

**BEFORE COMMISSIONERS APPOINTED BY WAIKATO REGIONAL
AND HAURAKI DISTRICT COUNCILS**

UNDER

the Resource Management Act 1991 (**RMA**)

AND

IN THE MATTER

of an application for resource consents to extend the Waihi Gold Mine via underground and open pit mining methods known as Project Martha

BY

OCEANA GOLD (NEW ZEALAND) LIMITED

Applicant

SYNOPSIS OF TECHNICAL REPORT (s42A) AND RESPONSE TO EVIDENCE BY

**Dr Cameron McKenzie
FOR THE HAURAKI DISTRICT COUNCIL**

(Blast Vibration Impact Assessment)

19 November, 2018

**BROOKFIELDS
LAWYERS**

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AUCKLAND

1. INTRODUCTION

- 1.1. My name is Cameron McKenzie, and I am the Managing Director of Blastotechnology, registered in Australia since 2004.
- 1.2. I hold the qualifications of Bachelor of Engineering (BE) with Honours, a Master of Engineering (ME), and a Doctor of Philosophy (PhD).
- 1.3. I have worked in the international mining industry since 1980 including 22 countries and have experience in the modelling, measurement, and optimisation of blasting mostly in mining and quarrying projects. I am a Blasting Consultant advising Hauraki District Council (HDC), and have acted in this capacity since 2004, involving applications and reviews of blasting impacts and effects from mining and quarrying activities including similar resource consent applications for the South Wall stability cutback, East Wall stability cutback, MDDP2, MDDP, Favona, Trio, Correnso (Golden Link) and Slevin Underground (SUPA) project areas associated with the Waihi gold mining operations.
- 1.4. I prepared a report for HDC titled “Technical Report on Expected Vibration Impacts from Project Martha”, dated 09 October 2018. The key findings of that report can be summarised as:
 - a. The analysis of expected impacts conducted by Heilig and Partners is detailed and thorough and in accordance with what I consider best practices.
 - b. I concur that the proposed mining project will be able to comply with the proposed consent conditions, provided that meticulous attention is given to blast design and implementation, and constant review occurs of monitoring results and trends.
 - c. I expressed concern in my report about the following issues:
 - The proposed vibration condition which discarded the requirement for separate compliance and averaging of vibrations from development and production blasting
 - Restrictions of building condition surveys, paid by OGNZL, to residential structures “in the vicinity of the vibration monitors”.

- Coverage gaps in the proposed locations of permanent monitors, specifically in the areas south of the central business district.
- Unlimited number and duration of blasts in Martha Phase 4 Pit (MP4)
- Safety against flyrock for blasting operations conducted at the top of the Martha Pit and outside the Martha Mining Zone (MMZ)
- Potential vibration anomalies.

2. OVERVIEW

Upon reviewing the evidence of Dr Heilig, dated 28 October 2018, and that of Bernie O’Leary dated 29 October 2018, my concerns relating to the first four dot points above have been allayed, as explained below.

- 2.1 Separating Development and Production Blasts.** My concern was allayed by Bernie O’Leary’s acceptance of separation in his statement of evidence. The original conditions proposed by OGNZL including combining all blasts (development and production). While I accept, and have never challenged, that all blasts in the underground operations are designed at a 95% Confidence Level to comply with the 5 mm/s vibration limit, I believe that accountability for compliance is best served by continuing to treat development and production blasts as different entities, potentially each with its own individual attenuation trend and attenuation parameters. Dr Heilig presents the argument in paragraph 21 of his Statement of Evidence that “*30 years of blasting and feedback from the community at Waihi has not indicated that a distinction between the types of blasting is discernible by the residents*”. I do not dispute that the type of blast producing a vibration disturbance is of no relevance to affected residents. The matter being addressed by separation of events is simply that development blast impacts have historically been, not surprisingly, much lower than the production blast impacts and far more prevalent, so that combining the two events for compliance purposes can tend to dilute the effort and attention to the higher impact production blasts. Separation of the events increases accountability. I recommend the adoption of conditions 33a through to 33l, in relation to separate conditions for

development and production blasting in the Martha Project Land Use Consent Conditions prepared by HDC.

2.1.1 Dr Heilig proposes, in his Statement of Evidence, a change in definition for development and production blasting, and I am satisfied with that proposed change. The definitions also appear as conditions 33j and 33k in the Project Martha Land Use Consent Conditions prepared by HDC.

