BLAST IMPACT ASSESSMENT - Project: 10351

Proposed Goulbourn Pit & Quarry
Blast Impact Assessment
Geographic Township of Goulbourn
City of Ottawa

Prepared for:

1394706 Ontario Inc.
c/o
McIntosh Perry Consulting Engineers Ltd.
115 Walgreen Road, R.R. #3
Carp, Ontario
K0A 1L0

Prepared by:

Derek Flake, M.Sc., P.Eng.
Bob Rimrott, M.A.Sc., P.Eng.

November 26, 2015
Table of Contents

1 Introduction ......................................................... 3
2 Site Description .................................................... 3
3 Overpressure and Vibration Criteria .......................... 3
4 Blasting Operation Design ...................................... 4
  4.1 Overpressure .................................................. 5
  4.2 Vibration ....................................................... 5
5 Predictions & Recommendations ......................... 6
  5.1 Overpressure Predictions .................................... 6
  5.2 Vibration Predictions ......................................... 6
  5.3 Summary of Predictions .................................... 7
6 Conclusions ......................................................... 8
1 Introduction

McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) is applying for a Category 2 Class “A” license for the proposed Goulbourn Pit & Quarry located at Part of Lot 11, Concession 10, Geographic Township of Goulbourn, City of Ottawa. The proposed extraction area consists of approximately 57 HA.

Aercoustics Engineering Limited (Aercoustics) has been retained to prepare a Blast Impact Assessment. The purpose of this study is to provide an assessment of the potential effects of the sound waves (overpressure) and ground vibration that will be produced by the proposed quarry’s blasting operations on nearby receptors.

Overpressure and vibration due to blasting has been evaluated on the basis of the Ontario Ministry of the Environment and Climate Change (MOE) guidelines. The impact of sound and vibration from blasting can be successfully controlled by optimizing the blast design parameters. Specifically, this is done by controlling the maximum allowable weight of charge per minimum delay period within specific setback distances. An acceptable setback distance and charge weight per delay schedule for the proposed blasting scenarios has been specified in this report.

Figure 1 provides a key plan showing the location of the aggregate quarry. A site plan is provided as Figure 2, illustrating the aggregate quarry extraction area and the locations of local residences, which are referred to as receptors.

2 Site Description

Figure 1 provides a key plan showing the location of the proposed quarry and the surrounding area. The site is located north of the intersection of Fernbank Road and Munster Road. The site is in a rural area where aggregate extraction, agriculture and residential subdivisions are the dominant land uses.

The proposed aggregate quarry addressed by this blasting study consists of operations within the lands outlined in Figure 2. There are several single family residential dwellings in the vicinity of the proposed quarry area. These are identified on Figure 2 as Receptors R01 to R16. Receptors R17 and R18 have been used to identify potential noise receptors on noise sensitive zoned lots adjacent to the proposed site and were not considered for the blasting study purposes.

It is understood that there are no waters designated as fisheries waters on the proposed quarry property.

3 Overpressure and Vibration Criteria

The appropriate blasting criteria for the receptors in the vicinity of the proposed Goulbourn Pit & Quarry are based on the MOE Noise Pollution Control publication NPC-119 “Blasting” (Refer to Appendix A). This publication defines limits of overpressure and
vibration and affecting residential buildings due to blasting operations. These criteria are set well below the thresholds of structural and cosmetic damage in order to limit nuisance.

As defined in NPC-119, the sound level or overpressure is assessed by the maximum peak pressure level during the blast, reported to the nearest decibel (dB). Vibration is assessed by the highest value of the peak particle velocity. The limits are classified into two sets: the cautionary limits and the standard limits. The cautionary limits apply when predicting impacts for operations during which blasts are not routinely monitored, or when blast monitoring has been initiated by MOE staff as a result of complaints. The standard limits apply when predicting impacts for operations during which blasts are routinely monitored. The overpressure and vibration criteria outlined in NPC-119 is summarized in Table 1.

