ENVIRONMENTAL NOISE ASSESSMENT REPORT R1

Ottawa, ON

For
Air-Rock Drilling

Prepared by
State of the Art Acoustik Inc.

Report Date: 2024-09-05

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2024-09-05

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Environmental Noise Assessment Report R1
Air-Rock Drilling Headquarters, Richmond, Ontario

Dear Kathy,

We are pleased to provide you with our report on the assessment of the environmental noise impact of the Air-Rock Drilling Headquarters' noise sources on the surrounding area.

This report is based on information provided to State of the Art Acoustik by Air-Rock Drilling, information made public by the City of Ottawa, and acoustical measurements taken by State of the Art Acoustik.

We assessed the environmental noise impact of the Headquarters by using on-site acoustical measurements taken from November 28th-30th, 2023, as well as August 8th, 2024, which were used to calibrate an environmental noise model. The environmental noise impact of the site was assessed, assuming the worst-case noise conditions. Our analysis shows that the site will require acoustical mitigation to comply with the City of Ottawa's Environmental Noise Control Guidelines (ENCG). Our mitigation recommendations are detailed in **Sections 3.2.2 and 4.0.**

This Acoustical Assessment Report was prepared in accordance with the City of Ottawa's ENCG and the Ministry of the Environment, Conservation and Parks (MECP) NPC-300.

Sincerely,

Tiffany-Rose Filler, M.Sc.,
Acoustic Consultant

1.0 Introduction & Site Description

The headquarters for Air Rock Drilling is located at 6659 Franktown Road RR 1 in Ottawa, Ontario. Air Rock Drilling has commissioned State of the Art Acoustik to assess the environmental noise impact of the current headquarters on the surrounding area, which includes residential housing to the west, east, and south of the facility. This report determines whether this site complies with the City of Ottawa's sound level limits outlined when in use.

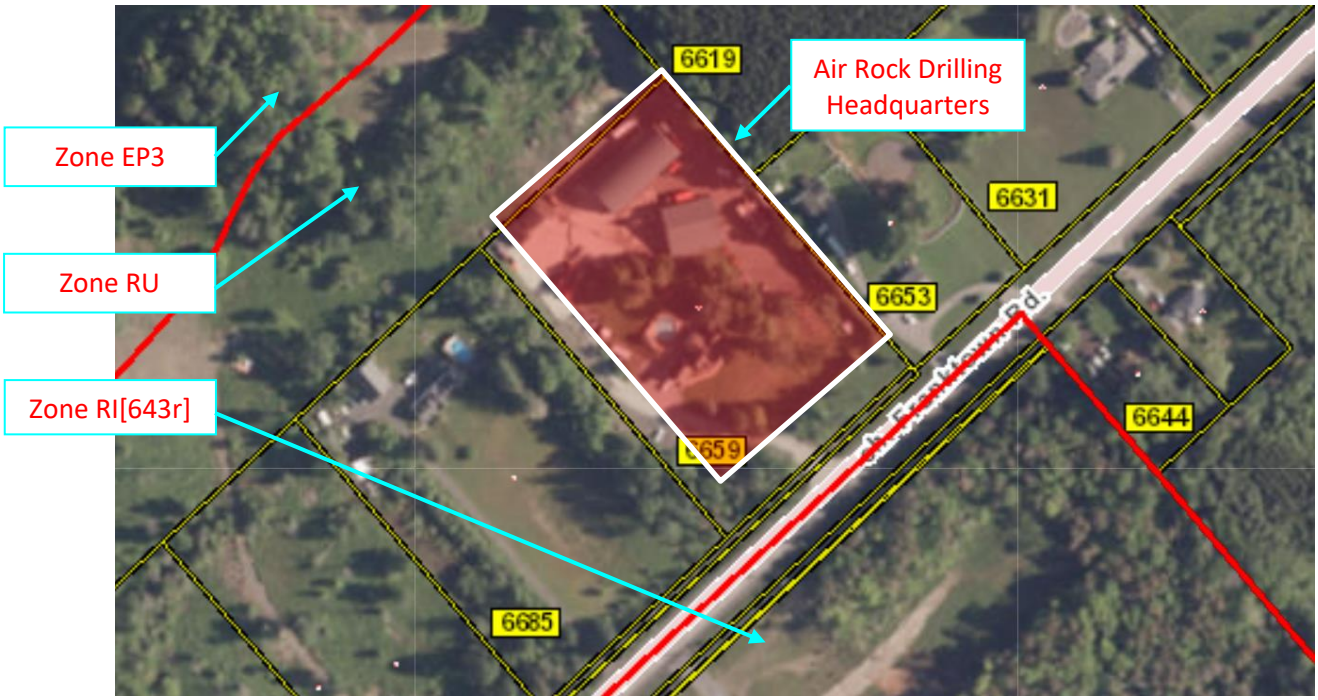

Figure 1.1 – Satellite view of the Air-Rock Drilling Headquarters and the surrounding area. Imagery obtained via geoOttawa. Zones are separated with red lines.

The City of Ottawa has classified Air Rock Drilling Headquarters and the surrounding environment as being a Class 3 area. Therefore, to comply with the City of Ottawa's ENCG, the facility must meet the MECP limits for Class 3 daytime permissible Sound Pressure Levels (SPL) at nearby noise-sensitive areas. The area around 6659 Franktown Road must meet noise limits of 45 dBA during the day (07:00 to 19:00 hours) and 40 dBA during the evening and night (19:00 to 07:00 hours).

There is currently a berm between 6685 Franktown Road and the Headquarters, as well as the berm between 6653 Franktown Road and the Headquarters, which were estimated to be approximately 1.6 to 2.0m tall. This study will use the lowest measured height as the worst-case scenario. A new earthen berm at the back of the property was put in place by Air Rock Drilling between them and 6685 Franktown Road at a height of approximately 4.8m. The approximate locations of the berms are identified in **Figure 1.2**.

Figure 1.2 – Approximate location of the 1.6m-tall (in blue) and 4.8m-tall (in pink) earthen berms at Air-Rock Drilling Headquarters. Imagery obtained via geoOttawa.

2.0 Noise Modelling Procedure

In this section, we describe the modelling procedure used to assess the environmental noise impact of the Air Rock Drilling Headquarters on its surroundings.

To construct an environmental noise model, we use a noise modelling software called CadnaA which references ISO 9613. CadnaA predicts environmental noise from calculations based on a 3D model which incorporates building geometry, landscape data, topography, and the sound power of the noise sources under consideration.

After inputting the Air Rock Drilling Headquarters into CadnaA, we then added the existing noise sources into the model at the locations observed during our visit. Finally, we assigned sound power data to the noise sources from direct measurements.

2.1 Modelling and Measurement Process

To assess the current environmental noise impact of Air Rock Drilling Headquarters, personnel from State of the Art Acoustik visited the facility on August 8th, 2024. During the site visit, all existing noise sources, significant or otherwise, were documented. All potential noise sources were measured during our visit. These sources are listed in **Table 2.1 and Table 2.2**.

