Blast Management Strategy

NEWCASTLE INNER CITY BYPASS – RANKIN PARK TO JESMOND (STAGE 4 – MAIN WORKS)

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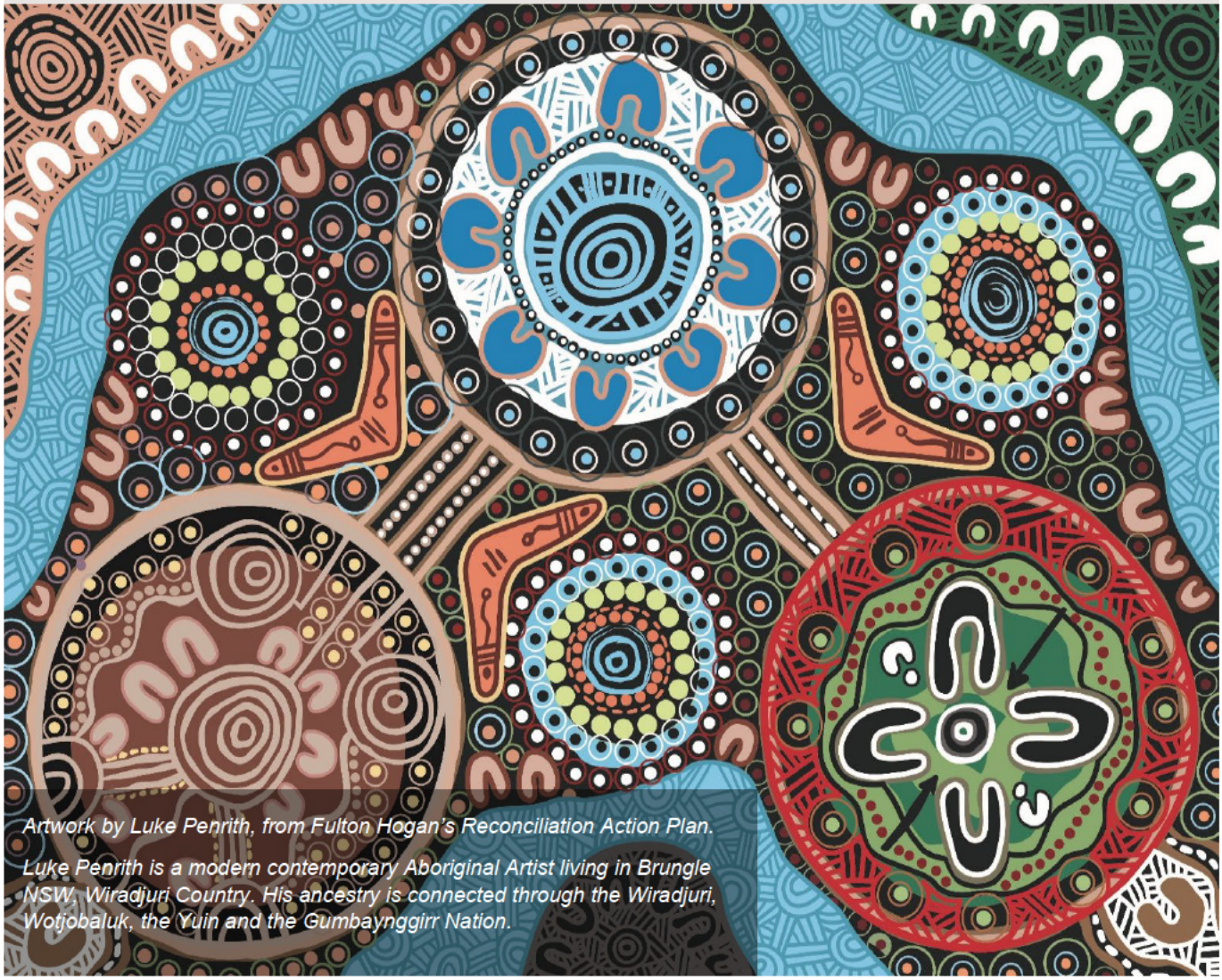
ACKNOWLEDGMENT OF COUNTRY

Fulton Hogan acknowledges the Awabakal People as the Traditional Owners of the land we are working on, and pay our respect to their Elders past, present and emerging.

We recognise their deep connection to Country and value the contribution to caring for, and managing the land and water.

We are committed to pursuing genuine and lasting partnerships with Traditional Owners to understand their culture and connections to Country in the way we plan for and carry out the delivery of the Works.



Artwork by Luke Penrith, from Fulton Hogan's Reconciliation Action Plan.

Luke Penrith is a modern contemporary Aboriginal Artist living in Brungle NSW, Wiradjuri Country. His ancestry is connected through the Wiradjuri, Wotjobaluk, the Yuin and the Gumbaynggirr Nation.

Document control

This is an e-copy of the Plan and it interfaces with the other associated plans, which together describe the proposed overall project management system for the project.

The latest revision of this plan is available on the Fulton Hogan server. If any unsigned hard copies of this document are printed, they are valid only on the day of printing.

The revision number is included at the bottom of each page. When revisions occur, the entire document will be issued with the revision number updated accordingly for each owner of a controlled copy.

Attachments/Appendices to this plan are revised independently of this plan.

Revision history

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Glossary/ Abbreviations

Term/ abbreviation	Definition
BCM	Bulk Cubic Meter
CCS	Community Communication Strategy
CEMP	Construction Environmental Management Plan
CoA	Condition of Approval
Construction	Has the same meaning as the definition of the term in the Project Approval
Construction Boundary	Has the same meaning as the definition of the term in the Project Approval: The area physically affected by works described in documents listed in Condition A1.
D&C	Design and Construct
Department/ DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
EMS	Environmental Management System
EPA	NSW Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPL	Environment Protection License
ER	Environmental Representative for the SSI
ESCP	Primary Erosion and Sediment Control Plan
EWMS	Environmental Work Method Statement
FFMP	Flora and Fauna Management Sub-Plan
HP	Hold Point: a point in the construction or verification process beyond which work may not proceed without receiving authorisation from the appropriate party.
JHH	John Hunter Hospital
Material harm	Has the same meaning as the definition of the term in the Project Approval: Is harm that: (a) involves actual or potential harm to the health or safety of human beings or to the environment that is not trivial, or (b) results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding $10,000, (such loss includes the reasonable costs and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment)
Minister, the	NSW Minister for Planning
CoAs	Conditions of Approvals
NA	Not applicable
Non-compliance	Has the same meaning as the definition of the term in the Project Approval: An occurrence, set of circumstances or development that is a breach of the Project Approval. This includes a failure to comply with the processes included within this CEMP.
Non-conformance	Failure to conform to the requirements of project or Fulton Hogan system documentation.

NCA	Noise Catchment Area
NVMM	Noise and Vibration Mitigation Measures
OEMP	Operational Environmental Management Plan
OEMS	Operational Environmental Management System
Planning Secretary, the	Planning Secretary of the DPE (or nominee, whether nominated before or after the date on which the Project Approval was granted.
POEO Act	*Protection of the Environment Operations Act 1997* (NSW)
Project, the	Newcastle Inner City Bypass Rankin Park to Jesmond
Project Approval, the	The Minister's approval for the SSI.
PV	Project Verifier
Relevant Council(s)	Has the same meaning as the definition of the term in the Project Approval: Lake Macquarie City Council and City of Newcastle, as relevant.
REMM	Revised Environmental Management Measure
RMS	Roads and Maritime Services (now TfNSW)
RMS Velocity	Root-Mean Square Velocity
RP2J	Rankin Park to Jesmond
SPIR	Submissions and Preferred Infrastructure Report
SSI	State Significant Infrastructure, as generally described in Schedule 1 of the Project Approval, the carrying out of which is approved under the terms of the Project Approval.
SWMP	Soil and Water Management Sub-Plan
SWTC	TfNSW Scope of Works and Technical Criteria
TfNSW	Transport for NSW
VC Curve	Vibration Criteria Curve
Work(s)	Has the same meaning as the definition of the term in the Project Approval: All physical activities to construct or facilitate the construction of the SSI, including environmental management measures and utility works. however, does not include work that informs or enables the detailed design of the SSI and generates noise that is no more than 5 dB(A) above the rating background level (RBL) at any residence

1. Introduction

1.1. Purpose

This Blast Management Strategy (BMS) has been prepared to detail how Fulton Hogan will satisfy Conditions E50 to E53 of the Project's Ministers State Significant Infrastructure (SSI) Conditions of Approval (CoAs) for blasting activities during construction of the Newcastle Inner City Bypass - Rankin Park to Jesmond (the Project).

Additionally, this plan will address all other relevant guidelines, including the Project EPL, to ensure the compliant and safe execution of controlled blasting on the Project. The document sets out how Fulton Hogan will manage blasting activities and the related environmental impacts such as vibration, airblast overpressure and flyrock. It sets out the anticipated performance requirements and procedures to ensure that the possible environmental impacts associated with blasting activities are adequately identified and controlled for the project.

1.2. Background

Geotechnical investigation carried out for the Project has identified that rock strata in cut 4 are at the upper limit of being able to be excavated with techniques other than blasting (such as rock breaking and ripping by large dozers). Further, the use of these techniques would result in increased duration to complete the excavation as well as generating high levels of construction noise with impacts to receives above that resulting from blasting activities.

To address the risks associated with blasting, a Blasting Assessment has been prepared by an independent specialist to provide a framework for the procedures required to maintain best practice controls to manage potential environmental impacts during the drilling and blasting activities linked with the construction of the Project.

1.3. Consultation for preparation of the BMS

In accordance with project approval, the BMS is to be '*endorsed by a suitably qualified and experienced independent person'* as per CoA E51(see Appendix D).

Following Transport for NSW (TfNSW) approval, the plan is to be submitted to NSW Department of Planning and Environment (DPE) Planning Secretary '*for information no later than one month before the commencement of blasting'* as per CoA E53.

2. Objectives and environmental performance outcomes

2.1. Objectives

The key objective of the BMS is to ensure that controlled blasting impacts to the local community, built environment and sensitive receivers are minimised. This will be achieved by addressing CoA E50, including:

- Sequencing and review of trial blasting to inform blasting
- regularity of blasting
- intensity of blasting
- periods of relief; and
- blasting program

2.2. Environmental performance outcomes

The environmental performance criteria on the blasting activity that have been specified as part of the CoAs address:

- Minimising the impact of vibration and airblast overpressure associated with blasting activities to acceptable amenity levels.
- Preventing damage to adjacent public utilities, structures and other buildings resulting from vibration and air overpressure effects.

In addition to the above-mentioned environmental objectives and performance criteria, all drilling and blasting activities will meet the following objectives:

- Control of flyrock and safety of all personnel.
- Compliance with the requirements of the project and Explosives Inspectorates.
- Fragmentation and diggability requirements commensurate with excavating equipment.

3. Legal and other requirements

3.1. Legislation

Legislation relevant to controlled blasting management includes:

- Protection of the Environment Operations Act 1997
- Protection of the Environment Operations (General) Regulation 2009
- Explosives Regulation 2013
- Explosives Act (NSW) 2003
- Australia Explosives Code
- Australian Code for The Transport of Explosives by Road and Rail - 3rd Edition
- WorkCover Licensing Requirements
- the General explosive licence and security clearance conditions under the NSW explosives act and regulation.