Table 1: MOE Overpressure and Vibration Limits for Blasting

<table>
<thead>
<tr>
<th>Limit Classification</th>
<th>Vibration Peak Particle Velocity (mm/s)</th>
<th>Overpressure Peak Pressure Level (dBZ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cautionary Limits</td>
<td>10.0</td>
<td>120</td>
</tr>
<tr>
<td>Standard Limits</td>
<td>12.5</td>
<td>128</td>
</tr>
</tbody>
</table>

The quarry operator has advised that the blasting operations will be contracted out to a blasting operator who will conduct routine monitoring of overpressure and ground vibration at the receptor nearest to each blast. Therefore, the standard limits were used for this study.

4 Blasting Operation Design

The site plans outline the phases of extraction along with the sequence and direction of operations in each phase. The blasting will occur with the working face moving to the south. A 5 m high acoustic barrier is proposed along the south boundary of the site and a 3 m high acoustic barrier is proposed along the west boundary of the Phase 3 area. These are expected to be earth berms which could reduce the impact of the overpressure on the receptors to the south, but these were not considered in the analysis for conservatism.

The maximum weight of explosive charge per delay for each blast should be designed such that the predicted sound and vibration levels at the worst-case receptor will comply with the standard limits of 128 dBZ and 12.5 mm/s, respectively. The design parameters and the levels recorded by the monitoring instrumentation for each blast should be noted by the blasting operator. Blast monitoring should be conducted using instrumentation and methodology that conforms to the requirements outlined in NPC-119. A report should be prepared for each blast to provide the information recommended in the MOE publication “Guidelines on Information Required for the Assessment of Blasting Noise and Vibration” (MOE, December 1985). The results of all blast monitoring should be reviewed and if the
measured overpressure and/or vibration levels are higher than would be predicted from the MOE model, the design of the blasting should be modified as required.

The MOE guidelines for blasting impact, as defined in NPC-119, are based on extensive measurement and research conducted by the American Bureau of Mines. Blasting sound and vibration can generally be predicted based on the maximum weight \( W \) of explosive (charge) per delay and the distance \( D \) from the blast to the point of reception. Details of the prediction methodology are included in Appendix B.

4.1 Overpressure

Overpressure is the pressure wave or sound wave which travels through the air produced by the direct movement of the air near the explosives or the indirect movement of the aggregate material being pushed outwards. Overpressure is predominantly comprised of acoustic energy below 20 Hz, known as infrasound. Although occasionally audible, overpressure is more commonly heard through secondary sources such as rattling and shaking within a structure.

The MOE model for overpressure prediction utilizes conservative methods due to the wide variations caused by factors outside the control of the blast design. Atmospheric variables such as temperature gradients, prevailing winds and local topography can significantly alter overpressure attenuation characteristics. The MOE criteria for overpressure is based on nuisance effects rather than damage; the level of overpressure required to cause damage is rare. Overpressure is reported as the peak sound pressure level in un-weighted linear decibels (dBZ). A-weighting, a more commonly used method of reporting sound levels, is meant to mimic the human response to hearing and therefore reduces the contribution of low frequency sound waves.

The peak sound pressure level of a blast from a quarry is a function of the Cube Root Scaled Distance (C.R.S.D.) and can be predicted from charted data provided by the MOE. The data addresses the two conditions of a receptor located either in front of or behind the quarry face. The C.R.S.D. is expressed as:

\[
C.R.S.D. = \frac{D}{W^{1/3}}
\]

The sound levels at receptors located in front of the quarry face will typically be higher than sound levels at receptors behind the quarry face.

4.2 Vibration

The intensity of ground vibration from a blast is defined by the speed of excitation of particles within the ground resulting from oscillatory motion. Although site-specific geological conditions affect vibration attenuation, prediction of ground vibration is generally more reliable than prediction of overpressure. Probabilistic and statistical
modeling can be employed to often achieve a 95% confidence interval for ground vibration forecasts.

The ground vibration from a blast, defined in terms of peak particle velocity, is a function of the Square Root Scaled Distance (S.R.S.D.) and can be predicted from charted data provided by the MOE. The S.R.S.D. is expressed as:

$$S.R.S.D. = \frac{D}{W^{1/2}}$$

Vibration impact is higher at receptors located behind the quarry face, but vibration from a given blast typically has a much smaller zone of influence than the associated overpressure.