Source ID	Source
S_{01}	Air Rock Drilling Truck (Idling/Circulating)
S_{02}	Propane Forklift (Idling)
S_{03}	Diesel Forklift (Idling)
S_{04}	Pressure Washer
S_{05}	Garage Doors (Moving Up/Down)
S_{06}	Air Conditioning (AC) Unit (Running)
S_{07}	Tank Refill Truck (Refueling)
S_{08}	Air Rock Digger Truck (Idling/Circulating)
S_{09}	Loading Pipe onto Truck by Diesel Forklift

Table 2.1 – List of Air Rock Drilling Equipment and Activities Included in Environmental Model

The following noise source is excluded from **Table 2.1** for the reason outlined below:

- The furnace did not produce a discernible noise above background noise during our visit, so it was not included in our simulation.

Table 2.2 lists each noise source measured at Air Rock Drilling: the average measured SPL, the spectrum of the SPL measurement, the total calculated L_w assuming hemispherical radiation (as input into the Environmental Noise Model), and related measurement details.

Source ID	Source	Average Measured SPL [dBA]	Average Measured SPL [dB] by Octave Band [Hz]								Calculated Lw [dBA]
			63	125	250	500	1000	2000	4000	8000	
S_{01}	Air Rock Drilling Truck (Idling)	83.3	81.2	67.0	75.0	78.6	80.0	75.7	73.3	61.6	85.5[1,2]
S_{02}	Propane Forklift (Idling)	77.4	91.4	75.6	76.4	76.1	70.0	69.3	63.8	59.0	90.4[1]
S_{03}	Diesel Forklift (Idling)	85.8	82.3	84.6	76.5	79.6	83.2	78.3	72.0	69.0	93.8
S_{04}	Pressure Washer	83.5	71.6	69.5	69.2	73.5	74.7	76.1	77.9	78.2	91.5
S_{05}	Garage Doors (Up/Down)	60.6	57.1	59.7	57.1	57.6	53.8	52.7	53.1	47.6	75.1
S_{06}	AC (Running)	65.8	64.5	59.0	58.2	63.4	59.5	59.9	55.4	47.5	75.8[1]
S_{07}	Tank Refill Truck (Refueling)	89.3	82.8	91.0	88.5	86.8	84.6	80.8	75.3	68.1	91.3[2]
S_{08}	Air Rock Digger Truck (Idling)	85.4	97.1	83.4	74.2	81.6	80.9	79.4	71.4	62.8	87.6[1,2]
S_{09}	Loading Pipe onto Truck by Diesel Forklift	79.5	72.7	67.6	69.3	72.2	73.5	75.3	68.8	66.2	92.5[1]

Note[1]: Noise source was determined to be tonal, therefore tonal penalty of 5 dBA was applied as per MOECP NPC 104, Section 4.1.
Note[2]: Noise source was observed to be intermittent, therefore an intermittent adjustment was applied as per MOECP NPC 104, Section 3.0.

Table 2.2 – Noise source emission specifications were obtained from on-site measurements for a single source. A microphone measured each source 1m from the center and 1.0-1.5m from the ground.

All the necessary sound level measurements were carried out at the facility using fully calibrated acoustic test measurement equipment, consisting of the following:

- Larson Davis 2559 1/2 Microphone Cartridge
- Larson Davis Type PRM 900C Microphone Preamplifier
- Larson Davis Type 2900B Real Time Analyzer
- CESVA SC310 Class 1 S/N T224599 Sound Level Meter
- CESVA Type PA13-2654 Microphone Pre-amplifier
- CESVA Type C-130 10230 1/2” Microphone
- Larson Davis Type CA250 Pistonphone Microphone Calibrator
- CESVA Capture Studio Software
- Associated cables
- Two 4" diameter windscreen
- 1.5 m high tripod

The Larson Davis Type 2900B Real Time Analyzer was calibrated to 114 dB at 250 Hz. The CESVA sound level measuring system was calibrated before the first test to 105.2 dBA. Measurements were made in 1/3 octave bands between 25 - 10,000 Hz. The ambient air temperature during the site visit was 21° C.

All noise sources except for the pipes being loaded onto a truck by a forklift were measured using the following procedure. The sound level meter was held at a fixed distance and height from the equipment, and a single, 30-second-long, stationary measurement was taken to determine the SPL and associated frequency spectrum.

The pipes being loaded onto a truck by a forklift were measured using the following procedure. The sound level meter was held at a fixed distance and height from the equipment, and two single, 30-second-long, walking measurements were taken to determine the SPL and associated frequency spectrum.

We modelled the sources using a hemispherical noise radiation calculation to determine and model the Sound Power Level of each source from its measured SPL.

Noise from morning activities at Air Rock Drilling, such as an idling truck and diesel forklift, was measured at the property boundaries of both 6685 and 6653 Franktown Road. Additionally, we measured at the plane-of-window for the residence at 6653 Franktown Road, which corresponds to the point of reception (POR-2) in our simulation model. Further details about this location are provided in Section 2.2, along with an accompanying figure. Unfortunately, we were unable to access the property at 6685 Franktown Road, so no measurements were taken at the plane-of-window of their residence which is used as our point of reception for that property in our simulation model as POR-1. The measurement locations are illustrated in **Figure 2.1**, and these measurements were intended to validate our noise model.

Due to high traffic volume during the measurement period (7-9am, Thursday, August 8th), the L95 Sound Pressure Level is reported as it most represents the constant background noise from the site. L95 is the sound level exceeded 95% of the time and is commonly used to determine stationary noise levels in an environment dominated by traffic noise.

Figure 2.1 – Measurement Positions During Morning Activities at Air Rock Drilling

Location	Statistical Noise Level at L95 (dBA)
Property Boundary at 6685 Franktown Road	44.5
Property Boundary at 6653 Franktown Road	43.1

Table 2.3 – L95 Measurement Results at **Figure 2.1**'s Measurement Positions during Morning Activities at Air Rock Drilling

2.2 Points of Reception (PORs)

Two locations were selected as our PORs. We identified POR-1 as the nearest window on the residential building at 6685 Franktown Road. We identified POR-2 as being the closest residential building at 6653 Franktown Road. The building located further away from the road is the barn and, therefore, is not considered a noise-sensitive receptor. POR height is set to a height of 1.5m tall as both residences are one-storey buildings. These locations are depicted in **Figure 2.2.**

