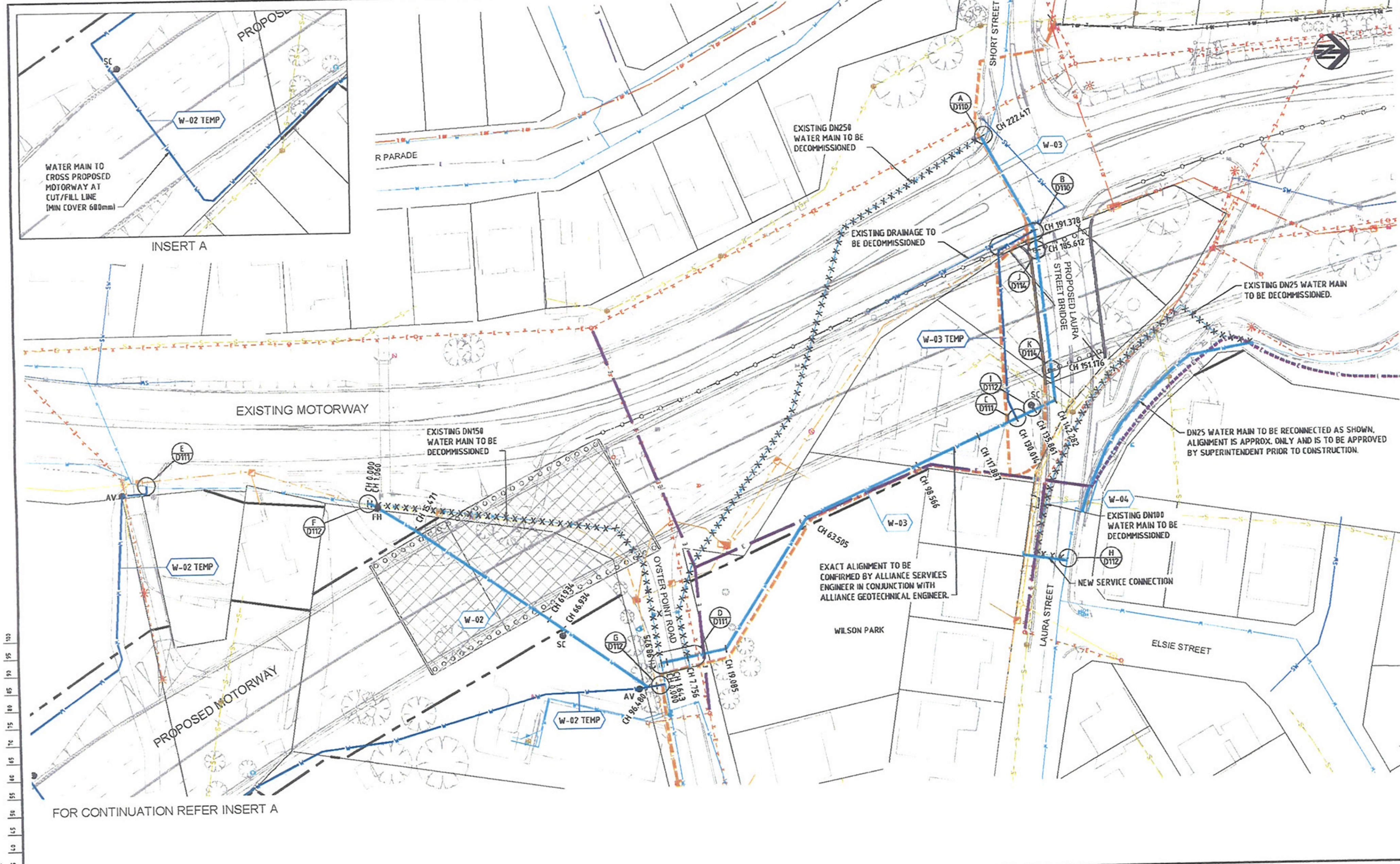
APPENDIX A – BLASTING AERIAL PHOTOS

Appendix A – Blast Aerial Image

APPENDIX B – BPUA MODIFICATION REQUEST FOR BLASTING LIMITS

Refer to modification request for blasting limits dated 13 December 2010

APPENDIX C – UTILITY LOCATIONS



ROADS AND TRAFFIC AUTHORITY OF NSW

H10 PACIFIC HIGHWAY — BANORA POINT UPGRADE — TWEED SHIRE

PUBLIC UTILITIES PLAN
W-02, W-03 & W-04 DETAILED LAYOUT

DRAWING FILE LOCATION / NAME: I:\Projects\3001750 - BANORA POINT\004_CADD\CAD\Dwg\Banora Design\12_UT_Utilities\BPA-UT201-D105_[A].dwg

PLOT DATE: 21 May 2010 — TIME: 14:47:10

REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No	APPROVAL
A	20.05.2010	ISSUED FOR CONSTRUCTION	27	M S

TITLE	NAME
DRAFTER	L.MOLONEY
DRAFTING CHECK	P.WYATT
DESIGNER	C.RITSON
DESIGN CHECK	T.WONG
PROJECT MANAGER	T.WONG
PROJECT DIRECTOR	C.ANDERSON

BANORA POINT UPGRADE ALLIANCE — Upgrading the Pacific Highway

SCALES AT A3 SIZE DRAWING: SCALE 1:1000

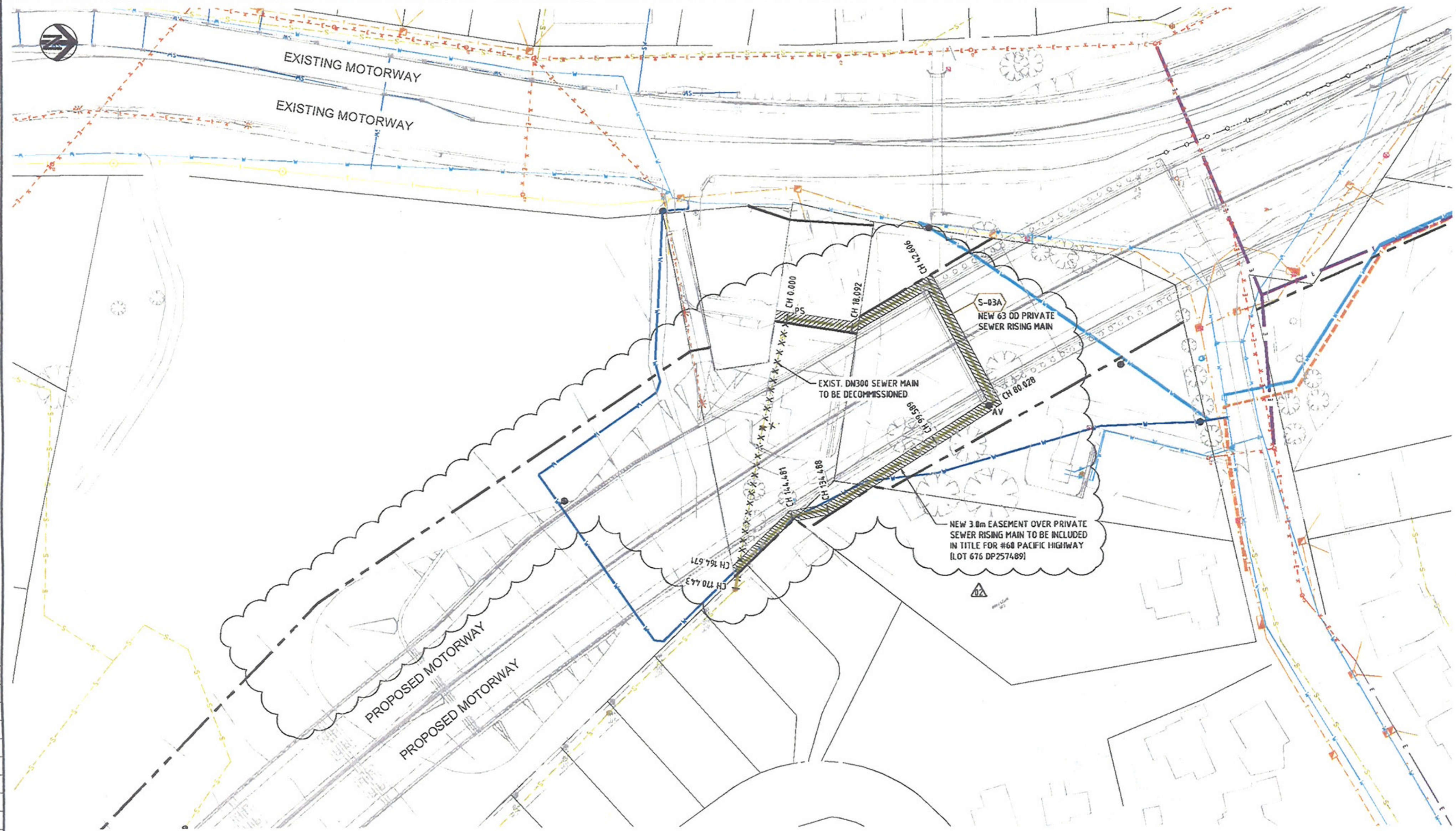
CO-ORDINATE SYSTEM: MGA ZONE 56 — HEIGHT DATUM: A.H.D.

