EXPLOTECH

Specialists in Explosives, Blasting and Vibration
Consulting Engineers

Blast Impact Analysis
James Dick Hidden Quarry
Part of Lot 1, Concession 6, Township of Guelph – Eramosa
Former Township of Eramosa, County of Wellington

Submitted to:

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Prepared by

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EXECUTIVE SUMMARY

Explotech Engineering Ltd. was retained in November 2012 to provide a Blast Impact Analysis for the proposed James Dick Construction Ltd. Hidden Quarry located on Part of Lot 1, Concession 6, Township of Guelph – Eramosa, Former Township of Eramosa, County of Wellington.

Vibration levels assessed in this report are based on the Ministry of Environment Model Municipal Noise Control By-law (NPC119) with regard to Guidelines for Blasting in Mines and Quarries. We have assessed the area surrounding the proposed Aggregate Resources Act license with regard to potential damage from blasting operations and compliance with the aforementioned by-law document.

We have inspected the property and reviewed the available site plans. Explotech is of the opinion that the planned aggregate extraction on the proposed property can be carried out safely and within MOE guidelines as set out in NPC 119 of the By-Law.

Recommendations are included in this report to ensure that blasting operations in all phases of this project are carried out in a safe and productive manner to ensure that no possibility of damage exists to any buildings, structures or facilities surrounding the property.

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INTRODUCTION

James Dick Construction Ltd. intends to apply for a Class A, Category 2 Licence for the property legally described as Part of Lot 1, Concession 6, Township of Guelph – Eramosa, Former Township of Eramosa, County of Wellington. The proposed name for the operation is the Hidden Quarry. This Blast Impact Analysis assesses the ability of the proposed licence to operate within the prescribed blast guideline limits as required by the Ontario Ministry of Environment (MOE).

The proposed Hidden Quarry operation is bounded by 6th Concession Road to the Southwest, Highway 7 to the Southeast, farmland containing a limited number of homesteads to the Northwest, and farmland and a non-farm based residence to the Northeast. The closest sensitive receptors, as currently defined by the MOE, lie along 6th Concession Road approximately 20m and 135m to the Northwest (R3 and R19 respectively), along Highway 7 and 5th Concession Road approximately 190m and 40m to the Southeast (R15 and R16 respectively), 15m to the Southeast (R12), and 600m to the North (R9) of the licenced boundary. The closest area of more densely populated residential receptors lies approximately 900m West of the licenced boundary (Dunbar Woods Subdivision). A detailed list of the closest sensitive receptors to the limits of extraction is provided later in this report.

This Blast Impact Analysis has been prepared based on the Ministry of the Environment (MOE) Model Municipal Noise Control By-law with regard to Guidelines for Blasting in Mines and Quarries (NPC 119). We have additionally assessed the area surrounding the proposed license with regard to potential damage from blasting operations.

Given that mining operations have not been undertaken in the past on this property, site-specific blast monitoring data is not available. We have therefore applied data generated at a variety of quarries across Ontario which present similar material characteristics. It has been our experience that this data represents a conservative starting point for blasting operations. It is a recommendation of this report that a vibration monitoring program be initiated on-site upon the commencement of blasting operations and maintained for the duration of all blasting activities to permit timely adjustment to blast parameters as required. We note that blast monitoring is a prescribed condition to any licence issued for the proposed quarry under the Aggregate Resources Act.

Recommendations are included in this report to ensure that the blasting operations are carried out in a safe and productive manner and to ensure that no possibility of damage exists to any buildings, structures or residences surrounding the property.

EXISTING CONDITIONS

The licence area for the proposed James Dick Construction Ltd. Hidden Quarry encompasses a total area of approximately 39.4HA with a net extraction area of 24.8HA when allowing for setbacks and sterilized areas. The proposed quarry operation is bounded by 6th Concession Road to the Southwest, Highway 7 to the Southeast, farmland containing a limited number of homesteads to the Northwest, and farmland and a non-farm based residence to the Northeast. An intermittent stream meanders across the property from the Northwest property line to the Southeast property line and a pond lies in the West corner.

The site is currently largely forested by coniferous trees, however, there are two former sand and gravel pits evident. The property is designated Prime Agricultural and Core Greenland and is mapped as a Mineral Aggregate Area in the County of Wellington Official Plan.

The bedrock within the subject lands is dolostone classified as part of the Amabel formation. Existing surface elevations range from 355masl to 358masl with bedrock elevations in the 349masl to 354masl range. The groundwater table elevation is at approximately 349masl.

The properties immediately surrounding the proposed licence area are largely characterized by farmland and sparse residential development. The closest sensitive receptors lie along Concession Road 6 and Highway 7 as identified within this report. There is a more densely populated residential development approximately 900m West of the proposed licence (Dunbar Woods).

Biological surveys of the on-site pond and stream failed to indicate any fish or spawning activity. Notwithstanding, setbacks around these water features have been included in quarry designs in order to prevent any potential impacts from the quarry operation.

PROPOSED AGGREGATE EXTRACTION

The extraction will proceed in three distinct phases defined as Phase 1, Phase 2, and Phase 3. Current applications call for a total yearly extraction limit of 700,000 tonnes. For typical quarry operations, at full quarry capacity, this would involve the execution of 15 to 30 blasts per year.

Extraction will be initiated along the Northeast perimeter of the Phase 1 area with retreat towards the Southwest and South (Refer to Appendix A Operational Plan). This sinking cut will be located approximately 425m from the closest sensitive receptors, namely R19 and R12. Top of bedrock elevations in the Phase 1 area are at approximate elevation 349masl with established final quarry floor at elevation 320masl.

The Phase 2 extraction area lies Northeast of the Phase 1 lands and Northeast of the intermittent stream. Extraction will be initiated along the Northwest perimeter of the Phase 2 lands and retreat towards the Southeast. This sinking cut will be located approximately 485m from the closest sensitive receptor, namely R12. Top of bedrock elevations in the Phase 2 area are at approximate elevation 354masl with established final quarry floor at elevation 320masl.

The Phase 3 extraction area lies Southeast of the Phase 1 lands and South of the Phase 2 lands. Extraction will leverage the existing Phase 1 Southeast face to eliminate the need for a sinking cut. Extraction will retreat towards the Southeast. Top of bedrock elevations in the Phase 3 area are at approximate elevation 350masl with established final quarry floor at elevation 317masl in this phase.