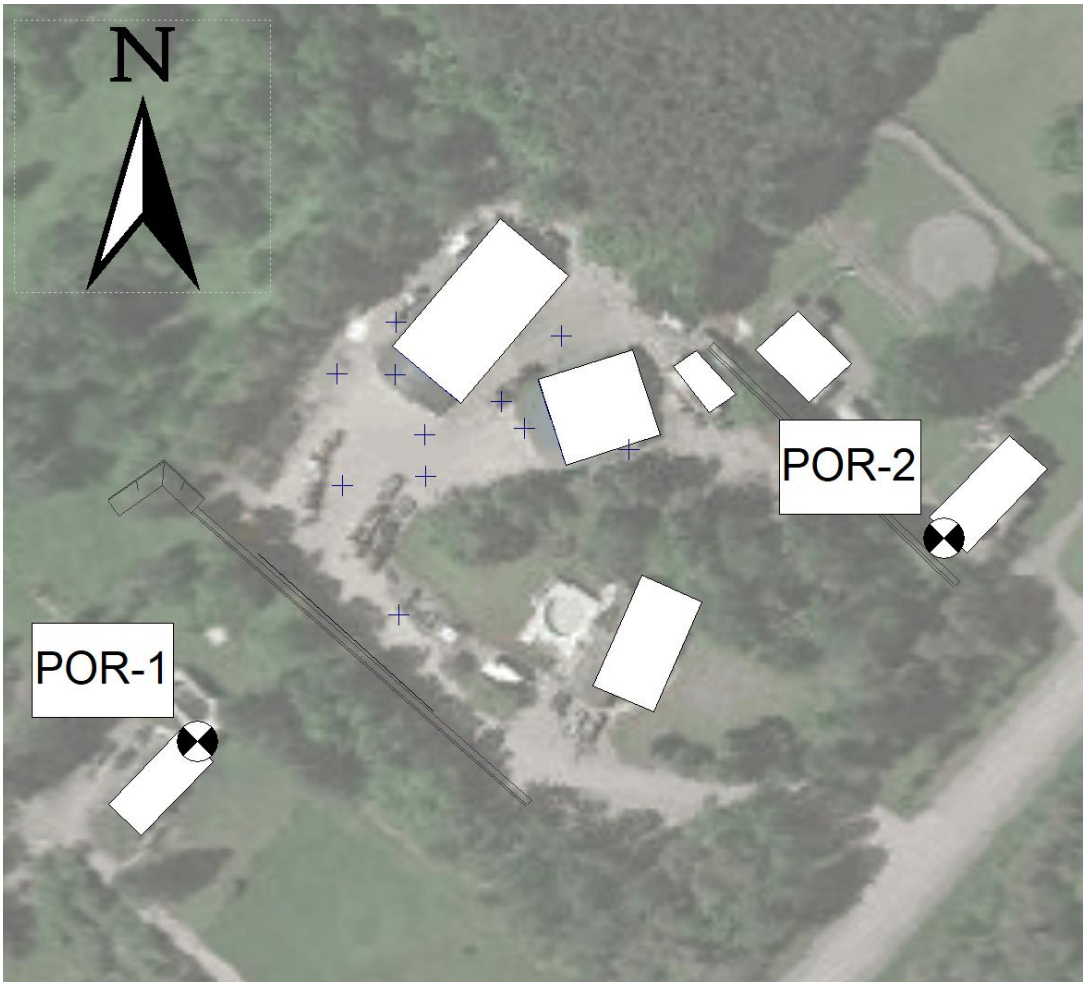

Figure 2.2 – Illustration depicting PORs around Air Rock Drilling Headquarters

2.3 Air Rock Drilling Noise Sources

Representatives of State of the Art Acoustik were present on site to observe a typical morning routine. Based on these observations, as well as discussions with Air Rock Drilling Representatives, the following noise sources are considered in the environmental noise model. This is a worst-case scenario. The locations of these noise sources are identified in **Figure 2.3**.

- 8 Air Rock Drilling trucks being driven in/out per hour of the Air Rock Drilling Headquarters. **($S_{01\text{-circulating}}$)**
- 3 Air Rock trucks idling for 20 minutes each **($S_{01\text{-idling}}$)**
- 1 propane forklift and 1 diesel forklift idling. **(S_{02} and S_{03})**
- 1 parked Air Rock Drilling truck being washed. **(S_{04})**
- All 4 warehouse (garage) doors being opened/closed. **(S_{05})**
- 1 Air Conditioning unit running. **(S_{06})**
- 1 Refueling Truck refuelling the gas tanks over 15 minutes. **(S_{07})**
- 2 Air Rock Digger trucks being driven in/out per hour of the Air Rock Drilling Headquarters. **($S_{08\text{-circulating}}$)**
- 1 parked Air Rock Drilling truck being loaded with pipes by a diesel forklift. **(S_{09})**
- 1 Air Rock Digger truck and 1 Air Rock Drilling truck idling while being refuelled at the gas tank for approximately 10 minutes total. **($S_{01\text{-idling}}$ and $S_{08\text{-idling}}$)**

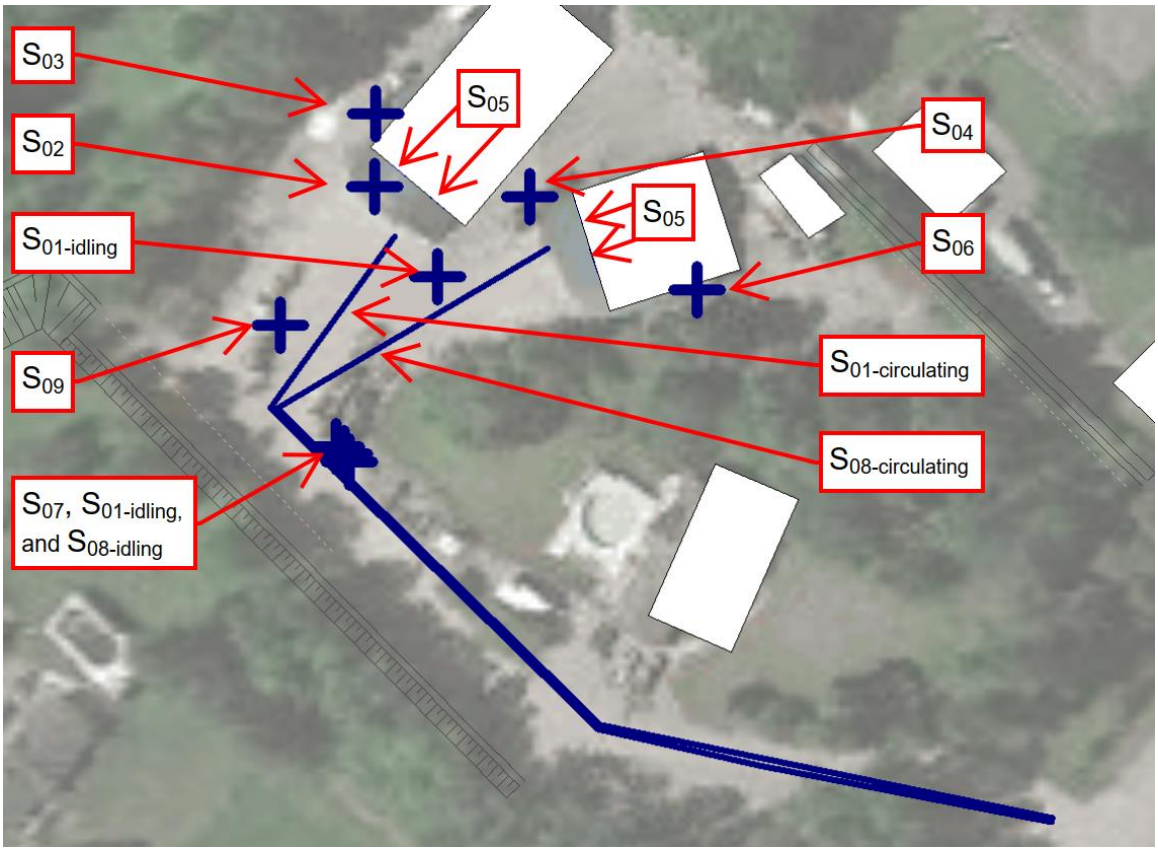

Figure 2.3 – Location of all Noise Sources at Air Rock Drilling during a typical morning routine over 1 hour

