

Technical Memorandum

To	North Kent 1 LP	Page	1
CC	Mark Van der Woerd (AECOM), Jody Law (Pattern), Joshua Vaidhyan (Samsung)		
Subject	North Kent Wind 1 (Chatham-Kent, ON) Well Water Impact Complaint Investigation – UPDATED v.2 [REDACTED] - PIN 007500067, [REDACTED]		
From	Jason Murchison, P.Geo.		
Date	November 15 th , 2017	Project No.	60343599

1. Introduction and Background

AECOM Canada Ltd. (AECOM) has been retained by North Kent Wind 1 LP (NKW1) to provide hydrogeological services pursuant to *Condition G* of Renewable Energy Approval (REA) No. 5272-A9FHRL.

The purpose of this Technical Memorandum (TM) is to present a response to email correspondence received by NKW1 from Ms. Deb Jacobs, Environmental Officer, with the Ministry of the Environment and Climate Change (MOECC), Windsor Area Office, dated 14-August-2017. In this correspondence, Ms. Jacobs provides a summary narrative of a well interference complaint that was received by MOECC on the afternoon of 14-August-2017 (exact time unspecified) from [REDACTED], the property owner of [REDACTED] (Dresden, ON).

In brief, Ms. Jacobs describes the well interference complaint as follows:

This caller indicated that Saturday night (Aug 12) they discovered that they had no water in the house. When the pump was checked, apparently one of the filters was completely plugged up with sediment. The caller indicated that the problem has not yet since resolved itself.

A copy of the MOECC correspondence described above is provided herein as **Attachment A**.

2. REA Condition Response

Table 1 provides a summary of action(s) taken pursuant to REA Condition G5 in response to the current well interference complaint.

TABLE 1: REA CONDITIONS AND RESPONSE SUMMARY

REA CONDITIONS	ACTION(S) TAKEN
G5. Should the Company receive a complaint about wells or well water from an owner of an active water well (i) within the Project Study Area; or (ii) outside of the Project Study area and located within 1 km from each individual Equipment and meteorological tower, the microwave tower, and the operations & maintenance building, the Company shall retain a qualified expert (P.Eng or P.Geo)	Steps undertaken to satisfy the requirements of Condition G5 are summarized, as follows: <ol style="list-style-type: none">(1) AECOM was retained by NKW1 to investigate the Well Interference Complaint received at approximately 5pm on 14-August-2017 following MOECC notification at about that same time.(2) AECOM arranged directly with the property owners

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REA CONDITIONS	ACTION(S) TAKEN
<p>to immediately undertake the following:</p> <ol style="list-style-type: none"> (1) collect a water well sample at the complainant's water well, prior to any treatment systems ("raw"), after allowing the distribution system to flow for approximately 5 minutes and submit the water sample to a qualified laboratory for an analysis of the general chemistry suite of water quality parameters identified in Condition G3; (2) compare the results of the analysis of the water sample noted in Condition G5(1) to the pre-construction water sampling analysis results noted in Condition G3 for the subject well (if a pre-construction water sample at the subject well was taken); and (3) provide a detailed written opinion as to whether the water sampling analysis results demonstrate that the construction, operation or decommissioning of the Facility caused or may have caused an adverse effect to the well's water supply. 	<p>an appointment to visit the property at 10am on 17-August-2017.</p> <ol style="list-style-type: none"> (3) Tasks completed by AECOM during the well interference complaint site visit included: <ol style="list-style-type: none"> i) interview with the property owner regarding their reported well interference issue(s); ii) collection of a raw (untreated) groundwater sample for analytical laboratory testing; and, iii) collection of digital photographs of pertinent site features (eg. pumphouse & water well, water treatment equipment, etc.). (4) Information obtained during the site visit has been compiled and is summarized within this technical memorandum. An opinion regarding potential association of the well interference complaint with local construction activities as part of the NKW1 Project is provided and potential remedial options are presented, as appropriate.

2.1 Property Owner Statements Regarding Well Interference Complaint

During AECOM's 17-August-2017 site visit to the subject property, a series of seven (7) standard questions were raised with the property owners ([REDACTED]) for the purposes of obtaining further details regarding their reported well water supply issue(s). The questions raised with the property owner were as detailed on *Form B: Well Complaint Procedure for Site Investigation*, included as part of MOECC's approved *Well Interference Protocol* (AECOM, 2017) for the NKW1 project.

TABLE 2: PROPERTY OWNER QUESTIONNAIRE RESPONSE SUMMARY

QUESTION	PROPERTY OWNER RESPONSE
"Please explain the type of problem you are having"	<ul style="list-style-type: none"> • Sediment filling filters resulting in flow restriction/loss at house. • Have never previously had issues with turbidity or sediment.
"What do you think is the cause?"	<ul style="list-style-type: none"> • Recent nearby pile driving as part of NKW1 project.
"When did you first notice the problem (Date/Time)?"	<ul style="list-style-type: none"> • 12-August-2017 at approximately 6pm. • Couldn't get water pressure in house, observed very dirty (plugged) filter cartridge at pumphouse.
"Is the problem still occurring?"	<ul style="list-style-type: none"> • Still experiencing water pressure issues. • Not as much sediment. • Have gone through four (4) filters as of 17-August-2017.
"Do you have an alternate source of potable water (i.e. municipal water)?"	<ul style="list-style-type: none"> • No. • Presently use a 5 gallon water cooler for drinking.
"Were you provided a temporary supply of potable water?"	<ul style="list-style-type: none"> • No
"Did you participate in the Detailed Well Assessment program prior to construction?"	<ul style="list-style-type: none"> • Yes

Upon completion of the questionnaire, both the property owners ([REDACTED]) and their representative from Water Wells First (Mr. Kevin Jakubec) were permitted an opportunity to review

the responses detailed in the table below and were all in agreement that the information provided was accurate to the best of their knowledge.

3. Construction Activities and Vibration Monitoring

Pile driving activities for foundation construction at Turbine Location #32 (T32) commenced in the area of Pile #15 at 9:00am on 11-August-2017. Following the initial pile installation, an additional eight (8) piles at the T32 site were driven on that same day, with work concluding at the location of Pile #1 at approximately 3:01pm. Nine (9) additional piles at the T32 site were installed approximately three (3) days thereafter (14-August-2017), with the final installation (Pile #3) having been completed at 4:57pm. The pile driving work described above at T32 was undertaken at a distance of approximately 750 m (north) from the [REDACTED] water well.

Monitoring of vibration effects during pile driving at T32 was completed by Golder Associates Ltd. (GAL) on behalf of NKW1 in accordance with *Condition H* of the REA. The monitoring program developed and implemented by GAL (and as approved by MOECC) comprised the measurement of particle velocities at locations in close proximity to the piles, as well as at two (2) local private water well supplies. The local groundwater well supplies monitored during pile driving at T32 included Well 9 ([REDACTED]) and Well 10 ([REDACTED]), being located at radial distances of about 680 m and 1,122 m from the T32 turbine foundation centre, respectively. Comparatively, the location of the water well on the [REDACTED] property is positioned at a distance of approximately 750 m from the location of work at T32. Vibration monitoring results obtained by GAL are summarized in a technical letter, dated 20-September-2017.

In addition to the foregoing, a site-specific vibration assessment pertaining to the subject property was completed by GAL, the results of which are presented in a letter, dated 26-October-2017 (revised 14-November-2017).

A copy of each GAL letter is included herein as **Attachment B**.

Based on the vibration monitoring completed by GAL, the following interpretation and conclusions are presented within their 20-September technical letter:

In summary, vibration measurements obtained with the geophone system (Instantel Minimate) on all sites reported herein were within expectations as compared to those measured at the T5 and T42 test pile sites and general project expectations. On sites where piles penetrated through the nearsurface soils under their own weight or a low number of hammer blows (e.g., less than 5) the ground surface vibrations during this phase of pile driving for each pile were nominal. Ground surface vibrations measured when driving the piles on the glacial till or rock were also either comparable to or less than those at the test pile sites and, in all cases, were within expectations. Vibration measurements made using the accelerometers mounted on the well casings were also within expectations based on the T5 and T42 test pile sites and turbine to well distances.

Well monitoring to-date has identified several wells for which the vibrations induced by the pumps dominated the instrument readings when the pumps were active or other activities dominated the measured vibrations. Relevant notes regarding various pumps, their operation and other influences on vibration measurements are described below:

Well 3: Activities at the Well 3 property included crop harvesting, movement of farm vehicles and loading of haul trucks in relatively close proximity to Well 3.

Well 4: Maximum well casing vibration velocities for Well 4 of about 4.8 mm/s were recorded on September 6, 2017 when a well pump was connected, operated and adjusted and the owner made

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frequent return visits to the well shed. Crop harvesting was also carried out as close as about 25 m from the well casing.

Well 6: The pump for Well 6 is mounted in close proximity to the well casing (as illustrated on the attached Photograph 1). Maximum particle velocities of as much as 0.8 mm/s were obtained from monitoring data collected at Well 6 on July 13, 2017 when the well pump was operating during a time period without pile driving. The influences of the pump were readily discernable in the monitoring data. Approximately 1 minute after driving of Pile 1 for turbine T12 concluded, a loaded tractor-trailer dump truck drove by on the road near Well 6 and, at the same time, the resident was hammering in a nearby shed. Vibrations associated with the loaded dump truck were also perceptible by our well monitoring staff and registered at about 2.8 mm/s.

Well 9: A piston pump for Well 9 is located within the barn adjacent to the Well 9 casing location, a total distance (inside and outside) of about 3 to 4 m. During pile driving for turbines T28 and T32, on August 11, 2017, other work was occurring near Well 9. This work included construction along the access road leading to the T32 site and included movement of heavy equipment, excavator operations, dump truck traffic, discharge of stone from delivery vehicles and other activities. This surface construction work was as close as 100 m to Well 9. Additionally, Well 9 is approximately 74 m from Countryview Line that experiences significant traffic. Traffic included loaded construction equipment, buses, fuel tanker trucks and other vehicles. Golder conducted a separate monitoring event at this well on September 8, 2017 to measure the influence of the pump on well casing vibrations in the absence of pile driving. Maximum measured casing vibrations during this test were about 1.2 mm/s. Measurements at Well 9 on dates other than August 11, 2017 are consistent with expectations based on local traffic volumes and the potential influence of the adjacent piston pump.

Well 10: Well 10 exhibited maximum vibrations of about 1.25 mm/s during pump operation. The influence of pump operations were clearly discernable in the vibration monitoring data. The proximity of the pump and well casing are illustrated in the attached Photograph 2.

Well 11: Vibrations of the casing at Well 11 were measured during water quality sampling on August 17, 2017 in the absence of pile driving at any location. When the pump was operating, a maximum vibration magnitude of 0.016 mm/s was measured at this well. The pump is located within the residence and approximately 40 m from the well.

Well 12: During pile driving, Well 12 operated on a number of clearly definable occasions. Maximum vibration measurements of pump-induced well casing vibrations were as much as 2.4 mm/s. The pump for Well 12 is a piston pump mounted directly on top of the well casing as illustrated in the attached Photograph 3.

Well 13: Well 13 is located approximately 87 m from the centreline of Union Line which is subjected to local truck traffic. Review of the data indicates that well pumping and non-pile driving transient sources influenced the results at this location. Additional evaluation of transient, non-pile driving data is on-going and a specific monitoring period for well pump operation is being planned for a time without pile driving.

Well 14: Well 14 is located approximately 13 m from the centreline of Union Line which is subjected to local truck traffic. A limited evaluation of transient traffic vibrations indicated well casing velocities of at least 0.079 mm/s associated with this cause, though inspection of the data indicates higher values occurred outside of pile driving times. Additional evaluation of transient, non-pile driving data is on-going and a specific monitoring period for well pump operation is being planned for a time without pile driving.

In summary, measured vibrations have been evaluated and reported as associated with driving 329 piles and replacement piles on the glacial till/rock along with restrrike events and pile dynamic testing events. These measurements have been obtained at the turbine sites and at wells located at distances ranging from 580 to 4,359 m from the turbine sites. It is our opinion, based on these

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measurements, that the vibration magnitudes at all wells during pile driving were within expectations, no greater than may be induced by other common day-to-day sources at these well sites, less than the observed and measured influence of well pumps and inconsequential for the wells.

The interpretation and conclusions above are reconfirmed by GAL within their site-specific assessment letter, dated 26-October-2017 (revised 14-November-2017), which reads:

Based on the data available to-date from the test pile and construction monitoring programs, pile-induced vibrations at the well would be expected to be one or more orders of magnitude less than vibrations induced by pumping systems similar to that used at [REDACTED], less than vibrations associated with vehicles operating near the wells and less than the International Standards Organization (ISO) threshold for human perception of vibrations at frequencies greater than 8 Hz (0.1 mm/s). It is our opinion, based on vibration measurements, that the vibration magnitudes during pile driving were within expectations, no greater than may be induced by other common day-to-day sources at this well, less than the observed and measured influences of typical well pumps in the area and inconsequential for the [REDACTED] well.

3.1 Discussion

The interpretation presented by GAL within their technical letter is confirmed through a review of the vibration monitoring data summary appended thereto. Reported daily Peak Particle Velocity (PPV) measurements obtained at Well 9 during pile driving activities at T32 ranged between 0.028 and 1.346 mm/s (average 0.251 mm/s), whereas at Well 12 the values ranged between 0.009 and 0.880 mm/s (average 0.308 mm/s). At Well 10, when the vibration effects of well pump operation are excluded by GAL, reported PPV values decrease significantly to less than 0.01 mm/sec.

GAL reports that vibration monitoring data collected at Well 9 on 11-August-2017, during construction works at Pile #11, 12, 13, 16, 17 were "higher than and inconsistent with other measurements during pile driving at the T32 site". GAL further reports that other construction activities occurring along the entrance road to T32 at distances as close as 100 m from Well 9 affected the monitoring results at that time.

Vibration monitoring completed by GAL in the immediate vicinity of T32 ranged in offset distance from a minimum of 9.5 m at Pile #8 to a maximum of 26.4 m at Pile #17 (average of 18.9 m). During this monitoring, reported daily PPV values for work completed on 11-August-2017 were consistent at 3.43 mm/s, and on 14-August-2017 at 4.83 mm/s. No apparent correlation (increase / decrease) is observed in PPV values reported by GAL in response to pile driving activities on either day.

Finally, GAL reports that local background PPV values generally fall within the range of <0.01 to 0.07 mm/s, based on data collected previously at T5 and T42. This range is generally consistent with the values presented above for monitoring during pile installation at T32. As a basis of comparison, the particle velocity threshold for human perception is stated by GAL to be approximately 0.1 mm/s at between about 8 and 100 Hz (ISO 2631-2).

4. Well Construction Details

Table 3 provides a summary of pertinent construction details for the water well located at [REDACTED], based on details provided to AECOM by Mr. Booksbank during our 17-August-2017 well interference complaint site visit, as well as information provided by the property owner on their completed baseline water well survey (WWS) form.

A review of the MOECC on-line database did not reveal a water well record for the subject property.

Measurement of well details (ie. including total depth, water level, etc.) was unable to be completed by AECOM during our 17-August-2017 site visit due to: i) the installation of a jerk-rod type pump within the well causing the casing lid to be inaccessible for removal; and, ii) the well being located within a small pumphouse and well pit that was considered to represent a confined space, as per O.Reg. 632/05.

A photograph of the well is provided as **Photo 1**, having been obtained by AECOM from the pumphouse entry door.

TABLE 3: REPORTED PRIVATE WELL CONSTRUCTION DETAILS

DETAILS	[REDACTED] (PIN 007500067)
Well Tag #	Unknown
Well ID	Unknown
Installation Date	Prior to 1973 (as on WWS)
Well Location	Rear of Property within Pumphouse / Well Pit
Contractor	Unknown
Contractor No.	Unknown
Construction Method	Drilled (as on WWS)
Total Depth	14.0 m / 46' (as on WWS)
Target Formation	Unknown
Casing Length	Unknown
Casing Diameter	157 mm / 6.25" (visual estimate by AECOM)
Casing Material	Steel
Casing Stick-Up	~1.0m below grade (visual estimate by AECOM)
Annular Seal	Unknown
Sealant Type	Unknown
Well Screen Installed?	Unknown
Well Screen Details	Unknown
Well Screen Interval	Unknown
Well Cover Type	Metal/rubber sanitary well cap; not sealed due to installed pump system
Pump Intake Depth	12.2 mBGS / 40' (as on WWS)
Pumping Rate	20 L/min / 5.3 USgpm (as measured by AECOM)
Well Pump Type	Jerk-rod (as observed by AECOM)
Well Pump Size	½ hp (as on WWS)
Static Level	Unknown
Pumping Level	Unknown

NOTE: mBGS - meters below ground surface; L/min – litres per minute; USgpm – US gallons per minute.



PHOTO 1: Site Well (as Observed by AECOM on 17-August-2017)

5. Water Quality Data

Table 4 provides a summary of available groundwater quality data for the site well. Laboratory Certificates of Analysis are included as **Attachment C**.

TABLE 4: PRIVATE WELL SAMPLING SUMMARY

LOCATION	SAMPLED BY	DATE	TYPE	PURPOSE
[REDACTED]	AECOM	26-January-2017	Raw (Untreated)	Baseline
[REDACTED]	AECOM	17-August-2017	Raw (Untreated)	Complaint Investigation

5.1 Discussion

Available raw (untreated) groundwater sampling data for the well indicates the presence of relatively poor baseline groundwater quality, with elevated levels of total dissolved solids, colour, sodium, and iron, as shown in **Table 5**. Groundwater quality data reported for the sample collected by AECOM during our 17-August-2017 site visit also is included in the table for comparative purposes.

TABLE 5: RAW (UNTREATED) GROUNDWATER SAMPLING RESULTS

PARAMETER	ODWQS CRITERIA	ODWQS TYPE	BASELINE (26-January-2017)	COMPLAINT INVESTIGATION (17-August-2017)
Escherichia coli	0 CFU/100mL	MAC	Non detection	Non detection
Total Coliforms	0 CFU/100mL	MAC	Non detection	Non detection
Electrical Conductivity	--	--	1,310 µS/cm	1,360 µS/cm
pH	6.5 – 8.5	OG	8.32	8.40

Total Hardness (as CaCO ₃)	80 – 100 mg/L	OG	75.7 mg/L	76.7 mg/L
Total Dissolved Solids	500 mg/L	AO	712 mg/L	702 mg/L
Total Suspended Solids	--	--	<10 mg/L	<10 mg/L
Alkalinity (as CaCO ₃)	30 – 500 mg/L	OG	386 mg/L	400 mg/L
Fluoride	1.5	MAC	0.89 mg/L	1.02 mg/L
Chloride	250	AO	215 mg/L	193 mg/L
Nitrate as N	10	MAC	<0.10 mg/L	<0.05 mg/L
Nitrite as N	1	MAC	<0.10 mg/L	<0.05 mg/L
Bromide	--	--	<0.10 mg/L	0.73 mg/L
Sulphate	500 mg/L	AO	<0.20 mg/L	<0.10 mg/L
Ammonia as N	--	--	0.18 mg/L	0.28 mg/L
Dissolved Organic Carbon	5 mg/L	AO	1.9 mg/L	1.4 mg/L
Colour	5 TCU	AO	18 TCU	16 TCU
Turbidity	5 NTU	AO	5 NTU	1.9 NTU
Calcium	--	--	20.1 mg/L	20.4 mg/L
Magnesium	--	--	6.19 mg/L	6.26 mg/L
Sodium	200 mg/L	AO	253 mg/L	257 mg/L
Potassium	--	--	2.14 mg/L	2.21 mg/L
Iron	0.300 mg/L	AO	0.422 mg/L	0.193 mg/L
Manganese	0.050 mg/L	AO	0.023 mg/L	0.022 mg/L

NOTE: MAC – maximum acceptable concentration (health-related); AO – Aesthetic Objective (non health-related); Operational Guideline (non health-related)

At the time of AECOM's baseline site visit on 26-January-2017, water treatment at the [REDACTED] residence reportedly was comprised of water softening, as per property owner's completed WWS form. During AECOM's 17-August-2017 site visit, a particle (cartridge) filtration system also was observed to have been installed within the pumphouse/well pit, as shown in **Photo 1**. According to [REDACTED], the filter housing contained a 0.5 µm pore diameter wound cord type cartridge. Packaging for the filter cartridge was not available at the time of our site visit to confirm. The particle filtration system was not present at the time of our 26-January-2017 site visit and is of recent origin, and according to the property owner was installed in early August 2017 at the recommendation of Water Wells First (WWF) as part of an ongoing particle/sediment quality study.

Due to the well being located within a well pit contained in a small pumphouse, raw groundwater quality sampling during our 17-August-2017 site visit was completed using a garden hose that was attached to a gate valve within the pumphouse/well pit at a location upstream of the particle filter assembly. Connection of the hose and operation of the gate valve was completed by [REDACTED] due to the fact that the pit is considered a confined space in Ontario and AECOM staff were not permitted to enter the pit. Prior to sampling, the system was permitted to flush for a period of 45 minutes. The extended flushing duration was completed to allow for periodic measurement of pumping discharge rate with time and to allow for prolonged flushing of the hose assembly. Approximately twenty (20) minutes of the total flushing period occurred as a result of a significant precipitation event which hindered the sample collection process. Periodic measurements obtained by AECOM during flushing indicated a steady water discharge rate of approximately 20 L/min (5.3 USgpm).

Both the baseline and complaint investigation sampling results indicate hardness levels that are relatively low (soft) in the raw (untreated) groundwater and below the Ontario Drinking Water Quality Standard (ODWQS) Operational Guideline (OG) range of 80-100 mg/L. This owes to the relatively low carbonate content of the local shale bedrock and correspondingly low concentrations of calcium and magnesium within the groundwater source. Low hardness levels within water can result in the accelerated corrosion of water pipes, appliances, and other metallic fixtures and components.

No exceedances of health-related parameters analyzed, including *Escherichia coli* and Total Coliform bacteria, Nitrate (as N), Nitrite (as N), and fluoride, were detected either in the baseline or complaint investigation raw (untreated) groundwater samples collected from the existing on-site well supply.

Turbidity is an Aesthetic Objective (AO) of the ODWQS. In this regard, a value of 5 Nephelometric Turbidity Units (NTU) has been established by MOECC. The MOECC's *Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines* (June 2003; revised June 2006) makes a clear distinction between turbidity related to organic constituents and inorganic constituents stating: "Raw water supply which is ground water with very low organic content may contain inorganic-based turbidity, which may not seriously hinder disinfection. For such waters, an Operational Guideline for turbidity is not established". Further guidance is provided by MOECC regarding the relationship between turbidity and its organic and inorganic components, the disinfection processes, and as a measure of the water supply filtration and treatment efficiency. The technical explanations also note that while organic turbidity is an important measure as related to health concerns, the AO value is an aesthetic component which is set for all waters at the point of consumption (i.e., not at the source). At the site well, turbidity levels were 5.0 NTU in the baseline sample and 1.9 NTU during the recent well interference complaint site visit. Both values are within ODWQS limits.

The potential for groundwater quality impacts associated with pile driving is both time-dependent and related to the intensity and propagation of ground-borne vibration. In the case of piling associated with T32, no significant vibrations attributed to pile driving were detected at either Well 9 or Well 10, as discussed previously in **Section 3**.

According to questionnaire responses provided by the property owners (**Table 2**) during our recent well interference complaint site visit, the outset of water quality issues was first detected at approximately 6 pm on 12-August-2017; approximately one (1) day following the completion of initial pile driving (50% of total piles) at T32. During active pile driving at T32 on 11-August-2017, low daily PPV values were detected by GAL based on their monitoring in close proximity to the individual pile locations. Based on GAL's monitoring data and considering the separation distance which exists between T32 and the site well (ie. ~750 m), the suspension of particles within or in its immediate vicinity is not considered plausible. As an alternate consideration, vibration impacts in the immediate vicinity of pile driving at T32 would have needed to result in: i) the suspension of settled particles within the groundwater system; ii) the particles remaining in suspension for a prolonged period of time; and, iii) the water well being situated in a position hydraulically downgradient of and/or within the radius of pumping influence relative to the location of T32. This second and third consideration also are not considered plausible in the context of the local hydrogeological setting (ie. potential hydraulic gradient and groundwater travel times) and reported timeline of outset of impact(s) at the site well. Our interpretation is supported by the results of recent flushing and sampling works completed by AECOM at the subject property where the well pump was permitted to discharge continuously for a period of approximately 45 minutes at a rate of about 20 L/min (5.3 USgpm) prior to water quality sample collection. During this prolonged flushing period, far greater stress (radius of influence) was placed on the local aquifer relative to typical residential use where the pump cycling would occur intermittently based on demand. During flushing, no decrease in pump discharge rate or water quality degradation (as evident in the laboratory testing data) was observed.

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6. Conclusions

Based on a review and interpretation of information gathered during AECOM's well interference complaint investigation, as presented herein, it is our opinion that the groundwater quality / supply issue reported by the property owners at [REDACTED] (PIN 007500067) is *not* as a result of NKW1 turbine foundation construction or pile-driving activities. No indication of water quality impact at the site well was apparent based on our recent sampling works relative to baseline data collected prior to the outset of construction.

This interpretation and opinions presented in this technical memorandum are based on information available as of the date the document was prepared. Should additional information become available at a future date, AECOM reserves the right to review and potentially reconsider the findings of our current assessment through the issuance of addenda to this technical memorandum.

-- End of Memorandum --



AECOM

Attachments



AECOM

Attachment A

Correspondence

From: Jacobs, Deb (MOECC) [<mailto:deb.jacobs@ontario.ca>]
Sent: Monday, August 14, 2017 4:53 PM
To: Josh Vaidhyan (j.vaidhyan@samsung.com); Jody Law (jody.law@patternenergy.com); Van der Woerd, Mark
Cc: Harman, Bruce (MOECC); Smith, Mark (MOECC); Gilbert, Teri (MOECC); Schofield, Carine (MOECC); Moroney, Michael (MOECC); Morrison, Sean (MOECC); Keyvani, Mohsen (MOECC); Colella, Nick (MOECC); Ubovic, Miroslav (MOECC); Lannin, Teresa (MOECC); Lehouillier, Jason (MOECC)
Subject: New well complaint - [REDACTED]
Importance: High

Hello Josh and Jody,

This afternoon I received a new water well Complaint from [REDACTED] at [REDACTED]. [REDACTED]. This caller indicated that Saturday night (Aug 12) they discovered that they had no water in the house. When the pump was checked, apparently one of the filters was completely plugged up with sediment. The caller indicated that the problem has not yet since resolved itself. The caller indicated that they are looking for an alternate water source as soon as possible. I have been given permission by this caller to provide you with the above-noted contact information.

It is the Ministry's expectation that Samsung / Pattern will treat this matter as an official complaint and initiate the complaint response procedure detailed in REA condition G5 forthwith.

I will be attending the site tomorrow (Aug 15th) at ~11am along with Bruce Harman, a hydrogeologist with our Southwest Region office if you / AECOM wishes to attend concurrently. As an additional note, I did receive assurance from the landowner that there would be no protesters or additional WWF members in attendance at that time.

Best regards

Deb Jacobs

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Ministère de l'Environnement et de l'Action en matière de changement climatique
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AECOM

Attachment B

**Vibration Monitoring Data
(Golder Associates Ltd.)**

November 30, 2017

Project No. 1668031-2000-L12R2

Mr. Jody Law
c/o North Kent Wind 1 LP
355 Adelaide Street West, Suite 1000
Toronto, ON M5V 1S2

**WATER WELL COMPLAINT 3
NORTH KENT WIND 1 PROJECT
CHATHAM-KENT, ONTARIO**

Dear Mr. Law:

This letter is provided to summarize vibration monitoring data associated with Well Complaint 3 dated August 14, 2017, as related to the well located at [REDACTED] in Dresden, Ontario. For the purposes of this letter, vibration data is summarized for the period starting one day prior to the first reported well issue, August 12, 2017 through to one day following the date of the reported well issue.

A table is attached summarizing the following data:

- 1) date of pile driving;
- 2) turbine site at which pile driving was undertaken and the number of piles driven on the identified date;
- 3) maximum measured particle velocities at three locations:
 - a. at the turbine site; and
 - b. at the two wells within the turbine cluster specified for monitoring where the distance from the turbine site to the monitored well is also shown;

where these tabulated measurements specifically exclude vibrations directly associated with the well pumps (described below) but include vibrations attributable to other general sources such as nearby road and utility construction, nearby road car and truck traffic and movements of farm equipment as examples, and the distances from the pile driving to the well monitoring locations;

- 4) notes specific to the monitoring data; and
- 5) the distance from the pile driving to the well for which the complaint was submitted.



Pile driving of the closed-end pipe piles was completed in accordance with the Project foundation design using equipment with a driving hammer with a rated energy no greater than the hammer used during the test pile vibration monitoring. During pile driving, the times during which the pile was being actively struck by the hammer were recorded from the start of hammering to conclusion of hammering. Further, the times during which the pile was driven on glacial till/rock were recorded based on observations of the pile driving conditions. It should be noted that very little energy was required during initial pile penetration since piles penetrated significant depths into the soft clay soil under their own weight or with very few hammer blows. Table 1 summarizes the numbers of individual piles driven at each turbine location on the noted dates, the distances from the turbine locations and monitored wells, and distances of pile driving to the well for which the complaint was reported.

Vibrations at the turbine sites were monitored using portable construction vibration monitoring geophone devices common to construction monitoring and in accordance with the approved monitoring work plan. Vibrations at the well locations were monitored using three accelerometers mounted to the steel well casings and a portable data collection system in accordance with the approved monitoring plan. Monitoring of the well casings and pile driving sites was completed continuously during driving of all piles relevant to this letter. All monitoring instruments were calibrated at the manufacturer or manufacturer-approved facility prior to use by Golder. All such calibrations were conducted on a schedule as required according to the manufacturer or instrument supplier. Field verification of accelerometer calibration was completed with a portable controlled vibration source before and after each time the accelerometers were installed on well casings. Accelerometer responses during field verification remained within required tolerances.

Following pile driving, data was downloaded from all devices, stored electronically, vibration magnitudes were assessed, compared to pile driving records and observations at the well sites and summarized. Assessment of vibrations included examination of time histories of data with a specific focus on comparing observation of vibration energy sources such as pile driving, well pumps and nearby farm and roadway vehicle traffic. Analysis of accelerometer data was completed using the methods defined in the test pile vibration monitoring program (June, 2017). Evaluation of data was completed in Golder's London, Ontario office.