The quarry will not be dewatered and as such, the majority of rock will be blasted below water. Given existing average top of bedrock elevations in the range of 349 – 354masl, and a groundwater table elevation of 349masl, at most only the top 5m of rock to be blasted will be exposed. This condition will affect overpressure and vibration levels as described later in this report.

As dewatering of the quarry will not be undertaken as part of the operation, extraction will take place in single benches to attain design floor elevation. Quarrying operations on varied phases may be ongoing concurrently throughout the life of the quarry.

The closest structures in the vicinity of extraction are as follows:

Receptor Label	Address	Separation distance from closest point of extraction (m)
R1	4264 Highway 7	310
R2	8470 Highway 7	500
R3	4943 Concession 6	165
R4	4958 Concession 6	440
R5	4963 Concession 6	290
R6	4970 7th line	720
R7	4969 7th line	670
R8	4952 7th line	650
R9	4944 7th line	620
R10	8559 Highway 7	215
R11	4953 Concession 6	250
R12	8590 Highway 7	165
R13	8532 Highway 7 – on quarry property	130
R14	5139 Highway 7	265
R15	14297 Concession 5	220
R16	5036 Highway 7	70
R17	14321 Concession 5 – Not a sensitive receptor (Business)	75
R18	4300 Highway 7	315
R19	W & T Mushroom – Concession 6	165
R20	5198 Highway 7	325
R21	8572 Highway 7	480
R22	8584 Highway 7 – MTO Yard – Not a sensitive receptor	620
R23	5290 Highway 7 – Storage yard – Not a sensitive receptor	640
R24	4907 7th Line – Not a sensitive receptor (Business)	750
R25	4917 – 4921 7th Line - Not a sensitive receptor (Business)	750
R26	4923 7th Line	740
R27	4925 7th Line	745
R28	4935 7th Line	770
R29	4936 7th Line – Not a sensitive receptor (Business)	610
R30	4961 7th Line	790
R31	4960 7th Line	720
R32	9298 Highway 7	360

R33	9216 Highway 7	485
R34	8456 Highway 7	800
R35	8438/8436 Highway 7	1000
R36	8420 Highway 7	1160
R37	8408 Highway 7	1300
R38	8400 Highway 7	1300
R39	8398 Highway 7	1300
R40	8384 Highway 7	1300
R41	8376 Highway 7	1340
R42	8368 Highway 7	1340
R43	8359 Highway 7	1480
R44	8358 Highway 7	1510
R45	644 Highway 7	1530

As quarry operations migrate across the property, the closest sensitive receptors to the required blasting operations will vary with the governing structures and approximate separation distances being as follows:

- North corner: R12 – Highway 7 – 500m
- West Corner: R3 and R1 – 6th Concession Road – 165m
- South corner – R16 – Highway 7– 185m
- East corner – R12 – Highway 7 – 165m
- Southeast blast limit – R16 – Highway 7 – 70m

The above distances incorporate maintenance of a minimum 15m extraction setback within the Quarry property limits as well as allowance for sterilized areas to account for the intermittent stream, pond and sensitive receptor offsets.

The closest separation distance between a sensitive receptor and any blast over the life of the quarry is 70m. While technically feasible, given current blasting technology and techniques, blasting at this separation distance would not be economically feasible. The actual point of termination of blasting operations in will be governed by the results of the on-site monitoring program and market economics.

As noted above, the closest sensitive receptors for the initial operations are located approximately 425m from the blast (R19 and R12). Our composite data suggests that a maximum explosive load of 300kg per period can be employed at a distance of 425m to remain compliant with MOE guidelines for ground vibrations. The closest sensitive receptor in front of the blast is located some 750m removed (R9), a distance which our composite data suggests would permit a maximum load per delay in excess of 1000kg per period to remain compliant with guidelines for overpressure.

Quarries in Ontario normally employ 76 to 152mm diameter blast holes which, for a maximum 33m bench, would employ 170kg to 675kg of explosive load per hole. The choice of hole diameter and bench height will govern the maximum number of holes to be fired per period for the sinking cut. Once the quarry is opened up, subsequent blasts can be designed to minimize the number of holes fired per period.

BLAST VIBRATION AND OVERPRESSURE LIMITS

The Ontario MOE guidelines for blasting in quarries are among the most stringent in North America.

Studies by the U.S. Bureau of Mines have shown that normal temperature and humidity changes can cause more damage to residences than blast vibrations and overpressure in the range permitted by the MOE. The limits suggested by the MOE are as follows.

Vibration ____________ 12.5mm/sec   Peak Particle Velocity (PPV)

Overpressure ________ 128 dB   Peak Sound Pressure Level (PSPL)

The above guidelines apply when blasts are being monitored. Cautionary levels are slightly lower and apply when blasts are not monitored on a routine basis. It is a recommendation of this report that all blasts at the operation be monitored to quantify and record ground vibration and overpressure levels employing a minimum of two (2) digital seismographs, one installed at the closest receptor behind the blast, or closer, and one installed at the closest receptor in front of the blast, or closer.

BLAST VIBRATION AND OVERPRESSURE DATA

Blast vibration and overpressure data listed below in Tables 1 and 2 was generated through the analysis of empirical data collected from an amalgamation of quarries and mines throughout Ontario. All ground vibration data was plotted using square root scaling for blast vibrations. The composite data employed has been proven to be very conservative and has been used as a start-up guideline for many aggregate extraction operations. The Table 1 data differs from that included later in this report under the heading *Predicted Vibration Levels at the Nearest Sensitive Receptor* in that the Table 1 data is an amalgamation of thousands of blasts representing a significant variation in geology, blast design, blast type, environmental conditions and the likes. The latter equation involved the analysis of a single quarry operation with similar operating parameters to the Hidden Quarry to arrive at calculated values. The Table 1 data has been shown to be more conservative with respect to calculated ground vibration levels when compared to the analysis of a single quarry operation.

Overpressure data was plotted employing cube root scaling. It should be noted that given the high dependence on local environmental conditions, overpressure prediction is far less reliable as a means of blast control. Ultimately, the recommended vibration and overpressure monitoring program will be used to confirm compliance with applicable guidelines and to guide blast design amendments.