2.2 **Averaging of Vibration Impacts as a Condition.** In his evidence, Bernie O'Leary has agreed to continue with the Correnso/SUPA Conditions involving separate averaging for development and production blasting. Dr Heilig argues it is not necessary, and the commissioners have requested that the HDC present the case for retaining the condition relating to averaging.

2.2.1 In his statement to commissioners on Tuesday 13 November, Dr Heilig stated that with all the historical data, the ability to predict levels now is high. I disagree with that statement, and cite Figure 10 (reproduced below) of his report dated April 2018 as justification. In those graphs, the straight lines represent the predicted values (average, 95% or effective maximum), and the blue points represent the measured values, and the large amount of scatter suggests a poor agreement between prediction and measurement. Statistically, the trend defined by the lines would have a correlation coefficient close to zero except perhaps in the case of the small and incomplete data set for Martha Phase 4 Pit.

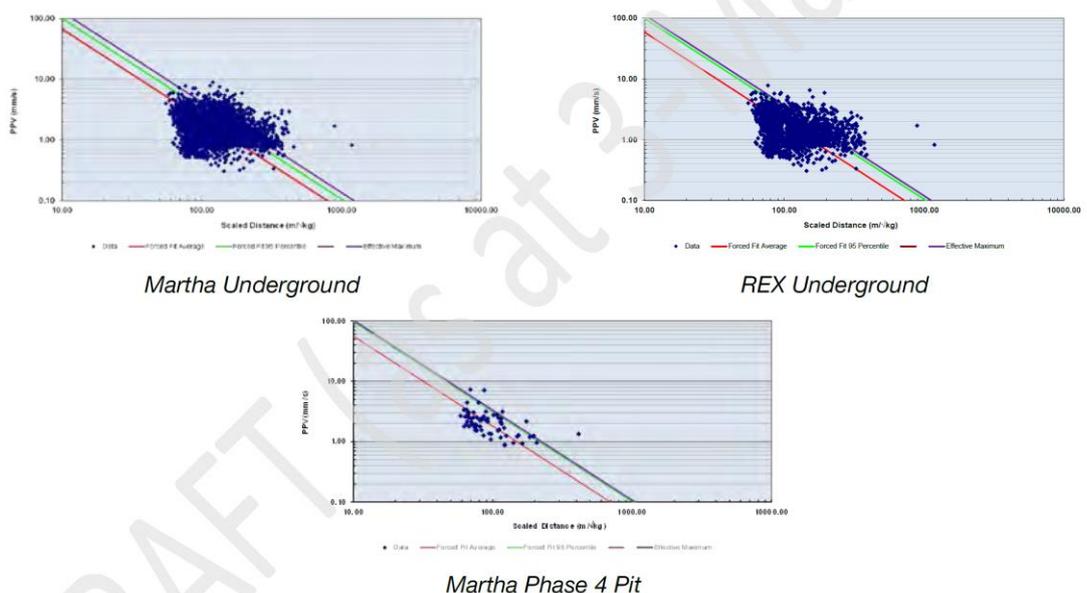


Figure 10 - Vibration vs scaled distance for each of the past five projects. These data have been used to develop the project specific relationships

2.2.2 I do accept, however, that the mine has convincingly demonstrated the ability to control levels to not exceed compliance levels, that is, an upper limit can be workably established within each of the data sets presented in Dr Heilig's Figure 10. I believe, firstly, that requiring compliance in terms of both average and 95 percentile vibration levels places a greater responsibility on mining personnel, during both blast design and implementation, for meticulous attention to detail, and constant review of vibration trends. A condition relating to a maximum average level effectively introduces another flag, or an orange warning light, to the design engineers and the charging crew encouraging them to take early action to avoid a non-compliance at the 95% level (the red light). Secondly, I consider it important to send the message to the Waihi community that the conditions for MP4 are no less stringent than those for Correnso. In the event that the conditions for the two operations look different, I am concerned that the difference could be interpreted as a watering-down of expectations and accountability. I fail to see that continuing with the condition relating to average values can slow down underground operations, or unnecessarily extend the duration of the project.

2.2.3 In his statement to the commissioners on Tuesday 13 November, Dr Heilig made reference to the restricted area of the Rex mining area as a reason for discontinuing the averaging condition. Rex will be challenging, but the Martha Project is more than the Rex mining activities – it also includes the Martha Underground project, for which the same issues apply as per the Correnso project. I recommend the adoption of condition 33b in the Project Martha Land Use Consent Conditions prepared by HDC.

