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# Technical Memorandum

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|---|---|---|---|
| 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)**<br>**Well Water Impact Complaint Investigation**<br>[redacted] **- PIN 007420011,** [redacted] **(Dresden, ON)** | | |
| From | Jason Murchison, P.Geo. | | |
| Date | January 25th, 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 a water well impact complaint that was received via the NKW1 project's toll-free line on 27-October-2017 (exact time unspecified) from [redacted], the property owner of [redacted] (Dresden, ON). Upon receipt of the complaint, email notification was provided by NKW1 (Mr. Joshua Vaidhyan) to Ms. Deb Jacobs, Environmental Officer, with the Ministry of the Environment and Climate Change (MOECC), Windsor Area Office that same day.

In brief, Mr. Vaidhyan describes the well interference complaint as follows:

> *We received a complaint on the Project's toll-free line, below.*
>
> *PIN 007420077*
> [redacted]
> *Phone:* [redacted]
>
> *Background /Issue*
>
> *Sept 28 – Wife was cleaning up to prepare the place to be rented.* [redacted] *turned on the pump and pressure was 28 to 34 and took around 10 minutes to get there. He shut the pump off because it wasn't quite right. Then Oct 1st there was no water and he tried priming several times. Still no water at present time.* [redacted] *contacted Kevin Jakubec who suggested he report under section G5 and G6 and request water immediately.*
>
> *AECOM will be following up with this landowner. I will inform you regarding the date they schedule the sampling.*
>
> *Looks like this property is about 1.3 kms from T35.*

It is noted that the PIN stated in the complaint description above is incorrect. The correct PIN for the [redacted] property, located at [redacted], is 007420011, as stated in the Subject Line of this TM.

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) to immediately undertake the following:<br>(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;<br>(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,<br>(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. | Steps undertaken to satisfy the requirements of Condition G5 are summarized, as follows:<br>(1) AECOM was retained by NKW1 to investigate a Well Interference Complaint received via the NKW1 Project's toll-free line on 27-October-2017.<br>(2) AECOM arranged directly with the property owner an appointment to visit the property at 1:00pm on 30-October-2017 (appointment based on property owner availability).<br>(3) Tasks completed by AECOM during the well interference complaint site visit included:<br>i) interview with the property owner regarding their reported well interference issue(s); and,<br>ii) digital photographs of pertinent site features (eg. well, water treatment equipment, etc.). A raw (untreated) groundwater sample was not collected as the pumping system at the property was not primed at the time of our site visit.<br>(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 30-October-2017 site visit to the subject property, a series of seven (7) standard questions were raised with the property owner ([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" | • Installed iron filter end of May / beginning of June and have had no issues with water quality.<br>• 14-September-2017: Pressure wash exterior of house with no issues.<br>• 19-September-2017: Pressure tank pumping up was noticeably slower.<br>• 28-September-2017: Pressure down on tank (very slow).<br>• 1-October-2017: Tenant to move in, no water at all. |

| | |
|---|---|
| | • Have tried pump since, still no water. |
| "What do you think is the cause?" | • Sediment from pile driving. |
| "When did you first notice the problem (Date/Time)?" | • 19-September-2017. |
| "Is the problem still occurring?" | • Yes. |
| "Do you have an alternate source of potable water (i.e. municipal water)?" | • No. |
| "Were you provided a temporary supply of potable water?" | • 27-October-2017: Drinking water provided.<br>• 31-October-2017: Water tank scheduled for delivery. |
| "Did you participate in the Detailed Well Assessment program prior to construction?" | • Yes |

Upon completion of the questionnaire, [redacted] was provided an opportunity to review the responses detailed in **Table 2** and was in agreement that the information provided was accurate to the best of his knowledge.

At the time of our site visit, the property owner provided copies of various water quality analysis results that reportedly were obtained from the site well. Unfortunately, with the exception of a baseline sample collected on 22-January-2017, AECOM did not undertake or witness the collection of any of these samples, nor are we able to independently verify the sampling, preservation and/or analytical methods used in the collection and testing of these samples. As a result, this information was not considered as part of the current complaint investigation.

## 3. Construction Activities and Vibration Monitoring

Within a two (2) week timeframe preceding [redacted]' reported outset of well impact (19-September-2017), pile driving for foundation construction as part of the NKW1 project was completed at the following four (4) turbine locations:

- T27 – September 15th @ 8,100 m Northwest
- T26 – September 14th & 15th @ 8,300 m Northwest
- T14 – September 11th & 18th @ 8,800 m Northwest
- T44 – September 18th @ 10,100 m Northwest
- T33 – September 5th & 6th @ 12,700 m Northwest

Although work was completed more than two (2) months prior to the reported outset of well impact at the [redacted] property, the closest turbine location (T35) also was assessed as part of the current complaint investigation.

- T35 – June 24th, 26th, 28th to 30th, July 4th & 6th @ 1,200 m Southwest

Approximate directions and distances away from the subject property are provided above for reference purposes.

Monitoring of vibration effects during pile driving at T35, T27, T26, T14, T44 and T33 relating to proximity and timing of the well impact reported by the property owner 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 local

private water well supplies. Local well supplies monitored by GAL during pile driving at the abovementioned six (6) turbine locations (including offset distances from the location of work) is summarized as follows:

- T35 – Well 5 ([redacted], 623 m) & Well 6 ([redacted] 880 m)
- T27 – Well 13 ([redacted] 2,326 m) & Well 14 ([redacted]., 1,705 m)
- T26 – Well 13 ([redacted]., 1,552 m) & Well 14 ([redacted]., 1,011 m)
- T14 – Well 13 ([redacted]., 841 m) & Well 14 ([redacted]., 580 m)
- T44 – Well 13 ([redacted]., 786 m) & Well 14 ([redacted]., 901 m)
- T33 – Well 3 ([redacted], 1,778 m) & Well 4 [redacted]., 2,080 m)

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 25-January-2018.

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-2017 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 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.*

The interpretation and conclusions above are reconfirmed by GAL within their site-specific assessment letter, dated 25-January-2017, which reads:

*The well at [redacted] was typically farther from the pile driving than the wells that were monitored for vibrations and more than 6.8 km from pile driving on the day the well issues were noted. Based on data available to-date from the test pile and construction monitoring programs, the distances between pile driving and [redacted], the dates on which pile driving occurred and the dates on which the complaints were first noted, it is our opinion that the well would not have experienced pile driving-induced vibrations of any consequence at the time of the complaints and any such vibrations would have been significantly less than those summarized in Table 1. Vibrations associated with pile driving would not be discernable from background*

*conditions at this well given the separation distances and, therefore, would be two or more orders of magnitude smaller than the threshold defined by Ontario NPC-207 (0.3 mm/s), one or more orders of magnitude smaller than nighttime vibration thresholds suggested by ASHRAE (0.144 mm/s, 8 to 80 Hz) and one or more orders of magnitude smaller 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 and distances between pile driving and the well, that vibrations associated with pile driving would be significantly less than may be induced by other common day-to-day sources at the well site and inconsequential for the [redacted] well.*

## 4. Well Construction Details

**Table 3** provides a summary of available construction details for the water well located at [redacted], based on details provided to AECOM by [redacted] during AECOM's 30-October-2017 well interference complaint site visit, as well as information provided by the property owner on their completed water well survey (WWS) form and during our baseline site visit on 22-January-2017.

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

Visual condition assessment and measurement of well details (eg. type, total depth, water level, etc.) was unable to be completed by AECOM during our 30-October-2017 site visit due to the wellhead being sealed and installed through the concrete floor of a small shed to the rear of the residence.

**TABLE 3:** REPORTED PRIVATE WELL CONSTRUCTION DETAILS

| DETAILS | [redacted] (PIN 007420011) |
|---|---|
| Well Tag # | *Unconfirmed* |
| Well ID | *Unconfirmed* |
| Installation Date | *Unconfirmed* |
| Well Location | Rear of Property, through concrete floor in basement of small shed structure (as observed) |
| Contractor | *Unconfirmed* |
| Contractor No. | *Unconfirmed* |
| Construction Method | *Unconfirmed* |
| Total Depth | 15.2 to 18.3 m (50 to 60')<br>(Property owner estimate) |
| Target Formation | *Unconfirmed* |
| Casing Length | *Unconfirmed* |
| Casing Diameter | 100 mm / 4" |
| Casing Material | Steel (at / above concrete basement floor),<br>below ground well components unconfirmed |
| Casing Stick-Up | Below Grade (0.39 m above basement floor) |
| Annular Seal | *Unconfirmed* |
| Sealant Type | *Unconfirmed* |
| Well Screen Installed? | *Unconfirmed* |
| Well Screen Details | *Unconfirmed* |
| Well Screen Interval | *Unconfirmed* |

| DETAILS | [redacted] (PIN 007420011) |
|---|---|
| Well Cover Type | Compression type |
| Pump Intake Depth | *Unconfirmed* |
| Pumping Rate | *Unconfirmed* |
| Well Pump Type | Jet Pump (as observed) |
| Well Pump Size | ½ hp (as observed) |
| Static Level | *Unconfirmed* |
| Pumping Level | *Unconfirmed* |

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

A photograph of the well, as observed during our 30-October-2017 site visit is provided as **Photo 1**.



**PHOTO 1: Site Well (Installed through basement floor in shed at rear of property)**

### 4.1 Limited Well Flow Rate Testing and Pumping System Assessment

During our well interference complaint visit to the [redacted] property on 30-October-2017, a limited flow rate test was planned to be completed to assess the current capacity of the ½ hp jet pump (Berkeley® Model: 5SN) that is connected to the well. Unfortunately, at the time of our site attendance the pump was not primed and, as a result, neither flow testing nor water quality sampling could be completed.

It is recommended that the property owner contact an MOECC-licenced well pump contractor (Class 1 / Class 4) to assess the current condition of the well, pump (including downhole components) and filtration system, and to make any necessary replacements, repairs or re-arrangements, as necessary.

## 5. Water Quality Data

**Table 4** provides a summary of available groundwater quality data for the site well. The laboratory Certificate of Analysis for the sample is included as **Attachment C**.

**TABLE 4:** PRIVATE WELL SAMPLING SUMMARY

| LOCATION | SAMPLED BY | DATE | TYPE | PURPOSE |
|---|---|---|---|---|
| [redacted] | AECOM | 22-January-2017 | Raw (Untreated) | Baseline |

## 5.1 Discussion

Available raw (untreated) groundwater sampling data for the well indicates the presence of a relatively poor baseline raw (untreated) groundwater quality, with elevated levels of total dissolved solids, colour, fluoride, and sodium, along with low hardness, as shown in **Table 5**. The reader is reminded that a raw (untreated) water sample was not able to be obtained during AECOM's 30-October-2017 site visit due to a lack of prime at the well pump.

**TABLE 5:** RAW (UNTREATED) GROUNDWATER SAMPLING RESULTS

| PARAMETER | ODWQS CRITERIA | ODWQS TYPE | BASELINE (22-January-2017) | COMPLAINT INVESTIGATION (30-October-2017) |
|---|---|---|---|---|
| Escherichia coli | 0 CFU/100mL | MAC | Non detection | *No Sampling* |
| Total Coliforms | 0 CFU/100mL | MAC | Non detection | *Completed* |
| Electrical Conductivity | -- | -- | 960 µS/cm | -- |
| pH | 6.5 – 8.5 | OG | 8.29 | -- |
| Total Hardness (as $CaCO_3$) | 80 – 100 mg/L | OG | **46.7 mg/L** | -- |
| Total Dissolved Solids | 500 mg/L | AO | **540 mg/L** | -- |
| Total Suspended Solids | -- | -- | <10 mg/L | -- |
| Alkalinity (as $CaCO_3$) | 30 – 500 mg/L | OG | 325 mg/L | -- |
| Fluoride | 1.5 | MAC | **1.52 mg/L** | -- |
| Chloride | 250 | AO | 115 mg/L | -- |
| Nitrate as N | 10 | MAC | <0.05 mg/L | -- |
| Nitrite as N | 1 | MAC | <0.05 mg/L | -- |
| Bromide | -- | -- | <0.05 mg/L | -- |
| Sulphate | 500 mg/L | AO | <0.10 mg/L | -- |
| Ammonia as N | -- | -- | 0.17 mg/L | -- |
| Dissolved Organic Carbon | 5 mg/L | AO | 1.0 mg/L | -- |
| Colour | 5 TCU | AO | **22 TCU** | -- |
| Turbidity | 5 NTU | AO | <0.5 NTU | -- |
| Calcium | -- | -- | 13.1 mg/L | -- |
| Magnesium | -- | -- | 3.39 mg/L | -- |
| Sodium | 200 mg/L | AO | 188 mg/L | -- |
| Potassium | -- | -- | 2.19 mg/L | -- |
| Iron | 0.300 mg/L | AO | <0.010 mg/L | -- |
| Manganese | 0.050 mg/L | AO | 0.014 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 22-January-2017, no water treatment devices reportedly were present. During AECOM's 30-October-2017 site visit however, a chemical-free iron filter (EcoWater System) was observed to have been installed on the distribution side of the property's plumbing system (ie. downstream of well pump and pressure tank). According to [redacted], the filter unit was installed in late-May / early-June 2017 to remove a minor amount of iron in the well water. The residence is a rental property and has been vacant since June 2017.

A sample of raw (untreated) groundwater was obtained by AECOM during our 22-January-2017 baseline sampling program using an exterior faucet installed at the rear of the residence. Prior to sampling, the faucet was permitted to flush thoroughly (minimum period of 5 minutes) with the pumped water being directed into a pail. Prior to sample collection, the faucet orifice was disinfected (using chlorine) and flushed. Clean nitrile gloves were worn by AECOM staff during sample collection.

The collected groundwater sample was examined in the field (both visual and olfactory) and then immediately placed in laboratory-supplied sample bottles prepared in advance with the appropriate preservatives. Each sample bottle was sealed, labeled and stored on ice to maintain a temperature of 10°C or lower during transportation under chain of custody documentation to a CALA-accredited environmental analytical laboratory within the specified analyte holding times.

An exceedance of the health-related criteria limit of the Ontario Drinking Water Quality Standards (ODWQS) for Fluoride of 1.52 mg/L (limit = 1.50 mg/L) was detected in the baseline sample collected from the site well. No other exceedances of health-related parameters, including Escherichia coli and Total Coliform bacteria, Nitrate (as N), and/or Nitrite (as N) were detected in the baseline raw (untreated) groundwater sample 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, the turbidity level in the baseline sample was reported to be less than the laboratory's Reference Detection Limit (RDL) of 0.5 NTU, being below the ODWQS AO limit.

Total suspended solids (TSS) levels within the baseline sample obtained from the site well was reported to be less than the laboratory's Reference Detection Limit (RDL) of 10 mg/L, indicating a lack of detectable sediment load in the raw (untreated) groundwater pumped from the well. An ODWQS criteria limit has not been established for this parameter.

The potential for groundwater quality impact(s) associated with pile driving is both proximity and time-dependent and related to the intensity and propagation of ground-borne vibration. In the case of pile driving at T35, T27, T26, T14, T44 and T33, no significant vibrations attributed to pile driving were detected either in close proximity to the work areas, nor at any of the monitored private wells, as reported by GAL and discussed previously in **Section 3**. Based on GAL's monitoring data, timing of the work completed, onset of reported well impact, and separation distance which exists between the

turbine sites and the [redacted] well supply at [redacted], the suspension of particles within or in its immediate vicinity is not considered plausible.

As an alternate consideration, to have the potential to impact the subject well, vibration impacts in the immediate vicinity of pile driving at T35, T27, T26, T14, T44 and T33 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 turbine locations. Factors (ii) and (iii) above are not considered plausible in the context of the local hydrogeological setting (ie. potential hydraulic gradient and groundwater travel times) and vibration monitoring data collected by GAL.

# 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 well supply issue reported by the property owner of [redacted] (PIN 007420011) does *not* appear to be as a result of NKW1 turbine foundation construction or pile-driving activities from a vibration monitoring perspective. However, due to a lack of prime in the well pumping system at the time of our complaint investigation site visit on 30-October-2017, flow testing of the well pump and sampling for analysis of current raw (untreated) groundwater quality was unable to be completed by AECOM. As a result, we are not presently able to fulfill the requirements of *Condition G5* of REA No. 5272-A9FHRL with regard to the [redacted] property located at [redacted].

The water well complaint submitted by the property owner appears to be related to local water system issues versus an area-wide impact to the local groundwater system. As noted within this report, assessment by a qualified professional of the current condition (including completion of any necessary repairs / replacement) of the on-site well supply, pumping equipment and treatment system is recommended. AECOM welcomes an opportunity to re-visit the [redacted] property at [redacted] on a future date, once the current well pump issues have been rectified, to re-sample the well such that we can provide a more fulsome response in respect of REA *Condition G5*.

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 --*

# Attachments

# Attachment A

## Correspondence

**From:** Joshua Vaidyan [mailto:j.vaidhyan@samsung.com]
**Sent:** Friday, October 27, 2017 11:30 AM
**To:** 'Jacobs, Deb (MOECC)'
**Cc:** 'Gilbert, Teri (MOECC)'; 'Smith, Mark (MOECC)'; 'Harman, Bruce (MOECC)'; 'Thuss, Simon (MOECC)'; 'Moroney, Michael (MOECC)'; 'Lehouillier, Jason (MOECC)'; 'McDonald, Dan (MOECC)'; 'Pat Murray'; Murchison, Jason; 'Sre.Bop'; 'Boone, Storer'; 'Colella, Nick (MOECC)'; 'Keyvani, Mohsen (MOECC)'; 'Jody Law'; Van der Woerd, Mark
**Subject:** New Complaint - [redacted] ([redacted])_North Kent 1

Hi Deb,

We received a complaint on the Project's toll-free line, below.

PIN 007420077
[redacted]
Phone: [redacted]

Background / Issue
Sept 28- Wife was cleaning up to prepare the place to be rented. [redacted] turned on the pump and pressure was 28 to 34 and took around 10 minutes to get there. He shut the pump off because it wasn't quite right. Then Oct 1st there was no water and he tried priming several times. Still no water at present time. [redacted] contacted Kevin Jakubec who suggested he report under section G5 and G6 and request water immediately.

AECOM will be following up with this landowner. I will inform you regarding the date they schedule the sampling.

*Looks like this property is about 1.3 kms from T35*



Regards,
Josh

# Attachment B

## Vibration Monitoring Data (Golder Associates Ltd.)

January 25, 2018 Project No. 1668031-2000-L25R

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

**WATER WELL COMPLAINT 15**
**NORTH KENT WIND 1 PROJECT**
**CHATHAM-KENT, ONTARIO**

Dear Mr. Law:

This letter is provided to summarize vibration monitoring data associated with Well Complaint 15 dated October 27, 2017 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 prior to the date on which the owner first reported well issues of September 19, 2017, through to one day after. Data related to the period two weeks preceding September 19, 2017 is also summarized in this letter and the data summary pages for each of the referenced turbines are also attached.

Table 1 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.

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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.