Our experience and analysis demonstrates that blast overpressure is greatest when blasting toward residences, and blast vibrations are greatest when retreating towards the residences. Based on our complete empirical data set from other Ontario quarries, we present the following initial guidelines for blasting operations at the proposed James Dick Construction Hidden Quarry:

RECOMMENDED MAXIMUM EXPLOSIVE LOADING BASED ON MOE GUIDELINE LIMITS

TABLE 1 – Blast Vibration Limit – 12.5 mm/sec

Distance to Receptor (Meters)	Allowable Explosives per Period - kg	
	Front of Blast	Back of Blast
150	39	17
200	69	30
250	108	48
300	156	68
350	213	94
400	278	122
500	434	190
600	625	275
700	851	374
800	1,111	477
900	1,406	604
1000	1,831	746
1100	2,216	903
1200	2,500	1,075

TABLE 2 – Blast Overpressure Limits – 128 dB

Distance to Receptor (Meters)	Allowable Explosives per Period – kg	
	Front of Blast	Back of Blast
150	8	38
200	20	88
250	38	171
300	67	296
350	105	470
400	158	702
500	308	1,372
700	846	3,764
900	1,799	8,000
1200	4,264	18,962

INITIAL BLASTING PARAMETERS

Blast Pattern:	1800 x 1800 to 3300 x 3300 mm
Number of holes:	Varies
Hole depth:	15m – 33m
Hole Diameter:	76 to 152mm
Stemming:	Clearstone
Toe Load:	Cast Booster / Cartridge
Column Load:	Emulsion
Maximum Charge per hole:	Varies with cut depth
Total Explosives per blast:	Varies with blast size
Material being blasted:	Dolostone
Tonnage per blast:	Varies
Number of blasts per year	Varies with production required

The above parameters provide initial guidance to direct blasting operations. Upon the commencement of blasting on site, these parameters will require revision based on site-specific data obtained and attenuation equations developed required as a recommendation of this report.

While the initial required blasting will take place further removed from sensitive receptors, special precautions must be implemented when operations encroach within 250m of any sensitive receptor. Revisions to blast designs, including adjustments to blasthole diameter and spacing, type of explosive, delay sequence, and collar heights have been proven to be very effective in controlling vibration and overpressure. All blasts shall be monitored at the nearest sensitive receptors as extraction retreats toward the structures to ensure constant compliance with MOE guideline limits and to permit timely adjustment to blast designs as required.

BLAST MECHANICS AND DERIVATIVES

The detonation of explosives within a borehole results in the development of very high gas and shock pressures. This energy is transmitted to the surrounding rock mass, crushing the rock immediately surrounding the borehole (approximately 1 borehole radius) and permanently distorts the rock to several borehole diameters (5-25, depending on the rock type, prevalence of joint sets, etc).

The intensity of this stress wave decays quickly so that there is no further permanent deformation of the rock mass. The remaining energy from the detonation travels through the unbroken material in the form of a pressure wave or shock front which, although it causes no plastic deformation of the rock mass, is transmitted in the form of vibrations.

Particle velocity is the descriptor of choice when dealing with vibrations because of its superior correlation with the appearance of cosmetic cracking. As such, for the purposes this report, ground vibration units have been listed in mm/s.

In addition to the ground vibrations, overpressure, or air vibrations are generated through the direct action of the explosive venting through cracks in the rock or through the indirect action of the rock movement. In either case, the result is a pressure wave which travels though the air, measured in decibels (or dB) for the purposes of this report.

VIBRATION AND OVERPRESSURE THEORY

Transmission and decay of vibrations and overpressure can be estimated by the development of attenuation relations. These relations utilize empirical data relating measured velocities at specific separation distances from the vibration source to predict particle velocities at variable distances from the source. While the resultant prediction equations are reliable, divergence of data occurs as a result of a wide variety of variables, most notably site-specific geological conditions and blast geometry and design for ground vibrations and local prevailing climatic conditions for overpressure.

In order to circumvent this scatter and improve confidence in forecast vibration levels, probabilistic and statistical modeling is employed to increase conservatism built into prediction models, usually by the application of 95% confidence lines to attenuation data.

The attenuation relations are not designed to conclusively predict vibrations levels at a specific location as a result of a specific blast design, application of this probabilistic model creates confidence that for any given scaled distance, 95% of the resultant velocities will fall below the calculated 95% regression line.

While the data still provides insight into probable vibration intensities, attenuation relations for overpressure tends to be less reliable and precise than results for ground vibrations. This is due primarily to wider variations in variables outside of the influence of the blast design which impact propagation of the vibrations. Atmospheric factors such as temperature gradients and prevailing winds (refer to Appendix B) as well as local topography can all serve to significantly alter overpressure attenuation characteristics.

Our experience and analysis demonstrates that blast overpressure is greatest when blasting toward receptors, and blast vibrations are greatest when retreating towards the receptor.

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PREDICTED VIBRATION LEVELS AT THE NEAREST SENSITIVE RECEPTOR

The most commonly used formula for predicting peak particle velocity (PPV) is known as Bureau of Mines (BOM) prediction formula or Propagation Law. We have used this formula to predict the PPV's at the closest house for the initial operations.

$$PPV = k\left(\frac{d}{\sqrt{w}}\right)^{e}$$

Where, PPV = the predicted peak particle velocity (mm/s)

K, e = site factors

d = distance from receptor (m)

w = maximum explosive charge per delay (kg)

The value of K is highly variable and is influenced by many factors (i.e. rock type, geology, thickness of overburden, etc.). Based on monitoring performed in an Ontario quarry with similar material characteristics, our initial estimates for "e" will be set at -1.76 and "K" will be set at 5175 (refer Appendix C). In the absence of data for the proposed aggregate extraction operation, these are used for initial prediction purposes.