5 Predictions & Recommendations

Using the above model provided by the MOE, maximum allowable charge weights per delay were determined such that the overpressure and vibration limits are met.

5.1 Overpressure Predictions

During Phases 1-3, only receptors R1-R3 are located in front of the blast face. The remaining receptors (R4-R16) are located behind the blast face for all of the three phases. The maximum weight of charge per delay due to the MOE sound level limits at each of Phases 1 to 3 is summarized in Table 2.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Orientation</th>
<th>Distance to nearest receptor (m)</th>
<th>Maximum charge weight per delay (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>In Front</td>
<td>770</td>
<td>604</td>
</tr>
<tr>
<td></td>
<td>Behind</td>
<td>650</td>
<td>28491</td>
</tr>
<tr>
<td>Phase 2</td>
<td>In Front</td>
<td>1070</td>
<td>1622</td>
</tr>
<tr>
<td></td>
<td>Behind</td>
<td>400</td>
<td>6640</td>
</tr>
<tr>
<td>Phase 3</td>
<td>In Front</td>
<td>1290</td>
<td>2842</td>
</tr>
<tr>
<td></td>
<td>Behind</td>
<td>125</td>
<td>203</td>
</tr>
</tbody>
</table>

5.2 Vibration Predictions

The blasting vibration level prediction does not depend on the orientation of the blast face with respect to the receptors. The maximum weight of charge per delay due to the MOE sound level limits at each of Phases 1 to 3 is summarized in Table 3.
Table 3: Maximum Allowed Charge Weight per Delay - Vibration

<table>
<thead>
<tr>
<th>Phase</th>
<th>Distance to nearest receptor (m)</th>
<th>Maximum charge weight per delay (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>650</td>
<td>1771</td>
</tr>
<tr>
<td>Phase 2</td>
<td>400</td>
<td>671</td>
</tr>
<tr>
<td>Phase 3</td>
<td>125</td>
<td>65</td>
</tr>
</tbody>
</table>

5.3 Summary of Predictions

Based on the above analysis, it was determined that the vibration predictions limit the maximum allowable charge weight for Phases 2 and 3. The Phase 1 charge weight is constrained by the overpressure guidelines for the receptors in front of the working face. Therefore, the combined predicted maximum allowable charge weights per delay for Phases 1 to 3 are summarized in Table 4.

Table 4: Maximum Allowed Charge Weight per Delay - Combined

<table>
<thead>
<tr>
<th>Phase</th>
<th>Distance to sensitive receptor (m)</th>
<th>Maximum charge weight per delay (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>770</td>
<td>604</td>
</tr>
<tr>
<td>Phase 2</td>
<td>400</td>
<td>671</td>
</tr>
<tr>
<td>Phase 3</td>
<td>125</td>
<td>65</td>
</tr>
</tbody>
</table>

These predictions are based on MOE guidelines which assume the blasts are routinely monitored for both overpressure and ground vibration levels. If routine monitoring is not performed, a qualified engineer should review the predictions and the maximum allowable charge weights per delay should be reduced accordingly.

The values summarized in Table 4 represent the maximum allowable charge weights per delay. When it becomes necessary to reduce the explosive (charge) weight detonated per delay period from the charge size typically used for this operation, one of or a combination of the following methods may be undertaken to achieve this:

- Reduce borehole diameter with a corresponding reduction to drill pattern;
- Reduce borehole length and associated quarry bench height; or
- Introduce decked charges within the boreholes.

All reasonable attempts should be made to avoid blasting under atmospheric conditions such as strong winds, overcast skies or temperature inversions, wherein overpressure might be increased.

All explosives will be brought to site on the day of each blast. No explosives shall be stored on site at any time.
6 Conclusions

Aercoustics has conducted a Blast Impact Assessment for the proposed Goulbourn Pit. The purpose of this blasting study was to provide an assessment of the potential effects of the sound waves (overpressure) and ground vibration that will be produced by the proposed quarry's blasting operations on nearby receptors.

To this end, overpressure and vibration sound level limits, based on the MOE guidelines, were determined. Calculations were then carried out to determine that blasting operations can be performed throughout the property while maintaining compliance with the MOE guidelines. The maximum allowable charge weights per delay for various distances to receptors were provided.