RTA PLAN REGISTRATION No: 0010.438.RC.2007

ISSUE STATUS: FOR CONSTRUCTION

PROJECT / DRAWING No: BPA-UT201-D105

ISSUE: A



PLAN LAYOUT
SCALE 1:1000

DRAWING FILE LOCATION \ NAME
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PLOT DATE 18 May 2010 TIME 16:15:03

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

EXTERNAL REFERENCE FILES

X_BANORA_CAS
X_DES_LOCAL
X_DES_MAIN
X_UTIL_AG
X_UTIL_ELEC
X_UTIL_SEWER
X_UTIL_TELSTRA
X_UTIL_WATER
X_UTIL_OH
X_CADAST
X_SURV
X_BRG_INFRA2
X_BRG_INFRA3

REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No	APPROVAL
1	05.03.2010	85% DETAIL DESIGN	13	MS
2	18.05.2010	100% FINAL DESIGN	29	MS

TITLE	NAME
DRAFTER	L.MOLONEY
DRAFTING CHECK	P.WYATT
DESIGNER	C.RITSON
DESIGN CHECK	T.WONG
PROJECT MANAGER	T.WONG
PROJECT DIRECTOR	C.ANDERSON

BANORA POINT
UPGRADE ALLIANCE
Upgrading the Pacific Highway

SCALES AT A3 SIZE DRAWING
SCALE 1:1000 5 0 10 20

CO-ORDINATE SYSTEM MGA ZONE 56 HEIGHT DATUM AHD

ROADS AND TRAFFIC AUTHORITY OF NSW

H10 PACIFIC HIGHWAY
BANORA POINT UPGRADE
PUBLIC UTILITIES
S-03 (A) DETAILED LAYOUT
TWEED SHIRE

RTA PLAN REGISTRATION No 0010.438.RC.2007
ISSUE STATUS 100% FINAL DESIGN
PROJECT / DRAWING No BPA-UT203-D106
ISSUE 02

APPENDIX D – MONITORING LOCATIONS

Appendix D – Monitoring Locations

APPENDIX E – EVALUATION TEST BLAST

Abigroup Contractors, Seymour Whyte Constructions and Snowy Mountain Engineering Corporation (SMEC)

Blasting for the Banora Point Upgrade Alliance Review of Trial Blasting

Prepared By:

HEILIG & PARTNERS PTY. LTD.

August, 2010

Distribution List:

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Executive Summary

The Banora Point upgrade is a project to upgrade 2.5 kilometres of the Pacific Highway through Banora Point. The Alliance intend to undertake drilling and blasting activities as part of the excavation process associated with the removal of the more competent rock masses in the cutting. This report addresses blasting in the section south of Laura Street.

In achieving this outcome, this report documents the results of a program undertaken to measure and analyse the level of vibration from various quantities of explosive that are likely to encompass the range that would be used as part of the construction activities. Calculated explosive weights and predicted contours are based on compliance at the nearest sensitive receivers of 5mm/s. Given the likely blast outcomes and blast costs, the Alliance should motivate for a higher acceptable level of vibration. Depending upon the impact on design, it may also be necessary to motivate for a relaxation in the overpressure criteria. The possible impact and any necessary mitigation measures should be addressed during the initial stages of the blasting activities.

It should also be noted that the compliance calculations are based on a 95% compliance value. Increasing the level of compliance to a 99% value reduces the quantities to around two-thirds of the values listed in the analysis section of this report. Given the importance of compliance, it is suggested that the explosive weights are carefully considered, erring on the conservative side until further data specifically relating to multiple hole, multiple deck, production blasts.

Table of Contents

1. BACKGROUND ... 4
2. ADJACENT INFRASTRUCTURE ... 5
3. ENVIRONMENTAL EFFECTS FROM BLASTING ... 5
4. TRIAL BLASTING ... 5
 4.1. Trial Blast Configuration ... 6
 4.2. Monitoring Configuration ... 6
 4.3. Vibration Relationship ... 7
5. POTENTIAL IMPACT OF GROUND VIBRATION ... 9
 5.1. Blasting Quantities ... 11
6. OVERPRESSURE EFFECTS ... 11
7. CONTINGENCIES ... 11
8. MONITORING AND REPORTING ... 12

1. BACKGROUND

The upgrade of the Pacific Highway at Banora Point is being delivered by the Banora Point Upgrade Alliance (BPUA), a team consisting of the NSW Roads and Traffic Authority, Abigroup Contractors, Seymour Whyte Constructions and Snowy Mountains Engineering Corporation (SMEC).

Key features of the project:

- A six-lane, 2.5 kilometres of dual carriageway from Barneys Point Bridge to the Tweed Head bypass;
- Retention of the existing Pacific Highway as a local access Road;
- Connection of South facing ramps at Barney's Point Bridge with a southern interchange roundabout;
- A land bridge approximately 100 metres wide which will provide a parkland connection between east and west Banora Point at Wilson Park;
- A 330 metre long viaduct across the valley south of Sexton Hill;
- Northern interchange connecting to Darlington Drive and Minjunbal Drive;
- Realignment and upgrade of the existing coastal cycle pedestrian route through Banora Point;
- Realignment of Laura Street to meet with Short Street and the existing Pacific Highway at a four-way intersection with traffic lights.

As part of the upgrade works in the area south of Laura Street, the Alliance have identified sections where the competency of the rock mass is such that removal via mechanical methods is likely to be uneconomic and drill and blast methods are preferred. The following image shows the extents of the proposed blasting area. The limits extend to the outer edges of the batters (*ie* assume zero free digging).

