeal to Trial Division by an applicant

52. (1) Where an applicant has made a request to a public body for access to a record or correction of personal information and has not filed a complaint with the commissioner under section 42 , the applicant may appeal the decision, act or failure to act of the head of the public body that relates to the request directly to the Trial Division.

(2) An appeal shall be commenced under subsection (1) not later than 15 business days

(a) after the applicant is notified of the decision of the head of the public body, or the date of the act or failure to act; or

(b) after the date the head of the public body is considered to have refused the request under subsection 16 (2).

(3) Where an applicant has filed a complaint with the commissioner under section 42 and the commissioner has refused to investigate the complaint, the applicant may commence an appeal in the Trial Division of the decision, act or failure to act of the head of the public body that relates to the request for access to a record or for correction of personal information.

(4) An appeal shall be commenced under subsection (3) not later than 15 business days after the applicant is notified of the commissioner's refusal under subsection 45 (2).

Appendix A

SOLAS
ENERGY CONSULTING

To: Tim Manning - Nalcor Energy

From: Paula McGarrigle and Evelyn Carpenter - Solas Energy Consulting Inc.

CC: Nancy Hart - Nalcor Energy

Date: 15 August 2015

RE: Resource assessment and capital cost estimate on various sizes and of wind farms on the island of Newfound

Nalcor Energy (Nalcor) has requested the completion of a wind resource assessment and wind farm capital cost estimate to understand the wind energy potential and project costs from a wind power facility located on the island of Newfoundland. This project is expected to supplement energy being produced in Labrador and potentially sold into the Maritime Provinces and New England as a result of the initiation of the Maritime Link and Muskrat Falls hydro facility.

The wind power project sizes under consideration are 100 MW, 200 MW and 400 MW. A preliminary resource assessment was completed by WSP, the wind resource consultant, and indicative pricing was received for the wind turbines from a turbine supplier and a balance of plant contractor. These results have been compiled into this report.

The wind resource estimates have been completed using the General Electric 2.85-103 and SWT 2.3-108 80 m turbines.

PORT AU PORT PENNINSULA SITE

Solas, in consultation with Nalcor, selected the Port-au-Port peninsula as a potential location for wind farm development. This regional selection was based on desktop analysis using the following parameters:

- access to a large port for turbine delivery,
- access to skilled population for facility construction, operations and maintenance,
- strong wind resource (winter and annual) as per the Canada Wind Energy Atlas[1],
- few residences in the center of the peninsula,
- milder winter conditions that other regions in Newfoundland, and
- proximity to the Maritime Link substations.

The following parameters were not taken into consideration:

- land use,
- environmental constraints and potential impacts,
- traditional land use,
- stakeholder constraints and concerns,
- noise constraints,
- land access,
- site access including inland transportation and port shipping restrictions,
- power flow studies, and

[1] http://www.windatlas.ca/en/index.php

- other considerations that may arise through field studies.

Based on the desktop study, the peninsula was identified to have a potentially suitable wind resource.

The following map shows the wind resource as identified in the Canada Wind Energy Atlas. The wind speeds for this region are similar to off-shore wind speeds.

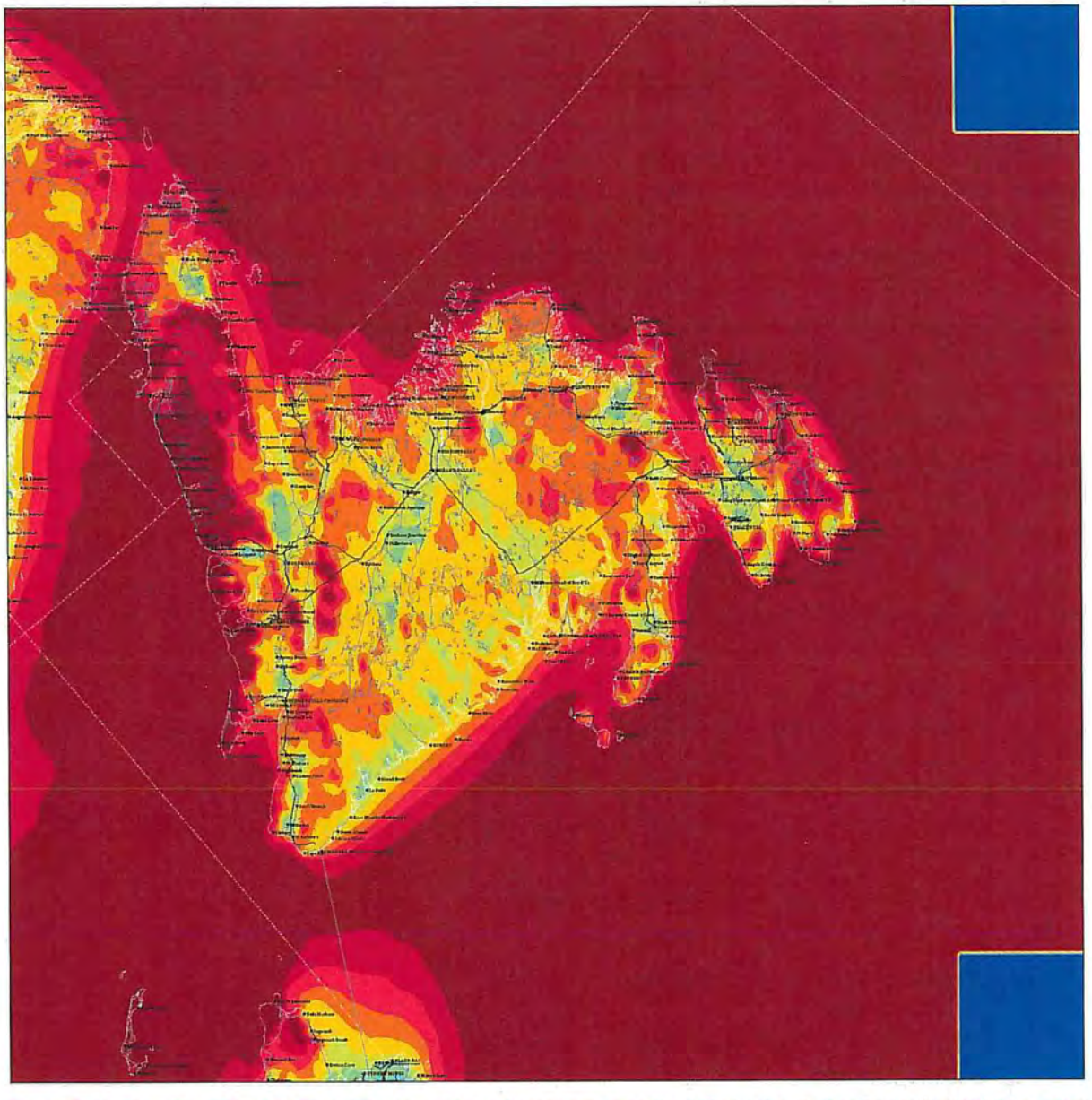


Figure 3: Newfoundland Overlay Map, 80 metre – Annual resource, Canadian Wind Atlas, Darker Red indicates higher wind energy

Resource Assessment

After selection of Port-au-Port, WSP reviewed the lands and identified two sites to determine the potential wind resource at each of these. WSP accessed data from Vortex. The Vortex data combined data from multiple regional reanalysis models and uses mesoscale modelling to determine predicted wind speeds.

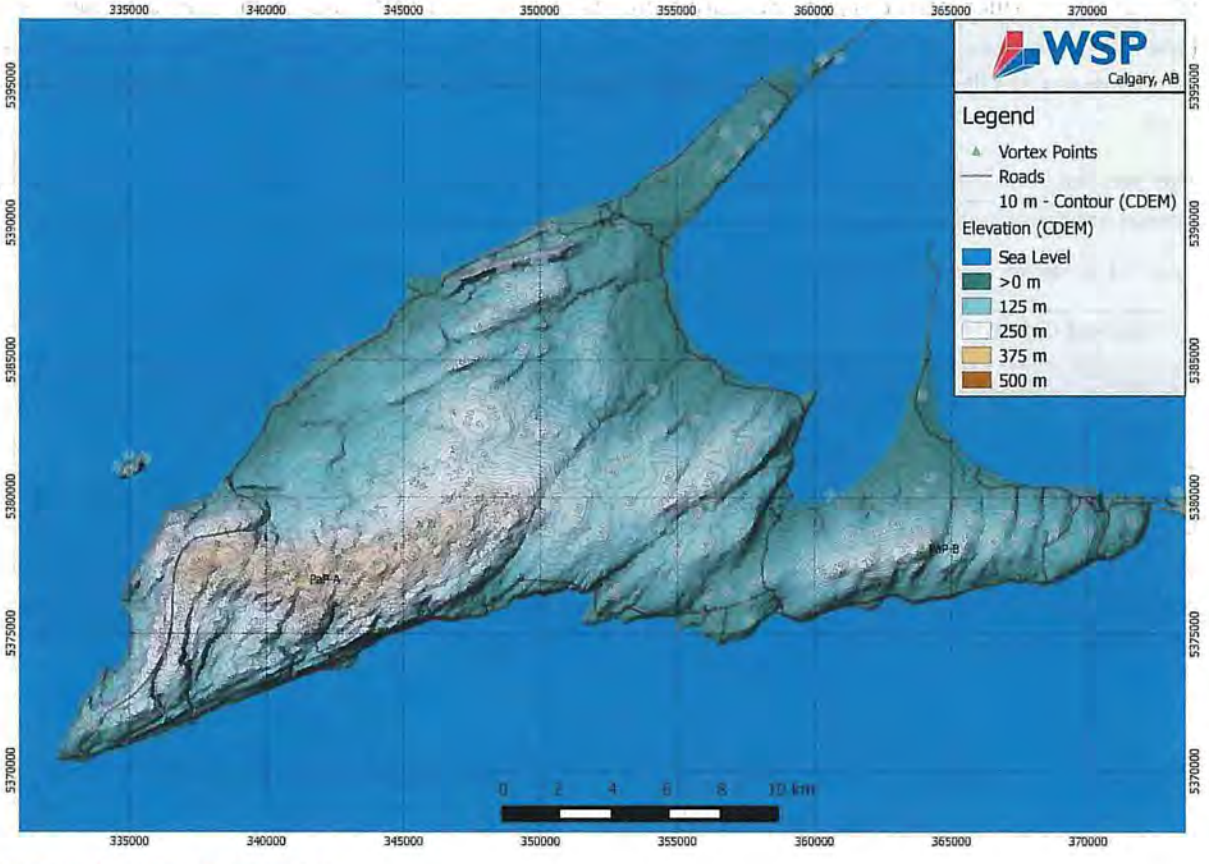


Figure 1: Site A and B, Port-au-Port

The full resource assessment report completed by WSP utilized the GE 2.85-103 turbine and SWT 2.3-108 turbine on 80 metre towers. WSP determined that the predominant wind direction is from the south-west. Two modeling points were selected to represent the range in wind conditions in the region of the southern ridge that runs east-west. The peninsula is expected to have a mixture of Class I conditions on the southern ridges and Class II/III conditions in the interior of the island. All wind sites are classified based on wind speed and turbulence. Class I is the highest wind speed class with an annual average wind speed at hub height of over 10 metres per second. Class II has a medium wind resource at 8.5 metres per second wind speed, and Class III with an annual average wind speed at hub-height of 7.5 metres per second.

The analysis completed by WSP used 20-year data sets to characterise the wind speed distribution as well as the site air density at each location. This assessment provides an indication of expected wind

resource at this location, however detailed on-site measurement is required to provide an assessment at an accuracy level needed to finance a project.

WSP determined that Site PaP-A has the highest wind speed at 9.2 m/s @ 80 metres, and Site PaP-B has the lower wind speed at 8.2 m/s @ 80 metres.

The analysis by WSP included gross and net yields of the GE 2.85-103 and SWT 2.3-108. The SWT 2.3 MW analysis demonstrated higher capacity factor than a GE 2.85 MW turbine for the same locations (Site PaP-A and Site PaP-B). A cold weather package is critical for this location as icing and extreme temperatures are likely. A generic loss value of 18% was used to calculate the net yield from the gross yield.

The two locations selected on the peninsula have strong wind power potential, with the following annual net capacity factors.

Table 1: Comparison of Net Capacity Factors for Site A and Site B by Turbine Type for Port-au-Port

Annual Net Capacity Factor	GE 2.85-103	SWT 2.3-108
PaP-A @ 80 metres	45.7%	51.8%
PaP-B @ 80 metres	38.5%	44.6%

One of the most interesting outcomes of the assessment is the shape of the annual capacity factor curve. In the summer months, the capacity factor is very high and demonstrates a very strong wind resource. Newfoundland's summer capacity factors are higher than annual averages seen in Ontario for equivalent turbines.

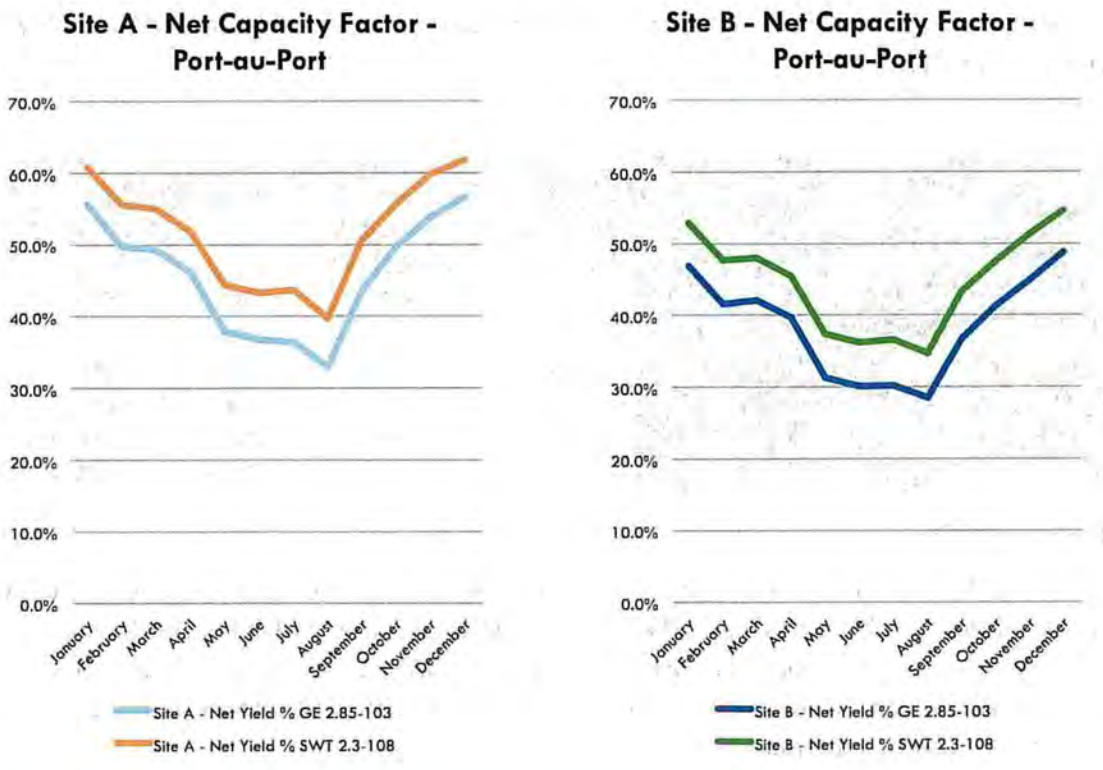


Figure 2: Comparison of Site A and B Annual Net Capacity Factor by Turbine and by Month

This wind resource assessment is not a determination of turbine suitability and on-site measurement should be completed to assess the viability of the site.

[redacted]

Section 29(1)(a) Section 35(1)(d) Section 35(1)(g)
Section 39(1)(a), (b), (c)(i)

Section 29(1)(a) Section 35(1)(d) Section 35(1)(g) Section 39(1)(a), (b), (c)(i)

[redacted]

Operating Expenses

Operating expenses for wind projects fall into three broad categories: 1) turbine operations, service and maintenance costs, 2) asset management costs, and 3) other operations costs.

1. **Turbine operations, service and maintenance costs** includes the scheduled and unscheduled maintenance and the daily turbine operations. Often the turbine service and maintenance is performed by the original equipment manufacturer (OEM) under warranty or a long term service agreement for a period of time, and the turbine operations is performed by an owner's representative. There are a minimum number of turbine technicians required to safely service any site and so for small projects the per turbine cost of operations, service and maintenance is usually high. As economies of scale are reached at the 80 to 100 MW plus size, the costs are typically proportional to the number of units to be maintained and are largely variable, so an increase in project size above the 100 MW will see a very slight decrease in costs on a per-turbine basis.
2. **Asset management costs** include the costs for management, reporting, warranty compliance, administration, contract maintenance and oversight of the facility. These costs are largely fixed costs with a minor dependency on project size.
3. **Other operating costs** which include land lease fees, electricity usage, any environmental post-monitoring studies, transmission costs, facility insurance, taxes, balance-of-plant maintenance, office rent, supplies, and personnel. Part of these costs typically depend on the number of units; however, also have a fixed cost component.

[redacted]

Section 29(1)(a) Section 35(1)(d) Section 35(1)(g)
Section 39(1)(a), (b), (c)(i)

Results Summary

Capital costs and operating costs provided by Solas are rough order of magnitude based on best available information. The resource estimated is based on regional re-analysis data and power curves provided by both Siemens and GE. The following table summarizes the information associated with the potential build of a wind farm at Port-au-Port and are specifically only for the GE turbine, and not the Siemens turbine.

Table 6: Summary Results - Port-au-Port Wind Farm (100 MW, 200 MW, 400 MW) – All in 2016 Canadian dollars, assuming GE 2.85-103 turbine Section 29(1)(a) Section 35(1)(d) Section 35(1)(g) Section 39(1)(a), (b), (c)(i)

	100 MW	200 MW	400 MW	Sensitivity
Resource				
Number of Units	35	70	140	
Net Wind Resource Estimate	38.5 - 45.7%	38.5 - 45.7%	38.5 - 45.7%	+/- 10%
Capex (CAD$M)				
Turbine	[redacted]			
Delivery				
BOP Construction				
Transmission Costs	*Not included*	*Not included*	*Not included*	
Regulatory/Permitting Costs	*Not included*	*Not included*	*Not included*	
Owner's Costs	*Not included*	*Not included*	*Not included*	
TOTAL Capex CAD$M	[redacted]			
$Capex/kW installed				
Operating Cost (CAD$M)				
Operating Cost – Annual, escalated yearly	[redacted]			
Escalation per year				

Should you have any questions, comments or concerns, please contact us at your earliest convenience and we would be happy to respond.

ATTACHMENT A – WSP RESOURCE ASSESSMENT

To: Paula McGarrigle
Solas Energy Consulting, Inc.

From: Matthew Breakey, P.Eng and Errol Halberg, P.Eng
WSP Canada Inc.

Date: July 22, 2015

Subject: Port au Port, Newfoundland – Yield Results

BACKGROUND

WSP has completed a preliminary analysis of the available wind resource for the Port au Port Island, located on the south-west coast of Newfoundland. The predominate wind direction is from the south-west. The topography of the island includes a ridge that runs along the south edge of the island and lower elevation areas to the north of the ridge. The island is ringed with a road and residences, but with few roads and residences in the interior of the island. Therefore, the most likely location for a wind farm is along the south ridge. Two modelling points were selected to represent the range of wind conditions in this area. Vortex long-term wind speed data sets were generated for both locations. The seasonal air density and wind speed distributions were characterized and the long-term gross and net energy yields were calculated at the two modelling points using both a GE 2.85-103 turbine and a Siemens SWT-2.3-108 turbine on 80 m towers.

WSP expects there to be a strong gradient of wind speeds across the island with class I conditions on the southern ridge and class II/III conditions in the interior of the island.

METEOROLOGICAL DATA

The two points used in the study are summarized in Table 1, and are shown on the map presented in Figure 3.

The two modeling points selected are expected to represent the best wind resource available in their respective region. Point PaP-A is the best developable location on the island whereas PaP-B is closer to an average location. The island has a ridge that runs along the south edge and is characterized by rugged terrain. The edge of the island is steep with large cliffs, particularly on the west coast. A long spit runs north of the island, but its orientation is parallel to the prevailing wind direction which makes it less desirable. In addition, a preliminary look at setbacks from houses indicates that there is little developable lands directly on the northern spit. The remaining land base on the island appear to be highly developable.

Twenty year data sets were ordered from Vortex and were used to characterize the wind speed distribution as well as the site air density at each location.

Parameter	PaP-A	PaP-B
Latitude (NAD 83)	48.526N	48.542N
Longitude (NAD 83)	59.150W	58.844W
Elevation at Ground	323 m	240 m
Long-term 80 m Wind Speed	9.2 m/s	8.2 m/s

Parameter	PaP-A	PaP-B
Long-term Air Density at 80 m AGL	1.216 kg/m^3	1.234 kg/m^3

Table 1: Summary of Vortex Modelling Points

Figure 1 shows the wind speed frequency distributions for the measured data at the two modelled locations.