When reviewing Table 1, attached, it should be noted that during well 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). 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. Peak well casing vibration velocities for Well 4 of nearly 5 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 on the previous day and vehicles travelled and parked on the site in close proximity to the well on September 5 and 6, 2017. Access to Well 4 was unavailable for monitoring after September 10, 2017. Data from monitoring Well 5 exhibited intermittent vibration characteristics similar to pump operations (i.e., constant, relatively high frequency vibrations). These vibrations were independent of pile driving times and were not consistent with traffic-induced transient vibrations. It is suspected that the pump for this well may have been located within the adjacent garage/shed, the plumbing between the pump and casing may be relatively rigid and coupled to the casing or a separate piece of machinery may have been operating from time to time within the garage/shed. The pump for Well 6 is mounted in close proximity to the well casing. Peak 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 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. Vibrations induced by the Well 13 pump were as much as 0.75 mm/s. Well 14 is located approximately 13 m from the centreline of Union Line which is subjected to local truck traffic. Peak vibration velocities measured at Well 14 of 0.613 mm/s and 0.675 mm/s were associated with a vehicle turning in the driveway and a tractor-trailer transport truck passing the well in the road lane closest to the well, respectively.

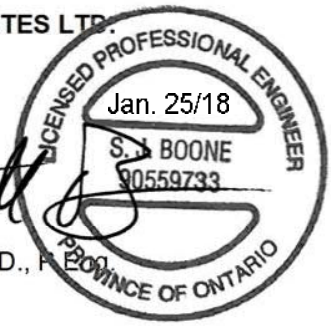
Details of the well or well pump at [redacted] were not available.

The well at [redacted] was typically farther from the pile driving than the wells that were monitored for vibrations and more than 6.8 km from pile driving on the day the well issues were noted. Based on data available to-date from the test pile and construction monitoring programs, the distances between pile driving and [redacted], the dates on which pile driving occurred and the dates on which the complaints were first noted, it is our opinion that the well would not have experienced pile driving-induced vibrations of any consequence at the time of the complaints and any such vibrations would have been significantly less than those summarized in Table 1. Vibrations associated with pile driving would not be discernable from background conditions at this well given the separation distances and, therefore, would be two or more orders of magnitude smaller than the threshold defined by Ontario NPC-207 (0.3 mm/s)[1], one or more orders of magnitude smaller than nighttime vibration thresholds suggested by ASHRAE (0.144 mm/s, 8 to 80 Hz)[2] and one or more orders of magnitude smaller than the International Standards Organization (ISO) threshold for human perception of vibrations at frequencies greater than 8 Hz (0.1 mm/s)[3]. It is our opinion, based on vibration measurements and distances between pile driving and the well, that vibrations associated with pile driving would be significantly less than may be induced by other common day-to-day sources at the well site 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/MAS/cr

CC: J. Vaidyan, Samsung

Attachments: Data Summary Tables T14, T26, T27, T33, T35, T44
Table 1 - Summary of Vibration Monitoring Data, Well Complaint 15

n:\active\2016\3 proj\1668031 pattern_north kent vib monit_chatham-kent\ph 2000-vib monit field work\2-correspondence\3-ltrs\l25\1668031-2000-l25r jan 25 18 (revised) water well complaint 15.docx

[1] Impulse Vibration in Residential Buildings, (NPC-207), Ministry of Environment, Ontario, 1983.

[2] 2007 ASHRAE Handbook—HVAC Applications (SI), American Society of Heating, Refrigerating and Air-Conditioning Engineers, threshold for nighttime acceptable levels.

[3] International Standards Organization. 1989. Evaluation of human exposure to whole-body vibration. Part 2: Continuous and shock-induced vibration in buildings, ISO 2631, threshold for human response in buildings.

**Table 1: Summary of Vibration Monitoring Data, Well Complaint 15[1]**

| 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) | Other Notes[3] | |
| ***Complaint 15 September 19, 2017*** | | | | | | |
| 6/21/2017 to 7/6/2017 | T35 (34) | 7.37 | 0.012 (W5, 623 m) | 0.219 (W6, 880 m) | See text regarding W6 | 1,206 |
| | | | | | | |
| 9/5/2017 | T33 (9) | 5.3 | 0.056 (W3, 1,778 m) | 0.298 (W4, 2,080 m) | See text regarding W4 | 12,655 |
| 9/6/2017 | T33 (11) | 4.1 | 0.023 (W3, 1,778 m) | 4.987 (W4, 2,080 m) | See text regarding W4 | 12,655 |
| 9/7/2017 through 9/10/2017 | *No Pile Driving* | | | | | |
| 9/11/2017 | T14 (18) | 4.95 | 0.114 (W13, 841 m) | 0.675 (W14, 580 m) | | 8,785 |
| 9/14/2017 | T26 (9) | 4.06 | 0.083 (W13, 1,552 m) | 0.104 (W14, 1,011 m) | | 8,260 |
| 9/15/2017 | T26 (9) | 2.67 | 0.028 (W13, 1,552 m) | 0.148 (W14, 1,011 m) | | 8,260 |
| 9/15/2017 | T27 (18) | 7.31 | 0.012 (W13, 2,326 m) | 0.116 (W14, 1,705 m) | | 8,075 |
| 9/18/2017 | T44 (16) | 5.08 | 0.034 (W13, 786 m) | 0.350 (W14, 901 m) | | 10,130 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

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 the property, farm equipment travel near the well, etc.
3) See letter text for discussion of pump and other influences.
4) Number of piles driven, including restrikes, on specified date shown in parentheses.

# NORTH KENT 1
# Vibration Monitoring Data Report

## Turbine Location: T14

| | Vibration Measurements at Turbine Site | | | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | Geophone Distance (m) | | Peak Particle Velocity (mm/s)[b] | | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | BE9555 | MP12721 | BE9555 | MP12721 | 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 | 16.3 | 1.78 | 1.93 | 0.020 | 0.206 | |
| 2 | 9/11/2017 16:24 | 9/11/2017 16:29 | 9/11/2017 16:32 | 21.0 | 18.9 | 1.52 | 1.79 | 0.010 | 0.056 | |
| 3 | 9/11/2017 15:48 | 9/11/2017 15:54 | 9/11/2017 15:56 | 22.6 | 21.0 | 1.14 | 1.43 | 0.017 | 0.132 | |
| 4 | 9/11/2017 15:33 | 9/11/2017 15:39 | 9/11/2017 15:43 | 23.6 | 22.6 | 1.27 | 1.36 | 0.012 | 0.190 | |
| 5 | 9/11/2017 15:19 | 9/11/2017 15:24 | 9/11/2017 15:26 | 24.0 | 23.6 | 1.14 | 1.15 | 0.006 | 0.064 | |
| 6 | 9/11/2017 15:04 | 9/11/2017 15:10 | 9/11/2017 15:13 | 23.6 | 24.0 | 1.14 | 1.58 | 0.005 | 0.221 | |
| 7 | 9/11/2017 12:33 | 9/11/2017 12:39 | 9/11/2017 12:44 | 22.6 | 23.6 | 1.27 | 1.43 | 0.007 | 0.083 | |
| 8 | 9/11/2017 12:17 | 9/11/2017 12:25 | 9/11/2017 12:27 | 21.0 | 22.6 | 1.40 | 1.00 | 0.005 | 0.338 | |
| 9 | 9/11/2017 11:53 | 9/11/2017 11:59 | 9/11/2017 12:02 | 18.9 | 21.0 | 1.65 | 1.22 | 0.114 | 0.675 | |
| 10 | 9/11/2017 11:36 | 9/11/2017 11:43 | 9/11/2017 11:45 | 16.3 | 18.9 | 1.52 | 1.46 | 0.013 | 0.240 | |
| 11 | 9/11/2017 11:20 | 9/11/2017 11:25 | 9/11/2017 11:28 | 13.5 | 16.3 | 1.78 | 1.51 | 0.013 | 0.168 | |
| 12 | 9/11/2017 10:24 | 9/11/2017 10:30 | 9/11/2017 10:34 | 10.6 | 13.5 | 2.41 | 1.62 | 0.428 | 0.077 | 0.011 |
| 13 | 9/11/2017 10:07 | 9/11/2017 10:14 | 9/11/2017 10:16 | 8.1 | 10.6 | 3.68 | 2.46 | 0.543 | 0.141 | 0.008 |
| 14 | 9/11/2017 9:50 | 9/11/2017 9:56 | 9/11/2017 10:01 | 7.1 | 8.1 | 4.32 | 3.82 | 0.021 | 0.102 | |
| 15 | 9/11/2017 9:34 | 9/11/2017 9:39 | 9/11/2017 9:42 | 8.1 | 7.1 | 4.95 | 4.04 | 0.004 | 0.014 | |
| 16 | 9/11/2017 9:17 | 9/11/2017 9:24 | 9/11/2017 9:28 | 10.6 | 8.1 | 4.45 | 4.11 | 0.318 | 0.021 | 0.007 |
| 17 | 9/11/2017 8:57 | 9/11/2017 9:03 | 9/11/2017 9:05 | 13.5 | 10.6 | 3.68 | 4.38 | 0.026 | 0.070 | |
| 18 | 9/11/2017 8:39 | 9/11/2017 8:47 | 9/11/2017 8:49 | 16.3 | 13.5 | 2.41 | 2.80 | 0.007 | 0.018 | |

**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

This data report must be read with "Construction Vibration Monitoring Report, North Kent 1," prepared by Golder Associates Ltd., dated December, 2017.

**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. Wells 13 and 14 are located approximately 87 m and 13 m from the centre line of Union Line, respectively. Evaluation of acceleration time histories concluded that other transient vibrations occurring before, during and after pile driving times dominated all measurements. The peak particle velocity of 0.675 mm/s during driving of Pile 9 was associated with a tractor-trailer truck driving northeast along Union Line (i.e., in lane closest to well).

Data for two 10-minute time periods on September 11, 2017 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. During these periods, the peak well casing vibration velocity was 0.079 mm/s. Three 10-minute vibration monitoring periods during which pile driving was not occurring were analyzed for Well 13 from data obtained on September 14, 2017, at 11:24 and 16:38 and September 15, 2017 at 08:29. The peak particle velocity of the Well 13 casing during these periods was 0.099 mm/s. On September 19 and 21, 2017 during water sampling events when the pump was operating, the peak particle velocity of the Well 13 casing was 0.655 mm/s. Three 10-minute vibration monitoring periods during which pile driving was not occurring were analyzed for Well 14 from data obtained on September 14, 2017, at 11:33 and 12:53 and September 15, 2017 at 08:35. The peak particle velocity of the Well 14 casing during these periods was 0.160 mm/s. On September 19, 2017 during a water sampling event when the pump was operating, the peak particle velocity of the Well 14 casing was 0.019 mm/s. Well 13 pump vibrations dominated data for periods of 1 to 5 minutes. Peak well casing vibrations exclusive of pump influences identified within the same monitoring period at Well 13 are shown in the "no pump" column.

**Footnotes:** a) start and end of pile driving are start and stop times for active hammering; b) values shown are peak values regardless of direction; c) well casing vibrations associated with multiple sources, see report text; 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 largest of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
# Vibration Monitoring Data Report

## Turbine Location: T26

| | Vibration Measurements at Turbine Site | | | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | Geophone Distance (m) | | Peak Particle Velocity (mm/s)[b] | | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | MP12710 | BE9555 | MP12710 | BE9555 | Well 13 | Well 14 | No Pump[e] |
| 1 | 9/15/2017 11:13 | 9/15/2017 11:17 | 9/15/2017 11:24 | 16.4 | 13.5 | 2.04 | 2.29 | 0.010 | 0.039 | |
| 2 | 9/15/2017 11:50 | 9/15/2017 11:55 | 9/15/2017 12:02 | 19.0 | 16.4 | 1.80 | 1.52 | 0.006 | 0.057 | |
| 3 | 9/15/2017 11:32 | 9/15/2017 11:36 | 9/15/2017 11:37 | 21.1 | 19.0 | 1.57 | 1.40 | 0.006 | 0.144 | |
| 4 | 9/15/2017 10:31 | 9/15/2017 10:40 | 9/15/2017 10:43 | 22.7 | 21.1 | 1.48 | 2.67 | 0.013 | 0.024 | |
| 5 | 9/15/2017 9:05 | 9/15/2017 9:10 | 9/15/2017 9:12 | 23.7 | 22.7 | 1.50 | 1.27 | 0.423 | 0.068 | 0.007 |
| 6 | 9/15/2017 8:44 | 9/15/2017 8:49 | 9/15/2017 8:50 | 24.1 | 23.7 | 1.20 | 1.27 | 0.005 | 0.036 | |
| 7 | 9/15/2017 8:06 | 9/15/2017 8:11 | 9/15/2017 8:14 | 23.7 | 24.1 | 1.06 | 1.52 | 0.009 | 0.118 | |
| 8 | 9/15/2017 7:46 | 9/15/2017 7:54 | 9/15/2017 7:55 | 22.7 | 23.7 | 1.04 | 1.27 | 0.028 | 0.148 | |
| 9 | 9/14/2017 18:24 | 9/14/2017 18:30 | 9/14/2017 18:34 | 21.1 | 22.7 | 1.36 | 1.27 | 0.005 | 0.058 | |
| 10 | 9/14/2017 18:05 | 9/14/2017 18:09 | 9/14/2017 18:11 | 19.0 | 21.1 | 1.44 | 1.14 | 0.592 | 0.104 | 0.010 |
| 11 | 9/14/2017 17:44 | 9/14/2017 17:48 | 9/14/2017 17:52 | 16.4 | 19.0 | 1.88 | 1.65 | 0.003 | 0.062 | |
| 12 | 9/14/2017 17:30 | 9/14/2017 17:34 | 9/14/2017 17:35 | 13.5 | 16.4 | 1.94 | 1.27 | 0.006 | 0.054 | |
| 13 | 9/14/2017 17:11 | 9/14/2017 17:18 | 9/14/2017 17:27 | 10.7 | 13.5 | 2.81 | 2.54 | 0.005 | 0.080 | |
| 14 | 9/14/2017 16:13 | 9/14/2017 16:19 | 9/14/2017 16:22 | 8.2 | 10.7 | 2.25 | 2.67 | 0.083 | 0.069 | |
| 15 | 9/14/2017 15:46 | 9/14/2017 15:53 | 9/14/2017 16:00 | 7.2 | 8.2 | 3.82 | 3.81 | 0.007 | 0.018 | |
| 16 | 9/14/2017 15:19 | 9/14/2017 15:26 | 9/14/2017 15:31 | 8.2 | 7.2 | 3.57 | 3.94 | 0.010 | 0.030 | |
| 17 | 9/14/2017 14:53 | 9/14/2017 15:05 | 9/14/2017 15:06 | 10.7 | 8.2 | 3.31 | 4.06 | 0.005 | 0.024 | |
| 18 | 9/15/2017 10:53 | 9/15/2017 11:02 | 9/15/2017 11:03 | 13.5 | 10.7 | 2.16 | 1.40 | 0.003 | 0.036 | |

**Well Information**

**Well No.:** 13
Municipal Address: [redacted]
Distance from Turbine Centre: 1,552 m

**Well No.:** 14
Municipal Address: [redacted]
Distance from Turbine Centre: 1,011 m

This data report must be read with "Construction Vibration Monitoring Report, North Kent 1," prepared by Golder Associates Ltd., dated December, 2017.

**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. Peak particle velocities of about 4 to 7 mm/s on September 14, 2017 as measured by geophone on-site were triggered by other equipment travelling in close proximity to the geophones. Wells 13 and 14 are located approximately 87 m and 13 m from the centre line of Union Line, respectively. Evaluation of acceleration time histories concluded that other transient vibrations occurring before, during and after pile driving times dominated all measurements. A peak well casing velocity of 0.675 mm/s during driving of Pile 9 at T14 on September 11, 2017 was associated with a tractor-trailer truck driving northeast along Union Line (i.e., in lane closest to well).

Data for two 10-minute time periods on September 11, 2017 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. During these periods, the peak well casing vibration velocity was 0.079 mm/s. Three 10-minute vibration monitoring periods during which pile driving was not occurring were analyzed for Well 13 from data obtained on September 14, 2017, at 11:24 and 16:38 and September 15, 2017 at 08:29. The peak particle velocity of the Well 13 casing during these periods was 0.099 mm/s. On September 19 and 21, 2017 during water sampling events when the pump was operating, the peak particle velocity of the Well 13 casing was 0.655 mm/s. Three 10-minute vibration monitoring periods during which pile driving was not occurring were analyzed for Well 14 from data obtained on September 14, 2017, at 11:33 and 12:53 and September 15, 2017 at 08:35. The peak particle velocity of the Well 14 casing during these periods was 0.160 mm/s. On September 19, 2017 during a water sampling event when the pump was operating, the peak particle velocity of the Well 14 casing was 0.019 mm/s. Peak well casing vibrations exclusive of pump influences identified within the same monitoring period at Well 13 are shown in the "no pump" column.

**Footnotes:** a) start and end of pile driving are start and stop times for active hammering; b) values shown are peak values regardless of direction; c) well casing vibrations associated with multiple sources, see report text; 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 largest of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
# Vibration Monitoring Data Report

## Turbine Location: T27

| | Vibration Measurements at Turbine Site | | | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | Geophone Distance (m) | | Peak Particle Velocity (mm/s)[b] | | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | BE18695 | MP12721 | BE18695 | MP12721 | Well 13 | Well 14 | No Pump[e] |
| 1 | 9/15/2017 10:12 | 9/15/2017 10:15 | 9/15/2017 10:16 | 8.4 | 9.6 | 0.02 | | 0.687 | 0.068 | 0.018 |
| 2 | 9/15/2017 10:04 | 9/15/2017 10:07 | 9/15/2017 10:08 | 9.4 | 8.6 | 4.57 | 7.31 | 0.710 | 0.090 | 0.008 |
| 3 | 9/15/2017 9:52 | 9/15/2017 9:55 | 9/15/2017 9:58 | 11.7 | 9.6 | 3.68 | 5.64 | 0.009 | 0.046 | |
| 4 | 9/15/2017 9:42 | 9/15/2017 9:46 | 9/15/2017 9:47 | 14.6 | 11.9 | 2.92 | 3.89 | 0.012 | 0.100 | |
| 5 | 9/15/2017 9:32 | 9/15/2017 9:35 | 9/15/2017 9:37 | 17.5 | 14.7 | 2.41 | 2.44 | 0.744 | 0.116 | 0.016 |
| 6 | 9/15/2017 9:22 | 9/15/2017 9:25 | 9/15/2017 9:27 | 20.1 | 17.6 | 3.56 | 2.62 | 0.699 | 0.042 | 0.024 |
| 7 | 9/15/2017 9:08 | 9/15/2017 9:10 | 9/15/2017 9:16 | 22.3 | 20.3 | 2.67 | 2.55 | 0.423 | 0.068 | 0.007 |
| 8 | 9/15/2017 8:54 | 9/15/2017 8:58 | 9/15/2017 9:02 | 23.9 | 22.5 | 2.41 | 2.01 | 0.010 | 0.005 | |
| 9 | 9/15/2017 8:41 | 9/15/2017 8:46 | 9/15/2017 8:48 | 24.9 | 24.1 | 1.65 | 1.54 | 0.006 | 0.011 | |
| 10 | 9/15/2017 11:20 | 9/15/2017 11:23 | 9/15/2017 11:24 | 25.3 | 25.1 | 1.02 | 1.00 | 0.010 | 0.008 | |
| 11 | 9/15/2017 11:28 | 9/15/2017 11:32 | 9/15/2017 11:33 | 24.9 | 25.5 | 1.27 | 1.44 | 0.006 | 0.007 | |
| 12 | 9/15/2017 11:37 | 9/15/2017 11:41 | 9/15/2017 11:45 | 23.9 | 25.1 | 1.40 | 1.17 | 0.483 | 0.048 | 0.007 |
| 13 | 9/15/2017 11:50 | 9/15/2017 11:53 | 9/15/2017 11:57 | 22.3 | 24.1 | 1.14 | 1.36 | 0.554 | 0.032 | 0.033 |
| 14 | 9/15/2017 12:02 | 9/15/2017 12:04 | 9/15/2017 12:06 | 20.1 | 22.5 | 1.65 | 1.45 | 0.006 | 0.030 | |
| 15 | 9/15/2017 12:11 | 9/15/2017 12:13 | 9/15/2017 12:16 | 17.5 | 20.3 | 1.65 | 1.50 | 0.009 | 0.026 | |
| 16 | 9/15/2017 12:34 | 9/15/2017 12:36 | 9/15/2017 12:39 | 14.6 | 17.6 | 2.54 | 2.22 | 0.010 | 0.026 | |
| 17 | 9/15/2017 12:22 | 9/15/2017 12:24 | 9/15/2017 12:28 | 11.7 | 14.7 | 3.18 | 3.40 | 0.002 | 0.005 | |
| 18 | 9/15/2017 11:08 | 9/15/2017 11:11 | 9/15/2017 11:13 | 9.4 | 11.9 | 3.05 | 4.06 | 0.010 | 0.015 | |

**Well Information**

**Well No.:** 13
Municipal Address: [redacted]
Distance from Turbine Centre: 2,326 m

**Well No.:** 14
Municipal Address: [redacted]
Distance from Turbine Centre: 1,705 m

This data report must be read with "Construction Vibration Monitoring Report, North Kent 1," prepared by Golder Associates Ltd., dated December, 2017.