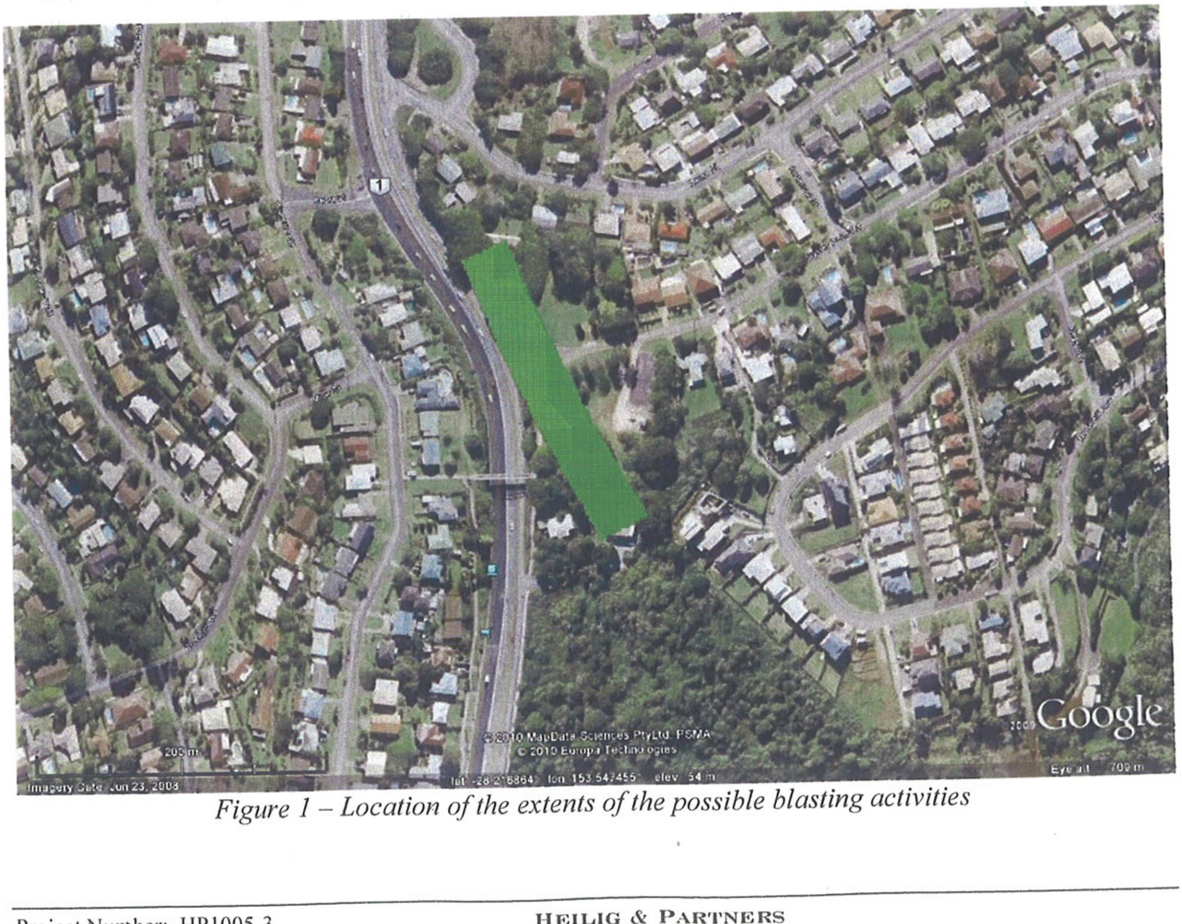

Figure 1 – Location of the extents of the possible blasting activities

A series of nine trial blasts have been initiated in three separate areas of the expected blasts zone (referred to as north, south and central) and the resulting vibration levels measured to assess the level of vibration as a function of distance and explosive weight. The methods of measurement and analyses are consistent with those specified in the Australian Standards AS2187.2.

This document provides the results of the trial blasts undertaken to assess the level of vibration from the planned blasting activities required as part of the BPUA project. The report, together with other geotechnical data and geology information, is prepared to assess the scale of blasting, and in particular, the quantity of explosive that can be detonated whilst complying with the project vibration restrictions. Tendering companies should however confirm the analyses and the potential impacts on the allowable explosive quantities, scale of blasting and the overall drill and blast costs.

2. ADJACENT INFRASTRUCTURE

The Alliance have indentified that the planned cutting will approach residential properties. The proximity of these locations have been identified from aerial photography sourced from via Google Earth (Date of Photography – 23rd June 2008). Properties constructed after this date are not considered in the analyses. Other properties have been demolished or acquired as part of the project. The relevant properties should be verified by the BPUA.

3. ENVIRONMENTAL EFFECTS FROM BLASTING

It is understood that the EPA have stipulated a vibration criterion of 5mm/s at each of the existing properties and an acceptable overpressure value of 115dBL. Both limits should however be confirmed.

Some vibration and air over-pressure from blasting is unavoidable. With the adoption of conscientious blasting practices, and an adequate separation distance between the blasting and the nearest sensitive structure, the level of ground vibration can be reduced to compliance values. By applying diligent practices and ensuring the quantity of explosive is adjusted to reflect the distance nearest property, it is expected that small scale controlled blasting can be developed within the EPA vibration constraints.

The purpose of this document is to identify the acceptable scale of blasting with respect to compliance with the 5mm/s vibration criterion. No measurements of overpressure were collected during the field trials given the absence of a free face and the highly confined explosive charges.

4. TRIAL BLASTING

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

- The weight of explosive per blasthole;
- The distance between the blastholes and the point of measurement;
- The local geological conditions, including rock mass conditions.

The trial program involved detonating a series of eleven blastholes and measuring the level of vibration at multiple monitoring locations, including residential properties and other near field locations chosen to assist with the regression analyses. Three trials involved multiple holes with two decks per blasthole (sequenced individually), one trial had two decks within a single blasthole and four single hole trial blasts were fired with a single explosive deck.

The trial blasting was completed with explosive weights varying between 0.5 and 2.3 kilograms. Each blast was monitored at multiple locations.

4.1. Trial Blast Configuration

The trial blast configuration and locations for the trial blast patterns are as given in Table 1. The blasts were initiated on the 3rd August 2010.

Blast Trial Number	*Trial Description*	*Cutting*	*Monitoring*	*Maximum Explosive Quantity*
1	Single hole/Single deck	South Zone	Distances between 41m and 43m	0.5 kilograms
2	Single hole/Single deck	South Zone	Distances between 38m and 181m	2.25 kilograms
3	Two holes with two decks per hole, each deck of 1.25 kilograms	South Zone	Distances between 36m and 101m	1.25 kilograms
4	Single hole with two decks, upper deck of 0.5 kilograms and lower deck of 0.75 kilograms	North Zone	Distances between 15m and 80m	0.75 kilograms
5	Single hole/Single deck	Middle Zone	Distances between 34m and 89m	1.0 kilograms
6	Single hole/Single deck	Middle Zone	Distances between 37m and 97m	1.75 kilograms
7	Two holes with two decks per hole, each deck of 1.75 kilograms	Middle Zone	Distances between 31m and 134m	1.75 kilograms
8	Two holes with two decks per hole, each deck of 0.6 kilograms	North Zone	Distances between 20m and 75m	0.6 kilograms

Table 1 –Blast trial details

Orica "*Sentanel*" packaged 55mm explosive was lowered to the base of the blasthole and initiated with an electronic delay element. Stemming material was placed above the explosive column to the collar to ensure no flyrock and the uncharged collar height exceeded normal practices for this purpose. A single detonator was used for each explosive column, placed at toe end of the column. No bulk emulsion or ANFO was used. Where multiple decks were initiated, the delay between decks was 25ms.

4.2. Monitoring Configuration

The level of vibration was measured by installing a triaxial geophone unit at each specific monitoring location. The units were configured to record the level of vibration together with the waveform. In accordance with the Australian Standards AS2187 and the ISEE recommendations, the units were anchored to the ground via a buried concrete block. All reported vibration levels are the instantaneous vector sum value of the three orthogonal components of vibration.

A total of thirteen monitoring stations were utilised and positioned at distances ranging from approximately 15 metres through 180 metres from the blast. The monitoring locations are referenced to Figure 2. The data for monitoring locations about the site and the locations of the blastholes were taken from GPS data points. Separation distances were calculated on the basis of these GPS coordinates.

Figure 2 – Summary of monitoring and blasting locations the three trial areas. Blast locations are shown as green dots and monitoring locations as red circles with a vibration pulse

Monitoring locations were chosen to allow measurement of vibration over a range of distances and different directions to identify if there are any anomalous regions around the cuttings and to allow direct measurement of vibration at one of the closest sensitive receivers.

4.3. Vibration Relationship

The vibration data have been analysed using techniques consistent with the recommendations provided in the Australian Standard AS2187. The form of the equations typically used to predict the level of vibration for a given explosive quantity and distance is used and has the following form:

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

where PPV is the peak particle velocity measured in mm/s, d is the distance from the blast measured in metres, w is the maximum quantity of explosive per delay, and K and α are site constants. The term in brackets ($d/\sqrt{w}$) is referred to as the scaled distance term.

Figure 3 shows the recorded vibration data for each of the trials according to the production blast. The values on the Y axis indicate the measured vibration level (vector sum value). The values on the X axis represent the value of the scaled distance term, calculated as the distance between the blast and the monitoring site divided by the square root of the explosive quantity.