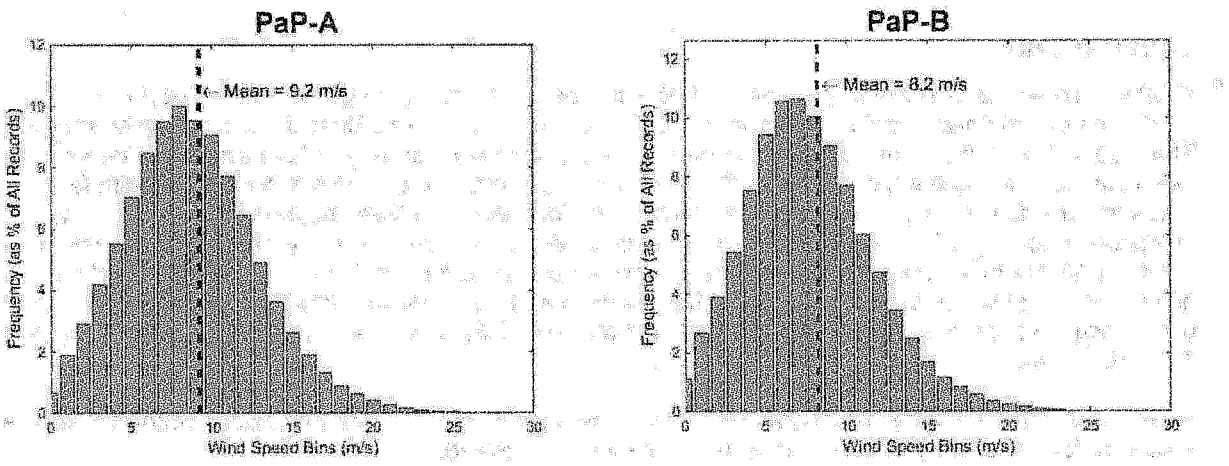


Figure 1: Wind Speed Distribution at 80 m Above Ground Level

Figure 2 shows the wind direction frequency distribution at the modelling locations. The frequency is presented as a percentage of all valid records. The wind directions are divided into 16 bins, each 22.5° wide.

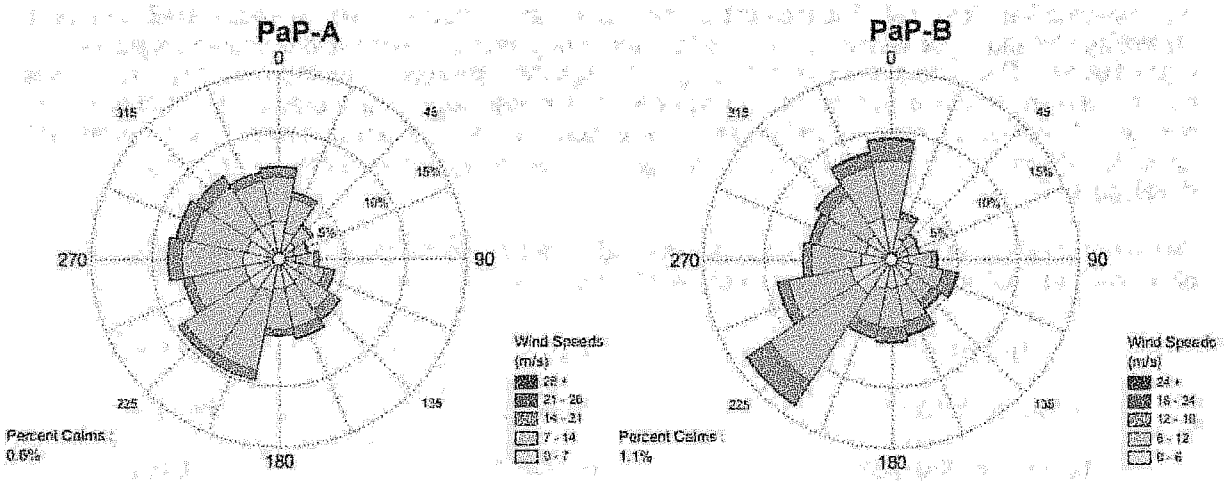


Figure 2: Wind Direction Distribution at 80 m Above Ground Level

LOSSES

A generic loss assumption for the project was assumed. Based on an approximate icing loss of 2%, a wake loss of 5%, a total loss of ~18% was assumed.

A detailed loss study is recommended including an icing loss assessment to confirm the magnitude and seasonal profile of losses. Actual losses may be higher due to the complex terrain (inflow angle and turbulence intensity), high wind hysteresis and environmental losses including low temperature shutdown.

GROSS AND NET YIELDS AT MODELLED LOCATIONS

The guaranteed power curves[1],[2], adjusted for hub height air density, was used to estimate a gross yield at both modelling locations. A generic loss value of 18% was applied to obtain a net yield for both modelling points. The results are summarized in Table 2 and Table 3 for modelling points PaP-A and PaP-B, respectively. The wind resource is high and turbine suitability could be an issue for either turbine technology depending on the turbulence intensity.

Month	Wind Speed [m/s]	GE 2.85-103		SWT 2.3-108	
		Gross Yield [%]	Net Yield [%]	Gross Yield [%]	Net Yield [%]
January	10.8	69.4%	55.6%	75.9%	60.8%
February	9.9	62.2%	49.8%	69.4%	55.6%
March	9.8	61.4%	49.3%	68.5%	55.0%
April	9.2	57.0%	46.2%	64.1%	51.9%
May	7.9	45.8%	37.9%	53.7%	44.4%
June	7.7	44.4%	36.8%	52.2%	43.3%
July	7.7	43.5%	36.4%	52.3%	43.7%
August	7.4	39.5%	33.0%	47.7%	39.8%
September	8.7	52.2%	43.6%	60.5%	50.6%
October	9.6	59.9%	49.7%	67.1%	55.6%
November	10.2	65.4%	53.8%	72.7%	59.8%
December	11.1	70.1%	56.6%	76.5%	61.8%
Total	**9.2**	**55.9%**	**45.7%**	**63.3%**	**51.8%**

Table 2: Estimated Seasonal Yields for Point PaP-A at 80 m

[1] Provided by Solas: "2 85DF-103_xxHz_PCD_allComp_xxxxxxxxxxx ENxxx 04a.pdf" Received by email 2015/07/17
[2] Provided by Solas: "PC Rev 1 Air Densities, SWT-2.3-108", Document E-R-WP-CTO-40-0000-1910-00, Received by email 2015/07/21

Month	Wind Speed [m/s]	GE 2.85-103		SWT 2.3-108	
		Gross Yield [%]	Net Yield [%]	Gross Yield [%]	Net Yield [%]
January	9.4	58.5%	46.9%	66.0%	52.9%
February	8.7	52.0%	41.6%	59.6%	47.7%
March	8.7	52.3%	42.1%	59.8%	48.0%
April	8.2	49.0%	39.7%	56.2%	45.5%
May	7.1	37.8%	31.3%	45.1%	37.4%
June	6.9	36.3%	30.1%	43.6%	36.2%
July	6.9	36.1%	30.2%	43.8%	36.6%
August	6.8	34.2%	28.5%	41.5%	34.7%
September	7.9	43.9%	36.7%	51.9%	43.3%
October	8.5	49.8%	41.3%	57.3%	47.5%
November	9.1	54.6%	44.9%	62.4%	51.3%
December	9.8	60.3%	48.8%	67.6%	54.6%
Total	**8.2**	**47.0%**	**38.5%**	**54.5%**	**44.6%**

Table 3: Estimated Seasonal Yields for Point PaP-B at 80 m

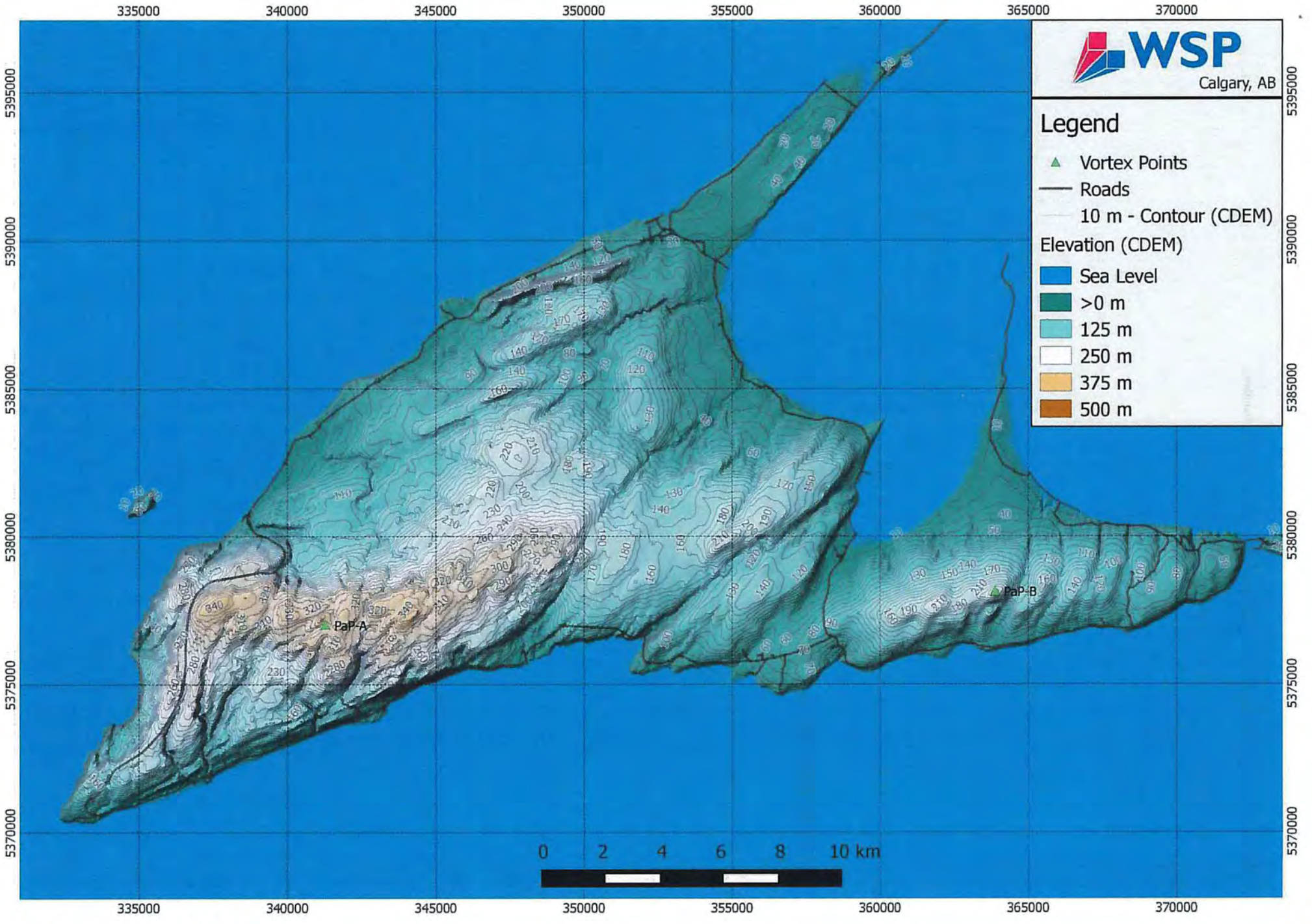


Figure 3: Elevation Map of Port au Port

ATTACHMENT B – BOREA COST ESTIMATE

CAPITAL COST PROJECTION

FOR A

200MW WIND FARM IN WESTERN NEWFOUNDLAND

Document No. 181917-E001-RPT-0001

File: 181917 4.5.7

Prepared for: Nalcor Energy

[redacted]

Section 40 1

PROVINCE OF NEWFOUNDLAND AND LABRADOR

PEG Newfoundland and Labrador

PERMIT HOLDER

This Permit Allows

Amec Foster Wheeler Americas Limited

To practice Professional Engineering in Newfoundland and Labrador.
Permit No. as issued by PEGNL D0018
which is valid for the year 2016

DATE	REVISION(S)	PREPARED BY	CHECKED BY	APPROVED BY
January 7,2016	FINAL ISSUE	[redacted]	ABD	ABD
December 16, 2015	ISSUED FOR REVIEW	WGC	ABD	ABD
December 15, 2015	Draft ISSUED FOR INFORMATION	WGC	ABD	ABD
December 4, 2015	Draft ISSUED FOR INFORMATION	WGC	ABD	ABD

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Amec FOSTER WHEELER JOB NO. 181917

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Appendices

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Appendix 2 Pennecon Estimate Data
Appendix 3 Concept Development Plan
Appendix 4 Civil Package and Details
Appendix 5 Foundation data Package
Appendix 6 Collector System data Package
Appendix 7 AACE Process Industry Estimate Classification Index
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Appendix 9 Solas Energy Consulting Memorandum to Tim Manning 15/12/2015
RE: Hare Hill-Estimated Development Costs
&
Solas Energy Consulting Memorandum to Tim Manning 15/12/2015
RE: Hare Hill-Turbine Capital Costs and Operating Costs
&
Solas Energy Consulting Memorandum to Tim Manning 5/01/2016
RE: Hare Hill Turbine Capital Costs and Operating Costs, Revision 1

1.0 Introduction

Nalcor Energy (Nalcor) is considering the development of a wind powered generating facility (wind farm) in western Newfoundland. Nalcor has engaged Solas Energy Consulting (Solas) to study the development requirements, capital cost expenditure (CAPEX) and the operating cost expenditure (OPEX).

The original site has been identified as the Port Au Port Peninsula site on the west coast of Newfoundland. Solas has submitted a Resource Assessment and Capital Cost Estimate dated August 15, 2015 to Nalcor.

The Solas report considers facilities nominally sized at 100MW, 200MW and 400MW. Solas attempted to obtain wind turbine generator (WTG) pricing from General Electric (GE) and Siemens however only GE has provided equipment pricing. The Solas report is based on using the GE 2.85-103 WTG to determine the number of WTGs required and the materials and delivery costs related to the WTGs.

In addition, Solas has solicited cost data related to site preparation, foundations, roads, the power collector system and substation as well as other development costs. Solas reported on discussions with three contractors. The report has been based on the lowest projected Contractor's estimate.

Amec Foster Wheeler has been engaged by Nalcor to review the Solas report and comment on the site preparation and installation capital cost data. Nalcor has asked this review to consider a 200MW facility located at Hare Hill in western Newfoundland. The Hare Hill site selection has been identified for use as a 'typical' site for the area, selected in part due the existence of a wind turbine generator layout plan for a 67 unit wind farm.

Cost information developed by Amec Foster Wheeler will be used in conjunction with wind turbine generator equipment costs being developed by Solas to enable Nalcor to consider a wind farm development relative to other activities and development plans.

This report will identify the projected capital expenditure for a 200MW wind farm for the site development including items such as the roads and power collector system and substation and the wind turbine generator supply and installation including transportation, foundations and erection of the turbine generators. Also included are connections to the transmission system and an on-site O&M building.

2.0 Solas Report Review

The report to be reviewed is ***Resource assessment and capital cost estimate on various sizes of wind farm on the island of Newfoundland*** and dated August 15, 2015 addressed to Tim Manning of Nalcor Energy from Paula McGarrigle and Evelyn Carpenter of Solas Energy Consulting Inc. A copy is included as ***Appendix 1.***

The report includes cost data related to wind farms of 100MW, 200MW and 400MW capacity.

2.1 Basis of this Report

Nalcor has directed Amec Foster Wheeler to consider the balance of plant costs for a wind farm capacity of 200MW. The Amec Foster Wheeler report is based on the following:

- Costs related to the WTG material cost and delivery to site will be included in this report. Efforts are underway to update WTG pricing by Solas.
- Site preparation and equipment installation represent a high percentage of the total capital cost and the validity of the expenditure is significant. The Solas report has identified general capital cost expenditure (CAPEX) for the site preparation and installation for 100MW, 200MW and 400MW installations. These costs require refinement.
- Site preparation and installation is referred to as the Balance of Plant (BoP). This is the work required to prepare the site infrastructure of roads, WTG site work and foundations, WTG erection and other work required to install the WTGs, make them operable and enable the power output connection the transmission system (often called the grid).
- Amec Foster Wheeler will develop BoP CAPEX costs by performing a review of available historical data as one method that may help to validate BoP CAPEX for comparison to the Solas data.
- A significant portion of the BoP CAPEX is related to five main cost areas. These are roads, foundations, WTG erection, the collector system and substation. The availability of a site plan showing tentative tower locations and the road system permits more accurate estimating of these particular costs. In addition cost associated with transmission line construction may be significant.
- Amec Foster Wheeler will bring specific focus to the five major cost areas of BoP CAPEX by developing estimates for these major areas with the input of costing from Pennecon, a Newfoundland based contractor. Pennecon has relevant experience related to wind farm development and the construction challenges in Newfoundland.

Section 29 1 a
Section 35(1)(d)
Section 35(1)(g)

[redacted]

- Amec Foster Wheeler will use site specific data to develop costs related to the transmission line construction.
- Other BoP costs will be reviewed that tend to be more site-specific. These are discussed in more detail in section 4.4.

2.2 Solas Report

The Solas report has provided BoP projected costs as follows:

Section 29 1 a
Section 35(1)(d)
Section 35(1)(g)



Solas in Table 3 has applied an escalation factor to the Borea BoP $/kW for the three station capacities to determine the 2016 BoP CAPEX projection.



Section 29 1 a
Section 35(1)(d)
Section 35(1)(g)

[redacted]

Section 29 1 a
Section 35(1)(d)
Section 35(1)(g)

[redacted]

3.0 Historical Data Review

3.1 Budget Breakdown

Amec Foster Wheeler has developed a list of significant cost items to help in identifying specific lines items that would normally be included in a BoP CAPEX budget breakdown. These include:

Engineering and Project Management
Environmental Engineering
Geotechnical Investigations
Site Survey
Substation Design
Collector Design
Grounding Design
Testing and Commissioning
Vendor Commissioning
Site Environmental Monitoring

Construction Management
Site Office and Services

Owner purchased equipment including such items as:

- Building
- Main Power Transformers
- Capacitor bank
- Pad Mount Switches and Junction Boxes
- Reactor System

Major Construction on Site

- Roads
- WTG Foundations
- WTG Erection
- Underground 34.5kV Collector System
- Substation

MET Towers

Warranties
Bonds
Permitting
Legal
230kV Switching Station
Transmission Line Construction
Contingency

3.2 Historical Data

Amec Foster Wheeler has reviewed historical data from several projects. As a general observation, existing installations may be considered in two categories that differ significantly in cost.

The lower cost category can be described as an ***ideal site*** situated on normal terrain in a relatively accessible area.

The higher cost category can be described as a ***challenging site*** situated on rough terrain in a less accessible area.

Historical data indicates that:

- ***An ideal site*** BoP CAPEX could be in a range of 700 -800 $/kW CAD
- ***A challenging site*** BoP could be in a range of 900-1100 $/kW CAD

The historical figures have been escalated at 2% per year based data originating at approximately 2012. For comparison to figures for 2018/2019, a multiplier of 1.15 has been used to adjust the ranges:

- An ideal site BoP CAPEX range for 2019 805-920 $/kW CAD
- A challenging site BoP CAPEX range for 2019 1035-1265 $/kW CAD[1]

It can be noted that the NALCOR Hare Hill site can be described as very rough terrain with potential accessibility issues and should be considered as a ***challenging site***.

[redacted]

Section 29.1 a
Section 35(1)(d)
Section 35(1)(g)

[redacted]

Section 29 1 a Section 35(1)(d) Section 35(1)(g)

[redacted]

4.0 Hare Hill Cost Estimates

In general, the BoP CAPEX committed to roads, foundations, collector systems and the substations for wind farms represents an average range of 50% of total BoP CAPEX project costs.

In order to obtain estimating that is more site specific, information packages have been prepared to provide Pennecon with site specific details. Refer to section 2.1. bullet 6 for additional discussion.

4.1 Civil Work

The following discussion is the Civil Basis of Estimate:

1. Layout information was provided as per GIS information that was converted to AutoCAD and used as a starting reference point.
2. Utilizing Google Earth Pro, and the locations of the towers, the main roads were plotted.
    a. Maximum grade of 10%
    b. Following existing roads to minimize disturbance

3. Main Road to TCH from sub-station is 9.5m wide with 40m ROW as per 230kV crossing detail
4. Access roads were kept to a minimum distance from main road
   a. Access roads and pad sizes were sized from attached details
   b. Materials and quantities based on Civil sections
5. Main Roads were based on 7.5m wide for having collector parallel the road
   a. 6m for driving width
   b. 1.5m for collector width
6. Culverts were based on the GIS data provided (Main roads)
7. Assumed 30 access roads will require culvert crossings.
8. 67 Locations identified on base map
   a. Identical data was used for each of the locations
   b. Access roads did not identify any cut quantities
9. Clearing and grubbing based on the ROW for each road

Uncertainties

1. Actual profile (topography) of land
   a. Cut/fill quantities can be off by 100%
   b. Number and location of culverts
   c. Sizes of stream crossings (# of culverts or bridges)
   d. Actual conditions of existing roads
   e. Actual width of existing roads
2. Geotechnical
   a. Depth of topsoil
   b. Bedrock
3. Development of a quarry for granular materials

Refer to ***Appendix 4*** for the Civil data Package details.

4.2 Foundations

The following discussion is the Foundation Basis of Estimate

The foundation to be considered as the base case is as follows:

1. Octagonal Gravity Base Foundation with dimension of 21.5m, volume of concrete 593 m^3 and rebar density of 100 kg/m^3
2. Transformer concrete pad for each foundation of 5m x 4m x 0.4m thick, rebar density of 60 kg/m^3
3. Each foundation to be cast in one pour operation
4. Number of foundations = 67.

The Structural information Foundation data Package is included in ***Appendix 5.***

4.3 Collector System

The following discussion is the Collector System Basis of Estimate

To refine this cost, the following were considered as relevant for more accurate cost development.

Collector system concept and basis of estimate:

1. The basis of the concept is the use of an underground collector system.
2. The collector system originates at the substation. The substation is supplied at 230kV from the transmission system. Conceptually, a dual substation is planned, each section sized to carry 50% of the generation. Substation sections are identified as East and West. For additional discussion see 'Substations' below.
3. The collector system follows the roads enabling year-round access to switching boxes.
4. WTGs are grouped for connection to individual collector circuits, maximum 10 WTG to any circuit. A collector plan was developed using the Concept Development Plan as the basis and eight collector circuits identified, four East circuits (E1, E2, E3 and E4) and four West circuits (W1, W2, W3 and W4). A sketch was developed to show the routing of the circuits and enable detailed cable quantities to be determined.
5. Cable sizing was developed using both aluminium and copper cable with the intent of identifying the cost of each type as well as determining the cost difference between the cable types
6. WTG grouping has made an initial attempt to optimize the collector system however detailed design may find improvements.
7. A data package has been provided to Pennecon. The data package is included in ***Appendix 6.***

4.4 Substation

Substation concept and basis of estimate

1. The basis of the estimate is to use a dual substation; each section of the substation will carry approximately 50% of the WTG output.
2. A significant feature of the dual substation concept is the change in the 34.5-230V transformer capacity from a single 150/200/266 MVA transformer to two 75/100/133 MVA transformers. The single transformer for a 200MW station is significantly larger and essentially twice as heavy thus making transport to site a major issue compared to the smaller transformers.
3. The 230kV transmission line will supply the dual substation. There will be duplication of some components on the 230kV side.