An ***example*** of this calculation is as follows:

For a distance of 425m (i.e. the closest standoff distance for initial operations at the proposed quarry) and a maximum explosives load per delay of 150kg (76mm diameter hole, 30m deep, 2.0m surface collar and 1 hole per delay), we can calculate the maximum PPV at the closest building as follows:

$$ppv = 5175\left(\frac{425}{\sqrt{150}}\right)^{-1.76} = 10.1mm/s$$

As discussed in previous sections, the MOE guideline for blast-induced vibration is 12.5mm/s (0.5 in/s). The calculated 95% predicted PPV (based on the proposed blasting data discussed above) would be 10.1mm/s, below the MOE guideline limit. The above theoretical blast design will require amendment to reduce explosive load per period as the separation distance to the closest sensitive receptors decreases in order to maintain compliance with NPC 119 guidelines.

The quarry will not be dewatered with water surface elevations anticipated to be at approximately 349masl. While the presence of the water will not affect the vibration attenuation behind the blast, it will result in a slower attenuation rate in front of the blast. However, given the direction of retreat and separation to the closest sensitive receptors, vibrations behind the blast will likely govern blast designs. Ultimately, the results of the monitoring program will guide the blasting operations from a round vibration perspective.

OVERPRESSURE LEVELS AT THE NEAREST SENSITIVE RECEPTOR

It is unusual for overpressure to reach damaging levels, and when it does, the evidence is immediate and obvious in the form of broken windows in the area. However, overpressure remains of interest due to its ability to travel further distances as well as cause audible sounds and excitation in windows and walls.

Air overpressure decays in a known manner in a uniform atmosphere, however, a uniform atmosphere is not a normal condition. As such, air overpressure attenuation is far more variable due to its intimate relationship with environmental influences. Air vibrations decay slower than ground vibrations with an average decay rate of 6dBL for every doubling of distance.

Air overpressure levels are analyzed using cube root scaling based on the following equation:

$$P = k\left(\frac{d}{\sqrt[3]{w}}\right)^{e}$$

Where, P = the peak overpressure level (Pa)
K, e = site factors
d = distance from receptor (m)
w = maximum explosive charge per delay (kg)

Data collected at an Ontario quarry with similar material characteristics was used to develop the following 95% regression equation (refer to Appendix C). The values for "e" and “K” have been established at -0.669 and 1222 respectively based on the collected empirical data.

$$P = 1222\left(\frac{D}{\sqrt[3]{W}}\right)^{-0.669}$$

As discussed in previous sections, the MOE guideline for blast-induced overpressure is 128dBL. For a distance of 750m (i.e. the standoff distance to the closest existing structure in front of the blast for the initial blasting) and a maximum explosive weight of 150kg (76mm diameter hole, 30m deep, 2.0m collar, one hole per delay), we can calculate the overpressure at the nearest receptor in front of the blast using the equation above to be 44.558Pa. This value converts to 126.9dBL on the linear decibel scale. Based on this calculation and the assumed blast parameters, overpressures from blasting operations will remain compliant with the MOE NPC 119 guideline limit of 128dBL. The design method of retreat has been planned so as to direct overpressures generated as much as practicable in the direction of vacant lands as opposed to sensitive receptors.

We reiterate that air overpressure attenuation is far more variable due to its intimate relationship with environmental influences and as such, the equation employed is less reliable than that developed for ground vibration. Overpressure monitoring performed on site shall be used to guide blast design as it pertains to the control of blast overpressures. As demonstrated in Appendix B, prevailing winds during quarry operational periods are predominantly out of the West, a condition which will assist in attenuating overpressures at the receptors in front of the majority of the blasts.

Given that the quarry will not be dewatered and all but the top 5m of the face will be below water, overpressures generated by gas venting at the face and direct movement of the rock will effectively be eliminated. The net effect will be a dramatic reduction in the actual overpressures to levels well below the above calculated levels. As such, compliance with MOE overpressure levels at the operation will be readily achieved.

BLAST IMPACT ON ADJACENT WATERCOURSES

The detonation of explosives in or near water can produce compressive shock waves which initiate damage to the internal organs of fish in close proximity, ultimately resulting in the death of the organism. Additionally, ground vibrations imparted on active spawning beds have the ability to adversely impact the incubating eggs and spawning activity. In an effort to alleviate adverse impacts on fish populations as a result of blasting, the Department of Fisheries and Oceans developed the *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (1998)*. This publication establishes limits for water overpressure and ground vibrations which are intended to mitigate impacts on aquatic organisms while providing sufficient flexibility for blasting to proceed. Specifically, water overpressures are to be limited to 100kPa and, in the presence of active spawning beds, ground vibrations at the bed are to be limited to 13mm/s.

While there are water bodies on and adjacent to the site, the Natural Environment study prepared for the application indicated that there were no spawning beds or fish habitat on the property or in the ‘study area’ which includes a 120m perimeter around the site. Based on this separation distance, water overpressures generated by the blasting will reside well below the DFO 100Kpa guideline limit and will have no impact on the adult fish populations present.

While spawning beds are not present within a 120m radius surrounding the site, spawning beds within a 400m radius surrounding the site may be subjected to vibrations in excess of the DFO limit of 13mm/s. In the event that <u>active</u> spawning beds are identified within 400m of any planned quarry blast, vibration monitoring will be required at the shoreline adjacent the spawning area, or closer to the blast, in order to ensure compliance with DFO limits for ground vibration.

The generation of suspended solids within the watercourse as a result of the blasting activities will be negligible and grossly subordinate to suspended solids generated as a result of spring runoff and rain activity.

RECOMMENDATIONS

It is recommended that the following conditions be applied for all blasting operations at the proposed James Dick Construction Hidden Quarry:

1. An attenuation study shall be undertaken by an independent blasting consultant during the first 12 months of operation in order to obtain sufficient quarry data for the development of site specific attenuation relations. This study will be used to confirm the applicability of the initial guideline parameters and assist in developing future blast designs.

2. All blasts shall be monitored for both ground vibration and overpressure at the closest privately owned sensitive receptors adjacent the site, or closer, with a minimum of two (2) digital seismographs – one installed in front of the blast and one installed behind the blast. Monitoring shall be performed by an independent third party engineering firm with specialization in blasting and monitoring.

3. When blasting on site is to take place within 400m of an active spawning bed, an additional seismograph shall be installed at the location of the closest spawning bed, or closer to the blast, to confirm compliance with the DFO guideline limit for ground vibrations of 13mm/s.

4. Orientation of the aggregate extraction operation will be designed and maintained so that the direction of the overpressure propagation and flyrock from the face will be away from structures as much as possible.

