Vipac Engineers and Scientists Limited
Level 2, 146 Leichhardt Street, Spring Hill, QLD 4000, Australia
PO Box 47, Spring Hill, Qld, 4000 Australia
t. +61 7 3377 0400 | **e.** brisbane@vipac.com.au
w. www.vipac.com.au | A.B.N. 33 005 453 627 | A.C.N. 005 453 627

Outline Planning Consultants Pty Ltd

Gulgong Quarry, Tallawang

Noise and Vibration Impact Assessment

70B-24-0362-TRP-81776-1-draft

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Prepared For:	**Prepared By:**
Outline Planning Consultants Pty Ltd Level 3, Suite 2301 4 Daydream Street Warriwood, New South Wales, 2102, Australia **Contact:** Gary Peacock **Tel:** 0418242762	Vipac Engineers and Scientists Limited Level 2, 146 Leichhardt Street, Spring Hill, QLD 4000, Australia **Tel:** +61 7 3377 0400

Author:	Michael Boult 23 Sep 2024	The author's signature will appear here once the document has been created.	Project Engineer
Reviewer:	Reviewer's name will appear here Review date will appear here	The reviewer's signature will appear here once the document has been reviewed.	Reviewer title will appear here
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Executive Summary

Vipac Engineers and Scientists Ltd was engaged by Outline Planning Consultants Pty Ltd to prepare a noise and vibration impact assessment to support the establishment of Gulgong Quarry, at 1848 Castlereagh Highway Gulgong, NSW.

The proposed quarry has a footprint of 7.34ha with a total quarry resource of 4.6 million tonnes. The quarry will operate in the daytime hours only and extract 350,000 tonnes of material per annum.

The purpose of this assessment is to evaluate the potential impacts of noise and vibration generated by the quarry and to provide recommendations to mitigate any potential impacts that might have an effect on any sensitive receptors.

Noise modelling has been undertaken using the SoundPLAN 8.2 computational noise modelling software package for two different operational scenarios supplied by Outline Planning Consultants plus the initial quarry construction.

Noise emissions have been calculated at the closest noise sensitive receptors and all operational and construction scenarios are predicted to comply under the neutral and adverse weather scenarios modelled.

Haul truck noise impacts along Castlereagh Highway are predicted to comply without the need for acoustic mitigation.

Blasting activities associated with the proposed quarry have the capacity to be safely completed within EPA blast vibration and overpressure limits provided that monitoring is conducted during all blasting operations.

Table of Contents

1 Introduction

Vipac Engineers and Scientists Ltd (Vipac) was engaged by Outline Planning Consultants Pty Ltd on behalf of Hamish and Sally Drury (the Proponent) to prepare a noise and vibration impact assessment to support a development consent application for a quarry at Tallawang NSW, on Lot 1 in Deposited Plan (DP) 1239728, which forms a part of a larger rural holding known as 'Talinga', No.1848 Castlereagh Highway Gulgong NSW 2852, otherwise known as 'Gulgong Quarry'. The Proponent proposes development of the hard rock quarry with a quarry footprint totalling approximately 7.34ha, a total resource of approximately 4.6 million tonnes and a proposed extraction rate of up to 350,000 tonnes per annum (the Project).

The purpose of this assessment is to evaluate the potential impacts of noise and vibration generated from the Project and to provide recommendations to mitigate any potential impacts that might have an effect on nearby sensitive receptors.

1.1 Study Objectives and Requirements

The NSW Environment Protection Authority (EPA) has considered the details of the proposals as provided by the Department of Planning, Industry and Environment (DPIE) and identified the information it requires to issue its general terms of approval. The key requirements specified in relation to noise and vibration and how the requirements are addressed within this document are summarised in Table 1-1.

The purpose of this assessment is to evaluate the potential impacts of noise and vibration generated from the Project which addresses the specific EPA requirements and provide recommendations to mitigate any potential impacts that might have an effect on nearby sensitive receptors.