4. The switchgear used for the 34.5kV will essentially be split in two, limiting the cost impact to a small cost.
5. A major benefit is redundancy offered with the dual substation. Outages at the substation, planned or un-planned, will impact only a portion of the wind farm.
6. The relative cost of the substations is low compared to such items as the roads and foundations. The methodology to estimate the cost of a dual substation will be to scale historical costs based on a 100MW substation.

4.5 WTG Vendor Equipment Supply Costs and Development Costs

Solas Consulting has solicited additional equipment pricing from various potential vendors and has submitted memorandums outlining the projected WTG supply and delivery costs as well as development costs. Refer to ***Appendix 9*** for copies of the memorandums addressed to Tim Manning dated December 15, 2015 and January 5, 2016.

4.6 Transmission System Alterations.

The location of the substation has been established on the Concept Development Plan. In addition, the route of the existing 230kV transmission line has been shown. The Plan identifies the right-of-way required for the interconnection from the transmission line to the substation.

A mono-pole design has been selected to minimize the RoW width and subsequent site work and land commitment for the line.

Amec Foster Wheeler will seek input from the Amec Foster Wheeler Centre of Excellence for Transmission Line Design in Vancouver to comment on the projected line cost.

A 230kV switching station will included where the new 230kV transmission line intercepts the existing transmission system.

The relative cost of the switching system is low compared to such items as the roads and foundations. The methodology to estimate the cost will be to use known historical costs

The Hare Hill site will require expenditure over and above the wind farm BoP CAPEX. The concept includes costs to as:

- Intercepting line TL 211 where the line crosses the site access road.
- Construct two new line sections from TL 211 to a new switching station to provide a 230kV looped supply to the station
- Construct a switching station in an appropriate area of the wind farm

- Construct two new lines from the switching station to supply each of side of the dual substation

5.0 PROJECTED CAPEX

The following section identifies the estimated cost breakdown for the BoP CAPEX. **Refer to tables below for estimate values.**

5.1 Pennecon Estimates Refer to *Appendix 2*

5.1.1 Main Roads:
5.1.2 Access Roads and Lay-down Areas:
5.1.3 Foundations:
5.1.4 Tower delivery to site:
5.1.5 Tower Erection:
5.1.6 Collector System:

5.2 From other sources;

5.2.1 Substation Cost
5.2.2. O&M Building
5.2.3 Other Costs
Other costs include costs such as construction management and services, site environmental monitoring as well as miscellaneous costs that include such items as engineering, geotechnical, and site surveying costs.

Contingency: see notes section 6 for discussion on contingency
Subtotal (less contingency)

5.3 WTG Project Development and WTG CAPEX

5.4 Transmission system and Switching Station

5.4.1 230kV Switching Station Cost
5.4.2 Transmission Line Cost:

Section 29 1 a Section 35(1)(d) Section 35(1)(g) Section 39(1)(a), (b), (c)(i)

[redacted]

Section 29 1 a Section 35(1)(d)Section 35(1)(g) Section 39(1)(a), (b), (c)(i)

6.0 CONCLUSIONS AND RECOMMENDATIONS

[redacted]

Based on the AACE International (formerly the Association for the Advancement of Cost Engineering) standards for estimate classification, the projected cost should be considered as a Class 5 estimate, providing a confidence level of 'low' of 20 to 50% and 'high' of 30 to 100%. It should be noted that some specific areas of the estimate are consistent with AACE Class 4 estimating.

Refer to ***Appendix 7*** for the AACE International standards matrix.

6.2 Contingency

Based on the AACE International standards, the projected contingency should be within a range from 15 to 40% for a Class 5 estimate or within 10 to 25 % for a Class 4 estimate.

The summary table of BoP costs in section 5 identifies nine individual significant line items that have been used to project total BoP CAPEX. Comparing the level of detail for various line items to the AACE International estimate Classification standards, it is reasonable to consider that some of the line items have achieved Class 4 accuracy however some items remain at Class 5. This blended cost is not an unusual result since some areas are better defined than others.

Overlap of the suggested contingency ranges between 15 and 25%. A conservative approach to determining an appropriate contingency is to select a value common to both classes of estimate.

This is supported by risk assessment discussions that indicated that many potential sites were available in this area and that future site assessment and selection would take into consideration areas where CAPEX costs were excessive. This methodology helps establish the confidence to use a mid-level contingency rather than a class 5 maximum contingency up to 40%.



Section 29(1)(a) Section 35(1)(d) Section 35(1)(g)

Section 39(1)(a), (b), (c)(i)

7.0 PROJECT RISK

In this case, the project deliverable is a projected cost for a typical 200MW wind farm in western Newfoundland. The client has identified the ultimate use of the information and has asked that a conservative approach be used so that decisions made when considering this potential investment will not be undermined by optimistic projections.

Section 29(1)(a) Section 35(1)(d) Section 35(1)(g)



Amec Foster Wheeler considers the contingency as:

- A general sum (may be referred to as a management reserve) allocated against a project for the unidentified and general risks based on a judgement of the overall risk.

AACE Contingency guidelines:

- Amec Foster Wheeler follows the guidelines developed by AACE International to determine the estimate classification. The classification helps to identify the level of detail available during cost development and thus the confidence level or potential range of projected cost. See discussion in section 6.
- The AACE estimate classification identifies a normal range of contingency to be carried depending on the classification of the estimate.

APPENDIX 1

SOLAS CONSULTING REPORT of Aug 15, 2015

SOLAS
ENERGY CONSULTING

To: Tim Manning - Nalcor Energy

From: Paula McGarrigle and Evelyn Carpenter - Solas Energy Consulting Inc.

CC: Nancy Hart - Nalcor Energy

Date: 15 August 2015

RE: Resource assessment and capital cost estimate on various sizes and of wind farms on the island of Newfound

Nalcor Energy (Nalcor) has requested the completion of a wind resource assessment and wind farm capital cost estimate to understand the wind energy potential and project costs from a wind power facility located on the island of Newfoundland. This project is expected to supplement energy being produced in Labrador and potentially sold into the Maritime Provinces and New England as a result of the initiation of the Maritime Link and Muskrat Falls hydro facility.

The wind power project sizes under consideration are 100 MW, 200 MW and 400 MW. A preliminary resource assessment was completed by WSP, the wind resource consultant, and indicative pricing was received for the wind turbines from a turbine supplier and a balance of plant contractor. These results have been compiled into this report.

The wind resource estimates have been completed using the General Electric 2.85-103 and SWT 2.3-108 80 m turbines.

PORT AU PORT PENNINSULA SITE

Solas, in consultation with Nalcor, selected the Port-au-Port peninsula as a potential location for wind farm development. This regional selection was based on desktop analysis using the following parameters:

- access to a large port for turbine delivery,
- access to skilled population for facility construction, operations and maintenance,
- strong wind resource (winter and annual) as per the Canada Wind Energy Atlas[1],
- few residences in the center of the peninsula,
- milder winter conditions that other regions in Newfoundland, and
- proximity to the Maritime Link substations.

The following parameters were not taken into consideration:

- land use,
- environmental constraints and potential impacts,
- traditional land use,
- stakeholder constraints and concerns,
- noise constraints,
- land access,
- site access including inland transportation and port shipping restrictions,
- power flow studies, and

[1] http://www.windatlas.ca/en/index.php

- other considerations that may arise through field studies.

Based on the desktop study, the peninsula was identified to have a potentially suitable wind resource.

The following map shows the wind resource as identified in the Canada Wind Energy Atlas. The wind speeds for this region are similar to off-shore wind speeds.

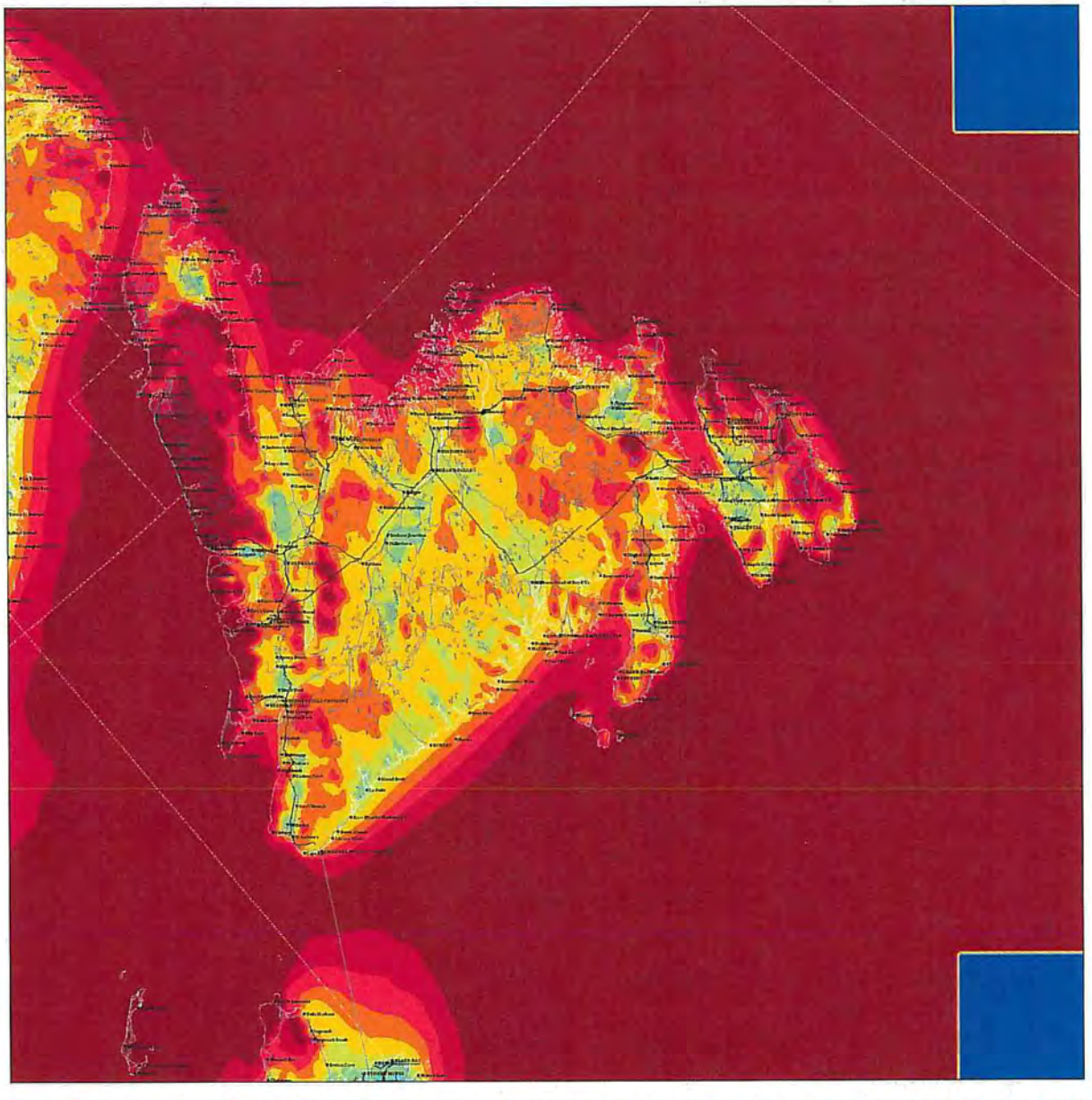


Figure 3: Newfoundland Overlay Map, 80 metre – Annual resource, Canadian Wind Atlas, Darker Red indicates higher wind energy

Resource Assessment

After selection of Port-au-Port, WSP reviewed the lands and identified two sites to determine the potential wind resource at each of these. WSP accessed data from Vortex. The Vortex data combined data from multiple regional reanalysis models and uses mesoscale modelling to determine predicted wind speeds.

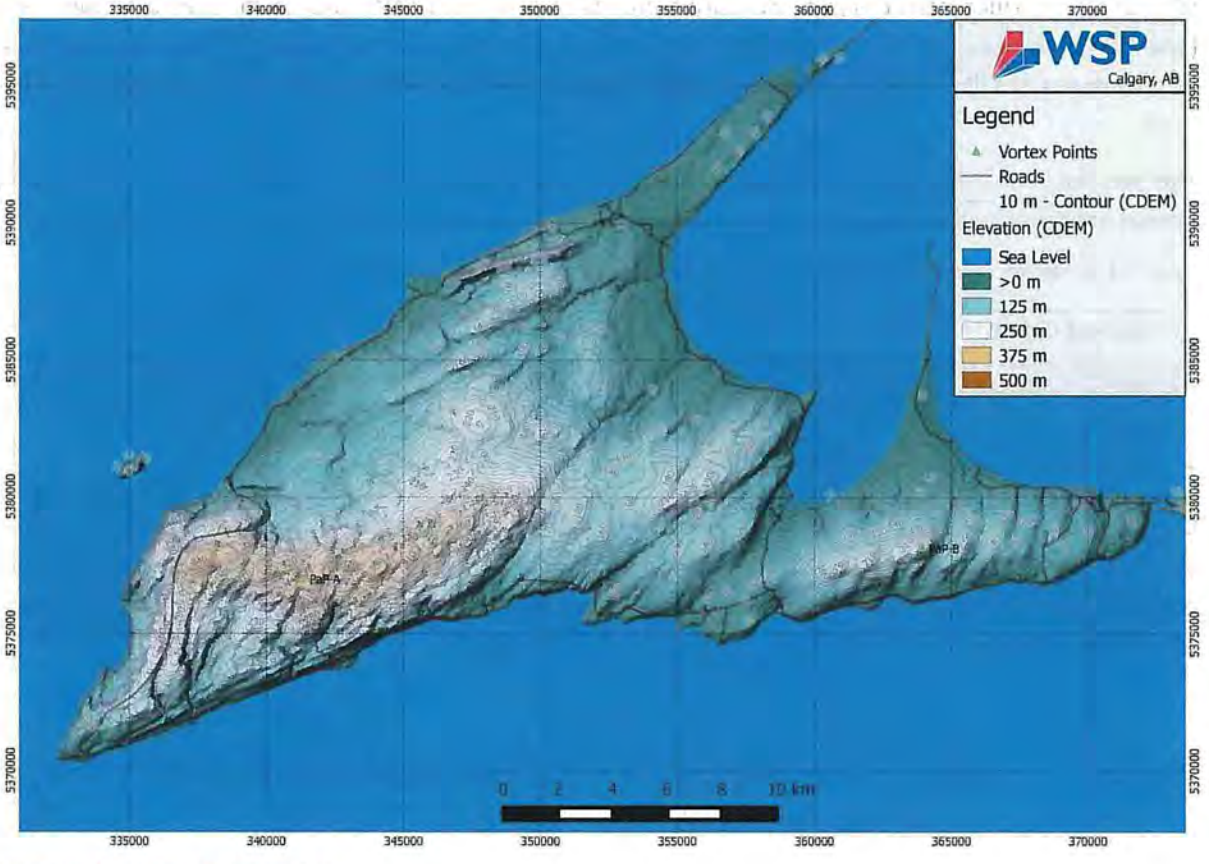


Figure 1: Site A and B, Port-au-Port

The full resource assessment report completed by WSP utilized the GE 2.85-103 turbine and SWT 2.3-108 turbine on 80 metre towers. WSP determined that the predominant wind direction is from the south-west. Two modeling points were selected to represent the range in wind conditions in the region of the southern ridge that runs east-west. The peninsula is expected to have a mixture of Class I conditions on the southern ridges and Class II/III conditions in the interior of the island. All wind sites are classified based on wind speed and turbulence. Class I is the highest wind speed class with an annual average wind speed at hub height of over 10 metres per second. Class II has a medium wind resource at 8.5 metres per second wind speed, and Class III with an annual average wind speed at hub-height of 7.5 metres per second.

The analysis completed by WSP used 20-year data sets to characterise the wind speed distribution as well as the site air density at each location. This assessment provides an indication of expected wind

resource at this location, however detailed on-site measurement is required to provide an assessment at an accuracy level needed to finance a project.

WSP determined that Site PaP-A has the highest wind speed at 9.2 m/s @ 80 metres, and Site PaP-B has the lower wind speed at 8.2 m/s @ 80 metres.

The analysis by WSP included gross and net yields of the GE 2.85-103 and SWT 2.3-108. The SWT 2.3 MW analysis demonstrated higher capacity factor than a GE 2.85 MW turbine for the same locations (Site PaP-A and Site PaP-B). A cold weather package is critical for this location as icing and extreme temperatures are likely. A generic loss value of 18% was used to calculate the net yield from the gross yield.

The two locations selected on the peninsula have strong wind power potential, with the following annual net capacity factors.

Table 1: Comparison of Net Capacity Factors for Site A and Site B by Turbine Type for Port-au-Port

Annual Net Capacity Factor	GE 2.85-103	SWT 2.3-108
PaP-A @ 80 metres	45.7%	51.8%
PaP-B @ 80 metres	38.5%	44.6%

One of the most interesting outcomes of the assessment is the shape of the annual capacity factor curve. In the summer months, the capacity factor is very high and demonstrates a very strong wind resource. Newfoundland's summer capacity factors are higher than annual averages seen in Ontario for equivalent turbines.

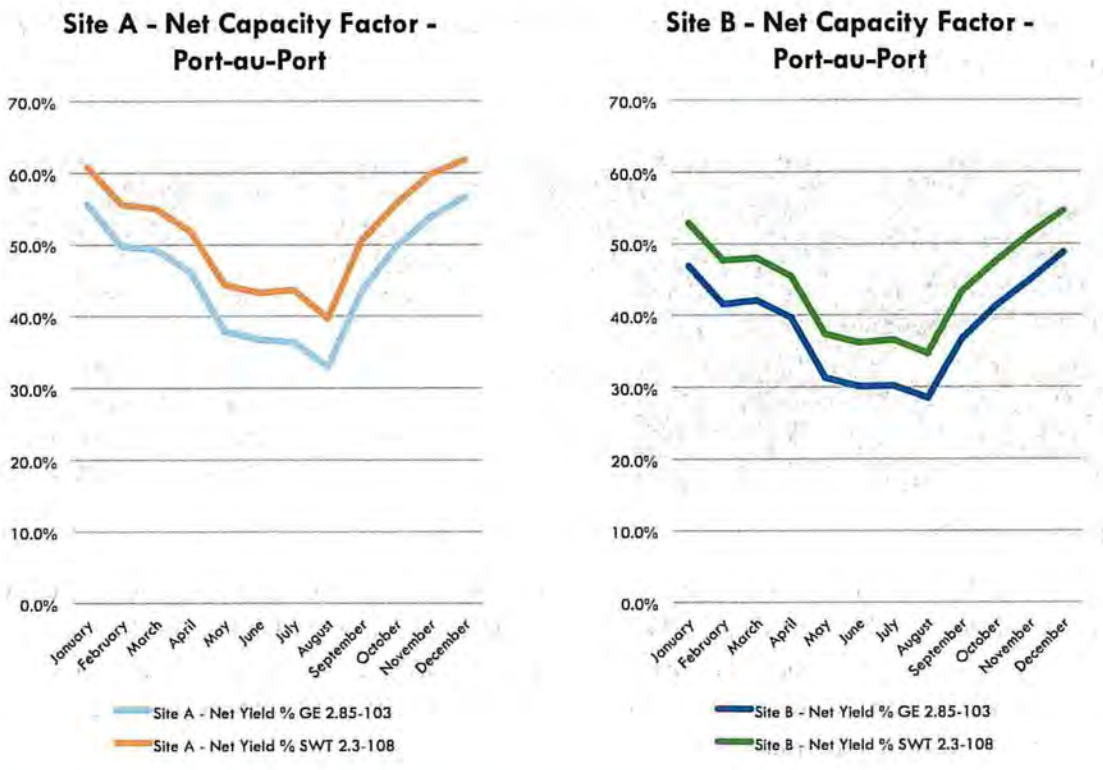


Figure 2: Comparison of Site A and B Annual Net Capacity Factor by Turbine and by Month

This wind resource assessment is not a determination of turbine suitability and on-site measurement should be completed to assess the viability of the site.

[redacted]

Section 29(1)(a) Section 35(1)(d) Section 35(1)(g)
Section 39(1)(a), (b), (c)(i)

Section 29(1)(a) Section 35(1)(d) Section 35(1)(g) Section 39(1)(a), (b), (c)(i)

[redacted]

Operating Expenses

Operating expenses for wind projects fall into three broad categories: 1) turbine operations, service and maintenance costs, 2) asset management costs, and 3) other operations costs.

1. **Turbine operations, service and maintenance costs** includes the scheduled and unscheduled maintenance and the daily turbine operations. Often the turbine service and maintenance is performed by the original equipment manufacturer (OEM) under warranty or a long term service agreement for a period of time, and the turbine operations is performed by an owner's representative. There are a minimum number of turbine technicians required to safely service any site and so for small projects the per turbine cost of operations, service and maintenance is usually high. As economies of scale are reached at the 80 to 100 MW plus size, the costs are typically proportional to the number of units to be maintained and are largely variable, so an increase in project size above the 100 MW will see a very slight decrease in costs on a per-turbine basis.
2. **Asset management costs** include the costs for management, reporting, warranty compliance, administration, contract maintenance and oversight of the facility. These costs are largely fixed costs with a minor dependency on project size.
3. **Other operating costs** which include land lease fees, electricity usage, any environmental post-monitoring studies, transmission costs, facility insurance, taxes, balance-of-plant maintenance, office rent, supplies, and personnel. Part of these costs typically depend on the number of units; however, also have a fixed cost component.