3.0 Environmental Noise Model and Analysis

This section summarizes the Environmental Noise Model noise modelling procedure and results for the aforementioned noise sources described in **Section 2.0**. The noise model aims to assess the impact of Air Rock Drilling's noise sources on the surrounding area and identify potential solutions for noise mitigation.

3.1 Environmental Noise Model

The environmental noise analysis was completed using environmental noise modelling software, which references ISO 9613. The Environmental Noise Model predicts environmental noise through calculations based on a 3D model that uses geometrical, landscape, and topography data combined with details of the site and our sound level meter measurements.

We created a 3D rendering of the neighbourhood around 6659 Franktown Road and populated it with buildings and existing berms as detailed in **Section 1**.

In addition to the modelling process described above, the following table lists the parameters used in the Environmental Noise Model:

Parameter	Value/Condition
Temperature (°C)	14
Relative Humidity (%)	81
All Buildings, Roads and Land Fully Reflective	Absorption Coefficient Alpha = 0
Maximum Order of Reflection	2
No Sub. of Neg. Ground Att.	ON
No Neg. Path Difference	ON

Table 3.1 – Parameters used in the Environmental Noise Model.

3.2 Environmental Noise Model Analysis

3.2.1 Environmental Model, Existing Conditions

The calculated worst-case scenario environmental noise impact is shown in **Figure 3.1**, with predicted noise at the PORs in **Table 3.2**.

Figure 3.1 – Predicted sound pressure levels for existing conditions, as detailed in **Section 2.3**. Sound pressure levels (SPL) for PORs in dBA. The grid was measured at 1.5m.

ID	Time of Day	SPL (dBA)	Maximum SPL Limit (dBA)	Acoustic Compliance?
POR-1	07:00 – 19:00	47.5	45.0	No
	19:00 – 23:00		40.0	No
	23:00 – 7:00		40.0	No
POR-2	07:00 – 19:00	42.2	45.0	Yes
	19:00 – 23:00		40.0	No
	23:00 – 7:00		40.0	No

Table 3.2 – Comparison of predicted value at POR-1 and POR-2 to the City of Ottawa's ENCG acoustic limits.

The model determines that Air Rock Drilling Headquarters currently does not meet the acoustic requirements of the City of Ottawa at 6685 Franktown Road (POR-1) at any time of day and at 6653 Franktown Road (POR-2) in the evening and at night.

3.2.2 Environmental Model, Acoustic Mitigation

Acoustical mitigation was investigated in order to reduce the noise impact at POR-1. The following measures were implemented into our acoustical model:

- An acoustical barrier was added at the property line bordering POR-1.
- Air Rock Drilling Headquarters will not be active between 19:00 and 07:00.

The predicted noise levels with these mitigation measures are shown in **Figure 3.2** and **Table 3.3**.

Figure 3.2 – Predicted sound pressure levels for existing conditions, as detailed in **Section 2.3**, with acoustic mitigation. Sound pressure levels (SPL) for PORs in dBA. The grid was measured at 1.5m.

ID	Time of Day	SPL (dBA)	Maximum SPL Limit (dBA)	Acoustic Compliance?
POR-1	07:00 – 19:00	44.9	45.0	Yes
POR-2	07:00 – 19:00	42.2	45.0	Yes

Table 3.3 – Comparison of predicted value at POR-1 and POR-2 with acoustic mitigation to the City of Ottawa's ENCG acoustic limits.

With the proposed acoustical mitigation measures, both PORs are within acceptable noise limits.

4.0 Acoustic Barrier Recommendations

An acoustical barrier is required between Air Rock Drilling Headquarters and 6685 Franktown Road. The location of this barrier is identified in **Figure 4.1**. It must a minimum of 4.5m-tall and 45m in length.

The barrier must meet one of the following criteria:

1. Surface mass density of at least 20 kg/m^2.
2. Lab STC Rating of 20 or more, per ASTM-E90 testing (test report required)
3. Historic Noise Reduction in the Field of STC 30 or greater

The barrier must also follow all other requirements listed in the City of Ottawa's Technical Requirements for Noise Control Barrier Systems (see **Appendix**)