The well at the property for which the complaint was reported is located in the rear yard of the residence in a well pit. An MOECC record was not available for this well. Information provided by AECOM Canada Ltd. (AECOM) dated September 6, 2017, indicated that the well is equipped with a mechanical lift pump mounted directly on the top of the well casing.

When reviewing Table 1, attached, it should be noted that during vibration monitoring of multiple wells in the area, well casing vibrations directly attributable to the well pumps were measured and these were as much as 2.4 millimetres per second (mm/s) with one well experiencing vibrations of almost 5 mm/s during installation, initial operation and adjustments. On the dates listed in Table 1, vibration monitoring at Wells 9 and 10 undertaken outside of times during which pile driving was underway, the maximum measured well casing vibration was about 1.2 mm/s, consistent with vibration magnitudes associated with other transient sources including nearby utility construction, traffic on the nearby road and vehicles entering and leaving the immediate vicinity of the wells. Maximum well casing vibration velocities for a similar mechanical lift pump in the area (Well 12) indicate that these systems induce casing vibrations on the order of 2.4 mm/s.

At the location of Well 9, monitored during pile driving for T32, specific pile induced vibrations were identified with a magnitude of less than 0.040 mm/s and these were less than those induced by other transient sources of vibration near this site such as traffic and other utility construction. Other data gathered as part of the Phase 1 test pile vibration monitoring program and other wells monitored during the Phase 2 construction pile driving monitoring program were also reviewed since the ground conditions, pile driving systems and pile types and sizes are directly comparable. At distances between pile driving and wells ranging from about 580 m to 911 m, directly

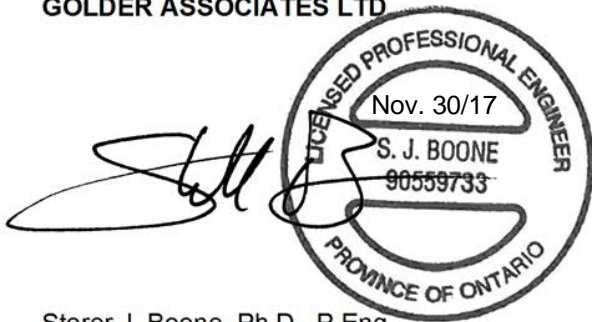
relevant to this water well complaint, maximum vibration velocities related to pile driving ranged from 0.003 to 0.030 mm/s. Vibration velocities at the well for which the complaint was reported would have been within this range. These measured well casing vibration magnitudes are consistent with expected vibration magnitude and distance attenuation relationships and less than the magnitudes anticipated based on the Phase I test pile driving evaluation.

Based on the data available to-date from the test pile and construction monitoring programs, pile-induced vibrations at the well would be expected to be one or more orders of magnitude less than vibrations induced by pumping systems similar to that used at [REDACTED], less than vibrations associated with vehicles operating near the wells and less than the International Standards Organization (ISO) threshold for human perception of vibrations at frequencies greater than 8 Hz (0.1 mm/s). It is our opinion, based on vibration measurements, that the vibration magnitudes during pile driving were within expectations, no greater than may be induced by other common day-to-day sources at this well, less than the observed and measured influences of typical well pumps in the area and inconsequential for the [REDACTED] well.

We trust that this letter is adequate for your present requirements. If any point requires further clarification, please contact this office.

Yours truly,

GOLDER ASSOCIATES LTD



Storer J. Boone, Ph.D., P.Eng.
Principal

SJB/MEB/MAS/cr

CC: J. Vaidyan, Samsung

Attachments: Table 1 - Summary of Vibration Monitoring Data, Well Complaint 3

n:\active\2016\3 proj\1668031 pattern_north kent vib monit_chatham-kent\ph 2000-vib monit field work\2-correspondence\3-ltrs\12\1668031-2000-l12 nov 30 17 (revised 2) water well complaint 3.docx

Table 1: Summary of Vibration Monitoring Data, Well Complaint 3¹

Date	Turbine and Piles ⁴	Measured Maximum Particle Velocities During Pile Driving, Inclusive of Traffic and Other Activities, Exclusive of Pump-Induced Vibrations (mm/s) ²				Distance from Well Complaint Residence (m)
		Turbine Site	Monitored Well (Well No., distance)	Monitored Well (Well No., distance)	Notes ³	
Complaint 3 August 12, 2017						
8/11/2017	T32 (9)	3.43	1.346 (W9, 680 m)	0.051 (W10, 1122 m)	Road and utility construction near Well 9, see text.	819
8/11/2017	T28 (6)	5.59	0.812 (W9, 2568 m)	0.112 (W10, 1769 m)	Road and utility construction near Well 9, see text.	3,025
8/12/2017	No Pile Driving					
8/13/2017	No Pile Driving					

- NOTES: 1) Table shall be read in conjunction with accompanying letter.
2) Other activities included nearby car and truck traffic on adjacent road, vehicles entering and leaving property, etc.
3) See letter text for additional discussion of other observations.
4) Number of piles driven and number of restrike events on specified date shown in parentheses.

September 20, 2017

Project No. 1668031-2000-L06

Mr. Jody Law
c/o North Kent Wind 1 LP
355 Adelaide Street West, Suite 1000
Toronto, ON M5V 1S2

**SUMMARY OF VIBRATION MONITORING
FOUNDATION PILE DRIVING – MULTIPLE TURBINES
NORTH KENT WIND 1 PROJECT
CHATHAM-KENT, ONTARIO**

Dear Mr. Law:

Please find attached a summary of the vibration monitoring that has been undertaken during driving of foundation piles for turbines being constructed as part of the North Kent Wind 1 project (NK1) at the locations listed in Table 1 (following the text of this letter) through to September 12, 2017, exclusive of data for Turbines T26 and T27 as these are still being processed and analyzed. Vibration monitoring was carried out to meet Section H1 of the Renewable Energy Approval (REA) document issued by the Ontario Ministry of the Environment and Climate Change (MOECC). The work was carried out in accordance with a vibration monitoring program prepared by Golder Associates Ltd. (Golder) dated June 2, 2017 and subsequently approved by MOECC and issued June 9, 2017.

This report addresses vibration monitoring data obtained during pile foundation driving at the turbine sites and domestic water well pairs listed in Table 1, attached, as defined by the times and dates for pile driving within the seven geographic turbine clusters. The locations of the turbines and associated wells are illustrated on the attached figures. The attached pages of summary data and notes include particle velocity measurements made at the referenced sites that were taken in close proximity to the pile driving together with measurements obtained at domestic water well casings associated with the relevant turbine clusters. Previously issued summary pages have been updated to reflect changes, if and as applicable, related to:

- detailed review of Instantel Minimate data histogram files for the turbine sites;
- well and turbine site vibration monitoring data associated with pile dynamic analyser testing, subsequent pile restrikes or replacements;
- monitoring of vibrations during well pump operating periods in the absence of pile driving;



- examination of vibration data associated with background conditions, other transient vibration sources (e.g., road traffic, movement of farm equipment, pump maintenance) and/or time durations during which pile driving was not actively in progress;
- clarifications or additions to pile driving monitoring notes; and
- typographical/clerical corrections, if and as needed.

The vibration measurements as reported on the attached pages are considered finalized for the analysis time periods, stated conditions and the context of this report. Golder reserves the right to update reports for the various turbine sites and wells as additional information becomes available and to address any of the items noted above. In particular, additional evaluation of turbine site geophone data is anticipated whereby actual off-set distances and vibration measurements at specific piles and times of day may be updated rather than the current listing of daily maximum measurements. A finalized report will be issued after the conclusion of all pile driving for this project.

Monitoring Work Plan

Vibration monitoring was carried out in accordance with the June 2, 2017 work plan submitted to and approved by the MOECC and reissued on June 9, 2017. In summary, key elements of the work plan include:

- Pile driving at the turbine sites is visually monitored by a Golder staff member who keeps notes regarding start and stop times of active pile hammering, monitoring data logging and instrument status and other site conditions as relevant to the pile driving. Ground surface vibrations at each turbine site are being monitored with two Instantel Minimate Pro III or Pro IV systems. Two systems are being utilized to allow periodic downloading of data so that vibrations, if any, could then be captured by the other redundant system. The geophone systems captured vibration velocities in three mutually perpendicular directions. One direction was vertical and the longitudinal direction was oriented toward the closest pile with the third (transverse) direction being determined by the other two.
- Three accelerometers are being securely coupled to the monitored well casings for which permissions to enter and carry out monitoring have been obtained. The accelerometers are oriented in three mutually perpendicular directions. One direction is vertical and the longitudinal direction is oriented toward the closest pile driving operation, with the third (transverse) direction being determined by the other two. Golder personnel monitor the instrument status and any other relevant activities around the wells such as local road traffic, movements of farm equipment, traffic in and out of the well properties, other construction activities (if any) and well pump operations or maintenance.

Overview of Pile Driving Conditions and Monitoring Notes

Pile driving at the turbine sites was conducted after constructing an access road, stripping topsoil, excavating to approximately 2.6 m below the ground surface and placing a concrete working pad. The concrete working pads have been fitted with pre-formed openings for the piles or constructed to a smaller diameter with the piles driven just beyond the outer perimeter of the concrete. Pile driving cranes were operated on timber mats placed on the concrete. Typically, piles were driven with the same hammer type as used for the pre-construction test pile and vibration monitoring program. In one case, a different hammer was used with a significantly lower driving energy. Subsequent use of this hammer has been rejected by the constructor.

On the attached monitoring reports, three times are reported for each driven pile. The column heading “Start” refers to the time of day when the pile hammering commenced on the indicated pile. Times of other site activities, such as crane movements, welding, equipment start-up and other work occurring prior to start of active pile hammering were not recorded except in specific instances where the turbine site geophones were inadvertently influenced by other equipment operating too closely. The column heading “Rock/Till” indicates the time at which hard driving started, as evidenced by the rate of pile depth change as compared to the numbers of hammer strikes on the pile. Commonly, the piles penetrated the first few metres of ground under their own weight, with nominal pile driving effort required until the underlying glacial till and/or rock was encountered. In many cases, the pile driving resistance in the upper soil layers was insufficient to engage the firing mechanism in the diesel hammer. Upon reaching the glacial till, the pile hammer fully engaged for the remainder of driving. The column heading “End” indicates the time of day at which active pile hammering ceased for the identified pile. While the total pile driving duration can be determined by the difference between the “Start” and “End” times, the duration of active pile hammering was frequently interrupted by pile splicing, welding, equipment repair, decision-making required for pile termination depths, pile testing and daily labour breaks. Many of these start and stop instances are identified on the attached summary pages.

Summary of Results

In summary, vibration measurements obtained with the geophone system (Instantel Minimate) on all sites reported herein were within expectations as compared to those measured at the T5 and T42 test pile sites and general project expectations. On sites where piles penetrated through the near-surface soils under their own weight or a low number of hammer blows (e.g., less than 5) the ground surface vibrations during this phase of pile driving for each pile were nominal. Ground surface vibrations measured when driving the piles on the glacial till or rock were also either comparable to or less than those at the test pile sites and, in all cases, were within expectations. Vibration measurements made using the accelerometers mounted on the well casings were also within expectations based on the T5 and T42 test pile sites and turbine to well distances.

Well monitoring to-date has identified several wells for which the vibrations induced by the pumps dominated the instrument readings when the pumps were active or other activities dominated the measured vibrations. Relevant notes regarding various pumps, their operation and other influences on vibration measurements are described below:

- **Well 3:** Activities at the Well 3 property included crop harvesting, movement of farm vehicles and loading of haul trucks in relatively close proximity to Well 3.
- **Well 4:** Maximum well casing vibration velocities for Well 4 of about 4.8 mm/s were recorded on September 6, 2017 when a well pump was connected, operated and adjusted and the owner made frequent return visits to the well shed. Crop harvesting was also carried out as close as about 25 m from the well casing.
- **Well 6:** The pump for Well 6 is mounted in close proximity to the well casing (as illustrated on the attached Photograph 1). Maximum particle velocities of as much as 0.8 mm/s were obtained from monitoring data collected at Well 6 on July 13, 2017 when the well pump was operating during a time period without pile driving. The influences of the pump were readily discernable in the monitoring data. Approximately 1 minute after driving of Pile 1 for turbine T12 concluded, a loaded tractor-trailer dump truck drove by on the road near Well 6 and, at the same time, the resident was hammering in a nearby shed. Vibrations associated with the loaded dump truck were also perceptible by our well monitoring staff and registered at about 2.8 mm/s.



- **Well 9:** A piston pump for Well 9 is located within the barn adjacent to the Well 9 casing location, a total distance (inside and outside) of about 3 to 4 m. During pile driving for turbines T28 and T32, on August 11, 2017, other work was occurring near Well 9. This work included construction along the access road leading to the T32 site and included movement of heavy equipment, excavator operations, dump truck traffic, discharge of stone from delivery vehicles and other activities. This surface construction work was as close as 100 m to Well 9. Additionally, Well 9 is approximately 74 m from Countryview Line that experiences significant traffic. Traffic included loaded construction equipment, buses, fuel tanker trucks and other vehicles. Golder conducted a separate monitoring event at this well on September 8, 2017 to measure the influence of the pump on well casing vibrations in the absence of pile driving. Maximum measured casing vibrations during this test were about 1.2 mm/s. Measurements at Well 9 on dates other than August 11, 2017 are consistent with expectations based on local traffic volumes and the potential influence of the adjacent piston pump.
- **Well 10:** Well 10 exhibited maximum vibrations of about 1.25 mm/s during pump operation. The influence of pump operations were clearly discernable in the vibration monitoring data. The proximity of the pump and well casing are illustrated in the attached Photograph 2.
- **Well 11:** Vibrations of the casing at Well 11 were measured during water quality sampling on August 17, 2017 in the absence of pile driving at any location. When the pump was operating, a maximum vibration magnitude of 0.016 mm/s was measured at this well. The pump is located within the residence and approximately 40 m from the well.
- **Well 12:** During pile driving, Well 12 operated on a number of clearly definable occasions. Maximum vibration measurements of pump-induced well casing vibrations were as much as 2.4 mm/s. The pump for Well 12 is a piston pump mounted directly on top of the well casing as illustrated in the attached Photograph 3.
- **Well 13:** Well 13 is located approximately 87 m from the centreline of Union Line which is subjected to local truck traffic. Review of the data indicates that well pumping and non-pile driving transient sources influenced the results at this location. Additional evaluation of transient, non-pile driving data is on-going and a specific monitoring period for well pump operation is being planned for a time without pile driving.
- **Well 14:** Well 14 is located approximately 13 m from the centreline of Union Line which is subjected to local truck traffic. A limited evaluation of transient traffic vibrations indicated well casing velocities of at least 0.079 mm/s associated with this cause, though inspection of the data indicates higher values occurred outside of pile driving times. Additional evaluation of transient, non-pile driving data is on-going and a specific monitoring period for well pump operation is being planned for a time without pile driving.

In summary, measured vibrations have been evaluated and reported as associated with driving 329 piles and replacement piles on the glacial till/rock along with restrike events and pile dynamic testing events. These measurements have been obtained at the turbine sites and at wells located at distances ranging from 580 to 4,359 m from the turbine sites. It is our opinion, based on these measurements, that the vibration magnitudes at all wells during pile driving were within expectations, no greater than may be induced by other common day-to-day sources at these well sites, less than the observed and measured influence of well pumps and inconsequential for the wells.

We trust that this letter is adequate for your present requirements. If any point requires further clarification, please contact this office.

Yours truly,

GOLDER ASSOCIATES LTD.

Storer J. Boone, Ph.D., P.Eng.
Principal

SJB/MEB/cr

Attachments: Table 1 - Vibration Measurement Locations
Photographs of Wells 6, 10 and 12 Pump Configurations
Preliminary Vibration Monitoring Summaries and Figures, Turbines T3, T4, T6, T7, T12, T14, T20, T21, T28, T30, T31, T32, T33, T35, T36, T43, T45 and T46

n:\active\2016\3 proj\1668031 pattern_north kent vib monit_chatham-kent\ph 2000-vib monit field work\2-correspondence\3-ltrs\06\1668031-2000-l06 sep 20 17 summary of vibration monitoring.docx

TABLE 1 – VIBRATION MEASUREMENT LOCATIONS

Turbine Cluster 1		
Turbine	Well	Well
Turbine Cluster 1		
T12	5 ([REDACTED])	6 ([REDACTED])
T35		
T36		
Turbine Cluster 2		
T6	7 ([REDACTED])	8 ([REDACTED])
T7		
T31		
Turbine Cluster 3		
T28	9 ([REDACTED])	10 ([REDACTED])
T30		
T32		
Turbine Cluster 4		
T3	11 ([REDACTED])	12 ([REDACTED])
T4		
T20		
T21		
T43		
T45		
T46		
Turbine Cluster 5		
T33	3 ([REDACTED])	4 ([REDACTED])
Turbine Cluster 6		
T14	13 ([REDACTED])	14 ([REDACTED])
T26		
T27		
Turbine Cluster 7		
No construction pile driving to date of this report	1A ([REDACTED])	2 ([REDACTED])

Note: Table to be read in conjunction with accompanying text.

Prepared By: SJB

Checked By: DB

SITE PHOTOGRAPHS



Photograph 1: Well 6 illustrating proximity of pump, hoses and tank to well casing.



Photograph 2: Well 10 illustrating proximity of pump, hoses and tank to well casing.



Photograph 3: Well 12 illustrating pump mounted directly on well casing.

NORTH KENT 1

Preliminary Vibration Monitoring Report

Turbine Location: T3

Vibration Measurements at Turbine Site

Vibration Measurements at Wells

Pile Driving Times and Dates						Particle Velocity (mm/s) ^{c, d}		
Pile No.:	Start ^a	Rock/Till	End ^a	Geophone Dist. (m)	Daily Maximum Particle Velocity (mm/s) ^b	Well 11	Well 12	No Pump ^e
1	8/23/2017 10:01	8/23/2017 10:10	8/23/2017 10:11	21.6	7.27	NA ^e	0.021	
2	8/23/2017 11:29	8/23/2017 11:35	8/23/2017 12:35	23.2	7.27	0.011	0.003	
3	8/23/2017 11:46	8/23/2017 11:56	8/23/2017 12:41	24.2	7.27	0.024	0.013	
4	8/23/2017 12:12	8/23/2017 12:19	8/23/2017 12:21	24.5	7.27	0.014	0.010	
5	8/23/2017 9:43	8/23/2017 9:49	8/23/2017 9:52	24.2	7.27	NA ^e	0.010	
6	8/23/2017 9:28	8/23/2017 9:35	8/23/2017 9:35	23.2	7.27	NA ^e	0.004	
7	8/22/2017 12:16	8/22/2017 12:22	8/22/2017 12:57	21.6	8.26	0.015	0.016	
8	8/22/2017 18:43	8/22/2017 18:49	8/22/2017 18:54	19.4	8.26	0.013	0.004	
9	8/22/2017 16:52	8/22/2017 16:58	8/22/2017 17:00	16.8	8.26	0.018	0.011	
10	8/22/2017 18:19	8/22/2017 18:27	8/22/2017 18:32	13.9	8.26	0.014	0.008	
11	8/22/2017 16:34	8/22/2017 16:40	8/22/2017 16:45	11.0	8.26	0.022	0.025	
12	8/22/2017 17:48	8/22/2017 17:57	8/22/2017 18:08	8.7	8.26	0.011	0.003	
13	8/22/2017 16:08	8/22/2017 16:16	8/22/2017 16:18	7.7	8.26	0.007	0.029	
14	8/22/2017 17:29	8/22/2017 17:38	8/22/2017 17:39	8.7	8.26	0.012	0.013	
15	8/22/2017 14:27	8/22/2017 14:33	8/22/2017 15:41	11.0	8.26	0.066	0.008	
16	8/22/2017 17:13	8/22/2017 17:20	8/22/2017 17:20	13.9	8.26	0.026	0.005	
17	8/22/2017 13:14	8/22/2017 13:22	8/22/2017 15:48	16.8	8.26	0.046	0.008	
18	8/23/2017 11:05	8/23/2017 11:12	8/23/2017 11:16	19.4	7.27	0.018	0.014	
Restrikes								
7C	8/23/2017 18:27	8/23/2017 18:27	8/23/2017 18:31	21.6	7.27	0.023	1.354	0.022
8C	8/23/2017 8:14	8/23/2017 8:14	8/23/2017 8:14	19.4	7.27	0.010	0.004	
11C	8/23/2017 8:18	8/23/2017 8:18	8/23/2017 8:18	11.0	7.27	0.009	2.405	0.006
12C	8/23/2017 8:22	8/23/2017 8:22	8/23/2017 8:22	8.7	7.27	0.009	2.405	0.006
13C	8/23/2017 8:25	8/23/2017 8:26	8/23/2017 8:26	7.7	7.27	0.009	0.007	
14C	8/23/2017 8:28	8/23/2017 8:28	8/23/2017 8:28	8.7	7.27	0.007	0.007	
16C	8/23/2017 8:31	8/23/2017 8:31	8/23/2017 8:32	13.9	7.27	0.007	0.007	
17C	8/23/2017 8:34	8/23/2017 8:34	8/23/2017 8:34	16.8	7.27	0.007	0.007	
6	8/23/2017 12:14	8/23/2017 12:15	8/23/2017 12:15	23.2	7.27	0.025	0.023	
Replacement Piles								
7A	9/6/2017 12:05	9/6/2017 12:14	9/6/2017 12:19	20.6	1.99	0.033	0.005	
Well Information								
Well No.:	11				Well No.:	12		
Municipal Address:					Municipal Address:			
Distance from Turbine Centre:		1707 m			Distance from Turbine Centre:		1264 m	

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Continued pile driving on subsequent days are marked "C". Replacement piles are marked "A". Vibration measurements were undertaken on August 17, 2017 at Wells 11 and 12 during water quality sampling events in the absence of pile driving within the cluster. Both pumps turned on and operated during the sampling events. Maximum vibration measurements for Well 11 were 0.016 mm/s and this pump was located within the residence approximately 40 m from the well. Maximum vibration measurements for Well 12 were 0.896 mm/s and this pump was mounted on the well casing. During pile driving on August 23, 2017, the maximum vibration measurement of the Well 12 casing was 2.4 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Data not available for Piles 1, 5 and 6 at Well 11 on August 23, 2017 due to battery failure in monitoring equipment. Battery was subsequently replaced. Driving/restriking of some piles occurred in relatively rapid succession and, therefore, in some cases the vibration measurement data for the 10 minute periods of analysis are applicable to multiple piles. Where total driving duration between till/rock start and end times noted above is not representative, actual driving duration is shown in parentheses in minutes and seconds: 2(6:42), 3(5:13), 7(8:45), 12(7:08), 15(1:20), 17(1:42). Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

NORTH KENT 1
Preliminary Vibration Monitoring Report

Footnotes: a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

Preliminary Vibration Monitoring Report

Turbine Location: T4

Vibration Measurements at Turbine Site

Vibration Measurements at Wells

Pile Driving Times and Dates				Geophone Dist. (m)	Daily Maximum Particle Velocity (mm/s) ^b	Particle Velocity (mm/s) ^{c, d}		
Pile No.:	Start ^a	Rock/Till	End ^a			Well 11	Well 12	No Pump ^e
1	8/25/2017 8:00	8/25/2017 8:08	8/25/2017 8:09	23.9	2.54	0.004	0.006	
2	8/25/2017 8:30	8/25/2017 9:15	8/25/2017 9:16	25.6	2.54	0.006	2.335	0.008
3	8/25/2017 9:03	8/25/2017 9:09	8/25/2017 9:10	26.6	2.54	0.007	2.335	0.008
4	8/25/2017 8:47	8/25/2017 8:56	8/25/2017 8:57	27.0	2.54	0.005	0.011	
5	8/25/2017 8:15	8/25/2017 8:22	8/25/2017 8:23	26.6	2.54	0.028	0.018	
6	8/24/2017 13:01	8/24/2017 13:10	8/24/2017 13:11	25.6	4.32	0.011	0.056	
7	8/24/2017 9:56	8/24/2017 10:04	8/24/2017 10:51	23.9	4.32	0.018	1.511	0.024
8	8/24/2017 13:19	8/24/2017 15:13	8/24/2017 15:14	21.6	4.32	0.024	1.777	0.014
9	8/24/2017 10:56	8/24/2017 11:04	8/24/2017 11:04	19.0	4.32	0.006	0.004	
10	8/24/2017 13:35	8/24/2017 13:45	8/24/2017 13:45	16.1	4.32	0.006	0.018	
11	8/24/2017 11:10	8/24/2017 11:18	8/24/2017 11:18	13.2	4.32	0.013	0.026	
12	8/24/2017 13:52	8/24/2017 15:09	8/24/2017 15:10	11.0	4.32	0.024	1.777	0.014
13	8/24/2017 11:23	8/24/2017 11:32	8/24/2017 11:33	10.1	4.32	0.009	0.009	
14	8/24/2017 14:07	8/24/2017 14:17	8/24/2017 14:17	11.0	4.32	0.007	0.006	
15	8/24/2017 11:38	8/24/2017 15:03	8/24/2017 15:04	13.2	4.32	0.009	1.374	0.028
16	8/24/2017 14:24	8/24/2017 14:33	8/24/2017 15:01	16.1	4.32	0.009	1.374	0.028
17	8/24/2017 12:46	8/24/2017 14:55	8/24/2017 14:56	19.0	4.32	0.030	1.374	0.028
18	8/24/2017 14:40	8/24/2017 14:52	8/24/2017 14:52	21.6	4.32	0.030	0.029	

Well Information

Well No.: 11

Municipal Address: [REDACTED]

Distance from Turbine Centre: 1424 m

Well No.: 12

Municipal Address: [REDACTED]

Distance from Turbine Centre: 1072 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: Vibration measurements were undertaken on August 17, 2017 at Wells 11 and 12 during water quality sampling events in the absence of pile driving within the cluster. Both pumps turned on and operated during the sampling events. Maximum vibration measurements for Well 11 were 0.016 mm/s and this pump was located within the residence approximately 40 m from the well. Maximum vibration measurements for Well 12 were 0.896 mm/s and this pump was mounted on the well casing. During pile driving on August 24, 2017, the maximum vibration measurement of the Well 12 casing was 1.777 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Note that driving of some piles was paused while the tip was in the upper soil deposits and subsequently driven to the glacial till/rock later in the day. In these instances, the hard driving conditions for different piles occurred in relatively rapid succession and, therefore, the vibration measurement data for the 10 minute periods of analysis are applicable to multiple piles. Where total driving duration between till/rock start and end times noted above is not representative, actual driving duration is shown in parentheses in minutes and seconds: 2(7:33), 7(1:32), 8(0:53), 12(1:10), 15(1:15), 16(1:02), 17(1:31). Total driving durations derived from start and end times noted above include labour breaks, equipment work, splicing, welding and other standby time.

Footnotes: a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

Preliminary Vibration Monitoring Report

Turbine Location: T6

Vibration Measurements at Turbine Site

Vibration Measurements at Wells

Pile Driving Times and Dates					Daily Maximum Particle Velocity (mm/s) ^b	Particle Velocity (mm/s) ^{c, d}	
Pile No.:	Start ^a	Rock/Till	End ^a	Geophone Dist. (m)		Well 7	Well 8
1	7/31/2017 11:25	7/31/2017 11:28	7/31/2017 11:32	27.0	4.57	0.068	0.049
2	7/31/2017 12:20	7/31/2017 12:26	7/31/2017 12:28	26.6	4.57	0.044	0.032
3	7/31/2017 12:37	7/31/2017 12:41	7/31/2017 12:46	25.6	4.57	0.018	0.028
4	7/31/2017 13:35	7/31/2017 13:40	7/31/2017 13:46	23.9	4.57	0.066	0.011
5	7/31/2017 13:18	7/31/2017 13:23	7/31/2017 13:28	21.6	4.57	0.017	0.010
6	7/31/2017 12:59	7/31/2017 13:05	7/31/2017 13:07	19.0	4.57	0.012	0.033
7	7/31/2017 7:33	7/31/2017 7:37	7/31/2017 7:42	16.1	4.57	0.050	0.050
8	7/31/2017 7:53	7/31/2017 7:56	7/31/2017 8:03	13.2	4.57	0.127	0.070
9	7/31/2017 8:14	7/31/2017 8:18	7/31/2017 8:22	11.0	4.57	0.051	0.015
10	7/31/2017 8:31	7/31/2017 8:37	7/31/2017 8:41	10.1	4.57	0.025	0.058
11	7/31/2017 8:48	7/31/2017 8:51	7/31/2017 8:53	11.0	4.57	0.035	0.012
12	7/31/2017 9:02	7/31/2017 9:07	7/31/2017 9:12	13.2	4.57	0.058	0.023
13	7/31/2017 9:21	7/31/2017 9:25	7/31/2017 9:33	16.1	4.57	0.118	0.005
14	7/31/2017 9:42	7/31/2017 9:47	7/31/2017 9:50	19.0	4.57	0.082	0.007
15	7/31/2017 10:21	7/31/2017 10:24	7/31/2017 10:29	21.6	4.57	0.039	0.032
16	7/31/2017 10:36	7/31/2017 10:40	7/31/2017 10:43	23.9	4.57	0.010	0.014
17	7/31/2017 10:51	7/31/2017 10:54	7/31/2017 10:58	25.6	4.57	0.040	0.057
18	7/31/2017 11:09	7/31/2017 11:13	7/31/2017 11:17	26.6	4.57	0.024	0.071

Well Information

Well No.: 7

Municipal Address:

Distance from Turbine Centre: 1049 m

Well No.: 8

Municipal Address:

Distance from Turbine Centre: 872 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: Well monitoring undertaken during periods of time on these same days when pile driving was not occurring measured maximum particle velocities of as much as 0.37 mm/s (Well 7). Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

Footnotes: a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction.

