

# **Trial Blast Monitoring Program**

M4-M5 Link Mainline Tunnels

July 2020

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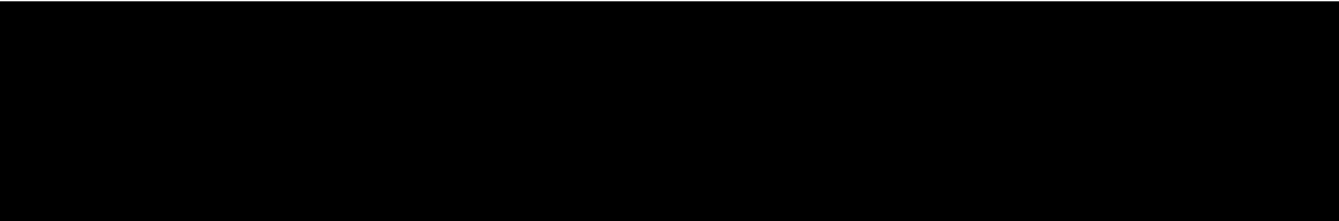
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# Document control

## Approval and authorisation

<b>Title</b>	M4-M5 Link Mainline Tunnels Trial Blast Monitoring Program
<b>Document No/Ref</b>	M4M5-LSBJ-PRW-EN-MP01-PLN-0034



## Internal review

Role	Name	Position	Date	Signature
Originator(s)		Environmental Manager		
Review		Environment & Sustainability Manager		
Authorised		Project Director		

## Glossary/ Abbreviations

Abbreviations	Expanded Text
AA	Acoustic Advisor
CBMP	Controlled Blast Monitoring Program
CCS	Community Communications Strategy
CEMP	Construction Environmental Management Plan
CSSI	Critical State Significant Infrastructure
DPIE	Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EPL	Environment Protection License
ER	Environmental Representative
LSBJV	Lendlease Samsung Bouygues Joint Venture
MIC	maximum instantaneous charge
NSW	New South Wales
REMM	Revised Environmental Mitigation Measures
SPIR	Submissions and Preferred Infrastructure Report
TBMP	Trial Blast Monitoring Program
TBMS	Trial Blast Management Strategy

# 1 Introduction

## 1.1 Context

This Trial Blast Monitoring Program (TBMP) has been prepared for the M4-M5 Link Mainline Tunnels (the Project).

This monitoring program has been prepared to address the requirements of the Minister's Condition of Approval (CoA) C9(d), the WestConnex M4-M5 Link Environmental Impact Statement (EIS) and the revised environmental management measures (REMM) listed in the WestConnex M4-M5 Link Submissions and Preferred Infrastructure Report (SPIR) and all applicable guidance and legislation.

## 1.2 Project background

Chapter 10 and Section 5.7.3 of Appendix J of the Environmental Impact Statement (EIS) (AECOM 2017) foreshadowed the use of blasting as a means to excavate the tunnel and provided some information about which blasting guidelines that may be relevant to this excavation methodology.

The EIS identified the potential for blast impacts during construction are dependent on the blast capacity, methodology and proximity to sensitive receivers. However, it concluded any potential impacts could be managed by tailored blast design to meet relevant criteria. This is undertaken through Trial blasting to assess impacts against known controlled inputs, to inform an appropriate blast design.

Alongside this Monitoring Program is the Trial Blast Management Strategy (TBMS) which describes management actions associated with this blast trial methodology. The TBMS has been prepared in accordance with CoA E98, which states that:

*The Blast Management Strategy must be prepared in accordance with relevant guidelines and in consultation with the EPA 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.*

A separate Blast Management Strategy will be prepared for controlled blasting, should production blasting be determined as viable.

Please refer to Section 1.3 of the Construction Environmental Management Plan (CEMP) for Project description, which was updated along with the Construction Noise and Vibration Management Plan and Community Communications Plan, to acknowledge preparation of blasting documentation and blasting as a construction activity in general.

## 1.3 Scope of the monitoring program

The scope of this monitoring program is to describe how Lendlease Samsung Bouygues Joint Venture (LSBJV) propose to carry out monitoring of a **trial blast** which will be used to determine if production blasting is viable and to inform potential future controlled blasting designs.