[redacted]

Section 29(1)(a) Section 35(1)(d) Section 35(1)(g)
Section 39(1)(a), (b), (c)(i)

Results Summary

Capital costs and operating costs provided by Solas are rough order of magnitude based on best available information. The resource estimated is based on regional re-analysis data and power curves provided by both Siemens and GE. The following table summarizes the information associated with the potential build of a wind farm at Port-au-Port and are specifically only for the GE turbine, and not the Siemens turbine.

Table 6: Summary Results - Port-au-Port Wind Farm (100 MW, 200 MW, 400 MW) – All in 2016 Canadian dollars, assuming GE 2.85-103 turbine Section 29(1)(a) Section 35(1)(d) Section 35(1)(g) Section 39(1)(a), (b), (c)(i)

	100 MW	200 MW	400 MW	Sensitivity
Resource				
Number of Units	35	70	140	
Net Wind Resource Estimate	38.5 - 45.7%	38.5 - 45.7%	38.5 - 45.7%	+/- 10%
Capex (CAD$M)				
Turbine	[redacted]			
Delivery				
BOP Construction				
Transmission Costs	*Not included*	*Not included*	*Not included*	
Regulatory/Permitting Costs	*Not included*	*Not included*	*Not included*	
Owner's Costs	*Not included*	*Not included*	*Not included*	
TOTAL Capex CAD$M	[redacted]			
$Capex/kW installed				
Operating Cost (CAD$M)				
Operating Cost – Annual, escalated yearly	[redacted]			
Escalation per year				

Should you have any questions, comments or concerns, please contact us at your earliest convenience and we would be happy to respond.

ATTACHMENT A – WSP RESOURCE ASSESSMENT

To: Paula McGarrigle
Solas Energy Consulting, Inc.

From: Matthew Breakey, P.Eng and Errol Halberg, P.Eng
WSP Canada Inc.

Date: July 22, 2015

Subject: Port au Port, Newfoundland – Yield Results

BACKGROUND

WSP has completed a preliminary analysis of the available wind resource for the Port au Port Island, located on the south-west coast of Newfoundland. The predominate wind direction is from the south-west. The topography of the island includes a ridge that runs along the south edge of the island and lower elevation areas to the north of the ridge. The island is ringed with a road and residences, but with few roads and residences in the interior of the island. Therefore, the most likely location for a wind farm is along the south ridge. Two modelling points were selected to represent the range of wind conditions in this area. Vortex long-term wind speed data sets were generated for both locations. The seasonal air density and wind speed distributions were characterized and the long-term gross and net energy yields were calculated at the two modelling points using both a GE 2.85-103 turbine and a Siemens SWT-2.3-108 turbine on 80 m towers.

WSP expects there to be a strong gradient of wind speeds across the island with class I conditions on the southern ridge and class II/III conditions in the interior of the island.

METEOROLOGICAL DATA

The two points used in the study are summarized in Table 1, and are shown on the map presented in Figure 3.

The two modeling points selected are expected to represent the best wind resource available in their respective region. Point PaP-A is the best developable location on the island whereas PaP-B is closer to an average location. The island has a ridge that runs along the south edge and is characterized by rugged terrain. The edge of the island is steep with large cliffs, particularly on the west coast. A long spit runs north of the island, but its orientation is parallel to the prevailing wind direction which makes it less desirable. In addition, a preliminary look at setbacks from houses indicates that there is little developable lands directly on the northern spit. The remaining land base on the island appear to be highly developable.

Twenty year data sets were ordered from Vortex and were used to characterize the wind speed distribution as well as the site air density at each location.

Parameter	PaP-A	PaP-B
Latitude (NAD 83)	48.526N	48.542N
Longitude (NAD 83)	59.150W	58.844W
Elevation at Ground	323 m	240 m
Long-term 80 m Wind Speed	9.2 m/s	8.2 m/s

Parameter	PaP-A	PaP-B
Long-term Air Density at 80 m AGL	1.216 kg/m^3	1.234 kg/m^3

Table 1: Summary of Vortex Modelling Points

Figure 1 shows the wind speed frequency distributions for the measured data at the two modelled locations.

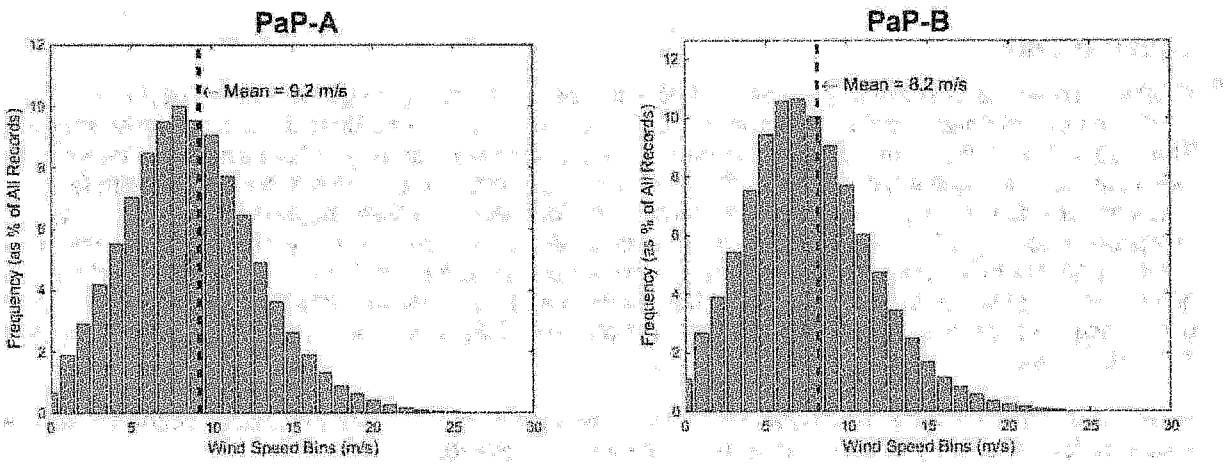


Figure 1: Wind Speed Distribution at 80 m Above Ground Level

Figure 2 shows the wind direction frequency distribution at the modelling locations. The frequency is presented as a percentage of all valid records. The wind directions are divided into 16 bins, each 22.5° wide.

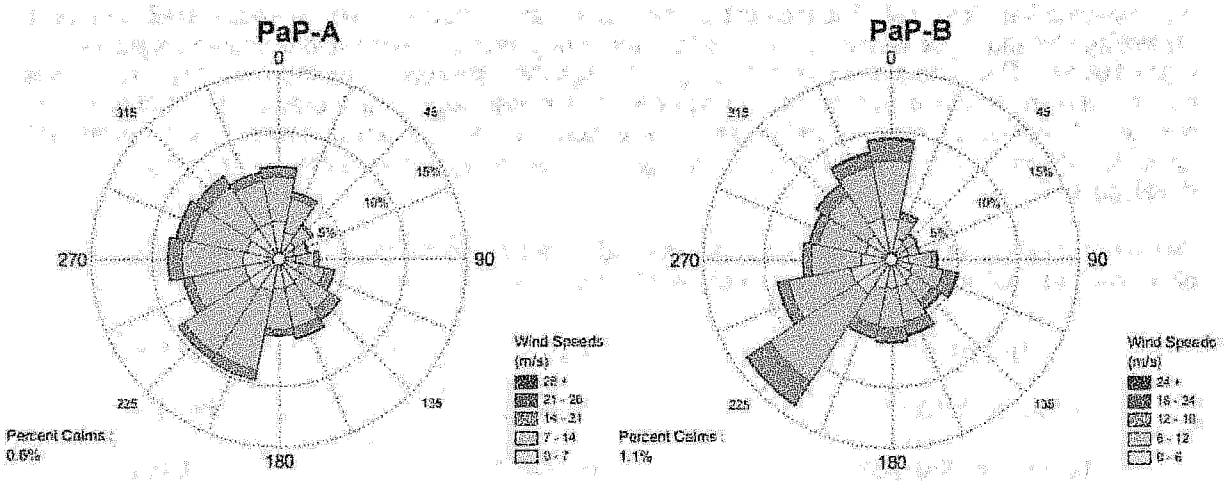


Figure 2: Wind Direction Distribution at 80 m Above Ground Level

LOSSES

A generic loss assumption for the project was assumed. Based on an approximate icing loss of 2%, a wake loss of 5%, a total loss of ~18% was assumed.

A detailed loss study is recommended including an icing loss assessment to confirm the magnitude and seasonal profile of losses. Actual losses may be higher due to the complex terrain (inflow angle and turbulence intensity), high wind hysteresis and environmental losses including low temperature shutdown.

GROSS AND NET YIELDS AT MODELLED LOCATIONS

The guaranteed power curves[1],[2], adjusted for hub height air density, was used to estimate a gross yield at both modelling locations. A generic loss value of 18% was applied to obtain a net yield for both modelling points. The results are summarized in Table 2 and Table 3 for modelling points PaP-A and PaP-B, respectively. The wind resource is high and turbine suitability could be an issue for either turbine technology depending on the turbulence intensity.

Month	Wind Speed [m/s]	GE 2.85-103		SWT 2.3-108	
		Gross Yield [%]	Net Yield [%]	Gross Yield [%]	Net Yield [%]
January	10.8	69.4%	55.6%	75.9%	60.8%
February	9.9	62.2%	49.8%	69.4%	55.6%
March	9.8	61.4%	49.3%	68.5%	55.0%
April	9.2	57.0%	46.2%	64.1%	51.9%
May	7.9	45.8%	37.9%	53.7%	44.4%
June	7.7	44.4%	36.8%	52.2%	43.3%
July	7.7	43.5%	36.4%	52.3%	43.7%
August	7.4	39.5%	33.0%	47.7%	39.8%
September	8.7	52.2%	43.6%	60.5%	50.6%
October	9.6	59.9%	49.7%	67.1%	55.6%
November	10.2	65.4%	53.8%	72.7%	59.8%
December	11.1	70.1%	56.6%	76.5%	61.8%
Total	**9.2**	**55.9%**	**45.7%**	**63.3%**	**51.8%**

Table 2: Estimated Seasonal Yields for Point PaP-A at 80 m

[1] Provided by Solas: "2 85DF-103_xxHz_PCD_allComp_xxxxxxxxxxx ENxxx 04a.pdf" Received by email 2015/07/17
[2] Provided by Solas: "PC Rev 1 Air Densities, SWT-2.3-108", Document E-R-WP-CTO-40-0000-1910-00, Received by email 2015/07/21

Month	Wind Speed [m/s]	GE 2.85-103		SWT 2.3-108	
		Gross Yield [%]	Net Yield [%]	Gross Yield [%]	Net Yield [%]
January	9.4	58.5%	46.9%	66.0%	52.9%
February	8.7	52.0%	41.6%	59.6%	47.7%
March	8.7	52.3%	42.1%	59.8%	48.0%
April	8.2	49.0%	39.7%	56.2%	45.5%
May	7.1	37.8%	31.3%	45.1%	37.4%
June	6.9	36.3%	30.1%	43.6%	36.2%
July	6.9	36.1%	30.2%	43.8%	36.6%
August	6.8	34.2%	28.5%	41.5%	34.7%
September	7.9	43.9%	36.7%	51.9%	43.3%
October	8.5	49.8%	41.3%	57.3%	47.5%
November	9.1	54.6%	44.9%	62.4%	51.3%
December	9.8	60.3%	48.8%	67.6%	54.6%
Total	**8.2**	**47.0%**	**38.5%**	**54.5%**	**44.6%**

Table 3: Estimated Seasonal Yields for Point PaP-B at 80 m

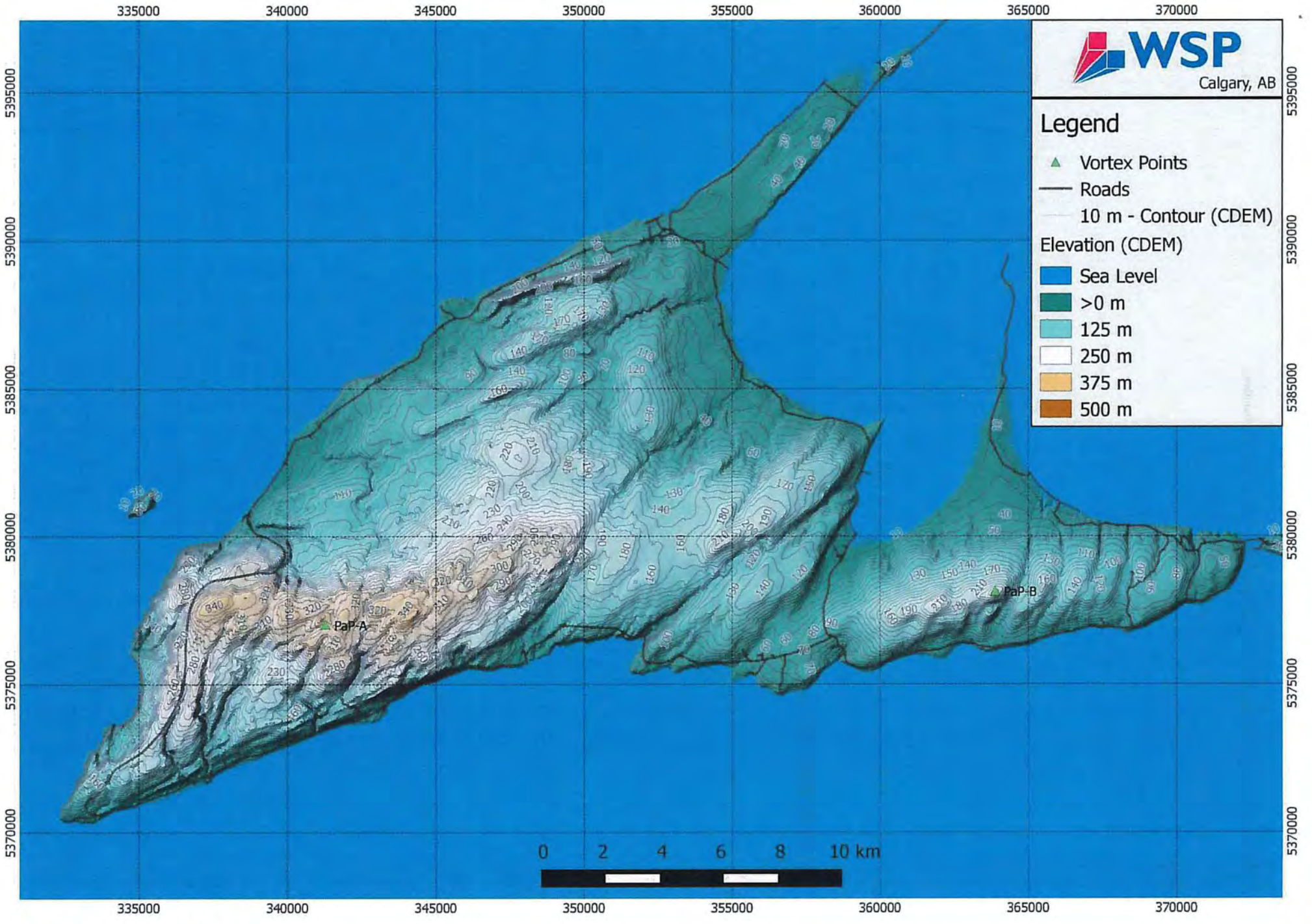


Figure 3: Elevation Map of Port au Port

ATTACHMENT B – BOREA COST ESTIMATE

APPENDIX 2

PENNECON PROJECTED COST DATA

Section 29(1)(a) Section 35(1)(d) Section 35(1)(g)
Section 39(1)(a), (b), (c)(i)

Pennecon Heavy Civil

P. O. Box 8274
1309 Topsail Road
St. John's, NL A1B 3N4
Canada

Phone: (709) 782-3404
Fax: (709) 782-0129

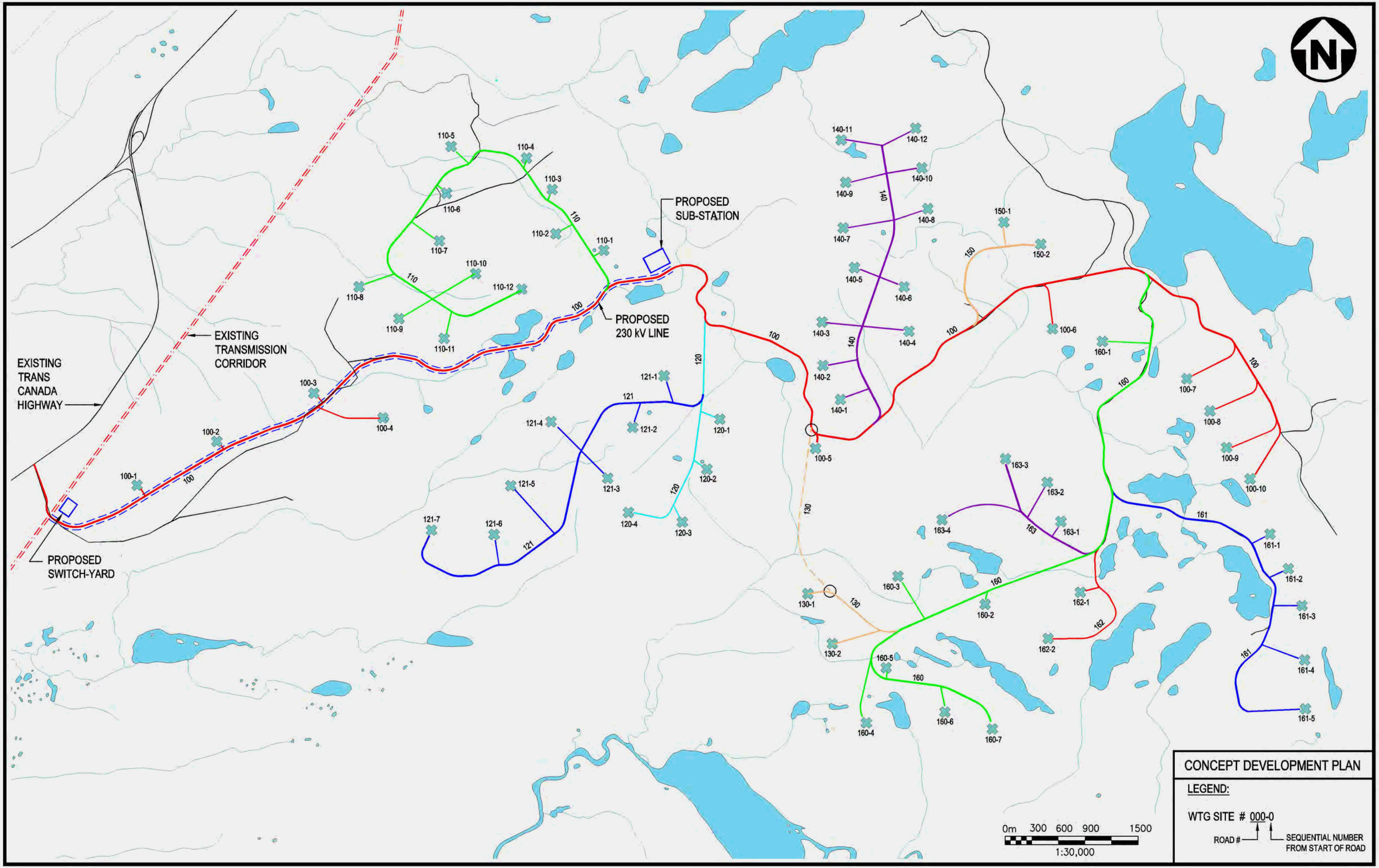
Item Price Summary

Project Name:	Hare Hill Wind Development (Budget)	**Customer:**	AMEC
Job Number:		**Billing Address:**	St. John's
Bid As:	Pennecon Heavy Civil Ltd.		
Estimator:	Kevin Mouland	**Phone:**	
Project Address:	Hare Hill, NL	**Contact:**	
Completion Date:	9/1/2020		

[redacted]