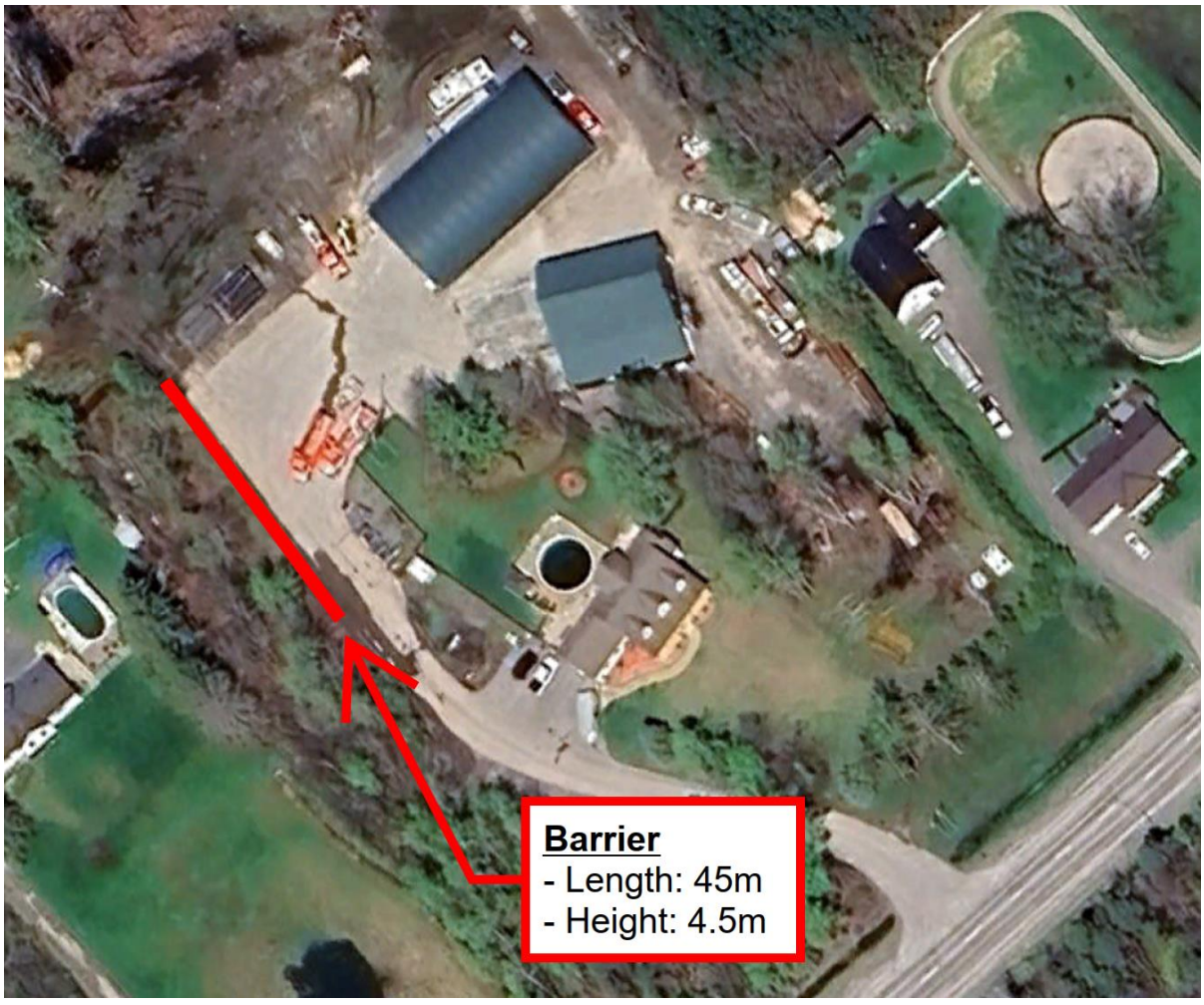

Figure 4.1 – Recommended approximate location and properties for the new barrier at Air Rock Drilling Headquarters (Satellite image from Google Earth Pro).

5.0 Conclusion

This report presents the measured and predicted environmental noise emitted by Air Rock Drilling in Ottawa. We have visited the site on November 28th-30th, 2023, as well as on August 8th, 2024. Using acoustic data collected on those days, we created a model of the site. We then populated it with noise sources based on our observations of a typical morning at Air Rock Drilling on August 8th, 2024.

We determined that the current site is not acoustically acceptable, and requires the following mitigation measures to meet the City of Ottawa's ENCG allowable acoustic limits:

1. Install a 4.5m-tall, 45m-long acoustical barrier at the property line between Air Rock Drilling and 6685 Franktown Road, as specified in **Section 4.0** and shown in **Figure 4.1**.
2. Restrict operations at Air Rock Drilling Headquarters to between 07:00 and 19:00.

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

Sincerely,

Tiffany-Rose Filler, M.Sc.
Acoustic Consultant

Approved By:

Donald Buchan, P.Eng
Principal
Buchan Lawton Parent Ltd.

APPENDIX

APPENDIX A1 - City of Ottawa's Technical Requirements for Noise Control Barrier Systems

PLANNING AND GROWTH MANAGEMENT
URBANISME ET GESTION DE LA CROISSANCE

DRAFT

Part 5:
TECHNICAL REQUIREMENTS FOR NOISE CONTROL BARRIER SYSTEMS

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This technical requirement document is a partial review of text of the May 10, 2006 City of Ottawa Environmental Noise Control Guidelines. This review was undertaken to address adjustments made by regulatory bodies (such as the Province of Ontario). This document has not been fully reviewed and edited to ensure full compliance with the City's Standard Tender Documents and renewal policies. This review will take place at a later time.

Contents

1.0 Introduction

This technical requirements document outlines specifications for the design and installation of noise barriers approved or constructed by the City. By necessity noise barriers are high mass, tall, physical barriers that may cross neighbourhoods and obscure the streetscape. While effective for noise attenuation, these barriers have the potential to fragment neighbourhoods, disrupt wildlife movements, create potentially unsafe public spaces and discourage pedestrian use of the street and sidewalk. Noise barriers are expensive and the long term maintenance of these structures may represent a long term financial burden for the City and private land owners. For these reasons noise barriers may only used as a last resort to attenuate noise in outdoor living spaces. Wherever possible, noise barriers must be used in concert with other noise and visual attenuation measures so as to reduce the negative impact of noise barriers to neighbourhoods and the environment.

Within the city noise barriers may be installed in connection with:

- New development approved under the Planning Act;
- Transportation corridors and transit corridor capital works projects that may be subject to the Environmental Assessment process;
- The City's Community Improvement process.

The following summarizes the principles of the noise barrier requirements:

- To introduce noise barriers to the neighbourhood as an mitigation measure only if other mitigation measures are not feasible;
- To use noise barriers in combination with other appropriate mitigation measures;
- To combine noise barrier design with appropriate landscaping to obscure the noise source from the receiver;
- Where appropriate to provide for an active and attractive pedestrian streetscape which is safe and accessible;
- To provide uniform design and construction parameters for the approval and installation of durable and high quality noise barrier systems.
- To ensure that barriers have a life expectancy of at least 20 years;
- To understand the lifecycle cost of barriers prior to their installation;
- To maintain connectivity of pedestrian and cycling walkways through neighbourhoods;
- Encourage the use of friendly, but durable, products that homeowners can relate to or maintain, where necessary;
- Provide realistic warranties that focus on the barrier system, and not only on the panels or materials;

- Provide effective implementation procedures for barrier design and installation.

The specific requirements described in this document are not to be considered all inclusive. Any new design, material or installation technique not specifically addressed in this document should be evaluated with the general fundamentals of acoustics, durability, safety, and functionality in mind.

2. 0 Applicable Standard for Noise Barriers

Certification organizations, such as the Canadian Standards Association (CSA), provide certification services for manufacturers who, under license, may use the appropriate registered CSA marks on products to indicate conformity with CSA Standards.

The City does not maintain a list of approved suppliers. Rather, the City requires noise barriers to bear the CSA mark as a minimum standard for effective acoustical mitigation.

3.0 Planning, Materials, Design and Construction of Noise Barrier Systems

Should the use of noise barriers be found necessary, the following describes the design and components required by the City for Noise Barriers system.

3.1 Submission Document Requirements

The following documents shall be submitted to the City for approval for each noise barrier wall project:

1. Shop drawings, signed and sealed by a qualified Professional Engineer licensed by the Professional Engineers of Ontario, showing the details of noise barrier system components, including material specifications (see 3.1.1 below).
2. Structural drawing(s), signed and sealed by a qualified Professional Engineer licensed by the Professional Engineers of Ontario, showing foundation details and specifying design criteria, climatic design loads, as well as applicable geotechnical data used in the design.
3. Layout plan, and wall elevations, showing proposed colours and patterns.
4. A covering letter stating deviations or exceptions to the City requirements and the reasons/justification for the deviations.