NORTH KENT 1

Preliminary Vibration Monitoring Report

Turbine Location: T7

Vibration Measurements at Turbine Site

Vibration Measurements at Wells

Pile Driving Times and Dates					Daily Maximum Particle Velocity	Particle Velocity (mm/s) ^{c, d}	
Pile No.:	Start ^a	Rock/Till	End ^a	Geophone Dist. (m)	(mm/s) ^b	Well 7	Well 8
1	7/27/2017 17:57	7/27/2017 18:03	7/27/2017 18:04	27.0	5.97	0.030	0.011
2	7/27/2017 18:31	7/27/2017 18:36	7/27/2017 18:36	26.6	5.97	0.063	0.013
3	7/28/2017 8:11	7/28/2017 8:16	7/28/2017 8:16	25.6	2.16	0.019	0.022
4	7/28/2017 8:37	7/28/2017 8:43	7/28/2017 8:44	23.9	2.16	0.035	0.045
5	7/27/2017 18:11	7/27/2017 18:17	7/27/2017 18:18	21.6	5.97	0.017	0.012
6	7/27/2017 15:27	7/27/2017 15:32	7/27/2017 15:33	19.0	5.97	0.019	0.028
7	7/27/2017 15:10	7/27/2017 15:15	7/27/2017 15:16	16.1	5.97	0.026	0.028
8	7/27/2017 14:30	7/27/2017 14:36	7/27/2017 14:37	13.2	5.97	0.017	0.027
9	7/27/2017 14:10	7/27/2017 14:16	7/27/2017 14:18	11.0	5.97	0.011	0.031
10	7/27/2017 13:55	7/27/2017 14:00	7/27/2017 14:01	10.1	5.97	0.030	0.012
11	7/27/2017 13:42	7/27/2017 13:46	7/27/2017 13:47	11.0	5.97	0.025	0.042
12	7/27/2017 13:09	7/27/2017 13:13	7/27/2017 13:23	13.2	5.97	0.019	0.035
13	7/27/2017 12:21	7/27/2017 12:34	7/27/2017 12:53	16.1	5.97	0.030	0.049
14	7/27/2017 15:42	7/27/2017 15:51	7/27/2017 15:54	19.0	5.97	0.026	0.039
15	7/27/2017 16:06	7/27/2017 16:12	7/27/2017 16:13	21.6	5.97	0.032	0.021
16	7/27/2017 16:34	7/27/2017 16:44	7/27/2017 16:45	23.9	5.97	0.010	0.066
17	7/27/2017 16:55	7/27/2017 17:01	7/27/2017 17:02	25.6	5.97	0.069	0.030
18	7/27/2017 17:17	7/27/2017 17:25	7/27/2017 17:26	26.6	5.97	0.027	0.060

Well Information

Well No.: 7

Municipal Address: [REDACTED]

Distance from Turbine Centre: 1354 m

Well No.: 8

Municipal Address: [REDACTED]

Distance from Turbine Centre: 2883 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: Well monitoring undertaken during periods of time on these same days when pile driving was not occurring measured maximum particle velocities of as much as 0.073 mm/s. Total driving duration between till/rock start and end times noted above for Pile 13 is not representative and actual driving duration was 00:1:45 due to pauses in actual hammering. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

Footnotes: a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction.

Preliminary Vibration Monitoring Report

Turbine Location: T12

Vibration Measurements at Turbine Site						Vibration Measurements at Wells		
Pile Driving Times and Dates					Daily Maximum Particle Velocity	Particle Velocity (mm/s) ^{c, d}		
Pile No.:	Start ^a	Rock/Till	End ^a	Geophone Dist. (m)	(mm/s) ^b	Well 5	Well 6	No Pump ^e
1	7/5/2017 12:33	7/5/2017 12:46	7/5/2017 12:47	27.5	5.97	0.008	0.044	See Notes
2	7/5/2017 15:47	7/5/2017 16:01	7/5/2017 16:01	27.8	5.97	0.001	0.106	
3	7/6/2017 8:08	7/6/2017 8:19	7/6/2017 8:20	27.5	4.32	0.010	0.775	
4	7/6/2017 7:47	7/6/2017 7:58	7/6/2017 7:59	26.4	4.32	0.002	0.048	
5	7/5/2017 12:57	7/5/2017 13:26	7/5/2017 13:27	24.7	5.97	0.002	0.729	
6	7/5/2017 14:11	7/5/2017 14:22	7/5/2017 14:23	22.5	5.97	0.002	0.298	
7	7/4/2017 14:48	7/4/2017 14:57	7/4/2017 14:58	19.8	5.97	0.002	0.026	
8	7/5/2017 11:38	7/5/2017 11:49	7/5/2017 11:50	16.8	5.97	0.008	0.030	
9	7/4/2017 9:26	7/4/2017 9:58	7/4/2017 10:00	14.0	9.91	0.011	0.246	0.014
10	7/5/2017 11:11	7/5/2017 11:25	7/5/2017 11:26	11.8	5.97	0.002	0.047	0.014
11	6/30/2017 12:03	6/30/2017 13:47	6/30/2017 13:54	11.0	11.20	0.004	0.755	
12	7/4/2017 15:15	7/4/2017 15:25	7/4/2017 15:25	11.8	9.91	0.002	0.179	
13	7/4/2017 11:22	7/4/2017 11:33	7/4/2017 11:34	14.0	9.91	0.002	0.066	
14	7/4/2017 15:47	7/4/2017 15:58	7/4/2017 15:58	16.8	9.91	0.069	0.037	
15	7/4/2017 11:55	7/4/2017 12:06	7/4/2017 12:07	19.8	9.91	0.003	0.023	
16	7/4/2017 16:35	7/4/2017 16:47	7/4/2017 16:47	22.5	9.91	0.004	0.155	
17	7/4/2017 13:01	7/4/2017 13:14	7/4/2017 13:20	24.7	9.91	0.007	0.085	
18	7/4/2017 15:08	7/4/2017 15:27	7/4/2017 15:28	26.4	9.91	0.002	0.729	
Restrikes								
7	7/5/2017 8:42	7/5/2017 8:42	7/5/2017 8:42	19.8	5.97	0.007	0.647	0.027
9	7/5/2017 8:47	7/5/2017 8:47	7/5/2017 8:48	14.0	5.97	0.007	0.634	0.027
11	7/5/2017 8:51	7/5/2017 8:51	7/5/2017 8:52	11.0	5.97	0.007	0.634	0.032
12	7/5/2017 8:57	7/5/2017 8:57	7/5/2017 8:58	11.8	5.97	0.003	0.624	
13	7/5/2017 9:02	7/5/2017 9:02	7/5/2017 9:03	14.0	5.97	0.008	0.662	
14	7/5/2017 9:09	7/5/2017 9:09	7/5/2017 9:10	16.8	5.97	0.008	0.624	
15	7/5/2017 9:13	7/5/2017 9:13	7/5/2017 9:14	19.8	5.97	0.003	0.546	0.057
16	7/5/2017 9:17	7/5/2017 9:17	7/5/2017 9:19	22.5	5.97	0.002	0.546	0.057
17	7/5/2017 9:22	7/5/2017 9:22	7/5/2017 9:23	26.4	5.97	0.002	0.546	0.057

Well Information

Well No.: 5
Municipal Address: [REDACTED]
Distance from Turbine Centre: 3346 m

Well No.: 6
Municipal Address: [REDACTED]
Distance from Turbine Centre: 3368 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". On July 5, 2017, approximately 1 minute after pile driving stopped for Pile 1, the well monitoring personnel at Well 6 observed a loaded tractor/trailer dump truck drive by the well at 54 m distance and ground vibrations were sensed. At this time, the resident was also hammering on equipment within a nearby (120 m) shed during which it sounded as though a heavy sledge was being used with multiple recoil/hammer falls after each main strike. Vibrations associated with these activities (not separable) registered as 2.8 mm/s, consistent with the perception of vibrations by the well monitoring personnel. Monitoring of deliberate pump operation at Well 6 on July 13, 2017, during a period when no pile driving was occurring, measured maximum particle velocities of 0.08 to 0.8 mm/s. Driving/restriking of some piles occurred in relatively rapid succession and, therefore, in some cases the vibration measurement data for the 10 minute periods of analysis are applicable to multiple piles. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time. The driving duration for Pile 11 on June 30, 2017 were unusually long since a small driving hammer was used for this pile. The total duration of driving on till/rock was 7 minutes for this pile.

Footnotes: a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

Preliminary Vibration Monitoring Report

Turbine Location: T14

Vibration Measurements at Turbine Site						Vibration Measurements at Wells		
Pile No.:	Pile Driving Times and Dates			Geophone Dist. (m)	Daily Maximum Particle Velocity (mm/s) ^b	Particle Velocity (mm/s) ^{c, d}		
	Start ^a	Rock/Till	End ^a			Well 13	Well 14	No Pump ^e
1	9/11/2017 16:01	9/11/2017 16:06	9/11/2017 16:09	18.9	4.95	0.020	0.206	
2	9/11/2017 16:24	9/11/2017 16:29	9/11/2017 16:32	21.0	4.95	0.010	0.056	
3	9/11/2017 15:48	9/11/2017 15:54	9/11/2017 15:56	22.6	4.95	0.017	0.132	
4	9/11/2017 15:33	9/11/2017 15:39	9/11/2017 15:43	23.6	4.95	0.012	0.190	
5	9/11/2017 15:19	9/11/2017 15:24	9/11/2017 15:26	24.0	4.95	0.006	0.064	
6	9/11/2017 15:04	9/11/2017 15:10	9/11/2017 15:13	23.6	4.95	0.005	0.221	
7	9/11/2017 12:33	9/11/2017 12:39	9/11/2017 12:44	22.6	4.95	0.007	0.083	
8	9/11/2017 12:17	9/11/2017 12:25	9/11/2017 12:27	21.0	4.95	0.005	0.338	
9	9/11/2017 11:53	9/11/2017 11:59	9/11/2017 12:02	18.9	4.95	0.114	0.675	
10	9/11/2017 11:36	9/11/2017 11:43	9/11/2017 11:45	16.3	4.95	0.013	0.240	
11	9/11/2017 11:20	9/11/2017 11:25	9/11/2017 11:28	13.5	4.95	0.013	0.168	
12	9/11/2017 10:24	9/11/2017 10:30	9/11/2017 10:34	10.6	4.95	0.428	0.077	0.011
13	9/11/2017 10:07	9/11/2017 10:14	9/11/2017 10:16	8.1	4.95	0.543	0.141	0.008
14	9/11/2017 9:50	9/11/2017 9:56	9/11/2017 10:01	7.1	4.95	0.021	0.102	
15	9/11/2017 9:34	9/11/2017 9:39	9/11/2017 9:42	8.1	4.95	0.004	0.014	
16	9/11/2017 9:17	9/11/2017 9:24	9/11/2017 9:28	10.6	4.95	0.318	0.021	0.007
17	9/11/2017 8:57	9/11/2017 9:03	9/11/2017 9:05	13.5	4.95	0.026	0.070	
18	9/11/2017 8:39	9/11/2017 8:47	9/11/2017 8:49	16.3	4.95	0.007	0.018	

Restrikes

Well Information

Well No.: 13
Municipal Address: [REDACTED]
Distance from Turbine Centre: 841 m

Well No.: 14
Municipal Address: [REDACTED]
Distance from Turbine Centre: 580 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time. Well 13 pump vibrations dominated data for periods of 1 to 5 minutes. "No pump" data column indicates vibration velocities exclusive of pump operating times for Well 13. Wells 13 and 14 are located approximately 87 m and 13 m from the centre line of Union Line, respectively. Vibration velocities noted above for both wells reflect maximum values induced by transient sources other than pile driving. Evaluation of acceleration time histories concluded that other transient vibrations occurring before, during and after pile driving times dominated all measurements. Data for two 10-minute time periods during which no pile driving occurred were evaluated with start times of 10:47 and 14:27 for Well 13 and 10:48 and 14:36 for Well 14 indicated a maximum velocity of 0.079 mm/s. Additional evaluation of pump operations and other transient sources for both wells is pending.

Footnotes: a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

Preliminary Vibration Monitoring Report

Turbine Location: T20

Vibration Measurements at Turbine Site

Vibration Measurements at Wells

Pile No.:	Pile Driving Times and Dates			Geophone Dist. (m)	Daily Maximum Particle Velocity (mm/s) ^b	Particle Velocity (mm/s) ^{c, d}		
	Start ^a	Rock/Till	End ^a			Well 11	Well 12	No Pump ^e
1	8/30/2017 15:30	8/30/2017 15:33	8/30/2017 15:54	25.0	5.33	0.016	NA ^e	
2	8/30/2017 18:17	8/30/2017 18:21	8/30/2017 18:29	26.0	5.33	0.005	0.008	
3	8/30/2017 18:33	8/30/2017 18:38	8/30/2017 18:45	26.3	5.33	0.003	0.004	
4	8/30/2017 17:55	8/30/2017 17:59	8/30/2017 18:10	26.0	5.33	0.004	0.005	
5	8/30/2017 17:38	8/30/2017 17:37	8/30/2017 17:49	25.0	5.33	0.004	0.855	0.022
6	8/30/2017 17:14	8/30/2017 17:19	8/30/2017 17:31	23.3	5.33	0.004	NA ^e	
7	8/30/2017 16:54	8/30/2017 16:56	8/30/2017 17:09	21.0	5.33	0.003	NA ^e	
8	8/30/2017 16:19	8/30/2017 16:24	8/30/2017 16:53	18.3	5.33	0.046	NA ^e	
9	8/30/2017 16:01	8/30/2017 16:05	8/30/2017 16:12	15.4	5.33	0.005	NA ^e	
10	8/30/2017 11:34	8/30/2017 11:38	8/30/2017 11:50	12.5	5.33	0.005	0.016	
11	8/30/2017 10:26	8/30/2017 10:29	8/30/2017 10:40	9.1	5.33	0.018	0.013	
12	8/30/2017 9:58	8/30/2017 10:02	8/30/2017 10:16	10.1	5.33	0.011	0.014	
13	8/30/2017 9:49	8/30/2017 9:44	8/30/2017 9:50	12.5	5.33	0.010	0.014	
14	8/30/2017 12:02	8/30/2017 12:04	8/30/2017 12:22	15.4	5.33	0.028	0.008	
15	8/30/2017 12:36	8/30/2017 12:39	8/30/2017 12:54	18.3	5.33	0.023	0.006	
16	8/30/2017 13:01	8/30/2017 13:05	8/30/2017 13:20	21.0	5.33	0.004	0.004	
17	8/30/2017 14:26	8/30/2017 14:29	8/30/2017 14:41	23.3	5.33	0.004	0.006	
18	8/30/2017 14:52	8/30/2017 14:56	8/30/2017 15:24	25.0	5.33	0.003	0.025	
Restrikes								
13	8/30/2017 13:23	8/30/2017 13:23	8/30/2017 13:35	12.5	5.33	0.008	0.008	

Well Information

Well No.: 11
Municipal Address: [REDACTED]
Distance from Turbine Centre: 3800 m

Well No.: 12
Municipal Address: [REDACTED]
Distance from Turbine Centre: 3962 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Vibration measurements were undertaken on August 17, 2017 at Wells 11 and 12 during water quality sampling events in the absence of pile driving within the cluster. Both pumps turned on and operated during the sampling events. Maximum vibration measurements for Well 11 were 0.016 mm/s and this pump was located within the residence approximately 40 m from the well. Maximum vibration measurements for Well 12 were 0.896 mm/s and the pump was mounted on the well casing. During pile driving on August 23, 2017, the maximum vibration measurement of the Well 12 casing was 2.4 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Data not available for Piles 1, 6, 7, 8 and 9 at Well 12 on August 30, 2017 due to battery failure in monitoring equipment. Battery was subsequently replaced. Total driving duration between till/rock start and end times noted above for Pile 1 is not representative and actual driving duration was 00:7:40 due to pauses in actual hammering. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

Footnotes: a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

NORTH KENT 1

Preliminary Vibration Monitoring Report

Turbine Location: T21

Vibration Measurements at Turbine Site

Pile Driving Times and Dates						Vibration Measurements at Wells		
Pile No.:	Start ^a	Rock/Till	End ^a	Geophone Dist. (m)	Daily Maximum Particle Velocity	Particle Velocity (mm/s) ^{c, d}		
					(mm/s) ^b	Well 11	Well 12	No Pump ^e
1	8/29/2017 12:01	8/29/2017 12:04	8/29/2017 12:14	23.7	2.79	NA ^e	0.008	
2	8/29/2017 1:27	8/29/2017 1:30	8/29/2017 1:39	25.4	2.79	0.003	0.006	
3	8/29/2017 1:44	8/29/2017 1:47	8/29/2017 1:54	26.4	2.79	0.009	0.006	
4	8/29/2017 11:20	8/29/2017 11:23	8/29/2017 11:32	26.8	2.79	0.003	0.013	
5	8/29/2017 11:05	8/29/2017 11:08	8/29/2017 11:13	26.4	2.79	NA ^e	0.013	
6	8/29/2017 8:48	8/29/2017 8:51	8/29/2017 8:59	25.4	2.79	NA ^e	0.026	
7	8/29/2017 8:28	8/29/2017 8:33	8/29/2017 8:40	23.7	2.79	NA ^e	0.005	
8	8/29/2017 8:07	8/29/2017 8:11	8/29/2017 8:19	21.5	2.79	NA ^e	0.003	
9	8/29/2017 7:51	8/29/2017 7:54	8/29/2017 7:59	18.8	2.79	0.004	0.004	
10	8/28/2017 16:40	8/28/2017 16:44	8/28/2017 16:53	15.9	3.30	0.015	0.071	
11	8/28/2017 16:11	8/28/2017 16:14	8/28/2017 16:27	13.0	3.30	0.007	1.551	0.039
12	8/28/2017 15:51	8/28/2017 15:58	8/28/2017 16:05	10.8	3.30	0.005	0.007	
13	8/28/2017 14:27	8/28/2017 14:30	8/28/2017 14:37	9.9	3.30	0.003	0.005	
14	8/28/2017 14:10	8/28/2017 14:13	8/28/2017 14:21	10.8	3.30	0.006	0.005	
15	8/28/2017 13:45	8/28/2017 13:48	8/28/2017 13:58	13.0	3.30	0.008	0.013	
16	8/28/2017 13:21	8/28/2017 13:24	8/28/2017 13:37	15.9	3.30	0.006	0.011	
17	8/28/2017 13:01	8/28/2017 13:05	8/28/2017 13:13	18.8	3.30	0.011	0.010	
18	8/29/2017 11:44	8/29/2017 11:47	8/29/2017 11:54	21.5	2.79	NA ^e	0.031	

Restrikes

Well Information

Well No.: 11
Municipal Address: [REDACTED]
Distance from Turbine Centre: 3960 m

Well No.: 12
Municipal Address: [REDACTED]
Distance from Turbine Centre: 4161 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: Vibration measurements were undertaken on August 17, 2017 at Wells 11 and 12 during water quality sampling events in the absence of pile driving within the cluster. Both pumps turned on and operated during the sampling events. Maximum vibration measurement for Well 11 was 0.016 mm/s and this pump was located within the residence approximately 40 m from the well. Maximum vibration measurement for Well 12 was 0.896 mm/s and the pump was mounted on the well casing. During pile driving on August 23, 2017, the maximum vibration measurement of the Well 12 casing was 2.4 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Data not available for Piles 1, 5, 6, 7, 8 and 18 at Well 11 on August 29, 2017 due to battery failure in monitoring equipment. Battery was subsequently replaced. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

Footnotes: a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

Preliminary Vibration Monitoring Report

Turbine Location: T28

Vibration Measurements at Turbine Site						Vibration Measurements at Wells		
Pile Driving Times and Dates				Geophone Dist. (m)	Daily Maximum Particle Velocity (mm/s) ^b	Particle Velocity (mm/s) ^{c, d}		
Pile No.:	Start ^a	Rock/Till	End ^a			Well 9	Well 10	No Pump ^e
1	8/15/2017 14:33	8/15/2017 14:41	8/15/2017 14:43	21.6	3.17	0.061	0.020	
2	8/15/2017 14:53	8/15/2017 15:04	8/15/2017 15:06	23.9	3.17	0.019	0.036	
3	8/15/2017 15:31	8/15/2017 15:42	8/15/2017 15:44	25.6	3.17	0.111	0.805	0.019
4	8/15/2017 13:23	8/15/2017 13:37	8/15/2017 13:39	26.6	3.17	0.022	0.804	0.100
5	8/15/2017 12:10	8/15/2017 12:22	8/15/2017 12:24	27.0	3.17	0.108	0.158	
6	8/15/2017 11:46	8/15/2017 11:59	8/15/2017 12:00	26.6	3.17	0.012	0.095	
7	8/15/2017 9:56	8/15/2017 10:08	8/15/2017 10:11	25.6	3.17	0.027	0.052	
8	8/15/2017 9:16	8/15/2017 9:34	8/15/2017 9:36	23.9	3.17	0.040	0.009	
9	8/15/2017 8:51	8/15/2017 9:03	8/15/2017 9:04	21.6	3.17	0.046	0.015	
10	8/15/2017 8:18	8/15/2017 8:33	8/15/2017 8:35	19.0	3.17	NA ^e	0.750	0.026
11	8/15/2017 7:45	8/15/2017 7:58	8/15/2017 8:02	16.1	3.17	NA ^e	0.007	
12	8/11/2017 13:27	8/11/2017 14:45	8/11/2017 14:46	13.2	5.59	0.812	0.014	
13	8/11/2017 12:36	8/11/2017 12:48	8/11/2017 12:50	11.0	5.59	0.054	0.006	
14	8/11/2017 12:13	8/11/2017 12:25	8/11/2017 12:27	10.1	5.59	0.055	0.112	
15	8/11/2017 11:19	8/11/2017 11:28	8/11/2017 11:30	11.0	5.59	0.244	0.015	
16	8/11/2017 11:48	8/11/2017 12:02	8/11/2017 12:03	13.2	5.59	0.183	0.007	
17	8/11/2017 10:22	8/11/2017 11:06	8/11/2017 11:07	16.1	5.59	0.686	0.034	
18	8/15/2017 13:56	8/15/2017 14:09	8/15/2017 14:10	19.0	3.17	0.015	0.705	0.052
Restrikes								
2	8/16/2017 8:19	8/16/2017 8:19	8/16/2017 8:23	23.9	2.65	0.017	0.029	

Well Information

Well No.: 9
Municipal Address: [REDACTED]
Distance from Turbine Centre: 2568 m

Well No.: 10
Municipal Address: [REDACTED]
Distance from Turbine Centre: 1769 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Data for Well 9 was not available for August 15, 2017 during driving of piles 10 and 11 while awaiting site security changes implemented following an incident at the Well 9 property the evening of August 14, 2017. Highlighted values for Well 9 on August 11, 2017 are higher than and inconsistent with other measurements during pile driving at the T28 site. On August 11, 2017, construction activities were underway along the entrance road to T32, located as close as about 100 m from Well 9. These activities included: hammering, movements of large construction equipment (e.g., loaders, dump trucks, excavators, "stone throwers"), and equipment travelled on access road site without construction mats, equipment operating on T32 access resulted in "pounding" sounds. The Well 9 area is also subject to heavy passing traffic on Countryview Line (74 m from well) including: fuel trucks, loaded dump trucks, large transport trucks, a bus, and cranes/boom trucks among other vehicles. Further analysis of Well 9 vibration data was undertaken for 10 minute periods on August 11, 2017 during which pile driving was not occurring between 08:32:00 and 08:42:00, 09:12:00 and 09:22:00, 11:22:00 and 11:32:00, and 13:48:00 and 13:58:00. During these periods the maximum velocities (regardless of direction) of the Well 9 casing ranged from 0.011 to 1.2 mm/s. Data shown for Well 9 during driving of Piles 12, 15, 16 and 17 (highlighted) are considered unrepresentative of pile driving and associated with other vibration sources. The piston pump for Well 9 is within the barn approximately 4 to 5 m from the well location. When the Well 9 pump was deliberately operated on September 8, 2017, in the absence of pile driving, well casing velocities were up to 0.04 mm/s. When the pump for Well 10 was operating, well casing vibrations of as much as 1.25 mm/s were measured. "No pump" data is provided to indicate measurements exclusive of data consistent with typical pump operations. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

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Preliminary Vibration Monitoring Report

Footnotes: a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

Preliminary Vibration Monitoring Report

Turbine Location: T30

Vibration Measurements at Turbine Site					Vibration Measurements at Wells			
Pile Driving Times and Dates					Daily Maximum Particle Velocity	Particle Velocity (mm/s) ^{c, d}		
Pile No.:	Start ^a	Rock/Till	End ^a	Geophone Dist. (m)	(mm/s) ^b	Well 9	Well 10	No Pump ^e
1	8/4/2017 14:24	8/4/2017 14:42	8/4/2017 15:01	23.0	4.70	0.054	0.815	0.014
1A	8/9/2017 9:30	8/9/2017 9:51	8/9/2017 9:58	23.5	2.41	0.080	0.935	0.027
2	8/8/2017 8:42	8/8/2017 8:52	8/8/2017 9:03	24.6	3.17	0.061	0.049	
3	8/8/2017 9:17	8/8/2017 9:25	8/8/2017 9:35	25.6	3.17	0.041	0.883	0.009
4	8/8/2017 7:49	8/8/2017 8:02	8/8/2017 8:10	26.0	3.17	0.035	1.251	0.036
5	8/4/2017 16:24	8/4/2017 16:32	8/4/2017 16:40	25.6	4.70	0.061	0.007	
6	8/4/2017 15:57	8/4/2017 16:03	8/4/2017 16:11	24.6	4.70	0.059	0.003	
7	8/4/2017 15:24	8/4/2017 15:34	8/4/2017 15:39	23.0	4.70	0.082	0.028	
8	8/4/2017 10:57	8/4/2017 11:03	8/4/2017 11:06	20.8	4.70	0.032	0.540	0.033
9	8/3/2017 13:33	8/3/2017 13:38	8/3/2017 13:46	18.1	5.33	0.076	0.088	
10	8/3/2017 13:07	8/3/2017 13:16	8/3/2017 13:20	15.2	5.33	0.088	0.014	
11	8/3/2017 11:46	8/3/2017 11:52	8/3/2017 11:56	9.1	5.33	0.029	0.007	
12	8/3/2017 11:25	8/3/2017 11:29	8/3/2017 11:34	10.1	5.33	0.066	0.005	
13	8/3/2017 10:44	8/3/2017 10:53	8/3/2017 10:59	12.4	5.33	0.059	0.876	0.005
14	8/3/2017 14:04	8/3/2017 14:11	8/3/2017 14:19	15.2	5.33	0.061	0.023	
15	8/3/2017 14:34	8/3/2017 14:47	8/3/2017 14:50	18.1	5.33	0.032	0.005	
16	8/4/2017 8:50	8/4/2017 8:55	8/4/2017 9:08	20.8	4.70	0.048	0.032	
17	8/4/2017 9:32	8/4/2017 9:38	8/4/2017 9:43	23.0	4.70	0.051	0.002	
18	8/4/2017 10:17	8/4/2017 10:33	8/4/2017 10:36	24.6	4.70	0.024	0.004	
Restrikes								
15C	8/4/2017 8:15	8/4/2017 8:15	8/4/2017 8:21	18.1	4.70	0.044	0.022	
1	8/8/2017 15:19	8/8/2017 15:19	8/8/2017 15:25	23.0	3.17	0.080	0.006	
5	8/8/2017 8:15	8/8/2017 8:15	8/8/2017 8:20	25.6	3.17	0.056	1.016	0.006
6	8/8/2017 9:40	8/8/2017 9:40	8/8/2017 9:41	24.6	3.17	0.041	1.116	0.146

Well Information

Well No.: 9
Municipal Address: [REDACTED]
Distance from Turbine Centre: 1808 m

Well No.: 10
Municipal Address: [REDACTED]
Distance from Turbine Centre: 1385 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: Piles noted with "A" represent piles installed to replace similarly-numbered piles. After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes" (where applicable). Piles noted with "C" were those that were started on one day and continued on a separate day; therefore, additional well monitoring data is presented for the time periods during which piling continued on till/rock. When the pump for Well 10 was operating, well casing vibrations of as much as 1.25 mm/s were measured. "No pump" data is provided to indicate measurements exclusive of data consistent with typical pump operations. Total driving duration between till/rock start and end times noted above for Pile 1 is not representative and actual driving duration was 00:11:50 due to pauses in actual hammering. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

Footnotes: a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

Preliminary Vibration Monitoring Report

Turbine Location: T31

Vibration Measurements at Turbine Site					Vibration Measurements at Wells		
Pile Driving Times and Dates					Daily Maximum Particle Velocity	Particle Velocity (mm/s) ^{c, d}	
Pile No.:	Start ^a	Rock/Till	End ^a	Geophone Dist. (m)	(mm/s) ^b	Well 7	Well 8
1	7/17/2017 13:18	7/17/2017 13:24	7/17/2017 13:26	8.1	2.92	0.042	0.028
2	7/17/2017 14:46	7/17/2017 14:52	7/17/2017 14:54	9.1	2.92	0.038	0.034
3	7/18/2017 7:39	7/18/2017 7:47	7/18/2017 7:49	11.4	4.19	0.016	0.075
4	7/18/2017 8:03	7/18/2017 8:10	7/18/2017 8:13	14.3	4.19	0.023	0.005
5	7/17/2017 12:56	7/17/2017 13:01	7/17/2017 13:05	17.2	2.92	0.020	0.071
6	7/17/2017 11:49	7/17/2017 11:53	7/17/2017 11:54	19.8	2.92	0.100	0.099
7	7/17/2017 11:25	7/17/2017 11:30	7/17/2017 11:35	22.0	2.92	0.014	0.028
8	7/17/2017 10:25	7/17/2017 10:31	7/17/2017 10:36	23.6	2.92	0.044	0.028
9	7/17/2017 8:03	7/17/2017 8:09	7/17/2017 8:30	24.6	2.92	0.011	0.041
10	NA	NA	NA	25.0		NA	NA
11	7/14/2017 16:18	7/14/2017 16:25	7/14/2017 16:28	24.6	5.46	0.041	NA
12	7/13/2017 15:38	7/13/2017 15:44	7/13/2017 15:45	23.6	5.08	0.037	0.034
13	7/13/2017 16:12	7/13/2017 16:26	7/13/2017 16:30	24.6	5.08	0.012	0.015
14	7/14/2017 8:22	7/14/2017 8:47	7/14/2017 8:48	25.0	5.46	0.072	0.023
15	7/13/2017 16:56	7/13/2017 17:06	7/13/2017 17:08	24.6	5.08	0.156	0.020
16	7/14/2017 11:18	7/14/2017 11:23	7/14/2017 11:29	23.6	5.46	0.044	0.034
17	7/14/2017 11:40	7/14/2017 11:48	7/14/2017 11:51	22.0	5.46	0.074	0.075
18	7/14/2017 12:10	7/14/2017 12:16	7/14/2017 12:21	19.8	5.46	0.050	0.041

Well Information

Well No.: 7

Municipal Address:

Distance from Turbine Centre: 636 m

Well No.: 8

Municipal Address:

Distance from Turbine Centre: 2497 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: On July 14, 2017 at about 14:00, Golder was informed that piling operations at T31 were concluded. At 15:45 instruments were therefore turned off at Well 8 in preparation for removal for the day. Piling resumed at approximately 16:15. As a result, data was not captured for Wells 7 or 8 when driving Pile 10 and Well 8 when driving Pile 11. Well monitoring undertaken during periods of time when pile driving was not occurring measured maximum particle velocities of as much as 0.37 mm/s at Well 7. Total driving duration between till/rock start and end times noted above for Pile 9 is not representative and actual driving duration was 00:04:00 due to pauses in actual hammering. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

Footnotes: a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction.

