SCHEDULE 17 – Cultural Heritage Monitoring Program

Stantec Consulting Ltd.
300W-675 Cochrane Drive, Markham ON L3R 0B8

July 17, 2017
File: 160960595

Attention: Mr. Sean Fairfield, Algonquin Power
Windlectric Inc.
354 Davis Road, Suite 100
Oakville, Ontario
L6J 2X1

Dear Mr. Sean Fairfield,

Reference: Construction Vibration Monitoring Program, Amherst Island Wind Energy Project Loyalist Township, County of Lennox and Addington, Ontario

Further to Algonquin Power's (Algonquin) request for monitoring plan and fee proposal, Stantec Consulting Ltd (Stantec) is pleased to provide the following monitoring program for the above noted project. The program is based on our understanding of the requirements outlined in Renewable Energy Approval Number 7123-9W9NH2 dated August 24, 2015 (REA) and similar project experience.

1 BACKGROUND

The REA identifies three distinctly different types of structure as cultural heritage resources and protected properties (CHR and PP) that require consideration of vibration as outlined in section M of the REA. These structures are:

a) ***Built Heritage Resources –*** there are nine built heritage resources identified that includes various types of structures including a general store, a church.

b) ***Cultural Heritage Landscape –*** there are four cultural heritage landscape structures identified; there are generally conventional residential buildings.

c) ***Dry Stone Walls*** *(*otherwise known as Irish stone fences) – there are 10 dry stone walls identified in the Loyalist Township Report and REA.

In addition to those listed above there are an additional seven dry stone walls identified in the Road Use Agreement and a residence identified by Loyalist Township through negotiation of the Operations Plan with Algonquin. While they are not identified in the REA they will be considered for vibration monitoring as part of this plan.

As required by the REA approval condition, monitoring will be required for the above type of structures that are within 50 metres (m) of the construction activity. The approval conditions further require such vibration be measured in peak particle velocity (PPV) and compared against

criteria that were established prior to construction. Stantec's measurement program has been developed to address these REA requirements.

2 MONITORING PLAN DEVELOPMENT

This section provides details of the vibration monitoring plan for construction activities occurring within 50 m of the structures discussed in Section 1. The REA document also indicates that construction activities include the transport by heavy vehicles of equipment and component parts necessary for the construction and installation of the project infrastructure.

The structures that fall within 50 m of construction will be inspected and the conditions be documented prior to construction. This information will be used to determine the monitoring strategy such as location of monitors, number of vibration monitors, and vibration limits.

2.1 IDENTIFICATION OF POTENTIAL STRUCTURES FOR MONITORING

As discussed in Section 1, the REA identifies three type of structures which are discussed in this Section.

2.1.1 Built Heritage Resources (BHR)

Under Section M of the REA there are nine (9) BHR identified as protected properties. The structures identified as BHR are:

1. 5170 Front Road (Neilson's General Store)
2. 5555 Front Road (Trinity United Church)
3. 2750 Front Road
4. 3190 Front Road
5. 3500 South Shore Road
6. 4125 South Shore Road
7. 3475 South Shore Road
8. 4725 Second Concession Road
9. 5950 Second Concession Road

As per the REA requirements, monitoring will be required for the BHR should construction activity be within the 50 m of BHR. If there are no construction activities within 50 m of BHR, then no monitoring will be required.

2.1.2 Cultural Heritage Landscapes (CHL)

The REA identifies four (4) CHL as follows:

1. Village of Stella

2. Ferry Landscape
3. 1652 Front Road (Pentland Cemetery)
4. 1995 Stella 40 Foot Road (St. Paul's Presbyterian Church)

The REA requires that vibration be considered in terms of PPV. The PPV is defined as the maximum instantaneous positive or negative peak of the vibration signal. PPV is used in monitoring vibration since it is related to the stresses that are experienced by structures due to vibration.

Therefore, as a first step, structures (buildings and other structures) associated with the four (4) CHL groups that are within 50 m of construction will be identified and vibration limits will be established. For CHL #3 and #4, as per the REA requirements, monitoring will be required for the structures should construction activity be within 50 m of the structures. If there are no construction activities within the 50 m of the structures, then no monitoring will be required.