**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. Wells 13 and 14 are located approximately 87 m and 13 m from the centre line of Union Line, respectively. Evaluation of acceleration time histories concluded that other transient vibrations occurring before, during and after pile driving times dominated all measurements. A peak well casing velocity of 0.675 mm/s measured during driving of Pile 9 at T14 was associated with a tractor-trailer truck driving northeast along Union Line (i.e., in lane closest to well).

Data for two 10-minute time periods on September 11, 2017 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. During these periods, the peak well casing vibration velocity was 0.079 mm/s. Three 10-minute vibration monitoring periods during which pile driving was not occurring were analyzed for Well 13 from data obtained on September 14, 2017, at 11:24 and 16:38 and September 15, 2017 at 08:29. The peak particle velocity of the Well 13 casing during these periods was 0.099 mm/s. On September 19 and 21, 2017 during water sampling events when the pump was operating, the peak particle velocity of the Well 13 casing was 0.655 mm/s. Three 10-minute vibration monitoring periods during which pile driving was not occurring were analyzed for Well 14 from data obtained on September 14, 2017, at 11:33 and 12:53 and September 15, 2017 at 08:35. The peak particle velocity of the Well 14 casing during these periods was 0.160 mm/s. On September 19, 2017 during a water sampling event when the pump was operating, the peak particle velocity of the Well 14 casing was 0.019 mm/s. Peak well casing vibrations exclusive of pump influences identified within the same monitoring period at Well 13 are shown in the "no pump" column.

**Footnotes:** a) start and end of pile driving are start and stop times for active hammering; b) values shown are peak values regardless of direction; c) well casing vibrations associated with multiple sources, see report text; 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 largest of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
# Vibration Monitoring Data Report

## Turbine Location: T33

| | Vibration Measurements at Turbine Site | | | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | Geophone Distance (m) | | Peak Particle Velocity (mm/s)[b] | | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | MP12721 | BE69555 | MP12721 | BE69555 | 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 | 12.1 | 5.3 | 3.7 | 0.015 | 0.118 | |
| 2 | 9/5/2017 13:46 | 9/5/2017 13:55 | 9/5/2017 14:03 | 11.8 | 11.2 | 2.8 | 3.3 | 0.011 | 0.138 | |
| 3 | 9/5/2017 14:11 | 9/5/2017 14:20 | 9/5/2017 14:27 | 14.0 | 12.1 | 2.9 | 3.4 | 0.056 | 0.174 | |
| 4 | 9/5/2017 14:38 | 9/5/2017 14:46 | 9/5/2017 14:54 | 16.8 | 14.2 | 2.2 | 2.7 | 0.035 | 0.082 | |
| 5 | 9/5/2017 15:05 | 9/5/2017 15:13 | 9/5/2017 15:18 | 19.7 | 17.1 | 2.1 | 2.2 | 0.049 | 0.137 | |
| 6 | 9/5/2017 15:34 | 9/5/2017 15:44 | 9/5/2017 15:48 | 22.4 | 20.0 | 2.2 | 1.9 | 0.009 | 0.072 | |
| 7 | 9/5/2017 17:02 | 9/5/2017 17:10 | 9/5/2017 17:10 | 24.6 | 22.7 | 2.2 | 2.3 | 0.030 | 0.298 | |
| 8 | 9/5/2017 17:32 | 9/5/2017 17:41 | 9/5/2017 17:49 | 26.3 | 24.9 | 2.0 | 2.3 | 0.036 | 0.131 | |
| 9 | 9/5/2017 18:14 | 9/5/2017 18:21 | 9/5/2017 18:28 | 27.4 | 26.6 | 1.4 | 1.4 | 0.034 | 0.083 | |
| 10 | 9/6/2017 9:30 | 9/6/2017 9:47 | 9/6/2017 9:53 | 27.8 | 27.7 | 1.3 | 1.4 | 0.004 | 0.243 | |
| 11 | 9/6/2017 10:09 | 9/6/2017 10:25 | 9/6/2017 10:35 | 27.4 | 28.1 | 1.5 | 1.8 | 0.004 | 0.089 | |
| 12 | 9/6/2017 12:03 | 9/6/2017 12:16 | 9/6/2017 12:26 | 26.3 | 27.7 | 1.5 | 1.8 | 0.005 | 0.179 | |
| 13 | 9/6/2017 12:58 | 9/6/2017 13:08 | 9/6/2017 13:16 | 24.6 | 26.6 | 1.8 | 1.9 | 0.003 | 0.162 | |
| 14 | 9/6/2017 13:33 | 9/6/2017 13:43 | 9/6/2017 13:58 | 22.4 | 24.9 | 1.9 | 2.0 | 0.004 | 0.161 | |
| 15 | 9/6/2017 14:37 | 9/6/2017 14:45 | 9/6/2017 14:54 | 19.7 | 22.7 | 0.5 | 0.4 | 0.005 | 4.987 | |
| 16 | 9/6/2017 16:01 | 9/6/2017 16:08 | 9/6/2017 16:20 | 16.8 | 20.0 | 1.8 | 1.8 | 0.006 | 0.277 | |
| 17 | 9/6/2017 15:29 | 9/6/2017 15:35 | 9/6/2017 15:45 | 14.0 | 17.1 | 2.5 | 2.2 | 0.003 | 0.175 | |
| 18 | 9/6/2017 14:13 | 9/6/2017 14:24 | 9/6/2017 14:36 | 11.8 | 14.2 | 4.1 | 2.2 | 0.004 | 0.622 | |
| **Restrikes** | | | | | | | | | | |
| 6 | 9/6/2017 18:15 | 9/6/2017 18:15 | 9/6/2017 18:23 | 22.4 | 20.0 | 1.1 | 1.4 | 0.009 | 4.858 | |
| 5 | 9/6/2017 17:02 | 9/6/2017 17:02 | 9/6/2017 17:03 | 19.7 | 17.1 | 1.1 | 1.1 | 0.023 | 0.129 | |

**Well Information**

| | | | |
|---|---|---|---|
| **Well No.:** | 3 | **Well No.:** | 4 |
| Municipal Address: | [redacted] | Municipal Address: | [redacted] |
| Distance from Turbine Centre: | 1,778 m | Distance from Turbine Centre: | 2,080 m |

This data report must be read with "Construction Vibration Monitoring Report, North Kent 1," prepared by Golder Associates Ltd., dated December, 2017.

**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. After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". 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 end of pile driving are start and stop times for active hammering; b) values shown are peak values regardless of direction; c) well casing vibrations associated with multiple sources, see report text; 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 largest of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
## Vibration Monitoring Data Report

**Turbine Location: T35**

| | Vibration Measurements at Turbine Site | | | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | Geophone Distance (m) | | Peak Particle Velocity (mm/s)[b] | | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | BE14711 | BE15696 | BE14711 | BE15696 | Well 5 | Well 6 | No Pump[e] |
| 1 | 6/21/2017 9:16 | 6/21/2017 9:31 | 6/21/2017 9:58 | 25.6 | 27.0 | 3.56 | 4.32 | 0.005 | 0.011 | |
| 1A | 7/4/2017 14:09 | 7/4/2017 14:15 | 7/4/2017 14:20 | 26.6 | 28.0 | 2.54 | 2.79 | 0.011 | 0.085 | |
| 2 | 6/28/2017 11:40 | 6/28/2017 11:50 | 6/28/2017 11:56 | 26.0 | 28.1 | 2.29 | 2.67 | 0.004 | 0.002 | |
| 3 | 6/29/2017 11:15 | 6/29/2017 11:26 | 6/29/2017 11:37 | 25.6 | 28.5 | 2.67 | 2.79 | 0.004 | 0.080 | 0.009 |
| 4 | 6/29/2017 11:45 | 6/29/2017 12:28 | 6/29/2017 12:35 | 24.6 | 28.1 | 2.29 | 2.41 | 0.002 | 0.003 | |
| 5 | 6/29/2017 10:36 | 6/29/2017 10:53 | 6/29/2017 10:59 | 22.9 | 27.0 | 2.79 | 2.29 | 0.003 | 0.008 | |
| 6 | 6/29/2017 9:49 | 6/29/2017 10:09 | 6/29/2017 10:19 | 20.7 | 25.3 | 2.03 | 1.91 | 0.002 | 0.017 | |
| 7 | 6/28/2017 16:45 | 6/28/2017 16:55 | 6/28/2017 16:59 | 18.1 | 23.0 | 1.78 | 1.65 | 0.002 | 0.006 | |
| 8 | 6/28/2017 16:19 | 6/28/2017 16:28 | 6/28/2017 16:36 | 15.2 | 20.3 | 1.78 | 1.91 | 0.004 | 0.008 | |
| 9 | 6/29/2017 15:55 | 6/29/2017 16:03 | 6/29/2017 16:09 | 12.3 | 17.4 | 0.13 | 0.25 | 0.003 | 0.011 | |
| 10 | 6/28/2017 15:23 | 6/28/2017 15:35 | 6/28/2017 15:43 | 10.0 | 14.6 | 5.21 | 4.06 | 0.002 | 0.010 | |
| 11 | 6/28/2017 14:34 | 6/28/2017 14:52 | 6/28/2017 14:56 | 9.1 | 12.4 | 7.37 | 5.33 | 0.002 | 0.081 | 0.011 |
| 12 | 6/28/2017 14:04 | 6/28/2017 14:19 | 6/28/2017 14:23 | 10.0 | 11.6 | 7.37 | 6.86 | 0.003 | 0.016 | |
| 13 | 6/26/2017 16:52 | 6/26/2017 17:15 | 6/26/2017 17:22 | 12.3 | 12.4 | 3.43 | 6.22 | 0.004 | 0.093 | 0.015 |
| 13A | 6/30/2017 10:53 | 6/30/2017 11:24 | 6/30/2017 11:36 | 13.3 | 13.4 | 4.19 | 4.19 | 0.001 | 0.093 | 0.015 |
| 14 | 6/28/2017 8:34 | 6/28/2017 8:59 | 6/28/2017 9:16 | 15.2 | 14.6 | 2.54 | 2.67 | 0.005 | 0.110 | 0.023 |
| 15 | 6/26/2017 16:03 | 6/26/2017 16:26 | 6/26/2017 16:28 | 18.1 | 17.4 | 3.68 | 4.45 | 0.002 | 0.009 | |
| 15A | 7/4/2017 12:54 | 7/4/2017 13:00 | 7/4/2017 13:21 | 19.1 | 18.4 | 3.18 | 2.79 | 0.008 | 0.130 | |
| 16 | 6/28/2017 9:32 | 6/28/2017 9:52 | 6/28/2017 9:57 | 20.7 | 20.3 | 3.30 | 4.57 | 0.002 | 0.004 | |
| 17 | 6/26/2017 7:45 | 6/26/2017 8:19 | 6/26/2017 8:20 | 18.1 | 23.0 | 4.19 | 4.83 | 0.012 | 0.002 | |
| 17A | 7/4/2017 13:39 | 7/4/2017 13:45 | 7/4/2017 13:51 | 19.1 | 24.0 | 3.30 | 3.94 | 0.004 | 0.105 | |
| 18 | 6/28/2017 10:40 | 6/28/2017 10:55 | 6/28/2017 11:25 | 20.7 | 25.3 | 2.41 | 2.16 | 0.004 | 0.015 | |
| **Restrikes** | | | | | | | | | | |
| 1 | 6/26/2017 7:39 | 6/26/2017 7:39 | 6/26/2017 7:40 | 25.6 | 27.0 | 0.28 | 0.28 | 0.007 | 0.007 | |
| 17 | 6/28/2017 12:54 | 6/28/2017 12:54 | 6/28/2017 13:14 | 18.1 | 23.0 | 0.89 | 1.65 | 0.004 | 0.014 | |
| 10 | 6/29/2017 13:31 | 6/29/2017 13:31 | 6/29/2017 13:32 | 10.0 | 14.6 | 3.43 | 3.04 | 0.006 | 0.004 | |
| 13 | 6/29/2017 13:37 | 6/29/2017 13:37 | 6/29/2017 13:42 | 13.3 | 13.4 | 1.14 | 1.52 | 0.004 | 0.002 | |
| 14 | 6/29/2017 13:47 | 6/29/2017 13:47 | 6/29/2017 13:50 | 15.2 | 14.6 | 1.65 | 2.05 | 0.006 | 0.003 | |
| 16 | 6/29/2017 13:54 | 6/29/2017 13:54 | 6/29/2017 13:56 | 20.7 | 20.3 | 1.65 | 1.65 | 0.005 | 0.003 | |
| 15 | 6/29/2017 14:20 | 6/29/2017 14:20 | 6/29/2017 14:25 | 18.1 | 17.4 | 3.43 | 3.68 | 0.008 | 0.011 | |
| **PDA** | | | | | | | | | | |
| 13A | 7/6/2017 10:06 | 7/6/2017 10:06 | 7/6/2017 10:15 | 13.3 | 13.4 | 2.413 | 2.667 | 0.005 | 0.138 | |
| 13 | 7/6/2017 11:05 | 7/6/2017 11:05 | 7/6/2017 11:23 | 12.3 | 12.4 | 3.302 | 5.207 | 0.006 | 0.219 | |
| 15A | 7/6/2017 11:39 | 7/6/2017 11:39 | 7/6/2017 11:40 | 19.1 | 18.4 | 1.524 | 2.032 | 0.009 | 0.130 | |
| 17A | 7/6/2017 11:55 | 7/6/2017 11:55 | 7/6/2017 11:56 | 19.1 | 24.0 | 1.016 | 2.032 | 0.010 | 0.061 | |
| 1A | 7/6/2017 12:18 | 7/6/2017 12:18 | 7/6/2017 12:18 | 26.6 | 28.0 | 1.524 | 1.397 | 0.011 | 0.084 | |

**Well Information**

**Well No.:** 5
Municipal Address: [redacted]
Distance from Turbine Centre: 623 m

**Well No.:** 6
Municipal Address: [redacted]
Distance from Turbine Centre: 880 m

This data report must be read with "Construction Vibration Monitoring Report, North Kent 1," prepared by Golder Associates Ltd., dated December, 2017.

# NORTH KENT 1
## Vibration Monitoring Data Report

**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. 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 occuring, measured peak well casing 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 for each pile is shown in parentheses following the pile number in minutes and seconds: 13A(10:00), 15A(6:24), 17 restrike (14:00), 13PDA(6:20). Peak well casing vibrations exclusive of pump influences identified within the same monitoring period at Well 6 are shown in the "no pump" column. Farm and silo equipment operating on July 4 and 6, 2017 on well property.

**Footnotes:** a) start and end of pile driving are start and stop times for active hammering; b) values shown are peak values regardless of direction; c) well casing vibrations associated with multiple sources, see report text; 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 largest of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
# Vibration Monitoring Data Report

## Turbine Location: T44

| | Vibration Measurements at Turbine Site | | | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | Geophone Distance (m) | | Peak Particle Velocity (mm/s)[b] | | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | MP12710 | BE9555 | MP12710 | BE9555 | Well 13 | Well 14 | No Pump[e] |
| 1 | 9/18/2017 13:38 | 9/18/2017 13:43 | 9/18/2017 13:44 | 23.2 | 22.8 | 1.08 | 1.27 | 0.033 | 0.237 | |
| 2 | 9/18/2017 13:54 | 9/18/2017 14:01 | 9/18/2017 14:02 | 23.6 | 23.8 | 1.70 | 1.40 | 0.005 | 0.049 | |
| 3 | 9/21/2017 14:39 | 9/21/2017 14:46 | 9/21/2017 14:47 | 23.2 | 24.2 | 1.22 | 1.27 | 0.641 | 0.026 | 0.010 |
| 4 | 9/21/2017 14:19 | 9/21/2017 14:25 | 9/21/2017 14:26 | 22.2 | 23.8 | 1.14 | 0.89 | 0.011 | 0.338 | |
| 5 | 9/18/2017 14:25 | 9/18/2017 14:29 | 9/18/2017 14:31 | 20.7 | 22.8 | 1.48 | 1.40 | 0.005 | 0.350 | |
| 6 | 9/18/2017 14:11 | 9/18/2017 14:16 | 9/18/2017 14:17 | 18.5 | 21.2 | 1.61 | 2.16 | 0.006 | 0.034 | |
| 7 | 9/18/2017 9:10 | 9/18/2017 9:18 | 9/18/2017 9:20 | 16.0 | 19.1 | 2.19 | 2.29 | 0.015 | 0.056 | |
| 8 | 9/18/2017 9:32 | 9/18/2017 9:37 | 9/18/2017 9:40 | 13.1 | 16.5 | 3.56 | 2.79 | 0.488 | 0.041 | 0.006 |
| 9 | 9/18/2017 9:46 | 9/18/2017 9:52 | 9/18/2017 9:54 | 10.2 | 13.6 | 3.45 | 2.79 | 0.034 | 0.100 | |
| 10 | 9/18/2017 10:05 | 9/18/2017 10:10 | 9/18/2017 10:11 | 7.8 | 10.7 | 4.32 | 4.19 | 0.007 | 0.021 | |
| 11 | 9/18/2017 10:20 | 9/18/2017 10:24 | 9/18/2017 10:27 | 6.7 | 8.3 | 5.01 | 4.70 | 0.005 | 0.167 | |
| 12 | 9/18/2017 10:37 | 9/18/2017 10:42 | 9/18/2017 10:45 | 7.8 | 7.3 | 3.65 | 4.57 | 0.018 | 0.085 | |
| 13 | 9/18/2017 11:31 | 9/18/2017 11:36 | 9/18/2017 11:39 | 10.2 | 8.3 | 3.09 | 5.08 | 0.015 | 0.075 | |
| 14 | 9/18/2017 11:46 | 9/18/2017 11:53 | 9/18/2017 11:55 | 13.1 | 10.7 | 2.74 | 3.56 | 0.018 | 0.214 | |
| 15 | 9/18/2017 12:02 | 9/18/2017 12:08 | 9/18/2017 12:10 | 16.0 | 13.6 | 2.04 | 2.16 | 0.006 | 0.017 | |
| 16 | 9/18/2017 12:25 | 9/18/2017 12:30 | 9/18/2017 12:34 | 18.5 | 16.5 | 1.46 | 1.65 | 0.020 | 0.194 | |
| 17 | 9/18/2017 12:58 | 9/18/2017 13:03 | 9/18/2017 13:06 | 20.7 | 19.1 | 1.48 | 1.65 | 0.009 | 0.055 | |
| 18 | 9/18/2017 13:14 | 9/18/2017 13:19 | 9/18/2017 13:23 | 22.2 | 21.2 | 1.21 | 1.91 | 0.380 | 0.102 | 0.011 |

**Well Information**

**Well No.:** 13
Municipal Address: [redacted]
Distance from Turbine Centre: 786 m

**Well No.:** 14
Municipal Address: [redacted]
Distance from Turbine Centre: 901 m

This data report must be read with "Construction Vibration Monitoring Report, North Kent 1," prepared by Golder Associates Ltd., dated December, 2017.