3.2. Guidelines and standards

The main guidelines, standards and policy documents relevant to this BMS include:

- German Standard DIN 4150-3: Structural Vibration – Part 3 Effects of vibration on structures
- British Standard BS 7385-1:1990 – Evaluation and measurement of vibration in buildings—Guide for measurement of vibration and evaluation of their effects on buildings
- Australian Standard 2187.1 - 1998 Explosives — Storage, transport and use, Part 1: Storage
- Australian Standard 2187.2 - 2006 Explosives – Storage and use, Part 2: Use of explosives
- Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006)
- RMS Specification R44 – Earthworks (Cl. 4.5; Cl. 4.7 Blasting and ANNEXURE R44/A6 Blasting)
- RMS Specification G36 – Environmental Protection

3.3. Conditions of approval

The CoAs relevant to this BMS are listed in 1. A cross reference is included to indicate where the condition is addressed in this BMS or other project management documents.

Table 1: Conditions of Approval relevant to BMS

CoA No.	Condition requirements	Document reference
PART E - CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN		
NOISE AND VIBRATION		
E25	A detailed land use survey must be undertaken to confirm sensitive receivers and landuses (including critical working areas such as operating theaters and precision laboratories) potentially exposed to construction noise and vibration, construction ground-borne noise and operational noise. The survey may be undertaken on a progressive basis but must be undertaken in any one area before the commencement of works which generate audible construction or operational noise, or do not meet safe working buffer distances for vibration or ground-borne noise in that area. With the exception of works associated with Bridge 7, the results of the survey must be included in the **Noise and Vibration CEMP Sub-plan.**	NVMP Section 4.1, App. D
E33	Noise generating work in the vicinity of sensitive receivers and land uses (including	NVMP Section

CoA No.	Condition requirements	Document reference
	community, religious, educational institutions and noise and vibration-sensitive businesses, medical facilities, and the John Hunter Hospital) resulting in noise levels above the NMLs at critical working areas (such as operating theatres and precision laboratories) must not be timetabled within sensitive periods, unless other reasonable arrangements with the affected receivers are made at no cost to the affected receivers.	5.1.2
E34	Mitigation measures must be implemented with the aim of achieving the following construction noise management levels and vibration criteria: (a) construction 'Noise affected' noise management levels established using the Interim Construction Noise Guideline (DECC, 2009);	NVMP Section 5.2.4
	(b) vibration criteria established using the Assessing vibration: a technical guideline (DEC, 2006) (for human exposure);	NVMP Section 7.5
	(c) Australian Standard AS 2187.2 - 2006 "Explosives - Storage and Use - Use of Explosives";	Section 3.2 NVMP Section 1.3
	(d) BS 7385 Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2" as they are "applicable to Australian conditions"; and	NVMP Section 7.5
	(e) The vibration limits set out in the German Standard DIN 4150-3: Structural Vibration- effects of vibration on structures (for structural damage). Any work identified as exceeding the noise management levels and/or vibration criteria must be managed in accordance with the Noise and Vibration CEMP Sub-plan, including in any Out-of-Hours Work Protocol or Out of Hours Work Management Process or equivalent, required by Condition E31, and in relation to Bridge 7 the documents required by Condition A9. Note: The Interim Construction Noise Guideline identifies 'particularly annoying' activities that require the addition of 5 dB(A) to the predicted level before comparing to the construction Noise Management Level.	NVMP Appendix C NVMP Section 7.5 NVMP Section 9.4.2
E35	Mitigation measures must be applied when the following residential ground-borne noise levels are exceeded: (a) evening (6:00 pm to 10:00 pm) — internal LAeq(15 minute): 40 dB(A); and (b) night (10:00 pm to 7:00 am) — internal LAeq(15 minute): 35 dB(A). The mitigation measures must be outlined in the Noise and Vibration CEMP Sub-plan, including in any Out-of-Hours Work Protocol or Out of Hours Work Management Process or equivalent, required by Condition E31, and in relation to Bridge 7 the documents required by Condition A9.	Section 6.1 NVMP Section 7.5.4
E36	Landowner(s) and occupier(s) of properties at risk of exceeding the screening criteria for cosmetic damage must be notified before works that generate vibration commences near those properties. If the potential exceedance is to occur more than once or extend over a period of 24 hours, landowner(s) and occupier(s) must be provided a schedule of potential exceedances on a monthly basis for the duration of	Section 4.2 NVMP Sections 7.5, 9.4.2

CoA No.	Condition requirements	Document reference
	the potential exceedances, unless otherwise agreed by the landowner and occupier. These properties must be identified and considered in the Noise and Vibration CEMP Sub-plan, including in any Out-of-Hours Work Protocol or Out of Hours Work Management Process or equivalent, required by Condition E31, and in relation to Bridge 7 the documents required by Condition A9. Note: Condition E54 requires Pre-construction Building and Structure Condition Surveys of buildings and structures of risk of damage to be undertaken prior to the commencement of work in the vicinity of the buildings or structures.	
E37	The Proponent must conduct vibration testing before and during vibration generating activities that have the potential to impact on minimum working distances to prevent cosmetic damage. In the event that the vibration testing and monitoring shows that the preferred values for vibration are likely to be exceeded, the Proponent must review the construction methodology and, if necessary, implement additional mitigation measures.	NVMP Section 9.4.2
Construction Vibration		
E44	The SSI must be delivered with the aim of achieving the following vibration goals: (a) for structural damage to heritage structures, the vibration limits set out in the German Standard DIN 4150-3: Structural Vibration – Part 3 Effects of vibration on structures; (b) for damage to other buildings and/or structures, the vibration limits set out in the British Standard BS 7385-1:1990 – Evaluation and measurement of vibration in buildings—Guide for measurement of vibration and evaluation of their effects on buildings (and referenced in Australian Standard 2187.2 – 2006 Explosives – Storage and use – Use of explosives); and (c) for human exposure, the acceptable vibration values set out in Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006).	Section 5.1 NVMP Section 5.2.1
E45	Blasting associated with the SSI must only be undertaken during the following hours:	Section 6.1
	(a) 9:00am to 5:00pm, Monday to Friday, inclusive; (b) 9:00am to 1:00pm on Saturday; and (c) at no time on Sunday or public holidays. This condition does not apply in the event of a direction from the NSW Police Force or other relevant authority for safety or emergency reasons to avoid loss of life, property loss and/or to prevent environmental harm. Blasting may be undertaken outside the above hours where: (a) no sensitive receivers would be impacted by blasting; or (b) an agreement has been made with potentially affected receivers.	
E46	Airblast overpressure generated by blasting associated with the SSI must not exceed the criteria specified in Table 6 when measured at the most affected	Section 5.4

<table>
<tr><th>CoA No.</th><th>Condition requirements</th><th>Document reference</th></tr>
<tr><td></td><td>residence or other sensitive receiver.

Table 6: Airblast overpressure limits for human comfort
<table>
<tr><th>Receiver</th><th>Type of blasting operations</th><th>Airblast Overpressure Limit</th></tr>
<tr><td>Sensitive site</td><td>Blasting operations lasting more than 12 months or more than 20 blasts</td><td>115 dBL for 95% of blasts per year
120 dBL maximum limit</td></tr>
<tr><td>Sensitive site</td><td>Blasting operations lasting less than 12 months or less than 20 blasts in total</td><td>120 dBL for 95% of blasts per year
125 dBL maximum limit</td></tr>
<tr><td>Occupied non-sensitive sites, such as factories and commercial premises</td><td>All blasting</td><td>125 dBL maximum limit.
For sites containing equipment sensitive to vibration, the vibration level should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation</td></tr>
</table>
Source – Table J5.4(A) – AS 2187.2 – 2006

Note: A sensitive site includes houses and low rise residential buildings, theatres, schools and other similar buildings occupied by people</td><td></td></tr>
<tr><td>E47</td><td>Ground vibration generated by blasting associated with the SSI must not exceed the criteria specified in Table 7 and Table 8 when measured at the most affected residence or other sensitive receiver.

Table 7: Ground vibration limits for human comfort
<table>
<tr><th>Receiver</th><th>Type of blasting operations</th><th>Peak component particle velocity (mm/s)</th></tr>
<tr><td>Sensitive site</td><td>Blasting operations lasting more than 12 months or more than 20 blasts</td><td>5 mm/s for 95% of blasts per year
10 mm/s maximum limit</td></tr>
<tr><td>Sensitive site</td><td>Blasting operations lasting less than 12 months or less than 20 blasts in total</td><td>10 mm/s maximum limit</td></tr>
<tr><td>Occupied non-sensitive sites, such as factories and commercial premises</td><td>All blasting</td><td>25 mm/s maximum limit.
For sites containing equipment sensitive to vibration, the vibration level should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation</td></tr>
</table>
Source – Table J4.5(A) – AS 2187.2 – 2006

Note: A sensitive site includes houses and low rise residential buildings, theatres, schools and other similar buildings occupied by people</td><td>Section 5.2</td></tr>
</table>

<table>
<tr><th>CoA No.</th><th>Condition requirements</th><th>Document reference</th></tr>
<tr><td></td><td>
Table 8: Ground vibration limits for control of damage to structures
<table>
<tr><th>Receiver</th><th>Type of blasting operations</th><th colspan="2">Peak component particle velocity (mm/s)</th></tr>
<tr><td>Other structures or architectural elements that include masonry, plaster and plasterboard in their construction [1]</td><td></td><td>15 mm/s 4 Hz to 15 Hz, except for heritage structures where a frequency dependent vibration criteria would be determined in accordance with AS 2187.2 – 2006.</td><td>20 mm/s 15 Hz and above</td></tr>
<tr><td>Reinforced or framed structures. Industrial and heavy commercial buildings [2]</td><td>All blasting</td><td>50 mm/s at 4 Hz and above</td><td></td></tr>
<tr><td>Unreinforced or light framed structure. Residential or light commercial type building [2]</td><td>All blasting</td><td>15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz</td><td>20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above</td></tr>
<tr><td>Unoccupied structures of reinforced concrete or steel construction</td><td>All blasting</td><td colspan="2">100 mm/s maximum, where agreed with the structure owner.</td></tr>
<tr><td>Infrastructure service structures, such as pipelines, powerlines, cables and reservoirs.</td><td>All blasting</td><td colspan="2">Limits to be determined by structural design methodology in consultation with the infrastructure service provider.</td></tr>
</table>
Source: Table J4.5(B) – AS 2187.2 – 2006 and Table J4.4.2.1 – AS 2187.2 – 2006 (BS 7385-2)
</td><td></td></tr>
<tr><td>E48</td><td>The blasting criteria specified in the tables in Conditions E46 and E47 may be exceeded where the Proponent has obtained the written agreement of the landowner and occupier to increase the relevant criteria. In obtaining the agreement, the Proponent must make available to the landowner and occupier:

(a) details of the proposed blasting program and justification for the proposed increase in blasting criteria including alternatives considered (where relevant);

(b) an assessment of the environmental impacts of the increased blasting criteria on the surrounding environment and most affected residences or other sensitive receivers including, but not limited to noise, vibration and air quality and any risk to surrounding utilities, services or other structures; and

(c) details of the blast management, mitigation and monitoring procedures to be implemented.</td><td>N/A – blasting criteria specified in E46 and E47 are not being exceeded.</td></tr>
<tr><td>E49</td><td>The Proponent must provide a copy of the landowner and occupier written agreement to the Planning Secretary and the EPA, including details of the consultation undertaken (with clear identification of proposed blast limits and potential property impacts), before commencing blasting at the higher limits.