5. Blast designs shall be continually reviewed with respect to fragmentation, ground vibration and overpressure. Blast designs shall be modified as required to ensure compliance with applicable guidelines and regulations. Decking, reduced hole diameters and sequential blasting techniques will be used to ensure minimal explosives per delay period initiated.

6. Once blasting progress encroaches to within 250m of any offsite sensitive receptor, a formal review of accumulated blast records including vibration data and blast designs shall be undertaken. This review will identify what modifications to blasting protocol and procedures are required to address the reduced separation distance.

7. Clear crushed stone will be used for stemming.

8. Primary and secondary dust collectors will be employed on the rock drills to keep the level of rock dust to a minimum.

9. Blasting procedures such as drilling and loading shall be reviewed on a yearly basis and modified as required to ensure compliance with industry standards.

10. Detailed blast records shall be maintained. The MOE (1985) recommends that the body of blast reports should include the following information:

- Location, date and time of the blast.
- Dimensional sketch including photographs, if necessary, of the location of the blasting operation, and the nearest point of reception.
- Physical and topographical description of the ground between the source and the receptor location.
- Type of material being blasted.
- Sub-soil conditions, if known.
- Prevailing meteorological conditions including wind speed in m/s, wind direction, air temperature in ^{o}C, relative humidity, degree of cloud cover and ground moisture content.
- Number of drill holes.
- Pattern and pitch of drill holes.
- Size of holes.
- Depth of drilling.
- Depth of collar (or stemming).
- Depth of toe-load.
- Weight of charge per delay.
- Number and time of delays.
- The result and calculated value of Peak Pressure Level in dB and Peak Particle Velocity in mm/s.
- Applicable limits.
- The excess, if any, over the prescribed limit.

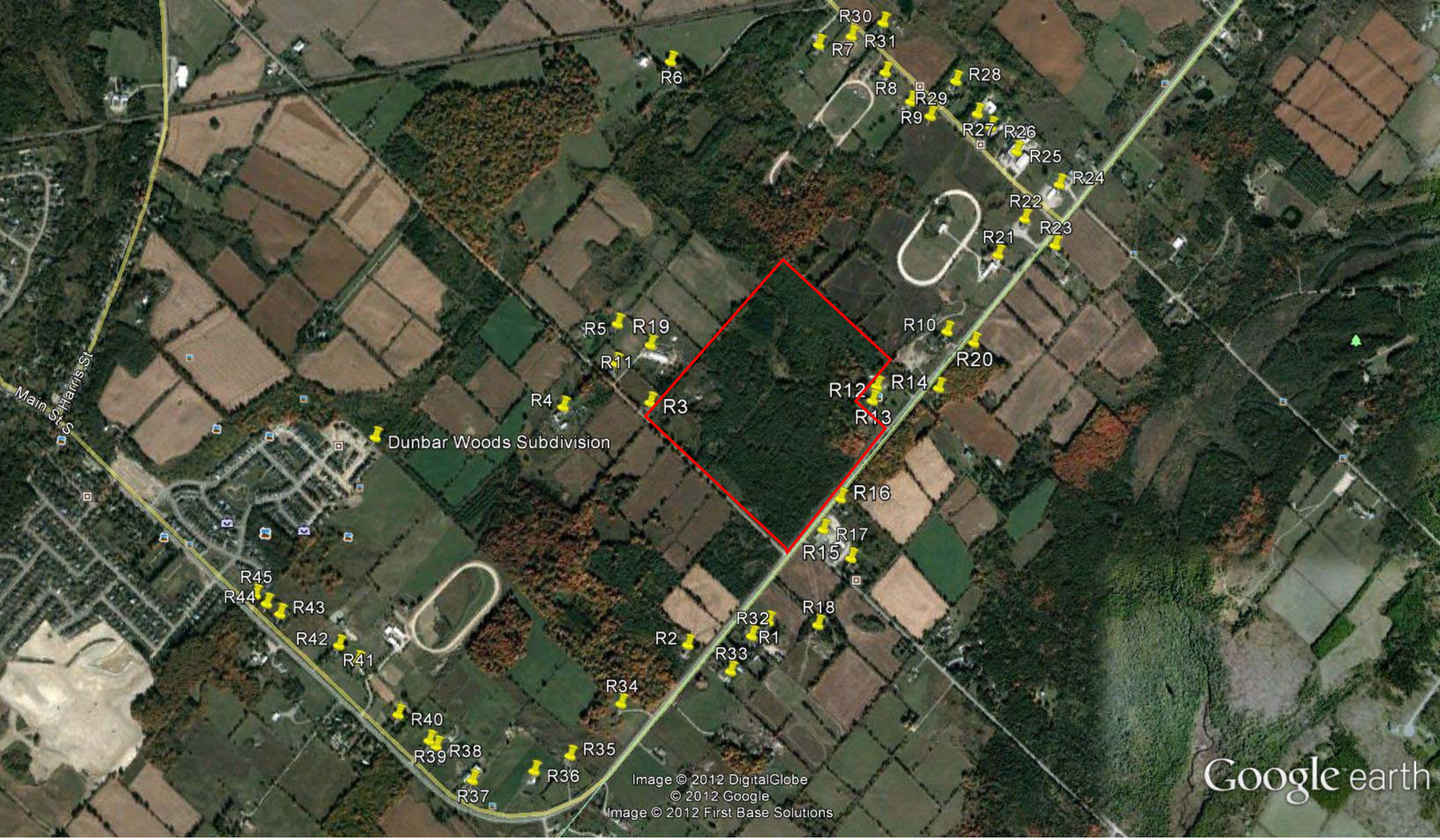
CONCLUSION

The blast parameters described within this report will provide a good basis for the initial blasting operations at this location. As site specific blast vibration and overpressure data becomes available, it will be possible to refine these parameters on an on-going basis.

Blasting operations required for operations at the proposed James Dick Construction Ltd. Hidden Quarry site can be carried out safely and well within governing guidelines set by the Ministry of the Environment.

Modern blasting techniques will permit blasting to take place with explosives charges below allowable charge weights ensuring that blast vibrations and overpressure will remain minimal at the nearest receptors and compliant with applicable guideline limits.