Preliminary Vibration Monitoring Report

Turbine Location: T32

Vibration Measurements at Turbine Site

Vibration Measurements at Wells

Pile Driving Times and Dates				Geophone Dist. (m)	Daily Maximum Particle Velocity (mm/s) ^b	Particle Velocity (mm/s) ^{c, d}		
Pile No.:	Start ^a	Rock/Till	End ^a			Well 9	Well 10	No Pump ^e
1	8/11/2017 14:41	8/11/2017 14:43	8/11/2017 15:01	25.0	3.43	0.069	0.020	
2	8/14/2017 15:43	8/14/2017 15:46	8/14/2017 16:19	23.3	4.83	0.050	0.013	
3	8/14/2017 16:25	8/14/2017 16:28	8/14/2017 16:57	21.1	4.83	0.045	0.045	
4	8/14/2017 14:51	8/14/2017 14:55	8/14/2017 15:21	18.4	4.83	0.046	0.697	
5	8/14/2017 13:52	8/14/2017 13:55	8/14/2017 14:11	15.5	4.83	0.059	0.035	
6	8/14/2017 13:12	8/14/2017 13:15	8/14/2017 13:33	12.7	4.83	0.055	0.009	
7	8/14/2017 11:40	8/14/2017 11:42	8/14/2017 12:18	10.4	4.83	0.062	0.049	
8	8/14/2017 11:20	8/14/2017 11:23	8/14/2017 11:33	9.5	4.83	0.050	0.880	
9	8/14/2017 7:47	8/14/2017 7:50	8/14/2017 7:54	10.4	4.83	0.041	0.733	
10	8/14/2017 10:59	8/14/2017 11:04	8/14/2017 11:12	12.7	4.83	0.028	0.010	
11	8/11/2017 10:53	8/11/2017 10:56	8/11/2017 11:00	15.5	3.43	1.090	0.049	
12	8/11/2017 10:42	8/11/2017 10:44	8/11/2017 10:47	18.4	3.43	0.871	0.014	
13	8/11/2017 10:28	8/11/2017 10:30	8/11/2017 10:34	21.1	3.43	1.346	0.738	0.005
14	8/11/2017 10:14	8/11/2017 10:19	8/11/2017 10:21	23.3	3.43	0.068	0.051	
15	8/11/2017 9:00	8/11/2017 9:03	8/11/2017 9:07	25.0	3.43	0.037	0.764	0.004
16	8/11/2017 11:07	8/11/2017 11:10	8/11/2017 11:14	26.0	3.43	0.229	0.034	
17	8/11/2017 13:12	8/11/2017 13:14	8/11/2017 13:19	26.4	3.43	0.230	0.684	0.009
18	8/11/2017 13:26	8/11/2017 13:28	8/11/2017 13:42	26.0	3.43	0.135	0.713	0.004

Restrikes

Well Information

Well No.: 9

Municipal Address:

Distance from Turbine Centre: 680 m

Well No.: 10

Municipal Address:

Distance from Turbine Centre: 1122 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: Highlighted values for Well 9 on August 11, 2017 are higher than and inconsistent with other measurements during pile driving at the T32 site. On August 11, 2017, construction activities were underway along the entrance road to T32, located as close as about 100 m from the well. These activities included: hammering, movements of large construction equipment (e.g., loaders, dump trucks, excavators, aggregate delivery equipment), and equipment travelled on site access road without construction mats, equipment operating on T32 access road resulted in "pounding" sounds. Well 9 area is subject to heavy passing traffic on Countryview Line (74 m from well) including: fuel trucks, loaded dump trucks, large transport trucks, a bus, and cranes/boom trucks among other vehicles. Further analysis of Well 9 vibration data was undertaken for 10 minute periods on August 11, 2017 during which pile driving was not occurring between 08:32:00 and 08:42:00, 09:12:00 and 09:22:00, 11:22:00 and 11:32:00, and 13:48:00 and 13:58:00. During these periods, the maximum velocities (regardless of direction) of the Well 9 casing ranged from 0.011 to 1.2 mm/s. Data shown for Well 9 during driving of Piles 12, 15, 16 and 17 (highlighted) are considered unrepresentative of pile driving and associated with other vibration sources. The piston pump for Well 9 is within the barn approximately 4 to 5 m from the well location. When the Well 9 pump was deliberately operated on September 8, 2017, in the absence of pile driving, well casing velocities were up to 0.04 mm/s. When the pump for Well 10 was operating, well casing vibrations of as much as 1.25 mm/s were measured. "No pump" data is provided to indicate measurements exclusive of data consistent with typical pump operations. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

Footnotes: a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

Preliminary Vibration Monitoring Report

Turbine Location: T33

Vibration Measurements at Turbine Site

Vibration Measurements at Wells

Pile Driving Times and Dates					Daily Maximum Particle Velocity (mm/s) ^b	Particle Velocity (mm/s) ^{c, d}		
Pile No.:	Start ^a	Rock/Till	End ^a	Geophone Dist. (m)		Well 3	Well 4	No Pump ^e
1	9/5/2017 13:10	9/5/2017 13:16	9/5/2017 13:25	10.9	5.3	0.015	0.118	
2	9/5/2017 13:46	9/5/2017 13:55	9/5/2017 14:03	11.8	5.3	0.011	0.138	
3	9/5/2017 14:11	9/5/2017 14:20	9/5/2017 14:27	14.0	5.3	0.056	0.174	
4	9/5/2017 14:38	9/5/2017 14:46	9/5/2017 14:54	16.8	5.3	0.035	0.082	
5	9/5/2017 15:05	9/5/2017 15:13	9/5/2017 15:18	19.7	5.3	0.049	0.137	
6	9/5/2017 15:34	9/5/2017 15:44	9/5/2017 15:48	22.4	5.3	0.009	0.072	
7	9/5/2017 17:02	9/5/2017 17:10	9/5/2017 17:10	24.6	5.3	0.030	0.298	
8	9/5/2017 17:32	9/5/2017 17:41	9/5/2017 17:49	26.3	5.3	0.036	0.131	
9	9/5/2017 18:14	9/5/2017 18:21	9/5/2017 18:28	27.4	5.3	0.034	0.083	
10	9/6/2017 9:30	9/6/2017 9:47	9/6/2017 9:53	27.8	3.2	0.004	0.243	
11	9/6/2017 10:09	9/6/2017 10:25	9/6/2017 10:35	27.4	3.2	0.004	0.089	
12	9/6/2017 12:03	9/6/2017 12:16	9/6/2017 12:26	26.3	3.2	0.005	0.179	
13	9/6/2017 12:58	9/6/2017 13:08	9/6/2017 13:16	24.6	3.2	0.003	0.162	
14	9/6/2017 13:33	9/6/2017 13:43	9/6/2017 13:58	22.4	3.2	0.004	0.161	
15	9/6/2017 14:37	9/6/2017 14:45	9/6/2017 14:54	19.7	3.2	0.005	4.987	
16	9/6/2017 16:01	9/6/2017 16:08	9/6/2017 16:20	16.8	3.2	0.006	0.277	
17	9/6/2017 15:29	9/6/2017 15:35	9/6/2017 15:45	14.0	3.2	0.003	0.175	
18	9/6/2017 14:13	9/6/2017 14:24	9/6/2017 14:36	11.8	3.2	0.004	0.622	
Restrikes								
6	9/6/2017 18:15	9/6/2017 18:15	9/6/2017 18:23	22.4	3.2	0.009	4.858	
5	9/6/2017 17:02	9/6/2017 17:02	9/6/2017 17:03	19.7	3.2	0.023	0.129	

Well Information

Well No.: 3
Municipal Address: [REDACTED]
Distance from Turbine Centre: 1778 m

Well No.: 4
Municipal Address: [REDACTED]
Distance from Turbine Centre: 2080 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time. During vibration monitoring on September 5, 2017, a forklift operated close to the geophone between 16:00:00 and 16:30:00 and triggered a maximum peak particle velocity of 6.2 mm/s. Value shown above excludes the peak measurement triggered by the forklift. On September 5, 2017, tractors, harvest haul trucks and other equipment travelled through Well 3 property frequently from 12:48 to 15:55 and occasionally thereafter until 16:50. On September 5, 2017, St. Clair Road traffic passing at 78 m from Well 4 was observed to include large tractor-trailers, concrete mixers and dump trucks at a rate of about 1 heavy vehicle every 1.5 to 2 minutes. Passenger vehicle movements on the Well 4 property passed and were parked near the well at 12:10, 14:40, 14:47, 15:06, 15:17, 15:42, 16:16, 16:35 and 19:02. On September 6, 2017, heavy vehicle traffic near Well 4 was similar to September 5, 2017. Combine harvesting was on-going as close as 25 to 30 m from Well 4, starting at 8:53 and continuing to after 14:30 on September 6, 2017. Passenger vehicle traffic on September 6, 2017 adjacent to Well 4 on the property was noted at 7:41, 10:40 - 10:45, 10:56 - 11:04, 11:46 - 11:52, 12:57 - 12:59, 13:22, 14:31, 14:36, 16:35, 16:42, 16:49, and 18:34. Various individuals were at and in the well shed at 16:35 to 16:54. Prior to September 6, 2017 observations by Golder personnel indicated that a pump was not connected at Well 4. During the afternoon of September 6, 2017 a pump was connected and operational. From 17:02 to 17:18 the newly connected Well 4 pump was cycled on and off, operating for periods of 1 to more than 7 minutes. The owner was physically working on Well 4 after 17:18 and returning to well shed frequently. All data highlighted above is considered to have been significantly influenced by near-well activities, particularly work directly related to the Well 4 pump and shed.

Footnotes: a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

Preliminary Vibration Monitoring Report

Turbine Location: T35

Vibration Measurements at Turbine Site						Vibration Measurements at Wells		
Pile No.:	Pile Driving Times and Dates			Geophone Dist. (m)	Daily Maximum Particle Velocity		Particle Velocity (mm/s) ^{c, d}	
	Start ^a	Rock/Till	End ^a		(mm/s) ^b		Well 5	Well 6
							No Pump ^e	
1	6/21/2017 9:16	6/21/2017 9:31	6/21/2017 9:58	25.3	4.32	0.005	0.011	
1A	7/4/2017 14:09	7/4/2017 14:15	7/4/2017 14:20	25.8	4.70	0.011	0.085	
2	6/28/2017 11:40	6/28/2017 11:50	6/28/2017 11:56	27.0	6.86	0.004	0.002	
3	6/29/2017 11:15	6/29/2017 11:26	6/29/2017 11:37	28.1	4.70	0.004	0.080	0.009
4	6/29/2017 11:45	6/29/2017 12:28	6/29/2017 12:35	28.4	4.70	0.002	0.003	
5	6/29/2017 10:36	6/29/2017 10:53	6/29/2017 10:59	28.1	4.70	0.003	0.008	
6	6/29/2017 9:49	6/29/2017 10:09	6/29/2017 10:19	27.0	4.70	0.002	0.017	
7	6/28/2017 16:45	6/28/2017 16:55	6/28/2017 16:59	25.3	6.86	0.002	0.006	
8	6/28/2017 16:19	6/28/2017 16:28	6/28/2017 16:36	23.0	6.86	0.004	0.008	
9	6/29/2017 15:55	6/29/2017 16:03	6/29/2017 16:09	20.3	4.70	0.003	0.011	
10	6/28/2017 15:23	6/28/2017 15:35	6/28/2017 15:43	17.4	6.86	0.002	0.010	
11	6/28/2017 14:34	6/28/2017 14:52	6/28/2017 14:56	14.6	6.86	0.002	0.081	0.011
12	6/28/2017 14:04	6/28/2017 14:19	6/28/2017 14:23	12.4	6.86	0.003	0.016	
13	6/26/2017 16:52	6/26/2017 17:15	6/26/2017 17:22	11.6	4.06	0.004	0.093	0.015
13A	6/30/2017 10:53	6/30/2017 11:24	6/30/2017 11:36	11.6	4.19	0.001	0.093	0.015
14	6/28/2017 8:34	6/28/2017 8:59	6/28/2017 9:16	12.4	6.86	0.005	0.110	0.023
15	6/26/2017 16:03	6/26/2017 16:26	6/26/2017 16:28	14.6	4.06	0.002	0.009	
15A	7/4/2017 12:54	7/4/2017 13:00	7/4/2017 13:21	15.1	4.70	0.008	0.130	
16	6/28/2017 9:32	6/28/2017 9:52	6/28/2017 9:57	17.4	6.86	0.002	0.004	
17	6/26/2017 7:45	6/26/2017 8:19	6/26/2017 8:20	20.3	4.06	0.012	0.002	
17A	7/4/2017 13:39	7/4/2017 13:45	7/4/2017 13:51	20.8	4.70	0.004	0.105	
18	6/28/2017 10:40	6/28/2017 10:55	6/28/2017 11:25	23.0	6.86	0.004	0.015	
Restrikes								
1	6/26/2017 7:39	6/26/2017 7:39	6/26/2017 7:39	25.3	4.06	0.007	0.007	
17	6/28/2017 12:54	6/28/2017 12:54	6/28/2017 13:14	20.3	6.86	0.004	0.014	
10	6/29/2017 13:31	6/29/2017 13:31	6/29/2017 13:32	17.4	4.70	0.006	0.004	
13	6/29/2017 13:37	6/29/2017 13:37	6/29/2017 13:42	11.6	4.70	0.004	0.002	
14	6/29/2017 13:47	6/29/2017 13:47	6/29/2017 13:50	12.4	4.70	0.006	0.003	
16	6/29/2017 13:54	6/29/2017 13:54	6/29/2017 13:56	17.4	4.70	0.005	0.003	
15	6/29/2017 14:20	6/29/2017 14:20	6/29/2017 14:25	14.6	4.70	0.008	0.011	
PDA								
13A	7/6/2017 10:06	7/6/2017 10:06	7/6/2017 10:15	12.1	5.21	0.005	0.138	
13	7/6/2017 11:05	7/6/2017 11:05	7/6/2017 11:23	11.6	5.21	0.006	0.219	
15A	7/6/2017 11:39	7/6/2017 11:39	7/6/2017 11:40	15.1	5.21	0.009	0.130	
17A	7/6/2017 11:55	7/6/2017 11:55	7/6/2017 11:56	20.8	5.21	0.010	0.061	
1A	7/6/2017 12:18	7/6/2017 12:18	7/6/2017 12:18	25.8	5.21	0.011	0.084	

Well Information

Well No.: 5

Municipal Address:

Distance from Turbine Centre: 623 m

Well No.: 6

Municipal Address:

Distance from Turbine Centre: 880 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: Tractor was observed operating frequently near Well 6. Water pump was observed cycling on and off during pile driving operations and remaining on for periods of 2 to 4 minutes. When pump was operating, casing at Well 6 exhibited particle velocities in the range of 0.08 to 0.12 mm/s and dominated analysis of data. Pile restrike events were of short duration with the following total number of hammer blows shown in parentheses: Pile 1 (20), Pile 10 (5 to 7), 13 (205), 14 (140), 16 (51), 15 (214). Pile 17 experienced 446 hammer blows over a period of 9 minutes. Piles noted with PDA indicate restrike events during which pile dynamics analyzer monitoring was completed. Piles noted with "A" represent piles installed to replace similarly-numbered piles. After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Monitoring of deliberate pump operation at Well 6 on July 13, 2017, during a period when no pile driving was occurring, measured maximum particle velocities of 0.08 to 0.8 mm/s. Where total driving duration between till/rock start and end times noted above is not representative, actual driving duration is shown in parentheses in minutes and seconds: 13A(10:00), 15A(6:24), 17 restrike (14:00), 13PDA(6:20). Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

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Preliminary Vibration Monitoring Report

Footnotes: a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

Preliminary Vibration Monitoring Report

Turbine Location: T36

Vibration Measurements at Turbine Site						Vibration Measurements at Wells		
Pile No.:	Pile Driving Times and Dates			Geophone Dist. (m)	Daily Maximum Particle Velocity		Particle Velocity (mm/s) ^{c, d}	
	Start ^a	Rock/Till	End ^a		(mm/s) ^b		Well 5	Well 6
							No Pump ^e	
1	7/26/2017 10:33	7/26/2017 10:38	7/26/2017 10:48	23.3	7.87		0.005	0.086
2	7/26/2017 18:16	7/26/2017 18:21	7/26/2017 18:28	21.1	7.87		0.003	0.016
3	7/26/2017 19:24	7/26/2017 19:28	7/26/2017 19:42	18.4	7.87		0.002	0.005
4	7/26/2017 18:37	7/26/2017 19:07	7/26/2017 19:19	15.5	7.87		0.002	0.027
5	7/26/2017 17:59	7/26/2017 18:04	7/26/2017 18:10	12.7	7.87		0.012	0.016
6	7/26/2017 17:30	7/26/2017 17:34	7/26/2017 17:44	10.4	7.87		0.004	0.032
7	7/26/2017 17:10	7/26/2017 17:13	7/26/2017 17:23	9.5	7.87		0.010	0.044
8	7/26/2017 16:41	7/26/2017 16:45	7/26/2017 16:56	10.4	7.87		0.007	0.038
9	7/26/2017 16:19	7/26/2017 16:23	7/26/2017 16:33	12.7	7.87		0.004	0.010
10	7/26/2017 15:48	7/26/2017 15:51	7/26/2017 16:03	15.5	7.87		0.005	0.070
11	7/26/2017 15:12	7/26/2017 15:15	7/26/2017 15:23	18.4	7.87		0.004	0.045
12	7/26/2017 14:32	7/26/2017 14:45	7/26/2017 14:57	21.1	7.87		0.005	0.048
13	7/26/2017 14:15	7/26/2017 14:21	7/26/2017 14:28	23.3	7.87		0.014	0.018
14	7/26/2017 13:58	7/26/2017 14:03	7/26/2017 14:08	25.0	7.87		0.009	0.031
15	7/26/2017 13:16	7/26/2017 13:20	7/26/2017 13:32	26.0	7.87		0.005	0.111
16	7/26/2017 12:48	7/26/2017 12:53	7/26/2017 13:05	26.4	7.87		0.011	0.038
17	7/26/2017 11:41	7/26/2017 11:47	7/26/2017 11:56	26.0	7.87		0.005	0.021
18	7/26/2017 11:08	7/26/2017 11:12	7/26/2017 11:22	25.0	7.87		0.006	0.068
Restrikes								
16	7/27/2017 7:36	7/27/2017 7:36	7/27/2017 7:37	26.4	0.89		0.003	0.437
								0.029

Well Information

Well No.: 5
Municipal Address: [REDACTED]
Distance from Turbine Centre: 4201 m

Well No.: 6
Municipal Address: [REDACTED]
Distance from Turbine Centre: 3380 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: A single restrike event occurred on the day following with a total of 24 hammer blows on Pile 16 during a period of approximately 65 seconds. After installation, one pile was struck again with the hammer to demonstrate resistance performance and this event is noted under "restrikes". Water pump was observed cycling on and off during pile driving operations and remaining on for periods of 2 to 4 minutes. When pump was operating during pile driving, casing at Well 6 exhibited particle velocities of up to 0.44 mm/s and this dominated analysis of data. Monitoring of deliberate pump operation at Well 6 on July 13, 2017, during a period when no pile driving was occurring, measured maximum particle velocities of 0.08 to 0.8 mm/s. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

Footnotes: a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

Preliminary Vibration Monitoring Report

Turbine Location: T43

Vibration Measurements at Turbine Site						Vibration Measurements at Wells		
Pile Driving Times and Dates						Particle Velocity (mm/s) ^{c, d}		
Pile No.:	Start ^a	Rock/Till	End ^a	Geophone Dist. (m)	Daily Maximum Particle Velocity (mm/s) ^b	Well 11	Well 12	No Pump ^e
1	8/18/2017 12:35	8/18/2017 12:45	8/18/2017 12:52	24.8	5.59	0.006	0.008	
2	8/18/2017 13:01	8/18/2017 13:12	8/18/2017 13:20	23.8	5.59	0.006	0.007	
3	8/21/2017 8:28	8/21/2017 8:38	8/21/2017 8:48	22.2	3.18	0.010	0.007	
4	8/21/2017 12:47	8/21/2017 12:59	8/21/2017 13:10	20.0	3.18	0.007	0.006	
5	8/21/2017 9:03	8/21/2017 9:16	8/21/2017 9:23	17.4	3.18	0.006	1.468	0.009
6	8/21/2017 7:56	8/21/2017 8:08	8/21/2017 8:17	14.5	3.18	0.024	0.024	
7	8/18/2017 14:32	8/18/2017 14:43	8/18/2017 14:50	11.6	3.18	0.006	0.006	
8	8/18/2017 13:37	8/18/2017 13:49	8/18/2017 13:57	9.3	3.18	0.007	0.005	
9	8/15/2017 15:09	8/15/2017 15:18	8/15/2017 15:27	8.3	7.37	0.086	0.005	
10	8/15/2017 13:21	8/15/2017 13:28	8/15/2017 13:37	9.3	7.37	0.004	0.002	
11	8/15/2017 12:22	8/15/2017 12:34	8/15/2017 12:35	11.6	7.37	0.002	0.006	
12	8/15/2017 11:58	8/15/2017 12:10	8/15/2017 12:13	14.5	7.37	0.018	0.018	
13	8/15/2017 9:19	8/15/2017 9:42	8/15/2017 11:40	17.4	7.37	0.003	0.002	
14	8/15/2017 15:46	8/15/2017 15:57	8/15/2017 16:10	20.0	7.37	0.006	0.013	
15	8/18/2017 9:17	8/18/2017 9:23	8/18/2017 9:31	22.2	5.59	0.005	0.009	
16	8/18/2017 9:43	8/18/2017 9:50	8/18/2017 9:59	23.8	5.59	0.012	0.009	
17	8/18/2017 10:10	8/18/2017 10:17	8/18/2017 10:28	24.8	5.59	0.004	0.018	
18	8/18/2017 11:45	8/18/2017 12:02	8/18/2017 12:21	25.2	5.59	0.008	0.004	
Restrikes								
14	8/21/2017 10:43	8/21/2017 10:43	8/21/2017 10:43	20.0	3.18	0.012	0.010	
16(1)	8/21/2017 10:30	8/21/2017 10:30	8/21/2017 10:30	23.8	3.18	0.011	0.010	
16(2)	8/21/2017 11:52	8/21/2017 11:52	8/21/2017 11:54	22.2	3.18	0.005	0.029	

Well Information

Well No.: 11

Municipal Address:

Distance from Turbine Centre: 4092 m

Well No.: 12

Municipal Address:

Distance from Turbine Centre: 4359 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Vibration measurements were undertaken on August 17, 2017 at Wells 11 and 12 during water quality sampling events in the absence of pile driving within the cluster. Both pumps turned on and operated during the sampling events. Maximum vibration measurements for Well 11 were 0.016 mm/s and this pump was located within the residence approximately 40 m from the well. Maximum vibration measurements for Well 12 were 0.896 mm/s and the pump was mounted on the well casing. During pile driving for turbine T3, on August 23, 2017, the maximum vibration measurement of the Well 12 casing was 2.4 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Note that driving/restriking of some piles occurred in relatively rapid succession and, therefore, the vibration measurement data for the 10 minute periods of analysis are applicable to multiple piles. Driving of pile 13 was started and stopped on multiple occasions because of problems with fuel pump resulting in a total of approximately 88 minutes of standby between driving intervals for a total driving time on till/rock of 14:45 (minutes:seconds). Pile 18 total driving time on till/rock was 8:46 (minutes:seconds) due to intermittent stops and starts. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

Footnotes: a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

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Preliminary Vibration Monitoring Report

Turbine Location: T45

Vibration Measurements at Turbine Site						Vibration Measurements at Wells		
Pile Driving Times and Dates					Daily Maximum Particle Velocity	Particle Velocity (mm/s) ^{c, d}		
Pile No.:	Start ^a	Rock/Till	End ^a	Geophone Dist. (m)	(mm/s) ^b	Well 11	Well 12	No Pump ^e
1	8/23/2017 11:47	8/23/2017 11:53	8/23/2017 12:18	14.8	7.75	0.025	0.010	
2	8/23/2017 14:20	8/23/2017 14:27	8/23/2017 14:41	12.0	7.75	0.024	NA ^e	
3	8/23/2017 15:10	8/23/2017 15:17	8/23/2017 15:27	9.6	7.75	0.017	0.005	
4	8/23/2017 16:49	8/23/2017 16:55	8/23/2017 17:05	8.7	7.75	0.008	1.148	
5	8/23/2017 17:22	8/23/2017 17:30	8/23/2017 17:44	9.6	7.75	0.011	0.007	
6	8/23/2017 10:50	8/23/2017 11:00	8/23/2017 11:16	12.0	7.75	0.018	0.016	
7	8/24/2017 8:30	8/24/2017 8:38	8/24/2017 8:47	14.8	3.30	0.014	0.014	
8	8/24/2017 9:05	8/24/2017 9:14	8/24/2017 9:21	17.7	3.30	0.021	0.040	
9	8/24/2017 9:36	8/24/2017 9:44	8/24/2017 10:48	20.4	3.30	0.018	1.511	
10	8/23/2017 12:49	8/23/2017 12:58	8/23/2017 13:15	22.6	7.75	0.009	0.005	
11	8/24/2017 13:32	8/24/2017 13:42	8/24/2017 13:48	24.2	3.30	0.004	0.018	
12	8/24/2017 15:06	8/24/2017 15:15	8/24/2017 15:23	25.2	3.30	0.007	0.008	
13	8/24/2017 15:35	8/24/2017 15:44	8/24/2017 15:53	25.6	3.30	0.026	0.034	
14	8/24/2017 16:05	8/24/2017 16:14	8/24/2017 16:22	25.2	3.30	0.012	0.061	
15	8/24/2017 16:40	8/24/2017 16:46	8/24/2017 16:55	24.2	3.30	0.015	0.007	
16	8/24/2017 17:11	8/24/2017 17:18	8/24/2017 17:24	22.6	3.30	0.012	0.004	
17	8/24/2017 17:33	8/24/2017 17:39	8/24/2017 17:45	20.4	3.30	0.006	0.009	
18	8/24/2017 17:57	8/24/2017 18:08	8/24/2017 18:12	17.7	3.30	0.005	0.006	
Restrikes								
6	8/23/2017 13:28	8/23/2017 13:28	8/23/2017 13:29	12.0	7.75	0.043	0.017	
1	8/23/2017 13:13	8/23/2017 13:13	8/23/2017 13:13	14.8	7.75	0.009	0.005	
15	8/25/2017 7:45	8/25/2017 7:45	8/25/2017 7:47	24.2	5.97	0.015	0.032	
16	8/25/2017 9:11	8/25/2017 9:11	8/25/2017 9:13	22.6	5.97	0.007	2.335	0.008
17	8/25/2017 9:03	8/25/2017 9:03	8/25/2017 9:06	20.4	5.97	0.007	0.019	
18	8/25/2017 8:51	8/25/2017 8:51	8/25/2017 8:55	17.7	5.97	0.011	0.011	
1	8/25/2017 11:44	8/25/2017 11:44	8/25/2017 11:45	14.8	5.97	0.013	0.037	
12	8/25/2017 9:22	8/25/2017 9:22	8/25/2017 9:25	25.2	5.97	0.024	0.010	
18	8/25/2017 9:16	8/25/2017 9:16	8/25/2017 9:18	17.7	5.97	0.011	0.011	
4	8/25/2017 8:43	8/25/2017 8:43	8/25/2017 8:45	8.7	5.97	0.013	0.007	
5	8/25/2017 8:36	8/25/2017 8:36	8/25/2017 8:37	9.6	5.97	0.013	0.013	
7	8/25/2017 8:30	8/25/2017 8:30	8/25/2017 8:32	14.8	5.97	0.006	0.028	
8	8/25/2017 8:25	8/25/2017 8:25	8/25/2017 8:26	17.7	5.97	0.006	0.018	
10	8/25/2017 9:28	8/25/2017 9:28	8/25/2017 10:19	22.6	5.97	0.021	0.011	
13	8/25/2017 7:53	8/25/2017 7:54	8/25/2017 7:59	25.6	5.97	0.013	0.007	
9	8/25/2017 8:09	8/25/2017 8:09	8/25/2017 8:19	20.4	5.97	0.028	0.010	
11	8/25/2017 8:03	8/25/2017 8:03	8/25/2017 8:05	24.2	5.97	0.008	0.024	
Spliced								
13	8/30/2017 11:06	8/30/2017 11:06	8/30/2017 11:07	25.6	6.10	0.006	0.012	
2	8/30/2017 10:06	8/30/2017 10:06	8/30/2017 10:06	12.0	6.10	0.005	0.018	
3	8/30/2017 10:09	8/30/2017 10:09	8/30/2017 10:10	9.6	6.10	0.005	0.018	
4	8/30/2017 10:14	8/30/2017 10:14	8/30/2017 10:16	8.7	6.10	0.011	0.014	
5	8/30/2017 10:19	8/30/2017 10:19	8/30/2017 10:20	9.6	6.10	0.011	0.014	
6	8/30/2017 10:23	8/30/2017 10:23	8/30/2017 10:25	12.0	6.10	0.013	0.016	
7	8/30/2017 10:27	8/30/2017 10:27	8/30/2017 10:29	14.8	6.10	0.013	0.016	
8	8/30/2017 10:32	8/30/2017 10:32	8/30/2017 10:34	17.7	6.10	0.013	0.013	
10	8/30/2017 10:40	8/30/2017 10:40	8/30/2017 11:00	22.6	6.10	0.003	0.018	
Replacement Piles								
6A	9/12/2017 7:51	9/12/2017 7:59	9/12/2017 9:41	13.0	4.70	0.014	0.007	
10A	9/12/2017 8:29	9/12/2017 8:36	9/12/2017 9:37	23.6	4.70	0.015	0.003	
13A	9/12/2017 9:07	9/12/2017 9:13	9/12/2017 9:29	26.6	4.70	0.015	0.011	

NORTH KENT 1

Preliminary Vibration Monitoring Report

Well Information

Well No.: 11
Municipal Address: [REDACTED]
Distance from Turbine Centre: 1223 m

Well No.: 12
Municipal Address: [REDACTED]
Distance from Turbine Centre: 1635 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