Unless otherwise agreed by the Planning Secretary, the following exclusions apply:

(a) the landowner and occupier may terminate at any time an agreement made with the Proponent to increase the blasting criteria, should concerns made by the landowner and occupier about the blasting criteria be unresolved. Where an agreement is terminated, the Proponent must not exceed the criteria specified in the tables in Conditions E46 and E47 for future blasting that affects the property; and</td><td>N/A – blasting criteria specified in E46 and E47 are not being exceeded.</td></tr>
</table>

CoA No.	Condition requirements	Document reference
	(b) the blasting limit agreed to under any agreement must not exceed a maximum Peak Particle Velocity vibration level of 25 mm/s or maximum Airblast Overpressure level of 125 dBL.	
Blast Management Strategy		
E50	A Blast Management Strategy must be prepared and must include: (a) sequencing and review of trial blasting to inform blasting; (b) regularity of blasting; (c) intensity of blasting; (d) periods of relief; and (e) blasting program.	Sections 5.5 6.1 5 and App A & B 6.1 6.1 and App C
E51	The Blast Management Strategy must be endorsed by a suitably qualified and experienced independent person.	Section 8 and Appendix D
E52	The Blast Management Strategy must be prepared in accordance with relevant guidelines in order to ensure that all blasting and associated activities are carried out so as not to generate unacceptable noise and vibration impacts or pose a significant risk to sensitive receivers.	Section 3, 8
E53	The Blast Management Strategy must be submitted to the Planning Secretary for information no later than one month before the commencement of blasting. The Strategy as submitted to the Planning Secretary, must be implemented for all blasting activities.	Section 8
Building Condition Survey		
E54	Pre-construction Building and Structure Condition Surveys must be undertake of all buildings, structures, and utilities and the like, identified in the documents listed in Condition A1, as being at risk of damage from works associated with the SSI. The surveys must be undertaken by a suitably qualified structural engineer before the commencement of any work that could cause damage to buildings, structures and utilities. The results of the surveys must be documented in a Pre-construction Building and Structure Condition Survey Report for each building, structure and utility surveyed. Copies of the Preconstruction Building and Structure Condition Survey Reports must be provided to the owners of the buildings, structures and utilities surveyed no later than one (1) month before the commencement of work in the vicinity of the impacted buildings, structures and utilities.	Section 4.2, 4.3 NVMP Section 7.5.1
E55	After completion of construction of the SSI, a follow-up condition survey of all items for which building and structure condition surveys were undertaken in accordance with Condition E54, must be undertaken by a suitably qualified structural engineer. The results of the surveys must be documented in a Post-construction Building and Structure Condition Survey Report for each building, structure and utility surveyed. Copies of the Post-construction Building and Structure Condition	NVMP Section 7.5.1.

CoA No.	Condition requirements	Document reference
	Survey Reports must be provided to the owners of the buildings, structures and utilities surveyed no later than three months following the completion of construction.	
E56	The Proponent, where liable, must rectify any damage caused directly or indirectly (for example from vibration or from groundwater change) by the construction or operation of the SSI at no cost to the landowner. Alternatively, the Proponent may pay compensation for the property damage as agreed with the landowner.	NVMP Section 7.5.1

3.4. Revised environmental management measures

Relevant construction-related Revised Environmental Management Measures (REMMs) from the Modification 1 Submissions Report are listed in 2. A cross reference is also included to indicate where the measure is addressed in the Project Noise and Vibration Management Plan or other project management documents.

Table 2: Revised environmental management measures from NVMP relevant to this BMS

ID No.	Revised environmental management measure	Document reference
Noise and Vibration		
Vibration impacts (sensitive equipment)		
NV05	Consultation with NSW Health and Hunter New England Local Health District will be carried out to identify the specific construction vibration limits for all sensitive equipment and facilities in the hospital precinct. Appropriate buffer distances will then be established.	BMS Section 4.3 NVMP Section 1.4, 5.2.3
Construction vibration impacts – John Hunter Hospital precinct		
NV12	Construction buffer distances and potential additional mitigation measures identified during detailed design will be implemented in relation to sensitive equipment, standard buildings and heritage buildings in the John Hunter Hospital precinct.	Community Communication Strategy (CCS) NVMP Chapter 8 mitigation measure ID NVMM34

ID No.	Revised environmental management measure	Document reference
Blasting overpressure and ground vibration impacts		
NV16	If blasting is to be carried out, a detailed blasting assessment will be carried out in consultation with NSW Health Infrastructure and Hunter New England Local Health District. The assessment will be prepared with reference to the human comfort, sensitive equipment and structural damage criteria for all receivers including residential receivers and receivers located in the John Hunter Hospital precinct. The assessment will be carried out by a suitably qualified and experienced blast consultant/contractor and determine the allowable blast sizes based on-site specific conditions and may include carrying out test blasts (or equivalent method). The assessment will identify all relevant requirements to be incorporated into a blasting management plan for the construction phase to ensure the relevant criteria can be met.	Community Communication Strategy (CCS) Section 4.3

3.5. Licensing Requirements

In addition to CoAs and legislation guiding blasting operations, the Project Environmental Protection Licence (EPL) 21762 includes limit conditions for all blasting activities on the Project. A cross reference is also included to indicate where the condition is addressed in the Project NVMP or other project management documents.

Table 3: EPL conditions relevant to blasting activities on the Project.

ID No.	EPL 21762	Document reference
3 Limit Conditions		
L4 Blasting		
L4.1	Blasting detonations must: a) only be undertaken between the hours of 9:00 am and 5:00 pm Monday to Friday; and b) only be undertaken between the hours of 9:00 am and 1:00 pm Saturday, and c) not be undertaken on Sundays or Public Holidays; and d) only be undertaken outside of the abovementioned hours where: i. a safety reason exists; and ii. the licensee notifies the EPA's environment line as soon as reasonably practicable.	Section 6.1
L4.2	When blasting operations occur at the premises, the airblast overpressure level must not exceed 120 dB (lin peak) at any time at the most impacted residence or other sensitive receiver.	Section 5.2
L4.3	When blasting operations occur at the premises the ground vibration peak particle velocity must not exceed 10 mm/sec at any time at the most impacted residence or other sensitive receiver.	Section 5.2
L4.4	Blasts, with the exception of trial blasts, must be limited to two detonations in any one day, and a maximum of five per week impacting the same Noise Sensitive Receivers. *Note: For the purposes of this condition, a single detonation may involve a number of individual blasts fired in quick succession in a discrete area*	Section 6.1

ID No.	EPL 21762	Document reference
L4.5	To determine compliance with condition(s) L4.2 to L4.4: a) Airblast overpressure and ground vibration levels must be measured and electronically recorded for all blasts carried out in or on the premises at location(s) representative of the most effected Noise Sensitive Receiver(s) that is not owned by the licensee or subject to a private agreement with the licensee; b) Instrumentation used to measure the airblast overpressure and ground vibration levels must meet the requirements of Australian Standard AS 2187.2-2006: Explosives—Storage and use Part 2: Use of explosives; and c) Error margins associated with any monitoring equipment used to measure airblast overpressure and ground vibration levels are not to be taken into account in determining whether or not the limit has been exceeded.	Section 7

4. Existing Environment

This Chapter provides a brief summary of predictions for blasting operations to be undertaken and modelled impacts on sensitive receivers and properties adjacent to the Project.

4.1. Existing Conditions

The Project is bounded by bushland immediately to the north, south, east and west of the proposed cutting. For the purpose of this BMS, distances to the nearest sensitive receivers are based on the assumption that blasting will occur at the perimeter of the proposed cut. This produces an assessment of impacted receivers that is on the conservative side and allows for any changes to the overall blasting design to be accounted for.

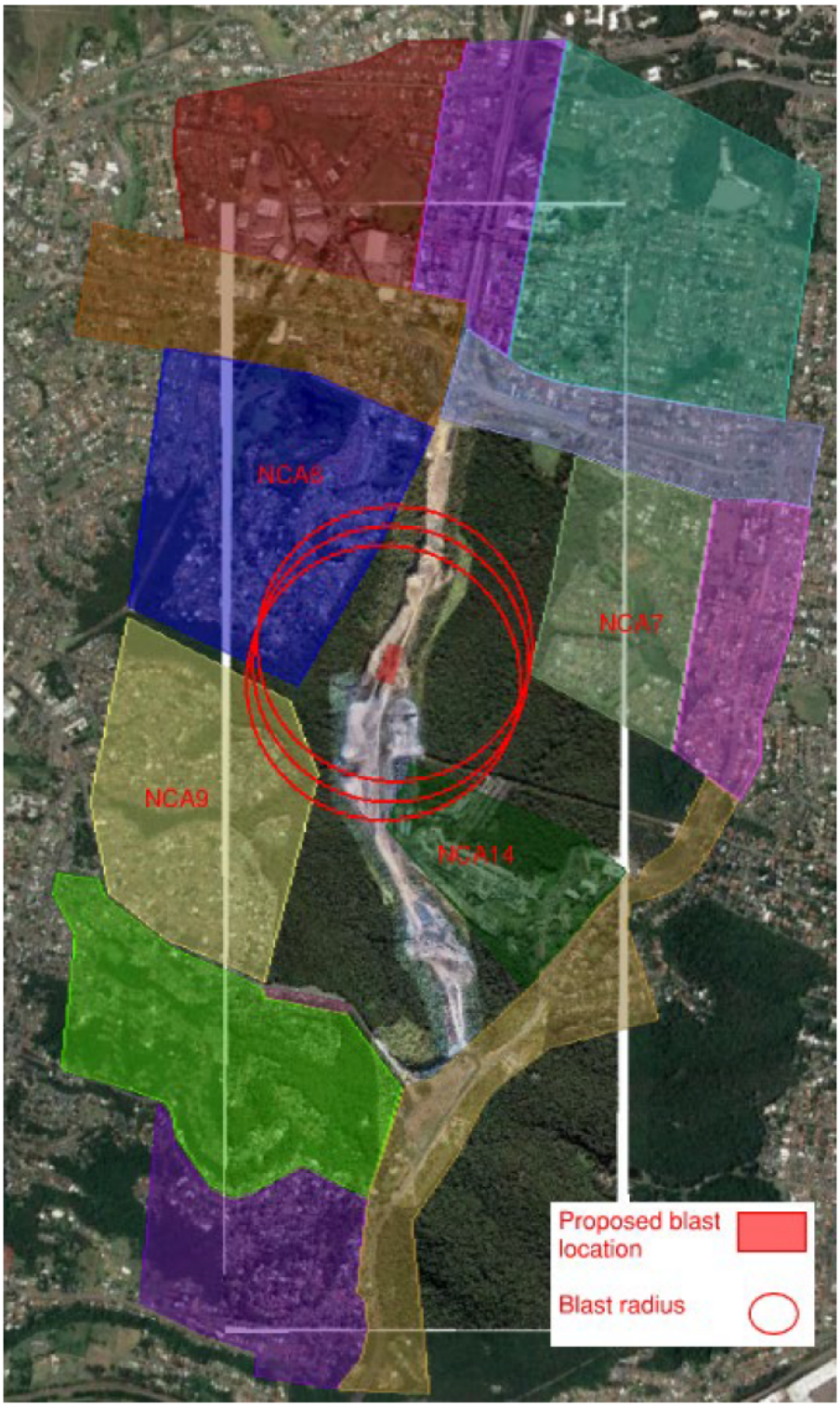
The existing conditions around the proposed location of blasting are typical of a suburban area, with minimal sources of elevated background vibration. Perceptible vibration would be limited to areas immediately around Newcastle Road and would only result from a combination of heavy vehicle movements and uneven pavement surfaces. Vibration from this source would not be measurable at the closest residential properties to proposed location of blasting due to their setback from Newcastle Road. A review of the surrounding residential streets show they are in reasonable condition and do not see regular heavy vehicle movements.