A separate Blast Monitoring Program will be prepared for controlled blasting, should production blasting be determined as viable.

## 1.4 Environmental management systems overview

The environmental management system overview is described in Section 1.5 of the CEMP.

## 2 Purpose and objectives

### 2.1 Purpose

The purpose of this TBMP is to describe how the LSBJV proposes to monitor and capture the vibration level data of trial blast in order to establish the K and  $\beta$  site specific constants of the Australian Standard AS2187.2 – Use of Explosives<sup>1</sup> formula presented below.

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

Where:

- d is the distance between the blastholes and the point of measurement;
- w is the maximum instantaneous charge weight per delay;
- K and  $\beta$  are site specific constants.

The K and  $\beta$  are site specific constants that are determined through a trial blast at reduced maximum instantaneous charges (MIC). Once these constants are determined, the relationship between the level of vibration, the quantity of explosive, the amount of rock that will be removed and the distance from the blast can be estimated. The estimation is the core of determining the viability of controlled blasting as a means to excavate the tunnel in the hard rock areas.

This Monitoring Program will apply for the duration of the Project's Trial blasting activities, unless a longer period is specified by the Secretary of the Department of Planning Industry and Environment (DPIE).

### 2.2 Objectives

The key objective of the monitoring program is to ensure that the monitoring of the trial blast is conducted in accordance with all relevant CoA, environmental management measures and licence/permit requirements relevant to controlled blasts are described, scheduled and assigned responsibility as outlined in:

- The EIS prepared for WestConnex M4-M5 Link
- The SPIR prepared for WestConnex M4-M5 Link
- Conditions of Approval granted to the Project on 17 April 2018 and Modified on 25 February 2019, including:
  - CoA C9d
  - CoA C10
  - And other relevant CoA.
- The Project's Environment Protection Licence (EPL) (#21149)

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<sup>1</sup> AS2187.2-2006, "Explosives – Storage, transport and use Part 2: Use of explosives"

A summary of relevant requirements are included in Table 2-1. Note, CoA E96 to E100 are addressed as a separate document, being the Trial Blast Management Plan.

Table 2-1 Requirements for Blasting

Ref.	Requirement	How Addressed				
<b>Conditions of Approval</b>						
A6	Where the terms of this approval require a document or monitoring program to be prepared or a review to be undertaken in consultation with identified parties, evidence of the consultation undertaken must be submitted to the Secretary with the document. <i>(refer to Project Approval for full condition)</i>	Addressed as a separate document, provided to DPIE. Refer to Section 3.2				
A26	The approved Acoustic Advisor must:  (d) review all noise and vibration documents required to be prepared under the terms of this approval and, should they be consistent with the terms of this approval, endorse them before submission to the Secretary (if required to be submitted to the Secretary) or before implementation (if not required to be submitted to the Secretary);  <i>(refer to Project Approval for full condition)</i>	Section 3.4				
C9 (d)	The following Construction Monitoring Programs must be prepared in consultation with the relevant authorities identified for each Construction Monitoring Program to compare actual performance of construction of the CSSI against predicted performance.  <table border="1" data-bbox="263 1164 1129 1406"> <thead> <tr> <th>Required Construction Monitoring Programs</th> <th>Relevant authority(s) and council(s) to be consulted for each Construction Monitoring Program</th> </tr> </thead> <tbody> <tr> <td>Blast Monitoring Program</td> <td>EPA</td> </tr> </tbody> </table>	Required Construction Monitoring Programs	Relevant authority(s) and council(s) to be consulted for each Construction Monitoring Program	Blast Monitoring Program	EPA	This document
Required Construction Monitoring Programs	Relevant authority(s) and council(s) to be consulted for each Construction Monitoring Program					
Blast Monitoring Program	EPA					
C10	Each Construction Monitoring Program must provide: (a) details of baseline data available;	Section 4				
	(b) details of baseline data to be obtained and when;	Section 4				
	(c) details of all monitoring of the project to be undertaken;	Section 5				
	(d) the parameters of the project to be monitored;	Section 5.1				
	(e) the frequency of monitoring to be undertaken;	Section 5.1				
	(f) the location of monitoring;	Section 5.1				