Monitoring Notes: After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Vibration measurements were undertaken on August 17, 2017 at Wells 11 and 12 during water quality sampling events in the absence of pile driving within the cluster. Both pumps turned on and operated during the sampling events. The maximum vibration measurement for Well 11 was 0.016 mm/s and this pump was located within the residence approximately 40 m from the well. The maximum vibration measurement for Well 12 was 0.896 mm/s and the pump was mounted on the well casing. The maximum vibration measurement of the Well 12 casing during all monitoring completed to the date of report issue was about 2.4 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Note that driving/restriking of some piles occurred in relatively rapid succession and, therefore, the vibration measurement data for the 10 minute periods of analysis are applicable to multiple piles. Data for Well 12 during driving of Pile 2 on August 23, 2017 was not captured when data logger battery failed and then changed. Total driving time on till/rock for Pile 9 was interrupted by repairs to the pile driving hammer and the actual driving duration on till/rock was 8:00 (minutes:seconds) for this pile. Total driving time on till/rock for restrike of Pile 10 was interrupted by damage to the pile top, splicing and welding and total driving duration on till/rock was 5:48 (minutes:seconds). Driving time on till/rock for driving of Pile 6A was interrupted from 8:07:35 to 8:10:35 and from 8:12:45 to 9:40:28. Driving time on till/rock for driving of Pile 10A was interrupted from 8:49:30 to 9:37:05. Driving time on till/rock for driving of Pile 13A was interrupted from 9:18:45 to 9:26:30. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

Footnotes: a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

Preliminary Vibration Monitoring Report

Turbine Location: T46

Vibration Measurements at Turbine Site						Vibration Measurements at Wells		
Pile Driving Times and Dates					Daily Maximum Particle Velocity	Particle Velocity (mm/s) ^{c, d}		
Pile No.:	Start ^a	Rock/Till	End ^a	Geophone Dist. (m)	(mm/s) ^b	Well 11	Well 12	No Pump ^e
1	8/29/2017 8:38	8/29/2017 8:44	8/29/2017 9:10	26.5	5.80	NA ^e	0.002	
2	8/29/2017 9:24	8/29/2017 9:33	8/29/2017 9:49	25.5	5.80	NA ^e	0.003	
3	8/29/2017 10:14	8/29/2017 10:19	8/29/2017 10:30	23.8	5.80	NA ^e	0.037	
4	8/29/2017 12:41	8/29/2017 12:52	8/29/2017 13:01	21.5	5.80	0.004	0.010	
5	8/29/2017 12:00	8/29/2017 12:09	8/29/2017 12:28	18.9	5.80	NA ^e	0.003	
6	8/29/2017 11:02	8/29/2017 11:11	8/29/2017 11:25	16.0	5.80	NA ^e	0.006	
7	8/28/2017 16:35	8/28/2017 16:47	8/28/2017 16:53	13.1	7.85	0.015	0.071	
8	8/28/2017 16:02	8/28/2017 16:12	8/28/2017 16:20	10.9	7.85	0.007	1.551	0.039
9	8/28/2017 13:25	8/28/2017 13:34	8/28/2017 13:36	10.0	7.85	0.006	0.011	
10	8/28/2017 12:44	8/28/2017 12:56	8/28/2017 12:59	10.9	7.85	0.006	0.008	
11	8/28/2017 11:25	8/28/2017 11:34	8/28/2017 11:41	13.1	7.85	NA ^e	0.011	
12	8/28/2017 10:07	8/28/2017 10:17	8/28/2017 10:20	16.0	7.85	0.003	0.009	
13	8/28/2017 9:33	8/28/2017 9:43	8/28/2017 9:49	18.9	7.85	0.021	0.015	
14	8/28/2017 9:00	8/28/2017 9:12	8/28/2017 9:16	21.5	7.85	0.003	0.003	
15	8/28/2017 8:30	8/28/2017 8:44	8/28/2017 8:47	23.8	7.85	0.004	0.004	
16	8/28/2017 13:53	8/28/2017 14:03	8/28/2017 14:07	25.5	7.85	0.002	0.006	
17	8/28/2017 14:27	8/28/2017 14:38	8/28/2017 14:48	26.5	7.85	0.017	0.004	
18	8/29/2017 7:53	8/29/2017 8:01	8/29/2017 8:05	26.9	5.80	NA ^e	0.002	
Restrikes								
9	8/29/2017 13:14	8/29/2017 13:14	8/29/2017 13:16	10.0	5.80	0.005	0.006	
8	8/29/2017 13:25	8/29/2017 13:25	8/29/2017 13:26	10.9	5.80	0.003	0.052	
16	8/29/2017 13:36	8/29/2017 13:36	8/29/2017 13:38	25.5	5.80	0.003	0.006	

Well Information

Well No.: 11

Municipal Address:

Distance from Turbine Centre: 1697 m

Well No.: 12

Municipal Address:

Distance from Turbine Centre: 2170 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

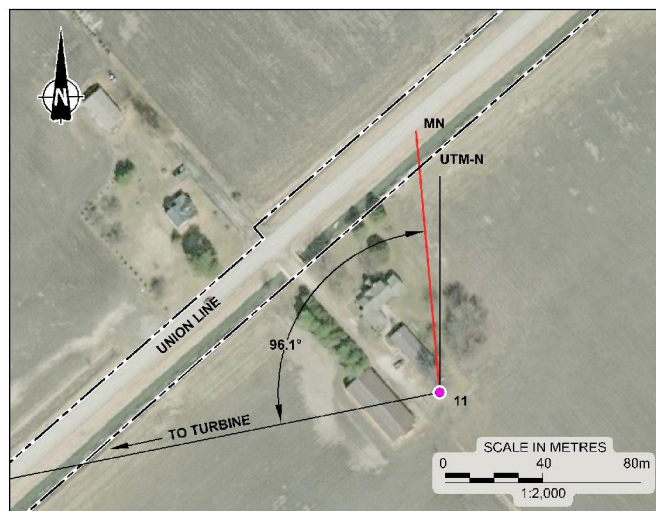
Monitoring Notes: Data obtained during pile dynamic analyses is pending. Piles noted with "A" represent piles installed to replace similarly-numbered piles. After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Total duration for pile driving on rock/till based on times noted above is not representative for Piles 1 and where the actual duration for driving on till/rock was (minutes:seconds): 1(11:30) and 5(18:32). Maximum vibrations for Well 12 were 1.55 mm/s for August 29, 2017. The pump was mounted on the well casing. During pile driving on August 23, 2017, the maximum vibration measurement of the Well 12 casing was 2.4 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Data not available for Piles 1, 2, 3, 5, 6, 11 and 18 at Well 11 on August 28 and 29, 2017 due to several separate battery failures in monitoring equipment. Batteries were subsequently replaced upon discovery.

Footnotes: a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

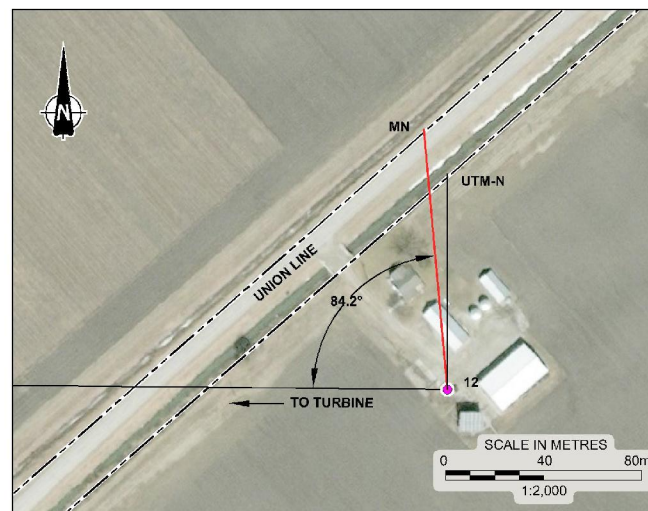
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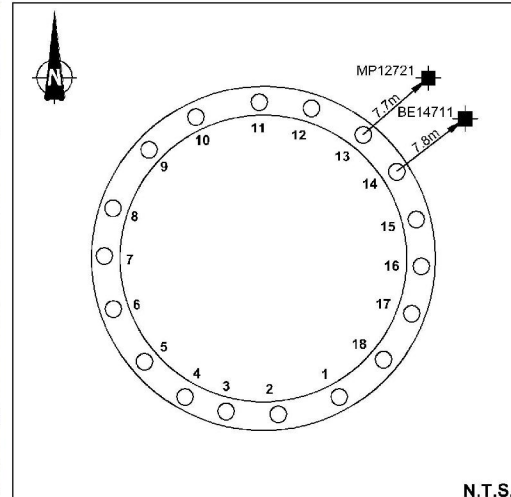
SITE PLAN



INSET A (WELL #11)



INSET B (WELL #12)



N.T.S.

TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

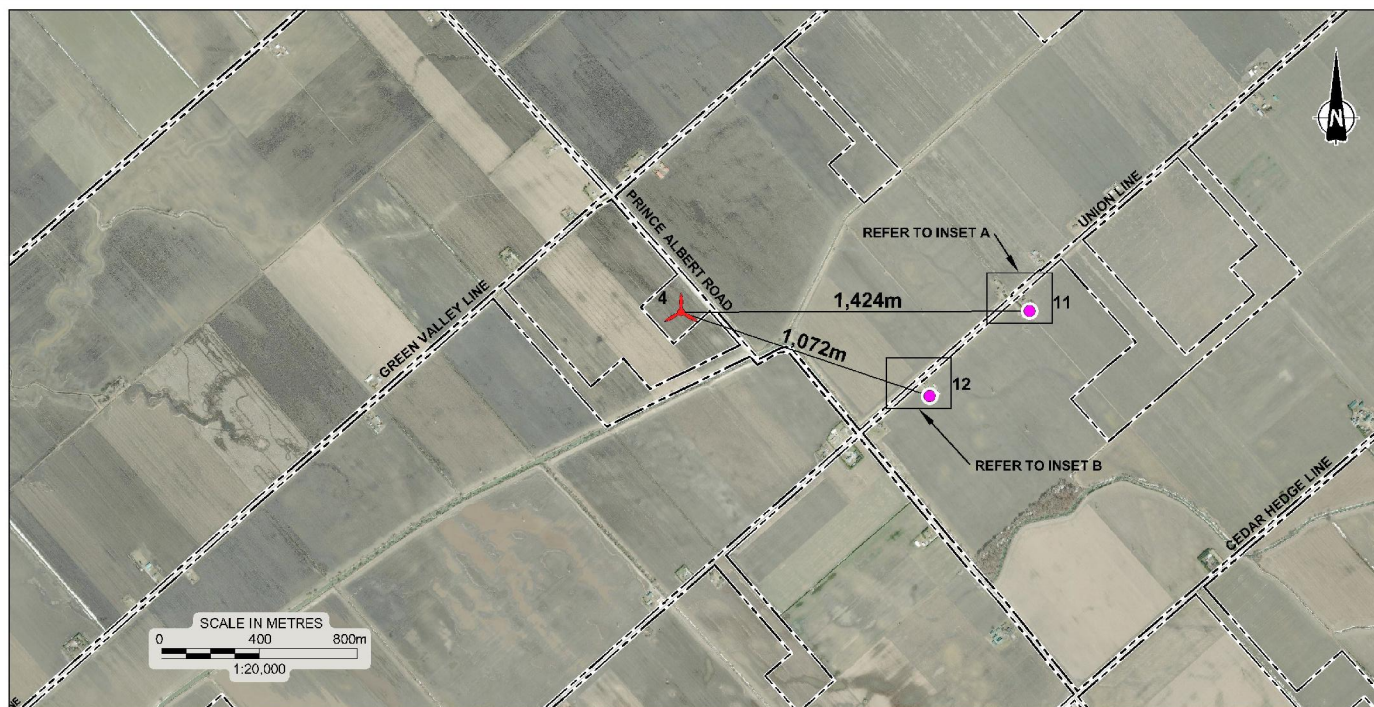
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NOTES

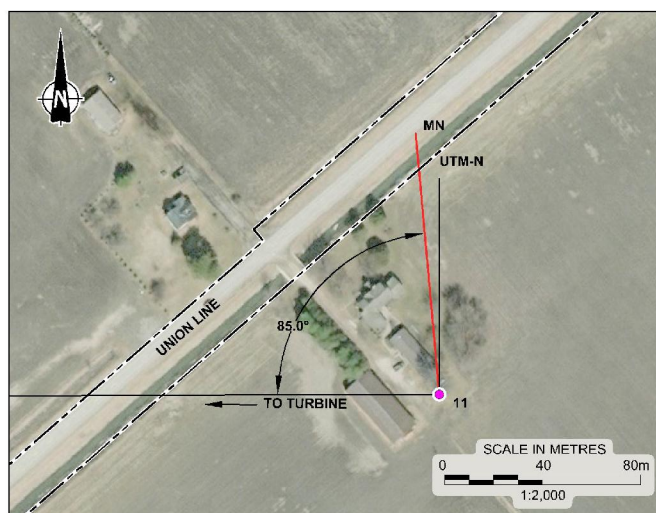
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ALL LOCATIONS ARE APPROXIMATE.

PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T3			
	PROJECT NO.	16686031	FILE NO. 16686031-2000-RC2013
	DATE	DCH/ZLB	Sept. 18/17
	CHECKED		
SCALE			AS SHOWN
			FIGURE T3

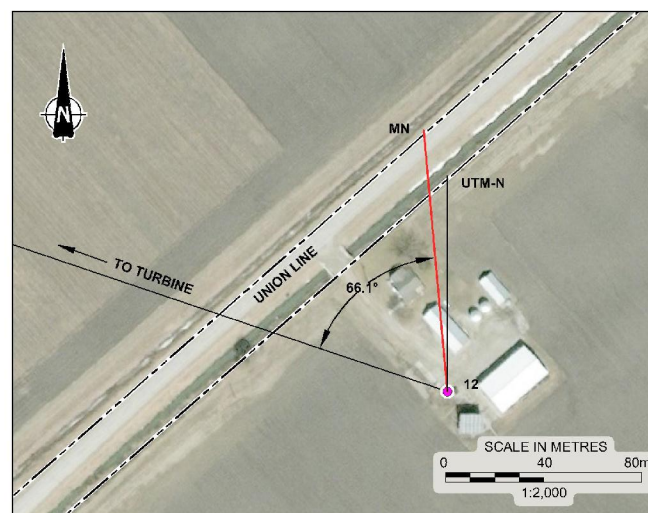
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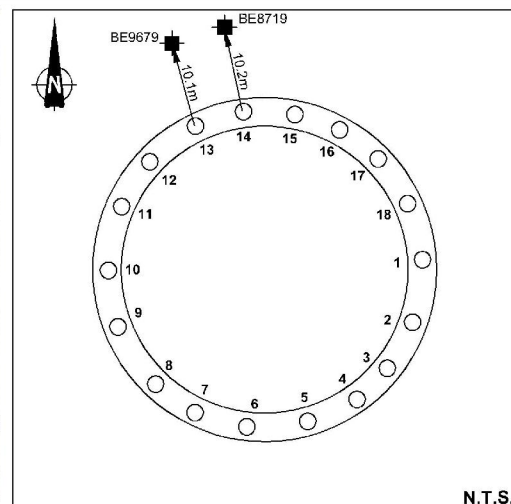
SITE PLAN



INSET A (WELL #11)



INSET B (WELL #12)



TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

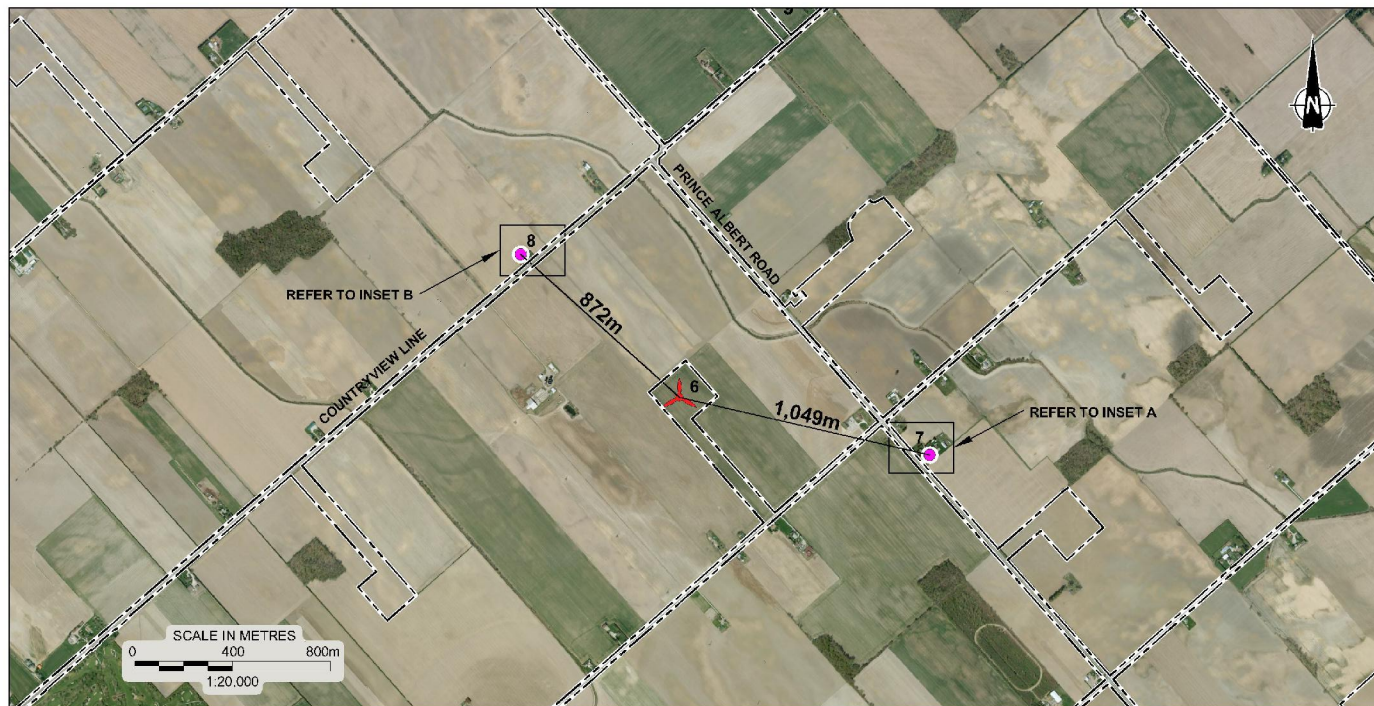
REFERENCE

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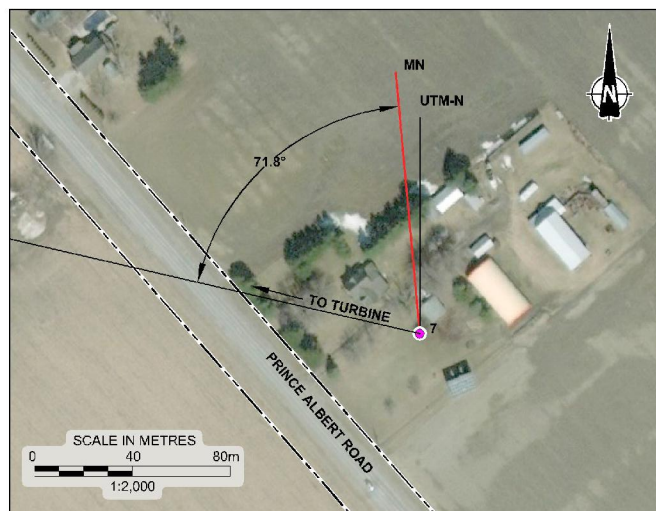
NOTES

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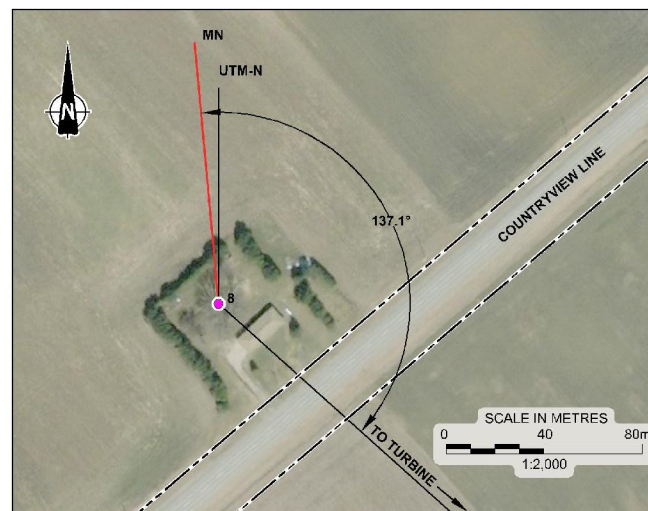
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FILE	TURBINE PILES AND WATER WELL LOCATION PLAN, T4		
PROJECT No.	1698031	FILE No.	1698031-2000-R020T4
DATE	DOH/ZLB	DATE	Sept 18/17
CHECKED		SCALE	AS SHOWN TYP
		FIGURE T4	



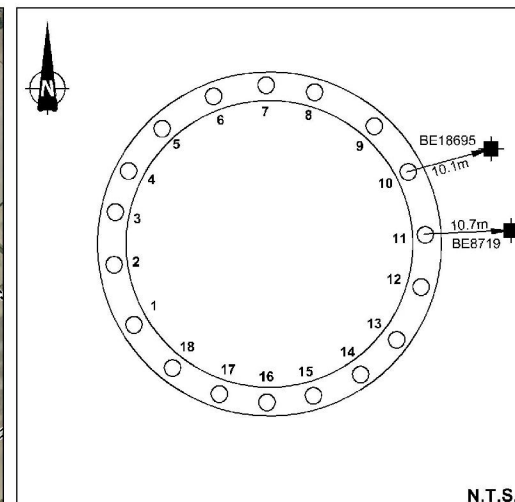
SITE PLAN



INSET A (WELL #7)



INSET B (WELL #8)



TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUTIVE, PROJECT No. C017-0190, DWG No. S002.

NOTES

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PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T6			
	PROJECT NO.	16686031	FILE NO. 16686031-2000-RC2016
	DATE	09/18/17	SCALE AS SHOWN
	CHIEF		REV.
			FIGURE T6

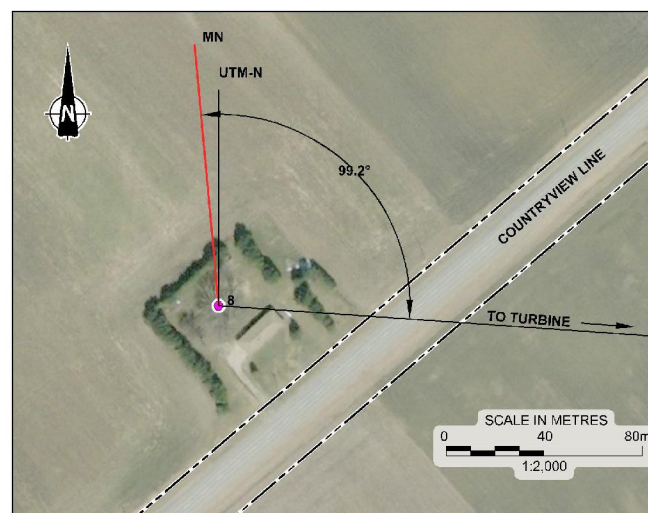
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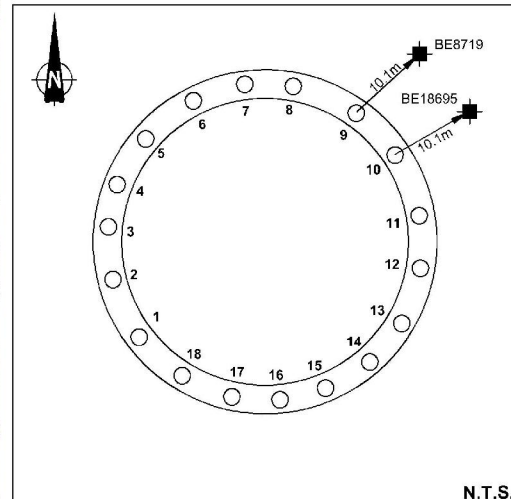
SITE PLAN



INSET A (WELL #7)



INSET B (WELL #8)



TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

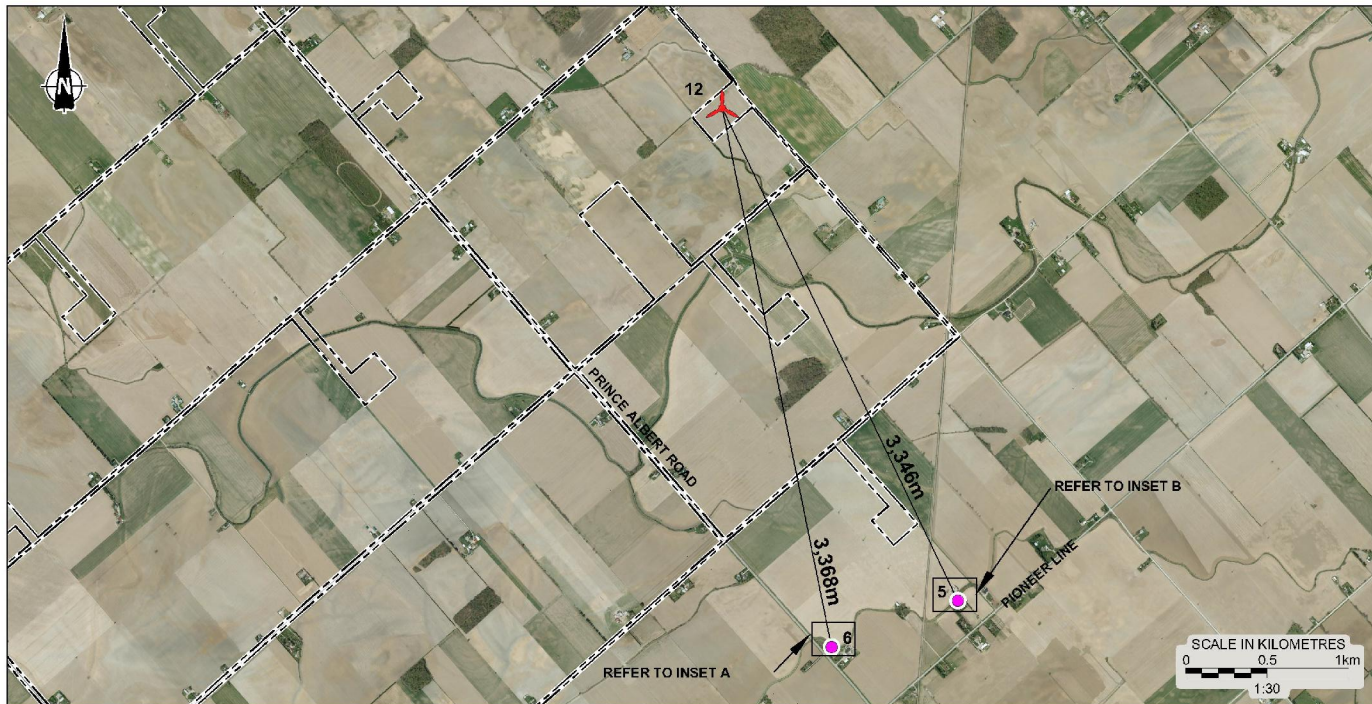
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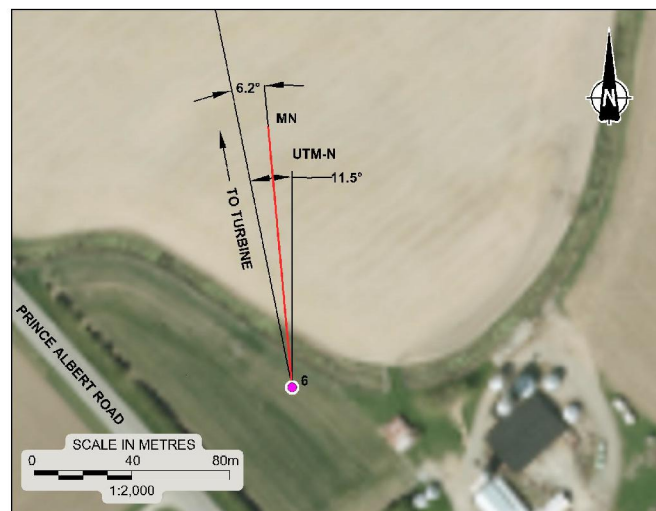
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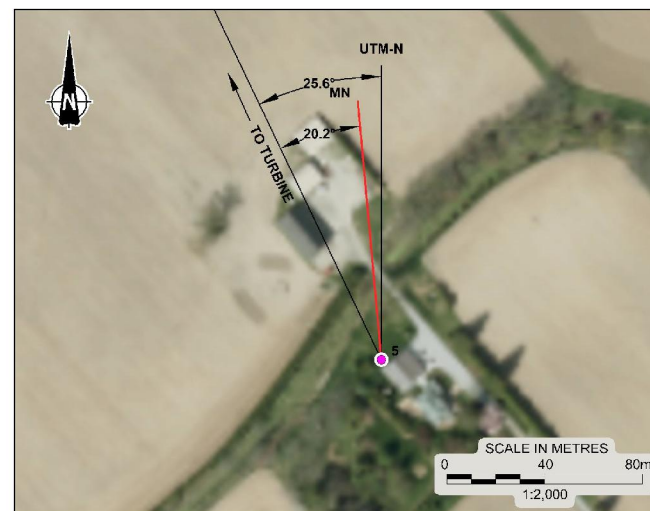
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TITLE	TURBINE PILES AND WATER WELL LOCATION PLAN, T7		
PROJECT No.	1688031	FILE No.	1688031-2000-R02017
DATE	DOH/ZLB Sep. 18/17	SCALE	AS SHOWN TYP.
CHECKED			
		FIGURE T7	



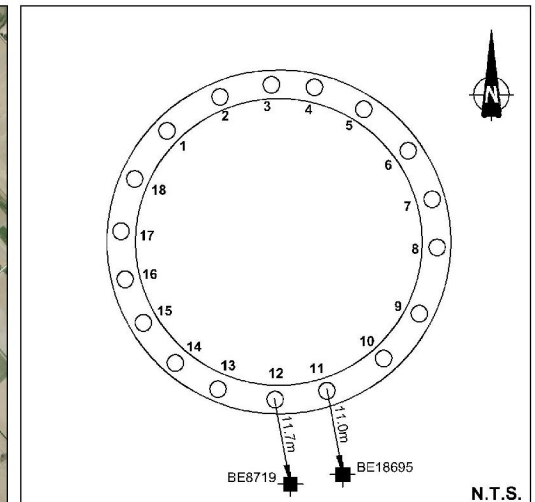
SITE PLAN



INSET A (WELL #6)



INSET B (WELL #5)