4.2. Sensitive Receivers

Figure 1 is an overview of the Project with the location of proposed blasting and predicted blast radius shown. From this figure, blasting is shown to occur further than 225 metres from the nearest dwelling in any direction. Affected residents are concentrated in NCA6, to the west of blasting location, and NCA9, to the south-west. Modelling shows residents to the east, in NCA7are outside the predicted blast radius for blasting activities. To the south, about 300 metres from blasting, a high pressure gas main feeding the JHH runs east-west through the alignment.

Of the residential properties affected by proposed blasting works, building condition surveys have been carried out as required by NVMM42 and NVMM43 of the Project NVMP and CoA E54.

Figure 1: Blast location with zone of influence shown.



4.3. John Hunter Hospital

440 metres to the south of proposed blasting location, sensitive equipment is located in JHH buildings within NCA14.

Performance requirements for sensitive equipment may be obtained from equipment manufacturer specifications, measured background levels or other agreed levels (after consultation with the affected organisation) whichever are higher. These levels will be clarified during consultation with JHH to ensure predicted impacts from blasting fall within tolerances of sensitive equipment or are appropriately mitigated.

In general, imaging equipment utilised by medical groups are more sensitive to elevated vibration than other equipment found in commercial or residential properties. Whilst the equipment like CT (computed tomography), MRI (magnetic resonance imaging), Ultrasound and nuclear medicine imaging, including positron-emission tomography (PET) are all sensitive to vibration, the installation is typically undertaken to a very high standard and includes effective vibration isolation systems to ameliorate naturally occurring vibration, as well as that which occurs from other unexpected activities around the site.

In the absence of a specified criterion, these groups often apply a guideline vibration criterion in accordance with the VC Curve specifications. The values in the VC Curve document list vibration curves which provide an acceptable vibration level between 1 and 80Hz in the one-third octave bands. The equipment descriptions and associated values are given in the following Table 5.

Table 4: VC criteria applied to sensitive equipment. Values represented as RMS

Equipment Description	Curve	RMS one third octave value for 8 to 80Hz
Adequate for computer equipment, probe test equipment, and microscopes less than 40 x	-	0.203 mm/s
Bench microscopes up to 100 x magnification; laboratory robots	-	0.102 mm/s
Bench microscopes up to 400 x magnification; optical and other precision balances; coordinate measuring machines; metrology laboratories; optical comparators; microelectronics manufacturing equipment; proximity and projection aligners, etc.	VC-A	0.051 mm/s
Microsurgery, eye surgery, neurosurgery; bench microscopes at magnification greater than 400 x; optical equipment on isolation tables; microelectronic manufacturing equipment, such as inspection and lithography equipment (including steppers) to 3 micron line widths	VC-B	0.025 mm/s
Electron microscopes up to 30 000 x magnification; microtomes; magnetic resonance imagers; microelectronics manufacturing equipment, such as lithography and inspection equipment to 1 micron detail sized	VC-C	0.013 mm/s
Electron microscopes at magnification greater than 30 000 x; mass spectrometers; cell implant equipment; microelectronics manufacturing equipment, such as aligners, steppers, and other critical equipment for photolithography with line widths of ½ µm; includes electron beam systems*	VC-D	0.0064 mm/s
Unisolated laser and optical research systems; microelectronics manufacturing equipment, such as aligners, steppers, and other critical equipment for photolithography with line widths of ¼ µm; includes electron beam systems	VC-E	0.0032 m/s

Consistent with the approach adopted for assessing the impact on amenity from blasting, an applicable vibration criterion in the velocity (mm/s) metric can be determined. The equivalent level of vibration corresponding to the varying VC criterion can be estimated. The criteria includes both external and internal peak vibration levels as shown in the following tables. The assessment data are given in Table 6 for equipment specified as VC-Operating Theatre or VC-A compliant equipment.

Table 5: Equivalent peak level of vibration based upon VC CURVE criterion

VC Criteria	VC 1/3 Octave Value	Equivalent Permissible Peak Vibration Value at equipment (equipment not isolated)	Equivalent Permissible Peak Vibration Value at equipment (equipment isolated)	Equivalent Permissible External Peak Vibration Value (equipment not isolated)	Equivalent Permissible External Peak Vibration Value (equipment isolated)
Adjustments		None	50% reduction attributable to isolation	25% reduction attributable to building transfer	50% reduction attributable to isolation and 25% reduction attributable to building transfer
VC-OP	100 µm/s per 1/3 octave	0.61 mm/s	1.2 mm/s	0.8 mm/s	1.6 mm/s
VC-A	50 µm/s per 1/3 octave	0.41 mm/s	0.8 mm/s	0.6 mm/s	1.0 mm/s

Where vibration criteria for sensitive equipment cannot be determined through consultation, the values as specified in Table 32 of the NVMP will be applied to sensitive equipment. For Class A Sensitive equipment, a criterion of 0.07mm/s has been adopted. Class B sensitive equipment has adopted a criterion of 0.035mm/s where located in the JHH precinct.

4.3.1 Consultation

Fulton Hogan has undertaken consultation with JHH (including Hunter New England Local Health District), NSW Health Infrastructure, APP Group and Multiplex to communicate the potential impacts of blasting activities on the hospital precinct. Emails, meetings and distribution of a blasting fact sheet (RP2J Blasting Factsheet) have occurred (see Appendix E). To date, the vibration criteria provided in Table 4 and Table 32 of the NVMP has been accepted by JHH and Health Infrastructure.

Further, the Project Blasting Specialist is scheduled to attend the hospital precinct to determine locations of sensitive equipment, assess installation of equipment and develop accurate PPV limits for all sensitive equipment located inside blast radius. If JHH identify any concerns during this meeting (Scheduled in Appendix E) and provide different vibration criteria specific to the sensitive equipment in JHH, then this vibration criteria will be adopted and the BMS will be updated accordingly.

In late January 2024, building condition surveys are to be completed on JHH precinct buildings, in accordance with E54, within the predicted blast radius, including the Hunter Medical Research Institute, Yallarwah and Kookaburra Houses and the Forensic Medicine Department.

Notification of specific timing of the blasts when confirmed will be detailed to the relevant parties in accordance with the Community Communication Strategy.

4.4. Ground Conditions

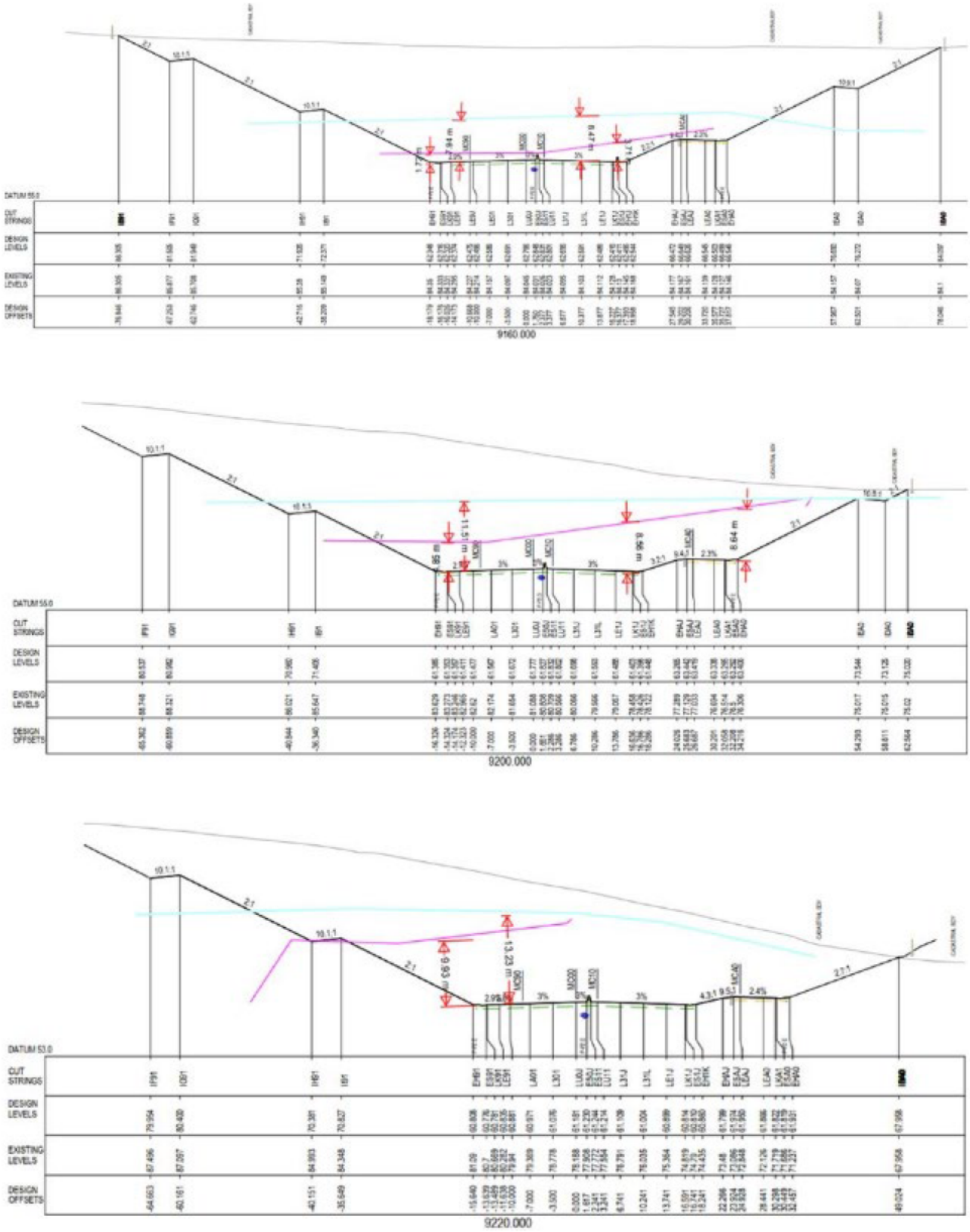
Based upon the data presented in the bore logs, an assessment of whether the material can be excavated using mechanical equipment or is expected to require blasting has been made. The following sections of the Project have been identified as requiring approximately 50,000m^3 of blasting. This area falls within the Wallsend cutting between Chainages (CH) 9160 and 9280. Figure 2 depicts cross sections of the alignment, through the Wallsend cutting, at CH 9160, 9200 and 9220, with:

- Blue identifying the actual rock height based on Sandstone/Siltstone/Conglomerate interface.
- Magenta representing strata identified in the geotechnical reports as specifically requiring blasting rather than just the rock layer.

The extent of the rock depth varies between 7.5 and 13.5 metres. The geometry indicates no areas where blasting occurs immediately above a “hinge” point establishing the berm and batter. These locations are closely related to zones where blast related damage affects the cut stability and are to be avoided.

Whilst isolated pockets of hard rock could be excavated using a hydraulic hammer, excavating large sections of the cut with hammering is impractical, and it may not be possible to rip the rock using various sizes of dozers. Duration of mechanical excavation would result in extended periods of highly intrusive noise generating activities and present additional risks to the Project through potential complaints around noise and dust. Whilst there will be occasions where the competency of the rock increases to prevent efficient use of mechanical equipment, blasting will always permit the excavation to continue through adjustments to the blasthole pattern, Blasting minimises the risk that the duration of the works could extend because of issues with the competency of the rock mass.