Ref.	Requirement	How Addressed
	(g) the reporting of monitoring and analysis results against relevant criteria;	Section 6
	(h) details of the methods that will be used to analyse the monitoring data;	Section 6
	(i) procedures to identify and implement additional mitigation measures where results of monitoring are unsatisfactory; and	Section 7
	(j) any consultation to be undertaken in relation to the monitoring programs.	Section 3.2
C13	The Construction Monitoring Programs must be developed in consultation with the relevant authorities as identified in Condition C9.	Section 3.2
C14	The Construction Monitoring Programs must be endorsed by the ER and then submitted to the Secretary for approval at least one (1) month prior to commencement of construction.	Section 3.4
C15	Construction must not commence until the Secretary has approved all of the required Construction Monitoring Programs relevant to that activity and all the necessary baseline data for the required monitoring programs has been collected, to which the CEMP relates.	Section 3.4
C16	The Construction Monitoring Programs, as approved by the Secretary, including any minor amendments approved by the ER, must be implemented for the duration of construction and for any longer period set out in the monitoring program or specified by the Secretary, whichever is the greater.	Section 3.4
C17	The results of the Construction Monitoring Programs must be submitted to the Secretary, and relevant regulatory authorities, for information in the form of a Construction Monitoring Report at the frequency identified in the relevant Construction Monitoring Program.	Section 6
C18	Where a relevant CEMP Sub-plan exists, the relevant Construction Monitoring Program may be incorporated into that CEMP Sub-plan.	This CBMP has been prepared as a separate document to the Trial Blast Management Strategy

### 3 Environmental requirements

#### 3.1 Relevant legislation

All legislation and guidelines relevant to this monitoring program are included in the TBMS.

## **3.2 Consultation**

This TBMP was provided to the EPA in accordance with CoA C9 (d) for review and comment. EPA comments were incorporated into the final revision of this document. A separate document, Stakeholder Consultation and Comments Tracking Register, has been prepared to detail the consultation response and how stakeholder comments were addressed in accordance with CoA A6. This document was submitted to DPIE along with this TBMP.

During the trial blast, Community consultation, feedback and complaints relating to blasting will be managed in accordance with the Community Communications Strategy (CCS).

## **3.3 Environment Protection Licence monitoring requirements**

The Project holds an Environment Protection Licence (EPL) (#21149) granted by the NSW Environment Protection Authority (EPA) and updated to detail the management and monitoring requirements associated with trial blasting. The management and monitoring of trial blasting activities will be undertaken in accordance with this EPL.

## **3.4 Endorsements and Approvals**

In accordance with CoA A26(d) the Project Acoustic Advisor (AA) must review all noise and vibration documents required to be prepared under the Project Approval and endorse as appropriate prior to submission to the Secretary. This document was provided to the AA and endorsement obtained prior to submission to DPIE, in accordance with this condition.

In accordance with CoA C14, this Monitoring Program must be endorsed by the Environmental Representative (ER) and then submitted to the Secretary for approval. Following DPIE approval of this Monitoring Program any minor amendments will be lodged with the ER for approval and will be implemented for the duration of trial blasting activities.

Following endorsement from the AA and ER, this TBMP was submitted to DPIE for approval in accordance with CoA C15.

## 4 Baseline Data

Due to the nature of trial blasts there is no baseline data available, rather the Australian Standard AS2187 – Use of Explosives<sup>2</sup> formula presented above in Section 2.1 will be used to design the trial blast using site specific criteria detailed in the Projects EIS.

A trial blast is proposed to occur in July 2020 where baseline data can be obtained. The trial blast will consist of **three individual blasts conducted over a single day** that will have a reduced Maximum Instantaneous Charge (MIC) and will be examined by way of detailed monitoring by the blasting expert in order to create a site-specific site law. This site law will essentially form the baseline data and will be used to design the potential future production blasts to ensure that the relevant vibration guidelines are met.