TURBINE PILE LAYOUT

LEGEND


- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

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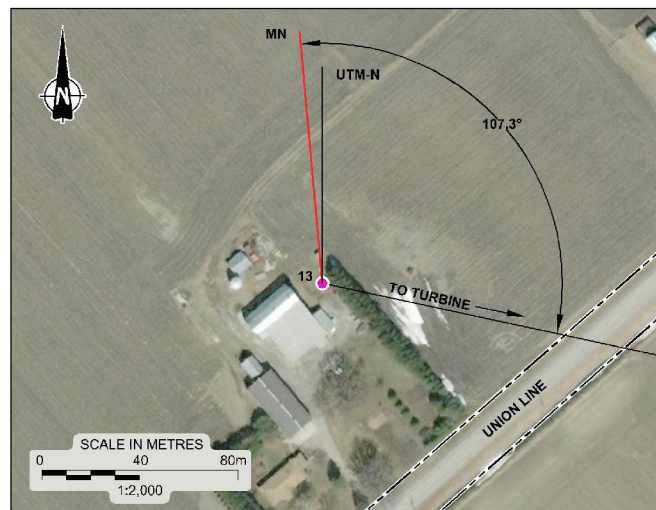
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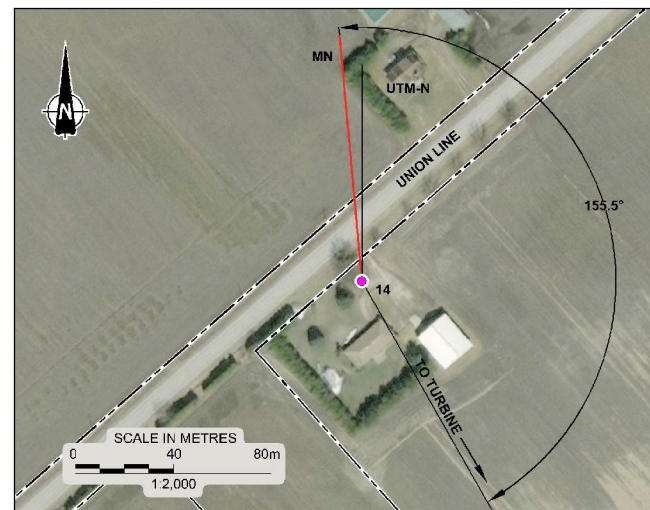
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NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T12			
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	FILE NO.		16686031-2000-RC2T12
	DATE	DCH/ZLB	Sept. 20/17
	CHECKED		
SCALE		AS SHOWN	
		FIGURE T12	



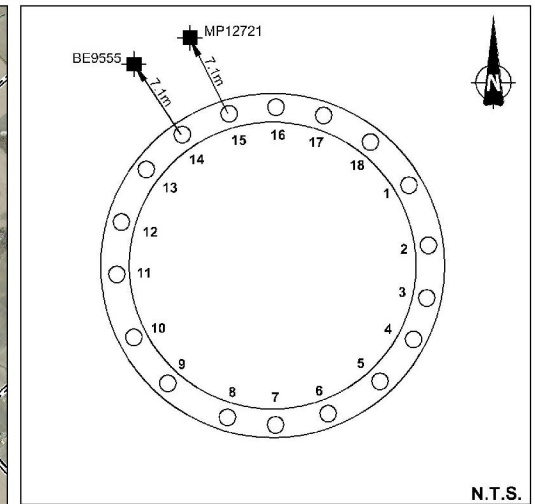
SITE PLAN



INSET A (WELL #13)



INSET B (WELL #14)



TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

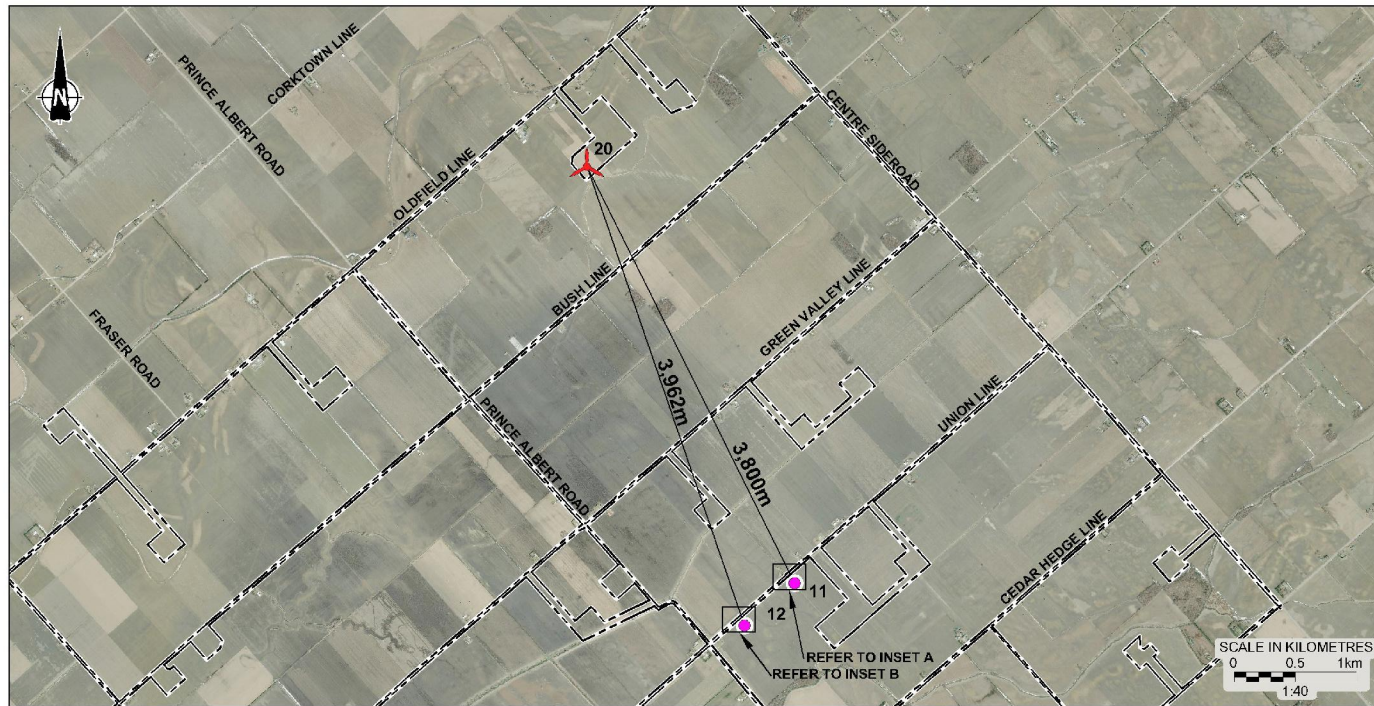
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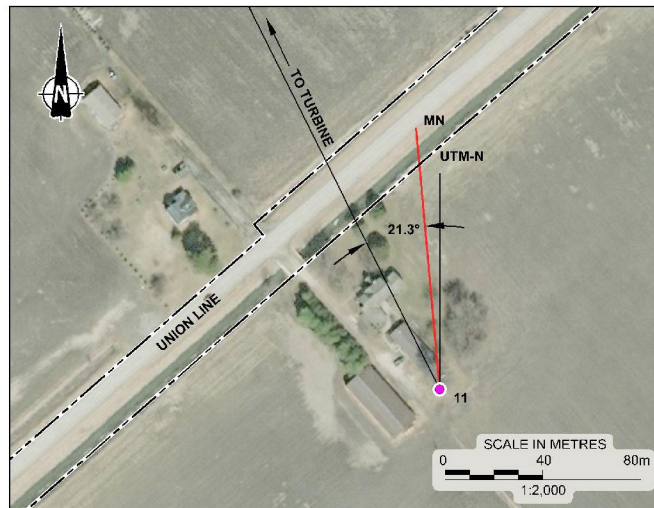
NOTES

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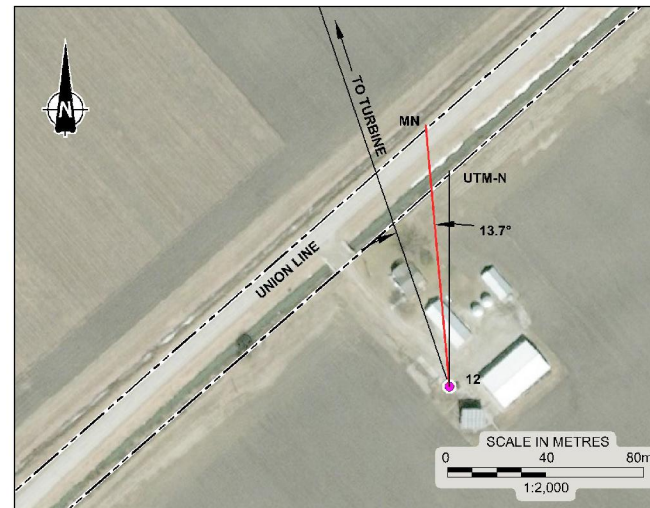
PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T14			
	PROJECT No.	1668031	FILE NO. 1668031-2000-R02T14
	DATE	DOH/ZLB	Sept. 18/17
	CHECKED		
SCALE			AS SHOWN
			FIGURE T14



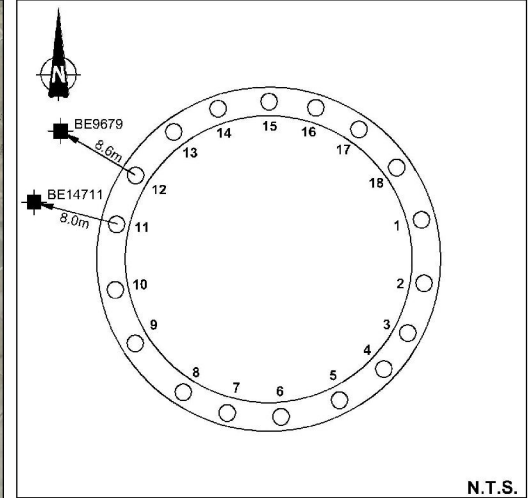
SITE PLAN



INSET A (WELL #11)



INSET B (WELL #12)



TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUTIVE, PROJECT No. C017-0190, DWG No. S002.

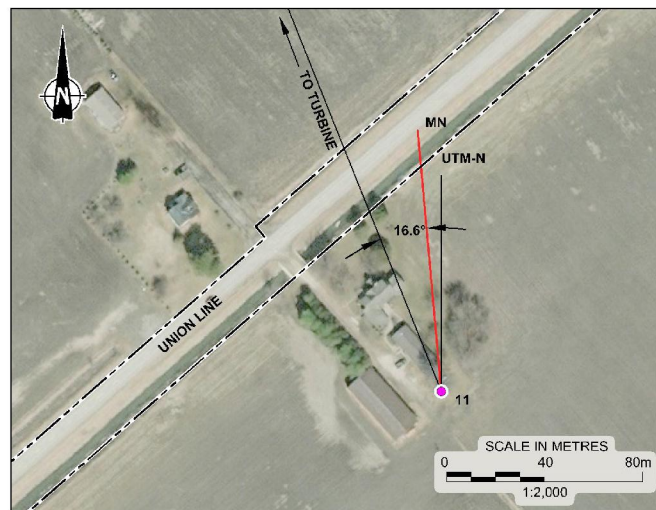
NOTES

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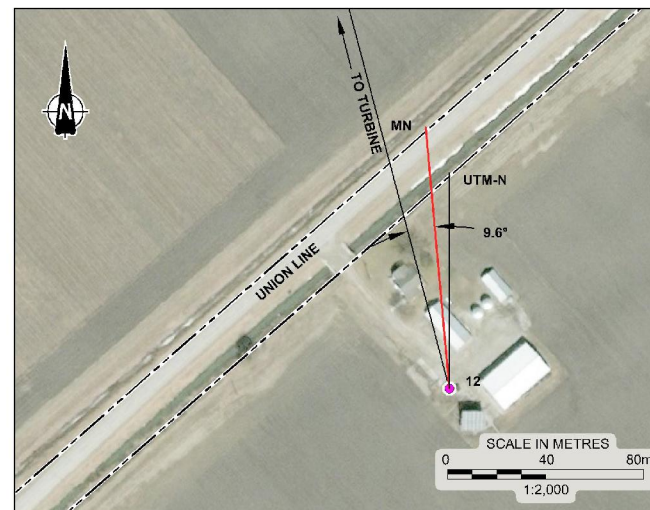
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NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T20			
	PROJECT NO.	16686031	FILE NO. 16686031-2000-RC2120
	DATE	DCH/ZLB Sept. 18/17	SCALE AS SHOWN
	CHECKED		REV.
			FIGURE T20



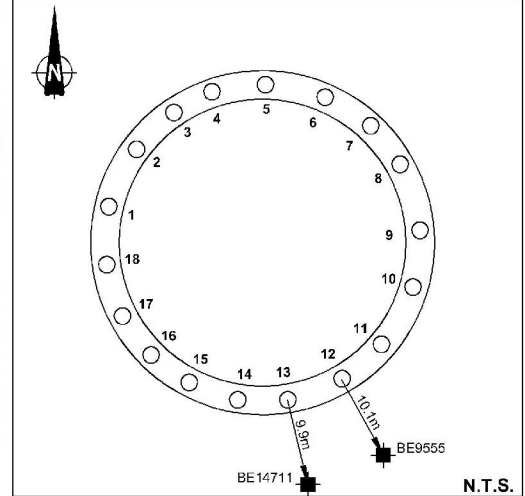
SITE PLAN



INSET A (WELL #11)



INSET B (WELL #12)



TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

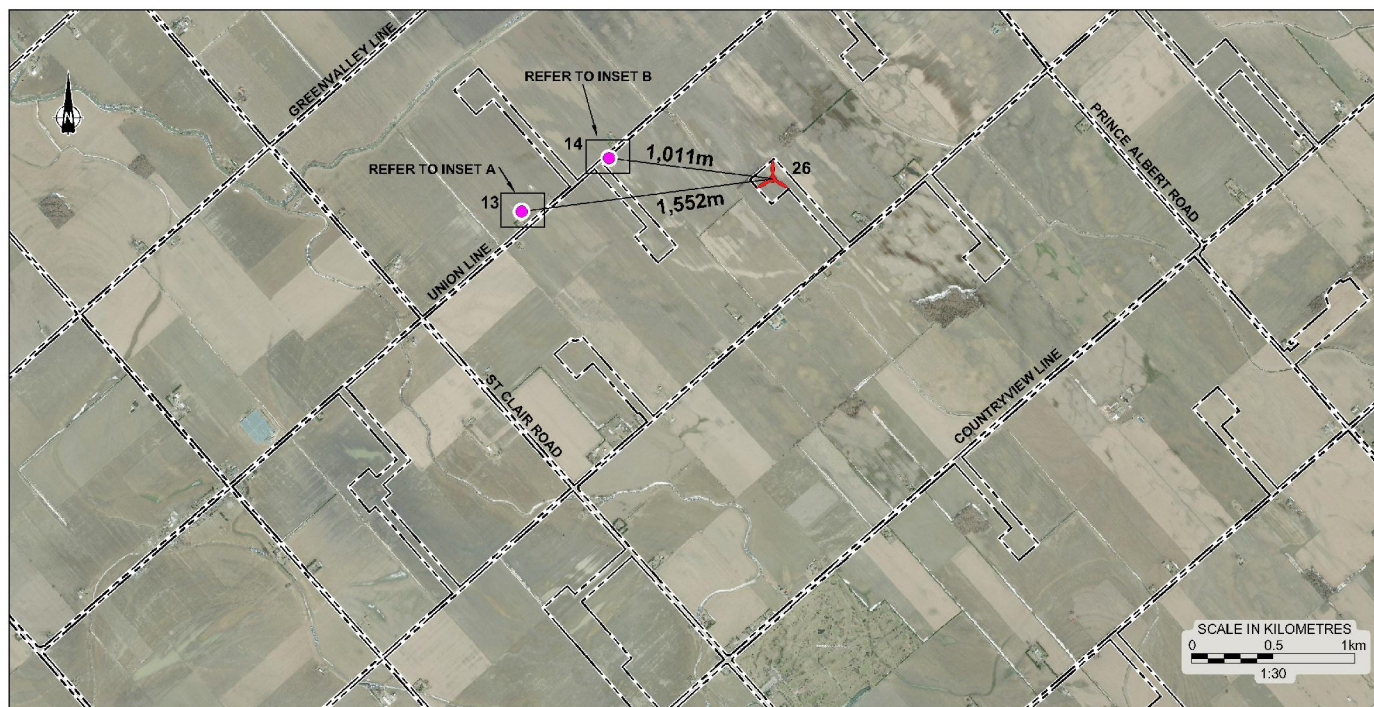
REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUTIVE, PROJECT No. C017-0190, DWG No. SC02.

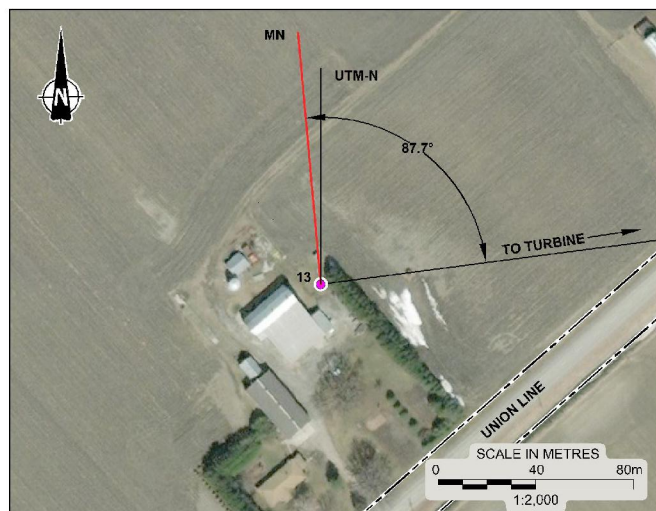
NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE.

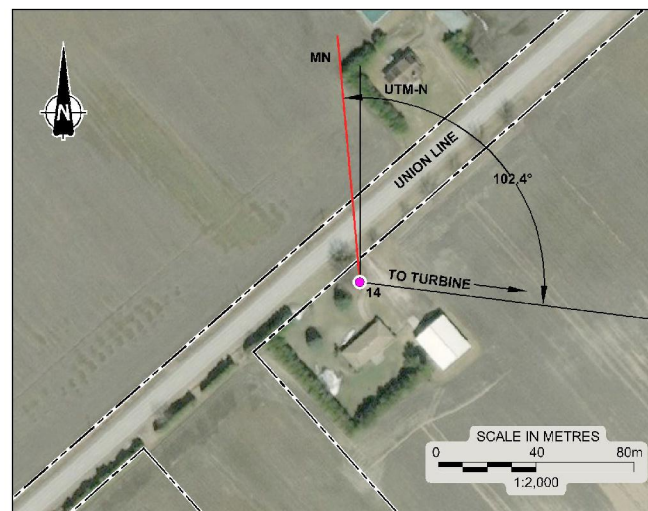
PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T21			
	PROJECT No.	1058031	FILE NO. 1058031-2000-RC02T21
	DATE	DOH/ZLB	Sept. 18/17
	CHECKED		
SCALE			AS SHOWN
FIGURE T21			



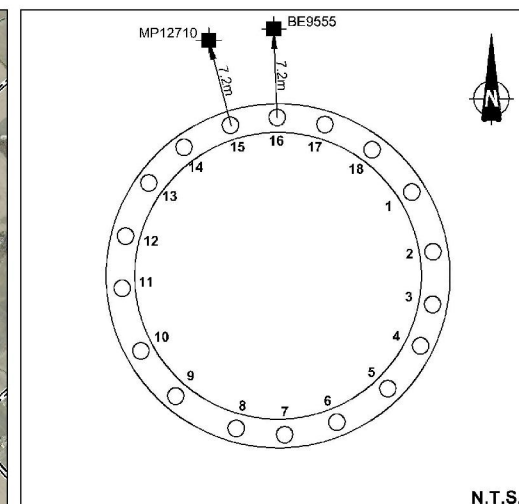
SITE PLAN



INSET A (WELL #13)



INSET B (WELL #14)



N.T.S.

TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUTIVE, PROJECT No. C017-0190, DWG No. S002.

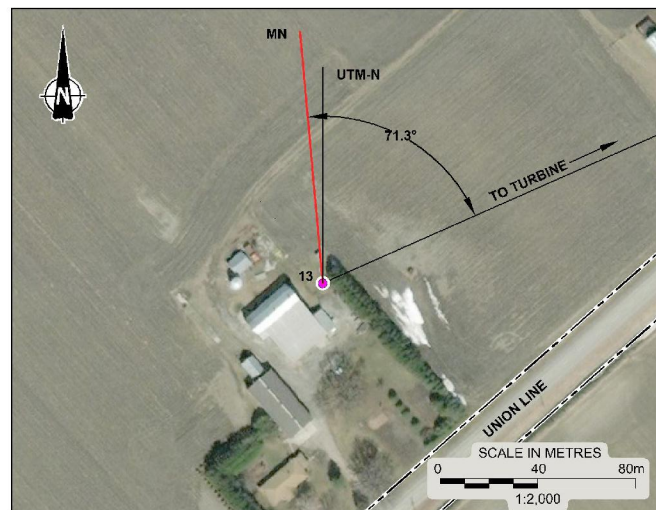
NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE.

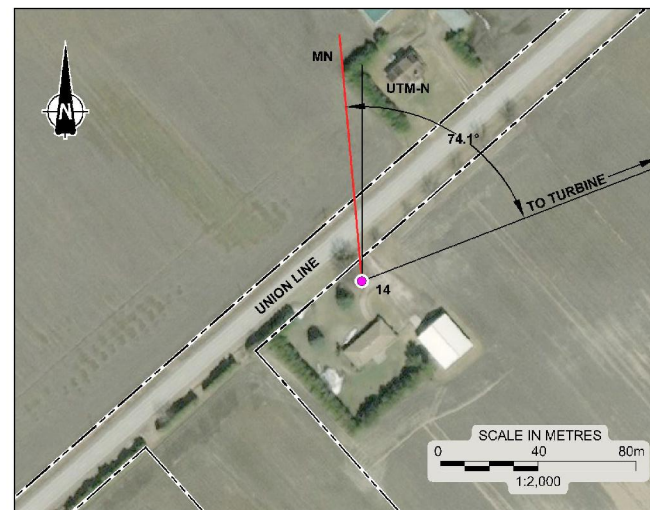
PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T26			
	PROJECT NO.	16686031	FILE NO. 16686031-2000-RC2126
	DATE	DCH/ZLB	Sept 20/17
	CHECKED		
		SCALE	AS SHOWN
		REV.	
FIGURE T26			



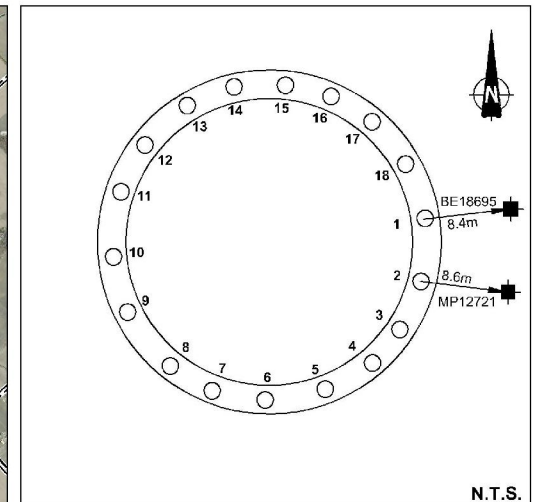
SITE PLAN



INSET A (WELL #13)



INSET B (WELL #14)



TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

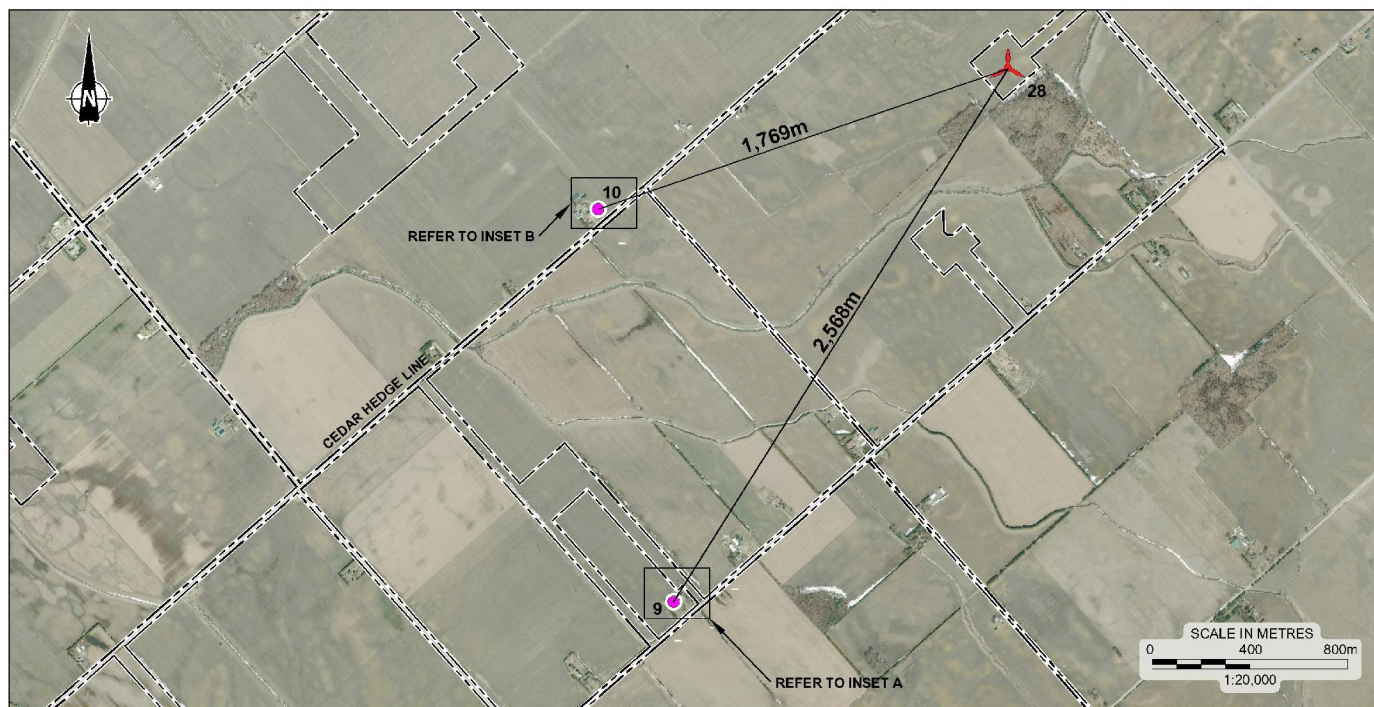
REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND 'FOUNDATION PLAN', ENTUTIVE, PROJECT No. C017-0190, DWG No. S002.

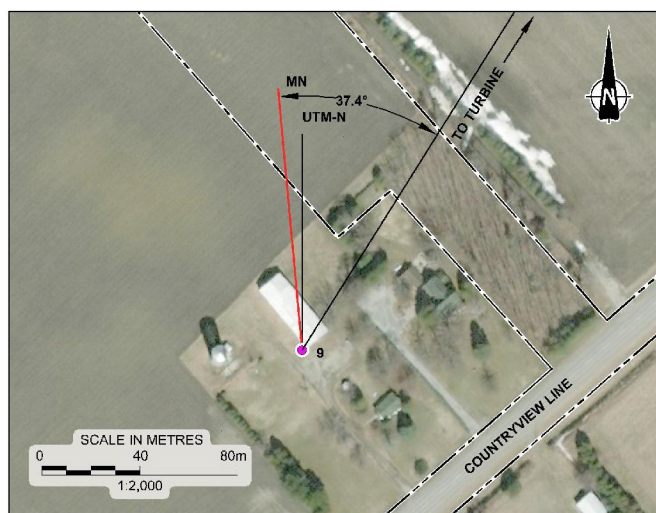
NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE.

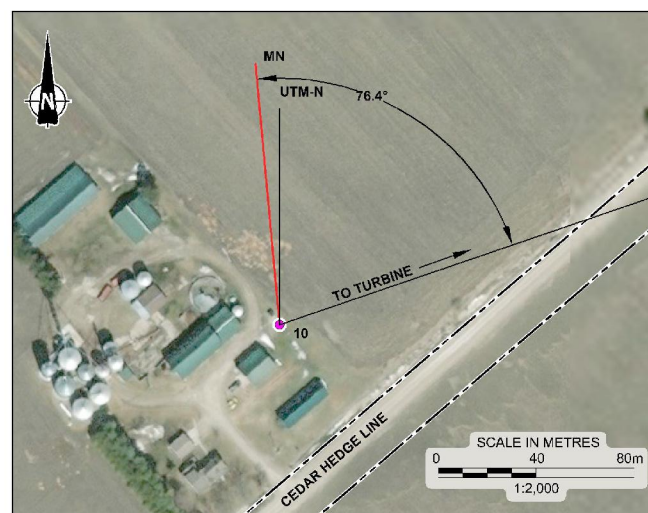
PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T27			
	PROJECT NO.	1668031	FILE NO. 1668031-2000-RC2127
	DATE	DCH/ZLB	Sept 20/17
	CHECKED		
SCALE			AS SHOWN
			FIGURE T27



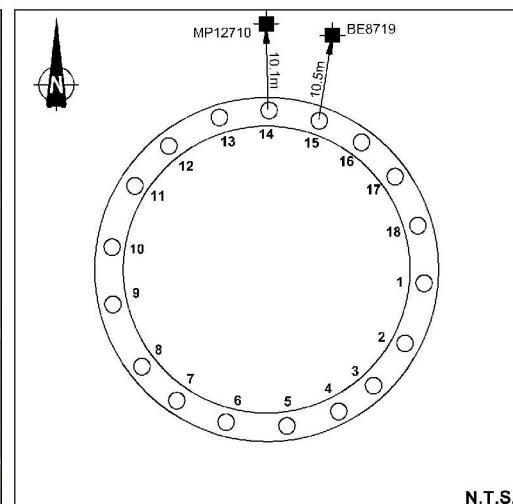
SITE PLAN



INSET A (WELL #9)



INSET B (WELL #10)



TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUTIVE, PROJECT No. C017-0190, DWG No. S002.