2.3 **Building Condition Survey Restrictions.** My concerns that building condition surveys might be limited to residential structures in close proximity to the permanent monitors stemmed from the OGNZL Proposed Condition 44 which stated "*The representative properties are to be located in the vicinity of the vibration monitors required under Condition 41(d).*" The next paragraph stated "*The surveys shall be carried out by an independent structural engineer suitably qualified and experienced in domestic building design and construction.*". I was concerned that this might limit the company's preparedness to meet the costs of condition surveys for structures considered distant from the monitors, and to consider non-domestic structures. In expressing this concern, I agree with the general assurances by Dr Heilig that the probability of damage to structures, from vibration levels not exceeding 5

mm/s, is very low. I also acknowledge that if levels do occasionally exceed 5 mm/s, there is still a low probability of damage until peak vibration exceeds levels around 25 mm/s. However, I would also add that the experience of the mining and blasting technical community, has rarely, if ever, included such a “busy” and long-lasting blasting regime as is planned for Waihi, given the many different surface and underground project areas. Given the uniqueness of the operations at Waihi, the repetitious nature of blasting events, and the extended duration of blasting events (including potentially-unlimited duration blasts in Martha Pit), I find myself unable to state with conviction that no sign of even cosmetic damage will manifest in any structure over the next 12 years (mining duration referred to by Bernie O’Leary). The condition assessment statistics referred to in paragraph 100 of Dr Heilig’s Statement of Evidence, and the photo in the same paragraph showing locations where company-funded condition surveys have been conducted to date, allay my concerns about restrictions. I recommend the adoption of the conditions set forth in paragraphs 55 and 56 of the Project Martha Land Use Consent Conditions prepared by HDC.

2.3.1 It is important to note, however, that the full value of a condition survey requires very detailed inspection of the structure before blasting commences, and again towards the end of blasting. A comparison between changes which occur over time in the affected structure, with those occurring due to daily environmental deterioration in control structures far removed from blasting, is the means by which blasting-related deterioration is typically detected.

2.4 Monitor Coverage Gaps. As regards coverage gaps for the permanent vibration monitors, I note in paragraph 93 of Dr Heilig’s evidence that he agrees that there may be value in locating an additional monitor in the Kenny Street area. While such a monitor may be further from blasting activities than other existing monitors (Main South, Main Central and the Scout Hall), its value would be in improving the ability to estimate vibration exposure at both residential and commercial structures in that area. I note that Dr Heilig acknowledges that. I also note that Dr Heilig has confirmed the presence of another permanent monitor in the CBD area, which was not shown in the Application, or in the Heilig and Partners’ impact assessment reports. With a commitment to those monitoring locations, my concerns relating to vibration impact coverage are allayed.

- 2.4.1 It is worth noting that, at least in my opinion, the CBD monitor and a monitor in Kenny Street will considerably assist in the assessment of impacts to the 4 commercial properties mentioned in paragraph 95 of Dr Heilig's Statement of Evidence, being 14 Haszard St, 74 Seddon St, 100 Seddon St and 112 Seddon St).
- 2.4.2 I have visited each of the 13 proposed Project Martha monitoring sites and am satisfied that they will provide good coverage of the potentially-affected areas, at least for the initial stages of Project Martha. I am satisfied that the constant deployment of roving monitors will identify any future gaps which might be identified after commencement of Project Martha blasting activities, and that, based on my discussions with Dr Heilig, the mine has the resources to install additional permanent monitors should they be required. I recommend adoption of the monitoring locations presented as Appendix 3 in the Project Martha Land Use Consent Conditions prepared by HDC.
- 2.5 **Unlimited Duration & Frequency of MP4 Blasts.** While I remain concerned about the potential "busyness" of blasting operations in an area of unlimited number and duration of blasts, I believe that the opportunities for multiple blasts in any one day in MP4 will be limited due to restricted access to the area and the small working footprint (Plate A, 30 June 2018, Heilig & Partners). Further, the conditions of the Martha Licence ML 32 2388, now ODP, place no restrictions on either frequency or duration of blasts within the pit.

3. POINTS OF CONCERN

I remain concerned about my first three dot points in paragraph 1.4c above, as detailed below.