Among the identified structures in the CHL - #1 Village of Stella/CHL - #2 Ferry Landscape, the closest structure to the construction (including transport by heavy vehicles of equipment and components part) movement will be monitored. The vibration monitoring will be conducted for the period during which construction is within 50 m of the identified structure. Since vibration diminishes as it propagates away from the source, if the structure that is closest to construction complies with the limits, then the structures that are farthest will be deemed to be in compliance with the limits.

2.1.3 Dry Stone Walls (DSW)

The REA identifies ten (10) DSW as follows:

1. Emerald 40 Foot Road and Second Concession Road
2. 3190 Front Road
3. 3850 South Shore Road
4. 570 Front Road
5. 2400 Front Road
6. 2750 Front Road
7. 12405 Front Road
8. 12515 Front Road
9. 12675 Front Road
10. 13555 Front Road

As per the REA requirements, monitoring will be required for the DSW should construction activity be within the 50 m of DSW. If there are no construction activities within 50 m of DSW, then no monitoring will be required.

Stantec reviewed these ten DSW and submitted a detailed report to the Ministry of the Environment on December 5, 2016. The information in that report along with the construction schedule will be used to determine the DSW structures that are within the 50 m construction area.

2.1.4 DSW Recently Identified in Road Use Agreement

In addition to those discussed above, the following seven (7) stone walls were identified in the Road Use Agreement under section 40 (a) (xii):

1. 360 MacDonald Lane
2. 6345 Second Concession Road
3. 9000 Second Concession Road
4. 4000 Front Road
5. 5675 Front Road
6. 15095 Front Road
7. 5830 Front Road (several fences – Stone Wall Festival)

2.1.5 Additional Resource based on Township Request

The residential dwelling located at 2450 South Shore Road will be added to the list as per the request by Loyalist Township.

While not required in the REA for items 2.1.4 and 2.1.5, a visual record of their respective present conditions will be obtained prior to any construction activity and monitoring for the DSW will be completed for the DSW should construction activity be within the 50 m of DSW. If there are no construction activities within 50 m of DSW, then no monitoring will be required.

2.2 DETERMINATION OF PPV LIMITS

The initial work will involve a review of the structure through visual inspection and determination appropriate limits for construction vibrations. The assessment will be based in general terms on the accepted standard DIN 4150: "*Structural vibration - Effects of vibration on structures*".

The German standard DIN 4150 Part 3 provides vibration limits in terms of PPV for construction vibration. A copy of Table 1 from this standard is provided below for reference. The limits provided are for buildings such as those used for residential, commercial or institutional purposes. For heritage buildings (i.e. listed buildings under preservation order), the limits are stringent and are provided in Table 2.

Table 1 - DIN 4150 Vibration Limits

Type of structure	Guideline values for velocity in mm/s			
	Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor at all frequencies
	1Hz to 10Hz	10 to 50Hz	50 to 100Hz (and above)	
Buildings for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g listed buildings under preservation order)	3	3 to 8	8 to 10	8

Stone fences are typically prone to adverse weather and forces of nature. Based on Stantec's experience, for dry stone fences a reasonable PPV is in the range of 100 mm/ sec for frequencies of 10 Hz or greater. For frequencies below 10 Hz, the values can be assumed to be 50 % (i.e. 50 mm). However, for the purpose of this monitoring program the limits for DSW are treated as similar to commercial buildings as listed in Table 1. The applicable limits for this project are summarized in Table 2.

Table 2 - Applicable Limits

Description	Vibration at foundation or ground level [PPV mm/s]		
	1 to 10 Hz	10 to 50 Hz	50 to 100 Hz
Heritage or listed buildings under preservation order this includes BHR and CHL	3	3 to 8	8 to 10
Protected structures such as DSW	20	20-40	40-50

2.3 INSTRUMENTATION

To monitor PPV Stantec proposes to use seismographs manufactured by Instantel. An automated remote access monitoring system will be set up for monitoring. The monitoring system will be set up to provide automatic alerts to field staff and other key personnel. The monitoring system will be set

up with battery power back-up for continuous functioning. A monthly network system access fee is included for the duration of the monitoring.

2.4 PROGRAM IMPLEMENTATION

The vibration monitoring program will involve calibrating and setting up the instruments, a period of ongoing monitoring and reporting and demobilization or relocation of equipment as required. The initial set-up requires a visit to the site with a calibrated instrument and communications modem. A seismograph will be set up at a representative location of the closest BHR, CHL and DSW structure types. Trigger levels will be set and tested with the Client preferred communication protocol established.