Appendix A



R30
R7
R31
R6
R8
R28
R29
R9
R27
R26
R25
R24
R22
R23
R21
R10
R20
R5
R19
R11
R12
R14
R13
R4
R3
Dunbar Woods Subdivision
Main St S
Harris St
R16
R17
R15
R45
R44
R43
R42
R41
R18
R32
R1
R2
R33
R34
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Image © 2012 DigitalGlobe
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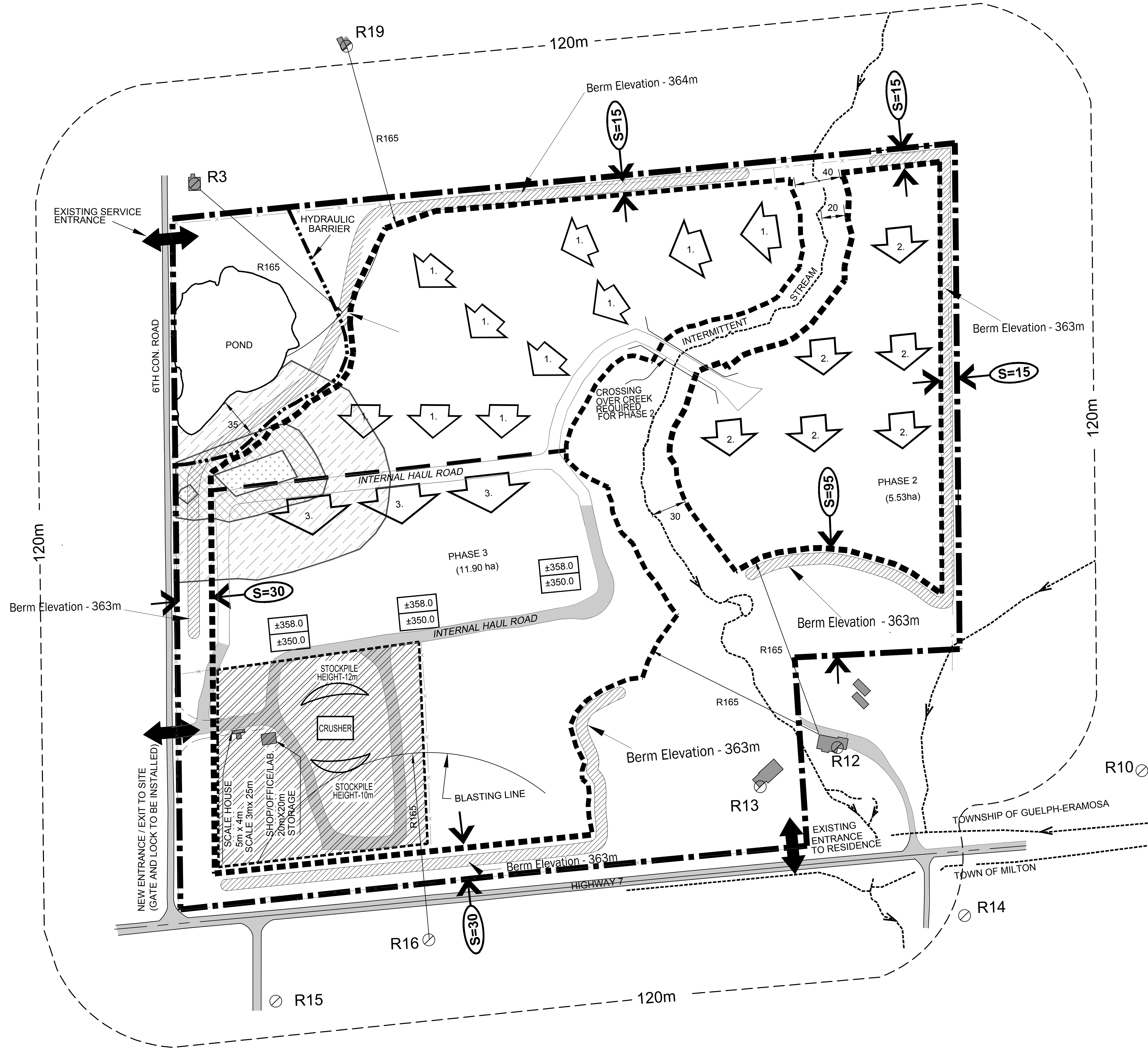
Google earth


R19
120m
Berm Elevation - 364m
S=15
S=15
R165
R3
40
20
EXISTING SERVICE ENTRANCE
HYDRAULIC BARRIER
R165
1.
1.
1.
1.
2.
1.
1.
1.
STREAM
INTERMITTENT
Berm Elevation - 363m
POND
6TH CON. ROAD
1.
CROSSING OVER CREEK REQUIRED FOR PHASE 2
2.
2.
S=15
35
1.
1.
1.
2.
2.
2.
120m
INTERNAL HAUL ROAD
3.
3.
3.
30
S=95
PHASE 2
(5.53ha)
120m
PHASE 3
(11.90 ha)
±358.0
±350.0
Berm Elevation - 363m
S=30
±358.0
±350.0
±358.0
±350.0
INTERNAL HAUL ROAD
Berm Elevation - 363m
R165
STOCKPILE HEIGHT-12m
CRUSHER
R165
Berm Elevation - 363m
R12
R10
STOCKPILE HEIGHT-10m
BLASTING LINE
R13
SCALE HOUSE 5m x 4m SCALE 3mx 25m
SHOP/OFFICE/LAB. 20mX20m STORAGE
R165
NEW ENTRANCE / EXIT TO SITE (GATE AND LOCK TO BE INSTALLED)
TOWNSHIP OF GUELPH-ERAMOSA
EXISTING ENTRANCE TO RESIDENCE
Berm Elevation - 363m
HIGHWAY 7
TOWN OF MILTON
R14
R16
S=30
R15
120m

Appendix B

EXPLOTECH

Hidden Quarry

PREVAILING METEOROLOGICAL CONDITIONS

Medians provided by Environment Canada

Date	Wind Direction	Wind Velocity Km/h	Temperature (Deg Celsius)
January	SW 15.4		- 7.6
February	W 14.0		- 6.6
March	W 14.9		- 1.3
April	W 14.9		5.9
May	W 12.3		12.3
June	W 10.9		16.9
July	W 9.6		19.7
August	W 8.7		18.6
September	W 9.8		14.31
October W		11.5	7.9
November SW		14.2	2.4
December SW		14.6	- 4.0

** Data is not available specifically for the proposed quarry location.
Nearest weather stations are Guelph and Waterloo, Ontario
** Data is based on averaged climate normals gathered 1971 – 2000.