APPENDIX 3

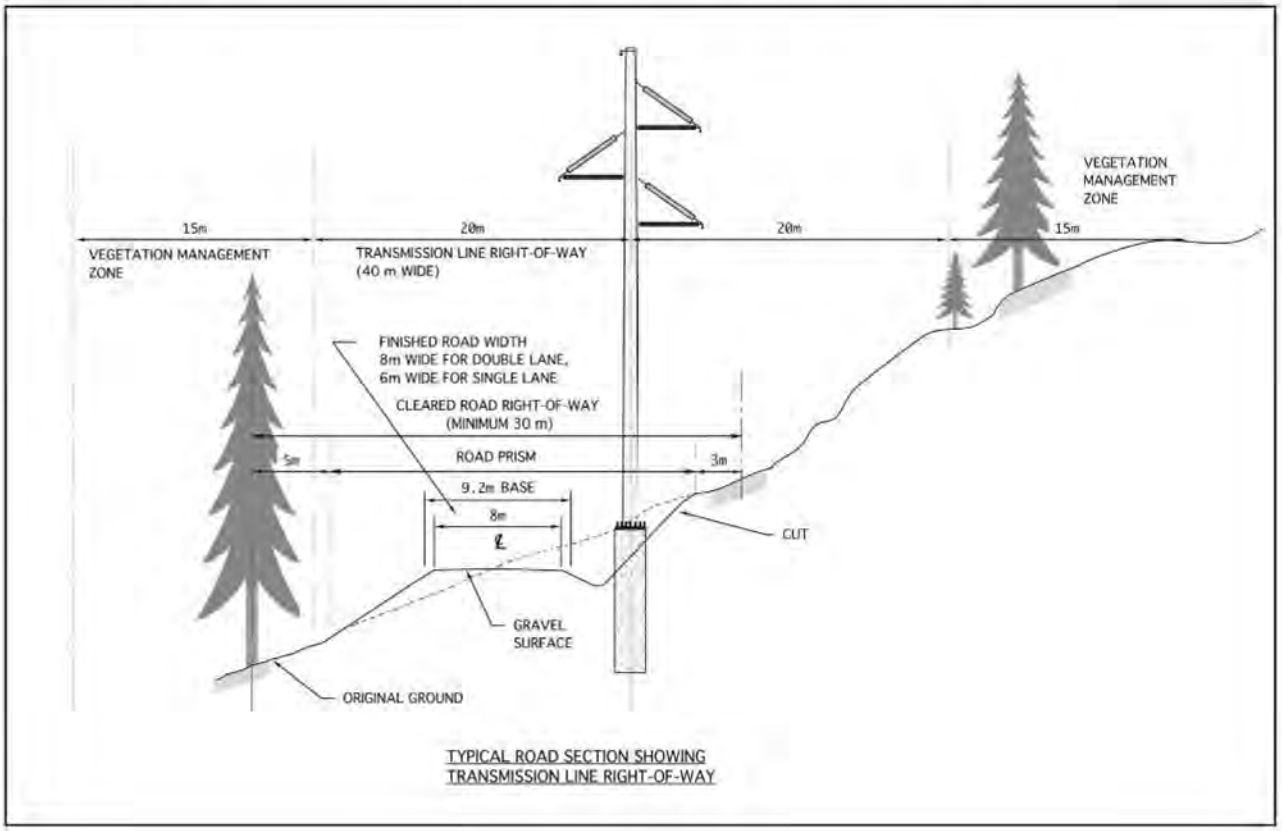
CONCEPTUAL DEVELOPMENT PLAN

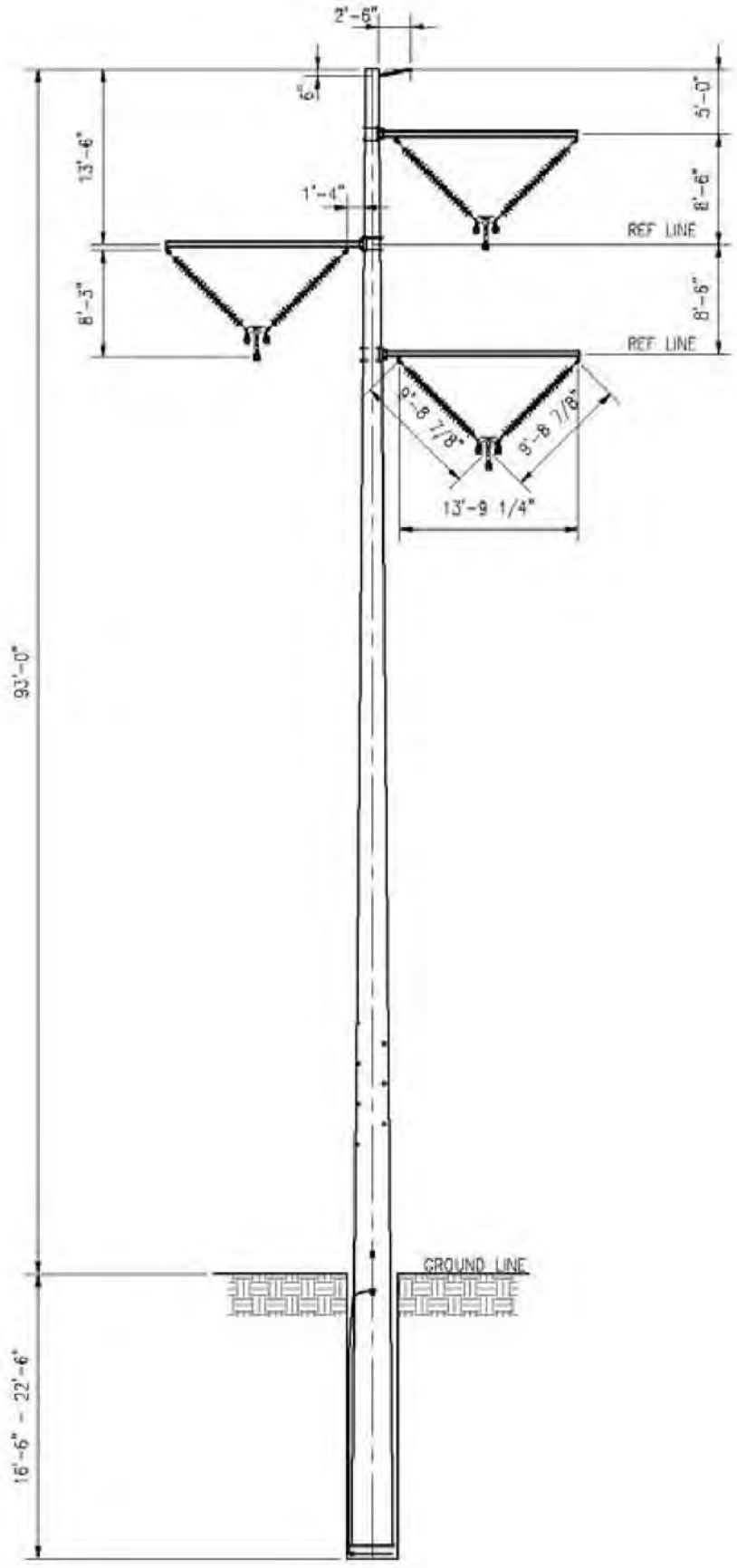

N
PROPOSED SUB-STATION
PROPOSED 230 kV LINE
EXISTING TRANSMISSION CORRIDOR
EXISTING TRANS CANADA HIGHWAY
PROPOSED SWITCH-YARD
110-1
110-2
110-3
110-4
110-5
110-6
110-7
110-8
110-9
110-10
110-11
110-12
100-1
100-2
100-3
100-4
100-5
100-6
100-7
100-8
100-9
100-10
120-1
120-2
120-3
120-4
121-1
121-2
121-3
121-4
121-5
121-6
121-7
130-1
130-2
140-1
140-2
140-3
140-4
140-5
140-6
140-7
140-8
140-9
140-10
140-11
140-12
150-1
150-2
160-1
160-2
160-3
160-4
160-5
160-6
160-7
161-1
161-2
161-3
161-4
161-5
162-1
162-2
163-1
163-2
163-3
163-4
0m 300 600 900 1500
1:30,000
CONCEPT DEVELOPMENT PLAN
LEGEND:
WTG SITE # 000-0
ROAD #
SEQUENTIAL NUMBER FROM START OF ROAD

APPENDIX 4

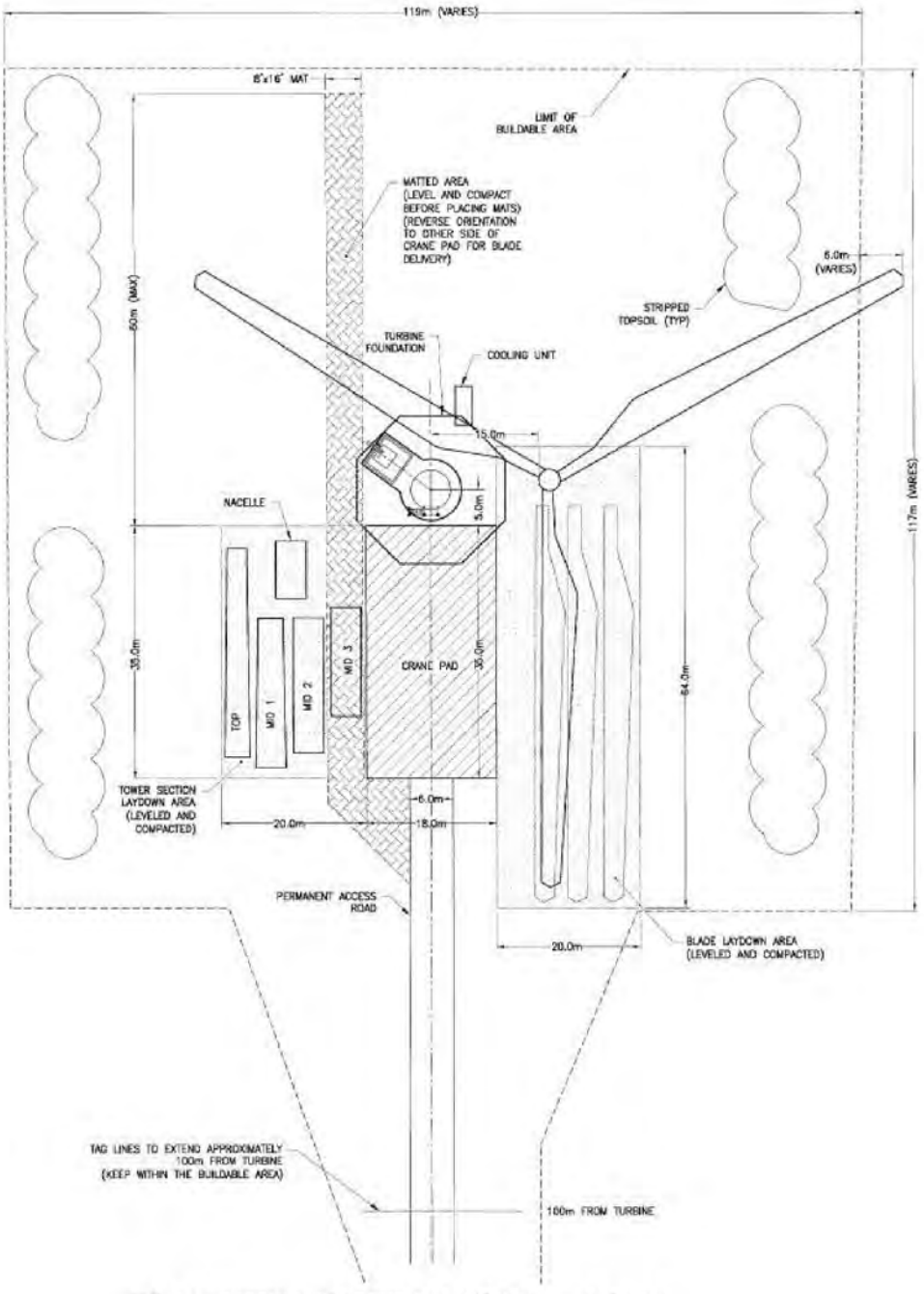
CIVIL DATA PACKAGE

Figure 2.12 - 2 Typical Right-of-way Cross Sections (287kV)





BLYTHE-JULIAN HINDS POLE
SINGLE CIRCUIT



TYPICAL TURBINE COMPONENT LAYDOWN – LAYOUT 1

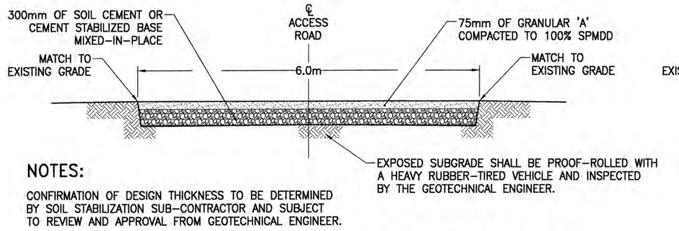
SCALE: 1:400

Access Roads and Laydown Yards

			Units		Quantity 67 Sites	Unit Price	Total
1.	Crane Pads						
		Terrefix 270R	m2	630	42210		
		Granular 'B' (350mm)	m3	221	14774		
		Granular 'A' (50mm)	m3	32	2111		
						Sub-Total	
2.	Laydown						
		Terrefix 270R	m2	1980	132660		
		Granular 'B' (350mm)	m3	693	46431		
		Granular 'A' (50mm)	m3	99	6633		
						Sub-Total	
3.	Permanent Access Roads (6m wide, 22400m Length)						
		Terrefix 270R	m2		134400		
		Granular 'B' (350mm)	m3		47040		
		Granular 'A' (50mm)	m3		6720		
						Sub-Total	
4.	Clearing And Grubbing						
		Laydown	m2	1980	132660		
		Crane Pads	m2	630	42210		
		Roads (10m ROW x 22400m)	m2		224000		
						Sub-Total	
5.	Crossing Culverts (30 culverts)						
		Rip Rap (w/Filter Fabric)	m3	1.2	72		
		Granular 'B' (1500mm)	m3	84	2520		
		Granular 'A' (650mm)	m3	36	1092		
		Culverts (900mm)	m	8	240		
						Sub-Total	
						Total	

Main Roads

		Units	Quantities	Unit Price	Total
1.	Grubbing	m2	533,465		
2.	Excavation	m3	712,570		
3.	Borrow	m3	2,271,410		
4.	Granular 'A'	m3	162,950		
5.	Geotextile	m2	230,200		
6.	Culverts (900mm)	m	900		
7.	Rip Rap (culverts)	m3	750		
8.	Quarry Development	each	1		
				Total	

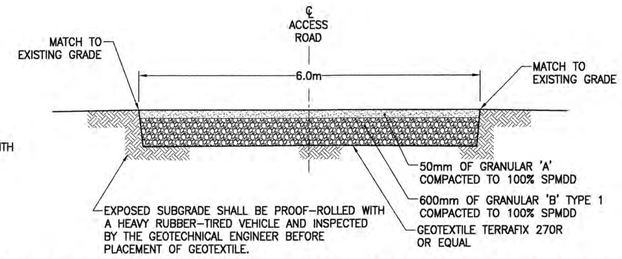


NOTES:

CONFIRMATION OF DESIGN THICKNESS TO BE DETERMINED BY SOIL STABILIZATION SUB-CONTRACTOR AND SUBJECT TO REVIEW AND APPROVAL FROM GEOTECHNICAL ENGINEER.

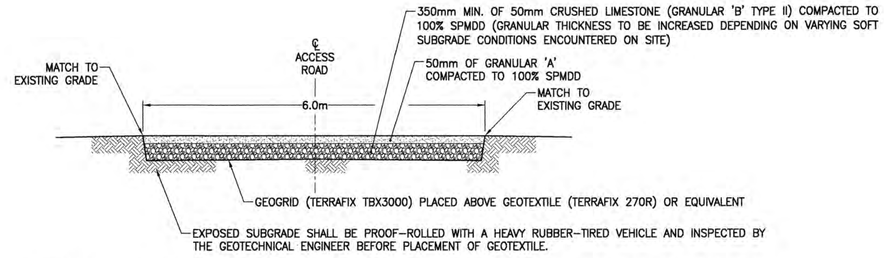
TYPICAL PERMANENT ACCESS ROAD CROSS SECTION USING SOIL STABILIZATION (ALTERNATIVE OPTION 1 FOR SOFT SOIL CONDITIONS)

DETAIL 1 — SCALE: N.T.S.



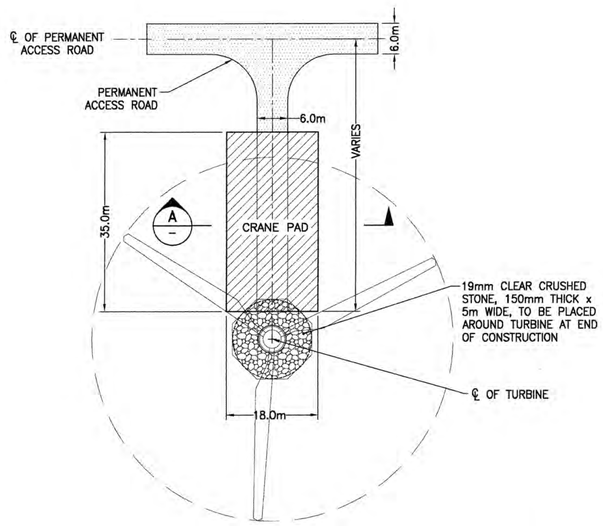
TYPICAL PERMANENT & TEMPORARY ACCESS ROAD CROSS SECTION (ALTERNATIVE OPTION 2 FOR SOFT SOIL CONDITIONS)

DETAIL 2 — SCALE: N.T.S.

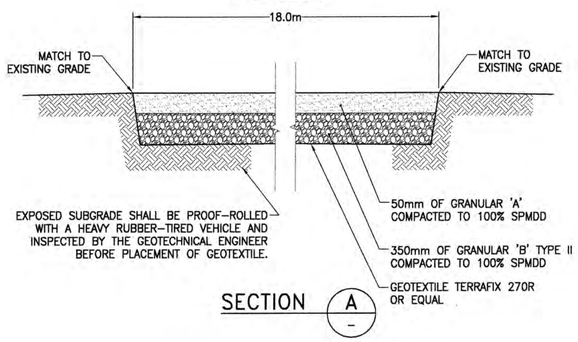


TYPICAL PERMANENT & TEMPORARY ACCESS ROAD CROSS SECTION (ALTERNATIVE OPTION 3 FOR SOFT SOIL CONDITIONS)

DETAIL 3 — SCALE: N.T.S.



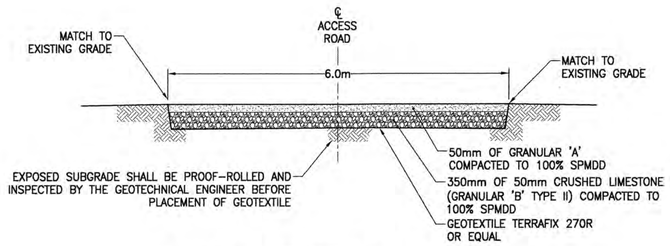
PLAN VIEW



SECTION A

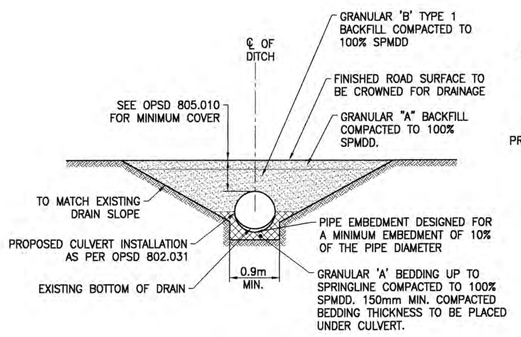
TYPICAL CRANE PAD DETAIL

DETAIL 5 — SCALE: N.T.S.

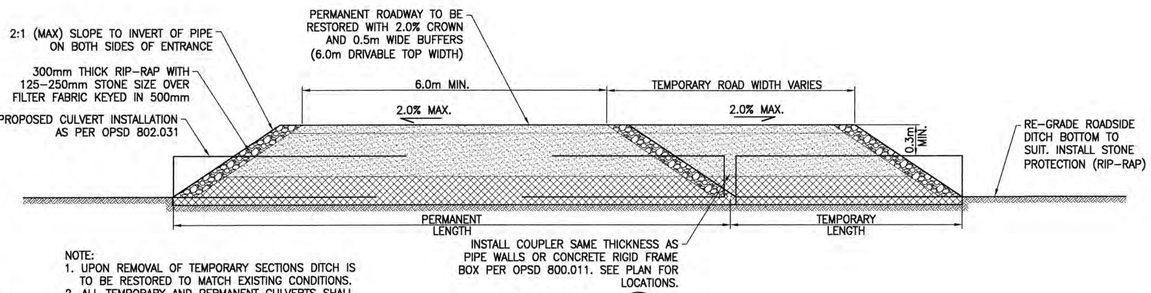


TYPICAL PERMANENT & TEMPORARY ACCESS ROAD CROSS SECTION (FOR GOOD SOIL CONDITIONS)

DETAIL 4 — SCALE: N.T.S.

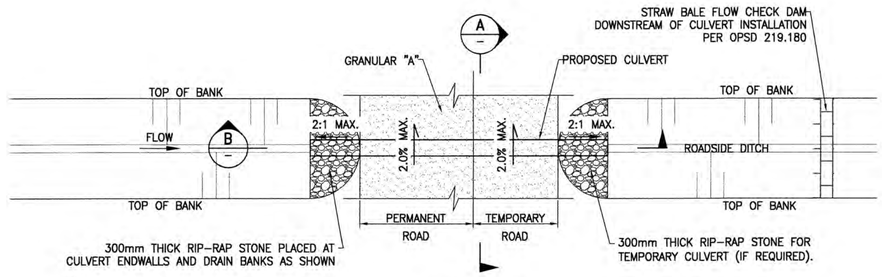


SECTION A



NOTE:
1. UPON REMOVAL OF TEMPORARY SECTIONS DITCH IS TO BE RESTORED TO MATCH EXISTING CONDITIONS.
2. ALL TEMPORARY AND PERMANENT CULVERTS SHALL BE CONNECTED TO A RECEIVING ROADSIDE DITCH OR MUNICIPAL DRAIN. APPROVAL MUST BE OBTAINED FROM GOVERNING AGENCY PRIOR TO CONSTRUCTION.