Figure 2: Cross sections of cutting at CH9160, 9200 and 9220 showing top of rock levels and conglomerates for the Wallsend cutting



5. Blasting Method

5.1. Blast Design

Due to the existing ground conditions and varying depths of cutting required to reach the floor of the cutting, several blast design options will be required. These will be selected depending on the localised depth to cutting floor at the location of the blast hole being drilled.

The blast design is based upon:

- A blasthole diameter of between 76 and 89mm, drilled using conventional and modern hydraulic drilling rig equipment.
- A nominal blasthole depth height of about 7.5 metres but possibly longer depending upon the geometry of the benches and the allowable explosive weights. Shorter bench heights maybe initially required to establish the cutting geometry.
- A nominal blasthole pattern with a burden and spacing of around 2.8 metres depending upon the competency of the rock mass (and the blasthole diameter).
- A single explosive charge per blasthole, independently sequenced to restrict the maximum explosive quantity per delay to a value permitting compliance at the nearest property.
- A powder factor is expected to vary to provide fragmentation and diggability commensurate with the excavation techniques with very limited use of hydraulic hammers, but likely to be 0.6 to 0.8kg/m3.

It is assumed a powder factor of 0.70 Kg/BCM will provide blasted material most suitable for the bulk excavation and crushing / sorting requirements of the Sandstone / Siltstone and Conglomerate rock types.

The quantity of explosive is modelled with weights varying between 5 and 30 kilograms. Figure 3 proposes different blasthole configurations that may be used according to the blasthole depth. The explosive density is kept constant and reflects a standard emulsion with a density of 1.15g/cm3. It may be possible to utilise a slightly lower density product which would give a small reduction in the weight of explosive per blasthole. Potential for the use of lower density product is to be reviewed following trial blasting. As an example, for a depth of the cutting taken as 11 metres, an explosive weight of around 56 kilograms would be required for an 89mm diameter blasthole, or around 22 kilograms for blasting with two successive passes, each of 5.5 metres and with the same blasthole diameter. Table 6 lists the explosive weights and associated blasting parameters.

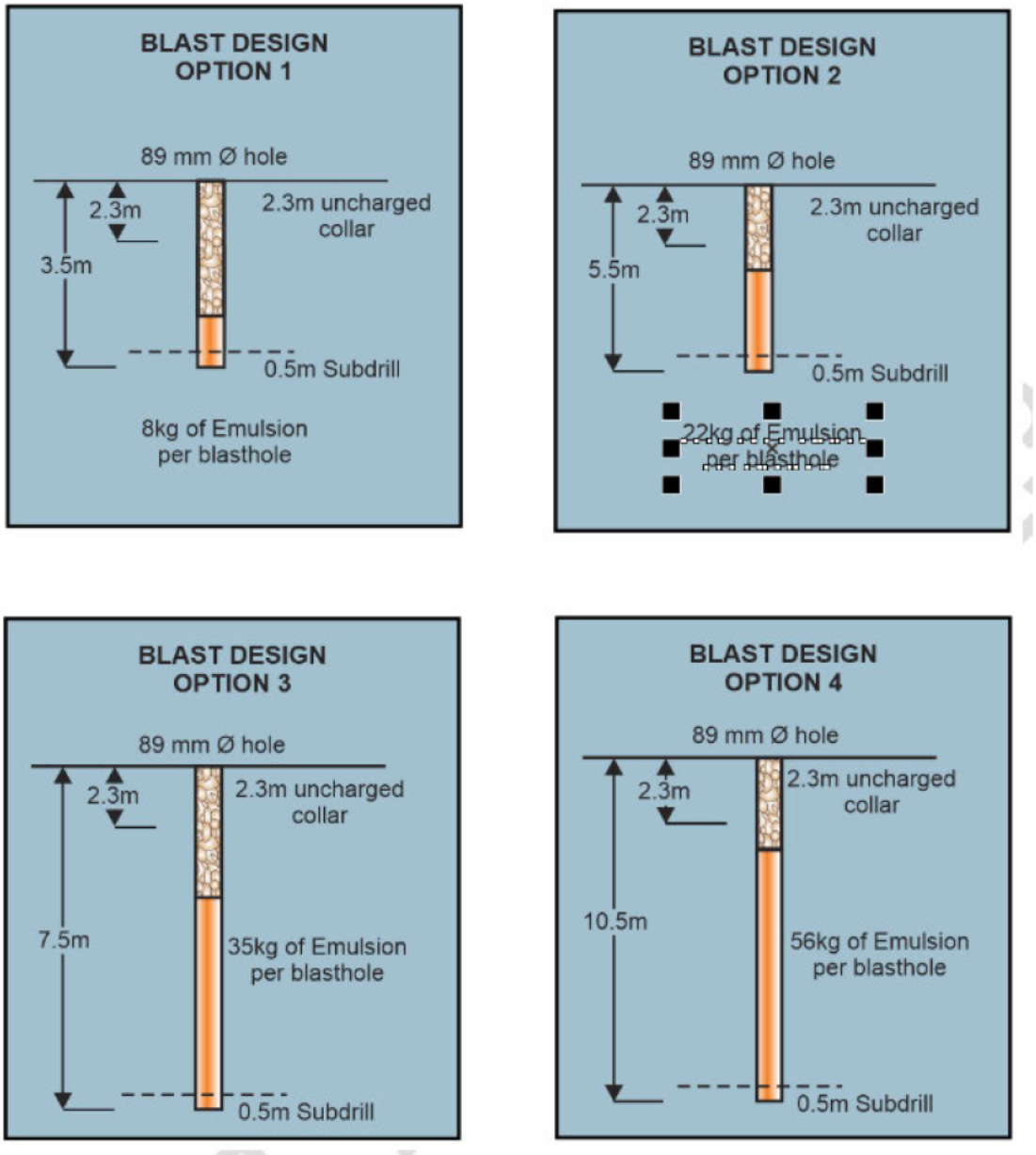
Table 6: Summary of blast design options

Blast Design Option	Explosive Weight (kg)	Blast Parameters
1	8	89mm diameter blasthole, 3.5 metre blasthole length with a 2.3 metre uncharged column (25 blasthole diameters). Explosive density consistent with standard density bulk emulsions
2	22	89mm diameter blasthole, 5.5 metre blasthole length with a 2.3 metre uncharged column (25 blasthole diameters). Explosive density consistent with standard density bulk emulsions
3	35	89mm diameter blasthole, 7.5 metre blasthole length with a 2.3 metre uncharged column (25 blasthole diameters). Explosive density consistent with standard density bulk emulsions
4	56	89mm diameter blasthole, 10.5 metre blasthole length with a 2.3 metre uncharged column (25 blasthole diameters). Explosive density consistent with standard density bulk emulsions

Blasting of the cutting will likely be designed around 3.5 to 10.5 metre blasthole depths, with the upper sections of the cutting adopting the smaller 3 metre blasthole depths as a vibration control measure and/or to allow blasting at

the ends of the cutting where the amount of rock will be shallower. The blasthole diameter is expected to be consistent with standard blasting practices for construction works at 89 mm. The blasting configuration for the various blasthole depths with ½ metre of sub-drill, an 89 mm diameter blasthole, a 2.3 metre uncharged collar height and loaded with bulk explosive as shown in Figure 3. The uncharged collar length of 2.3 metres is proposed to limit air overpressure levels and control any ejection of material from around the blasthole.

Figure 3: Drilling and blasting design for 3, 5, 7 and 10 meter benches



5.2. Blast Modelling

The primary factors known to influence the level of ground vibration from blasting include:

a) The weight of explosive per delay;

b) The distance between the blastholes and the point of measurement;

c) The local geological conditions and the influence of geology and topography on vibration attenuation.

Consistent with the recommendations of the Australian Standard, the most common form of the vibration equation to predict the amplitude of ground vibration from blasting at any distance from the blasthole and is given as:

$$PPV = K\left(\frac{d}{\sqrt{w}}\right)^{-\beta}$$

where d is the distance between the blastholes and the point of measurement;

w is the maximum instantaneous charge weight per delay;

K and β are site specific constants.

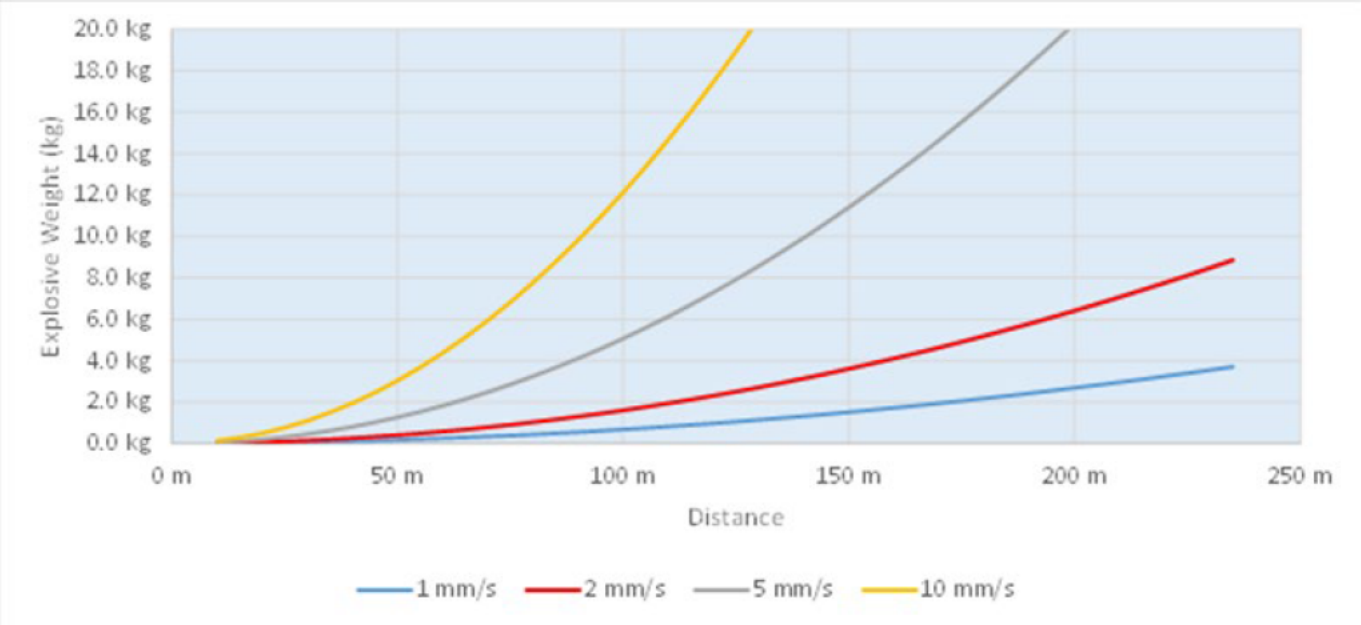
Based on the above equation, the expected level of ground vibration can be determined for a given distance and maximum charge weight.