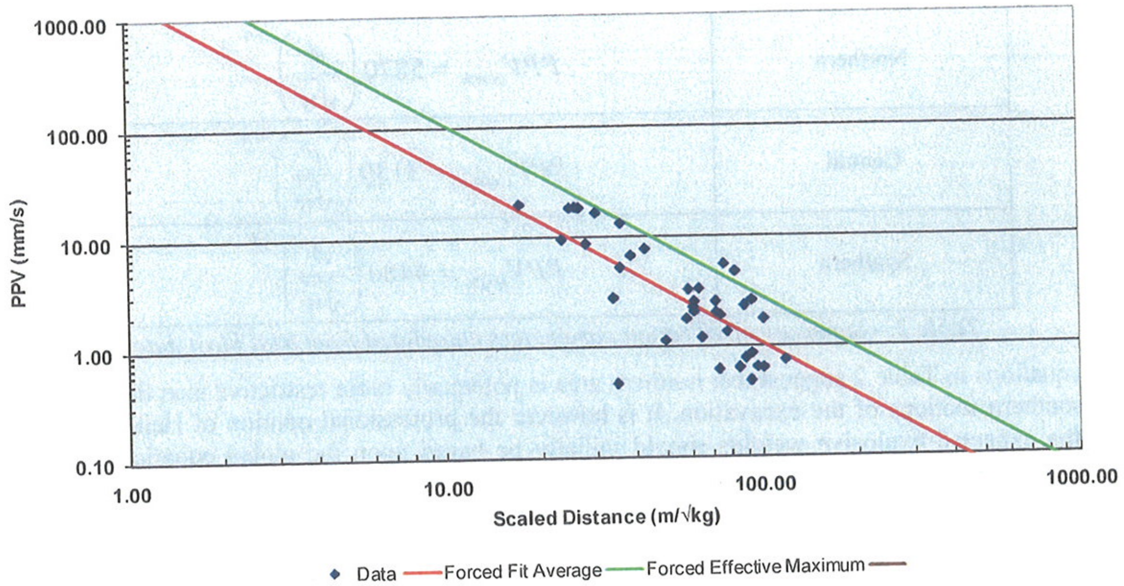

Figure 3 – Vibration levels measured from the trial blasting

A global relationship between the level of vibration, the quantity of explosive and the distance from the blast has been derived from vibration measurements collected from all of the monitoring locations and eight trial blasts. The regressed equation is as follows:

$$PPV_{Average} = 1670\left(\frac{d}{\sqrt{w}}\right)^{-1.6}$$

To account for variability in the explosive performance and rock mass variations, best practice is to predict vibration levels as the "*effective maximum*" where this level exceeds 95% of all measurements. The equation is as follows:

$$PPV_{Maximum\ Blasting} = 4420\left(\frac{d}{\sqrt{w}}\right)^{-1.60}$$

where $PPV_{Maximum\ Blasting}$ is the *"effective maximum vibration level"*, d is the distance between the blasthole and the point of measurement and w is the maximum quantity of explosive per blasthole.

A review of the vibration data measured at the Banora Point project has shown no appreciable increase in the level of vibration measured from a single blasthole when compared to that generated by a multi-hole, multi-deck production blasts. This may however be strongly influenced by the ground conditions, initiation sequence and the use of precise electronic delays. In the event of different blasting designs, the equation should be verified as production blasting data are collected.

In addition to a global vibration equation for the Banora Point area, the measured data have also been analysed based upon the location of the trial area. The excavation has been divided into three areas: north, central and south. In each case, the data have been fitted to a constant attenuation parameter to highlight any differences in geology and explosive coupling. Vibration relationships for each have been determined and are shown in Table 2. It should be noted that the amount of data for each area is minimal and any conclusions from the data should consider the small number of tests.

Excavation Area	*Equation*
Northern	$PPV_{North} = 5870\left(\frac{d}{\sqrt{w}}\right)^{-1.6}$
Central	$PPV_{Central} = 3130\left(\frac{d}{\sqrt{w}}\right)^{-1.6}$
Southern	$PPV_{South} = 4480\left(\frac{d}{\sqrt{w}}\right)^{-1.6}$

Table 2 – Summary of vibration parameters calculated from trial blast data

The equations in Table 2 suggest that northern area is potentially more restrictive than the central area and southern sections of the excavation. It is however the professional opinion of Heilig & Partners that the expected explosive weights should initially be based upon the global equation noting that some areas of the cut may lead to an increase in the allowable quantity whilst other areas may necessitate a reduced quantity. These effects can be further verified through monitoring and analysis once production blasting commences.

5. POTENTIAL IMPACT OF GROUND VIBRATION

Using the site specific equation given above, the minimum distance to comply with a vibration criterion of 5mm/s for adjacent properties can be estimated for differing explosive quantities. The results in Table 3 are shown for different blasting configurations based upon different explosive deck lengths and densities. The blasthole length, or more correctly the explosive column length, affects the quantity of explosive which directly impacts upon the level of vibration measured. It is taken that the explosive density is 0.85g/cm^3, as per operating practices with ANFO, or where wet ground conditions are encountered, an explosive density is 1.2g/cm^3, as per operating practices with cartridge emulsion. Other explosive configurations can also be considered based upon the column length and density.

The distances are based upon the equation with the K co-efficient of 4420 and an attenuation co-efficient of -1.60.

Blasting Design Option	*Description*	*Explosive quantity per blasthole*	*Minimum distance to comply with 5mm/s*
i	Explosive column length of ≈½ cartridge of 55x400 Explosive column length of ≈2/3 cartridge of 45x400 ANFO column of ≈1/3 metre in 45mm diameter blasthole	≈ 0.5 kilograms	50 metres
ii	Explosive column length of ≈1 cartridge of 55x400 Explosive column length of ≈1½ cartridges of 45x400 ANFO column of ≈¾ metre in 45mm diameter blasthole	≈ 1.0 kilograms	70 metres

iii	Explosive column length of ≈1½ cartridge of 55x400 Explosive column length of ≈2 cartridges of 45x400 ANFO column of ≈1 metre in 45mm diameter blasthole	≈ 1.5 kilograms	85 metres
iv	Explosive column length of ≈2 cartridges of 55x400 Explosive column length of ≈3 cartridges of 45x400 ANFO column of ≈1½ metre in 45mm diameter blasthole	≈ 2.0 kilograms	100 metres

Table 3 – Minimum distance between the blast area and the closest residential receiver to comply with 5mm/s for different blasting options

It should also be noted that the compliance calculations are based on a 95% compliance value. Increasing the level of compliance to a 99% value reduces the quantities to around two-thirds of the values listed in the analysis section of this report. Given the importance of compliance, it is suggested that the explosive weights are carefully considered, erring on the conservative side until further data specifically relating to multiple hole, production blasts have been collected.

These distances can be used to define the scale of blasting for the cutting. Based upon the critical vibration level for residential infrastructure of 5mm/s, the allowable explosive quantity will vary according to the proximity of the blasting to the property. The equations derived in Section 5 and separation distances given in Table 3 can be used to show the potential impacts of the adjacent properties on the scale of blasting that can be undertaken.

Rather than restricting the analyses to the possible extraction area determined by the hard rock/rippable or free dig areas, the full extent of the excavation shown in Figure 1 (*ie* to the limit of the batter) has been modelled to determine the possible influence of the properties on the scale of blasting activities. This is considered a worst case as some areas may be excavated without any requirement for blasting.

The distance between the blast area and the existing residences will control the quantity of explosive that can be detonated. In areas of blasting nearer to the residences the scale of blasting must be reduced to ensure compliance.

Plate A shows the expected explosive quantity to comply with the existing properties about the bypass road alignment based upon the vibration relationship identified from the trial blast data, as well as the location of the 2.5mm/s, 5mm/s, 7.5mm/s and 10mm/s contours based upon blasting activities using these quantities.