The initial trial blast site law will be developed consistent with Sydney Harbour Tunnel reference project, as detailed in the Project EIS (Volume 2D, Appendix J – Noise and Vibration, Section 5.7.3 *Rock-breaking and blasting*, page 279).

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<sup>2</sup> AS2187.2-2006, “Explosives – Storage, transport and use Part 2: Use of explosives”

## 5 Monitoring

Vibration monitoring will be undertaken during the trial blast to assess the quantity of MIC against attenuation of vibration over distance within the subject geology.

Monitoring locations will be identified prior to the trial blasts as being fit for use (AS 2187) by the expert blasting consultant, and approval received from the property owners as required. At least **five** monitoring locations will generally be near the perimeter of the sensitive receiver (building) at the point closest to the detonation. However, monitoring locations may differ where property owner permission cannot be obtained.

Trial blast data will be reviewed by the expert blast consultant for analysis, to identify a relationship between MIC and vibration impacts.

All monitoring will be undertaken by competent personnel, suitability trained and experienced in undertaking trial blast monitoring. Vibration monitoring will be undertaken in accordance with AS AS2187 recommendations.

All vibration instruments will be calibrated in accordance with manufacturers specifications or relevant Australian Standards. Records of monitoring equipment calibration will be maintained by LSBJV throughout the delivery of the Project.

All monitoring records will be retained throughout the delivery of the Project by LSBJV.

### 5.1 Vibration Monitoring Strategy

As detailed above, due to the location of the trial blasts deep underground and away from the tunnel portal, vibration and not air blast overpressure will be the key impact to be monitored.

The trial blast will be completed in a representative geological area along the alignment. The trial blast will not provide any detail on fragmentation or diggability, but rather information on the vibration attenuation over distance. These relationships are integral in determining the scale of blasting (i.e. advance rate per day) that can be used.

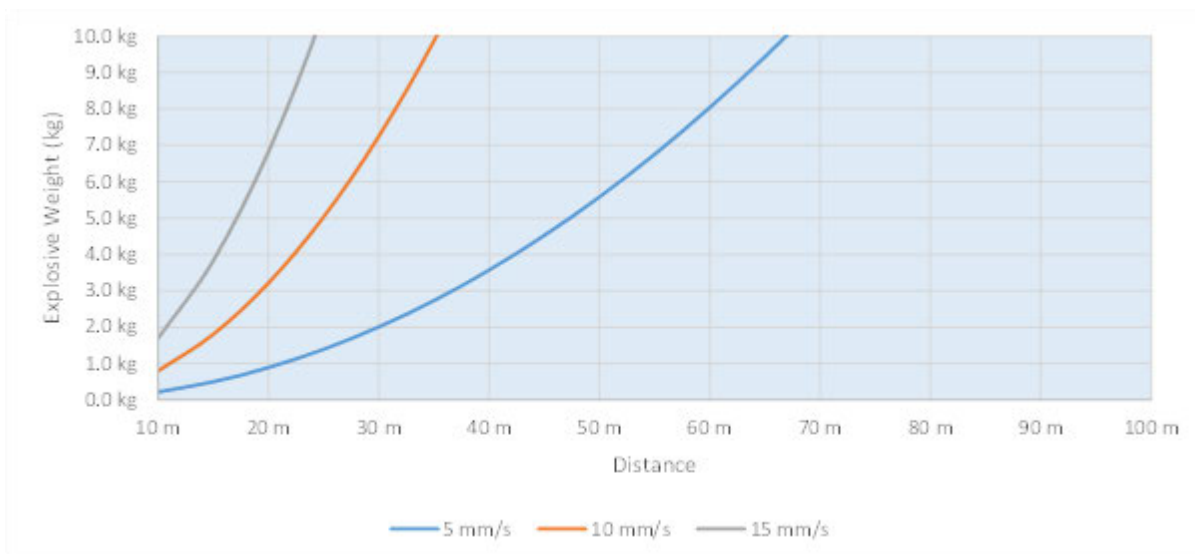
A series of **three** blastholes will be drilled into the wall of the tunnel to a minimum depth of approximately 3 metres. Into each blasthole, a known quantity of explosive will be loaded and the remaining section of the blasthole filled with inert stemming material to control the high-pressure explosive gases. The blastholes will be initiated separately with the results reviewed after each blast to check the vibration level and confirm the explosive loading for the next blast. It is likely that therefore could be **several hours** between each blast to account for the analysis of the monitoring data and loading of the subsequent blast holes.