**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. Truck drove very close to geophone at turbine site at 9:39:25 on September 18, 2017. Wells 13 and 14 are located approximately 87 m and 13 m from the centre line of Union Line, respectively. 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 on September 11, 2017 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. During these periods, the peak well casing vibration velocity was 0.079 mm/s. Three 10-minute vibration monitoring periods during which pile driving was not occurring were analyzed for Well 13 from data obtained on September 14, 2017, at 11:24 and 16:38 and September 15, 2017 at 08:29. The peak particle velocity of the Well 13 casing during these periods was 0.099 mm/s. On September 19 and 21, 2017 during water sampling events when the pump was operating, the peak particle velocity of the Well 13 casing was 0.655 mm/s. Three 10-minute vibration monitoring periods during which pile driving was not occurring were analyzed for Well 14 from data obtained on September 14, 2017, at 11:33 and 12:53 and September 15, 2017 at 08:35. The peak velocity of the Well 14 casing during these periods was 0.160 mm/s. On September 19, 2017 during a water sampling event when the pump was operating, the peak velocity of the Well 14 casing was 0.019 mm/s. Peak well casing vibrations exclusive of pump influences identified within the same monitoring period at Well 13 are shown in the "no pump" column.

**Footnotes:** a) start and end of pile driving are start and stop times for active hammering; b) values shown are peak values regardless of direction; c) well casing vibrations associated with multiple sources, see report text; 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 largest of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

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;

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- 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.

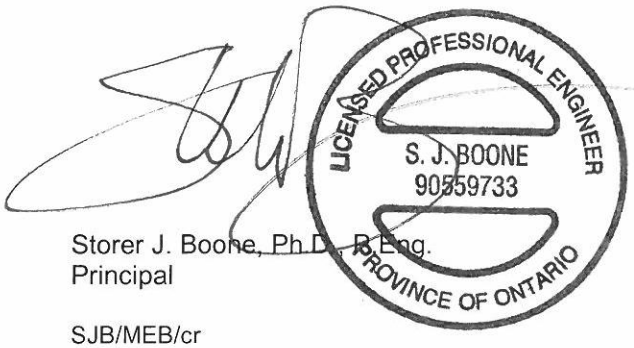
- **Well 9:** A piston pump for Well 9 is located within the barn adjacent to the Well 9 casing location, a total distance (inside and outside) of about 3 to 4 m. During pile driving for turbines T28 and T32, on August 11, 2017, other work was occurring near Well 9. This work included construction along 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\l06\1668031-2000-l06 sep 20 17 summary of vibration monitoring.docx

## TABLE 1 – VIBRATION MEASUREMENT LOCATIONS

| 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 | | | | 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 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
Municipal Address: [redacted]
Distance from Turbine Centre: 1707 m

**Well No.:** 12
Municipal Address: [redacted]
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 occured 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.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** T4

| | 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[c] |
| 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 occured 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.

# NORTH KENT 1
## 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 | 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 | 7/31/2017 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: [redacted]
Distance from Turbine Centre: 1049 m

**Well No.:** 8
Municipal Address: [redacted]
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 occuring 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 occuring 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.

# NORTH KENT 1
## 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 occuring, measured maximum particle velocities of 0.08 to 0.8 mm/s. Driving/restriking of some piles occured 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.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** T14

| Pile No.: | Pile Driving Times and Dates Start[a] | Rock/Till | End[a] | Vibration Measurements at Turbine Site Geophone Dist. (m) | Daily Maximum Particle Velocity (mm/s)[b] | Vibration Measurements at Wells Particle Velocity (mm/s)[c, d] 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 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.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location: T20**

| | 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 | 8/30/2017 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 | | | | | 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 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.

# NORTH KENT 1
# Preliminary Vibration Monitoring Report

## Turbine Location: T28

| | 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 | 8/15/2017 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 occuring 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 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: T30**

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells Particle Velocity (mm/s)[c, d] | | |
|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | | | |
| 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.

# NORTH KENT 1
## 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: [redacted]
Distance from Turbine Centre: 636 m

**Well No.:** 8
Municipal Address: [redacted]
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 occuring 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.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** **T32**

| | 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[c] |
| 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: [redacted]
Distance from Turbine Centre: 680 m

**Well No.:** 10
Municipal Address: [redacted]
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 occuring 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.

# NORTH KENT 1
# Preliminary Vibration Monitoring Report

## Turbine Location: T33

| Pile No.: | Pile Driving Times and Dates: Start[a] | Rock/Till | End[a] | Vibration Measurements at Turbine Site: Geophone Dist. (m) | Daily Maximum Particle Velocity (mm/s)[b] | Vibration Measurements at Wells: Particle Velocity (mm/s)[c, d] 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 obersvations 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.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location: T35**

| | 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 | 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: [redacted]
Distance from Turbine Centre: 623 m

**Well No.:** 6
Municipal Address: [redacted]
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 tc 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 occuring, 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.

**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.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** T36

| | 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 | 7/26/2017 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 | 0.029 |
| 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 | 0.028 |

**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 occured 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 occuring, 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.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location: T43**

| | 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 | 8/18/2017 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: [redacted]
Distance from Turbine Centre: 4092 m

**Well No.: 12**
Municipal Address: [redacted]
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 occured 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 intermittant 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.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** T45

| | Pile Driving Times and Dates | | | Vibration Measurements at Turbine Site | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 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* | **Well No.:** | 12 |
| Municipal Address: | [redacted] | Municipal Address: | [redacted] |
| Distance from Turbine Centre: | 1223 m | 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 occured 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.

# NORTH KENT 1
## 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 | |

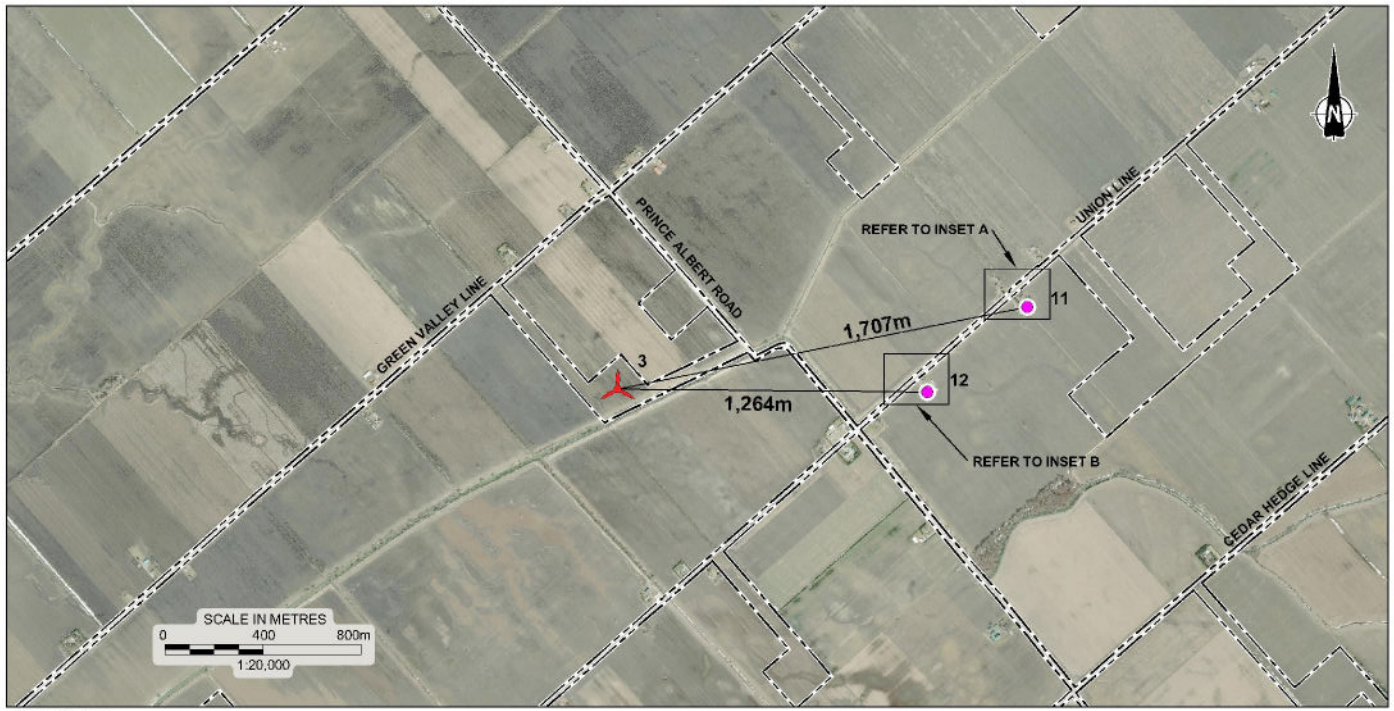
**Well Information**

| | | | |
|---|---|---|---|
| ***Well No.:*** | ***11*** | **Well No.:** | 12 |
| Municipal Address: | | Municipal Address: | |
| Distance from Turbine Centre: | 1697 m | Distance from Turbine Centre: | 2170 m |

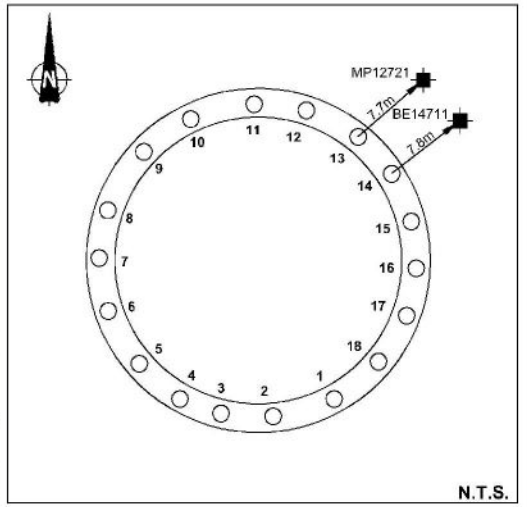
ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**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.




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

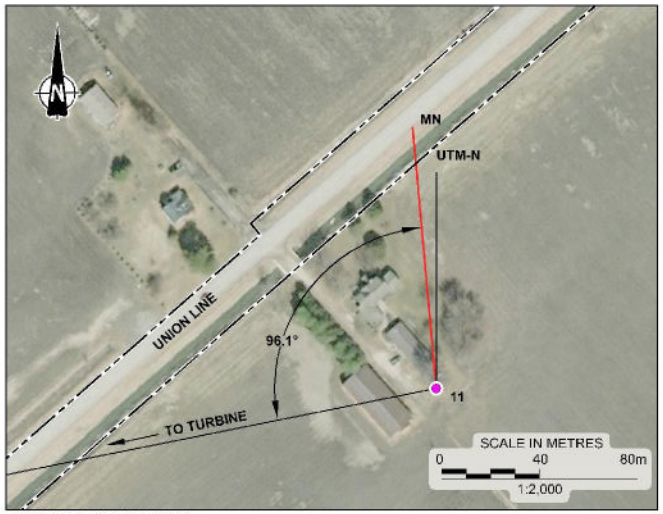
## REFERENCE

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.

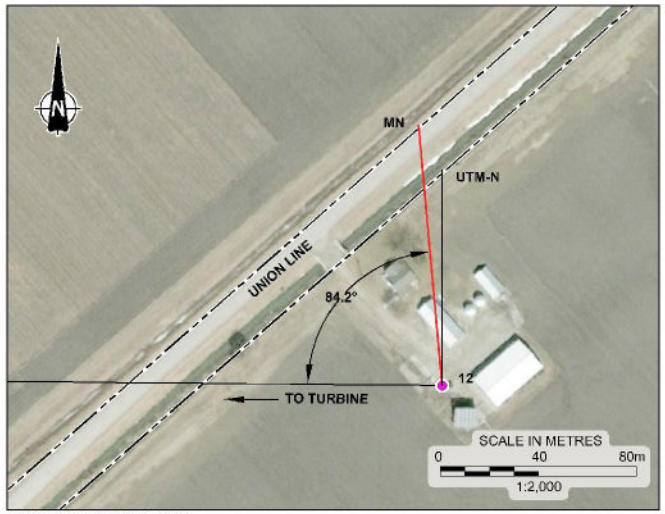
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #11)




INSET B (WELL #12)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

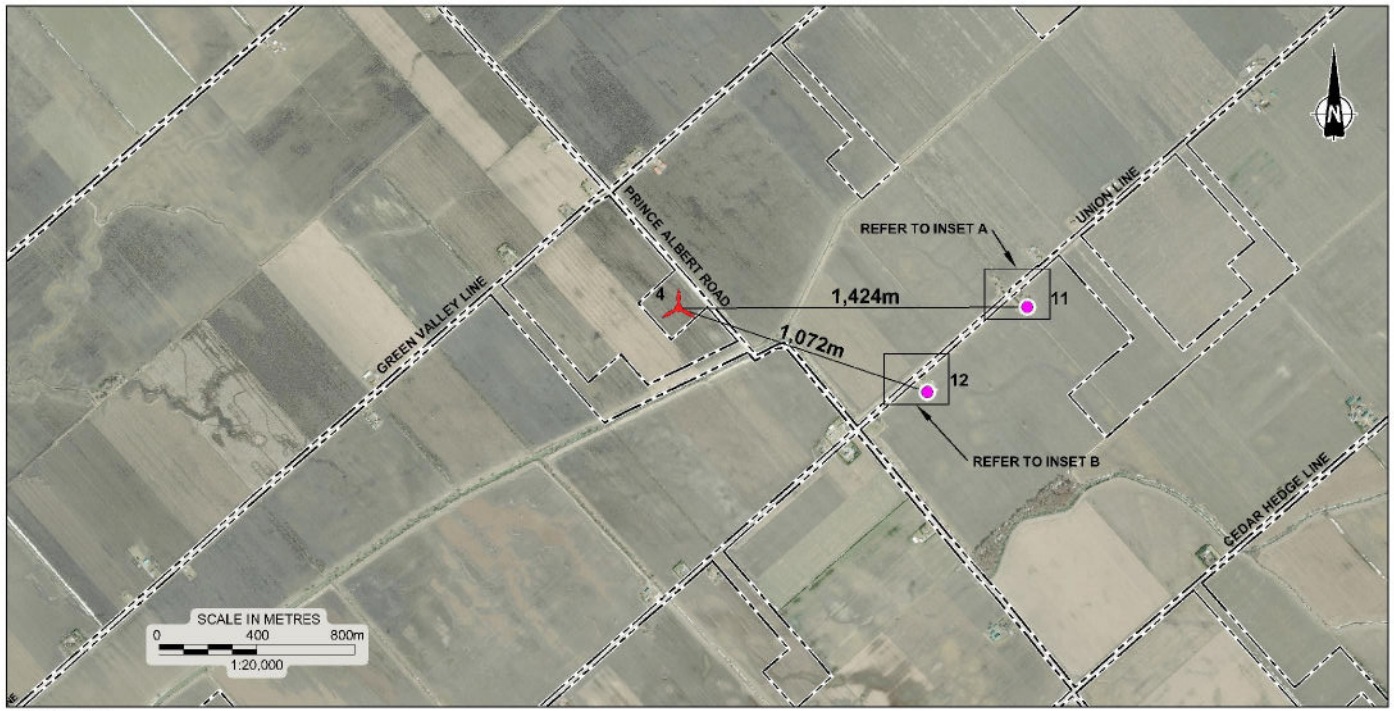
**TURBINE PILES AND WATER WELL LOCATION PLAN, T3**

Golder Associates

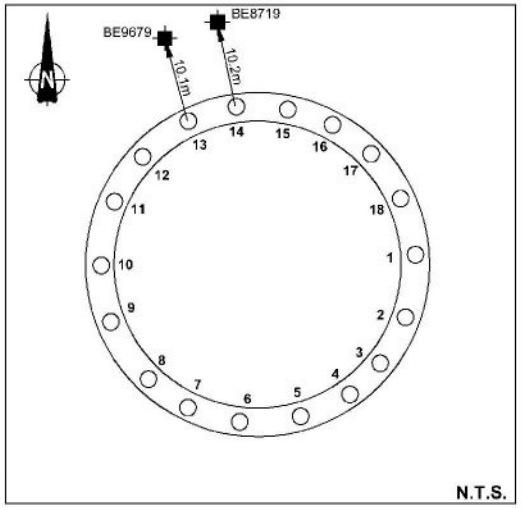
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|---|---|---|---|
| PROJECT No. | 1668031 | FILE No. | 1668031-2000-R020T3 |
| | | SCALE | AS SHOWN |
| CADD | DCH/ZJB Sept. 18/17 | REV. | |
| CHECK | | | |

FIGURE T3

Drawing file: 1668031-2000-R020T3.dwg Sep 20, 2017 - 2:49pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

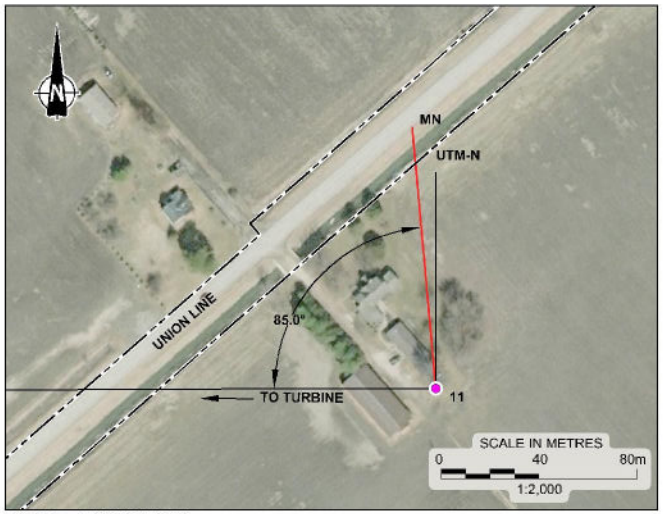
## REFERENCE

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.