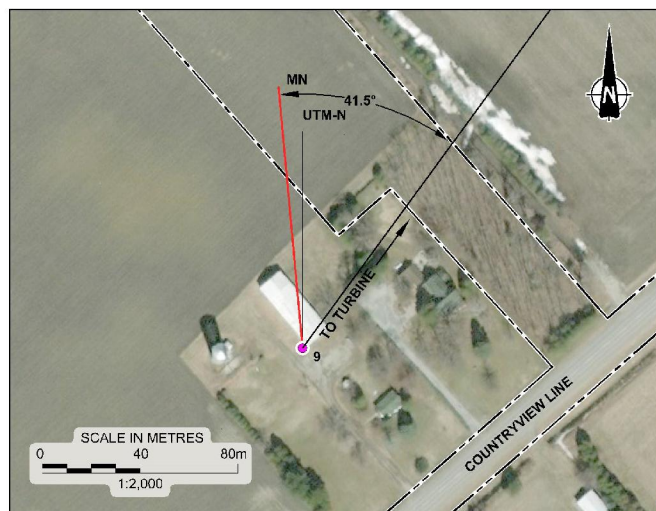
NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE.

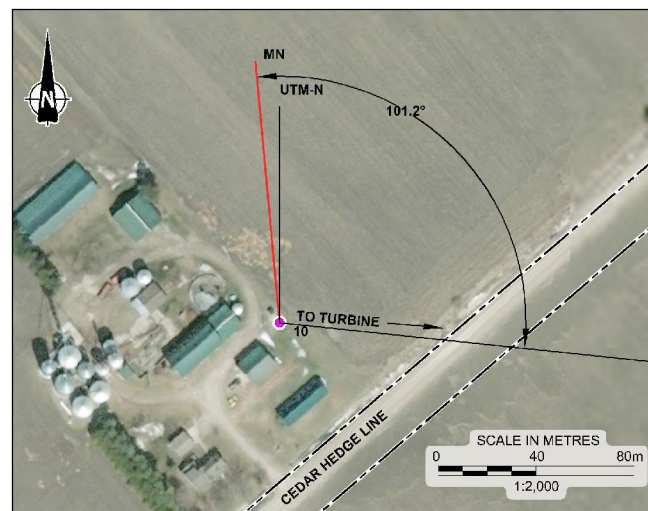
PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T28			
	PROJECT No.	1098031	FILE # 1098031-2000-R02728
	DATE	DOH/ZLB Sept. 20/17	SCALE AS SHOWN
	CHECKED		
			FIGURE T28



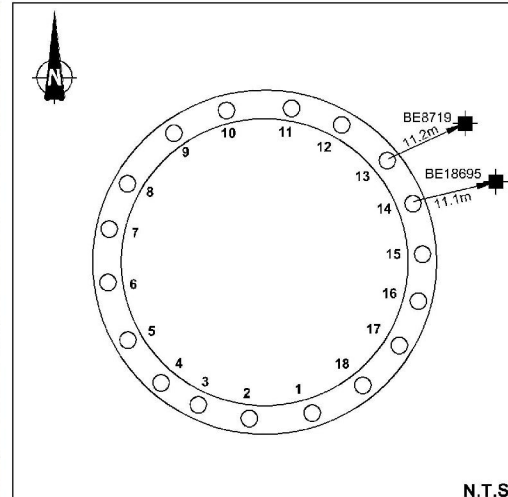
SITE PLAN



INSET A (WELL #9)



INSET B (WELL #10)



N.T.S.

TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

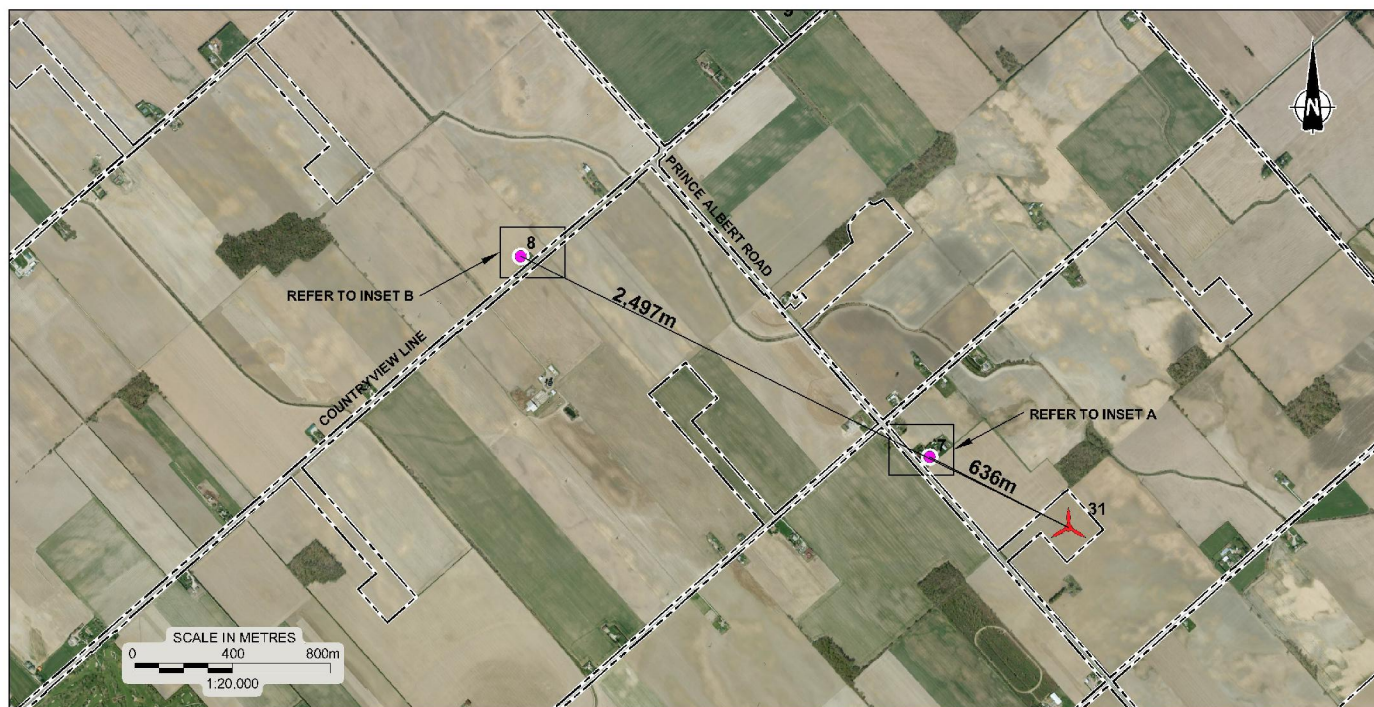
DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND 'FOUNDATION PLAN', ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T30			
	PROJECT NO.	16686031	FILE NO. 16686031-2000-RC2130
	DATE	DCH/ZLB	Sept. 20/17
	CHECKED		
		SCALE	AS SHOWN
		REV.	

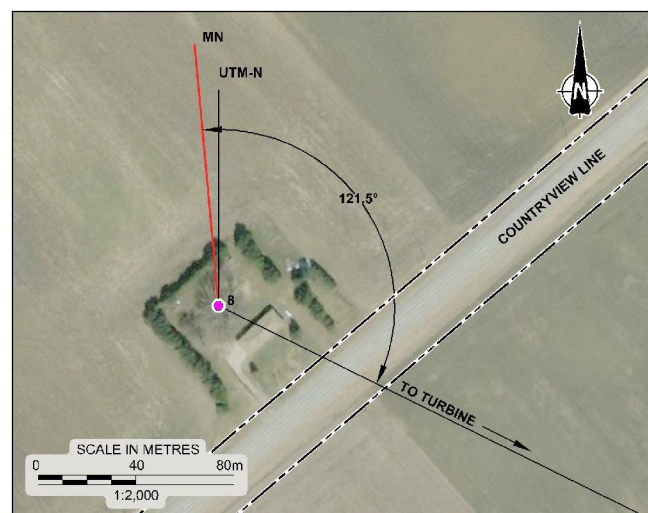
FIGURE T30



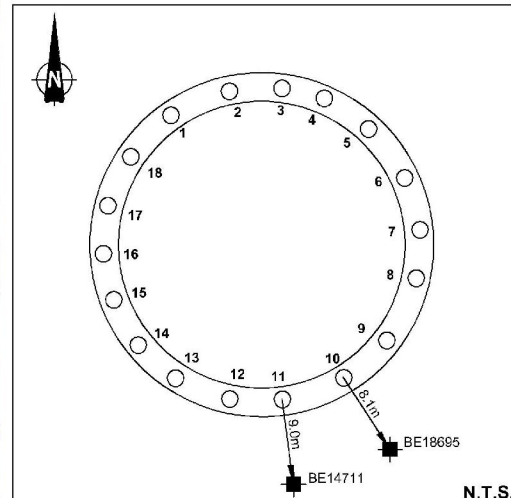
SITE PLAN



INSET A (WELL #7)



INSET B (WELL #8)



TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUTIVE, PROJECT No. C017-0190, DWG No. S002.

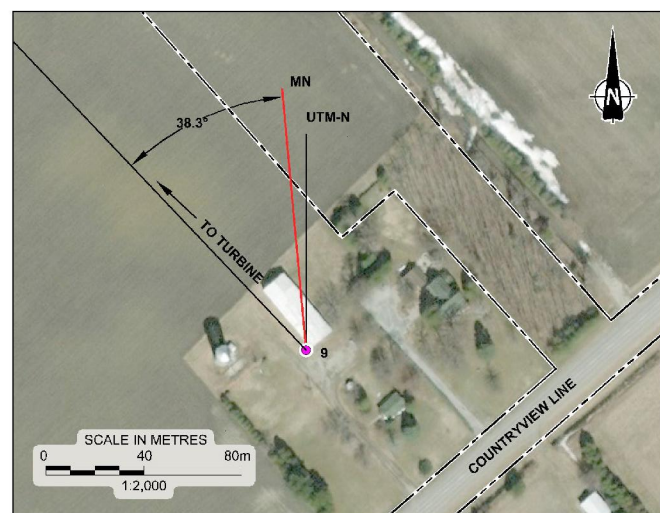
NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE.

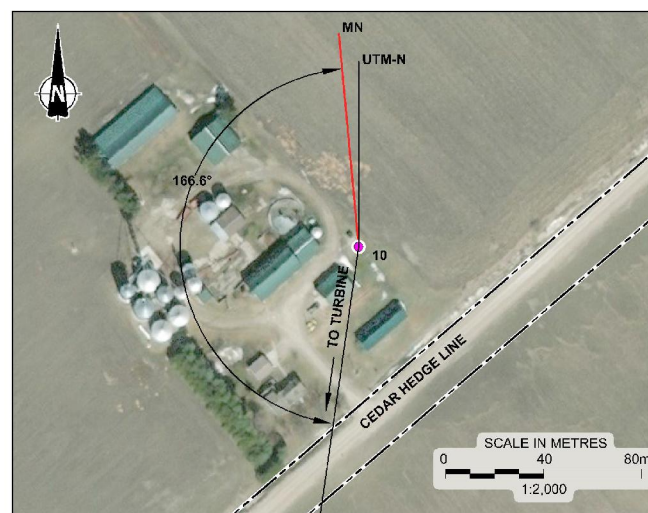
PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T31			
	PROJECT No.	1058031	FILE No. 1058031-2000-RC2131
	DATE	DOH/ZLB Sept. 18/17	SCALE AS SHOWN
	CHECKED		FIGURE T31



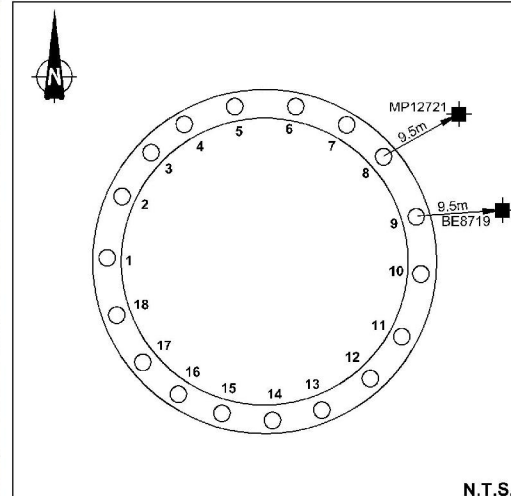
SITE PLAN



INSET A (WELL #9)



INSET B (WELL #10)



N.T.S.

TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUTIVE, PROJECT No. C017-0190, DWG No. S002.

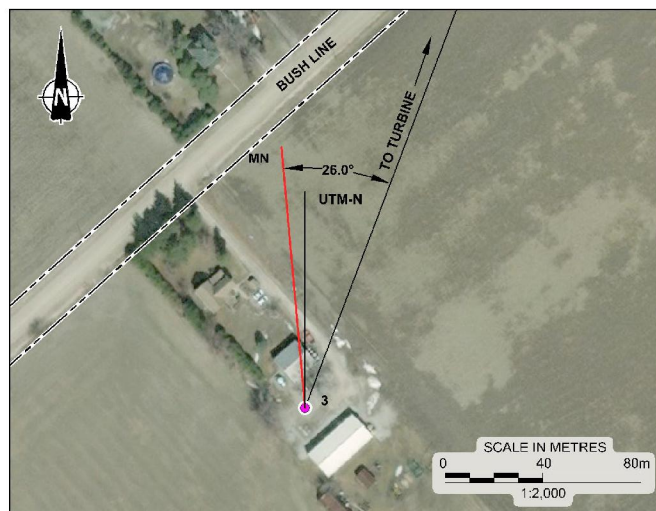
NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE.

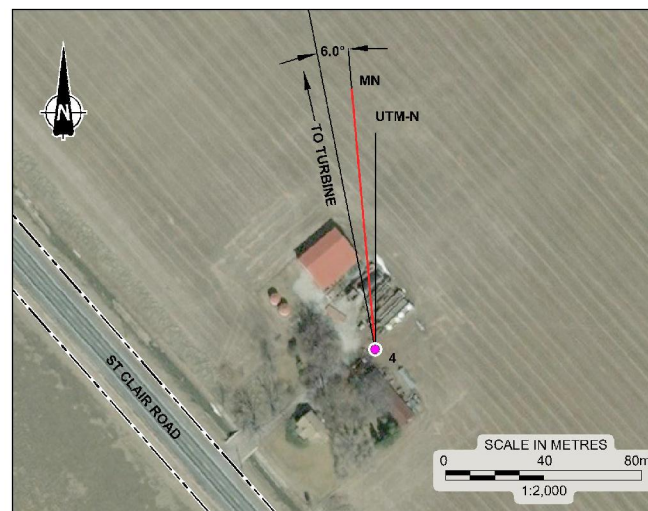
PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T32			
	PROJECT No.	1688031	FILE 13-1688031-2000-R02132
	DATE	DOH/ZLB	Sept. 18/17
	CHECKED		
SCALE			AS SHOWN
FIGURE T32			



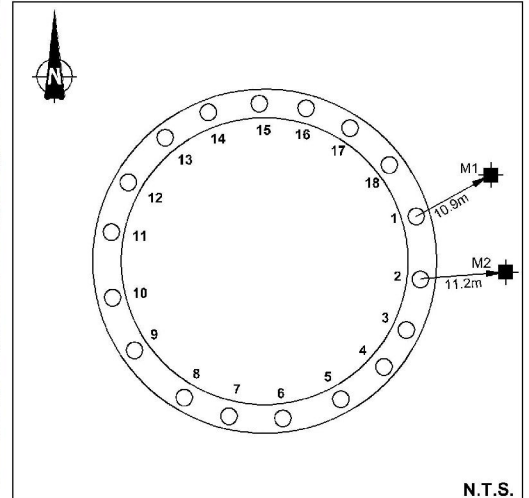
SITE PLAN



INSET A (WELL #3)



INSET B (WELL #4)



N.T.S.

TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

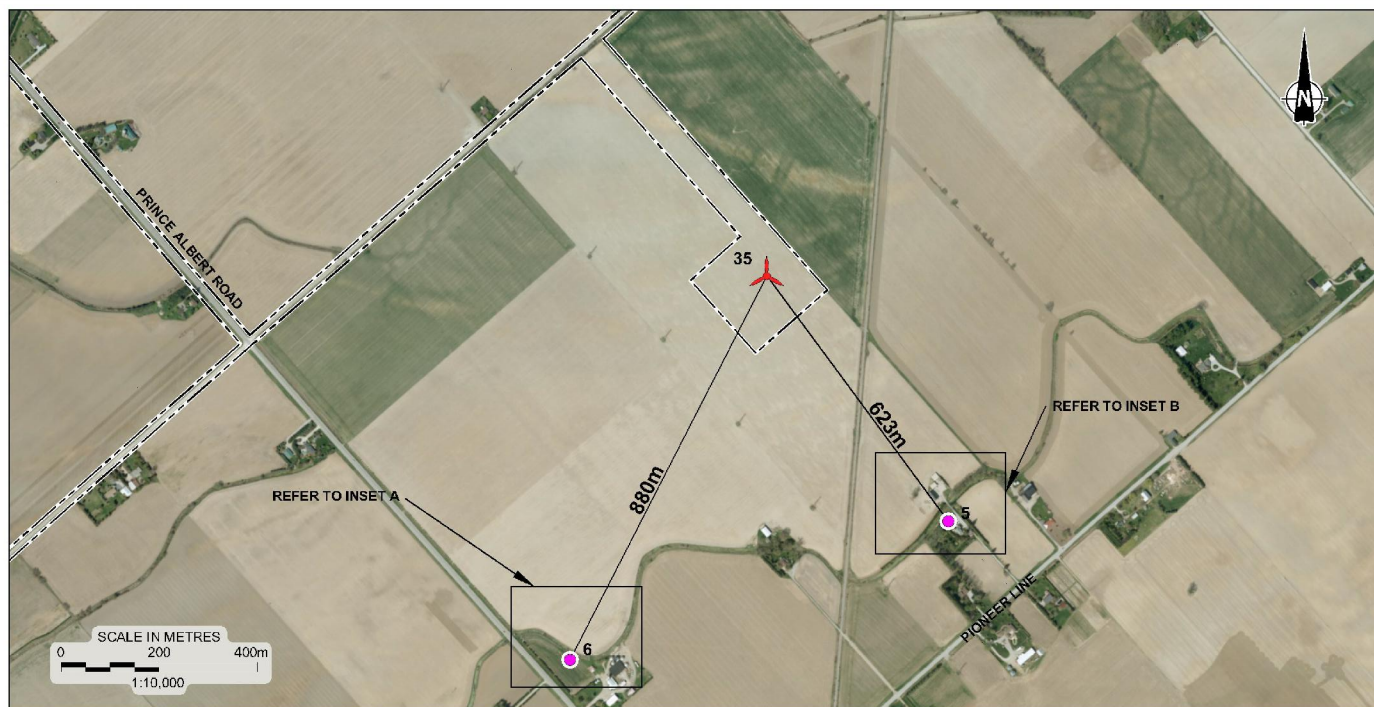
DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL © 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUTIVE, PROJECT No. C017-0190, DWG No. S002.

NOTES

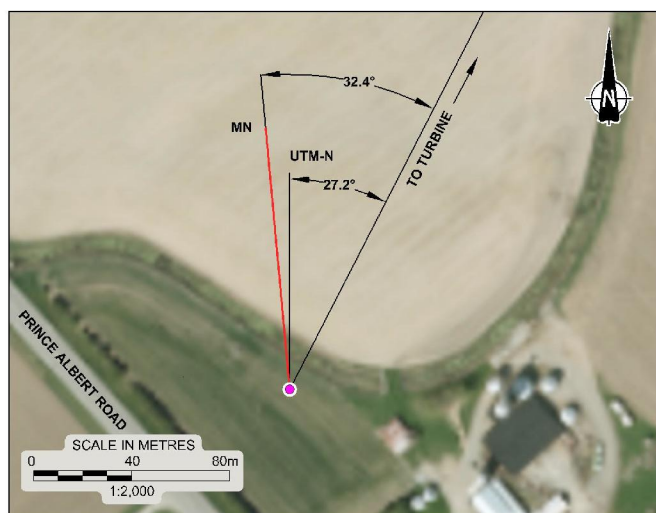
THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T33			
	PROJECT NO.	1668031	FILE NO. 1668031-2000-RC2133
	DATE	DCH/ZLB	Sept. 18/17
	CHECKED		
SCALE			AS SHOWN
			FIGURE T33

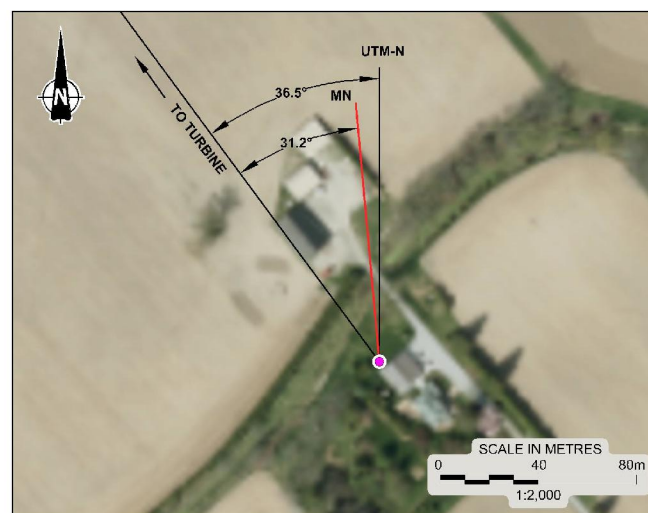
Drawing file: "666031_2000_R02"35.dwg Sep 20, 2017 12:47pm



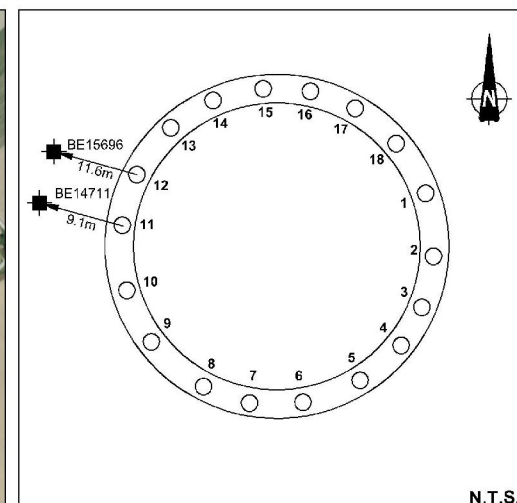
SITE PLAN



INSET A (WELL #6)



INSET B (WELL #5)



TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUTIVE, PROJECT No. C017-0190, DWG No. S002.

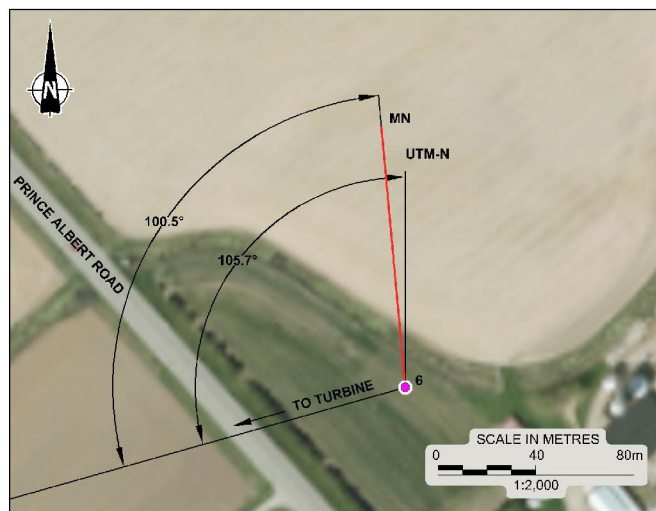
NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE.

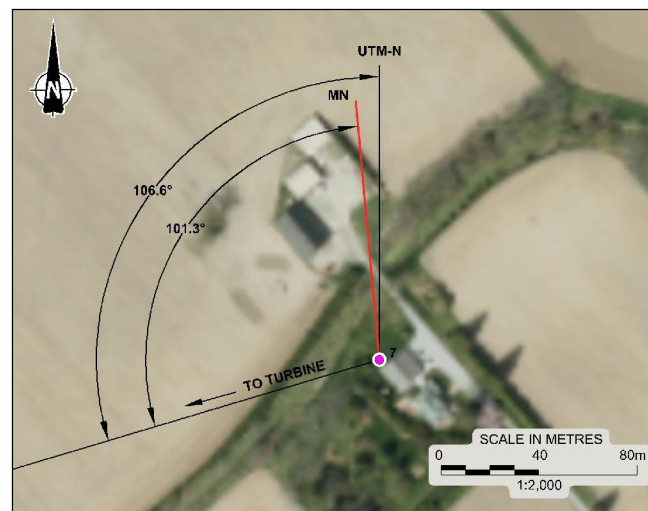
PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T35			
	PROJECT No.	1098031	FILE No. 1098031-2000-R02T35
	DATE	09/28/17	SCALE AS SHOWN
	DRAWN BY	SEP 18/17	FIGURE T35



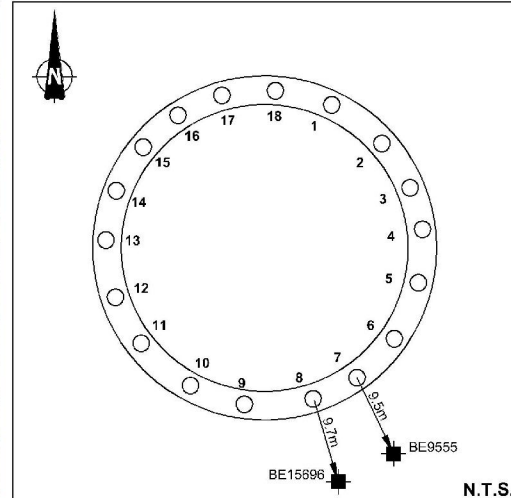
SITE PLAN



INSET A (WELL #6)



INSET B (WELL #5)



TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL © 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

NOTES

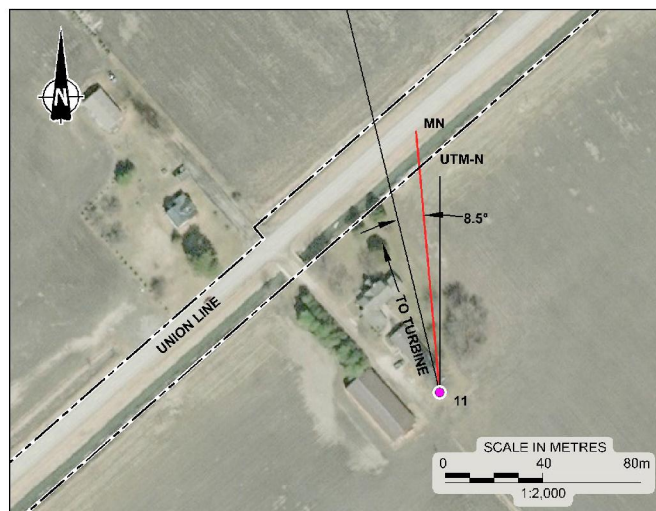
THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT		NORTH KENT 1 VIBRATION MONITORING	
TITLE		TURBINE PILES AND WATER WELL LOCATION PLAN, T36	
PROJECT No.	1668031	FILE No.	1668031-2000-R02T36
DATE	09/20/2017	SCALE	AS SHOWN
CHECKED		BY	
Golden Associates		FIGURE T36	

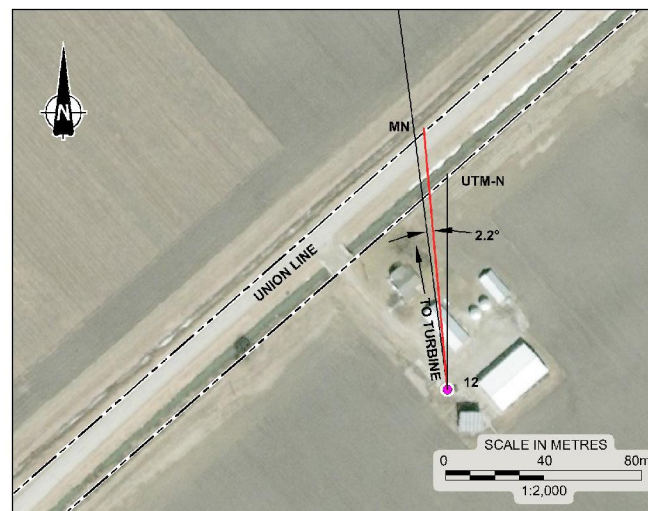
Drawing file: '608021-2000-RC2143.dwg' Sep 20, 2017 - 12:00pm



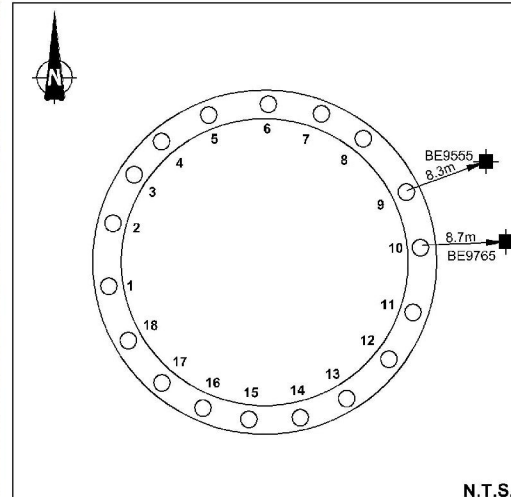
SITE PLAN



INSET A (WELL #11)



INSET B (WELL #12)



TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

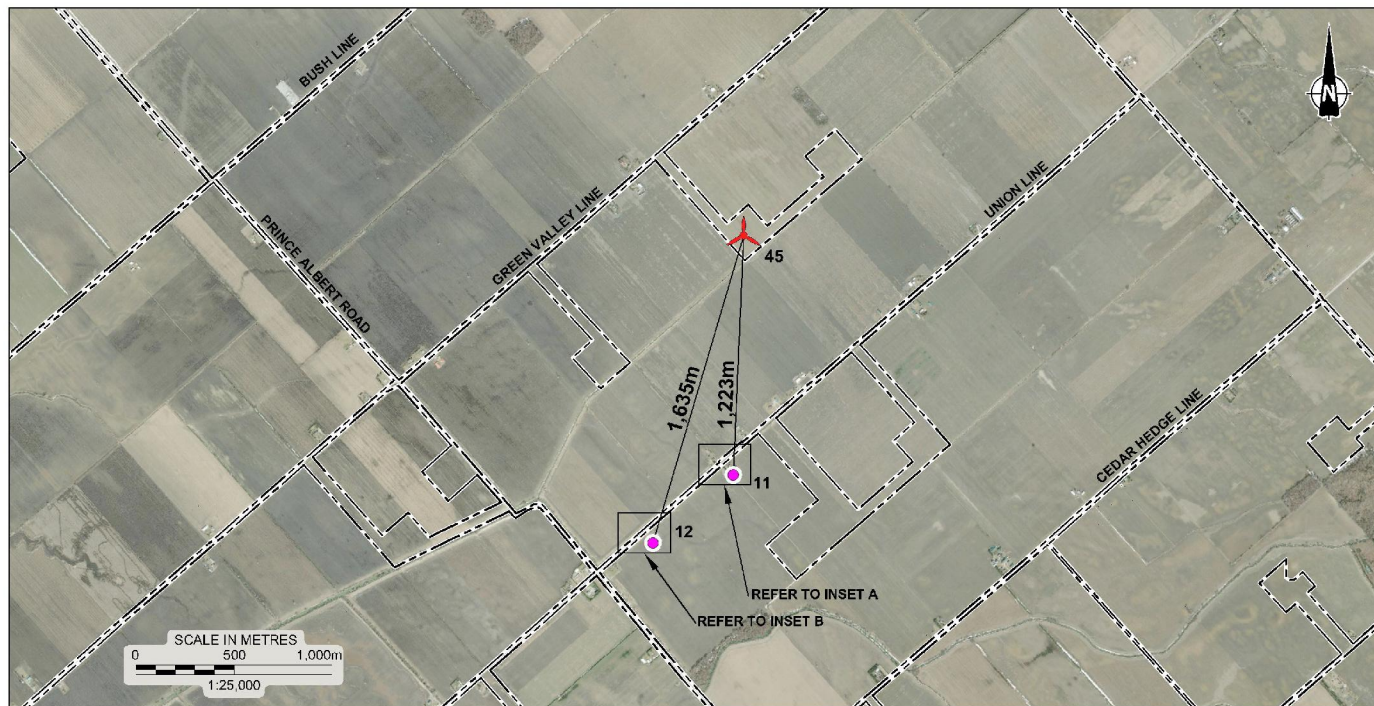
DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL © 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUTIVE, PROJECT No. C017-0190, DWG No. S002.