The data in Plate A indicates that the properties on the eastern side of the project at both the northern and southern ends of the cutting will have the greatest influence on the allowable quantity of explosive. Explosive quantities greater than 2 kilograms per deck should not be expected with the majority of the excavation using between 0.5 and 1.0 kilograms. Consideration should be given to motivating for an increase in the allowable vibration level, possibly better aligned with the Australian Standard AS2187 values. This will permit the use of greater explosive quantities, be far more cost effective and provide better fragmentation and diggability of the blasted rock, still without the possibility of damage to adjacent structures.

The location of the properties should also be verified to ensure no properties have been omitted from the modelling, or conversely, some properties may have been resumed and are no longer a critical receiver.

5.1. Blasting Quantities

Based upon the planned blasting areas for the excavation and the analyses provided in Plate A, the percentage of the cut that can be blasted with the different explosive quantities has been estimated. The percentage is based on the plan area of the cut and does not account for the varying excavation depths required in the different sections of each cut (*ie* square metres and **not** cubic metres of material removed). The percentages are as shown in the following Table 4.

Blast Design Reference	*Explosive Quantity*	*Percentage of excavation K=4420 & α=-1.6*
A	<0.5 kilograms	11%
B	0.5 – 1.0 kilograms	43%
C	1.0 – 1.5 kilograms	33%
D	1.5 – 2.0 kilograms	13%
E	2.0- 2.5 kilograms	0%
F	>2.5 kilograms	0%

*Table 4 – Percentage of the excavation that can be completed with varying explosive quantities. Calculations based on plan area and **not** total volume of blasted material*

6. OVERPRESSURE EFFECTS

Overpressure from blasting refers to the transient, but elevated, levels of pressure above atmospheric pressure. It is measured irrespective of frequency with no weighting, and on this basis, is distinguished from noise criteria. Air overpressure generally features the greatest proportion of the energy in the inaudible minus 20 Hz band. Unlike ground vibration, the level of air overpressure is influenced by both topography and prevailing weather conditions.

Depending upon the orientation of the blasting patterns, the scale of blasting, the prevailing weather conditions and the topography, overpressure levels may exceed the 115dBL permissible value. No site data has been measured to permit modelling of the expected effects and any subsequent and required adjustments to the blast designs.

The exposure to the properties will however be for no more than a second throughout a blast event. When compared with other natural phenomena, like wind and thunder, these effects will often exceed the 115 dB (Lin) for many hours during each day. Further, these naturally occurring and uncontrollable sources may induce levels more than 50 times than 115 dB (Lin) for extended periods each day and without any adverse effects.

Depending upon the impact on design, it may be necessary to motivate for a relaxation in the overpressure criteria. The possible impact and any necessary mitigation measures should be addressed during the initial stages of the blasting activities.

7. CONTINGENCIES

The trial results have reasonably guaranteed that the levels of vibration from the blasting will comply with the proposed 5mm/s criteria at locations as near as 45 metres with a 0.5 kilogram weight. In the event that the trial blast programme has underestimated the level of vibration, several mitigative procedures are available and could include:

- limiting the quantity of explosive by further reducing the length of the blasthole or the length of the explosive column;
- introducing additional explosive columns within the blasthole;
- reducing the blasthole diameter;
- alternative explosive types, including both low density products and cartridge explosives.

8. MONITORING AND REPORTING

The procedure for demonstrating vibration compliance at the residential infrastructure is expected to remain essentially unchanged from typical practices employed for blasting at construction sites. Vibration monitoring systems are expected to be positioned at several locations about the cutting at the nearest potentially affected properties and configured to detect any increase in the ambient vibration level above a pre-set threshold value.

Data are expected be analysed and collated regularly to allow the continual refinement of the vibration predictions.

LEGEND

- Expected 10mm/s Vibration Contour
- Expected 7.5mm/s Vibration Contour
- Expected 5mm/s Vibration Contour
- Expected 2.5mm/s Vibration Contour

SCALE

0 25 50 75 100 125m

Project Description: Banora Point predicted explosive weights based upon trial blast results

HEILIG & PARTNERS

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Plate No. A	**Date Drawn: 11 August 2010**
Scale as Shown	**Ref No: Banora Point Blast.cdr**

APPENDIX F – SUBCONTRACTOR BLAST MANAGEMENT PLAN

The subcontractors Blast Management Plan will be attached once the subcontract has been awarded. Attached is the Blast Management Plan produced for the Blast Evaluation.

Note that the drill and blast subcontractor will be working under the BPUA Blast Management Plan as the over arching document.

ABN 004 117 828
Orica Quarry & Construction Services
1 Nicholson St, MELBOURNE, VIC, 3000

Blasting Management Plan

And

Safe Work Method Statement

Project Identification

Blasting Evaluation for
Banora Point Upgrade Alliance
Pacific Highway Re-alignment Project
NSW

BANORA POINT
UPGRADE ALLIANCE
Upgrading the Pacific Highway

Prepared and Authorised by:

Rohan Stevens
Construction Blasting Engineer
Orica Quarry & Construction Services
18/06/10

Table of Contents

1. Scope of Work 3
2. Document Control 4
3. Specific WH&S and Blast Management Items 5
4. Risk Assessment 8
5. Implementation Plans 9
6. Other Procedures and Documents 10

Appendix A Risk Assessment - Blasting Operations 12
Appendix B Site Specific Pre-Blast Checklist 22
Appendix C Personnel List 23
Appendix D Site Specific Blast Clearance Procedure 24
Appendix E Instructions for Blast Sentries (Guards) 26
Appendix F Definitions 27
Appendix G Index Mapping to AS2187.2-2006 Appendix 2 28
Appendix H Sign Offs 30

1. Scope of Work

The Banora Point upgrade is a project to upgrade 2.5km of the Pacific Highway through Banora Point approximately 100km south of Brisbane.

The design of the upgrade requires a substantial amount of cut material to be excavated slightly south of the Darlington Drive exit at Banora point. Geotechnical investigations indicate that the cutting hosts a basalt flow that would be uneconomical to rip by mechanical means and will require blasting prior to excavation.

Adjacent to the cut, as close a 35m, are a number of privately owned properties. In addition the cutting design is bordered to the west by the existing pacific motorway. A number of services, including overhead powerlines, exist on the site. Due to the close proximity to the previously mentioned infrastructure and services it is extremely important to have systems in place to manage ground vibrations and airblast from any blasting activity.

BPUA have engaged Orica to conduct a Blast Evaluation to determine the vibration attenuation characteristics of the local geology in the area.

The field work involved in this evaluation will include:

1. The use of a drill rig to drill a series of holes into the basalt layer;
2. Setting up a number of environmental monitors at the nearest sensitive receivers (houses) to the site.
3. Surveying in the locations of blast holes and monitors to establish accurate distances.
4. Firing 1 to 3 small charges (400g – 4000g) down each hole.

Once the field work is completed a site law will be developed from the data collected on site to ensure that production blasting can be designed to comply with set environmental limits.

Project Principal:	Roads and Traffic Authority, NSW
Client:	Banora Point Upgrade Alliance
Blasting Contractor:	Orica Quarry and Construction Services
Drilling Contractor:	Pacific Drilling and Blasting

2. Document Control

This is a controlled document, frequently amended and updated as site conditions change and procedures are amended. This document is controlled by the Author. Check with the Author that you have the latest copy before using this document. The revision in use will be identified by the date and time of printing shown on the bottom of each page.

Author: Rohan Stevens Orica Quarry and Construction Services Ph 0423 841 935

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Craig Gordon	Craig.Gordon@BanoraPt.com.au	Project Engineer - BPUA

Revision List

Date	By	Revision Details

3. Specific WH&S and Blast Management Items

Legislative References, Codes of Practice and Standards

The following have been identified as specifically relevant to the activities to be undertaken.