The key aspects include:

- a) **Objective:** The objective is to confirm the relationship between vibration level, distance and explosive quantity that will allow confirmation of the scale of blasting that can be undertaken.
- b) **Explosive weight:** Explosive weight will be low so as to provide the minimum acceptable level of vibration, ideally **between 5mm and 10mm/s** so as to gather data near but below that would be required for production blasting. Explosive weights at this level will assist in creating a site law that does not overly rely on extrapolation beyond the vibration levels experienced in the trial blasts.
- c) **Design:** The explosive type and trial blast location will be decided depending upon the area of the tunnel that has been advanced at the time of the blast. It is proposed that **three** trial blast holes will be fired.

- d) **Firing Plan:** The preferable requirement is to initiate multiple holes at different times reviewing the vibration results before proceeding to load and initiate the next hole. This will provide the most relevant data as well as ensuring vibration levels remain compliant.
- e) **Monitoring locations:** The number and location of the vibration monitors will vary according to the blast location, however a minimum of **five locations** will be used. There will be no requirement to measure overpressure. Refer to monitoring locations drawing on page 16.
- f) **Analysis:** The measured vibration data will be analysed to develop the site-specific vibration relationship.
- g) **Report:** A technical letter including the data and analysis methods will be prepared.

The key deliverable for the project will be to confirm the EIS vibration relationship between distance, explosive weight and vibration level. This will control the scale of blasting and confirm the length of advance that can be achieved each day. The EIS relationship is shown below:



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 dominant vibration frequency will be identified for each of the **three** trial blasts.

The proposed monitoring sites will generally include:

- The nearest **five** residential properties generally a property towards the north, south, east and west of each blast zone, or as otherwise determined by the expert blasting consultant;
- Any heritage item at risk of damage, that is within 50 metres of each blast zone (this refers to heritage listed buildings/infrastructure or other items, and not Heritage Conservation Areas);
- Commercial properties that contain potentially sensitive equipment, such as electronic or scientific apparatus or other equipment with tight tolerances for vibration impacts;
- As otherwise required under the Project EPL.

The recording duration will be set to exceed the duration of the blast to ensure that the entire event is captured.

Where property owner approval is not obtained, alternative locations may need to be utilised in appropriate public areas.

Vibration monitoring equipment will be installed in accordance with AS2187. The selected monitoring locations will be solid and rigid to best represent the vibration entering the structure of the building under investigation.

Vibration monitoring records will be completed to record details like:

- Date and time of measurements
- Name of person undertaking the measurements
- Type and model number of instrumentation
- Time of day, length of measurement and measurement time intervals
- Monitoring location (including a sketched map of area)
- Measurement location details and number of measurements at each location
- Possible vibration influences from other sources (e.g. domestic vibrations, other mechanical plant, traffic etc.).

## 6 Analysis and Reporting

The monitoring data obtained from the trial blasts will be reviewed the expert blast consultant using standard industry practice in order to determine the K and  $\beta$  site specific constants as described in Section 2.1. This data will be utilised to inform potential future controlled blast designs and to determine the overall viability of controlled production blasting.

In addition to any reporting required under the EPL conditions, in accordance with CoA C17, the results of the trial blast will be reported within the six-monthly Construction Monitoring Reports, which will be submitted to the Secretary of the DPIE and relevant regulatory authorities for information. They will also be provided to the ER and AA.

The Construction Monitoring Report will contain details of blast monitoring including the following information:

- Locations of the monitoring positions;
- Controlled blast monitoring results;
- Date and time when testing was performed.

## 7 Continual improvement and corrective action

Monitoring results from each of the **three trial blasts** will be analysed in order to inform subsequent blast design and MIC in order to comply with the EPL conditions.



# Trial Blast

Proposed Monitoring Locations

## Legend

 Vibration Monitors