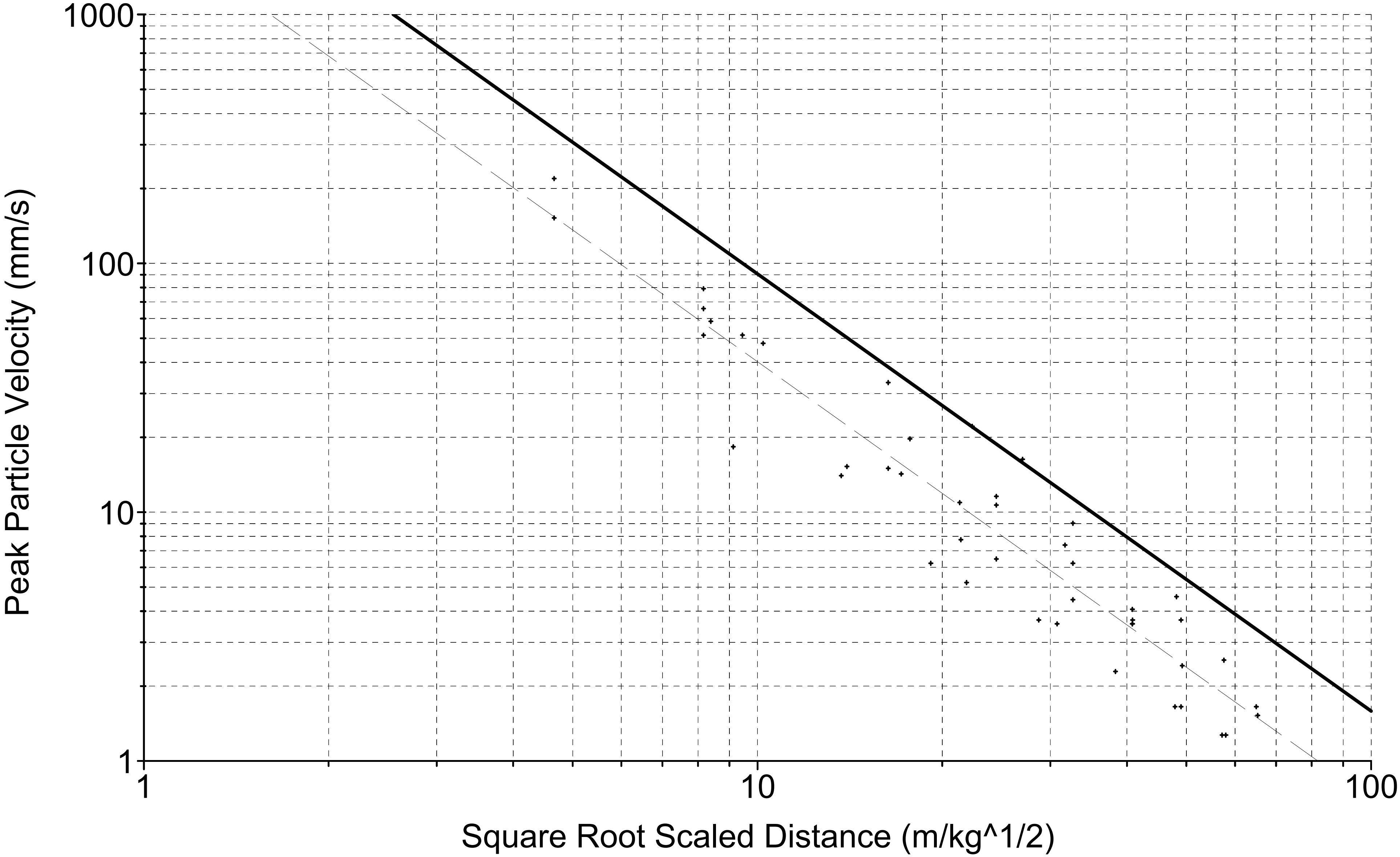
Appendix C

Regression Behind the shot

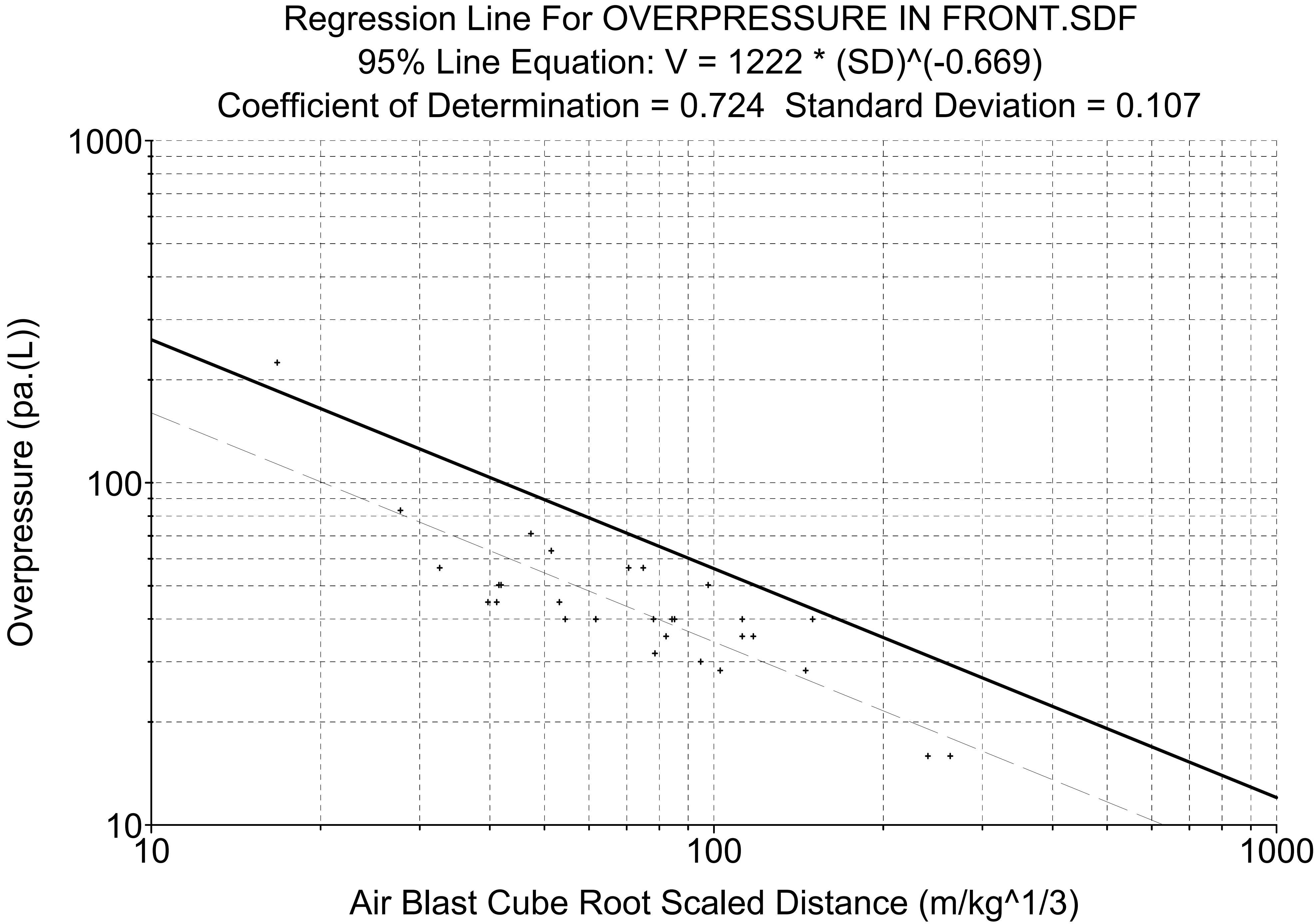
Regression Line For GROUND VIBRATION BEHIND.SDF

95% Line Equation: V = 5175 * (SD)^(-1.76)

Coefficient of Determination = 0.903 Standard Deviation = 0.176



Regression analysis in front of the shot



Appendix D

EXPLOTECH

René A. (Moose) Morin, P. Eng.

Co-owner, Principal of Explotech Engineering Ltd.

EDUCATION

B. Sc. Mining Engineering, University of Alberta 1959
Summer Management Program University of Western Ontario
Extension English - Queen's University
Extension French - University of Montreal

PROFESSIONAL AFFILIATIONS

P. E. O. O.I.Q.
Canadian Institute of Mining and Metallurgy (CIMM)
International Society of Explosives Engineers (ISEE)

SUMMARY OF EXPERIENCE

Since 1958, Mr. Morin has specialized in drilling and blasting phases of mining, quarrying and construction throughout Canada as well as offshore. This experience includes all aspects of drilling, blast design, blast control, operations and management. Mr. Morin has been accepted as an expert witness in the field of explosives and blasting in provincial and federal courts as well as at Municipal Board hearings in Ontario.

INSTANTEL INC., the world leader in digital blasting seismographs was created by Mr. Morin and Mr. Doyle some twenty years ago.

PROFESSIONAL RECORD

1979- Present	**- Owner/Principal, Explotech Engineering Ltd.**
1977 - 1979	**- Manager Operations, Armac Drilling and Blasting**
1961 - 1977	**- Various responsibilities, starting as Branch Manager in Western Quebec, through Construction Sales Manager, Bulk Products Manager and National Sales Manager DuPont of Canada Explosives Division.**

EXPLOTECH

Robert J. Cyr, P. Eng.

Associate, Explotech Engineering Ltd.

EDUCATION

Bachelor of Applied Science,
Civil Engineering, Queen's University

PROFESSIONAL AFFILIATIONS

Association of Professional Engineers of Ontario (APEO)
Association of Professional Engineers and Geoscientists of BC (APEG)
International Society of Explosives Engineers (ISEE)
Aggregate Producers Association of Ontario (APAO)
Canadian Institute of Mining and Metallurgy (CIMM)

SUMMARY OF EXPERIENCE