The K and β factors have been proposed as representative values from blasting activities in similar rock type to that present on the Project. These values are to be assessed following each blast to ensure compliance with all management parameters. To account for the variability in explosive performance and ground characteristics, it is accepted industry practice to design blast patterns using an equation that predicts the 95-percentile level (i.e. a level which will exceed 95% of all measured values) and continually update and review practices according to the measured levels. If measured levels routinely exceed, or fall below, the predicted value, the equation is adjusted to reflect the different site conditions. A proposed vibration relationship for the rock type is as follows:

$$PPV = 2120\left(\frac{d}{\sqrt{w}}\right)^{-1.59}$$

Figure 4 shows vibration level as a function of distance from the blasthole for varying quantities of explosive for the two relationships. Because of the sufficient separation distance between the blasting area of the project and the nearest properties, the explosive quantities per blasthole will be generally consistent with that used at conventional small to medium scale blasting operations. Figure 4 shows the explosive quantities per blasthole ranging up to 20 kilograms as a function of distance for compliance with varying vibration criterion at residential properties and the health care facilities. Explosive weights per blasthole will necessarily vary according to the blasthole depth with greater variation in explosive quantities expected during the start and finish of the cutting where the depth of overburden above the finished road profile stages are established.

Figure : Vibration level as a function of distance from varying explosive quantities per delay for compliance with 10mm/s



Included in Appendix A and B are figures showing two options for shot loading of boreholes and the expected vibration contours for these loads.

Plate 1, Appendix A, shows the expected explosive quantities that can be used in the total footprint of the proposed cutting based upon compliance with 10mm/s at the nearest residential properties and 1mm/s at the nearest health care facilities. Whilst it is expected that some of the areas in the excavation footprint may not require blasting as they may be used in establishing benches or part of the stand-off from the final crest, however all areas are considered in the analyses to ensure flexibility of the design. The scale of blasting material and corresponding bench heights are therefore modelled to be based upon the predicted quantities in Plate 1 and the permissible explosive quantities referenced to Figure 3.

Plate 1 also shows the expected location of vibration contours for blasting with explosive quantities modelled to comply at the nearest sensitive receivers with a 10mm/s vibration limit at residential properties and 1mm/s at healthcare facilities. Those locations lying nearer to the blast than the 2mm/s contour will on occasions receive vibration levels exceeding 2mm/s, but not predicted to be more than 5mm/s. Those further from blast than the 2mm/s contour are predicted to receive vibration less than 2mm/s. The contours show the maximum extent of vibration and not the vibration level that would be produced from every blast. When blasting in the south-eastern section of the cutting, the level of vibration at residential properties on the western side of the cutting for instance on Bellinger Close, will become less than the modelled vibration levels where blasting occurs on the north-western side of the cutting. Only when blasting in the western side of the cutting will the level of vibration reach the maximum expected value for those residential properties in Wallsend. Plate 1 also indicates:

- The scale of blasting in the cutting will be controlled to low explosive weights to limit vibration at the adjacent residential properties as well as the John Hunter Hospital. Whilst there are no areas of the cutting where the explosive weight will reduce to uneconomic quantities. The minimum scale of blasting could continue at 3.5 metre blasthole depth and comply at the closest properties along Bellinger or Claymore Close as well as the John Hunter Hospital precinct.
- Whilst the residential properties along Bellinger or Claymore Close will receive perceptible levels of vibration (2mm/s), they do not significantly impact on the permissible explosive quantities that can be used as the vibration requirement is significantly lower at the John Hunter Hospital.
- The properties to the east along Roberts Circuit and Drysdale Drive do affect the scale of blasting but may on some occasions perceive low level vibration from the blasting, typically around 1 to 2mm/s maximum.

- The gas main is compliant with a 20mm/s vibration criterion.

Plate 2, Appendix B, shows the expected location of vibration contours for blasting with explosive quantities modelled to comply at the nearest sensitive receivers with the same 10mm/s vibration limit at residential properties along Bellinger or Claymore Close (as well as other areas) but with a 1.6mm/s at healthcare facilities in the John Hunter Hospital Precinct, equivalent to a VC-OP criterion. Plate 2 indicates:

- Similar to the 1mm/s criterion (equivalent to VC-A) at the John Hunter Hospital, the adjustment to the scale of blasting required to comply with 2mm/s criterion at the John Hunter Hospital however the permissible weights increase from around 15 to 20 kilograms in the southern section through to 20 to 30 kilogram in the northern section of the cutting.
- Whilst the explosive quantities per blasthole are controlled by the John Hunter Hospital, the vibration at the Bellinger or Claymore Close are near to the 10mm/s limit, indicating that if any increase in the permissible level of vibration at the John Hunter Hospital Precinct were possible, the scale of blasting would continue to be limited by the proximity of these residential receivers.
- Sections of the cutting can be blasted with the maximum 3 to 10 metre bench heights and achieve compliance with the vibration conditions.

Ground vibration criteria for blasting activities are outlined in CoA E47. Tables 7 and 8 specify criteria for ground vibration limits for human comfort and control of damage to structures respectively. The blast modelling indicates compliance with these limits with further verification to be carried out through a trial blast and continued monitoring of all blasting activities.

Table 7: Ground vibration limits for human comfort from E47 of CoAs

Table 7: Ground vibration limits for human comfort

Receiver	Type of blasting operations	Peak component particle velocity (mm/s)
Sensitive site	Blasting operations lasting more than 12 months or more than 20 blasts	5 mm/s for 95% of blasts per year
		10 mm/s maximum limit
Sensitive site	Blasting operations lasting less than 12 months or less than 20 blasts in total	10 mm/s maximum limit
Occupied non-sensitive sites, such as factories and commercial premises	All blasting	25 mm/s maximum limit. For sites containing equipment sensitive to vibration, the vibration level should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation

Source – Table J4.5(A) – AS 2187.2 – 2006

Note: A sensitive site includes houses and low rise residential buildings, theatres, schools and other similar buildings occupied by people

Table 8: Ground vibration limits for control of damage to structures from E47 of CoAs

Table 8: Ground vibration limits for control of damage to structures

Receiver	Type of blasting operations	Peak component particle velocity (mm/s)	
Other structures or architectural elements that include masonry, plaster and plasterboard in their construction [1]		15 mm/s 4 Hz to 15 Hz, except for heritage structures where a frequency dependent vibration criteria would be determined in accordance with AS 2187.2 – 2006.	20 mm/s 15 Hz and above
Reinforced or framed structures. Industrial and heavy commercial buildings [2]	All blasting	50 mm/s at 4 Hz and above	
Unreinforced or light framed structure. Residential or light commercial type building [2]	All blasting	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Unoccupied structures of reinforced concrete or steel construction	All blasting	100 mm/s maximum, where agreed with the structure owner.	
Infrastructure service structures, such as pipelines, powerlines, cables and reservoirs.	All blasting	Limits to be determined by structural design methodology in consultation with the infrastructure service provider.	

Source: Table J4.5(B) – AS 2187.2 – 2006 and Table J4.4.2.1 – AS 2187.2 – 2006 (BS 7385-2)

5.3. Flyrock Modelling

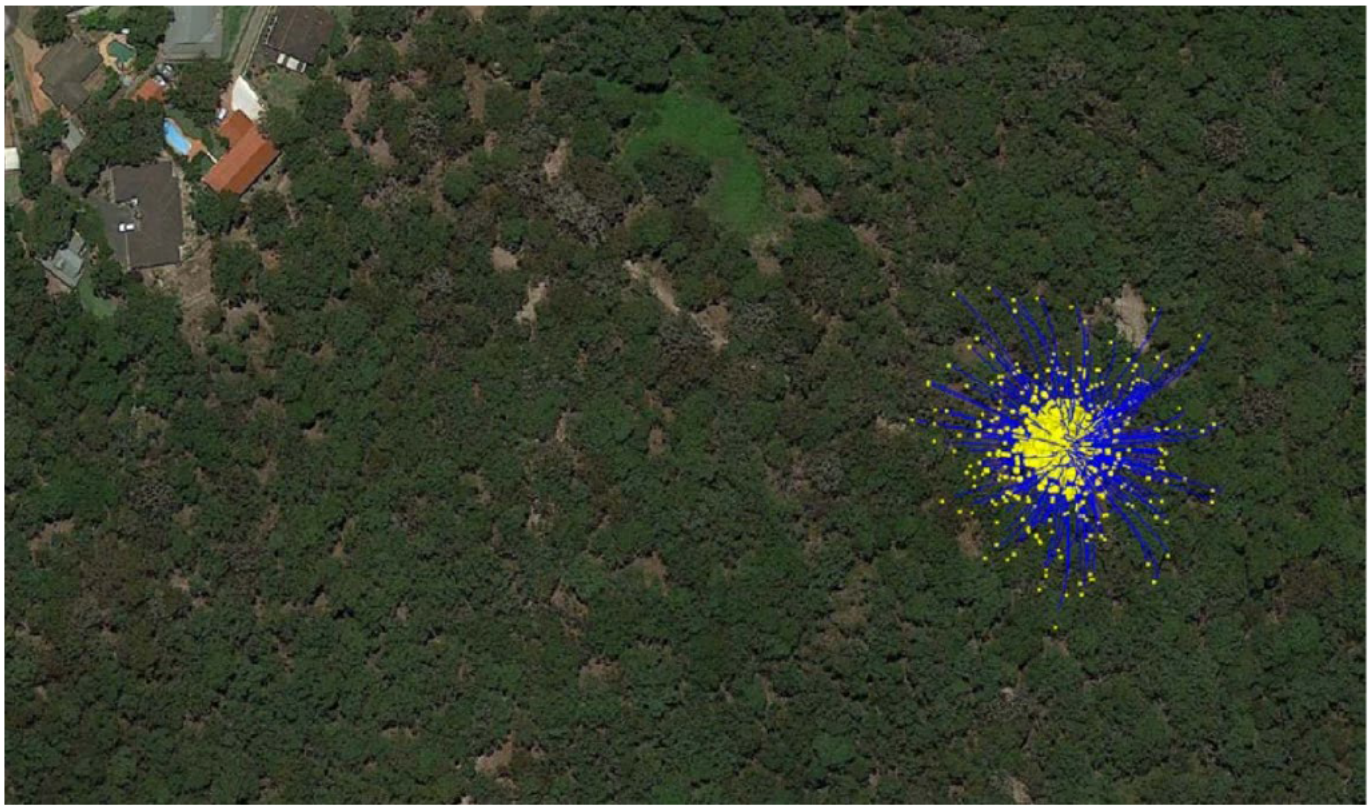
An engineered flyrock model combining all the relevant aspects of projectile motion based upon rock ejection velocities has been developed and applied to the Project. The model incorporates the results of more than ten different documented research projects specifically aimed at estimating flyrock ejection velocities, flyrock ranges and/or safety exclusion zones. These models account for both blast designs, in particular the proximity of the explosive column to the free face, and fluid dynamics code addressing projectile motion and air resistance (drag) of the ejected blast fragments. The models incorporate specific derived code to best estimate flyrock ranges and corresponding safe exclusion zones. The presented results are based on probabilistic analyses and estimate the likely landing position of possible ejected rock fragments based upon their equivalent diameter.

The uncontrolled movement of rock from the horizontal surface (i.e. ejection of rock around the collar) and vertical free face represent the possible sources of flyrock. Confined blasting (i.e. without a free face) virtually eliminates the possibility of flyrock from the vertical face, although the propensity for flyrock from the collar region increases and necessitates an increased uncharged collar to better control rock movement from around the collar.

Blasting in built up areas where control of flyrock is critical, commonly employs an uncharged collar length equivalent to between 25 and 30 times the blasthole diameter, or for an 89mm diameter blasthole, 2.3 to 2.7 metres. These ratios are as per the Australian Standard AS2187.2 for the control of flyrock from blasting.