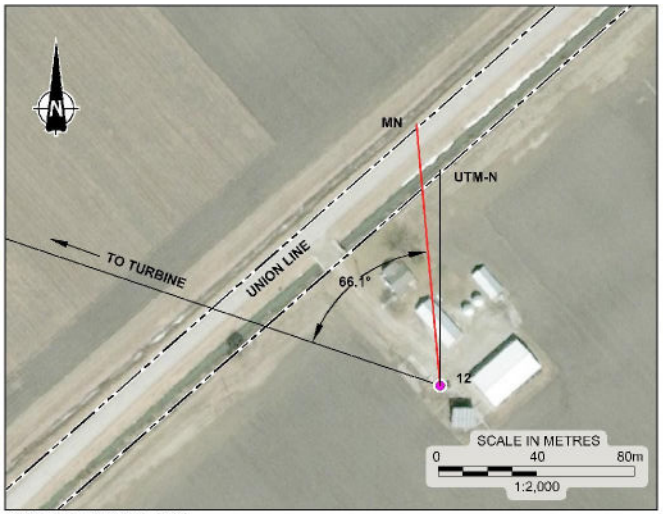
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #11)




INSET B (WELL #12)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T4**

Golder Associates

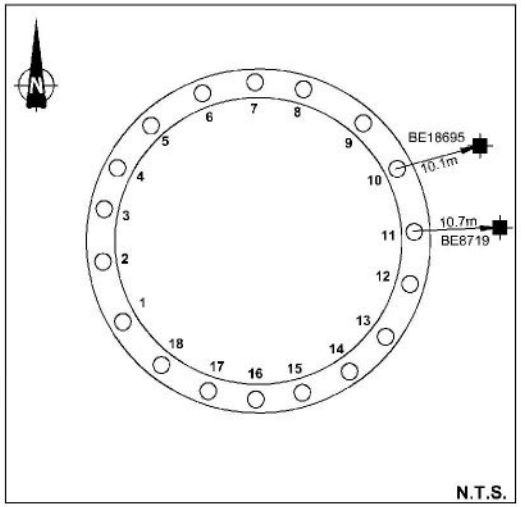
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|---|---|---|---|
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| | | SCALE | AS SHOWN |
| CADD | DGH/ZJB Sept. 18/17 | REV. | |
| CHECK | | | |

FIGURE T4

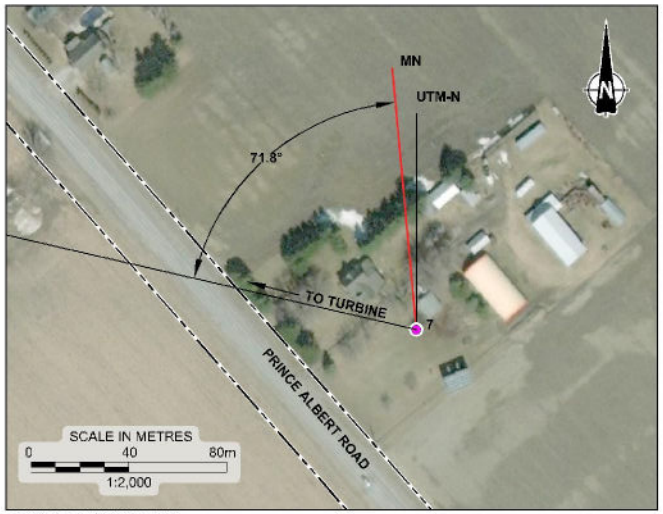
Drawing file: 668031 2000 R020T4.dwg Sep 20, 2017 12:51pm



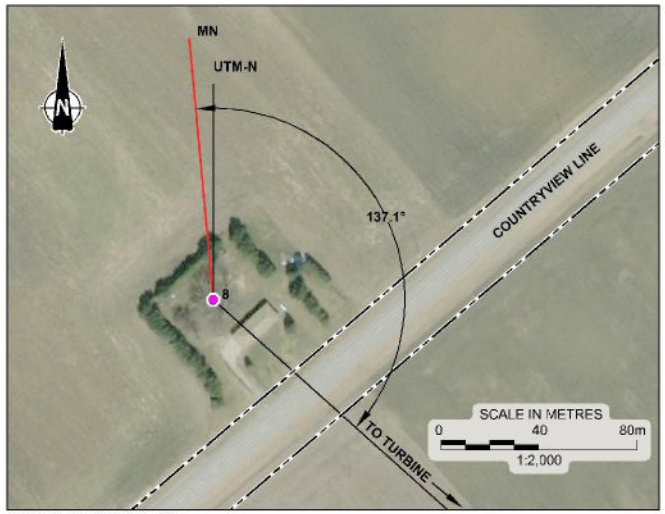

SITE PLAN




TURBINE PILE LAYOUT




INSET A (WELL #7)




INSET B (WELL #8)

## 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, T6**

Golder Associates

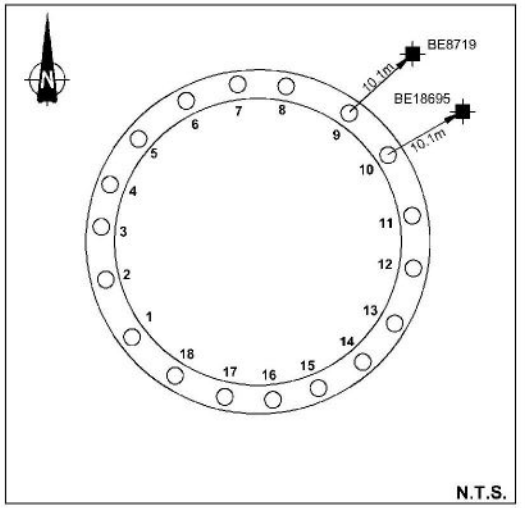
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| DESIGN | | SCALE | AS SHOWN |
| CADD | DCH/ZJE Sept. 18/17 | REV. | |
| CHECK | | | |

FIGURE T6

Drawing file: 1658031-2000-R02016.dwg Sep 20, 2017 - 2:52pm




SITE PLAN




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.

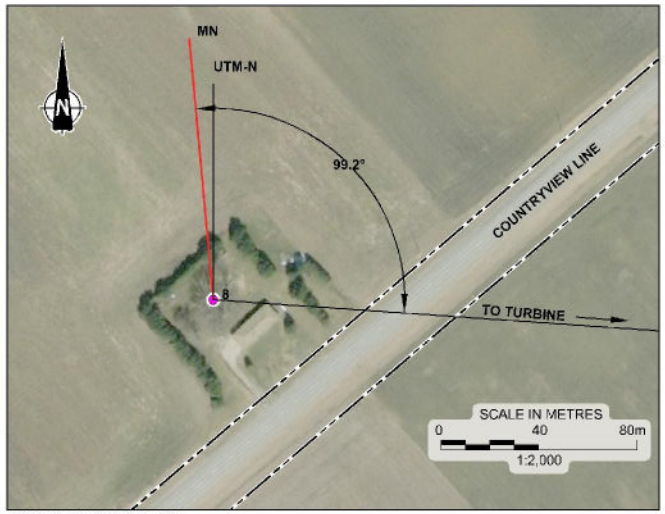
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #7)




INSET B (WELL #8)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T7**

Golder Associates

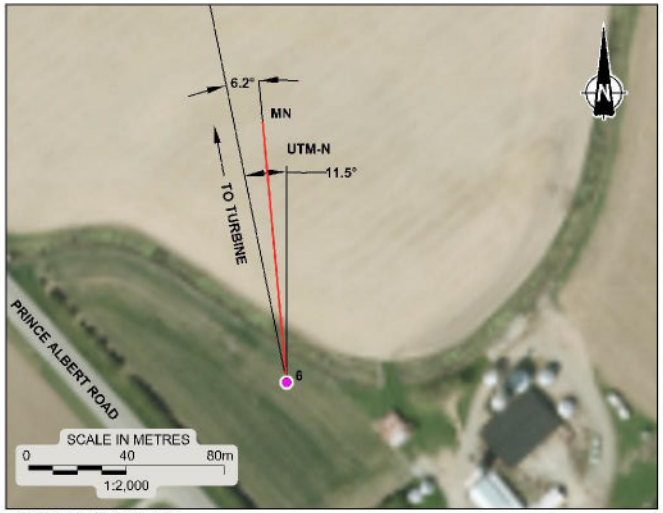
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| | | SCALE | AS SHOWN |
| CADD | DCH/ZJB | Sept. 18/17 | REV. |
| CHECK | | | |

FIGURE T7

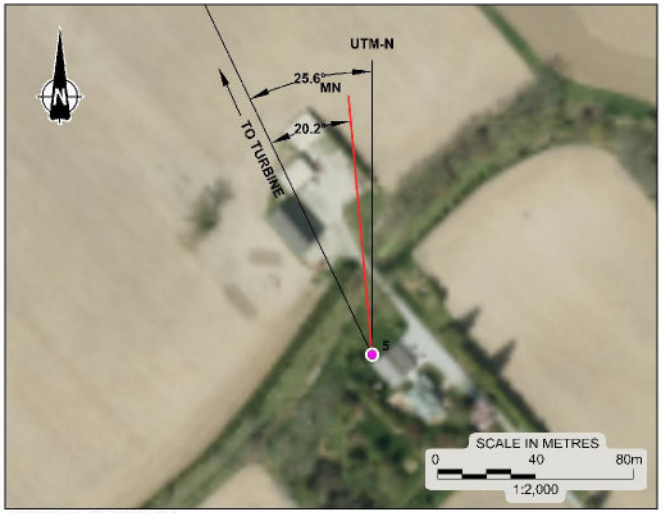
Drawing file: 668031 2000 R02T7.dwg Sep 20, 2017 12:54pm



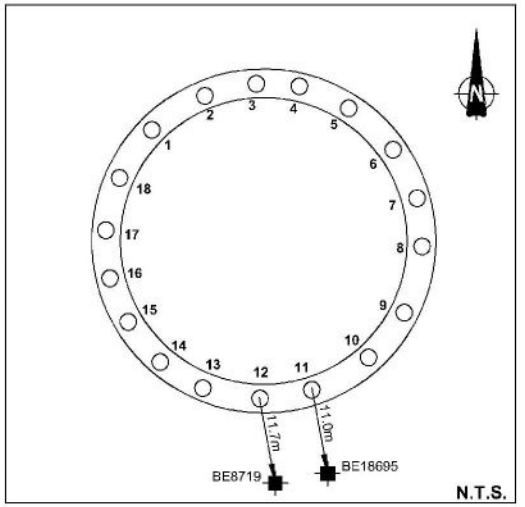

SITE PLAN




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", 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, T12**

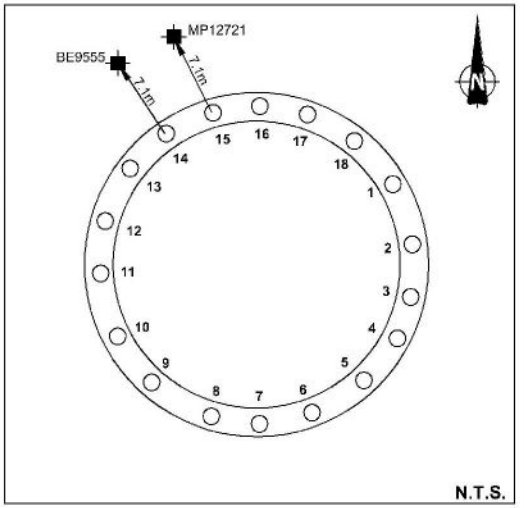
Golder Associates

| | | | | |
|---|---|---|---|---|
| PROJECT No. | | | 1658031 | FILE No. 1658031-2000-R02T12 |
| | | | | SCALE AS SHOWN REV. |
| CADD | DCH/ZJB | Sept. 20/17 | | FIGURE T12 |
| CHECK | | | | |

Drawing file: 1658031-2000-R02T12.dwg Sep 20, 2017 - 12:39pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

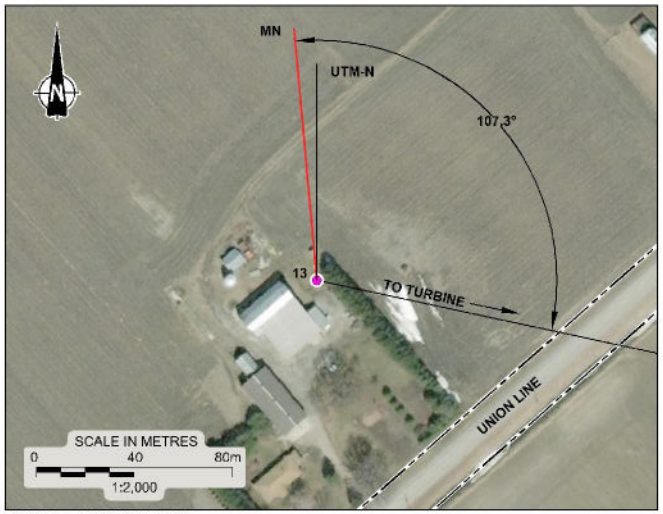
## REFERENCE

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.

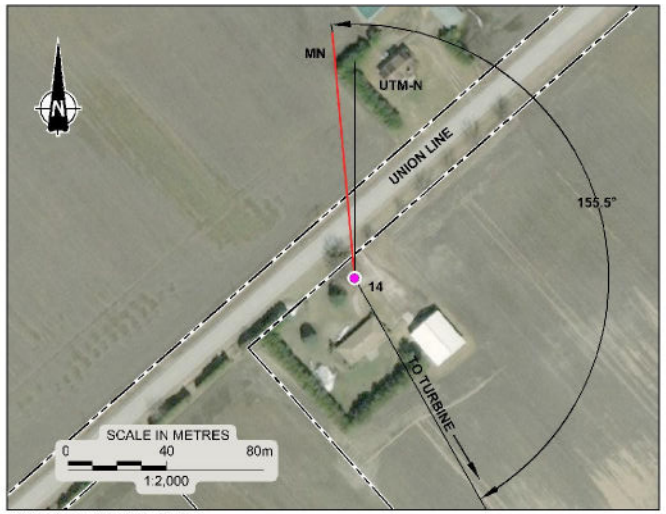
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #13)




INSET B (WELL #14)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T14**

Golder Associates

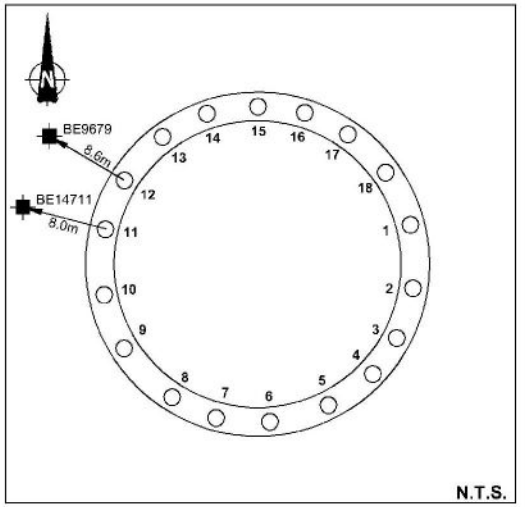
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| PROJECT No. | | | 1668031 | FILE No. 1668031-2000-R02T14 |
| | | | | SCALE AS SHOWN REV. |
| CADD | DCH/ZJB | Sept. 18/17 | | |
| CHECK | | | | |

FIGURE T14

Drawing file: 668031 2000 R02T14.dwg Sep 18, 2017 4:46pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

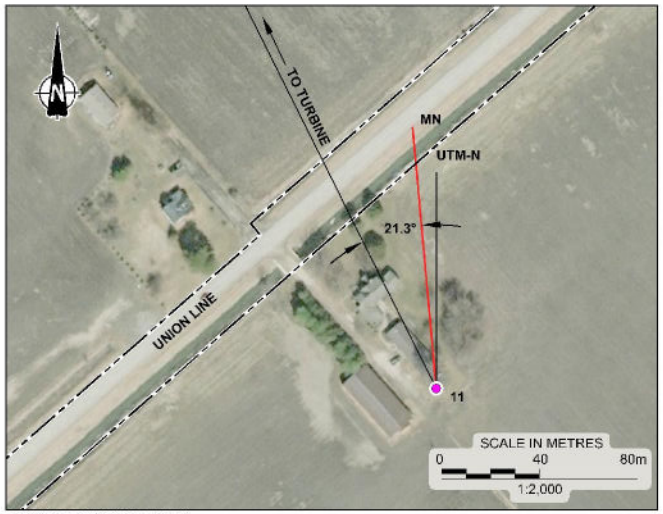
## REFERENCE

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.

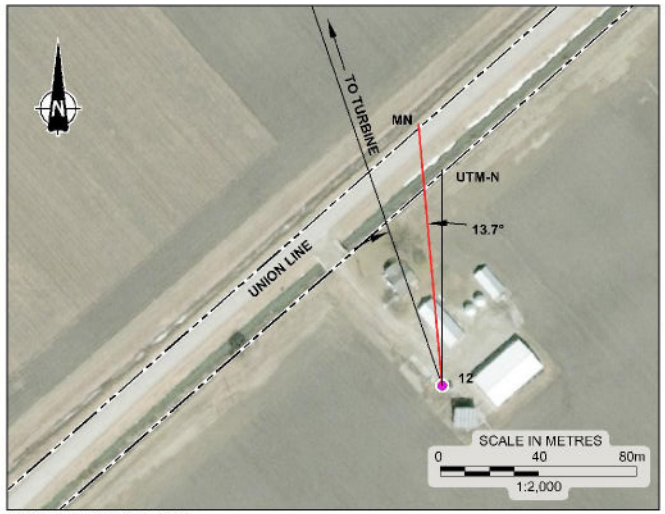
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #11)




INSET B (WELL #12)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T20**

Golder Associates

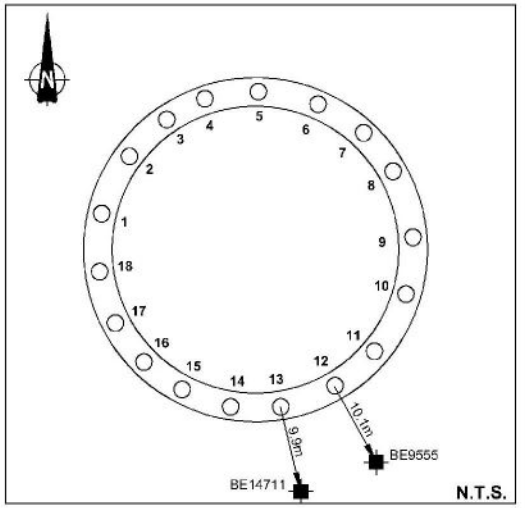
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|---|---|---|---|---|
| PROJECT No. | | | 1668031 | FILE No. 1668031-2000-R02T20 |
| | | | | SCALE AS SHOWN REV. |
| CADD | DCH/ZJB | Sept. 18/17 | | |
| CHECK | | | | |

FIGURE T20

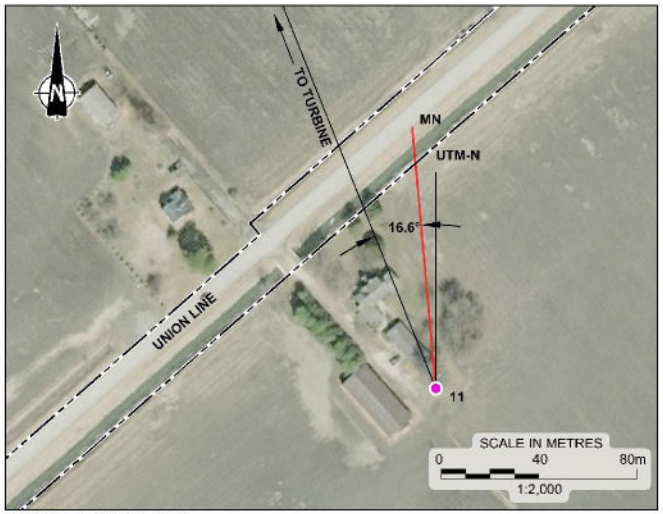
Drawing file: 1668031-2000-R02T20.dwg Sep 18, 2017 - 2:21pm



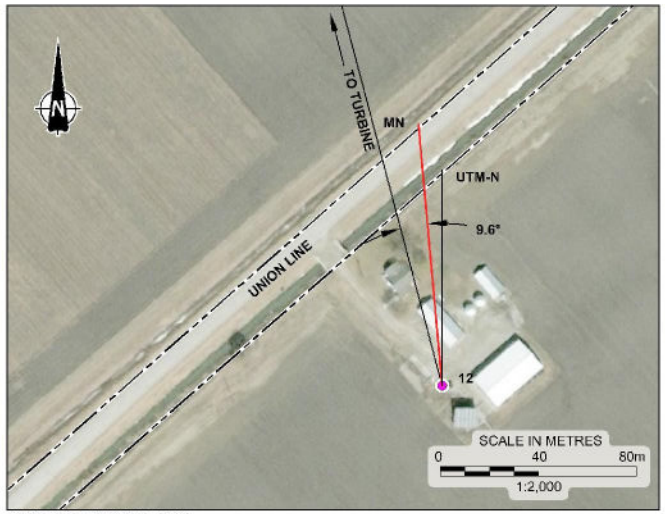

SITE PLAN




TURBINE PILE LAYOUT




INSET A (WELL #11)




INSET B (WELL #12)

## 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, T21**

Golder Associates

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|---|---|---|---|
| PROJECT No. | | | 1668031 |
| CADD | DCH/ZJB | Sept. 18/17 | |
| CHECK | | | |

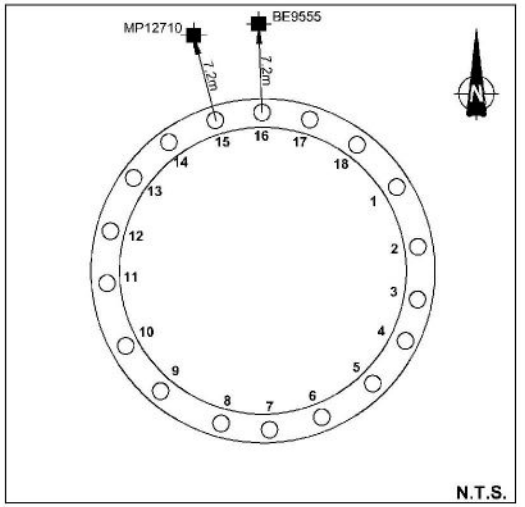
FILE No. 1668031-2000-RG2T21
SCALE AS SHOWN REV.