3.1.1 General Submission Information Requirements

In order for the noise barrier system design, and materials, to be qualified and be considered for installation at a specific site, the submission should provide the following information:

1. CSA certification documentation;
2. The manufacturer's name and address and trade name of the product (if applicable);

3. A general statement as to the composition of the materials;
4. An estimate of life cycle cost over the period of installation, maintenance and repair through replacement in 20 or more years;
5. Certification by a Geotechnical Engineer (calculations may be requested);
6. Certification by a Structural Engineer (calculations may be requested);
7. Detailed drawings of the entire noise barrier system and all its components including detailed material specifications;
8. Specifications regarding installation requirements as well as sequence of construction;
9. Noise Reduction Coefficient (NRC) report if the noise barrier is to be considered as sound absorptive; if required by the noise study;
10. Sound Transmission Class (STC) and/or the material surface density.

Any new design, material or installation technique for a noise barrier system will be evaluated for acceptability of use in the City with a view to safety, durability, functionality, esthetics and cost effectiveness.

The design drawings and calculations shall be signed, sealed and dated by a Professional Engineer licensed in the area of expertise for which the approval is being sought.

3.1.2 Plan Requirements

Typical and all worst case cross sections (and additional cross sections as may be necessary) at a reasonable vertical and horizontal scale should be provided to clearly illustrate the proposed berm and/or wall configuration in relation to the future grade at the Outdoor Living Area based on the proposed Lot Grading Plan (for a Noise Feasibility Study, use the existing grades. For a Detailed Study, existing and proposed future grades at the site must be indicated). Cross sections and/or the data in the report must include the location of the noise source, the location and elevation of the receiver, top elevation of the noise barrier, ground elevations of the berm, berm slopes, sidewalks, boulevards, ditches, roadway or railway elevations and property limits of the lands in question. Cross sections must provide all information (distances and heights) required to calculate the sound level reductions due to barriers.

The location of the cross sections must be indicated on a copy of the submitted plan. Preliminary grading plans should identify and make reference to all information shown on the cross sections (Corridor ground elevations, ground elevation at noise receivers, ground and top elevations of the berm, elevations of the rear yards, sidewalks, ditches, boulevards and ground elevation at the building face).

Height of receiver to be used is 1.5m above the ground at a point located 3.0m from the rear and/or closest wall within the identified Outdoor Living Area of the dwelling unit. If the house or development design shows other alternative locations for the Outdoor Living Area, such as a

common Outdoor Living Area, then the receiver location(s) should be shown on the applicable project drawings.

Other suitable and acoustically effective Outdoor Living Area locations may be selected in consultation with the City based on site specific cases.

3.2 Design

3.2.1 System Design

The details presented below refer to noise barriers as a system of various components including the base berm, the wall, and all other associated components.

- The design of noise barriers should have regard for applicable urban design guidelines, landscaping requirements and aesthetic principles.
- Each design must include drainage, grading and landscaping design.
- The design of the barrier should be complimentary with nearby existing barriers.
- All individual components shall be designed to be capable of being assembled on site and to conform to the drawings and specifications. The panels to also be designed to facilitate ease of on-site replacement.
- The design of the system shall be site-specific and in accordance with the Canadian Highway Bridge Design Code (CHBDC), prepared by qualified Professional Engineers and Acoustic Consultants. Input will be required from Geotechnical and/or Structural Engineers.
- The noise barrier shall be designed to withstand all possible forces and loads encountered during the design life of the barrier and remains serviceable. The design shall be site specific with reference to the wind pressure, earthquake load, freezing depth and soil conditions.
- The foundation of the barrier wall shall be designed to be founded on undisturbed soil, and at required depth of embedment as per the design requirements, but not less than the depth of freezing of the area.
- The noise barrier is to be designed and installed so as to accommodate movement of the noise barrier panel during the weather cycle without placing undue stress on any structure and the noise barrier installation, or reducing acoustical attenuation. The joints in the noise barrier are to match the size and location of the structure joints.
- Noise barrier elements should be designed and oriented to minimize entrapment and ponding of water, and accumulation and infiltration of dirt and debris inside and on any surface of any component. Corrugated, or ribbed panels, should be mounted such that the features are oriented vertically.

- Noise barrier panels with fire hose access openings, if required, shall be designed with additional reinforcement and protective coating around the opening, as necessary, to maintain structural integrity.
- The noise barrier is continuous or is turned through appropriate angles away from the source at both ends to protect the receivers from the flanking sides.
- The City may approve the use of an acoustic gate where the installation of the gate is advantageous in order to allow for access to a rear yard amenity area and a shortened length of noise wall
- sufficient measures are to be taken to prevent drumming of the panels caused by wind or ground vibration.
- Where the use of a sound barrier is approved by the City, landscaping for aesthetic purposes will be required to the satisfaction of the City. This landscaping should include trees, shrubs and vines
- City policies pertaining to access to roads and transit systems must be fully considered as part of the barrier design.

3.2.2 Barrier Design

Location

A noise barrier wall should be located entirely on the development under consideration; on the side of the property line which is on private property. Its location should be a minimum of 0.3m from the City right-of-way. The location of the noise barrier wall should take into account requirements for future roadway widening.

The barrier berm should be located entirely on the development under consideration on the side of the property line which is on private property. Only in exceptional cases, the City may accept a portion of the berm and the portion of the berm on the City or railway company right-of-way be subject to acceptance and approval by the authorities having jurisdiction prior to making any commitment to this effect. The design of the berm could be affected by future roadway widening. The proponent and/or their Consultants should prepare the necessary details related to the berm design and address all matters of concern such as compaction, grade elevations, drainage, safety, cover and landscaping, side slopes, maintenance,...etc.

In all cases, the noise barrier wall should be located in an approved location relative to the berm. Only in exceptional cases, the portion of the berm facing the road transportation facility on private property may have to be dedicated to the City at no cost where requested by the City.

Where a barrier is required, the receptors should be located within its acoustical "shadow zone".

For roadways and bus Transitways, the noise barrier shall be located to conform to the ultimate roadway width and cross section to prevent future barrier relocation.

Information on noise barriers, berms and berm/wall combinations must include location and height of the barrier relative to final grade.

Height

The maximum height of berm/barrier allowed is to be determined in each case by the City.

The minimum acceptable barrier wall height is 2.2m for a flat grade case. In all cases, the noise barrier wall for new development should not exceed 2.5m in height unless approved by the City.

Should the result of the analysis indicate the need for a barrier up to 2.2m high to protect the Outdoor Living Area, there is no need to consider the use of an additional setback to accommodate the planned noise barrier. For situations where the barrier wall height exceeds 2.2m,

In general, the maximum combined barrier height (i.e. berm and wall) above the road or bus Transitway centre line or the ground-oriented Outdoor Living Area should be 4.5m. Otherwise, the proponent should investigate other lot grading possibilities. For railway corridors, the minimum acceptable heights of the berm-wall combination should be consistent with the railway requirements for noise and safety.