Blasts are to be monitored routinely and the data is to be reviewed after each blast to ensure continued compliance. If the measured levels are higher than the predictions based on the MOE model, the design of the blasting should be reviewed by a qualified engineer and modified as required.
Appendix A

MOE Publication NPC-119 “Blasting”
1. **Scope**

   This Publication refers to limits on sound (concussion) and vibration due to blasting operations.

2. **Technical Definitions**

   The technical terms used in this Publication are defined in Publication NPC-101 - Technical Definitions.

3. **Measurement Procedures**

   All measurements of peak pressure level and vibration velocity shall be made in accordance with the "Procedure for Measurement of Sound and Vibration due to Blasting Operations" set out in Publication NPC-103 - Procedures, section 5.

4. **Concussion - Cautionary Limit**

   Subject to section 5 the peak pressure level limit for concussion resulting from blasting operations in a mine or quarry is 120 dB.

5. **Concussion - Peak Pressure Level Limit**

   If the person in charge of a blasting operation carries out routine monitoring of the peak pressure level, the peak pressure level limit for concussion resulting from blasting operations in a mine or quarry is 128 dB.

6. **Vibration - Cautionary Limit**

   Subject to section 7, the peak particle velocity limit for vibration resulting from blasting operations in a mine or quarry is 1.00 cm/s.

7. **Vibration - Peak Particle Velocity Limit**

   If the person in charge of a blasting operation carries out routine monitoring of the vibration the peak particle velocity limit for vibration resulting from blasting operations in a mine or quarry is 1.25 cm/s.

8. **Preemption**

   If blasting monitoring is initiated by MOE staff as a result of noise complaints, the results of all subsequent monitoring shall be in compliance with the cautionary limits.
Appendix B

MOE Prediction Charts
FIGURE 1. BLASTING NOISE PREDICTION

Receptor location in front of quarry face.
FIGURE 2. BLASTING NOISE PREDICTION
Receptor location behind quarry face.
Appendix C

Qualifications of the Authors
derek flake  M.Sc., P.Eng.

Profile

Derek is an employee of Aercoustics Engineering Limited, an engineering consulting company specializing in acoustics, noise and vibration. Prior to that, he worked for several years at another acoustics, noise and vibration firm and he completed a Master of Science in the field of ultrasound transducer design. Derek is a Professional Engineer with the Professional Engineers Ontario.

Employment History

2012 – Present  Project Engineer, Aercoustics Engineering Ltd.
2009 – 2012  Engineering Intern, Jade Acoustics Incorporated

Additional Activities / Committees

2014 – Present  Member of Training and Development Committee at the Ontario Sand, Stone and Gravel Association (OSSGA)

Professional Registration / Affiliations

Licensed Professional Engineer with the Professional Engineers of Ontario (PEO)

Education

Master of Science (M.Sc.)  Medical Biophysics (Ultrasound Physics)
University of Toronto

Bachelor of Applied Science (B.A.Sc.)  Engineering Physics (Mechanical)
Queen’s University

Courses and Speaking Events

Instructor, Municipal Law Enforcement Officers’ Association (MLEOA) Environmental Noise training courses. This is an annual four-day training program which provides the officers with an understanding of sound measurement and its relationship with
environmental noise impact. The officer is trained in the utilization of technical equipment required in the application of sound measurement theories. This course also covers the unique elements of qualitative noise regulations and is authorized by the Ministry of the Environment and Climate Change.

1-day course on “Aggregates 101 Training,” OSSGA Health and Safety Seminar, Toronto, 2015. Mr. Flake both attended and aided in the development for parts of the course.


Professional Activities

**Land Use Planning**

In the field of environmental acoustics, Mr. Flake has completed numerous projects involving noise impact from planned stationary sources as well as noise impact studies for proposed residential developments. These projects included conducting studies for proposed operations and developments and addressing noise concerns for existing operations. Peer reviews of noise studies prepared by other acoustic consultants were also completed by Mr. Flake. In the land use planning process, Mr. Flake has completed studies which provide assessments of the noise impact on proposed residential, commercial and industrial developments from the local environment which includes noise from road, rail, and aircraft traffic and stationary noise sources such as industrial and commercial uses. Also, vibration measurements and studies were conducted to assess vibration from rail traffic such as trains, streetcars and subways. The studies include recommendations for noise control of the sources, dwelling building components, wall, window, and door constructions to satisfy the Ministry of Environment and Climate Change noise guidelines.