Table 1-1: Summary of EAR

Requirements	How Requirement is Addressed
4.1 Construction noise associated with the proposed development should be assessed using the *Interim Construction Noise Guideline* (DECC, 2009). These are available at: https://www.epa.nsw.gov.au/your-environment/noise/industrial-noise/interim-construction-noise-guideline	Construction noise associated with quarry and mining is not covered by the Interim Construction Noise Guideline (in accordance with Section 1.2 of the Guideline). Instead it states construction noise for quarries is assessed under the Noise Policy for Industry.
4.2 Vibration from all activities (including construction and operation) to be undertaken on the premises should be assessed using the guidelines contained in the *Assessing Vibration: a technical guideline* (DEC, 2006). These are available at: https://www.epa.nsw.gov.au/your-environment/noise/industrial-noise/assessing-vibration	Vibration levels from the quarry road traffic movements along the surrounding road networks were assessed in Section 6 at the closest receivers along the haul routes. Vibration from Quarry operation is addressed in Section 7.1.
4.3 If blasting is required for any reasons during the construction or operational stage of the proposed development, blast impacts should be demonstrated to be capable of complying with the guidelines contained in *Australian and New Zealand Environment Council – Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (ANZEC, 1990). These are available at: https://www.epa.nsw.gov.au/your-environment/noise/industrial-noise/interim-construction-noise-guideline	Blasting impacts are addressed in Section 7.2.
4.4 Operational noise from all industrial activities (including private haul roads and private railway lines) to be undertaken on the premises should be assessed using the guidelines contained in the *NSW Noise Policy for Industry* (EPA, 2017). https://www.epa.nsw.gov.au/your-environment/noise/industrial-noise/noise-policy-for-industry-(2017)	Operational noise of the quarry was modelled and illustrated under Section 4.2. Other details of the modelling and methodology are shown in Section 4 and detailed results are shown in Section 5. Road traffic noise from existing quarry truck movements along the haul routes were also assessed in the road traffic noise impact assessment in Section 6.2.
4.5 Noise on public roads from increased road traffic generated by land use developments should be assessed using the guidelines contained in the *NSW Road Noise*	A road traffic noise impact assessment was conducted for the potential increase in quarry truck movements along

Policy and associated application notes (EPA, 2011). https://www.epa.nsw.gov.au/your-environment/noise/transport-noise	the haul routes in Section 6.2 at a number of closest receivers along the haul routes.

2 Project Description

The Gulgong Quarry is proposed to operate on a stony, elevated hill on a site currently used as a borrow pit for supplying hard rock for farm-related purposes, extracting 350,000 tonnes per annum of quarry material from a quarry footprint of 7.34ha. The total resource of the quarry is 4.6 million tonnes, and it will be accessed from an internal access route connecting directly with the Castlereagh Highway.

The proposed quarry site is situated approximately 21.5 km north of Gulgong within the Mid-Western Regional Council area. It is proposed that the extracted hard rock resource from this quarry will be used as road base or select fill, primarily supporting infrastructure projects in the nearby Central-West Orana Renewable Energy Zone (CWO-REZ). Drawings of the quarry are reproduced in Appendix A.

2.1 Noise Sensitive Receptors

The region surrounding the project site is sparsely populated, with the nearest noise sensitive receptors (NSRs) shown in Figure 2-1 and Table 2-1. Note that R4 is owned by the quarry proponent but is still included in the assessment results for the purposes of transparency.