The noise barrier system design should provide details of methods and materials to be used to accommodate varying wall heights above the top of footing.

Berm Design

For single family, detached or semi-detached and townhouse residential development, a minimum of 6.0m depth of a relatively flat rear yard is required as measured from the rear face of the building and containing no slope in excess of 4%.

For roadway and bus Transitways, a maximum slope of 3:1 will be required for any earth-work (i.e. berm) adjacent to the boulevard. Slopes steeper than 3:1 will be tolerated on the lot side of the earthwork by the use of retaining walls, where accepted by the City for drainage and landscaping (the 3:1 ratio on the lot side may only be modified at the discretion of the City). For railways, the slope on the railway side should be 2.5:1.

In cases where the attenuation facility is interrupted, barrier returns or parallel screens may be required and the detailed design and calculations of the treatment in such cases will have to be

incorporated into the acoustical report. The report and the grading plan must include a detailed plan and appropriate cross sections of such cases.

Berm setbacks

The following table provides guidance on the additional setbacks required to accommodate a base berm and a wall on top of the berm. The berm must be placed entirely within the property line of the proposed development. The City will not accept any berming on its r.o.w. Maintenance of the barrier, including the side facing the road, is the responsibility of the property owner. Additional setbacks required for berms

BERM HEIGHT	ADDITIONAL SETBACK
0.5m	3.5m
1.0m	6.5m
1.5m	9.5m
2.0m	12.5m
2.5m	15.5m

3.4 Materials

3.4.1 Material - General

Type and surface density of the barrier should be specified and the manufacturer and/or supplier described, if known. The City recommends that the barrier design parameters be similar to those developed by the City with respect to structural specifications, wind loading, footing design, reinforcement, rust protection, warranty requirements,...etc.

Noise barriers should have the following general characteristics:

- Have no holes or gaps.
- the manufacturer should demonstrate to the City that the material has a minimum predicted maintenance free lifespan of 20 years.
- Provide the desired minimum sound level reduction and protect all receiver locations (3m from building face closest to transportation facility) subject to the guidelines.

- All materials should have a flame spread classification less than, or equal to, 140 and smoke developed classification less than, or equal to, 180 when tested in accordance with the ULC standards.
- Be generally resistant to graffiti or include a graffiti resistance coating conforming to relevant ASTM standards

3.4.2 Material – Metal

- Metal and non-metallic components of noise barrier systems, including their performance, such as corrosion and weathering, to be in accordance with the applicable CSA, ASTM, CAN/L1LC, ULC, CSA/CAN and ANSI standards.
- Coatings refer to all paints, stains and laminates. All coated components to be rated for accelerated weathering. All coated steel components to be resistant to corrosion.
- Components which are hot dip galvanized, or coated with a polyvinyl chloride (PVC) plastisol using an epoxy primer using no adhesives for bonding, need not have accelerated weathering test data
- All steel reinforcing to conform to the requirements of the CSA Standards. The bars to be free from rust, scale, or other substances, that will prevent bonding.
- All reinforcing bars should be epoxy coated, conforming to ASTM Standards. The concrete cover over the steel reinforcing should meet the requirements of the CSA Standards and in no case should it be less than 50mm.
- All bare metal components to be either fabricated of nonferrous materials, or hot dip galvanized after fabrication, according to the requirements of CSA Standards. All welding to conform to CSA Standards.
- Steel panels, exposed to traffic and snow removal operations, to be minimum nominal 0.91 mm galvanized steel (20 gauge). All other panels to be of minimum nominal 0.76 mm galvanized steel (22 gauge). All steel sheeting components to be coated with a material meeting the requirements of this standard.
- Acceptable products include galvanized panels and then coated with an organic polyvinyl chloride (PVC) plastisol using an epoxy primer using no adhesives for bonding. The coating system thickness must be 200 um on the surfaces exposed to traffic and snow removal operations, and 100 um thick on all other panel surfaces.
- Pop-rivets shall be either aluminum, with an aluminum mandrel, or aluminum, with a stainless steel mandrel.
- Other composites or metal panels, such as aluminum, may be used as panels for sound barriers, provided that such products are corrosion resistant and meet the acoustic and other performance criteria in this document.

3.4.3 Material – Concrete, Brick, Granular

- Concrete (precast or cast-in-place) to conform to requirements of CSA standards

- All bricks used to be in accordance with the CSA standards.
- All granular materials shall be free from deleterious materials, debris and organic materials. When used, it shall be compacted to 98% of Standard Proctor Dry Density .

3.4.4 Material -Wood

For wooden noise barriers, the following are the minimum acceptable features to qualify as an acceptable noise barrier system:

- All wood products to be made out of graded lumber (conforming to National Lumber Grading Association or Standard Grading Rules of Canadian Lumber 2000) and to be either naturally resistant to decay for a minimum of 20 years, or to be pressure treated. The panel must be composed of tightly fitted wood boards so as to avoid warping, splitting and loosening of particles, knots and imperfections. All boards must be tightly butted and secured.
- All wood shall be selected for good appearance and free of defects and large/heavy knots. In addition, all torn grain and surface stains shall be eliminated by appropriate surface refinishing.
- All skirts, coming in contact with the ground/soil, shall be pressure treated with finished cut edges treated or protected from moisture penetration, and to be buried 100 to 150mm below the finished ground level.
- All exposed panels to be dressed with beveled edges on both sides.
- All wooden posts (metal posts are also acceptable) to have minimum dimensions of 140 x 140mm, or larger, as required by the governing code, dressed to pattern.
- Double posts are required on all directional changes greater than 20°.
- Install coping on top of panels using one piece wood (or other acceptable metal products)
- The use of decorative elements such as pilasters, curved (scalloped) top rail, post caps, wood designs, etc. is preferable. In all cases, the decorative elements should not affect the minimum barrier height requirements, the density, or any other acoustic/structural requirements.
- Wood, and/or metal frames, to be used to support the wood panels in place, and to be designed to allow expansion/contraction of the wood panels/elements, and for making the necessary field adjustments, where required.
- All metal components, if any, used in a wooden sound barrier to conform to the metal or steel component specifications in this document.
- The use of board-on-board panels to meet the stated density/acoustic criteria is acceptable provided that the boards are thoroughly secured. In addition, board-on-board panels shall have tightly butted joints that are staggered, with provision to allow for expansion/contraction, and for making the necessary field adjustments (e.g. for tightening up of developed gaps), where required.
- The use of Tongue and Groove, and V-joints for joining panels is acceptable provided that the tongue or V -joint extent is not less than 19mm (3/4") long.

- Nails, and other fastening devices, must be either hot dip galvanized steel, or made of nonferrous or stainless steel.
- When there is ground contact with wood, the wood must be pressure treated and cut ends to be treated also, or protected from moisture penetration.