- QLD Workplace Health and Safety Regulation 2008
- QLD Explosives Act 1999 and Explosives Regulation 2003
- Australian Standard 2187.2 Use of Explosives
- Australian Explosives Code (AEC) (6th Edition)

High Risk Construction Activities

The following High Risk Construction Activities are expected to occur on this job:

High Risk Construction Activity	
Entering a Trench more than 1.5m deep	N
Using explosives;	Y
Entering a confined space;	N
Using a hazardous substance;	N
Working where the person could fall at least 2.0m;	N
Doing asbestos work or demolition work;	N
Working near moving powered mobile plant at a workplace;	Y
Working in, over or adjacent to water where there is a risk of drowning;	N
Working on, or adjacent to, a road or railway;	Y
Working on or near a pressurised gas distribution mains or pipes;	N
Working near exposed energised electrical installation;	Y
Other work that could result in death or bodily harm :	N

Responsible Persons

Person	Skill / Competency / Licence	Expires
Martin Adam (Mgr Tech Services Q&C)	Registered Professional Engineer (QLD) # 8144 QLD Cat 3 Shotfirer's Licence (Unrestricted) 0404702	30/6/2010 31/10/2010
Rohan Stevens (Construction Blasting Engineer)	Bachelor of Science & Engineering (Mining) QLD Shotfirers Licence 0900328	29/102014
Rick MacMaster (Construction Operations Manager)	QLD Cat 2 Shotfirer's Licence (Unrestricted) 0405253	30/06/2010
Geoff Radford	QLD Cat 2 Shotfirer's Licence	TBA

The Shotfirer and engineer for each blast in a project may vary from time to time. The responsible shotfirer for each blast is named on the front of the Orica Job pack folder.

The Orica Shotfirer will provide supervision of Orica activities. The Shotfirer will inspect and assess the work area before starting work and will have the final authority regarding all aspects of the work related to Orica's contract while onsite.

The Orica Engineer is responsible for cross checking the Shotfirer's work and updating the Site Data Sheet (SDS) and blast designs as required when the blast design parameters change.

Consultation

Orica operate a system of blast classification from Class 1 (simple blasts) to Class 4 (complex blasts). The blast design must be cross checked and reviewed by others, with the level of review being commensurate with the class of blast. Full details are contained in the Orica Shotfirer's Work Instructions (SWI's).

Orica use the "Take 5" system for conducting daily pre-start assessment of working conditions and on-the-spot hazard assessment.

Orica uses a centralised data base (SHERMIS) to manage incident reporting and auditing processes.

Electrical Equipment

Orica propose to bring the following electrically powered portable equipment on site:

- nil

Personal Protective Equipment (PPE)

The minimum standard of PPE required by Orica is:

- Hard Hat, Safety Boots, Safety Glasses
- Long sleeves and long trousers (hi-visibility)
- Hearing Protection, Respiratory Protection, Face Shields if required
- Gloves (When operating)
- Dust Masks (when required eg. Working near drill)

Hazardous Substances

The Orica Engineer will provide Material Safety Data Sheets to the client for all explosives and ancillary chemical items brought on site. Up to date MSDS's for all Orica products can be obtained from www.oricaminingservices.com.

Lifting Equipment

Orica do not plan to bring any lifting equipment to site.

Plant

Orica propose to bring light vehicles (Shotfirer & Surveyor Vehicles) and possibly a Heavy Rigid Explosives Mobile Manufacturing Unit (MMU) to site.

Warning Signs and Control Measures

Warning signs and flagging will be erected around the blast area.

Accidents and Incidents

All accidents and incidents are to be reported to BPUA and Orica. See the list in Appendix C for details of contacts to be notified.

Fire Protection

Fire extinguishers on light and heavy vehicles are checked daily as part of the Orica Pre-Start checklist. Light Vehicles are equipped with one 1.5kg dry chemical extinguisher.

Permits and Licences Required

A blasting notification must be submitted to the Tasmanian explosives inspectorate.

4. Risk Assessment

A Risk Assessment for the job is contained within Appendix A. The following points were identified as the greatest risk or hazards to be addressed:

Summary of Risk Brainstorming Points

- Ensuring availability of Key Personnel
- Obtaining statutory notifications and permits
- Avoiding drilling into underground services
- Transporting explosives in a busy construction environment
- Temporarily storing explosives – eliminating risk of loss or theft
- Ensuring no misfires are left onsite
- Eliminating the chance of flyrock beyond the blast clearance zone
- Reducing the possibility of nuisance or damage due to airblast
- Reducing the possibility of nuisance or damage due to vibration
- Eliminating the need to rush to meet fixed firing times

Summary of Risk Matrix and Conclusions

- Key personnel will be made available;
- Statutory permits and notifications will be obtained;
- A permit to dig will be provided by BPUA;
- Transport and temporary storage of explosives will be in Orica licensed SF vehicle.
- Explosives to be kept locked in Orica vehicle
- Test blast charges to be initiated with pre-logged electronic detonators. Detonation will be confirmed by vibration records.
- Blast design to be prepared to eliminate fly rock and air blast by ensuring sufficient depth of burial
- Charge weights for test blast are to be conservative;
- Vibration results are to be reviewed after each test;
- Monitoring to control and measure vibration;
- Neighbours to be advised of day of blasting;
- Siren to be used to signal blasting;
- Blast times to be flexible. Community Relations not to advise fixed blast times.

5. Implementation Plans

The following plans and responsibilities have been identified from the Risk Assessment and must be executed before the commencement of the project.

ACTIONS	PERSON
Notify Work Cover (david.barker@workcover.nsw.gov.au & bill.brooks@workcover.nsw.gov.au)	Orica Eng
Provide Clearance to Dig (drill)	BPUA
Advise direct neighbours of blasting activity	BPUA
Complete site inductions	Orica/BPUA
Ensure security of area during loading, firing and temporary storage of explosives	Orica Shotfirer (SF)
Provide stemming material	BPUA
Design blast holes and blast clearance	Orica Eng
Load and fire blast holes	Orica SF
Monitor vibration and airblast	Orica Eng
Video blasts	Orica SF
All personnel involved in Risk Assessment meeting to sign off	ALL
All personnel involved in job to sign onto this document	ALL

6. Other Procedures and Documents

This section details other Orica documents that form an integral part of the Blast Management Plan. The objective of the Blast Management Plan is to ensure the safety of all personnel is maintained and appropriate environmental controls are in place. A Blast Management Plan is required to conform to AS2187.2 Appendix A.

The process of developing the Blast Management Plan commences with a site visit by Orica personnel to record and assess the Site Safety Management Plans already in place on the customer site. Orica personnel conduct a Risk Assessment to identify risks that people may be exposed to while working on the customer site.

The Blast Management Plan comprises the following documents;

- **Customer Site Risk Review** – A review of safety processes already existing at the site, conducted before commencing work on site for the first time.
- **Risk Assessment** – Assessment of all risks associated with blasting operations at the site. Identifies site-specific gaps in exiting procedures, including the Shotfirer's Work Instructions. Updated and reviewed as the task, conditions or method of work changes.
- **Orica Shotfirer's Work Instructions (SWI's)** - a standard set of existing Orica Procedures that are used to manage everyday blasting operations and control blasting risk. A copy of these is carried by the shotfirer at all times.
- **Surveyor's Work Instructions (if applicable).** Not applicable in this case, customer to supply all survey services.
- Customer Procedures as applicable.

Orica Job Pack

The blast designs and blast records will be contained in the standard Orica "Job pack". A job pack is prepared for each blast and is kept on file by the local Orica plant office. The job pack contains all standard records of the blast including:

- Pre-blast survey data and bore raking (if applicable)
- As-drilled depths and locations of all blast holes
- Record of short or blocked blast holes
- As-loaded record of all short or blocked blast holes
- Types and quantities of initiating explosives and packaged explosives used;
- Types and quantities of bulk explosives used;
- Initiation plan including charge mass per delay (MIC) and method of initiation
- Vibration and Air blast records

Orica Site Data Sheet (SDS)

Under normal Orica Quarry Blasting procedures, the blast design parameters to be used for a specific site will be contained in the "Site Data Sheet". The SDS will be updated if blast design parameters change. The Site Data Sheet is an integral part of the blast management plan, and is kept in the Orica Job pack for each blast. In the case of construction blasts, the Site Data Sheet may be represented as a series of dated design drawings (Drill design, Loading design, Cover design, and Initiation design) to facilitate more effective communication of detail.