Over twenty years experience in many facets of the construction and mining industry has provided the expertise and experience required to efficiently and accurately address a comprehensive range of engineering and construction conditions. Sound technical training is reinforced by formidable practical experience providing the tools necessary for accurate, comprehensive analysis and application of feasible solutions. Recent focus on vibration analysis, blast monitoring, blast design, damage complaint investigation for explosives consumers and specialized consulting to various consulting engineering firms.

PROFESSIONAL RECORD

2001 – Present	-Project Engineer, Explotech Engineering Ltd.
1996 – 2001	-Leo Alarie & Sons Limited - Project Engineer/Manager
1993 – 1996	-Rideau Oxford Developments Inc. – Project Manager
1982 – 1993:	-Alphe Cyr Ltd. – Project Coordinator/Manager/Engineer

Appendix E

EXPLOTECH

Blasting Terminology

ANFO:	Ammonium Nitrate and Fuel Oil – explosive product
ANFO WR:	Water resistant ANFO
Blast Pattern:	Array of blast holes
Body hole:	Those blast holes behind the first row of holes (Face Holes)
Burden:	Distance between the blast hole and a free face
Column:	That portion of the blast hole above the required grade
Column Load:	The portion of the explosive loaded above grade
Collar:	That portion of the blast hole above the explosive column, filled with inert material, preferably clean crushed stone
Face Hole:	The blast holes nearest the free face
Overpressure:	A compressional wave in air caused by the direct action of the unconfined explosive or the direct action of confining material subjected to explosive loading.
Peak Particle Velocity*:*	The rate of change of amplitude, usually measured in mm/s or in/s. This is the velocity or excitation of the particles in the ground resulting from vibratory motion.
Scaled distance:	An equation relating separation distance between a blast and receptor to the energy (usually expressed as explosive weight) released at any given instant in time.
Spacing:	Distance between blast holes
Stemming:	Inert material, preferably clean crushed stone applied into the blast hole from the surface of the rock to the surface of the explosive in the blast hole.
Sub-grade:	That portion of the blast hole drilled band loaded below the required grade
Toe Load:	The portion of explosive loaded below grade