A weekly monitoring fee and/or site visit cost has been provided should servicing or re-locating the units be required. We have committed up to six (6) seismograph units to this project.

The number of units can be increased or reduced as required based on the construction schedule.

At the end of the monitoring period a demobilization fee will be charged to remove and clean each unit. This will be based on a single trip to the site and for up to six (6) individual seismographs. Additional seismograph demobilization will be billed at an hourly rate.

2.5 REPORTING AND CONSULTATION

The vibration monitoring program includes a weekly report of activity. Should professional consulting services be required to respond to Ministry of Environment or homeowner/stakeholder concerns our hourly rates would apply. As the level of effort in this area is not clearly defined we have provided unit rates and our estimate for this work is based on our experience on similar projects. Billing will be for actual hours applied.

3 TECHNICAL SUPPORT

The effective and timely completion of a project is only as good as the project team. For this project, we have identified the following professionals with substantial experience in vibration monitoring, and visual inspection and condition documentation. In addition to those listed below, the project team has support from Acoustic Noise and Vibration (ANV) group and Building group.

Kana Ganesh, M.A.Sc., PhD., P.Eng.

Project Responsibilities: Kana will provide technical leadership and expert support for this project. Dr. Kana Ganesh is a Senior Engineer with over 16 years of consulting and research experience in acoustics, noise, and vibration(ANV) and will provide technical leadership to the project. Kana obtained a Doctorate from the *Institute of Sound and Vibration Research (ISVR), University of Southampton, UK* for his research work in active sound and vibration control. Kana has extensive

experience in ANV monitoring and impact assessments. Kana has led several vibration assessment and measurement projects for construction and operations vibration that includes Niagara Wind farm, CN rail expansions in Ontario and Winnipeg, as well as others for TransCanada Pipelines Inc., Enbridge Gas and Union Gas.

Christopher Woodcock, B.Sc.

Project Responsibilities: Chris will lead the building condition documentation part of this project.

Mr. Woodcock is an inspector, assessor, and designer with Stantec's Buildings Engineering group and will lead building condition documentation part of this project. Chris studied at Queen's University and obtained a B.Sc. in Civil Engineering. He will be the site vibration monitoring engineer. His building envelope work with Stantec includes inspection of new commercial construction, roof and exterior wall investigation, and facility assessments of heritage structures. Chris was actively involved in the West Block vibration monitoring for over 4 years.

Prabu Surendran, B.Eng., EIT

Project Responsibilities: Prabu will lead the field program.

Prabu Surendran B.Eng., EIT, completed his undergraduate degree in Mechanical Engineering in June, 2012. During his undergraduate career, Prabu has completed large data collection and analysis for the energy sector which resulted in peer reviewed publications. At Stantec he has developed a strong background in data collection and analysis. Prabu is a member of our ANV group, where he specializes in environmental assessments and vibration monitoring. As recently as the autumn of 2016, Prabu conducted vibration monitoring for an oil and gas sector pipeline horizontal directional drilling program involving a heritage barn structure in Ontario. He also looks after calibration and maintenance of our many precision acoustic testing and sound/vibration measurement instruments. Prabu is working toward achieving his Professional Engineer Certification.

Leaman Chow P.Eng

Project Responsibilities: Acoustical Engineer, technical leadership in Kana's absence

Leaman has a diverse range of experience in the area of environmental acoustic projects related to commercial, residential and industrial facilities involving the completion of detailed noise impact assessments. Further, Leaman has also conducted on-site noise source measurements, baseline monitoring, complaint based investigations and worked with regulatory bodies in support of obtaining environmental compliance approvals on behalf of clients. Leaman also specializes in the area of building acoustics related to commercial, residential and industrial facilities. Leaman is experienced in on-site field measurements, inspections as well as in-situ investigative and compliance testing in support of the acoustic assessments.

4 CLOSURE

This proposal has been prepared based on our understanding of the project and Client needs. If we have not captured your requirements, please contact the undersigned directly. Thank you for this opportunity to submit this proposal. We look forward to working with you on this project.

Yours truly,

STANTEC CONSULTING LTD.

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Attachment: None

c. Kerrie Skillen, Stantec

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