SCHEDULE 17 – Cultural Heritage Monitoring Program

December 20, 2016
File: 160960595

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

Dear Mr. Sean Fairfield,

Reference: Monitoring Program Fee Proposal - Amherst Island Wind Energy Project
Loyalist Township, County of Lennox and Addington, Ontario

Further to your request we are pleased to provide the following monitoring program and associated fee schedule for the above noted project. The program is based on our understanding of your needs and the requirements outlined in Renewable Energy Approval Number 7123-9W9NH2 dated August 24, 2015. As we have not received a copy of the proposed construction schedule we are providing unit rates established from our experience on similar projects.

1 MONITORING PROGRAM

There are three (3) distinctly different types of structure that require monitoring in terms of the REA requirements outlined in section M;

a) Buildings that fall under ***"Built Heritage Resources"***; (nine total)

b) Conventional residential buildings within the ***"Cultural Heritage Landscape"***; (four total)

c) ***"Dry Stone Walls"*** otherwise known as Irish stone fences and identified in the Loyalist Township Report; (ten total).

Monitoring will include measurement of vibration peak particle velocity (PPV) for buildings within 50m of the construction activity. Accordingly, we have separated our program into each category to satisfy the requirements of section M, *"Cultural Heritage Resources and Protected Properties"* of the REA. Our Qualified Independent Structural Engineer (QE) has been engaged in the preparation of this program;

1.1 MONITORING PLAN DEVELOPMENT

1.1.1 Built Heritage Resources

Under section M1 of the REA there are nine (9) Built Heritage Resources identified as requiring protection. These buildings and appurtenances may be located within the 50m zone where section M3 requires PPV be measured and maintained within levels established for each structure by the QE as described in section M4. To assign an acceptable peak particle velocity (PPV) vibration level to each cultural heritage resource a visual assessment will need to be performed at each location.

The buildings that are identified as falling within the 50m monitoring zone will be inspected and the theoretical natural resonant frequency of the building calculated. This information and the condition assessment will be used to determine if the building requires instrumentation to monitor PPV or if a similar, possibly more sensitive, structure in the vicinity should be instrumented. Based on the German DIN 4150 standard accepted internationally we would likely assign these structures as "Tier 3" properties as defined in Table 1, DIN 4150 Vibration Limits, included herein.

1.1.2 Cultural Heritage Landscapes

There are four (4) Cultural Heritage Landscapes identified in the REA. Where residential structures of conventional construction exist within these areas we would undertake to monitor representative or sensitive structures not assigned a heritage designation. The QE would review all structures within a 50m zone of the proposed construction and provide recommended monitoring locations and PPV. An example of a representative or sensitive structure might be St. Paul's Presbyterian Church. Normally, we would only consider construction vibrations to be a concern within 30m of this type of structure. Based on our experience the most stringent assignment of PPV would likely be "Tier 2" of Table 1, DIN 4150 Vibration Limits.

1.1.3 Dry Stone Walls

The REA document section M considers construction activities to include the transport by heavy vehicles of equipment and component parts necessary for the construction and installation of the project infrastructure. Given this, monitoring of the stone fences will be required should they be adjacent to or along the road where significant construction vehicles will travel.

We have reviewed the ten (10) dry stone walls identified in section M1 and have prepared a detailed written and photographic report of their condition in accordance with M6 (1). This report was submitted on December 5, 2016 and shall form the basis of our monitoring program.

It is the opinion of the QE, based on first hand observations of the dry stone fences in question, that a reasonable PPV for these structures ranges from 100 to 150 mm/ sec at a frequency of 10 Hz or greater. Below 10 Hz the values will be 50% of those presented. Accordingly, it is unlikely that construction activity will result in vibrations within this range. In such case, visual monitoring of the

dry stone walls would be carried out in accordance with M6 (1) through (3). A review of the walls would be conducted weekly in comparison to the record obtained in accordance with M6 (1). A photographic record of any changes would be recorded and the cause for the changed reviewed by the QE.

The written condition assessment referenced in M6 (1) suggests three of the dry stone walls are in poor condition and as such, construction related vibrations might be an issue. Should the identified three stone walls be within 50 m of construction, we propose to conduct baseline testing during peak large vehicle movement. The baseline monitoring will measure vibration in PPV under this extreme condition. We will use this as a reference point for future monitoring practice. This work will be conducted over a full site day for each of the dry stone walls identified in our report. Our fee to conduct the baseline work is presented in the attached work breakdown structure (WBS) and fee table.

1.2 REVIEW OF EXISTING STRUCTURES AND PPV DETERMINATION BY QE

The initial work will involve a review of the structure by the QE to determine the condition and appropriate tolerance 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 velocity guidelines for use in evaluating the effect of vibration on structural integrity. The guideline limits presented in the standard are based on experience, and are defined as 'safe limits' up to which no damage due to vibration effects has been observed for a particular class of building. "Damage" is defined by DIN4150 to included even minor non-structural damage. For example, continuous long-term vibration, at 10 mm/s peak vibration velocity is a safe limit for structural integrity in industrial buildings.

Although these limits are defined in the code as being for vibration in the horizontal direction at the top floor of a building, experience with vibration studies has shown that these limits are effective for local vibration levels as well. Structural damage has been observed on members where the vibration velocity exceeds approximately between 20-40 mm/s, and is dependent on the frequency. For heritage or sensitive structures Table 1 in DIN 4150-3 provides peak particle velocity limits based on the frequency of the vibration. A copy of Table 1 from this standard is provided below for reference.