FIGURE T21

Drawing file: 668031 2000 RG2T21.dwg Sep 18, 2017 2:24pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

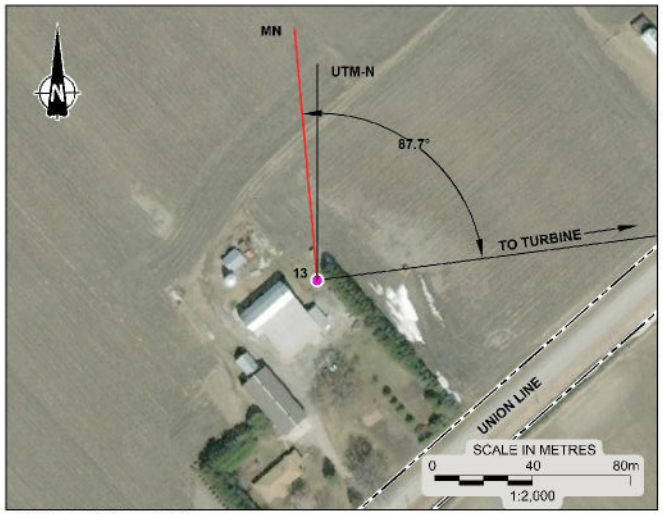
## REFERENCE

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.

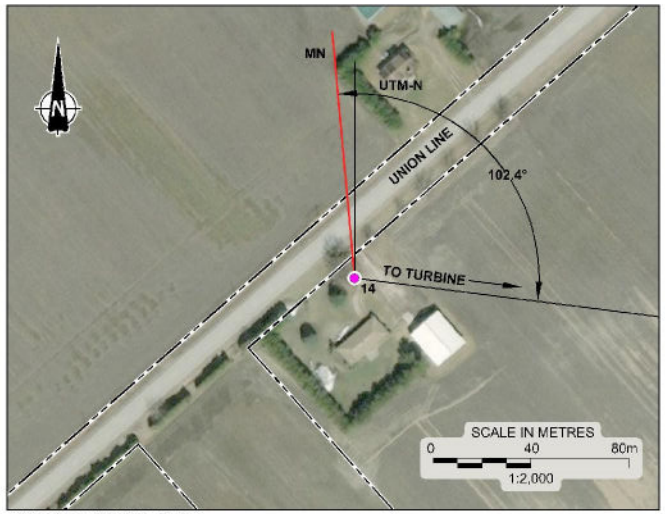
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #13)




INSET B (WELL #14)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T26**

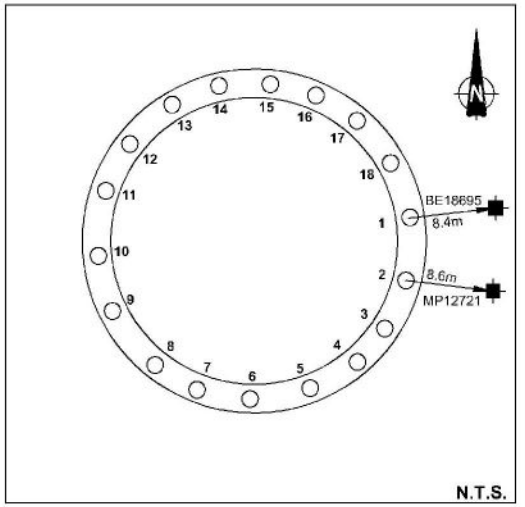
Golder Associates

| | | | | |
|---|---|---|---|---|
| PROJECT No. | | | 1668031 | FILE No. 1668031-2000-R02T26 |
| | | | | SCALE AS SHOWN REV. |
| CADD | DCH/ZJB | Sept. 20/17 | | FIGURE T26 |
| CHECK | | | | |

Drawing file: 1668031-2000-R02T26.dwg Sep 20, 2017 - 11:15am




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

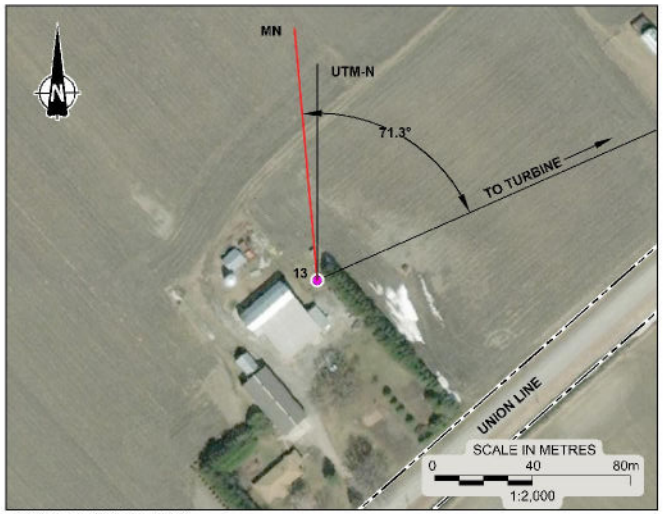
## REFERENCE

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.

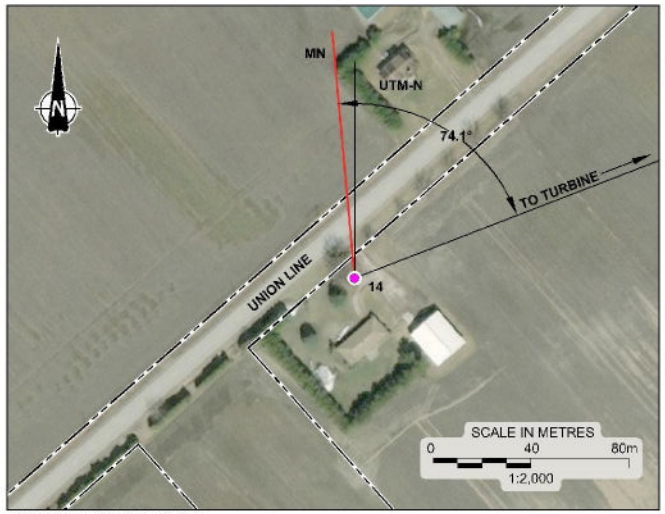
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #13)




INSET B (WELL #14)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

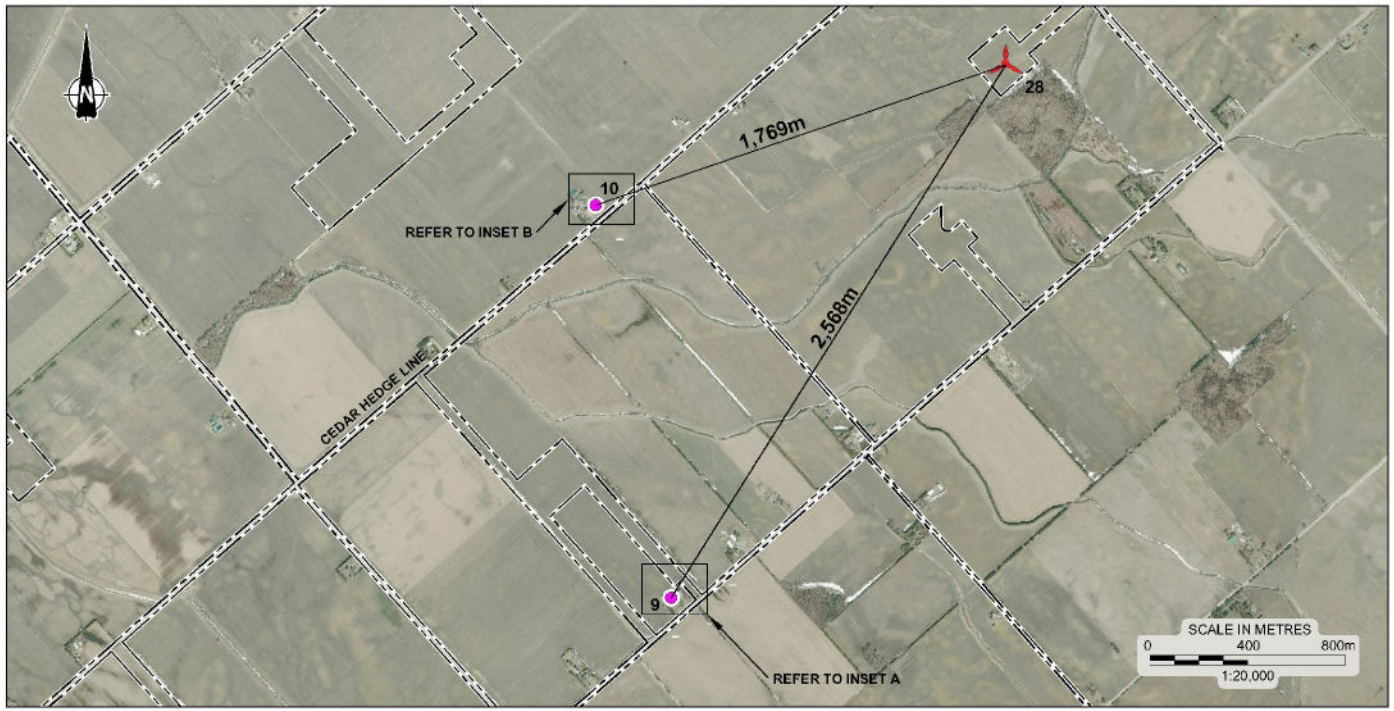
**TURBINE PILES AND WATER WELL LOCATION PLAN, T27**

Golder Associates

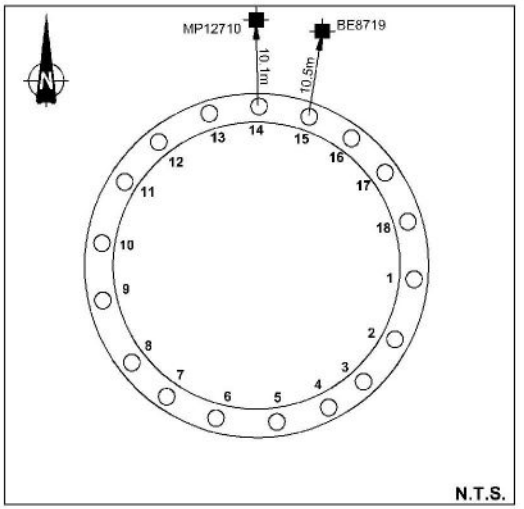
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| | | | SCALE AS SHOWN | REV. |
| CADD | DCH/ZJB | Sept. 20/17 | | |
| CHECK | | | | |

FIGURE T27

Drawing file: 1668031-2000-R02727.dwg Sep 20, 2017 - 11:10am




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

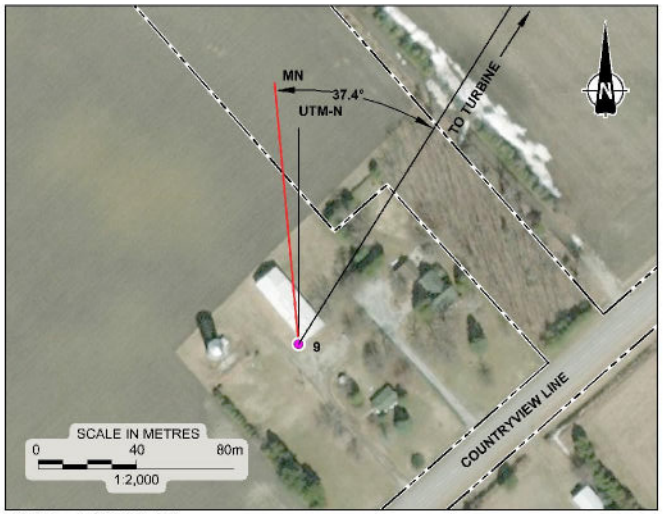
## REFERENCE

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.

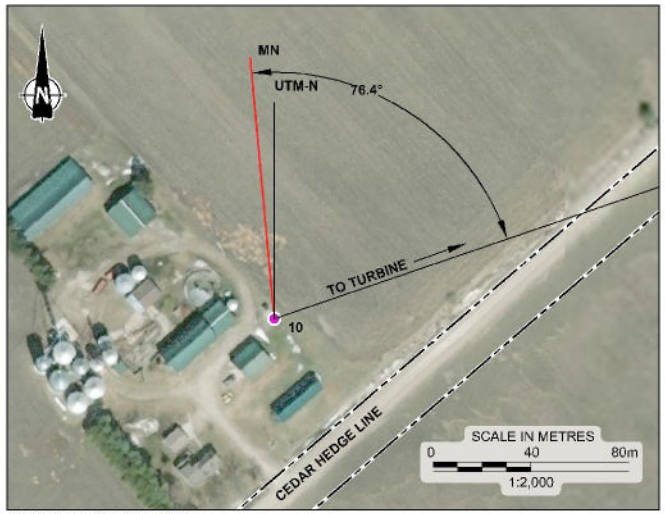
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #9)




INSET B (WELL #10)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T28**

Golder Associates

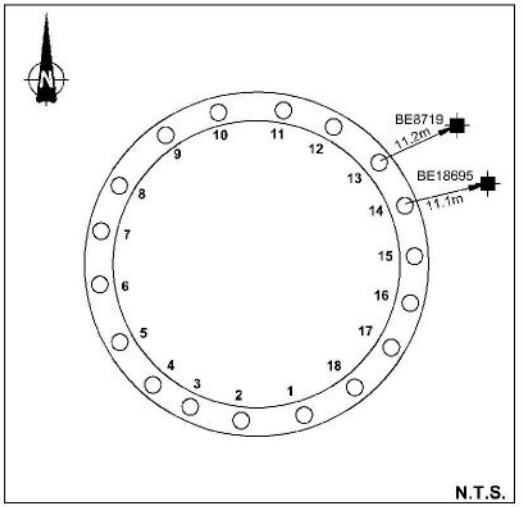
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| | | | | SCALE AS SHOWN REV. |
| CADD | DCH/ZJB | Sept. 20/17 | | |
| CHECK | | | | |

FIGURE T28

Drawing file: 668031 2000 R02T28.dwg Sep 20, 2017 12:39pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

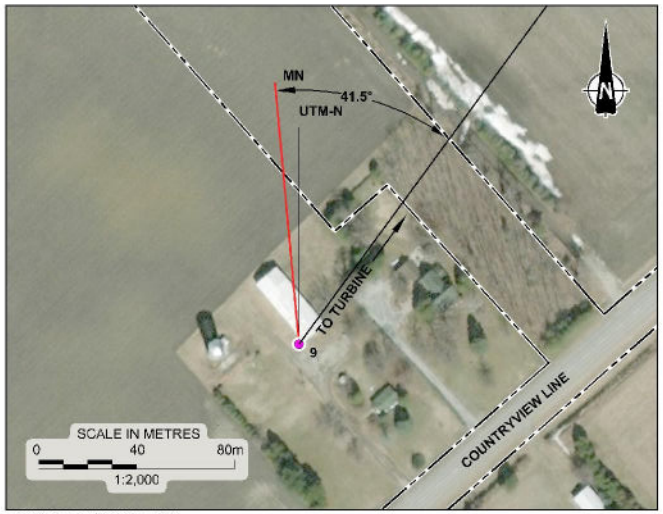
## REFERENCE

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.

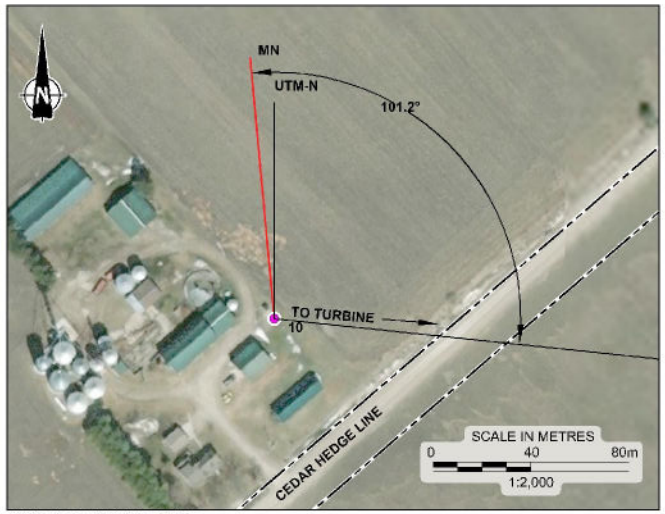
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #9)




INSET B (WELL #10)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T30**

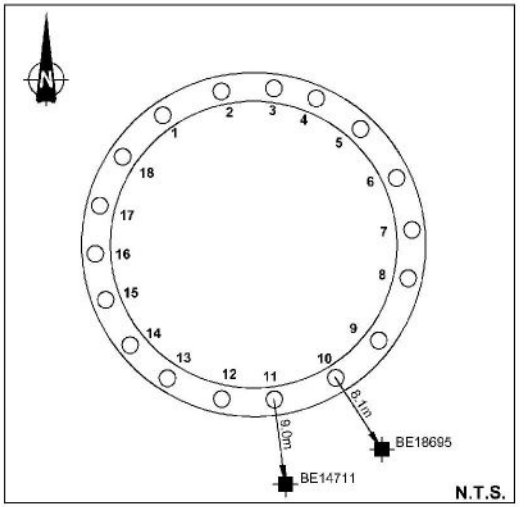
Golder Associates

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| PROJECT No. | | | 1668031 | FILE No. 1668031-2000-R02T30 |
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| CADD | DCH/ZJB | Sept. 20/17 | | |
| CHECK | | | | FIGURE T30 |

Drawing file: 1668031-2000-R02T30.dwg Sep 20, 2017 - 2:41pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

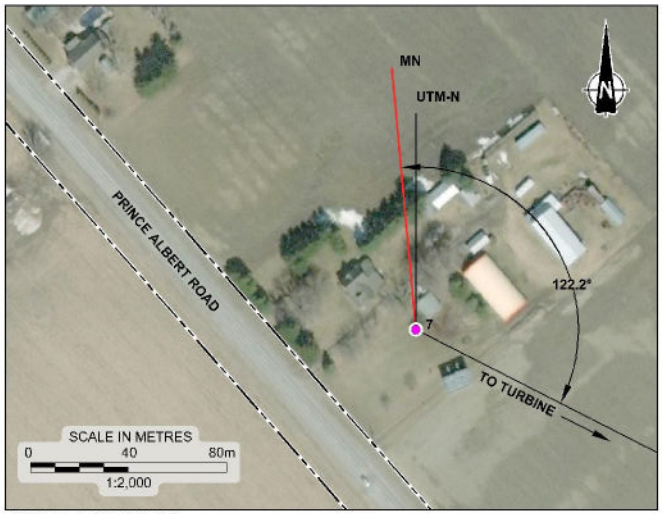
## REFERENCE

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.