In addition, Mr. Flake has conducted architectural drawing reviews for residential and commercial developments to ensure the construction plans will meet the requirements set out in environmental noise studies and specifications documents.

**Aggregates**

Mr. Flake has done work in the aggregates industry which involved the preparation and support of over a dozen noise impact studies to determine technical feasibility of aggregate license applications to the Ministry of Natural Resources. This work included preparing the noise impact studies, supporting the findings at public meetings, and performing acoustic audits to confirm compliance with the noise requirements.

**Renewable Energy**

Mr. Flake has performed IEC 61400 testing of Wind Turbines and Transformer Station noise audits.
Environmental Compliance Approvals

Mr. Flake was involved with in several noise and vibration impact studies for industrial uses. He has prepared several Acoustic Assessment Reports for use in applications for Environmental Compliance Approvals. These studies provided conceptual as well as detailed designs of noise mitigation to reduce in-plant noise or noise emission into the environment. In-plant projects generally involved noise surveys, detailed noise/vibration measurements of equipment, data analysis and computer modelling of noise controls to evaluate effectiveness. In some cases, detailed designs and specifications have been provided.

Noise Source Investigations and Room Acoustics

Mr. Flake has completed several projects involving design of spaces where sound privacy and room acoustics were critical. These projects have included noise complaint investigation, room acoustics, mechanical noise, noise measurements to quantify sound isolation, and environmental noise impact. Examples of spaces include cinemas, hospitals and residential condominiums.
PROFESSIONAL PROFILE

H. ROBERT RIMROTT, M.A.Sc., P.Eng.

EDUCATION

B.A.Sc., University of Toronto
M.A.Sc., University of Toronto

PROFESSIONAL MEMBERSHIPS

Professional Engineer, Ontario (PEO)
Consulting Engineer, Ontario (PEO)
Acoustical Society of America (ASA)
American Society of Mechanical Engineers (ASME)

PROFESSIONAL BACKGROUND

In 1987, Mr. Rimrott began his work as an acoustics and vibration consultant. In his many years in this field, he has completed many successful projects. In 1992, he joined Aercoustics Engineering Limited. He is a partner and principal engineer with the firm. Mr. Rimrott is recognized as an expert by the Ministry of Environment and Energy and has provided expert testimony in the forum of the Ontario Municipal Board Hearings.

In the field of environmental acoustics, Mr. Rimrott has completed numerous projects involving noise from planned stationary sources as well as noise studies for residential developments. These projects included conducting studies for both proposed operations and developments, studies addressing noise concerns for existing operations, and peer review of noise studies conducted by other acoustic consultants. Projects have included Industrial plants, Aggregate Pits and Quarries, and many other operations.

In the land use planning process Mr. Rimrott has completed studies provide assessments of the noise on the proposed residential development from the local environment which includes noise from road, rail, and aircraft traffic and stationary noise sources such as industries, and gun clubs. The studies include recommendations on noise control of the sources, dwelling building components, wall, window, and door constructions to satisfy the Ministry of Environment and Energy noise guidelines.
Partial Listing of Representative Projects

PITS AND QUARRIES

Dufferin Aggregates, many Pits
Wimpey, Nolan Quarry
Truax Pit
United Aggregates, Acton quarry
Cox Construction, Puslinch Pit
Beamish Construction,
Coboconk Quarry

INDUSTRIAL

Coutrice Steel
Co Steel Lasco
Georgia Pacific Flakeboard
Boise Cascade Oriented Strand Board Plant
Boise Cascade Co-Generation Station
Moore Business Forms
Metal Coating
Alcan Foil Products
INCO
Alcan Rolled Products
Townsend Lumber

BLAST / IMPULSE NOISES

Quarry Blasting Noise
Meaford Artillery Range
Walker Dog Kennel
Pioneer Sportsmen Club