- 3.1 **Flyrock Safety.** It is commonly stated that the greatest danger from blasting operations is from flyrock. Flyrock fragments which travel significant distance move at sufficient velocity and are of sufficient size as to cause death, serious injury, or significant property damage. The closer blasting is conducted to occupied structures, the greater is the concern and the risk level. I acknowledge the Applicant's statistics with respect to recorded flyrock incidents, and I acknowledge Dr Heilig's calculations. I do not disagree with his calculations of maximum expected projection distance. My concerns are more about the things that we can't see, anticipate, control, or model,

associated with the rock mass and the unconventional style of blasting which the Applicant has described.

3.1.1 With respect to the style of blasting in the Martha Pit, the proposed practices result in many instances where adjacent holes are detonated at intervals much longer than is conventional. Dr Heilig describes in paragraph 98 of his Statement of Evidence delay periods of several seconds between the firing of sub-panels. As a charge detonates, it disturbs (by design) a volume of rock surrounding the hole. The zone of disturbance can easily extend to any or all of the adjacent blast holes. With very large delays between adjacent holes, a charge can therefore detonate in an unexpected state of confinement, or lack of confinement. These are precisely the conditions that promote flyrock.

3.1.2 I acknowledge that mining has been safely conducted in the Martha Pit, with only a single flyrock incident, which projected rock fragments 300 metres. An important factor that concerns me is that in the case of MP4, occupied houses are located as close as just 105 metres, according to the Response by Heilig & Partners dated 04 July 2018. The combination of such close proximity and the unusual blasting methodology suggests to me that additional layers of security should be investigated. What was not stated when reference was made to the previous flyrock incident is that the holes which generated the flyrock had been identified and marked as a risk by the shot crew, but appropriate actions were nevertheless not taken. This was a clear case of a failure to act on a highlighted concern – a human failure, and a lack of accountability. The building struck by flyrock fragments was occupied at the time of the incident.

3.1.3 I am aware that conditions applied to MP4 may conflict with the conditions of Martha Mining Licence 32 2388 (now incorporated into the Operative District Plan) in all MP4 areas except those outside the MMZ. I am also aware that a condition requiring a minimum Factor of Safety, which does not also define the method by which the maximum projection distance is calculated, serves no practical purpose. I therefore recommend that the conditions stipulate that a new Vibration Management Plan (VMP) be certified prior to the commencement of the Martha Project, with particular attention to identifying the level of risk as a function of distance from occupied structures, and the controls to be implemented to mitigate the risks i.e. a formal Risk Assessment. Such an assessment would not be conducted for every blast, but would be conducted prior to any blasting in the Martha Pit by a group of qualified and

experienced Risk Assessors who would quantify the level of risk in each area, define the controls for risk mitigation, and specify measures to ensure the controls are in place. Such a Risk Assessment must be acceptable to OGNZL, HDC and their respective advisors. The VMP should also address flyrock training for surface shot-crew and appropriate Safe Work Instructions on the topic. I recommend changes to the current wording of section 2.6.3 of the Newmont Waihi Gold VMP dated September 2012 "*Blasting mats are available to be laid on top of the blast if there is a demonstrated need to manage flyrock.*", since there is no indication of the trigger which would see a second level of protection deployed (blasting mats or other). The term "*a demonstrated need*" sounds like a reactive action after a flyrock event rather than a proactive action to prevent the event. If a flyrock event occurs near the top of MP4, it could prove fatal. I recommend adoption of condition 47a(vi) in the Project Martha Land Use Consent Conditions prepared by HDC.

3.2 Vibration Anomalies. Dr Heilig refers in paragraph 55 of his evidence dated 28 October 2018 to the methodology for identifying an anomalous location, being where measured levels are more than 2.2 times the expected maximum levels. I agree with that definition which we jointly developed. The report refers to there being only a single instance of an anomalous location (6 Mataura Rd). In response to that statement, I recall the results of an intensive vibration monitoring programme conducted around 1988 by a US-based company, Geosonics, a prominent outcome of which was the starkly inhomogeneous nature of vibration transmission around the pit, suggesting the presence of a number of anomalous zones. Further, in Figure 6 of Dr Heilig's report dated April 2018, he presents a graph showing a portion of results from the Main Central permanent monitor over a 6 month period from 01 Jan to 30 Jun, 2017 (reproduced below). Unless I am misunderstanding the graph (and I do not understand the term Sub-blast which appears in the legend), it seems to show both predicted (yellow dots) and measured (orange dots) vibration levels, from which it seems reasonable to conclude that on many occasions measured levels are very significantly higher than predicted levels at this location, over this period of time.