SECTION B

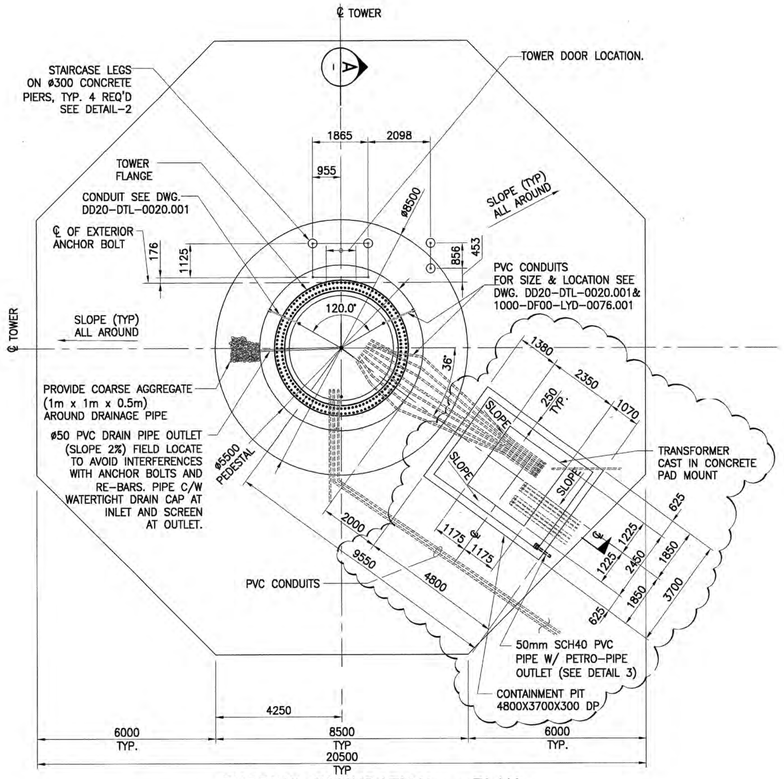


PLAN VIEW
SCALE: NTS

TYPICAL ACCESS ROAD ENTRANCE CULVERT INSTALLATION DETAIL

SCALE: NTS

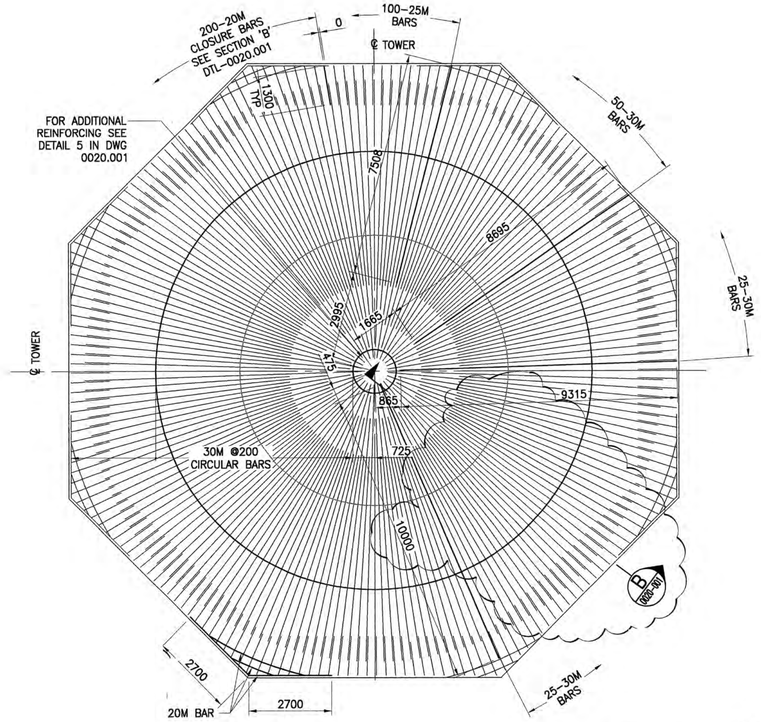
amec foster wheeler

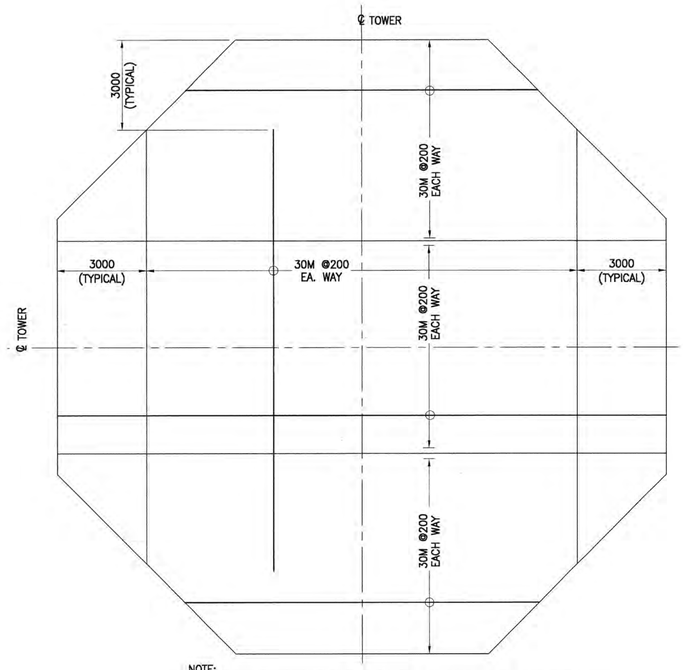


TURBINE FOUNDATION – PLAN

1:100

(FOR LOCATION OF GRAVEL AREA SEE ROAD LAYOUT DWG 1000-DD10-LYD 0001.001 TO 0001.017 & OTHER CIVIL AND ELECTRICAL GROUNDING DWGS)

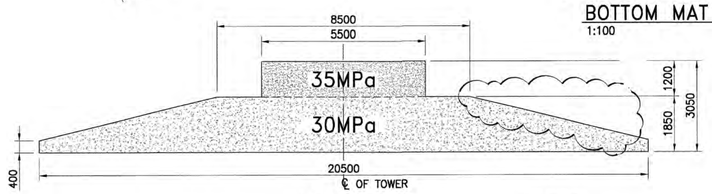




NOTE:
BOTTOM MAT REINFORCING BARS SHALL BE GRADE 500R DEFORMED BARS.

BOTTOM MAT REINFORCING PLAN

1:100

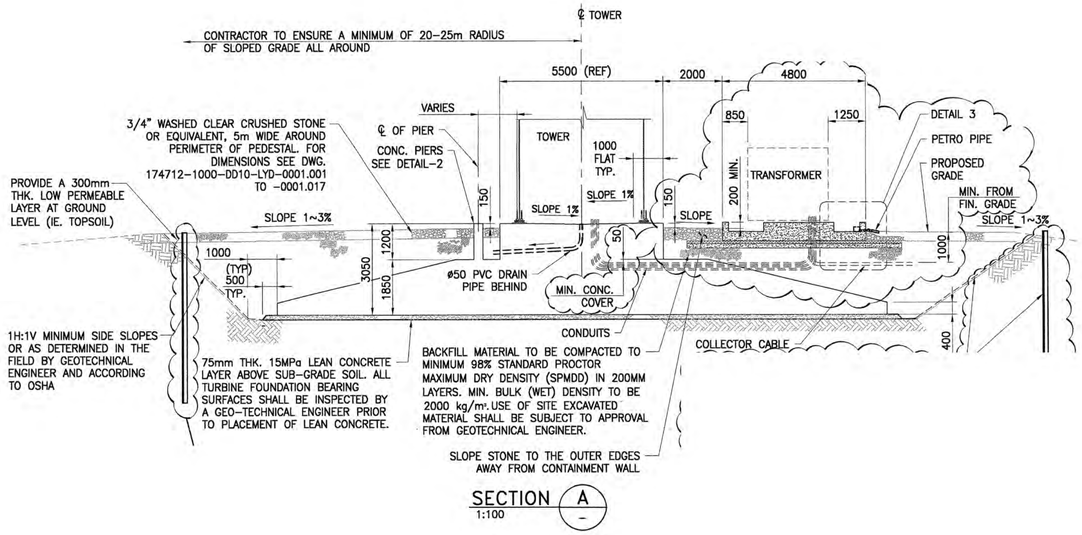


DETAIL 1

CONCRETE GRADE DISTRIBUTION

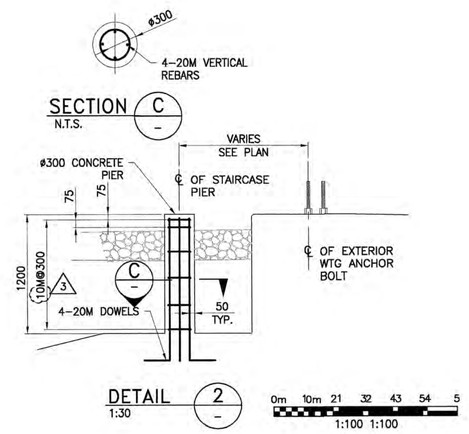
NOTES:

1. ALL DIMENSIONS SHOWN ON THIS DRAWING ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.



SECTION A

1:100



DETAIL 2

1:30

0m 10m 21 32 43 54 5

1:100 1:100

amec foster wheeler

APPENDIX 5

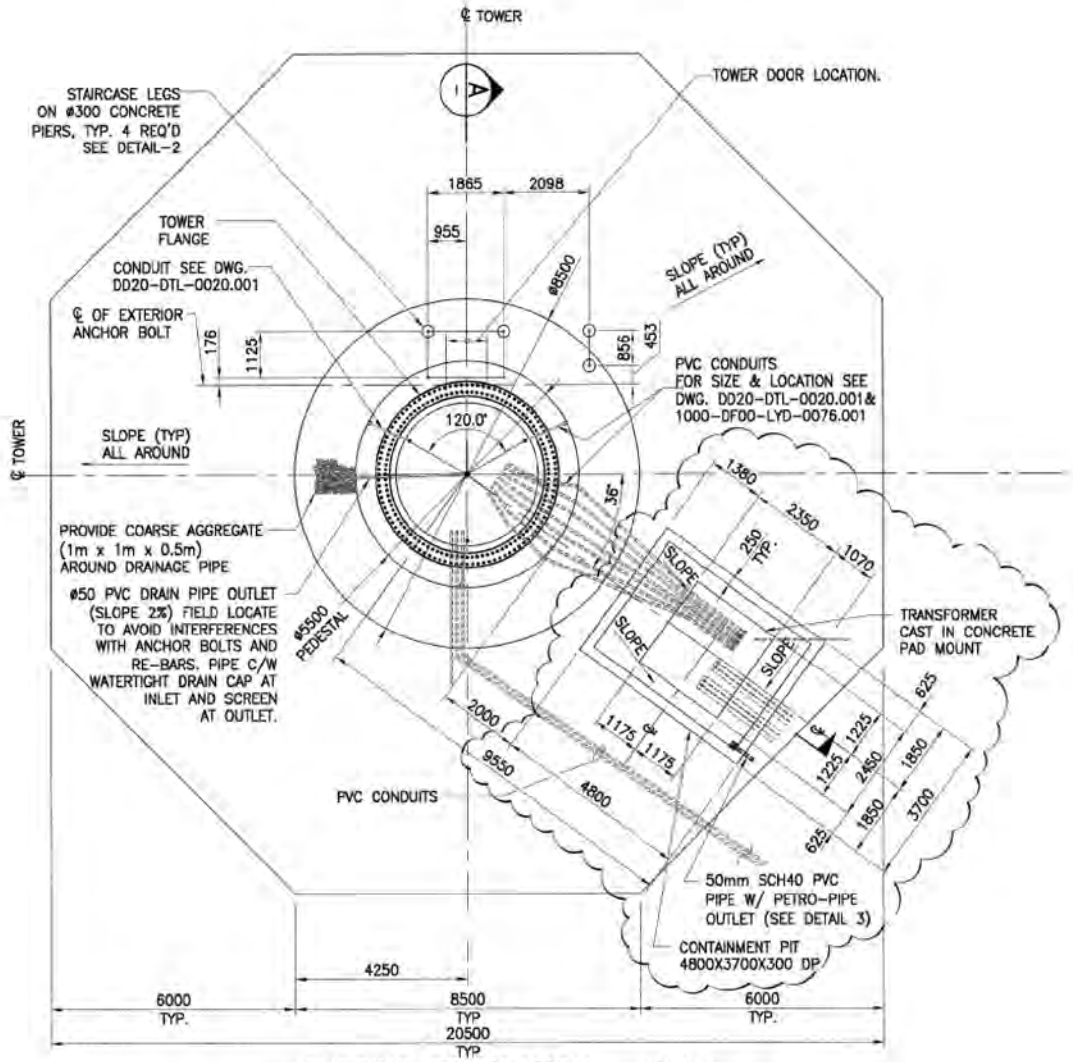
FOUNDATION DATA PACKAGE

Structural Information Package for Foundations

The foundation to be considered as the base case is as follows:

5. Octagonal Gravity Base Foundation with dimension of 21.5m, volume of concrete 593 m^3 and rebar density of 100 kg/m^3
6. Transformer concrete pad for each foundation of 5m x 4m x 0.4m thick, rebar density of 60 kg/m^3
7. Each foundation to be cast in one pour operation
8. Number of foundations = 67.

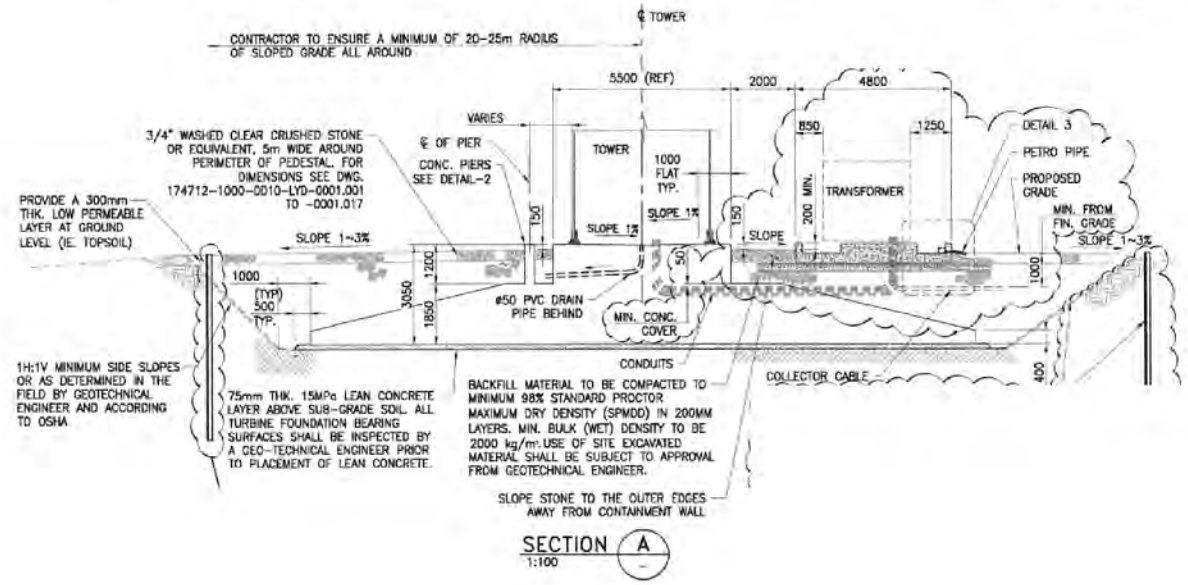
The following are some plans and details for a similar base with a 20.5m base dimension.



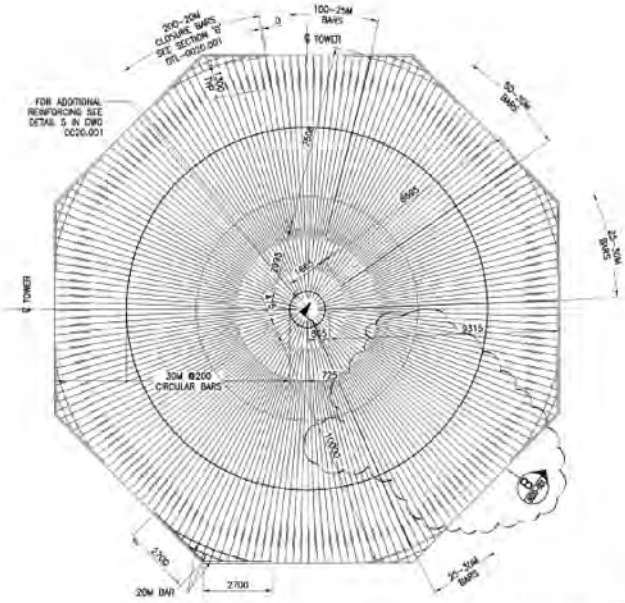
TURBINE FOUNDATION – PLAN

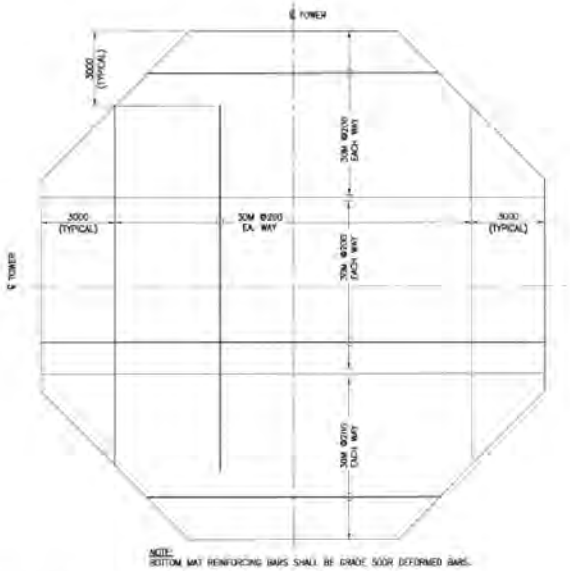
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(FOR LOCATION OF GRAVEL AREA SEE ROAD LAYOUT DWG 1000-DD10-LYD 0001.001 TO 0001.017 & OTHER CIVIL AND ELECTRICAL GROUNDING DWGS)



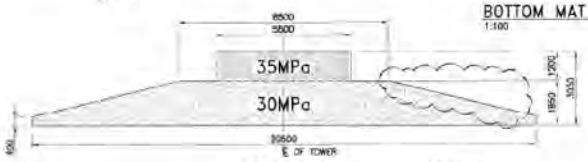
SECTION A
1:100





NOTE:
BOTTOM MAT REINFORCING BARS SHALL BE GRADE 500R DEFORMED BARS.

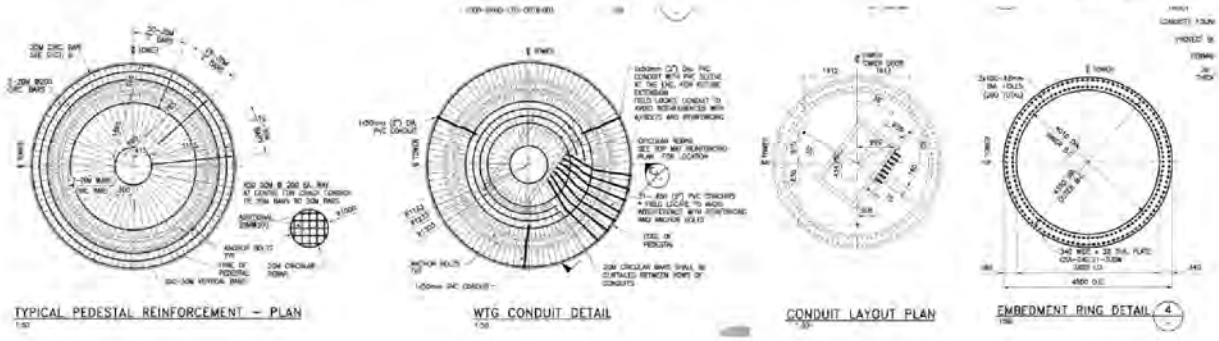
BOTTOM MAT REINFORCING PLAN
1:100



DETAIL 1
CONCRETE GRADE DISTRIBUTION

NOTES:

1. ALL DIMENSIONS SHOWN ON THIS DRAWING ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.

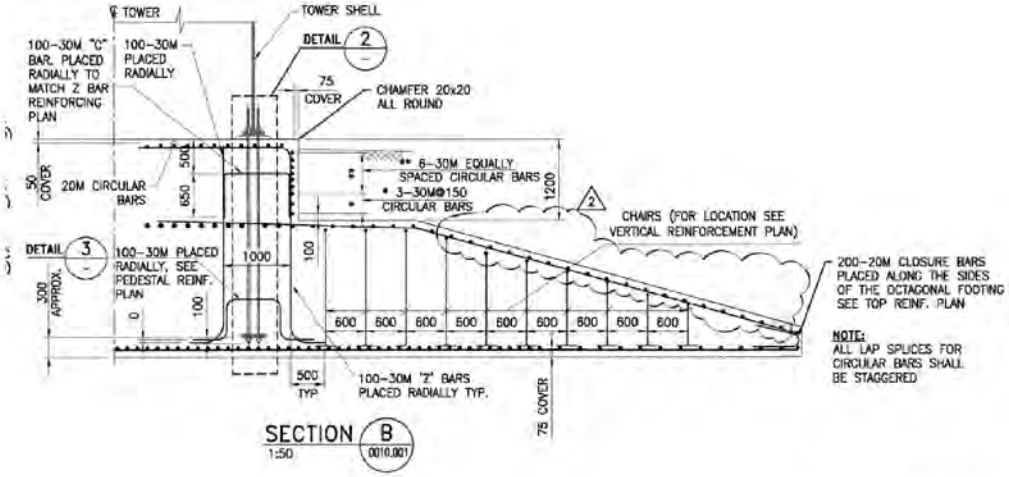


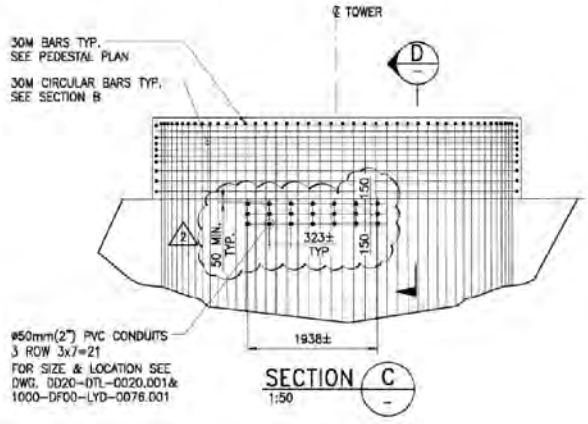
TYPICAL PEDESTAL REINFORCEMENT – PLAN

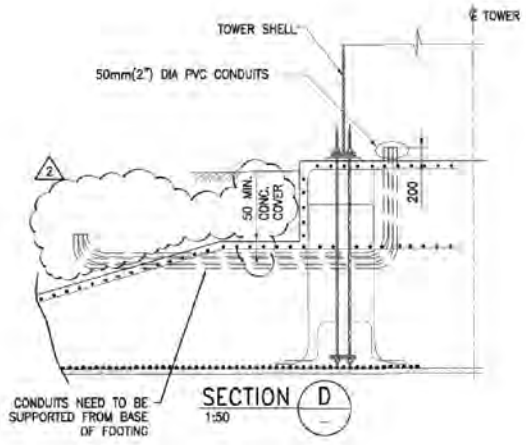
WTG CONDUIT DETAIL

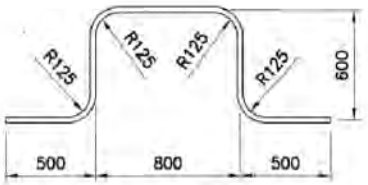
CONDUIT LAYOUT PLAN

EMBEDMENT RING DETAIL 4

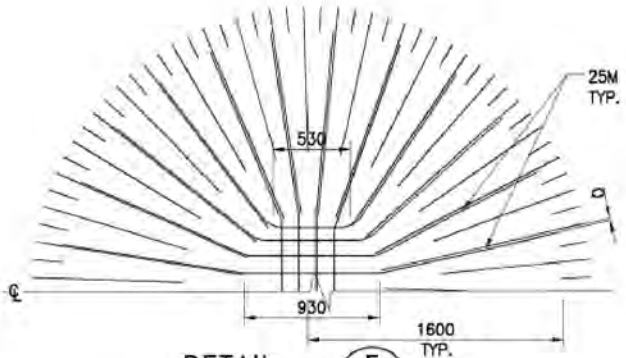






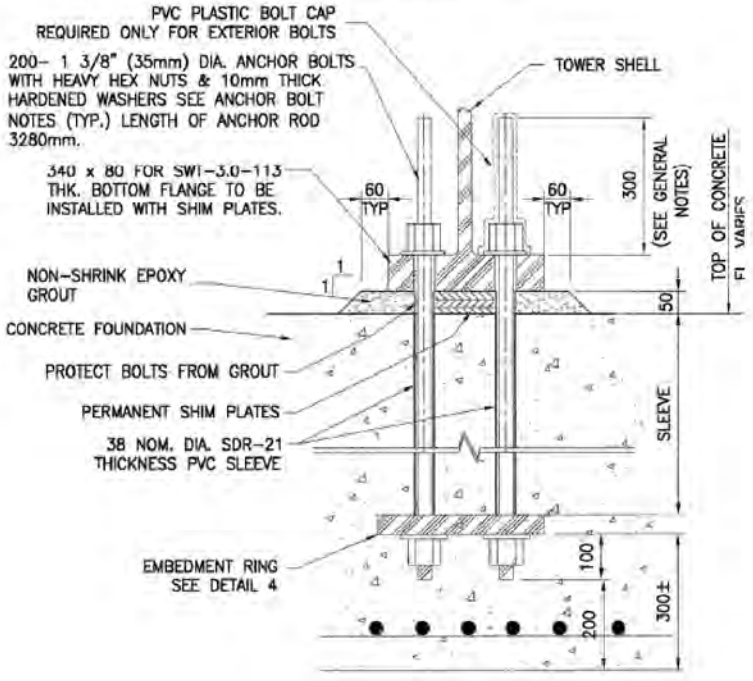


DETAIL 3
1:25



DETAIL 5
1:30
0010.001

ADDITIONAL TOP MAT REINFORCING
MIN. LAP 1100mm



DETAIL 2
1:10

Assumptions:

The information above was derived based on the following assumptions.