Main elements: (from AS / NZS 4360:2004)

a) Communicate & Consult
b) Establish Context
c) Identify Risks
d) Analyse Risks
e) Evaluate Risks
f) Treat Risks
g) Monitor & Review

Communicate & Consultation Steps:

- ❑ Consider costs, payment and liability for Orica conducting risk assessment.
- ❑ Physically visit and "walk" the area of any blasting proposal.
- ❑ Convene a meeting in a location with whiteboard / write-up capability.
- ❑ Gather a team of persons familiar with the site and blasting objectives.
- ❑ Review the objectives of any blasting proposal.
- ❑ Specify a "typical" blast design that might be anticipated.
- ❑ List potential hazards associated with setting up, charging and firing such a blast.
- ❑ Describe the expected environmental and other potential effects of such a blast.
- ❑ Locate site plans covering the full potential range of vibrations, air blast, fly rock.
- ❑ Highlight circles of radius around blast site (eg 10 m, 50 m, 100 m, 200 m, etc.)
- ❑ Identify all equipment, services, facilities within target ranges.
- ❑ Use the assessment sheets provided to identify the hazards, determine the risk and identify the controls associated with each potential target or hazard.
- ❑ Document these on the risk management forms.
- ❑ Determine whether each hazard can be safely reduced and managed.
- ❑ Arrange to draft site-specific operational procedures covering all aspects of the blasting process.
- ❑ After completion, have qualified persons review the draft and when completed produce the final operational procedure documentation.
- ❑ Ensure every appropriate person on site is familiar with the assessments and the procedures in place to ensure safety.
- ❑ Measure and record blast outcomes and effects.
- ❑ Complete summary report after blasting as required by law and site procedures.

Context of Risk Assessment

When identifying blast-related hazards, we consider:

- ❑ Regulation requirements
- ❑ Other activities in area
- ❑ Associated tasks
- ❑ Site layout
- ❑ Property in non-safety zone
- ❑ Internal property damage
- ❑ Power lines, underground services
- ❑ All weather conditions
- ❑ Timing of activity
- ❑ Safety equipment needed
- ❑ Visitors and contractors
- ❑ Uneven surfaces
- ❑ Vehicle suitability
- ❑ Operator competence
- ❑ Delays in charging / firing
- ❑ Neighbours
- ❑ Traffic/ Speed limits
- ❑ Restricted areas / Signs
- ❑ Face / ground conditions
- ❑ Geology
- ❑ Off-spec drilling, lost holes
- ❑ Oversize
- ❑ Toe
- ❑ Back break
- ❑ Air blast, Vibration
- ❑ Evacuation areas, Road blocks

BLASTING RISK ASSESSMENT TABLE (Acknowledgement to Orica Australia)

L (Likelihood) X C (Consequence) = R (Risk)

Likelihood of Occurrence	**Potential Consequences**					
	5 Notable	**10 Significant**	**15 Highly Significant**	**20 Serious**	**25 Very Serious**	**30 Catastrophic**
Probable	25	50	75	100	125	150
Possible	20	40	60	80	100	120
Unlikely	15	30	45	60	75	90
Very Unlikely	10	20	30	40	50	60
Extremely Unlikely	5	10	15	20	25	30

Likelihood of Occurrence

5	**Probable**	A common occurrence. The event is expected to occur in most circumstances.
4	**Possible**	**Event will probably mostly occur - known to have happened in similar situations.**
3	**Unlikely**	**The event could occur but not expected.**
2	**Very Unlikely**	**The event may occasionally occur at some time but rarely**
1	**Extremely Unlikely**	**The event may occur only in exceptional circumstances.**

Note that the risk estimations and "weightings" are subjective and based on the experience and interpretation of those persons contributing to the study. For matters relating to blasting technology and design this is mostly provided by the writer of this report.

Orica Internal Hazard Management Table

Risk	Who Signs Off	Type of Investigation
1-10	Shotfirer / Supervisor	Site visit, sign off note in job pack
11-20	TS Blasting Engineer	Site visit, report in job pack
21-50	Snr TS Engineer / Project / Business Mngr	Site visit, Risk report in job pack
Over 50	Must be reduced	Unlikely to accept work

Potential Consequence Examples

	Notable	Significant	Highly Significant	Serious	Very Serious	Catastrophic
Safety & Health	1 Minor Injury	Single MTI	Single LWC or Multiple MTI	Permanent disability or Multiple LWC	Single Fatality	Multiple Fatality
Environment	Very Minor pollution	Minor Local pollution	Evident Pollution local concern	Significant Local pollution	Major Local pollution	Extremely Severe pollution
Reputation and Image	Minor issue 1 complaint	Local issue 10 complaints	Local media 100 complaints	Regional or state media	National media coverage	Headlines, corporate damage
Services / Business Interruption	Minor re-connection required	Minor temporary loss of resource	Short-term supply loss of major resource	Medium term supply loss for major resource	Long term loss of production and/or major resource	Permanent loss of production and/or major resource
Business Liability	>$5000	>$50,000	>$200,000	>$1m	>$15m	>$50m

BLASTING RISK EVALUATION GUIDE (ISEE)

The Journal of Explosives Engineering, July/ August 2000

Concern	Primary Impacts	Controls
Fly rock	Damage and Injury	Pre-qualification requirements, blasting controls (blast mats-burden requirements) stemming requirement blast plan reviews, and inspection work.
Structural damage to buildings	Damage claims, work delays or suspension	Pre-qualification requirements, blasting controls, blast plan submittals and reviews, careful inspection of work, public education, effects monitoring and pre, blast condition surveys.
Damage to rock slopes and final excavation walls	Rock fall , remedial slope repairs, work disruption	Evaluate in situ condition of slopes and install additional support is needed. Develop blasting controls and carefully monitor the work.
Damage to buried pipes and utilities	Unrealistic restrictions or total ban on blasting	Pre-qualification requirements, blasting(controls, blast plan submittals and reviews, careful inspection of work, effects monitoring and blasting effects evaluation study by expert.
Startled people	Complaints	Inform neighbours before each blast.
Damaged water wells or aquifers	Blasting prohibition or project delays	Blasting controls, pre-blast / post blast inspections, effects monitoring and blasting effects evaluation study by expert
Environmental Impacts or other Animal Effects	Disapproved EIS, blasting prohibition or delays	Blasting controls, pre-blast and/or post. Blast inspections, and blasting impacts and mitigation study by expert.
Work or business disruption	Financial damage claims and/or organised opposition to the work	Public education, blasting controls, monitoring and schedule blasting during non-working hours.
Contractual Claims and Legal Actions	Financial damages	*Owners and Engineers:* Have appropriate experts review contract documents and specifications. Prepare pre-qualification requirements to ensure personnel are capable of performing the work, and carefully inspect and document all non-conforming work. *Contractors:* Carefully evaluate all available documents-including all geotechnical information, attend pre-construction meetings, document all efforts to conform and barriers to conformance

Blasting Job Safety & Risk Assessment Form. Banora Point – Pacific Motorway Re-alignment						Date 17/6/10			
Event or Activity	**Potential Hazards & Effects**	**L**	**C**	**R**	**Possible Elimination Measures**	**Responsibility/ Comments**	**L**	**C**	**R**
Obtain Key Personnel	Limited number of qualified and inducted personnel.	4	10	40	Prepare Key Personnel with advance notice and inductions.		2	10	20
Obtain Blast Permits and Notifications	Notification to neighbours not done. Explosive Inspectorate not notified	5	5	25	Statutory Notification (Work Cover) by Orica Neighbours notified by BPUA		1	5	5
Design Blast	Poor Blast Design may lead to safety, environmental or productivity problems fly rock, vibration, misfires, hard digging).	5	15	75	Cross check of blast design by Snr Orica Engineer. Adopt design measures to reduce the risk of misfires, fly rock and vibration.	Small charge weights and high depth of burial during testing mean risk is very low	2	10	20
Design Blast	Failure to achieve grade.	3	20	60	BPUA to provide survey data for Orica to calculate correct blast hole drill depths	Geotechnical drawing with depths required	1	20	20
Establish drainage	Inadequate control of water will block blast holes possibly resulting in fly rock, air blast, and poor digging. Vehicles may get bogged.	5	15	75	BPUA to establish benches with sufficient drainage to provide a work free of standing water.	The nature of the site (being on a hill) means drainage issues are unlikely	3	10	30
Establish safe work area	Danger of falling Working around Large earth moving equipment	5	15	75	Use of 2m rule when working near crests. Ensure all blast areas are clearly marked and signed before loading commences. Bollards and flagging minimum 3m around holes during loading. Site personnel to be notified via pre-start meeting.	Orica SF and engineer to confirm adequacy of controls before starting work.	1	10	10