NOTES

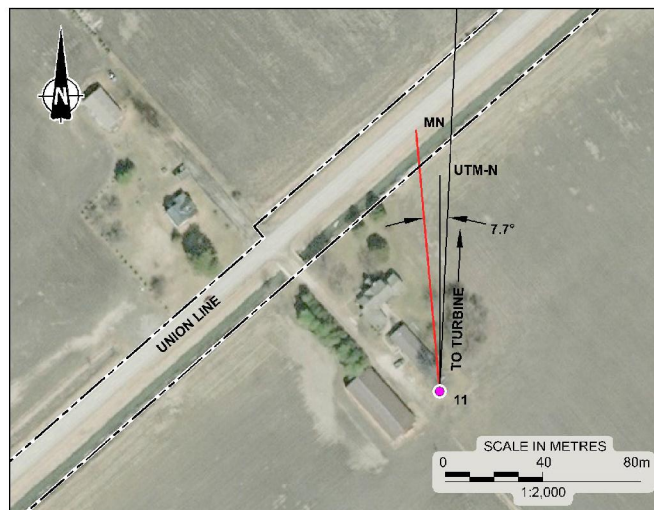
THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T43			
	PROJECT NO.	1668031	FILE NO. 1668031-2000-RC2143
	DATE	09/21/17	SCALE AS SHOWN
	CHG	09/21/17	REV.
			FIGURE T43

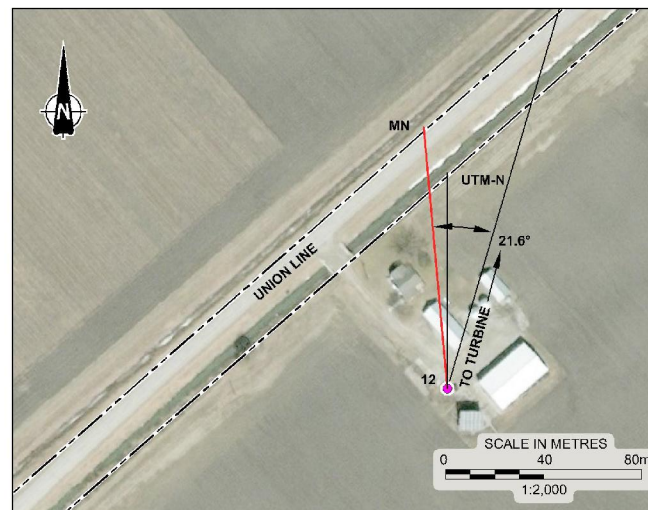
Drawing file: '608021-2000-RC2145.dwg' Sep '08, 2017 - 2:07pm



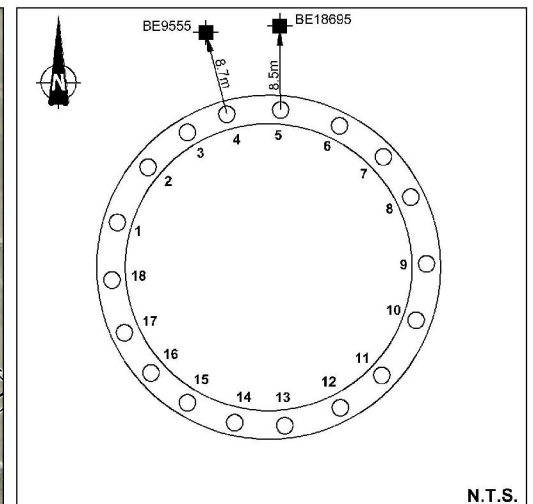
SITE PLAN



INSET A (WELL #11)



INSET B (WELL #12)



TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

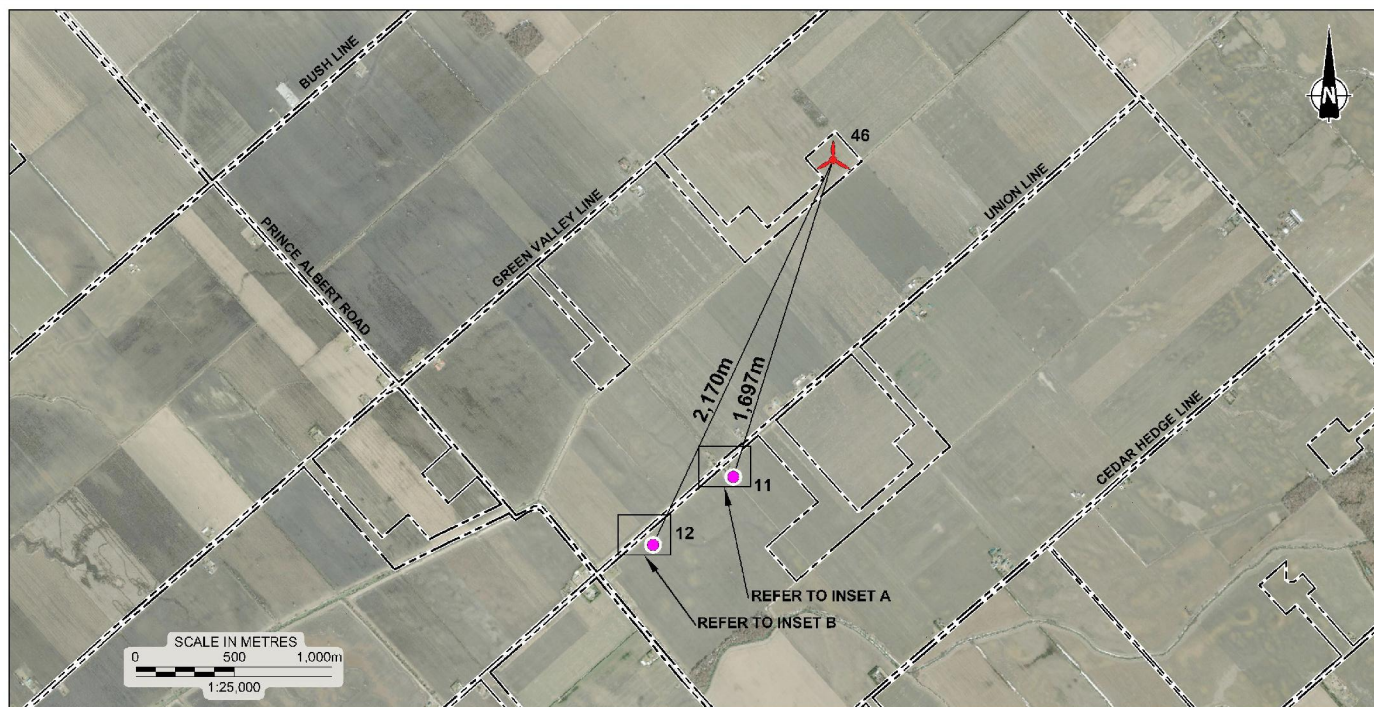
REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUTIVE, PROJECT No. C017-0190, DWG No. S002.

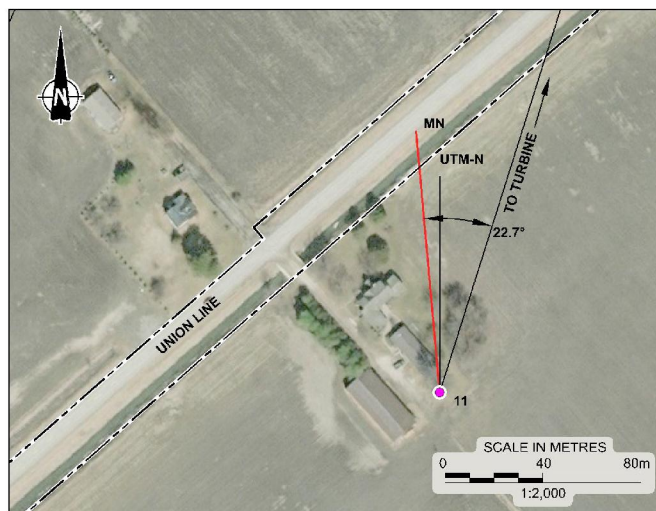
NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE.

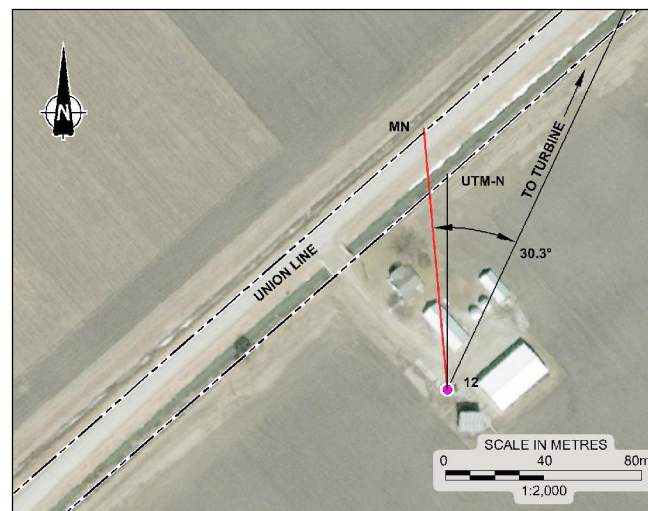
PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T45			
	PROJECT NO.	1668031	FILE NO. 1668031-2000-RC2145
	DRAWN	DCH/ZLB	DATE: 18/17
	CHECKED		SCALE: AS SHOWN
			FIGURE T45



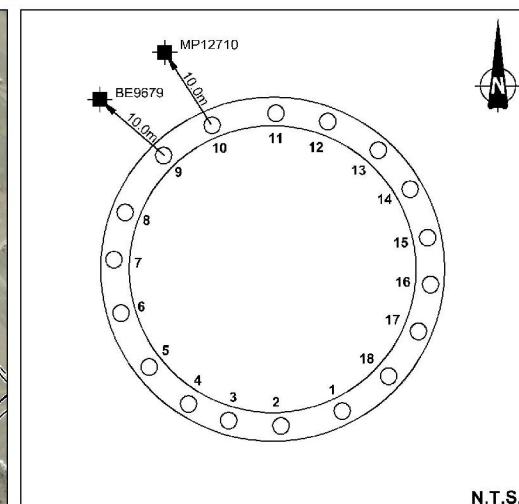
SITE PLAN



INSET A (WELL #11)



INSET B (WELL #12)



N.T.S.

TURBINE PILE LAYOUT

LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUTIVE, PROJECT No. C017-0190, DWG No. SC02.

NOTES

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT			
NORTH KENT 1 VIBRATION MONITORING			
TITLE			
TURBINE PILES AND WATER WELL LOCATION PLAN, T46			
	PROJECT No.	1668031	FILE No. 1668031-2000-R02T46
	DATE	DCH/ZLB	Sept. 18/17
	CHECK		
	SCALE	AS SHOWN	REV.
FIGURE T46			



AECOM

Attachment C

Water Quality Data

**CLIENT NAME: AECOM CANADA LTD
105 COMMERCE VALLEY DR.W 7TH FLOOR
MARKHAM, ON L3T7W3
(905) 886-7022**

ATTENTION TO: Erin Wilson

PROJECT: 60343599

AGAT WORK ORDER: 17T181834

MICROBIOLOGY ANALYSIS REVIEWED BY: Inesa Alizarchyk, Inorganic Lab Supervisor

WATER ANALYSIS REVIEWED BY: Mike Muneswar, BSc (Chem), Senior Inorganic Analyst

DATE REPORTED: Feb 07, 2017

PAGES (INCLUDING COVER): 9

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

***NOTES**

VERSION 1: Partial report sent January 30, 2017.

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 17T181834

PROJECT: 60343599

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: AECOM CANADA LTD

SAMPLING SITE:

ATTENTION TO: Erin Wilson

SAMPLED BY: D. D.

Microbiological Analysis (water)

DATE RECEIVED: 2017-01-27

DATE REPORTED: 2017-02-07

007500067

SAMPLE DESCRIPTION:

SAMPLE TYPE:

Water

DATE SAMPLED:

2017-01-26

Parameter	Unit	G / S	RDL	8152989
Escherichia coli	CFU/100mL	0	1	ND
Total Coliforms	CFU/100mL	0	1	ND

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to SDWA - Microbiology
8152989 ND - Not Detected.

Certified By:



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 17T181834

PROJECT: 60343599

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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<http://www.agatlabs.com>

CLIENT NAME: AECOM CANADA LTD

ATTENTION TO: Erin Wilson

SAMPLING SITE:

SAMPLED BY: D. D.

North Kent - Groundwater Samples

DATE RECEIVED: 2017-01-27

DATE REPORTED: 2017-02-07

007500067

SAMPLE DESCRIPTION:

SAMPLE TYPE:

Water

DATE SAMPLED:

2017-01-26

Parameter	Unit	G / S	RDL	8152989
Electrical Conductivity	uS/cm		2	1310
pH	pH Units	(6.5-8.5)	NA	8.32
Total Hardness (as CaCO ₃)	mg/L	(80-100)	0.5	75.7
Total Dissolved Solids	mg/L	500	20	712
Total Suspended Solids	mg/L		10	<10
Alkalinity (as CaCO ₃)	mg/L	(30-500)	5	386
Fluoride	mg/L	1.5	0.10	0.89
Chloride	mg/L	250	0.50	215
Nitrate as N	mg/L	10.0	0.10	<0.10
Nitrite as N	mg/L	1.0	0.10	<0.10
Bromide	mg/L		0.10	<0.10
Sulphate	mg/L	500	0.20	<0.20
Ammonia as N	mg/L		0.02	0.18
Dissolved Organic Carbon	mg/L	5	0.5	1.9
Colour	TCU	5	5	18
Turbidity	NTU	5	0.5	5.0
Calcium	mg/L		0.10	20.1
Magnesium	mg/L		0.10	6.19
Sodium	mg/L	20 (200)	0.10	253
Potassium	mg/L		0.10	2.14
Iron	mg/L	0.3	0.010	0.422
Manganese	mg/L	0.05	0.002	0.023

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to O.Reg.169/03(mg/L)

8152989 Elevated RDLs for Anions & Cations indicate the degree of dilution prior to analysis in order to keep analytes within the calibration range of the instruments and to reduce matrix interferences.

Certified By:



Guideline Violation

AGAT WORK ORDER: 17T181834

PROJECT: 60343599

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: AECOM CANADA LTD

ATTENTION TO: Erin Wilson

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
8152989	007500067	O.Reg.169/03(mg/L)	North Kent - Groundwater Samples	Colour	TCU	5	18
8152989	007500067	O.Reg.169/03(mg/L)	North Kent - Groundwater Samples	Iron	mg/L	0.3	0.422
8152989	007500067	O.Reg.169/03(mg/L)	North Kent - Groundwater Samples	Sodium	mg/L	20 (200)	253
8152989	007500067	O.Reg.169/03(mg/L)	North Kent - Groundwater Samples	Total Dissolved Solids	mg/L	500	712

Quality Assurance

CLIENT NAME: AECOM CANADA LTD

PROJECT: 60343599

SAMPLING SITE:

AGAT WORK ORDER: 17T181834

ATTENTION TO: Erin Wilson

SAMPLED BY: D. D.

Microbiology Analysis

RPT Date: Feb 07, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE	
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper

Microbiological Analysis (water)

Escherichia coli	8152989	8152989	ND	ND	NA	< 1
Total Coliforms	8152989	8152989	ND	ND	NA	< 1

Comments: ND – Not detected; NA - % RPD Not Applicable

Microbiological Analysis (water)

Escherichia coli	8153062	8153062	ND	ND	NA	< 1
Total Coliforms	8153062	8153062	5	4	NA	< 1

Comments: ND – Not detected; NA - % RPD Not Applicable

NA - % RPD Not Reportable based on the number of colonies count acceptable for RPD calculation

Certified By:



Quality Assurance

CLIENT NAME: AECOM CANADA LTD

PROJECT: 60343599

SAMPLING SITE:

AGAT WORK ORDER: 17T181834

ATTENTION TO: Erin Wilson

SAMPLED BY: D. D.

Water Analysis															
RPT Date: Feb 07, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
North Kent - Groundwater Samples															
Electrical Conductivity	8153041	8153041	758	762	0.5%	< 2	103%	80%	120%	NA				NA	
pH	8153041	8153041	8.33	8.20	1.6%	NA	100%	90%	110%	NA				NA	
Total Dissolved Solids	8153041	8153041	428	422	1.4%	< 20	100%	80%	120%	NA				NA	
Total Suspended Solids	8149764		<10	<10	NA	< 10	100%	80%	120%	NA				NA	
Alkalinity (as CaCO3)	8153041	8153041	329	328	0.3%	< 5	97%	80%	120%	NA				NA	
Fluoride	8161424		0.49	0.45	8.5%	< 0.05	95%	90%	110%	98%	90%	110%	104%	80%	120%
Chloride	8161424		33.6	33.6	0.0%	< 0.10	98%	90%	110%	102%	90%	110%	89%	80%	120%
Nitrate as N	8161424		0.45	0.45	0.0%	< 0.05	100%	90%	110%	104%	90%	110%	111%	80%	120%
Nitrite as N	8161424		<0.05	<0.05	NA	< 0.05	NA	90%	110%	102%	90%	110%	90%	80%	120%
Bromide	8161424		<0.05	<0.05	NA	< 0.05	110%	90%	110%	92%	90%	110%	94%	80%	120%
Sulphate	8161424		28.2	28.2	0.0%	< 0.10	96%	90%	110%	95%	90%	110%	96%	80%	120%
Ammonia as N	8152989	8152989	0.18	0.18	0.0%	< 0.02	107%	90%	110%	97%	90%	110%	100%	80%	120%
Dissolved Organic Carbon	8152989	8152989	1.9	1.7	NA	< 0.5	100%	90%	110%	106%	90%	110%	94%	80%	120%
Colour	8161451		56	56	0.0%	< 5	102%	90%	110%	NA				NA	
Turbidity	8152989	8152989	5.0	5.0	0.0%	< 0.5	109%	90%	110%	NA				NA	
Calcium	8153005	8153005	11.9	11.7	1.7%	< 0.05	101%	90%	110%	101%	90%	110%	100%	70%	130%
Magnesium	8153005	8153005	4.75	4.80	1.0%	< 0.05	96%	90%	110%	97%	90%	110%	95%	70%	130%
Sodium	8153005	8153005	176	174	1.1%	< 0.05	102%	90%	110%	101%	90%	110%	98%	70%	130%
Potassium	8153005	8153005	1.47	1.51	2.7%	< 0.05	99%	90%	110%	99%	90%	110%	98%	70%	130%
Iron	8152989	8152989	0.422	0.431	2.1%	< 0.010	98%	90%	110%	94%	90%	110%	89%	70%	130%
Manganese	8152989	8152989	0.023	0.023	0.0%	< 0.002	103%	90%	110%	107%	90%	110%	80%	70%	130%

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By:



Method Summary

CLIENT NAME: AECOM CANADA LTD

PROJECT: 60343599

SAMPLING SITE:
AGAT WORK ORDER: 17T181834

ATTENTION TO: Erin Wilson

SAMPLED BY: D. D.

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Microbiology Analysis			
Escherichia coli	MIC-93-7010	EPA 1604	Membrane Filtration
Total Coliforms	MIC-93-7010	EPA 1604	Membrane Filtration
Water Analysis			
Electrical Conductivity	INOR-93-6000	SM 2510 B	PC TITRATE
pH	INOR-93-6000	SM 4500-H+ B	PC TITRATE
Total Hardness (as CaCO ₃)	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Total Dissolved Solids	INOR-93-6028	SM 2540 C	BALANCE
Total Suspended Solids	INOR-93-6028	SM 2540 D	BALANCE
Alkalinity (as CaCO ₃)	INOR-93-6000	SM 2320 B	PC TITRATE
Fluoride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Chloride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrate as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Bromide	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-93-6059	QuikChem 10-107-06-1-J & SM 4500 NH ₃ -F	LACHAT FIA
Dissolved Organic Carbon	INOR-93-6049	EPA 415.1 & SM 5310 B	SHIMADZU CARBON ANALYZER
Colour	INOR-93-6046	SM 2120 B	SPECTROPHOTOMETER
Turbidity	INOR-93-6044	SM 2130 B	NEPHELOMETER
Calcium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Magnesium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Sodium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Potassium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Iron	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Manganese	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS

CLIENT NAME: AECOM CANADA LTD
105 COMMERCE VALLEY DR.W 7TH FLOOR
MARKHAM, ON L3T7W3
(905) 886-7022

ATTENTION TO: Jason Murchison

PROJECT: 60343599

AGAT WORK ORDER: 17T250347

MICROBIOLOGY ANALYSIS REVIEWED BY: Inesa Alizarchyk, Inorganic Lab Supervisor

WATER ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

DATE REPORTED: Aug 23, 2017

PAGES (INCLUDING COVER): 8

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 17T250347

PROJECT: 60343599

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: AECOM CANADA LTD

SAMPLING SITE:

ATTENTION TO: Jason Murchison

SAMPLED BY:JM

Microbiological Analysis (water)

DATE RECEIVED: 2017-08-18

DATE REPORTED: 2017-08-19

007500067



SAMPLE DESCRIPTION:

SAMPLE TYPE:

Water

DATE SAMPLED:

2017-08-17

Parameter

Unit

G / S

RDL

8648901

Escherichia coli

CFU/100mL

0

1

ND

Total Coliforms

CFU/100mL

0

1

ND

Comments:

RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to SDWA - Microbiology

Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8648901

ND - Not Detected.

Certified By:



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 17T250347

PROJECT: 60343599

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: AECOM CANADA LTD

SAMPLING SITE:

ATTENTION TO: Jason Murchison

SAMPLED BY:JM

Inorganic Chemistry (Water)

DATE RECEIVED: 2017-08-18

DATE REPORTED: 2017-08-23

007500067



SAMPLE DESCRIPTION:

SAMPLE TYPE: Water

DATE SAMPLED: 2017-08-17

8648901

Parameter	Unit	G / S	RDL	
Electrical Conductivity	uS/cm		2	1360
pH	pH Units	(6.5-8.5)	NA	8.40
Total Hardness (as CaCO3)	mg/L	(80-100)	0.5	76.7
Total Dissolved Solids	mg/L	500	20	702
Total Suspended Solids	mg/L		10	<10
Dissolved Organic Carbon	mg/L	5	0.5	1.4
Alkalinity (as CaCO3)	mg/L	(30-500)	5	400
Fluoride	mg/L	1.5	0.05	1.02
Chloride	mg/L	250	0.50	193
Nitrate as N	mg/L	10.0	0.05	<0.05
Nitrite as N	mg/L	1.0	0.05	<0.05
Bromide	mg/L		0.05	0.73
Sulphate	mg/L	500	0.10	<0.10
Ammonia as N	mg/L		0.02	0.28
Colour	TCU	5	5	16
Turbidity	NTU	5	0.5	1.9
Calcium	mg/L		0.10	20.4
Magnesium	mg/L		0.10	6.26
Sodium	mg/L	20 (200)	0.10	257
Potassium	mg/L		0.10	2.21
Iron	mg/L	0.3	0.010	0.196
Manganese	mg/L	0.05	0.002	0.022
% Difference/ Ion Balance	%		NA	2.72

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to O.Reg.169/03(mg/L)

Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Certified By:

Divine Basily



Guideline Violation

AGAT WORK ORDER: 17T250347

PROJECT: 60343599

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
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TEL (905)712-5100
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CLIENT NAME: AECOM CANADA LTD

ATTENTION TO: Jason Murchison

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
8648901	007500067 ([REDACTED])	O.Reg.169/03(mg/L)	Inorganic Chemistry (Water)	Colour	TCU	5	16
8648901	007500067 ([REDACTED])	O.Reg.169/03(mg/L)	Inorganic Chemistry (Water)	Sodium	mg/L	20 (200)	257
8648901	007500067 ([REDACTED])	O.Reg.169/03(mg/L)	Inorganic Chemistry (Water)	Total Dissolved Solids	mg/L	500	702



Quality Assurance

CLIENT NAME: AECOM CANADA LTD

PROJECT: 60343599

SAMPLING SITE:

AGAT WORK ORDER: 17T250347

ATTENTION TO: Jason Murchison

SAMPLED BY:JM

Microbiology Analysis

RPT Date:			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Microbiological Analysis (water)

Escherichia coli	8646198	ND	ND	NA	< 1
Total Coliforms	8646198	ND	ND	NA	< 1

Comments: ND – Not detected; NA - % RPD Not Applicable

Certified By:

Quality Assurance

CLIENT NAME: AECOM CANADA LTD

PROJECT: 60343599

SAMPLING SITE:

AGAT WORK ORDER: 17T250347

ATTENTION TO: Jason Murchison

SAMPLED BY: JM

Water Analysis															
RPT Date:			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Inorganic Chemistry (Water)															
Electrical Conductivity	8653842		24600	24300	1.2%	< 2	103%	80%	120%						
pH	8653842		9.38	9.57	2.0%	NA	99%	90%	110%						
Total Dissolved Solids	8648901	8648901	702	728	3.6%	< 20	98%	80%	120%						
Total Suspended Solids	8652502		<10	<10	NA	< 10	98%	80%	120%						
Dissolved Organic Carbon	8650140		4.2	4.5	6.9%	< 0.5	92%	90%	110%	104%	90%	110%	95%	80%	120%
Alkalinity (as CaCO3)	8653842		321	311	3.2%	< 5	100%	80%	120%						
Fluoride	8648837		1.09	1.09	0.0%	< 0.05	103%	90%	110%	99%	90%	110%	108%	80%	120%
Chloride	8648837		216	222	2.7%	< 0.10	91%	90%	110%	107%	90%	110%	101%	80%	120%
Nitrate as N	8648837		<0.25	<0.25	NA	< 0.05	92%	90%	110%	103%	90%	110%	99%	80%	120%
Nitrite as N	8648837		<0.25	<0.25	NA	< 0.05	NA	90%	110%	107%	90%	110%	109%	80%	120%
Bromide	8648837		<0.25	<0.25	NA	< 0.05	101%	90%	110%	99%	90%	110%	115%	80%	120%
Sulphate	8648837		<0.50	<0.50	NA	< 0.10	95%	90%	110%	105%	90%	110%	101%	80%	120%
Ammonia as N	8648822		0.25	0.25	0.0%	< 0.02	108%	90%	110%	92%	90%	110%	82%	80%	120%
Colour	8649975		<5	<5	NA	< 5	107%	90%	110%						
Turbidity	8648901	8648901	1.9	1.9	NA	< 0.5	107%	90%	110%						
Calcium	8651247		86.7	83.0	4.4%	< 0.05	100%	90%	110%	101%	90%	110%	97%	70%	130%
Magnesium	8651247		17.5	17.1	2.3%	< 0.05	98%	90%	110%	99%	90%	110%	96%	70%	130%
Sodium	8651247		84.3	80.6	4.5%	< 0.05	101%	90%	110%	101%	90%	110%	97%	70%	130%
Potassium	8651247		1.14	1.08	5.4%	< 0.05	96%	90%	110%	96%	90%	110%	99%	70%	130%
Iron	8649986		<0.010	<0.010	NA	< 0.010	92%	90%	110%	96%	90%	110%	75%	70%	130%
Manganese	8649986		0.763	0.772	1.2%	< 0.002	101%	90%	110%	102%	90%	110%	100%	70%	130%

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By:

Divine Basily

1

Method Summary

CLIENT NAME: AECOM CANADA LTD

PROJECT: 60343599

SAMPLING SITE:

AGAT WORK ORDER: 17T250347

ATTENTION TO: Jason Murchison

SAMPLED BY:JM

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Microbiology Analysis			
Escherichia coli	MIC-93-7010	EPA 1604	Membrane Filtration
Total Coliforms	MIC-93-7010	EPA 1604	Membrane Filtration
Water Analysis			
Electrical Conductivity	INOR-93-6000	SM 2510 B	PC TITRATE
pH	INOR-93-6000	SM 4500-H+ B	PC TITRATE
Total Hardness (as CaCO ₃)	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Total Dissolved Solids	INOR-93-6028	SM 2540 C	BALANCE
Total Suspended Solids	INOR-93-6028	SM 2540 D	BALANCE
Dissolved Organic Carbon	INOR-93-6049	EPA 415.1 & SM 5310 B	SHIMADZU CARBON ANALYZER
Alkalinity (as CaCO ₃)	INOR-93-6000	SM 2320 B	PC TITRATE
Fluoride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Chloride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrate as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Bromide	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-93-6059	QuikChem 10-107-06-1-J & SM 4500 NH ₃ -F	LACHAT FIA
Colour	INOR-93-6046	SM 2120 B	SPECTROPHOTOMETER
Turbidity	INOR-93-6044	SM 2130 B	NEPHELOMETER
Calcium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Magnesium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Sodium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Potassium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Iron	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Manganese	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
% Difference/ Ion Balance		SM 1030 E	CALCULATION



AECOM