1. Foundation type: octagonal gravity base foundation.
2. Hub height = 100m.
3. Wind reference pressure for 1/50 annual probability of occurrence is 0.60 kPa. This resulted in estimated forces at the foundation of:
   Base shear: = 1,100 kN
   Overturning moment = 69,000 kN.m
4. Size of base determined based on having no tension at the heel under the design wind loads and that bearing capacity of material under the toe was adequate.

Discussion of Sensitivity of Assumptions and Risks:

The assumptions were made in order to determine the sizing of a typical turbine foundation. This section discusses the basis for the assumption and the sensitivity of the foundation design to changes in these assumptions.

Foundation Type

The gravity base foundation is quite commonly used for large wind turbines. It can be used on a variety of sites, providing the underlying material has a reasonable load bearing capacity. The octagonal shape is commonly used and details of such a base are shown in a following section.

Other foundation types are possible. If the underlying material is of poor quality, it may be necessary to use a deep foundation, such as a concrete base supported on piles. This type of foundation could be significantly more costly than a gravity base, depending on the distance below of the competent material.

If the base material is rock, it may be possible to use a smaller concrete base and secure it to the rock using drilled steel rock anchors grouted in place. However, if the rock is fractured, grouting may be difficult and the feasibility would have to be investigated at each tower site. This could be a possible optimization study done in a subsequent project stage.

Mitigation of Risk: conduct a site geotechnical investigation to determine bearing capacities of underlying material.

Hub Height

The height will be determined based on the blade height and wind regime in order to optimize the performance. In general for a turbine this size, the hub height will be in the range of 80-100m. A lower hub height reduces the moment arm for overturning moment at the base. So assuming a hub height at the upper part of this range should be conservative for the purpose of preliminary sizing of the foundation.

Mitigation of Risk: once the wind regime at the site is known, the selected turbine supplier can provide the required hub height. This is an opportunity for optimization in a subsequent project stage.

Wind Overturning

The maximum wind force on the foundation depends on the maximum design wind speed at the site and the geometry of the turbine superstructure. At this time, no information is available for design wind speed. From the climactic data in Appendix C of the National Building Code of Canada:

Corner Brook

$q_{1/50}$ = reference velocity pressure = 0.55 kPa

Stephenville

$q_{1/50}$ = reference velocity pressure = 0.58 kPa

These are the reference pressures for one hour averaged wind speeds representative of a 10m height in flat open terrain corresponding to an annual probability of occurrence of 1/50.

For the purpose of sizing the foundation, a reference wind pressure of 0.60 kPa was assumed in absence of size specific data. The wind profile was taken according to the power law using the following coefficients:

α = exponent of wind profile = 0.14

C_{f1} = peak drag coefficient on the blades = 1.15

C_{f2} = peak drag coefficient on the tower = 1.5

C_p = drag coefficient on the tower = C_{f2} (1+□) = 1.71

This wind distribution was placed on the assumed turbine geometry with a hub height of 100m to determine the base shear and overturning moment for design of the foundation.

Initially the values were calculated using the value for St. John's.

$q_{1/50}$ = reference velocity pressure = 0.78 kPa

However, this resulted in a significantly larger overturning moment and a larger volume of concrete than the reference foundation shown in the figures. It was therefore considered that the larger reference pressure, in conjunction with conservative estimates of the hub height and turbine geometry might too large. However, for information, the sensitivity of the foundation sizing to the assumed wind reference pressure, is shown in the following table.

Parameter	**$q_{1/50}$ = 0.60 kPa**	**$q_{1/50}$ = 0.78 kPa**
Reference 1 hour velocity at 10m height	v = 30 m/s	v = 37 m/s
Base Shear	1,100 kN	1,500 kN
Overturning Moment	69,000 kN.m	102,000 kN.m
Concrete Volume	593 m^3	731 m^3
Rebar Tonnage	60 tonnes	74 tonnes

Mitigation of Risk: determine wind regime at the site. Use the design overturning moment and base shear as provided by the turbine supplier for the known wind regime and particular turbine geometry.

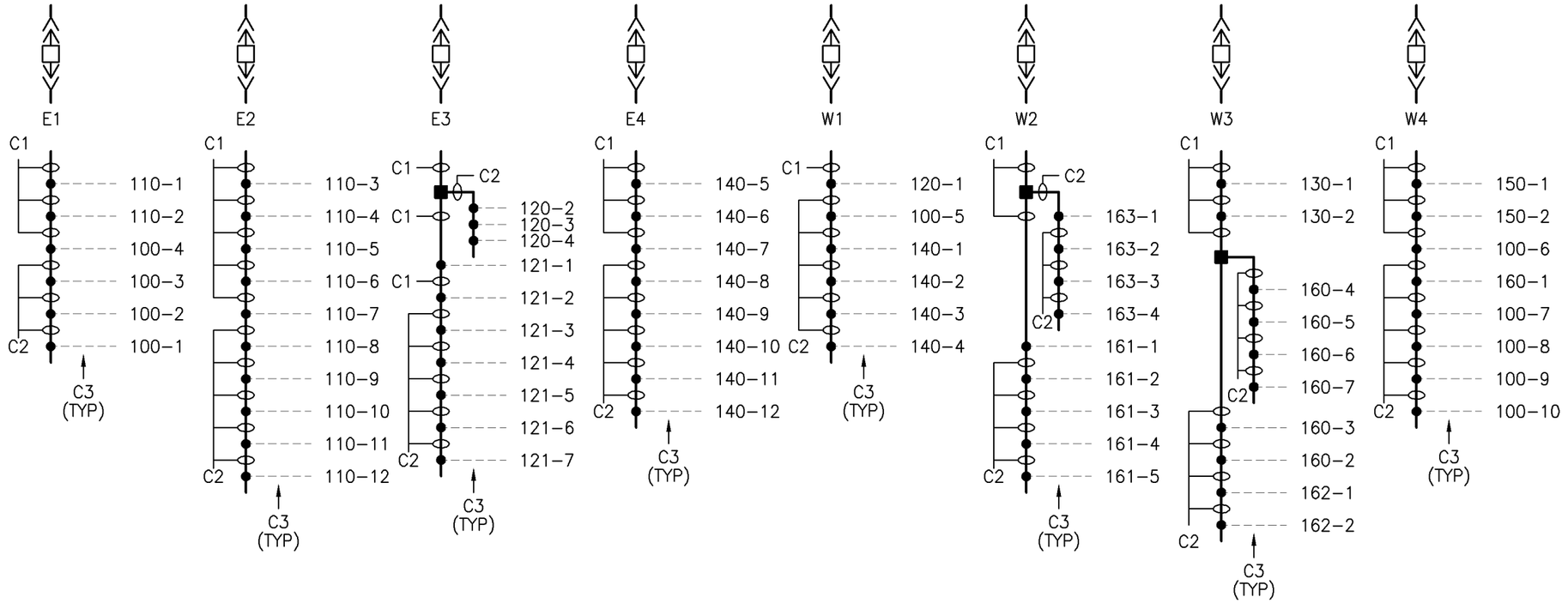
Bearing Capacity

The sizing of the foundation was determined based on the assumption there would be adequate bearing capacity at the toe of the footing under the design overturning moment. However, the suitability of the chosen foundation type and the design geotechnical parameters should be confirmed.

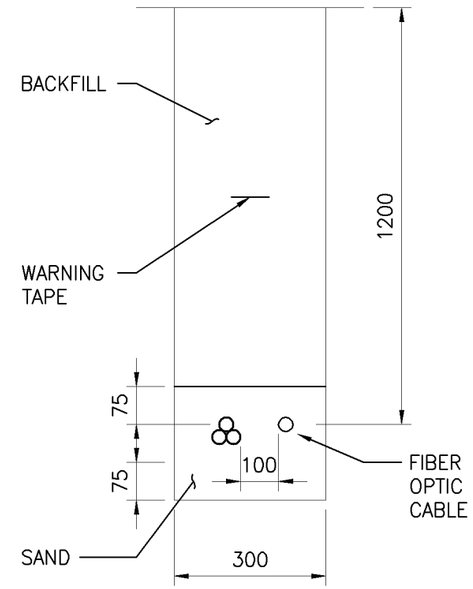
Mitigation of Risk: perform a geotechnical site investigation and prepare a report with recommended foundation type(s) and geotechnical design parameters.

APPENDIX 6

COLLECTOR DATA PACKAGE



34.5kV FEEDERS



DIMENSIONS SHOWN ARE MINIMUM.

EACH ADDITIONAL COLLECTOR CABLE SPACED AT 200 CENTER TO CENTER
– ADD TAPE OVER EACH CABLE
– INCREASE WITH OF TRENCH TO SUIT

TRENCH DETAIL FOR COLLECTOR CABLE

LEGEND:

NOTE 110–1
ROAD # — WTG SITE NUMBER

S&C VISTA SW FOR WTG CONNECTION ABOVE GROUND

COLLECTOR SYSTEM TAP BOX ABOVE GROUND

NOTES:

– INCLUDE ALLOWANCE FOR TOWER & FOUNDATION GROUNDING AT EACH WTG SITE.
– DO NOT INCLUDE ALLOWANCE FOR GROUNDING AT SUBSTATION OR 230KV SWITCHING STATION
– INCLUDE ALLOWANCE FOR FIBER OPTICAL CABLE TO 67 WTG SITES
– COLLECTOR SYSTEM
– PROVIDE PRICING FOR COPPER AND ALUMINUM CABLE
– CABLES 3x1C TRIPLEXED & TY–WRAPPED AT INTERVALS NOT TO EXCEED 3M.

TYPE	ALUMINUM	COPPER
C1	35KV 3x1C 1250MCM AL TRXLPE 133% 1/12 CONC NEUT	35KV 3x1C 750MCM CU TRXLPE 133% 1/6 CONC NEUT
C2	35KV 3x1C 750MCM AL TRXLPE 133% 1/6 CONC NEUT	35KV 3x1C 500MCM CU TRXLPE 133% 1/6 CONC NEUT
C3	35KV 3x1C 1/0 AL TRXLPE 133% FULL CONC NEUT	35KV 3x1C 1/0 CU TRXLPE 133% FULL CONC NEUT

THIS SKETCH REPLACES HAND SKETCH OF DEC 1/2015 BY WGC

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REV	DDMMMYY	REVISION / ISSUE DESCRIPTION	DRN	CHK	APP	APP	APP	APP
A	15/12/15	ISSUED FOR INFORMATION	IVL	WGC				

REF | NUMBER | TITLE
REFERENCE

UNLESS OTHERWISE AGREED IN A WRITTEN CONTRACT BETWEEN AMEC FOSTER WHEELER AND ITS CLIENT: (I) THIS DOCUMENT CONTAINS INFORMATION, DATA AND DESIGN THAT IS CONFIDENTIAL AND MAY NOT BE COPIED OR DISCLOSED; AND (II) THIS DOCUMENT MAY ONLY BE USED BY THE CLIENT IN THE CONTEXT AND FOR THE EXPRESS PURPOSE FOR WHICH IT HAS BEEN DELIVERED. ANY OTHER USE OR RELIANCE ON THIS DOCUMENT BY ANY THIRD PARTY IS AT THAT PARTYS SOLE RISK AND RESPONSIBILITY.

APPROVED FOR _____
CLIENT PM DEPT MGR PROJ MGR

PROJECT PHASE

SCALE NTS | PROJECT NO.

	BY	DDMMMYY
DES	WGC	15/12/15
DRN	IVL	15/12/15
CHK		
APP		

SUBJECT
34.5kV FEEDERS & TRENCH DETAIL

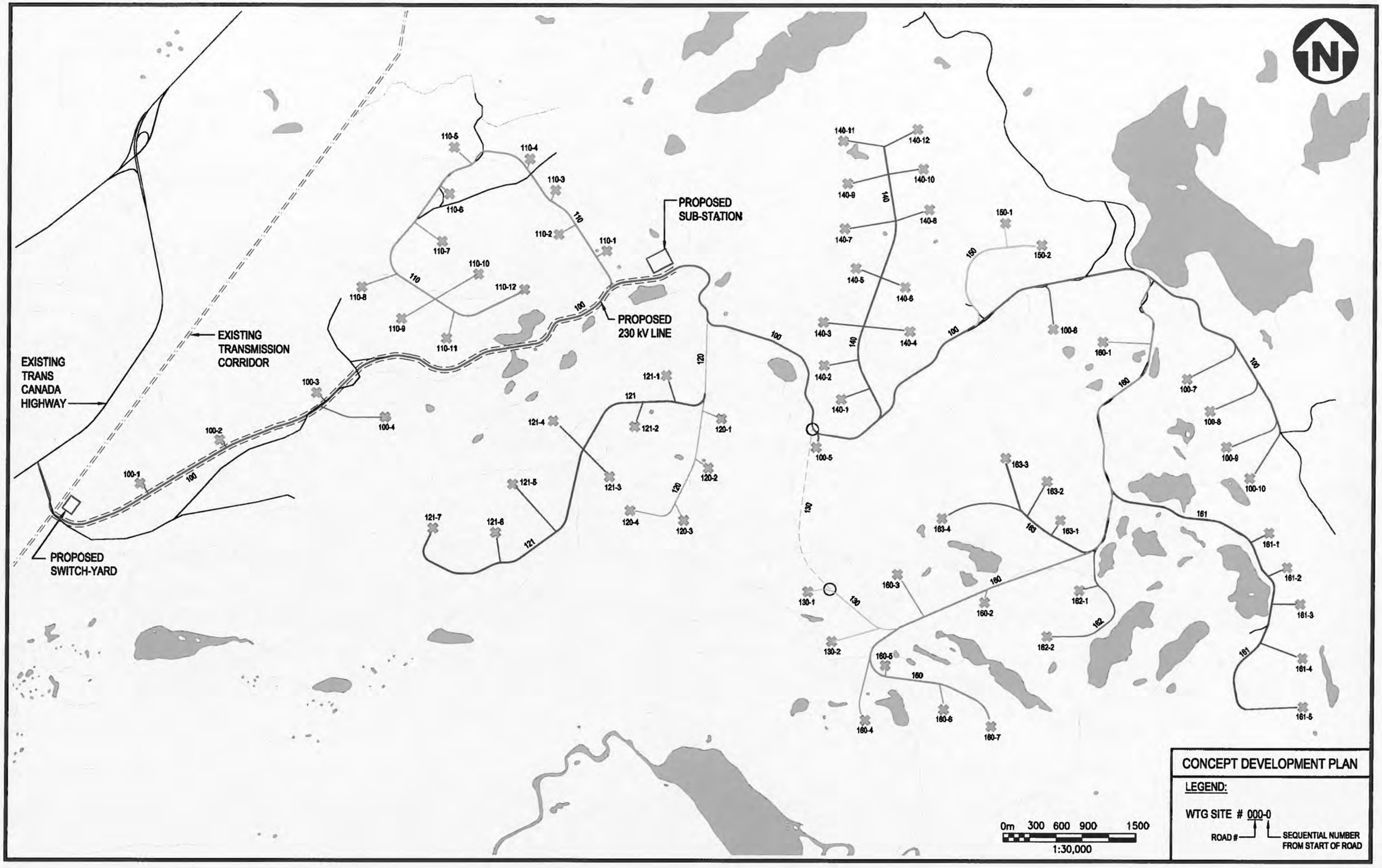
amec foster wheeler

AREA

CLIENT DWG NO.

DRAWING NO. SK–1 | REV A

CAD FILE: P:\CAD\FILE\WKS\SK–1.DWG
SAVED: 15–Dec–15 2:55 PM PLOTTED: 15–Dec–15 2:57 PM USER: LEPIR, IVANA
ANSI B–11x17


N
PROPOSED SUB-STATION
PROPOSED 230 kV LINE
EXISTING TRANSMISSION CORRIDOR
EXISTING TRANS CANADA HIGHWAY
PROPOSED SWITCH-YARD
110-1
110-2
110-3
110-4
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110-9
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121-7
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162-1
162-2
163-1
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163-3
163-4
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1:30,000
CONCEPT DEVELOPMENT PLAN
LEGEND:
WTG SITE # 000-0
ROAD #
SEQUENTIAL NUMBER FROM START OF ROAD

EXISTING TRANS CANADA HIGHWAY

EXISTING TRANSMISSION CORRIDOR

PROPOSED SUB-STATION

PROPOSED 230 kV LINE

PROPOSED SWITCH-YARD

COLLECTOR E1

COLLECTOR E2

COLLECTOR E3

COLLECTOR E4

COLLECTOR W1

COLLECTOR W2

COLLECTOR W3

COLLECTOR W4

S&C VISTA SW ABOVE GROUND

COLLECTOR SYSTEM TAP ABOVE GROUND

COLLECTOR SYSTEM CABLE AS MARKED

SKETCH - ADDED COLLECTORS E1 E2 E3 E4 W1 W2 W3 W4

by WGC Dec 1/15

0m 300 600 900 1500

1:30,000

181917

CONCEPT DEVELOPMENT PLAN

LEGEND:

WTG SITE # 000-0

ROAD # — SEQUENTIAL NUMBER FROM START OF ROAD

APPENDIX 7

AACE PROCESS INDUSTRY ESTIMATE CLASSIFICATION MATRIX

AACE Process Industry Estimate Classification Matrix

AACE ESTIMATE CLASS	**LEVEL OF PROJECT DEFINITION** Expressed as % of Complete Project Definition	**END USAGE** Typical Purpose of Estimate	**METHODOLOGY** Typical Estimating Techniques	**EXPECTED ACCURACY RANGE** At 90% Confidence Level	**TYPICAL CONTINGENCY** To Achieve 50% Probability of Overrun/Underrun
5	<= 2%	Preliminary Project Screening Estimate, Capital Budget OOM Estimate, Alternate Schemes Evaluation, Strategic Analysis	Capacity Factored, Parametric Models, Judgement Analogy, Historical Project Comparisons, Gross Unit Cost	Low: -20% to -50% High : +30% to +100%	15% to 40%
4	1% to 15%	Preliminary Project Estimate, Reality Check Estimate, Alternate Schemes Evaluation, Feasibility Study	Equipment Factored, Parametric Models, Historical Relationship Factors, Broad Unit Cost Data	Low: -15% to -30% High : +20% to +50%	10% to 25%
3	10% to 40%	Project Funding Estimate, Fair Price Check Estimate, Change Alert Check Estimate, Alternate Schemes Evaluation	Semi-Detailed Unit Costs with Assemby Level Line Items by Trade, Historical Relationship Factors	Low: -10% to -20% High : +10% to +30%	5% to 15%
2	30% to 70%	Project Funding Estimate, Control Estimate, Change Alert Estimate, Firm Bid Estimate	Detailed Estimating Data by Trade with (Forced) Detailed Takeoff Quantities	Low: -5% to -15% High : +5% to +20%	5% to 15% of unexpended funds
1	50% to 100%	Change Alert Estimate, Firm Bid Estimate	Detailed Estimating Data by Trade, with Detailed Firm Takeoff Quantities	Low: -3% to -10% High : +3% to +15%	3% to 10% of unexpended funds

APPENDIX 8

RISK REGISTER

APPENDIX 9

Solas Energy Consulting Memorandum to Tim Manning 15/12/2015
RE: Hare Hill-Estimated Development Costs
&
Solas Energy Consulting Memorandum to Tim Manning 15/12/2015
RE: Hare Hill-Turbine Capital Costs and Operating Costs
&
Solas Energy Consulting memorandum to Tim Manning 5/01/2016
RE: Hare Hill-Turbine Capital Cost and Operating Costs, Revision 1

MEMORANDUM

SOLAS
ENERGY CONSULTING

To: Tim Manning, Nalcor
From: Stephen Glendinning & Paula McGarrigle (Solas)
cc: Nancy Hart, Nalcor,
Evelyn Carpenter (Solas)

Date: December 15, 2015

RE: Hare Hill – Estimated Development Costs

Nalcor is interested in responding to the "NOTICE OF REQUEST FOR PROPOSALS FROM PRIVATE DEVELOPERS FOR CLEAN ENERGY AND TRANSMISSION" issued on November 12, 2015. Nalcor is determining the costs associated a wind farm development on the island of Newfoundland. Solas has been asked to assist in the determination of the third party development costs for the Hare Hill project located near Bottom Brook in Newfoundland. Nalcor has identified that a wind project of approximately 210 MW would be appropriately sized to match the energy requirements of the RFP.