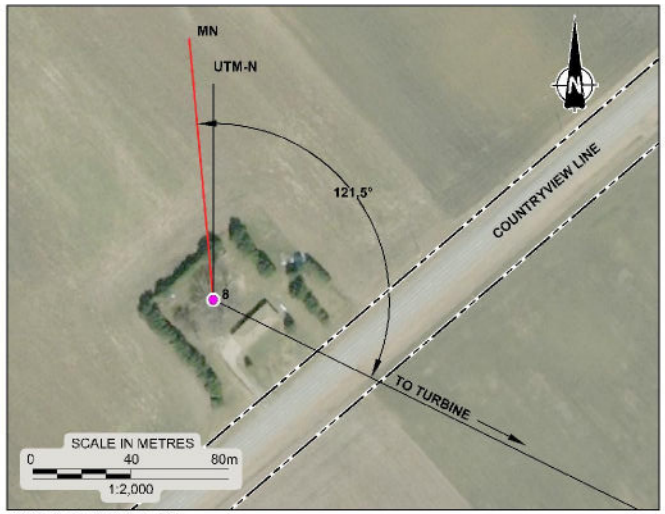
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #7)




INSET B (WELL #8)

PROJECT
NORTH KENT 1
VIBRATION MONITORING

TITLE
**TURBINE PILES AND WATER WELL LOCATION PLAN, T31**

Golder Associates

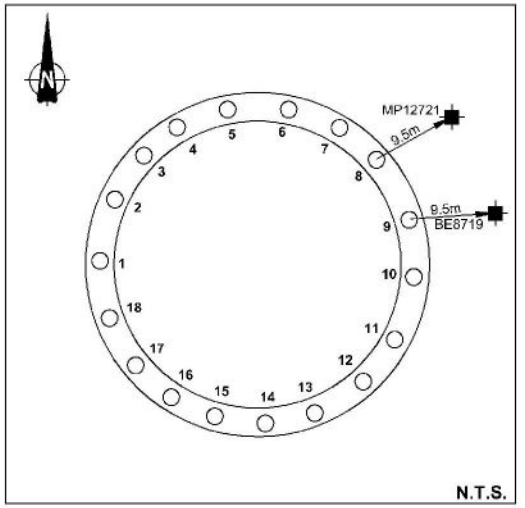
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| CADD | DDI/ZJB | Sept. 18/17 | REV. | |
| CHECK | | | | |

FIGURE T31

Drawing file: 668031 2000 RG2T31.dwg Sep 20, 2017 12:42pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

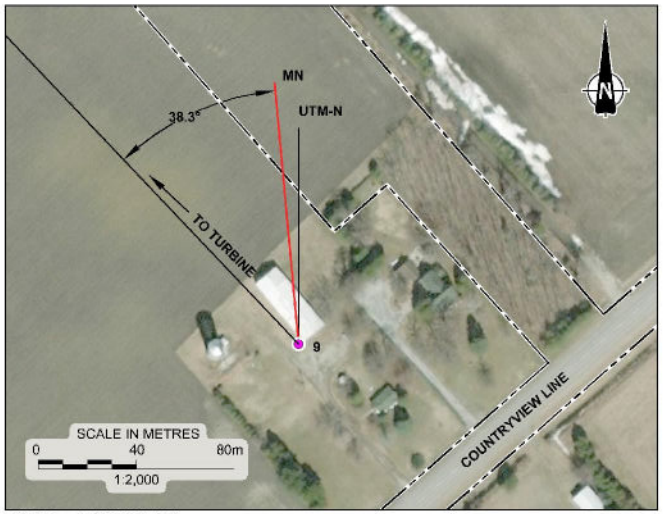
## REFERENCE

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.

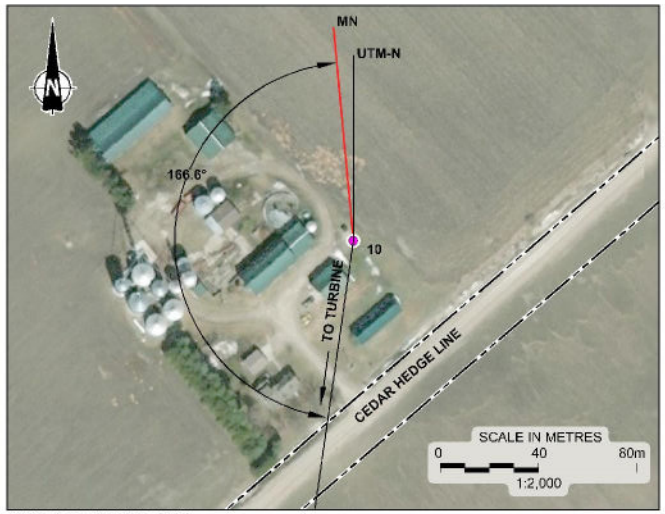
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #9)




INSET B (WELL #10)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T32**

Golder Associates

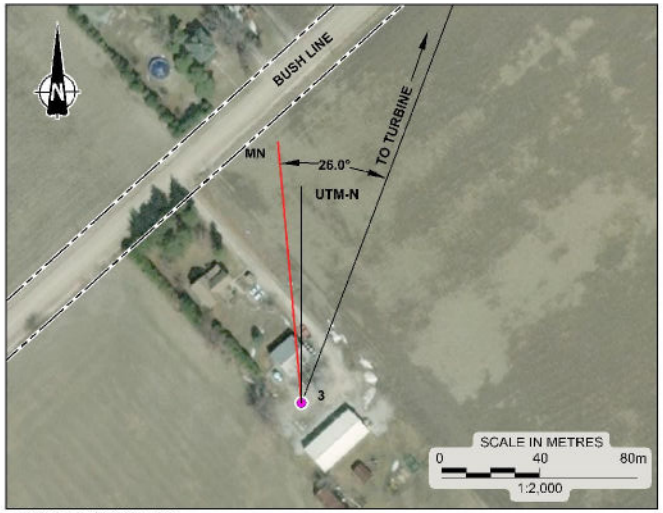
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| CADD | DCH/ZJB Sept. 18/17 | REV. | |
| CHECK | | | |

FIGURE T32

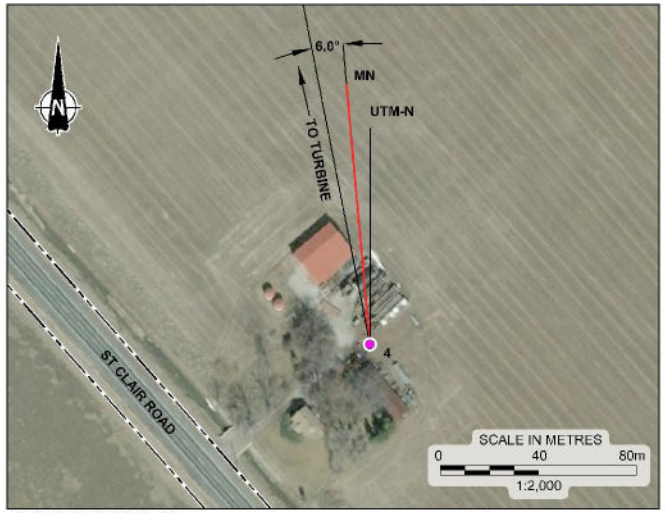
Drawing file: 668031 2000 R02T32.dwg Sep 20, 2017 12:55pm



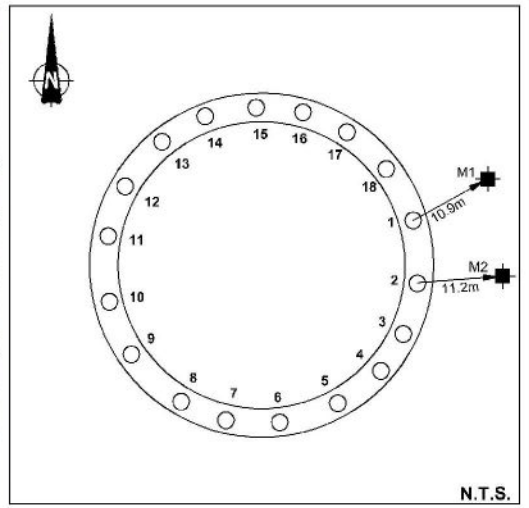

SITE PLAN




INSET A (WELL #3)




INSET B (WELL #4)




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, T33

Golder Associates

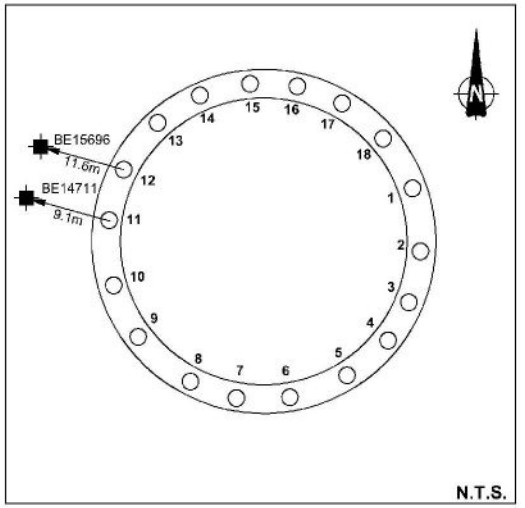
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| | | SCALE | AS SHOWN |
| CADD | DCH/ZJB Sept. 18/17 | REV. | |
| CHECK | | | |

FIGURE T33

Drawing file: 1668031-2000-R02T33.dwg Sep 20, 2017 - 2:46pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

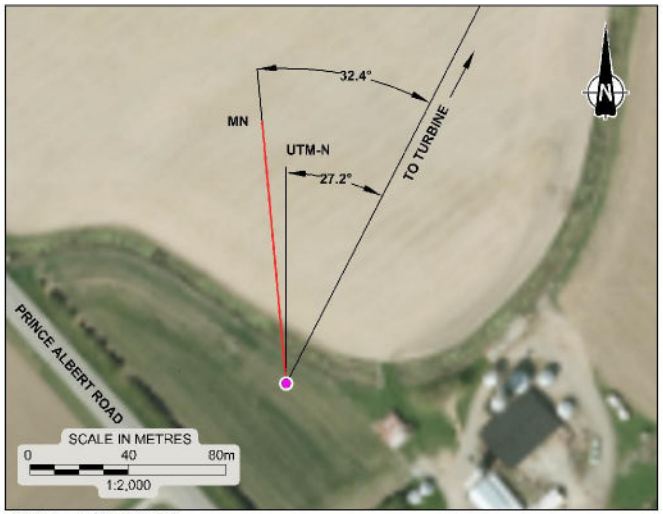
## REFERENCE

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.

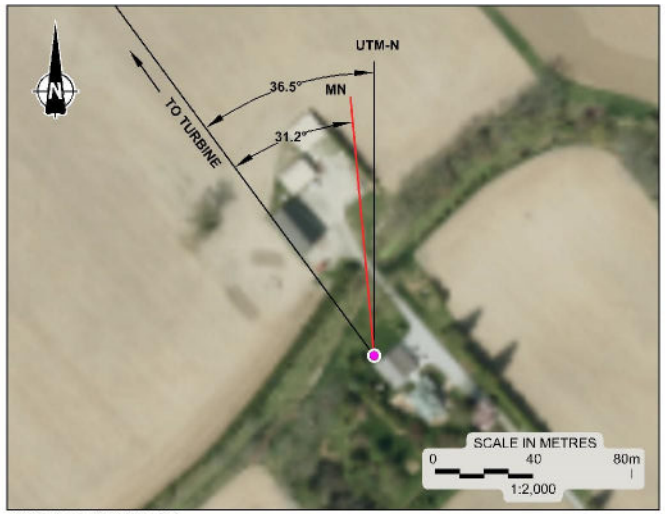
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #6)




INSET B (WELL #5)

PROJECT
NORTH KENT 1
VIBRATION MONITORING

TITLE
**TURBINE PILES AND WATER WELL LOCATION PLAN, T35**

Golder Associates

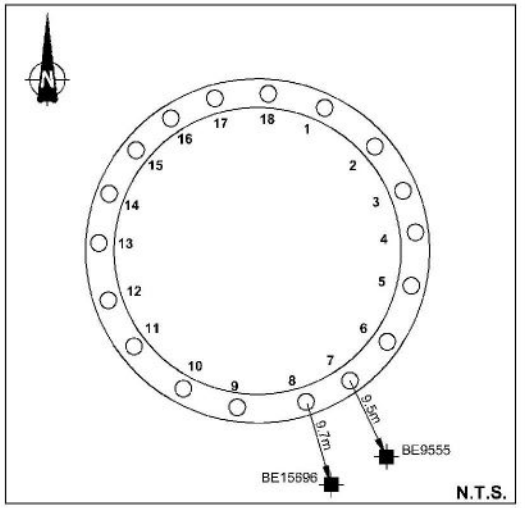
| PROJECT No. | 1668031 | FILE No. 1668031-2000-R02T35 |
|---|---|---|
| | | SCALE AS SHOWN REV. |
| CADD | DDH/ZJB Sept. 18/17 | |
| CHECK | | |

FIGURE T35

Drawing file: 1668031 2000 R02T35.dwg Sep 20, 2017 12:47pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

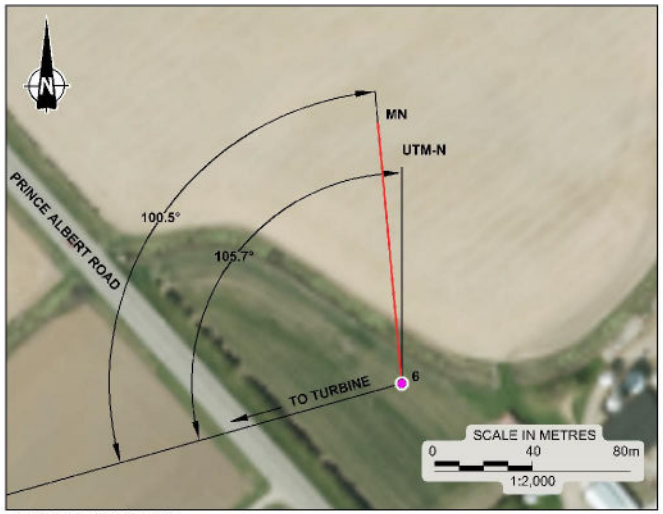
## REFERENCE

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.

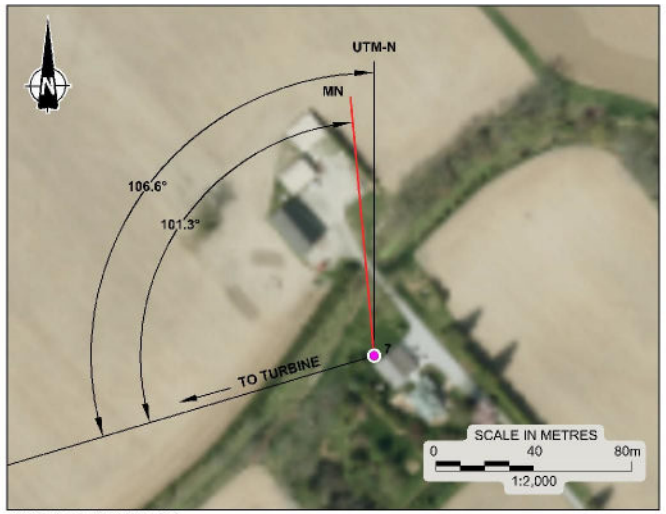
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #6)




INSET B (WELL #5)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T36**

Golder Associates

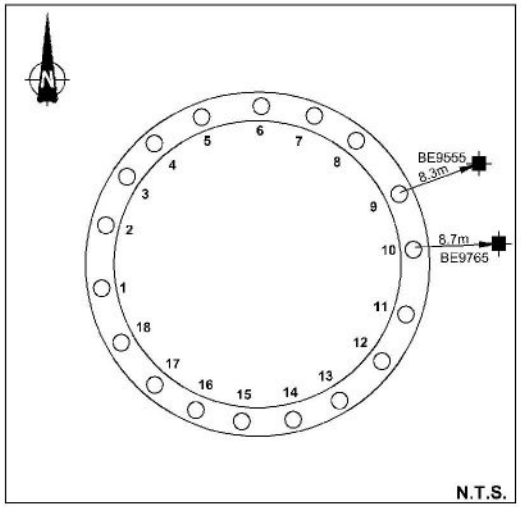
| | | | | |
|---|---|---|---|---|
| PROJECT No. | 1668031 | | FILE No. | 1668031-2000-R02T36 |
| CADD | DCH/ZJB | Sept. 20/17 | SCALE | AS SHOWN |
| CHECK | | | REV. | |

FIGURE T36

Drawing file: 1668031-2000-R02T36.dwg Sep 20, 2017 - 2:49pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

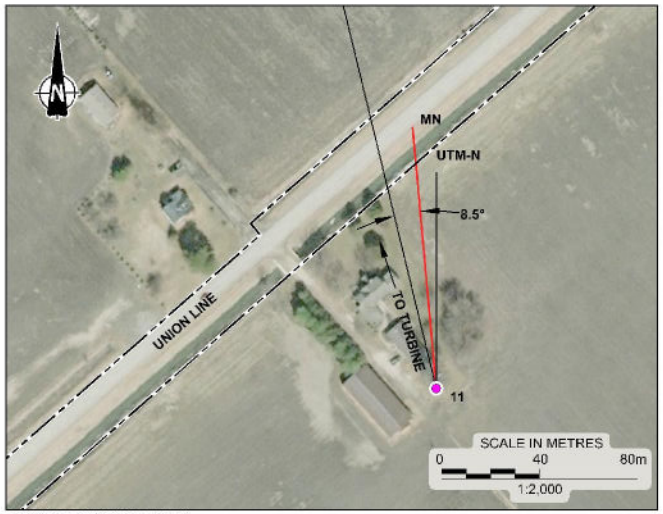
## REFERENCE

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.