Our fee to conduct the review of the existing structures and assignment of an acceptable threshold vibration PPV is presented in the attached work breakdown structure (WBS) and fee table.

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 occuparcy	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

1.3 INSTRUMENTATION AND MONITORING PROGRAM

To monitor PPV Stantec proposes to use a four channel seismograph manufactured by Instantel, a world leader in this technology. Stantec is a distributor of the Instantel seismograph. If awarded this work, we would deploy these units on the project. Specifically, we would recommend an automated system providing Windlectric Inc. with utmost flexibility. Stantec will provide the specified quantity of Micromate seismographs equipped with a three channel geophone.

The Instantel® Auto Call Home™ automated call-in program allows remote access to the monitors and data. Whenever an event occurs, the monitor automatically places a call to the primary PC and downloads event data into one central location on the hard disk drive. A utility installed on the PC will automatically send an email to a mobile device carried by your Superintendent. He/she can go to their PC, to access the vibration level at the alarming instrument. In addition to this feature, we would be able to provide remote access on a tier-basis to your Client and other stakeholders. Stantec would manage the system and have administrator rights allowing read, download, and delete functions. The Superintendent and Windlectric Inc. staff would have read and download capabilities and other stakeholders would be given read-only capabilities. Each unit will also call home at least once per day ensuring continuous power and communication.

To install the system, Windlectric Inc. would need to provide continuous power for the modems and base seismograph units. The seismograph instruments are provided with a battery backup. The transmission of real time information and communication with the seismographs requires power to the modems. A battery/alternate power source for this purpose will be provided if required. A monthly network system access fee is included for the duration of the monitoring.

1.3.1 Vibration Monitoring Program

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. The seismograph is set up in a representative location within the protected building and communication established with the server. Trigger levels are set and tested with the Client specified communication distribution list.

The unit will not send an alert unless active vibrations above the trigger threshold are measured. Once per day, typically at 5:00am, all stakeholders on the email distribution list will be sent a notification (Call Home) that will present a histogram of the previous 24-hour vibration history, regardless of any triggered events. This confirms the units are powered up and monitoring and able to immediately report any events. It also provides a vibration signature for the day. Email notifications can be stored in a project specific folder in Outlook by recipients.

A weekly monitoring fee and/or site visit cost has been provided should servicing or re-locating the units be required.

NOTE: We have assumed a 12 week period for one unit in our fee proposal. If the program requires more than three seismograph units for a full time monitoring period greater than six months we will reduce our equipment costs by 20%.

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 three (3) individual seismographs. Additional seismograph demobilization will be billed at an hourly rate.

1.3.2 Vibration Reporting and Expert Consulting Services

The vibration monitoring program includes a weekly fundamental report of activity. Should professional consulting services be required to respond to MOE or homeowner 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 based on our experience on similar projects. Billing will be for actual hours applied. Our fees are provided in the attached WBS and fee table.

1.3.3 Visual monitoring

Should the PPV measured at the stone walls be less than the criteria established by the QE, instrumented monitoring will not be required. Visual monitoring of the dry stone walls would be carried out weekly by our qualified heritage masonry professional. Alternatively, visual monitoring may be conducted by Stantec site staff acting under the direct supervision of our heritage masonry professional. Our fee to conduct the monthly visual assessment, including a written report, is presented in the attached WBS and fee table.

4 TECHNICAL SUPPORT

The following team is proposed for this assignment.

Paul R. Walkington, CET, rcca, LEED® AP
Mr. Walkington will lead the team and act as the Client liaison. The monitoring and software management of the data will be by Paul R. Walkington. He has over 37 years of experience in construction quality management and instrumentation and has been a member of the International Society of Explosives Engineers for over 34 years. He will perform the analysis and provide recommendations for the vibration monitoring program and mitigating measures.

Kana Ganesh, M.A.Sc., PhD., P.Eng.
Dr. Kana Ananthaganeshan (Ganesh) is a Senior Engineer with over 16 years of consulting and research experience in acoustics, noise, and vibration(ANV). Kana will be the "Qualified Independent Structural Engineer (QE)", as defined in the REA. 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 impact assessments, building acoustic assessment, regulatory environmental permitting (EA, ECA, Class EA, and REA). Kana's environmental permitting experience includes mining, oil and gas, aggregate, power, health care and industrial/commercial facilities, renewable energy, transportation (road and rail), urban development and water sectors.

Christopher Woodcock, B.Sc.
Mr. Woodcock is an inspector, assessor, and designer with Stantec's Buildings Engineering group. 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.

5 OPINION OF PROBABLE COST

The proposal provided herein is made with several unknowns including the constructor's methodology and schedule. Our fees should be evaluated based on the unit rates. We are also willing to look for value added opportunities such as utilizing staff already on the project. Based on the assumption of three months we estimate a fee of [redacted] will be required. To scale this fee value to a monthly additional cost, the Client should consider [redacted] per month for budget purposes. The unit rates are included on the attached fee table.

The Stantec Terms and Conditions are included in this proposal. Written approval is required for us to proceed. Due to calibration of equipment we require one weeks' notice prior to deploying our instruments.

6 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 author directly. Thank you for this opportunity to submit this proposal. We look forward to working with you on this project. Please call me directly if you have any questions or we can be of further assistance.

Yours truly,

STANTEC CONSULTING LTD.

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