Blasting Job Safety & Risk Assessment Form. Banora Point – Pacific Motorway Re-alignment						Date 17/6/10			
Event or Activity	**Potential Hazards & Effects**	**L**	**C**	**R**	**Possible Elimination Measures**	**Responsibility/ Comments**	**L**	**C**	**R**
Drill Blast holes	Holes drilled to wrong depth or in wrong place Holes blocked after drilling or redrills not remedied	3	10	30	Holes to be drilled to design, all holes to be dipped and checked by Orica before charging. All holes to be protected with a plug (bag or hat).		1	10	10
Drill Blast Holes	Drilling into underground services	2	25	50	BPUA to provide permit to dig.		1	25	25
Drill Blast holes	Holes drilled to wrong depth or in wrong place – fail to achieve grade. Holes blocked after drilling or redrills not remedied – poor fragmentation	3	10	30	Holes to be drilled to design, all holes to be dipped and checked by Orica/BPUA before charging. All holes to be protected with a plug (bag or hat).		1	10	10
Drill Blast Holes	Mast of drill contacting overhead powerlines	3	25	75	Maintain 3m horizontal distance between blast holes and overhead lines. Ensure Drill is aware of risk.		1	25	25
Secure Worksite	Other activities or people in work area may interfere, hot work while loading or near stored explosives may cause explosion.	3	20	60	No other trades, activities or machines to be working in Blast area while explosives loading activities are underway. Blast area appropriately signed and demarcated before loading commences.		1	20	20

Blasting Job Safety & Risk Assessment Form. Banora Point – Pacific Motorway Re-alignment						Date 17/6/10			
Event or Activity	**Potential Hazards & Effects**	**L**	**C**	**R**	**Possible Elimination Measures**	**Responsibility/ Comments**	**L**	**C**	**R**
Select Blast Time	Blast time fixed too far in advance – rushing	5	10	50	Blast times to be agreed between Shotfirer and BPUA Supervisor no more than 24 hrs in advance. BPUA community relations to provide open-ended advice of blasting rather than fixed blast times.		1	10	10
Transport Explosives to worksite	Wrong quantity of explosives brought to site – project delay	5	5	25	Orica Engineer/Shotfirer to confirm quantities		2	10	20
Transport Explosives to worksite	Interaction between Orica SF ute and other vehicles – collision, fire, explosion	3	25	75	Orica personnel to be familiar with route and complete defensive driver training.		1	25	25
Store Explosives at worksite	Theft, Loss Fire	3	25	75	Explosives to remain under control of SSAN cleared Orica person or locked in Vehicle. Daily reconciliation of quantities used. Theft or loss to be reported. Fire near explosives vehicle will demand immediate relocation of vehicle or evacuation of site.		1	25	25

Blasting Job Safety & Risk Assessment Form. Banora Point – Pacific Motorway Re-alignment						Date 17/6/10			
Event or Activity	**Potential Hazards & Effects**	**L**	**C**	**R**	**Possible Elimination Measures**	**Responsibility/ Comments**	**L**	**C**	**R**
Return unused explosives to magazine	Magazines are not accessible at all hours. Mon-Fri 5am – 4pm. Out of hours access may result in storage problem or delay.	3	10	30	Quantities brought to site to match exact requirements whenever possible. Any returns must be allow for travel time to Magazine		2	5	10
Check and Load Blast holes	Incorrect quantity of explosives loaded – vibration / fragmentation problems Explosives jammed in blast hole – fly rock / air blast.	5	15	75	Orica Shotfirer responsible for ensuring correct quantity is loaded and reconciled. Work area must be free of standing water. Use ANFO if possible to eliminate jamming.		2	10	20
Tie Up Blast holes	Incorrect initiation sequence may cause vibration. Missed connection will cause misfire.	5	15	75	Use electronic surface initiation to simplify tie-up sequence and allow positive confirmation that correct number of connections has been made.		2	10	20

Blasting Job Safety & Risk Assessment Form. Banora Point – Pacific Motorway Re-alignment						Date 17/6/10			
Event or Activity	**Potential Hazards & Effects**	**L**	**C**	**R**	**Possible Elimination Measures**	**Responsibility/ Comments**	**L**	**C**	**R**
Stem Blast	Insufficient stemming – fly rock and air blast. Damage to initiation system – misfire.	4	20	80	Shotfirer to dip all holes before stemming. Use experienced personnel to ensure correct quantity of stemming in each holes Orica Shotfirer or engineer to supervise. Use electronic initiation system to allow constant confirmation of circuit continuity.		2	10	20
Radio Interference from Radio Transmitter Towers	High powered AM/FM radio transmission towers can cause interference with low voltage communications systems when using electronic detonators- unable to fire detonators - misfire	4	20	80	Orica Eng to inspect area for radio transmission towers, not within 2 km	Tower within 2km would require further tests, e.g. radio spectrum test.	1	20	20
Clear Blast Area	Failure to clear could result in death or injury	4	25	80	Orica to develop blast clearance plan and brief blast guards.		1	25	25
Fire Blast	Breakdown in blast clearance – personnel in area Overpressure – damage or injury to people or machines.	4	20	80	Written blast clearance plan required. Personnel and machines to be cleared beyond specified clearance zones		1	20	20

Blasting Job Safety & Risk Assessment Form. Banora Point – Pacific Motorway Re-alignment						Date 17/6/10			
Event or Activity	**Potential Hazards & Effects**	**L**	**C**	**R**	**Possible Elimination Measures**	**Responsibility/ Comments**	**L**	**C**	**R**
Check for misfires	Misfires pose a high threat to drillers, excavator operators and future users of spoil	3	20	60	Use electronic detonators with 2 way communication down hole. Orica engineer to confirm initiation of all test charges by checking vibration waveforms.		1	10	10
Excavating Blast	Not the subject of this WMS				Not the subject of this WMS Blast must be mucked out to hard rock before drilling begins again.				
Review WMS					This WMS is to be reviewed after each blast.				
Site Environmental Policy Compliance	Personnel may not be aware of responsibilities with regard to the environment Blast hole drill could leak fuel or oil Orica Equipment could leak fuel or oil Orica packaging, raw materials could be left on site	3	10	30	Induction training prior to start of work on site to cover environmental requirements Drilling Sub Contractors audit performed to ensure equipment is compliant and the correct spill recovery systems are available to the sub contractor Orica packaging and any spilled raw materials to be managed as per Orica procedures		2	5	10

Blasting Job Safety & Risk Assessment Form. Banora Point – Pacific Motorway Re-alignment						Date 17/6/10			
Event or Activity	Potential Hazards & Effects	L	C	R	Possible Elimination Measures	Responsibility/ Comments	L	C	R

Appendix B Site Specific Pre-Blast Checklist

This checklist is to highlight actions specific to the site that are to be completed during loading and before each firing.

Pre-Blast Checklist	By	Completed	Comments
Before first blast			
Work Cover notification completed	Orica		
Adequate stemming placed on shot	BPUA		
Minimum 1 day before loading			
Permit to Dig	BPUA		
Install Blast Monitors	Orica		
Neighbours notified of blasting	BPUA		
Day of the blast (start of shift)			
Notify site personnel via pre-start			
30 minutes before the blast			
Blast Sentries report to Orica Shotfirer	All		
Arm Monitors	Orica		
After the blast			
Orica to confirm all detonators fired	Orica		