Figure 5 shows the results of the flyrock outcomes for a 7.5 metres bench height blasthole loaded with approximately 35 kilograms of explosive. The representative blasthole is modelled in the north-western section of the cutting nearest to the residential properties along Bellinger Court. The modelled landing positions for flyrock are based upon the calculated trajectories and a probabilistic component accounting for the fragment size, direction and velocity. The probabilistic component of the model estimates flyrock ranges based upon a combination of operating conditions and therefore predicts the outermost envelope of flyrock landing points.

Figure 4: Predicted flyrock locations from blasting with a 89mm diameter blast-hole and 7.5 metre bench. The predicted locations are shown as the yellow markers.



The modelling predicts that any blast generated flyrock is constrained to within a zone of approximately 70 metres around the perimeter of the blast zone, or around 30% of the minimum separation distance to the closest properties.

5.4. Airblast Overpressure

Like the vibration analyses (Section 5.2), site data has been collected from other blasting operations to determine the overpressure level as a function of distance and explosive weight. The assessment is therefore based upon information presented in the peer reviewed international literature.

Unlike ground vibration, geology has a negligible impact on the levels of air overpressure. The overpressure level is affected by blast design, in particular the proximity of the explosive charges to the free surface. Also, unlike ground vibration, overpressure level is significantly affected by local conditions including:

- Topography and vegetation with treed areas or other elevated features aiding in affecting the measured level of overpressure. Properties on the leeward side of the hill will commonly measure overpressure up to 5dBL less than those of the windward side.
- Atmospheric conditions with wind direction, humidity and temperature inversions combining to affect overpressure levels by as much as 10dBL for upwind versus downwind areas of the blast.
- Orientation of blast with measurements point in front of the blast receiving levels up to 5dBL greater than those points directly behind the blast.

As outlined in Table 6 of CoA E46, airblast overpressure for all blasting activities on the project is required to comply with the below limits for human comfort. Fulton Hogan and the blasting subcontractor will undertake monitoring of all blasts to ensure compliance with limits in Table 9.

Table 9: Table 6 from E46 of CoAs for airblast overpressure limits for human comfort

Table 6: Airblast overpressure limits for human comfort

Receiver	Type of blasting operations	Airblast Overpressure Limit
Sensitive site	Blasting operations lasting more than 12 months or more than 20 blasts	115 dBL for 95% of blasts per year
		120 dBL maximum limit
Sensitive site	Blasting operations lasting less than 12 months or less than 20 blasts in total	120 dBL for 95% of blasts per year
		125 dBL maximum limit
Occupied non-sensitive sites, such as factories and commercial premises	All blasting	125 dBL maximum limit. For sites containing equipment sensitive to vibration, the vibration level should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation

Source – Table J5.4(A) – AS 2187.2 – 2006

Note: A sensitive site includes houses and low rise residential buildings, theatres, schools and other similar buildings occupied by people

A trial blast will be carried out to ensure site results are conducive with predicted compliance of air blast overpressure.

5.5. Trial Blasting

A small-scale trial blast will be designed using conservative estimates of vibration prediction constants and be undertaken within the location identified for blasting at Cut 4 (area identified by the proposed blast location in Figure 1). The trial blast will not provide any detail on fragmentation or diggability, but rather information on the vibration attenuation over distance and conformance of ground vibration and air overblast pressure predictions with conditions as set out by CoAs.

This trial blast will be monitored using:

- Airblast overpressure monitoring is monitored using a microphone, with the results expressed in decibels Linear (dBL). The absolute maximum pressure level will be recorded for the full duration of the blast event.

Where required, the microphones will be located adjacent to the vibration monitors, orientated towards the blasting location.

- External geophones (transducers) will monitor ground vibration (Peak Particle Velocities - PPV) in three directions (transverse, vertical and longitudinal particle velocities) and report the level in mm/s. The recording duration will be set to exceed the duration of the blast to ensure that the entire event is captured.

Adjustments will be made to blasting operations where results of trial blasting airblast overpressure and ground vibration results differ from levels as predicted by those described in this BMS.

5.6. Fumes

Blast fumes may result from non-ideal detonation of explosives due to a number of factors, including presence of ground water and lack of confinement within bore hole, allowing for escape of blasting gasses.

Fumes due to groundwater can be prevented by using the appropriate explosive type for the ground conditions which has been assessed by the blasting contractor and specialist. Monitoring of groundwater bores installed for the Project show no groundwater interaction is expected during blasting with either the perched or regional

groundwater table. Additionally, the use of bulk pumped emulsion explosives have a greater water resistance, reducing the risk of post blast fume events.

Fumes due to lack of confinement are generally a result of soft ground conditions. Geotechnical investigation reports based on bore logs through the Wallsend cutting within the blasting area (Figure 2) show a hard rock strata (magenta line) where blasting is to occur, indication that the presence of soft rock is not likely to be encountered during blasting.

Other controls relating to fume mitigation such as quality assurance of manufactured products and correct priming and loading practices will be addressed through quality control procedures undertaken by the blasting contractor.

At low levels, nitrogen dioxide (NO_2), the main gas created during inefficient blasting, is extremely unlikely to be harmful to health, If there is no visible reddish/brown gas following blasting, there is minimal risk to human health. Additionally, NO_2 has a strong odour that can be smelt at a lower level than tolerable limits. NO_2 present in the atmosphere above 2.5 parts-per-million (ppm) is visible. Concentrations above 5ppm for short tern exposure limits (15 minute exposure period) should not be repeated more than 4 times a day with at least 60 minutes between successive exposures. Blast radius exclusion zones and post blasting clearance times will be sufficient to mitigate any potential health impacts from unexpected blast fumes.

6. Blasting Program

6.1. Program

Based on program for the blasting activities, an estimated 13 weeks have been allocated for the drill/blast and crushing activities. Appendix C contains an indicative program, with dates subject to change as dictated by site constraints and weather.

Week 1 will incorporate mobilisation of subcontractor to site and trial blasting. Drilling of Area 1 will commence on Week 2 and continue with blasting scheduled for Friday. Crushing for material from Area 1 will run simultaneously with drilling activities from Weeks 3-5.

Area 2 drilling will commence in Week 3 and blasting end of the same week. This leaves a respite of 1 week between Blast 1 and 2.

Drilling for area 3 is to commence in Week 8 with completion for shot firing same the same week. This leaves and respite of 5 weeks between blast 2 and 3.

Drilling for the final shot in area 4 will begin in week 9 with blasting in the same week. Crushing of material will continue for 4 weeks through to the end of the 13 week program. Between shots 3 and 4, a 5 day window of respite will occur for the impacted residents and sensitive receivers.

All blasting will occur in works hours as outlined in the CoAs and EPL of:

(a) 9:00am to 5:00pm, Monday to Friday, inclusive.

(b) 9:00am to 1:00pm on Saturday; and

(c) at no time on Sunday or public holidays.

No blasting activities are to be conducted outside the above hours as per CoA E45.

7. Environmental Mitigation Measures

7.1. Vibration

In line with the Project NVMP, implementation of environmental mitigation measures NVMM32, 33, 41, 42, 43, 44, and 45 (NVMP Section 8) carried out in relation to blasting activities on the Project.

Additional mitigation measures to further reduce vibration effects during blast activities are not expected to be required based upon the conservative modelling results and the separation distances from any sensitive receivers. If geological profiles change and control measures are required, they could include an increase in:

- Ensuring all relevant areas associated with blast activities have been properly analysed to determine scale of blasting required based upon the most recently collected data.
- Ensuring only exact quantity of explosives is used for each hole.
- Condition surveys by Fulton Hogan for adjacent structures whose risk assessment has highlighted that vibration from blasting may be elevated or where the owner has expressed concern in relation to the possibility of damage, will be undertaken.
- Regular vibration monitoring to confirm that vibrations being induced by the blasting activities are at or below design limits specified in Section 5.2.

Following each blast, a review of all data will be carried out to ensure compliance with limits. Where exceedances are recorded, Fulton Hogan will implement additional mitigation measures listed above as required to ensure compliance on subsequent blasts.

7.2. Airblast Overpressure

Additional mitigation measures to reduce overpressure effects during blast activities other than the low explosive weights that have been proposed are not expected to be required based upon the modelling results and the separation distances from any sensitive receivers. If the blast geometry changes and control measures are required, they could include:

- Ensure all relevant areas associated with blast activities have been properly analysed to determine scale of blasting required based upon the recent recorded results.
- Notification and/or discussions with the residents as to the effect of the blasting activities.
- Ensure only exact quantity of explosives is used for each hole.
- Regular airblast overpressure monitoring to confirm that vibrations being induced by the blasting activities are at or below design limits specified in Section 5.2.
- All blasts designed with a minimum uncharged collar length.
- Where uneven or irregular vertical faces are encountered, ensure that a minimum front row burden is maintained by undertaking face profiling and borehole tracking.

Following each blast, a review of all data will be carried out to ensure compliance with limits. Where exceedances are recorded, Fulton Hogan will implement additional mitigation measures listed above as required to ensure compliance on subsequent blasts.

7.3. Flyrock

Mitigation measures to reduce flyrock during blast activities are not expected to be required based upon the modelling results and the separation distances from any sensitive receivers. If circumstances change and control measures are required, they could include:

- An increased minimum uncharged collar lengths (beyond that recommended in the Australian Standard AS2187.2) is applied to all blastholes.
- Ensuring that all design criteria are very accurately measured, documented and adhered to prior to any blasting activity proceeding.

Controlling flyrock is paramount to the design. It is suggested that all blast patterns are recorded by video (drone footage) to determine the appropriateness of the uncharged collar lengths and overall blast design parameters. Where stemming ejection occurs, or face bursting is observed, the blast design should be reviewed as part of best practices.

Following each blast, a review of all data will be carried out to ensure compliance with limits. Where exceedances are recorded, Fulton Hogan will implement additional mitigation measures listed above as required to ensure compliance on subsequent blasts.

8. Document review

This BMS will be reviewed to ensure compliance with legislative requirements and its suitability and effectiveness for the project.