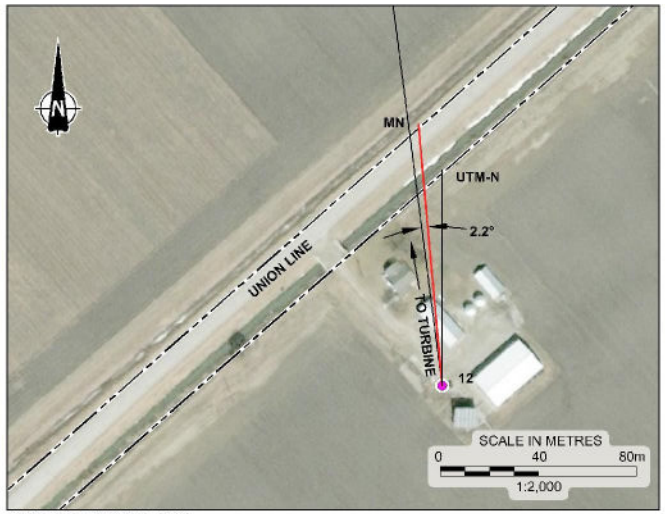
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #11)




INSET B (WELL #12)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T43**

Golder Associates

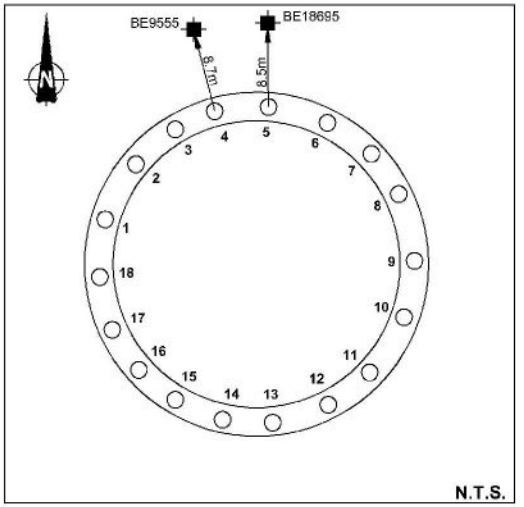
| | | | |
|---|---|---|---|
| PROJECT No. | 1668031 | FILE No. | 1668031-2000-R02T43 |
| | | SCALE | AS SHOWN |
| CADD | DCH/ZJR Sept. 20/17 | REV. | |
| CHECK | | | |

FIGURE T43

Drawing file: 1668031-2000-R02T43.dwg Sep 20, 2017 - 2:08pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

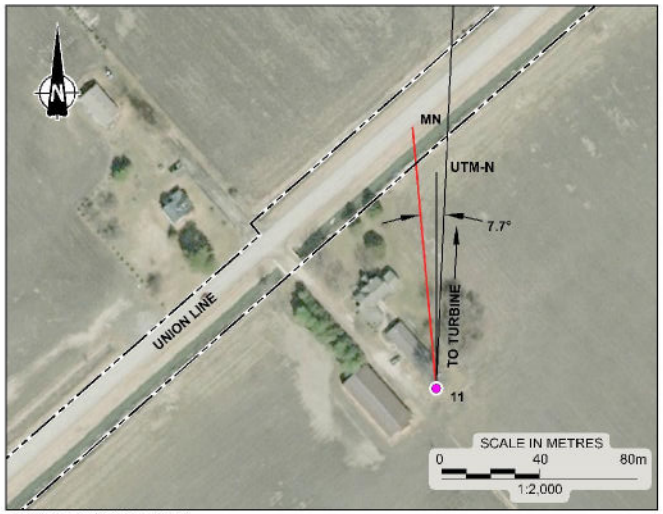
## REFERENCE

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.

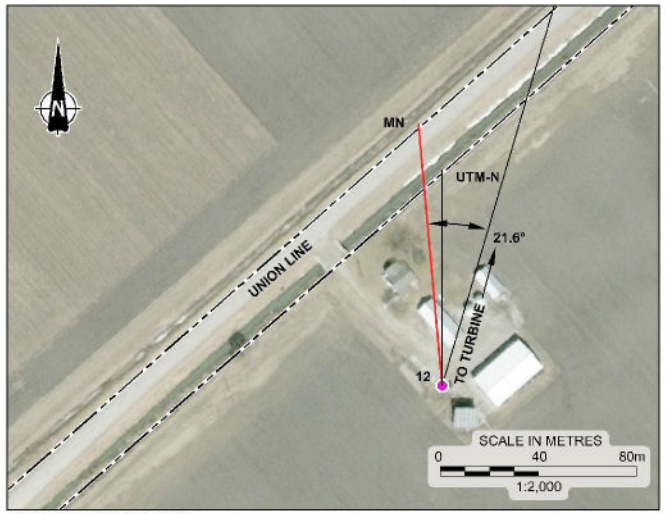
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #11)




INSET B (WELL #12)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T45**

Golder Associates

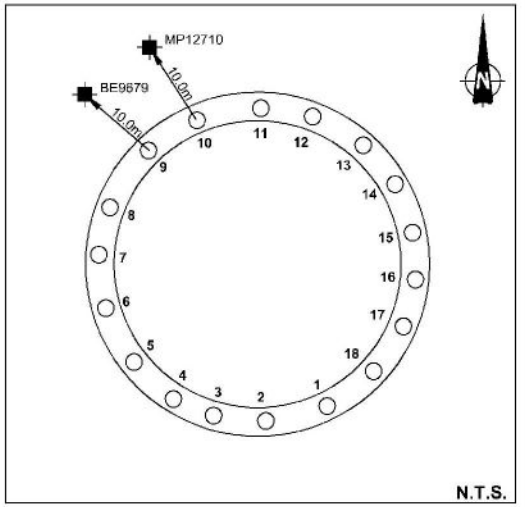
| | | | |
|---|---|---|---|
| PROJECT No. | 1668031 | FILE No. | 1668031-2000-R02T45 |
| CADD | DCH/ZJB Sept. 18/17 | SCALE | AS SHOWN |
| CHECK | | REV. | |

FIGURE T45

Drawing file: 1668031-2000-R02T45.dwg Sep 18, 2017 - 2:07pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

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

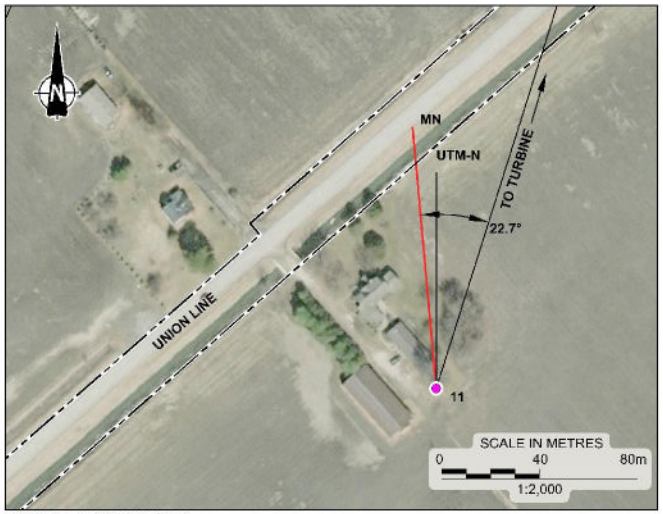
## REFERENCE

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.

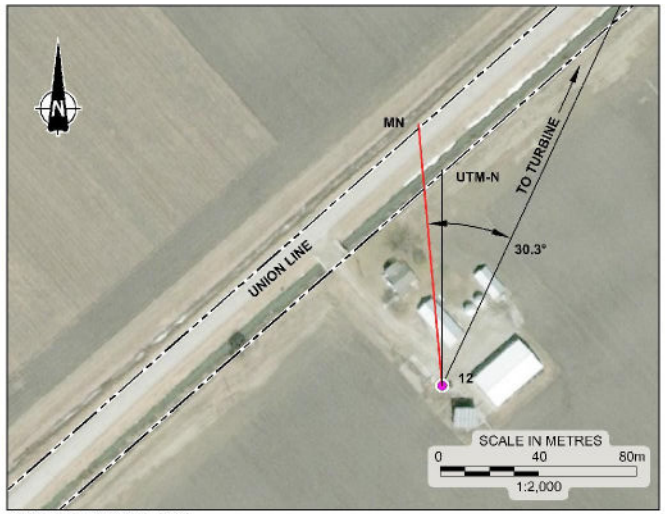
## NOTES

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ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #11)




INSET B (WELL #12)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T46**

Golder Associates

| | | | |
|---|---|---|---|
| PROJECT No. | 1658031 | FILE No. | 1658031-2000-R02T46 |
| | | SCALE | AS SHOWN |
| CADD | DCH/ZJB Sept. 18/17 | REV. | |
| CHECK | | | |

FIGURE T46

Drawing file: 1658031 2000 R02T46.dwg Sep 18, 2017 2:07pm

# Attachment C

## Water Quality Data

AGAT Laboratories

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**
**105 COMMERCE VALLEY DR.W 7TH FLOOR**
**MARKHAM, ON L3T7W3**
**(905) 886-7022**

**ATTENTION TO:** **Erin Wilson**

**PROJECT:** **60343599**

**AGAT WORK ORDER:** **17T180617**

**MICROBIOLOGY ANALYSIS REVIEWED BY:** **Inesa Alizarchyk, Inorganic Lab Supervisor**

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

**DATE REPORTED:** **Jan 31, 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.**



Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)
Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

*Results relate only to the items tested and to all the items tested*
*All reportable information as specified by ISO 17025:2005 is available from AGAT Laboratories upon request*

AGAT Laboratories

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

# Certificate of Analysis

**AGAT WORK ORDER: 17T180617**

**PROJECT: 60343599**

**CLIENT NAME: AECOM CANADA LTD**

**ATTENTION TO: Erin Wilson**

**SAMPLING SITE:**

**SAMPLED BY:S. C.**

## Microbiological Analysis (water)

**DATE RECEIVED: 2017-01-24**

**DATE REPORTED: 2017-01-31**

| | | | | 007420011 |
|---|---|---|---|---|
| | | | SAMPLE DESCRIPTION: | [redacted] |
| | | | SAMPLE TYPE: | Water |
| | | | DATE SAMPLED: | 2017-01-22 |
| Parameter | Unit | G / S | RDL | 8143334 |
| 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

**8143334** ND - Not Detected.

Certified By:



*Results relate only to the items tested and to all the items tested*

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# Certificate of Analysis

**AGAT WORK ORDER: 17T180617**

**PROJECT: 60343599**

**CLIENT NAME: AECOM CANADA LTD**

**SAMPLING SITE:**

**ATTENTION TO: Erin Wilson**

**SAMPLED BY:S. C.**

## North Kent - Groundwater Samples

**DATE RECEIVED: 2017-01-24**

**DATE REPORTED: 2017-01-31**

| | | | | 007420011 [redacted] |
|---|---|---|---|---|
| | | | SAMPLE DESCRIPTION: | [redacted] |
| | | | SAMPLE TYPE: | Water |
| | | | DATE SAMPLED: | 2017-01-22 |
| Parameter | Unit | G / S | RDL | 8143334 |
| Electrical Conductivity | uS/cm | | 2 | 960 |
| pH | pH Units | (6.5-8.5) | NA | 8.29 |
| Total Hardness (as CaCO3) | mg/L | (80-100) | 0.5 | 46.7 |
| Total Dissolved Solids | mg/L | 500 | 20 | **540** |
| Total Suspended Solids | mg/L | | 10 | <10 |
| Alkalinity (as CaCO3) | mg/L | (30-500) | 5 | 325 |
| Fluoride | mg/L | 1.5 | 0.05 | **1.52** |
| Chloride | mg/L | 250 | 0.50 | 115 |
| 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 | <0.05 |
| Sulphate | mg/L | 500 | 0.10 | <0.10 |
| Ammonia as N | mg/L | | 0.02 | 0.17 |
| Dissolved Organic Carbon | mg/L | 5 | 0.5 | 1.0 |
| Colour | TCU | 5 | 5 | **22** |
| Turbidity | NTU | 5 | 0.5 | <0.5 |
| Calcium | mg/L | | 0.05 | 13.1 |
| Magnesium | mg/L | | 0.05 | 3.39 |
| Sodium | mg/L | 20 (200) | 0.05 | **188** |
| Potassium | mg/L | | 0.05 | 2.19 |
| Iron | mg/L | 0.3 | 0.010 | <0.010 |
| Manganese | mg/L | 0.05 | 0.002 | 0.014 |

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

**8143334** Elevated RDLs for Chloride indicate the degree of dilution prior to analysis in order to keep analyte within the calibration range of the instrument and to reduce matrix interferences.

Certified By:



*Results relate only to the items tested and to all the items tested*

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CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

# Guideline Violation

**AGAT WORK ORDER: 17T180617**

**PROJECT: 60343599**

**CLIENT NAME: AECOM CANADA LTD**

**ATTENTION TO: Erin Wilson**

| SAMPLEID | SAMPLE TITLE | GUIDELINE | ANALYSIS PACKAGE | PARAMETER | UNIT | GUIDEVALUE | RESULT |
|---|---|---|---|---|---|---|---|
| 8143334 | 007420011 [redacted] | O.Reg.169/03(mg/L) | North Kent - Groundwater Samples | Colour | TCU | 5 | 22 |
| 8143334 | 007420011 [redacted] | O.Reg.169/03(mg/L) | North Kent - Groundwater Samples | Fluoride | mg/L | 1.5 | 1.52 |
| 8143334 | 007420011 [redacted] | O.Reg.169/03(mg/L) | North Kent - Groundwater Samples | Sodium | mg/L | 20 (200) | 188 |
| 8143334 | 007420011 [redacted] | O.Reg.169/03(mg/L) | North Kent - Groundwater Samples | Total Dissolved Solids | mg/L | 500 | 540 |



*Results relate only to the items tested and to all the items tested*

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FAX (905)712-5122
http://www.agatlabs.com

# Quality Assurance

**CLIENT NAME: AECOM CANADA LTD**

**AGAT WORK ORDER: 17T180617**

**PROJECT: 60343599**

**ATTENTION TO: Erin Wilson**

**SAMPLING SITE:**

**SAMPLED BY:S. C.**

## Microbiology Analysis

| RPT Date: Jan 31, 2017 | | | DUPLICATE | | | | REFERENCE MATERIAL | | | METHOD BLANK SPIKE | | | MATRIX SPIKE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | Batch | Sample Id | Dup #1 | Dup #2 | RPD | Method Blank | Measured Value | Acceptable Limits | | Recovery | Acceptable Limits | | Recovery | Acceptable Limits | |
| | | | | | | | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| **Microbiological Analysis (water)** | | | | | | | | | | | | | | | |
| Escherichia coli | 8143327 | 8143327 | ND | ND | NA | < 1 | | | | | | | | | |
| Total Coliforms | 8143327 | 8143327 | ND | ND | NA | < 1 | | | | | | | | | |

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

Certified By:



AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

*Results relate only to the items tested and to all the items tested*

AGAT Laboratories

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

# Quality Assurance

**CLIENT NAME: AECOM CANADA LTD**

**AGAT WORK ORDER: 17T180617**

**PROJECT: 60343599**

**ATTENTION TO: Erin Wilson**

**SAMPLING SITE:**

**SAMPLED BY:S. C.**

## Water Analysis

| RPT Date: Jan 31, 2017 | | | DUPLICATE | | | | REFERENCE MATERIAL | | | METHOD BLANK SPIKE | | | MATRIX SPIKE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | Batch | Sample Id | Dup #1 | Dup #2 | RPD | Method Blank | Measured Value | Acceptable Limits | | Recovery | Acceptable Limits | | Recovery | Acceptable Limits | |
| | | | | | | | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| **North Kent - Groundwater Samples** | | | | | | | | | | | | | | | |
| Electrical Conductivity | 8142104 | | 550 | 550 | 0.0% | < 2 | 100% | 80% | 120% | NA | | | NA | | |
| pH | 8142104 | | 8.40 | 8.27 | 1.6% | NA | 100% | 90% | 110% | NA | | | NA | | |
| Total Dissolved Solids | 8147132 | | 612 | 612 | 0.0% | < 20 | 100% | 80% | 120% | NA | | | NA | | |
| Total Suspended Solids | 8147132 | | <10 | <10 | NA | < 10 | 98% | 80% | 120% | NA | | | NA | | |
| Alkalinity (as CaCO3) | 8142104 | | 256 | 265 | 3.5% | < 5 | 103% | 80% | 120% | NA | | | NA | | |
| Fluoride | 8143327 | 8143327 | 1.08 | 1.12 | 3.6% | < 0.05 | 95% | 90% | 110% | 95% | 90% | 110% | 102% | 80% | 120% |
| Chloride | 8143327 | 8143327 | 57.1 | 59.5 | 4.1% | < 0.10 | 96% | 90% | 110% | 90% | 90% | 110% | 94% | 80% | 120% |
| Nitrate as N | 8143327 | 8143327 | < 0.05 | <0.05 | NA | < 0.05 | 94% | 90% | 110% | 100% | 90% | 110% | 105% | 80% | 120% |
| Nitrite as N | 8143327 | 8143327 | < 0.05 | <0.05 | NA | < 0.05 | NA | 90% | 110% | 91% | 90% | 110% | 100% | 80% | 120% |
| Bromide | 8143327 | 8143327 | 0.37 | 0.39 | 5.3% | < 0.05 | 102% | 90% | 110% | 94% | 90% | 110% | 96% | 80% | 120% |
| Sulphate | 8143327 | 8143327 | < 0.10 | <0.10 | NA | < 0.10 | 95% | 90% | 110% | 96% | 90% | 110% | 87% | 80% | 120% |
| Ammonia as N | 8143334 | 8143334 | 0.17 | 0.17 | 0.0% | < 0.02 | 97% | 90% | 110% | 97% | 90% | 110% | 98% | 80% | 120% |
| Dissolved Organic Carbon | 8143327 | 8143327 | 2.0 | 2.0 | NA | < 0.5 | 99% | 90% | 110% | NA | 90% | 110% | 106% | 80% | 120% |
| Colour | 8134375 | | 25 | 25 | 0.0% | < 5 | 99% | 90% | 110% | NA | | | NA | | |
| Turbidity | 8143327 | 8143327 | < 0.5 | <0.5 | NA | < 0.5 | 106% | 90% | 110% | NA | | | NA | | |
| Calcium | 8143830 | | 96.6 | 97.4 | 0.8% | < 0.05 | 103% | 90% | 110% | 103% | 90% | 110% | 104% | 70% | 130% |
| Magnesium | 8143830 | | 39.7 | 39.6 | 0.3% | < 0.05 | 98% | 90% | 110% | 99% | 90% | 110% | 99% | 70% | 130% |
| Sodium | 8143830 | | 3.87 | 3.77 | 2.6% | < 0.05 | 102% | 90% | 110% | 102% | 90% | 110% | 98% | 70% | 130% |
| Potassium | 8143830 | | 1.43 | 1.41 | 1.4% | < 0.05 | 101% | 90% | 110% | 101% | 90% | 110% | 103% | 70% | 130% |
| Iron | 8143327 | 8143327 | 0.117 | 0.121 | 3.4% | < 0.010 | 99% | 90% | 110% | 106% | 90% | 110% | 94% | 70% | 130% |
| Manganese | 8143327 | 8143327 | 0.009 | 0.009 | NA | < 0.002 | 108% | 90% | 110% | 108% | 90% | 110% | 91% | 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:



AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

*Results relate only to the items tested and to all the items tested*

AGAT Laboratories

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# Method Summary

**CLIENT NAME: AECOM CANADA LTD**

**AGAT WORK ORDER: 17T180617**

**PROJECT: 60343599**

**ATTENTION TO: Erin Wilson**

**SAMPLING SITE:**

**SAMPLED BY:S. C.**

| 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 CaCO3) | 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 CaCO3) | 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 NH3-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 |



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