Development of the project will likely require a team of approximately 3-4 people full time to manage and co-ordinate the project. The personnel costs for the development team, including overhead have not been included in this estimate.

The following process was used to identify the development costs.

Methodology

Solas developed a standard list of typical development costs for a wind farm as the basis for identification of cost categories. This list was cross-checked with AMEC to ensure that AMEC was not duplicating any costs in their estimating efforts.

The key categories identified include: Land, Resource, Environmental Studies, Non-Environmental Studies, Permitting/regulatory, Pre-construction Feasibility and Other studies.

Land

- Lands for the proposed Hare Hill project site are owned by the Province of Newfoundland and Labrador. This land requires a one-time application fee of $113 per application to the department of Ministerial and Government Affairs, and if approved then requires the applicant to complete a legal land survey. The cost to rent the lands is based on the land's value, determined by a land assessor assigned by the department. An inquiry was made regarding the cost of the existing Lawrence wind farm (25 MW). This facility has a 50-year lease on 700 ha (1,730 acres) at a cost of $8,150 per year. This is approximately 69.2 acres/MW. Using the same ratio, the wind farm for 210 megawatts would require approximately 14,000 acres. This cost would then be approximately $65,000 per year assuming that the land is valued the same as that at St. Lawrence wind farm. No land agent is required for the transaction.

Resource

- Resource development costs typically include the following: Meteorological tower data collection (collection, archive, quality control) meteorological tower maintenance (annual maintenance including replacement of measurement devices and tightening of the guy wires), meteorological tower installation and decommissioning, wind resource assessment reports (identification of wind resource statistical measurement, correlation and prediction)
- Five meteorological towers were assumed in the development cost estimate, which is appropriate for the region. The meteorological tower height was assumed to be 60 metres.
- Cost was also estimated for additional sodar/lidar campaigns, which are likely required to confirm the shear for up to an 80 metre or higher turbine hub height. Two sodar/lidar campaigns of approximately 8 months each were included in the estimate.

Environmental Studies

- Preparation of a Project description, or Registration, is required under the *Environmental Protection Act* in Newfoundland and Labrador. Based on the results of the Department of Environment and Conservation - Environmental Assessment Division, and public review, the Minister of Environment and Conservation can:
    1. release the proposed project from further environmental assessment, subject to approval conditions;
    2. require the preparation of an Environmental Preview Report (EPR);
    3. require the preparation of an Environmental Impact Statement (EIS); or
    4. reject the proposed project.
- The currently operational Fermeuse and St. Lawrence wind facilities were both released from further environmental assessment on the condition that further pre-construction bird, noise and/or visual impact studies were completed.
- Other wind power projects have also been through the environmental process and have been:
    1. released from environmental assessment with conditions (Kruger Inc, 40 MW "Arches and Flat Hills Wind Farm" and Anemos Energy Corporation, 10 MW "St. John's (Goulds) Wind Farm");
    2. required to prepare an EIS (Wind Power Inc., 2005 registration for a 42 MW "Argentia Wind Farm" – subsequently withdrawn by Wind Power Inc.); or,
    3. rejected (Wind Power Inc., 2009 reregistration of the "Argentia Wind Farm").
- In all cases, conditions of release have included the collection of baseline environmental data, particularly bird migration data, and breeding bird data, the scope of which has varied for each project.
- In all cases, a condition of release has also required post-construction bird and bat mortality monitoring.
- Proponents are recommended to consult with Wildlife Division staff of the NFLD Department of Environment and Conservation and Environment Canada's Canadian Wildlife Service personnel for the purpose of scoping any wildlife

surveys prior to Project registration. Consultation with these agencies for study scoping is estimated at [redacted]

- Spring bird migration studies are estimated at [redacted] however, could range up to [redacted] depending on regulatory requirements identified during consultation.
- Breeding bird surveys are estimated at [redacted]
- Fall bird migration studies are estimated at [redacted], but could range up to [redacted] depending on regulatory requirements identified during consultation.
- Addition pre-construction environmental studies could include: wetland delineation, habitat mapping, rare and listed plant studies, caribou, arctic hare or ptarmigan studies (as requested at the Kruger proposed Arches and Flat Hills Wind Farm. These studies, if required, would typically be identified during the regulatory consultation stage.

Non-Environmental Studies:

- Aviation study and permit – included in the estimate at [redacted]
- Historical, archaeological and paleontological studies – these studies were not included in the estimate as regulators did not require previous wind farm developments to complete these studies.
- Hydro-geology studies – this was estimated at [redacted] if required.
- Radio & Radar Interference studies – these have been assumed to be required for the Hare Hill development and budgeted at [redacted]
- Socio-economic Resource Studies – based on the information on previous wind farm applications, this has not historically been completed therefore Solas did not include this study.
- Soils & Terrain – Solas has accounted for this study at [redacted] and assumes a desktop only study.
- Visual landscape study – Solas has integrate visual study costs of approximately [redacted] however can range up to [redacted]

Permitting/Regulatory

- Environmental Document Preparation – included in the development costs
- Regulatory Agency Fees – Not included in the development costs
- Regulatory/Permitting Consultant – this has been included in the development costs
- Regulatory Application Preparation – included in the development costs
- Stakeholder consultation – included in the development costs

Pre-construction studies

- Constructability Surveys including a transportation feasibility study – These costs have been included in the AMEC balance of plant estimate.
- Project Preliminary Engineering – This has been included in the BOP cost estimate and therefore has not been included in the development cost estimate.
- Preliminary Geotechnical studies – This has been included in the BOP cost estimate and therefore has not been included in the development cost estimate.
- Interconnection and Transmission studies – This has been estimated based on typical study requirements in many jurisdictions and assumes similar costs. The

scope of work in the power flow and dynamic studies will significantly affect the cost of the work. We have estimated approximately $160,000 for the costs of these studies. These studies may be completed by Newfoundland and Labrador Hydro.

Development cost estimates were prepared based on experience with the respective studies in other jurisdictions of Canada. Third party cost estimates were developed by adjusting the costs of known markets to those of the Newfoundland market using Stats Canada published 2014/2015 average hourly wages by occupation.

Assumptions made in the identification of environmental development costs have been listed in the table below.

Table 1. Assumptions used in the identification of the development costs.

Topic	Assumption	Risk
Wildlife studies	Provincial, federal and non-governmental wildlife representatives do not consider the proposed Project area to pose significant risk to wildlife.	If deemed otherwise, the scope and duration of wildlife studies likely increase, as does the potential escalated environmental assessment and/or project rejection.
Wildlife studies	Provincial and federal wildlife authorities will participate in consultation to help direct proposed wildlife studies in advance of the project Registration process.	If otherwise, the potential for unforeseen requirements may occur. Depending on the requirements, they could become approval conditions or justification to increase the environmental assessment effort.
Wildlife studies	Suitably trained and experienced biologists, from the local area (Stephenville or Corner Brook) are willing and able to accept contracts for the field programs.	If otherwise, additional costs for suitable biologists to travel to and find accommodation will be necessary.
Wildlife studies	Regulatory authorities will be sufficiently satisfied with up to 6 rounds (survey days) of spring bird migration, 2 survey-days of breeding bird survey and 8 rounds of fall bird migration.	If otherwise, additional cost for an increased scope of work are necessary.
Site access	Existing roads or trails are available	If otherwise, additional

Topic	Assumption	Risk
	to access the proposed site with no more than 1-hour travel from the nearby centres of Stephenville or Corner Brook. No all-terrain vehicles are necessary for site access.	scope is required for site access and potentially additional surveys.

Section 29(1)(a) Section 35(1)(d) Section 35(1)(g)

Results

Solas' estimate of third party development costs are [redacted] which includes a [redacted] This excludes internal costs associated with team salaries and overhead.

The summary of the third party development costs are identified in the appended table.

Should you have any questions regarding this memorandum, please do not hesitate to contact us.

Regards,

[redacted]

Section 40.1

Paula McGarrigle
Solas Energy Consulting Inc.

MEMORANDUM

To: Tim Manning - Nalcor
From: Evelyn Carpenter and Paula McGarrigle, Solas Energy Consulting Inc.
cc: Nancy Hart - Nalcor

Date: December 15, 2015

RE: Hare Hill – Turbine Capital Costs and Operating Costs

Nalcor is intending to respond to the "NOTICE OF REQUEST FOR PROPOSALS FROM PRIVATE DEVELOPERS FOR CLEAN ENERGY AND TRANSMISSION" ("RFP") issued on November 12, 2015 with a combination of existing or under development hydro resources and a proposed new wind farm on Newfoundland. Nalcor, in conjunction with Emera, has identified the Hare Hill site near Stephenville as the wind site for the RFP response.

Nalcor has retained AMEC Foster Wheeler to develop a detailed balance of plant construction estimate for the facility, and Solas is tasked with providing an estimate for the turbine supply as well as the operations and maintenance costs for the facility. The division of cost estimating responsibility (Table 1) is as follows:

Table 1: Hare Hill Wind Project Estimating Scope of Work

Scope	Solas Estimate	AMEC/FW Estimate
Turbine manufacturing & supply	X	
Turbine transportation to port of Stephenville	X	
Off-load at port, transportation to Project Site		X
Turbine erection, mechanical completion and Balance of Plant Construction		X
Turbine transformer supply (or external pad-mount supply)	X	
Turbine transformer installation (if external to turbine)		X
Turbine commissioning	X	
Turbine operations and maintenance	X	
Wind Plant Management, Operations and Maintenance (MOMA)	X	
Balance of Plant Maintenance	X	

Methodology

Solas and AMEC developed key parameters for an estimate basis and Solas was tasked with obtaining turbine supply, operations and maintenance costs from turbine suppliers. Solas developed, issued and evaluated a request for quotation ("Turbine

RFQ") for indicative pricing for the wind turbines for the proposed project (Appendix A). In addition to obtaining indicative pricing, the purpose of the Turbine RFQ was to determine the technologies that are likely to be available during the projected time frame for commercial operations. The key parameters provided to turbine suppliers for the Turbine RFQ are provided in Table 2.

Table 2: Turbine RFQ Assumptions

	Key Parameters	Notes
Project Size	~210 MW	Based on energy requirement of 750 GWh per year
Wind Regime	Class IIA	Vortex data supplied by WSP
Estimated Mean Wind Speed	8.1 – 8.5 m/s @ 80 metres	Vortex data supplied by WSP
Hub Height	80 metres minimum	Or as recommended by turbine supplier
Delivery Window	Beginning of 3Q2020	Assuming construction starting in 2019; foundations, roads, collection system completed by June 2020.
Anticipated Project Commercial operation Date	December 31, 2020	Identified through the RFP requirements
Project Location	Hare Hill, NFLD	Provided by Emera
Delivery Requirements	To port of Stephenville	
GST and HST	excluded	
Turbine Service and Maintenance	10 – 15 year long term service agreement	Longer terms, full service agreement including all scheduled and unscheduled maintenance preferred.
Icing Requirements	De-icing or anti-icing technology required	Vendors to identify available solutions
Pad mounted transformers	Provide optional pricing if not included within the turbine nacelle or tower base.	

Solas approached nine turbine manufacturers, see list identified in Table 3. Five turbine vendors provided quotes. Some turbine manufacturers as noted were unable to participate in the RFQ process due to time constraints or inability to execute a non-disclosure agreement (NDA) within the required time period.

Request for Quotation – Indicative Pricing and Turbine Platform Options

The Newfoundland Island Wind Project

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Summary

Nalcor Energy (www.nalcorenergy.com) has hired Solas Energy Consulting Inc. (Solas) and AMEC to jointly develop a capital and operating cost estimate for a proposed project on Newfoundland Island. Solas is responsible for soliciting information from potential turbine suppliers regarding the available technology, options, and indicative pricing for the project. The information from the turbine suppliers will be provided to Solas under the existing NDA with the turbine suppliers. Solas will summarize the responses including turbine platform, options, and generic $/kW pricing from each of the suppliers to create a high, low and average $/kW price for turbines for the project. The specific turbine characteristics and the generic summary turbine pricing range will be provided to Nalcor and AMEC for use in the capital cost estimates. Key suppliers have been invited to supply information, and that pricing will be consolidated for sharing with Nalcor and AMEC.

RFQ Schedule

November 27, 2015	RFQ issued to turbine suppliers with existing NDAs with Solas
November 27-30, 2015	NDAs negotiated with remaining turbine suppliers
December 9, 2015	Turbine supplier responses due to Solas

Project Details

Item	Description
Project Name	Confidential Newfoundland Island Wind Project
Estimated Mean Wind Speed	8.1 – 8.5 m/s
Expected Wind Class	IIA
Project Size	210 MW
Anticipated Project Commercial Operation Date	December 31, 2020
1st Turbine Delivery Date	May 1, 2020
Hub height, rotor diameter, size	Manufacturer to propose most suitable technology in development for 2020 delivery considering parameters as specified Suggested 80 metre or higher hub height
Options	Cold weather package and anti-icing or de-icing technology required
Delivery	Assume delivery to port of Stephenville, Newfoundland
Turbine Operations and Maintenance	Requesting details for long term service agreements
Pricing	Please provide expected indicative non-binding $/kW pricing in 2015 Canadian dollars for turbine deliver to specified location, and long term service agreement packages. Identify the US and EU exchange rates used in your assumptions.

RFQ Submittals

Please submit your RFQ to Evelyn Carpenter ecarpenter@solasenergyconsulting.com by December 9, 2015.

Submittals may be in the form of a letter proposal. Please include the following in your submittal:

1. Proposed turbine technology and quantity of units to meet project energy requirements
2. Information regarding the turbine proposed (brochure or specifications)
3. Information regarding the cold weather package and de-icing or anti icing technology
4. Indicative non-binding pricing (or range of pricing) for 2020 delivery to port of Stephenville
5. Information regarding any long term service agreements available for the technology
6. Indicative non-binding pricing for the long term service agreements based on the number of units specified in your proposal
7. Details regarding turbine transformer locations (pad-mounted or in nacelle). If pad-mounted, please provide optional pricing to supply.

MEMORANDUM

To: Tim Manning - Nalcor
From: Evelyn Carpenter and Paula McGarrigle, Solas Energy Consulting Inc.
cc: Nancy Hart - Nalcor

Date: January 5, 2016

RE: Hare Hill – Turbine Capital Costs and Operating Costs, Revision 1

Nalcor is intending to respond to the "NOTICE OF REQUEST FOR PROPOSALS FROM PRIVATE DEVELOPERS FOR CLEAN ENERGY AND TRANSMISSION" ("RFP") issued on November 12, 2015 with a combination of existing or under development hydro resources and a proposed new wind farm on Newfoundland. Nalcor, in conjunction with Emera, has identified the Hare Hill site near Stephenville as the wind site for the RFP response.

Nalcor has retained AMEC Foster Wheeler to develop a detailed balance of plant construction estimate for the facility, and Solas is tasked with providing an estimate for the turbine supply as well as the operations and maintenance costs for the facility. The division of cost estimating responsibility (Table 1) is as follows:

Table 1: Hare Hill Wind Project Estimating Scope of Work

Scope	Solas Estimate	AMEC/FW Estimate
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Turbine transportation to port of Stephenville	X	
Off-load at port, transportation to Project Site		X
Turbine erection, mechanical completion and Balance of Plant Construction		X
Turbine transformer supply (or external pad-mount supply)	X	
Turbine transformer installation (if external to turbine)		X
Turbine commissioning	X	
Turbine operations and maintenance	X	
Wind Plant Management, Operations and Maintenance (MOMA)	X	
Balance of Plant Maintenance	X	

Methodology

Solas and AMEC developed key parameters for an estimate basis and Solas was tasked with obtaining turbine supply, operations and maintenance costs from turbine suppliers. Solas developed, issued and evaluated a request for quotation ("Turbine

RFQ") for indicative pricing for the wind turbines for the proposed project (Appendix A). In addition to obtaining indicative pricing, the purpose of the Turbine RFQ was to determine the technologies that are likely to be available during the projected time-frame for commercial operations. Table 2 shows the key parameters provided to turbine suppliers for the Turbine RFQ.

Table 2: Turbine RFQ Assumptions

	Key Parameters	Notes
Project Size	~210 MW[1]	Based on energy requirement of 750 GWh per year
Wind Regime	Class IIA	Vortex data supplied by WSP
Estimated Mean Wind Speed	8.1 – 8.5 m/s @ 80 metres	Vortex data supplied by WSP
Hub Height	80 metres minimum	Or as recommended by turbine supplier
Delivery Window	Beginning of 3Q2020	Assuming construction starting in 2019; foundations, roads, collection system completed by June 2020.
Anticipated Project Commercial operation Date	December 31, 2020	Identified through the RFP requirements
Project Location	Hare Hill, NFLD	Provided by Emera
Delivery Requirements	To port of Stephenville	
GST and HST	excluded	
Turbine Service and Maintenance	10 – 15 year long term service agreement	Longer terms, full service agreement including all scheduled and unscheduled maintenance preferred.
Icing Requirements	De-icing or anti-icing technology required	Vendors to identify available solutions
Pad mounted transformers	Provide optional pricing if not included within the turbine nacelle or tower base.	

[1] Note, pricing was requested for 210 MW, however the estimate has been developed on a $/kW basis and scaled to 200 MW to align with the BOP estimates performed by AMEC

Solas approached nine turbine manufacturers, see list identified in Table 3. Five turbine vendors provided quotes. Some turbine manufacturers as noted were unable to participate in the RFQ process due to time constraints or inability to execute a non-disclosure agreement (NDA) within the required time period.



Section 29(1)(a) Section 35(1)(d) Section 35(1)(g)
Section 39(1)(a), (b), (c)(i)

[2] Both GE and Siemens provided pricing for delivery in 2018 assuming an executed turbine supply agreement and first milestone payment in 2016.

Request for Quotation – Indicative Pricing and Turbine Platform Options

The Newfoundland Island Wind Project

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Summary

Nalcor Energy (www.nalcorenergy.com) has hired Solas Energy Consulting Inc. (Solas) and AMEC to jointly develop a capital and operating cost estimate for a proposed project on Newfoundland Island. Solas is responsible for soliciting information from potential turbine suppliers regarding the available technology, options, and indicative pricing for the project. The information from the turbine suppliers will be provided to Solas under the existing NDA with the turbine suppliers. Solas will summarize the responses including turbine platform, options, and generic $/kW pricing from each of the suppliers to create a high, low and average $/kW price for turbines for the project. The specific turbine characteristics and the generic summary turbine pricing range will be provided to Nalcor and AMEC for use in the capital cost estimates. Key suppliers have been invited to supply information, and that pricing will be consolidated for sharing with Nalcor and AMEC.

RFQ Schedule

November 27, 2015	RFQ issued to turbine suppliers with existing NDAs with Solas
November 27-30, 2015	NDAs negotiated with remaining turbine suppliers
December 9, 2015	Turbine supplier responses due to Solas

Project Details

Item	Description
Project Name	Confidential Newfoundland Island Wind Project
Estimated Mean Wind Speed	8.1 – 8.5 m/s
Expected Wind Class	IIA
Project Size	210 MW
Anticipated Project Commercial Operation Date	December 31, 2020
1st Turbine Delivery Date	May 1, 2020
Hub height, rotor diameter, size	Manufacturer to propose most suitable technology in development for 2020 delivery considering parameters as specified Suggested 80 metre or higher hub height
Options	Cold weather package and anti-icing or de-icing technology required
Delivery	Assume delivery to port of Stephenville, Newfoundland
Turbine Operations and Maintenance	Requesting details for long term service agreements
Pricing	Please provide expected indicative non-binding $/kW pricing in 2015 Canadian dollars for turbine deliver to specified location, and long term service agreement packages. Identify the US and EU exchange rates used in your assumptions.

RFQ Submittals

Please submit your RFQ to Evelyn Carpenter ecarpenter@solasenergyconsulting.com by December 9, 2015.

Submittals may be in the form of a letter proposal. Please include the following in your submittal:

1. Proposed turbine technology and quantity of units to meet project energy requirements
2. Information regarding the turbine proposed (brochure or specifications)
3. Information regarding the cold weather package and de-icing or anti icing technology
4. Indicative non-binding pricing (or range of pricing) for 2020 delivery to port of Stephenville
5. Information regarding any long term service agreements available for the technology
6. Indicative non-binding pricing for the long term service agreements based on the number of units specified in your proposal
7. Details regarding turbine transformer locations (pad-mounted or in nacelle). If pad-mounted, please provide optional pricing to supply.

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