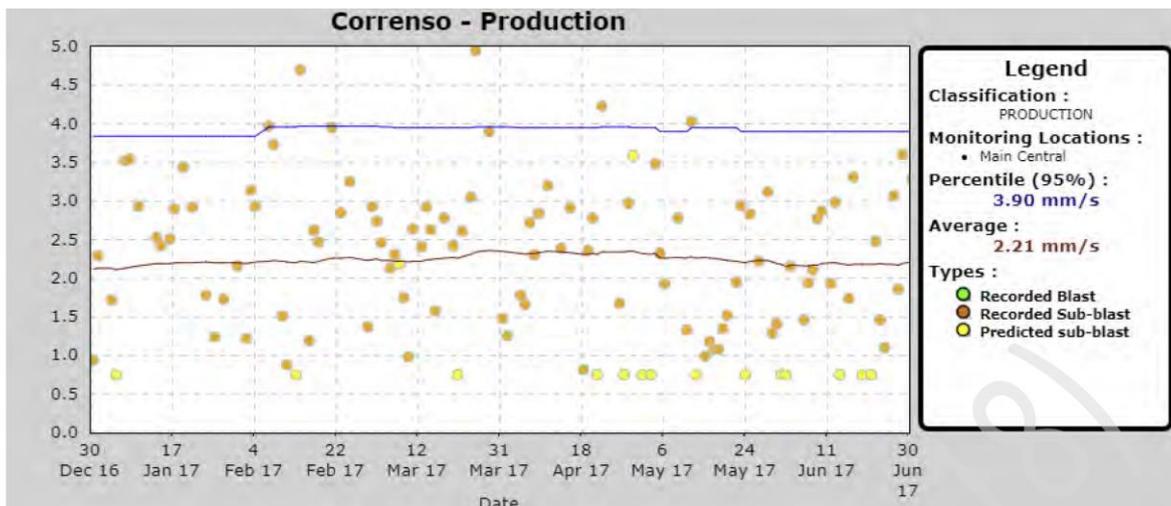


Figure 6 - Summary of measured vibration at Main Central site for 1st January to 30th June, 2017

3.2.1 I conclude that nobody really knows how many anomalous areas exist in the mining-affected area, and the only reason that the anomaly at 6 Mataura Rd was detected was because the readings frequently exceeded the maximum permitted level of 5 mm/s, thereby forcing a closer examination. It took several years for those data to be reviewed and confirmed as reliable. Where anomalies or higher-than-expected levels exist but are below the permitted levels, they are likely to go unnoticed or unaddressed. This conclusion, coupled with the fact that neither Dr Heilig (paragraph 56 of his Statement of Evidence) nor I fully understand the cause of the anomalous readings, makes me wary about dismissing or downplaying the possibility of future occurrences.

3.2.2 One should remember when considering expected vibration impacts that it is not only anomalous areas that report higher-than-expected vibration levels. Reference to Dr Heilig's Figures 9 and 10 of his April 2018 Assessment report shows very wide scatter in vibration levels, even when the large database shown in Figure 9 is filtered to define localised trends of Figure 10.

3.2.3 I concur with Dr Heilig's proposal in paragraphs 55 to 57 of his Statement of Evidence that the details of the path of investigation to identify anomalous areas, including the triggers for deployment of roving monitors and statistical analysis of data, be specified to the approval of HDC, OGNZL and their respective advisors, in the VMP and support condition 47a(vii) in the Project Martha Land Use Consent Conditions prepared by HDC. I also concur with Bernie O'Leary's Statement of Evidence paragraphs 61 and 62 in relation to

available options for management of anomalous zones once statistically verified.

4. ADDITIONAL MATTERS

4.1. Maintenance Blasting. A definition of the term was provided in Dr Heilig's statement of evidence made before the commissioners on Tuesday 13 November, and expanded upon by Bernie O'Leary during discussions on 15 November. I understand and accept the definition and the need and the revised definition is reproduced as condition 33k1 in the Project Martha Land Use Consent Conditions prepared by HDC.