The review may be in the form of:

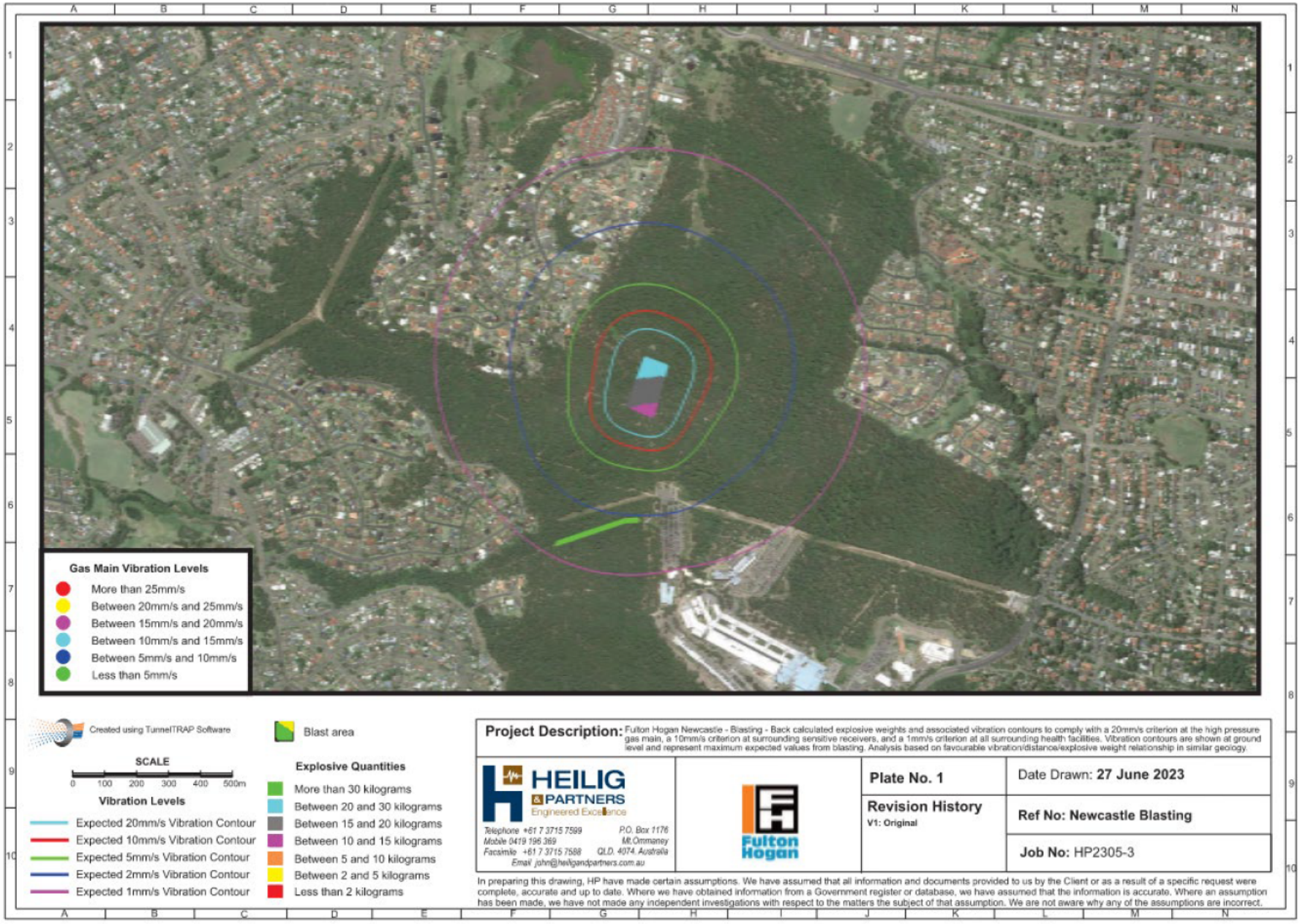
- A review by a suitably qualified and experienced independent person.
- An audit, and/or
- An inclusion as a separate item at a site meeting.

The Environmental Manager may review and update the BMS more regularly where:

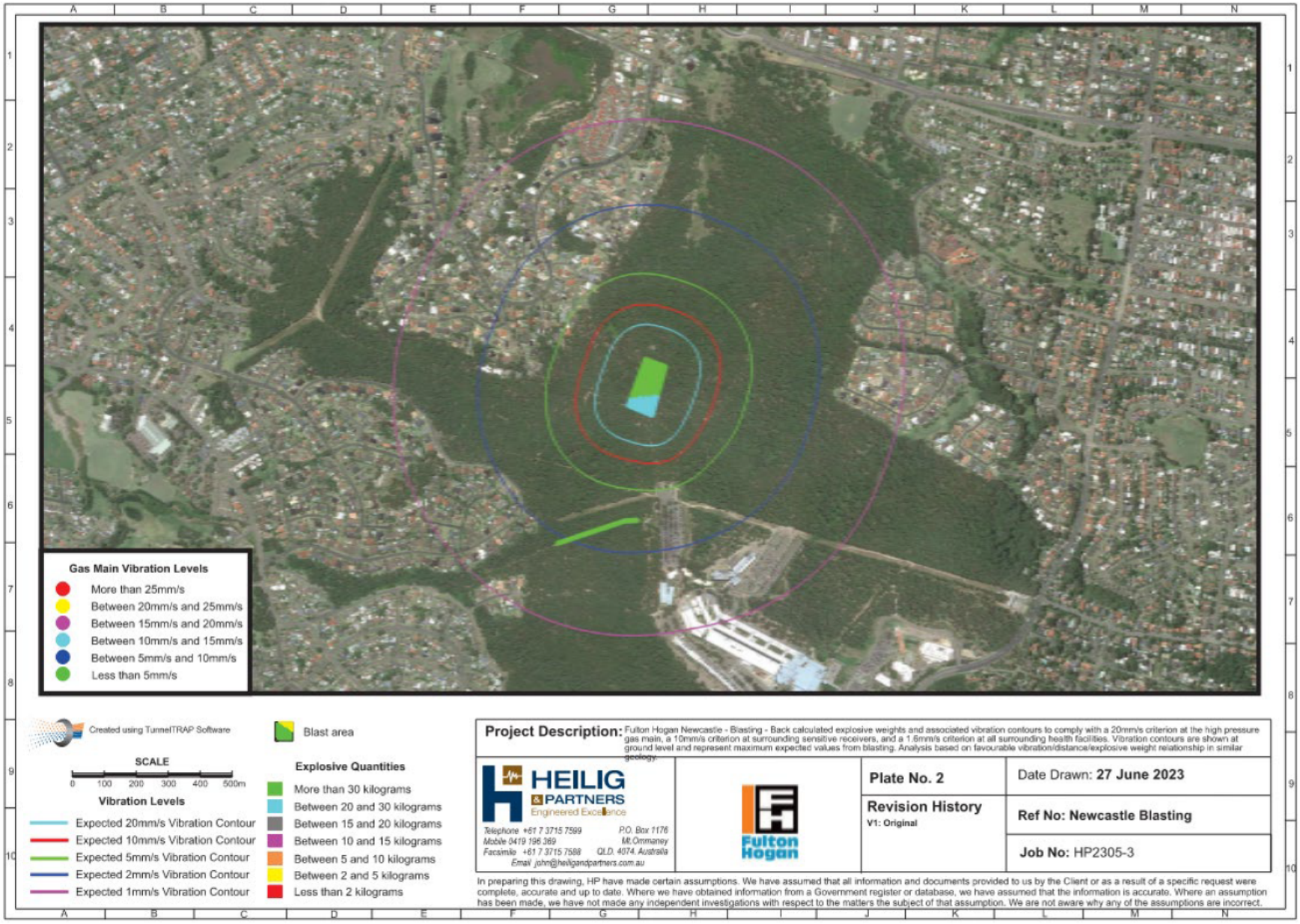
- Significant changes in construction activities occur
- Where targets are not being achieved, or
- In response to audits and non-conformance reports.
- Following trial blasting to ensure compliance with all CoAs
- As a result of consultation around blasting criteria

This document will be submitted to the Planning Secretary for information no later than one month before the commencement of blasting.

Appendix A: Blasting Model Plate no. 1



Appendix B: Blasting Model Plate no. 2



Appendix C: Indicative Program

Blasting Programn

	Week 1					Week 2					Week 3					Week 4				
	Mon	Tue	Wed	Thu	Fri	Mon	Tue	Wed	Thu	Fri	Mon	Tue	Wed	Thu	Fri	Mon	Tue	Wed	Thu	Fri
	04 Mar	05 Mar	06 Mar	07 Mar	08 Mar	11 Mar	12 Mar	13 Mar	14 Mar	15 Mar	18 Mar	19 Mar	20 Mar	21 Mar	22 Mar	25 Mar	26 Mar	27 Mar	28 Mar	29 Mar
Mob Drill Rig																				
Trial Blast																				
Drill Area 1					Drill															
Load and Shot										Blast										
Crush											Crushing									
Drill Blast Area 2											Drill									
Load and Blast																				Blast
Crush																				
Dill Area 3																				
Load and Blast																				
Crush																				
Drill Area 4																				
Load and Blast																				
Crush																				

	Week 5					Week 6					Week 7					Week 8				
	Mon	Tue	Wed	Thu	Fri	Mon	Tue	Wed	Thu	Fri	Mon	Tue	Wed	Thu	Fri	Mon	Tue	Wed	Thu	Fri
	01 Apr	02 Apr	03 Apr	04 Apr	05 Apr	08 Apr	09 Apr	10 Apr	11 Apr	12 Apr	15 Apr	16 Apr	17 Apr	18 Apr	19 Apr	22 Apr	23 Apr	24 Apr	25 Apr	26 Apr
Mob Drill Rig																				
Trial Blast																				
Drill Area 1																				
Load and Shot																				
Crush																				
Drill Blast Area 2																				
Load and Blast																				
Crush							Crushing													
Dill Area 3															Drill					
Load and Blast																				Blast
Crush																				
Drill Area 4																				
Load and Blast																				
Crush																				

	Week 9					Week 10					Week 11					Week 12				
	Mon	Tue	Wed	Thu	Fri	Mon	Tue	Wed	Thu	Fri	Mon	Tue	Wed	Thu	Fri	Mon	Tue	Wed	Thu	Fri
	29 Apr	30 Apr	01 May	02 May	03 May	06 May	07 May	08 May	09 May	10 May	13 May	14 May	15 May	16 May	17 May	20 May	21 May	22 May	23 May	24 May
Mob Drill Rig																				
Trial Blast																				
Drill Area 1																				
Load and Shot																				
Crush																				
Drill Blast Area 2																				
Load and Blast																				
Crush																				
Dill Area 3																				
Load and Blast																				
Crush			Crushing																	
Drill Area 4		Drill																		
Load and Blast										Blast										
Crush												Crushing								

	Week 13				
	Mon	Tue	Wed	Thu	Fri
	27 May	28 May	29 May	30 May	31 May
Mob Drill Rig					
Trial Blast					
Drill Area 1					
Load and Shot					
Crush					
Drill Blast Area 2					
Load and Blast					
Crush					
Dill Area 3					
Load and Blast					
Crush					
Drill Area 4					
Load and Blast					
Crush					

Appendix D: Independent Endorsement

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Engineered Excellence

- Tunnelling
- Construction
- Open Pit Mining
- Quarrying
- Underground Mining
- Blast Design
- Blast Permitting
- Vibration Monitoring
- Vibration Analysis
- Expert Witness

91 Burdekin Drive
Sinnamon Park. QLD. 4073. Australia
P.O. Box 1176
Mt.Ommaney QLD. 4074. Australia

Telephone +61 7 3715 7599
Facsimile +61 7 3715 7588

Email group@heiligandpartners.com.au
www.heiligandpartners.com.au

datatrap
vibration management software

Wednesday, November 15, 2023

Ref:jhh:BMS FH Endorsement November

[redacted]

RE: Endorsement of Newcastle Inner City Bypass Blast Management Strategy (BMS)

[redacted]

Further to the Blast Management Strategy (BMS) that has been prepared for the Rankin to Jesmond Newcastle Inner City Bypass, I have reviewed this document with respect to its accuracy, appropriateness for the project and its ability to act as a working document to inform and guide management to deliver a safe solution with respect to blast outcomes.

The reviewed version of the BMS dated 31st October 2023 has addressed the matters that relate the prediction of the blast impacts, including how this will inform subsequent blasting. I confirm that the document is consistent with best practices and in my view adequately addresses the requirements.

It is my professional view that the BMS has met the key requirements of a document that illustrates the potential impacts associated with blasting, how these will be assessed, the controls that might be necessary to mitigate the effects to acceptable levels as specified in the Conditions of Approval and a monitoring approach to quantify confirm compliance with the above.

The BMS addresses the requirements of the Conditions of Approval and the Newcastle Inner City Bypass blast management framework appropriately.

As always, you are most welcome to contact me at your convenience to discuss in further detail any of the issues raised in this letter.

Yours truly,

John Heilig

Dr. John Heilig
Principal - Heilig & Partners Pty Ltd
RPEQ#6304