3.5 Acoustic Characteristics

3.5.1 Sound Transmission Class

Noise barriers should have one or more of the following acoustic characteristics:

- The Sound Transmission Class (STC) of the panel material to be 20, or greater, when tested in accordance with ASTM-E90 (a test report to be submitted for approval).
- The Sound Transmission Class (STC) of the panel material has historically been demonstrated to be 30 or greater.
- Surface mass density not less than 20 kg/sq. m (4 lbs/sq.ft.) in order to ensure that the sound component transmitted through the barrier material is at least 10 dB below the sound component diffracted across the top of the barrier.

3.5.2 Sound Absorption

If the noise barrier system is specified by the Acoustical Consultant to be sound absorptive, the average Noise Reduction Coefficient (NRC) shall be not less than 0.70 (70%). Sound absorptive materials used to fill cavities in double walled noise barrier systems, to increase sound absorption, shall be semi-rigid type.

If the noise barrier system is specified by the Acoustical Consultant to be sound absorptive, the barrier panels should be tested to determine the Noise Reduction Coefficient (NRC) in accordance with ASTM-C423. A panel or an assembly of panels should be tested, as required, in accordance with the ASTM Procedures for free-standing screens.

The use of alternate methods of providing the necessary sound absorptive qualities by a barrier system should be subject to special approval by the City based on qualified technical data to be submitted by the proponent. This may include the use of double walled noise barrier panels (sandwich construction with perforated facing) or the use of substantial landscaping designs along the barrier faces by a Landscape Architect.

4.0 Installation and Construction

All work and noise barrier materials for specific installations are subject to field certification by the design professionals to ensure adherence to the requirements in this specification.

All materials delivered to the construction site should be visually inspected by the owner, and/or their representative, for proper dimensions, cracks, voids, surface defects, inconsistency in colour and texture, and any other damage or imperfections.

4.1 Height and Alignment

The noise barrier to be constructed to the height and alignment as specified by the Acoustical Consultant. The minimum specified height of the noise barrier to be maintained at all times.

4.2 Footings, Posts And Panels

The foundation, footing and post design, shall meet the objective of constructing a durable sound barrier that meets or exceeds the objectives of this document of a 20-year life expectancy and the set minimum guarantee of 5 years for material and installation of the noise barrier system.

4.2.1 Footings

The footing shall be founded on undisturbed soil at the design embedment length as required but shall be minimum below freezing depth of the area. The founding surface shall be confirmed by a Geotechnical Engineer. All the soft spots to be removed and bottom of the footing protected from freezing. In case of solid rock encountered at a depth less than the freezing depth, foundation shall be carried minimum 300mm in the rock. The concrete of footing shall be as follows:

1. Minimum 28 days compressive strength to be 20 Mpa
2. Ready mix concrete or site mix concrete to confirm CSA-A23.2
3. All site placed concrete to be protected from freezing and to be protected in excessive summer temperature from drying.
4. The concrete in the footing shall be cured for a minimum period of 5 days before the installation of panels.

Footing In Earth

If drilled footing is used, it shall be cast entirely against undisturbed soil. Footing other than drilled caisson to be formed and the excavation shall be backfilled with granular material. The backfilled material to be compacted to 98% Standard Proctor Dry Density of the granular material.

Footing In Rock

When rock is encountered with in the excavation depth of the footing, the footing depth to be embedded minimum 300 mm into the solid rock.

All excavation into rock shall be back filled entirely with concrete. The excavation above the top of rock may be formed to the required dimensions and the remainder of the excavation backfilled with granular materials.

4.2.3 Post

The barrier shall be constructed to the line and grades specified with the tolerance of ± 10mm. The post shall be plumb within a tolerance of ± 10mm in 5m. In all cases for wood posts, the minimum dimension shall be 150mm square.

4.2.3 Panels

The profile of the barrier shall be installed to match the ground profile up to the maximum grade specified on the drawings. To accommodate ground profiles greater than the maximum grade, the barrier shall be stepped in accordance with manufacturer's recommendations.

4.3 Site Grading And Preparation

Earth grading and berm construction associated with the barrier installation shall be completed to within 25mm of the proposed elevation of the bottom of the barrier. Grading shall be completed and approved prior to construction of the barrier footings.

To prevent openings from occurring under the barrier an additional timber, not less than 5mm x 20mm in section, shall be securely fastened horizontally to the bottom of the barrier, and shall extend the full width of each barrier panel between adjacent vertical posts. This additional timber shall be buried to a depth equal to one-half its width during the final grading operation. Earth and pavement grading shall be sloped at a minimum of 2% and a maximum of 50% away from the barrier.

Frozen earth shall not be used for embarkment. Where imported fill is required for backfill or for minor grading, the fill material should be comprised of granular material, select sub-grade material, or other approved fill and to be compacted to at least 98% Standard Proctor Maximum Dry Density (SPMDD). All graded earth to be compacted to at least 98% Standard Proctor Dry Density.

The earth area surrounding the barrier wall shall be sloped away in order to prevent water ponding and water filtration to the barrier footings.

Changes in alignment to occur at the posts, by suitable means, to avoid acoustical degradation.

4.3.1 Masonry Walls

Masonry walls to be installed in accordance with the requirements of AASHTO Guide Specifications for Structural Design of Sound Barriers.

Bricks to be installed on a suitable foundation not less than 500 mm above the final groundline.

The top row of all masonry walls and posts to be protected with coping and/or flashing.

Mortar used to set the bricks, shall be in accordance with the CSA Standards.

4.3.2 Fire Hydrant Access

When the installation of a noise barrier interferes with the access to existing, or proposed fire hydrants, the noise barrier installation should include fire hose access openings and associated identification signs. Location and demand for these openings to be established in cooperation with the local fire department.

Overhead High Voltage Lines

Where the potential of arcing exists, due to the close proximity of existing overhead high voltage lines, each metal panel and girt must be grounded in accordance with CSA Standards and the local Hydro/Utility company.

4.4 Installation

4.4.1 Proponent Responsibilities

- Site preparation and grading
- Foundations
- Delivery, handling, storage and protection
- Erection / installation of noise barrier
- Clean up
- Testing, inspection and quality assurance

An Initial Certification by the proponent's Project Engineer is to be prepared and submitted to the City following completion of the project.

4.4.2 Guarantee and Maintenance Period

The material and installation of the noise barrier system, including landscaping materials, is to be guaranteed for a minimum period of five (5) years from the date of the initial Certification and Performance Acceptance. A Letter of Credit in the amount of 15% of the sound barrier total cost shall be deposited with the City to cover the warranty.

After 3 years from Certification, an inspection is to be carried out by the proponent's Engineer with a report to be submitted to the City. Any components which exhibit defects that are likely to affect the longevity of the barrier shall be replaced and/or repaired by the proponent.

To obtain release of the noted Letter of Credit, a final unconditional warranty inspection shall be prepared by the proponent's Engineer after five (5) years from the date of original Initial Certification and Performance Acceptance of the barrier to certify that there are no deficiencies

of any component of the barrier system; this includes but is not necessarily limited to grading, berm, posts, panels, landscape materials and soil condition.