4.1.1. I note that Maintenance Blasting remains unconstrained in terms of duration and frequency. By the nature of the definition provided, I would expect such events to be neither frequent nor regular. I also recall Dr Heilig saying that such activities would be restricted to a few holes, in which case, I believe that in addition to the condition of a limit of 1 mm/s, the duration of the events should be limited to no more than 2 seconds and the frequency to no more than once per shift. Such a time should assist in minimising the perceptibility of the event at times when people are resting or sleeping. I agree that maintenance blasting should be reported, as per condition 53a of the Project Martha Land Use Consent Conditions prepared by HDC. I recommend adoption of condition 33f(iv) in the Project Martha Land Use Consent Conditions prepared by HDC.

4.1.2. With a condition of 1 mm/s applied to maintenance and safety blasts, it will be necessary for all monitors to be active 24 hours per day, and 7 days per week. This is not currently the case, and some adjustments to data analysis and trigger thresholds may be required for the secondary and roving monitors. I recommend that these matters be addressed in the VMP.

4.2. Pumphouse Monitoring. In relation to vibration monitoring at the Cornish Pumphouse, my personal preference is to focus on direct methods of assessing damage rather than indirect ones like vibration measurement. Vibration limits are subjective. I doubt the ability of any structural engineer to specify a vibration level that represents the onset of any level of damage to that structure, or a sustained level below which damage could never occur. Using vibration levels as a way of managing personal amenity issues, which

are also subjective, is a reasonable process. Using subjective vibration limits to control damage, which is not a subjective matter, appears pointless when there are alternative direct measurements. My preference is for periodic structural inspections by an experienced and qualified structural engineer over the duration of the project, and a commitment by the applicant to make good structural defects which are detected over the period of the MP4 operations. I note that the EMMA conditions require vibration monitoring and structural assessment, though the frequency of structural inspection is ambiguous. I recommend the adoption of condition 33I in the Martha Project Land Use Consent Conditions prepared by HDC.

4.3. Why not assign a limit of 10 mm/s? Assigning a vibration level on its own, when the concern is potential damage, carries misleading implications, principally that if the measured levels are less than the limit, then no damage can have occurred, and if the level is exceeded, then damage probably has occurred. I believe it is not possible to assign a vibration damage threshold, and therefore prefer to focus efforts on methods which can identify damage at various intensity levels. A vibration limit that acts as a trigger for structural inspection is worth considering, but the level then needs to be related to some probability of damage.

4.4. What would I say to a concerned resident? My advice would be:

4.4.1. Open and calm communication with OGNZL or HDC to express concern, and request that a roving monitor be installed for a period of several months. Engage with the company.

4.4.2. Become informed – request background information from the environmental group (Donna).

4.4.3. Recognise that Donna's information obtained from technical literature may not be totally applicable to the unique case of Waihi, being typically associated with a much less "busy" vibration environment.

4.4.4. Request a condition survey from an independent group that reports directly to the resident/home-owner.

4.4.5. Understand that, while minor damage is unlikely, it cannot be categorically ruled out because the Waihi situation is unique. Any such damage incurred

will be very minor, easily remedied, and will certainly not extend to any degree of structural damage.

4.4.6. Recognise that OGNZL wants to operate in harmony with the community, values communication of concerns from the community, and is prepared to remedy damages which are credibly related to the effects of mining. Work with the company, not against it. Engagement rather than estrangement.

5. CONCLUSIONS

- 5.1. I acknowledge, and commend the mine on, the degree of compliance achieved over the last 10 years or more, and its commitment to the most comprehensive impact assessment monitoring programme that I have ever seen. I also commend Dr Heilig on the detail with which he has conducted his assessment of vibration effects, and I agree with his approach in all areas.
- 5.2. I have no concerns as to the integrity of the monitoring system, or the people managing the monitoring system, and believe it to be of a world-class standard. I have no concerns about the sanctity of the data recorded by the system, and I am satisfied as to the transparency of the process and results obtained.
- 5.3. I believe that Project Martha can be undertaken and comply with the proposed average and 95% vibration conditions for both development and production blasting, provided that the company maintains a sharp focus on measurement, analysis, and quality control.
- 5.4. I recommend that significant adjustments be made to the VMP, including a Trigger Action Response Plan (TARP) for anomalous areas identified by deployment of the roving monitors by both HDC and OGNZL, and a detailed Risk Assessment by qualified and experienced Risk Assessors of flyrock risk and appropriate controls for all blasting areas within the Marth Pit.

C. K. McKenzie

Name

Cameron K McKenzie

Date: 19 Nov, 2018