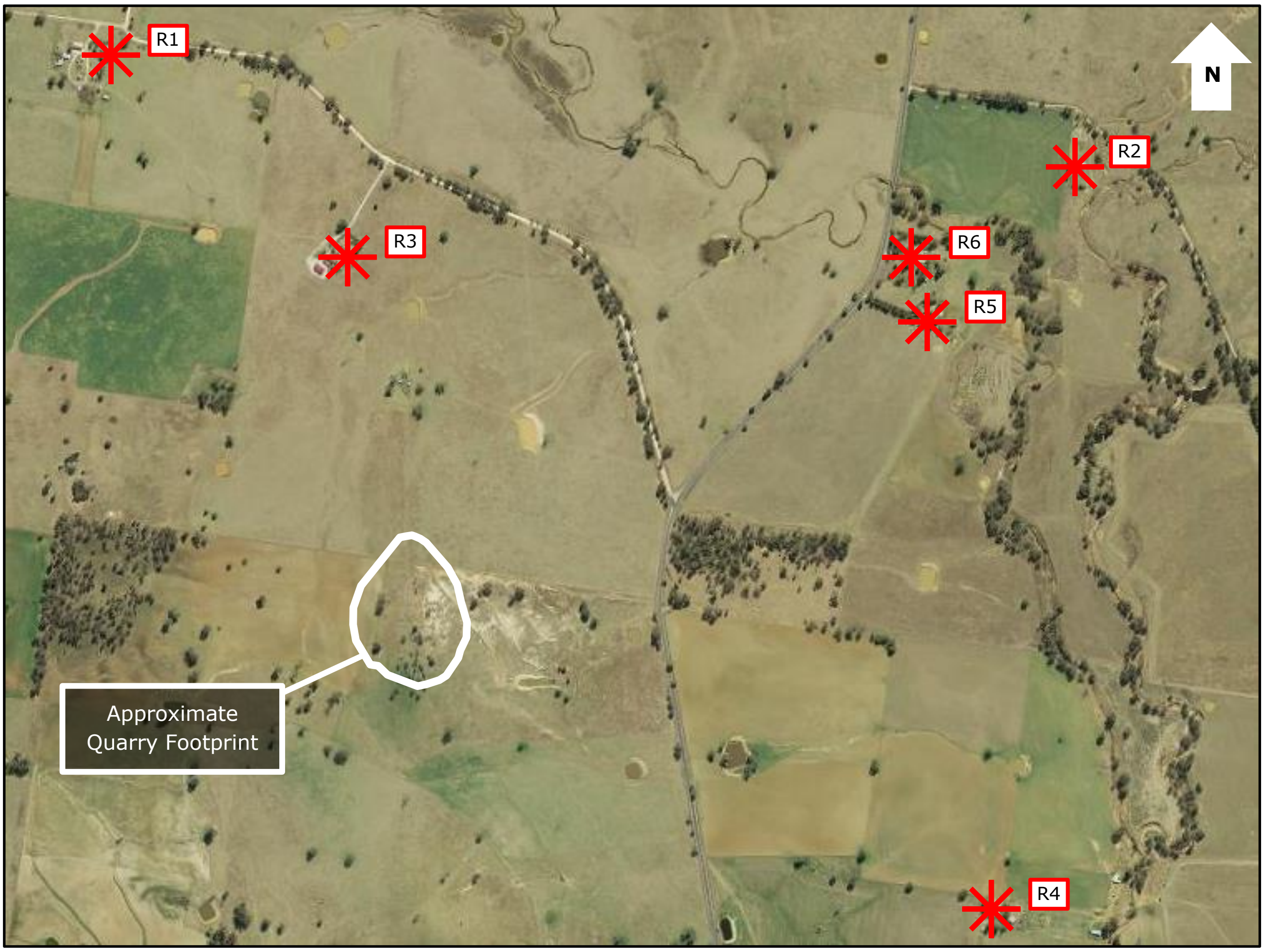


Figure 2-1: Map of Noise Sensitive Receptors

Table 2-1: List of Nearest Noise Sensitive Receptors (NSRs)

Identifier	Lot Number	Address	Distance & Direction to Site
R1	Lot 98 on DP750751	7 Corishs Lane, Tallawang	1415m NW of site
R2	Lot 1 on DP861634	40 Whistons Lane, Tallawang	1900m NE of site
R3	Lot 2 on DP1239728	117 Tucklan Road, Tallawang	788 NW of site
R4*	Lot 40 on DP1248995	1848 Castlereagh Highway, Tallawang	1400m SW of site
R5	Lot 12 on DP750751	2152 Castlereagh Highway, Tallawang	1345m NW of site
R6	Lot 18 on DP750751	2162 Castlereagh Highway, Tallawang	1460m NW of site

* R4 a rural dwelling owned by the quarry proponent and is associated with Talinga Pastoral Farm Holding.

2.2 Quarry Operation

The quarry is proposed to operate in three stages that include:

1. Quarry Construction, consisting of topsoil removal and limited equipment (refer to Section 4.2.1 for details).
2. Stage 1 Operation, where the southern half of the quarry is extracted to an approximate RL of 496m to 500m.
3. Stage 2 Operation, extraction of the northern half of the quarry to the same approximate depth as Stage 1.

During all stages, quarry construction and operation will occur between:

- 7:00am to 6:00pm, Monday to Saturday.
- Blasting is restricted to 9:00am to 3:00pm. Monday to Friday.

3 Criteria

The noise criteria are determined in accordance with the NSW Noise Policy for Industry (NPI, 2017), the NSW Road Noise Policy (RNP, 2011) and the NSW Interim Construction Noise Guideline (ICNG, 2009). Vibration criteria are determined in accordance with the NSW Assessing Vibration: A Technical Guideline (2006).

3.1 NSW EPA Noise Policy for Industry (NPI)

The project specific noise criterion limits the noise that a development can make in accordance with the *NSW Noise Policy for Industry 2017* (NPI) in order to limit the effects of the development on the existing noise sensitive receptors.

3.1.1 Project Specific Noise Criterion

The project specific noise criterion limits the noise that a development can make in accordance with the NPI in order to limit the impact of the development on the existing noise sensitive receptors.

The NPI sets limits on the noise that may be generated by a wide array of facilities and includes guidance that is applicable for the assessment of potential noise impacts from the operational stages of developments and construction stages of quarries. These limits are dependent upon the existing noise levels at the site and are designed to ensure changes to the existing noise environment are minimised and deal with the intrusiveness of the noise and the amenity of the environment. The most stringent of the limits is taken as the Project Specific Noise Level which is the most stringent of the amenity criteria or the intrusiveness criteria for the location.

The amenity criteria for this project are recommended acceptable $L_{Aeq,T}$ noise levels for residences in rural areas as provided in Table 2.2 of the NPI. Amenity criteria are formulated to protect against cumulative impacts. The intrusiveness noise criterion requires that the $L_{Aeq,15minutes}$ for the noise source, measured at the most sensitive receiver under worst-case conditions, should not exceed the Rated Background Level (RBL) by more than 5dB, represented as follows:

- $L_{Aeq,15minutes}$ < RBL+ 5dB

Noise levels associated with the quarry at nearby noise sensitive receptors (located in the surrounding area) should not exceed the Project Specific Noise Levels detailed in Table 3-2 which have been determined from the lower of the amenity and intrusiveness criteria.

3.1.2 Amenity Noise Criterion

The amenity criterion is specific to land use and associated activities. It aims to limit continuing increases in noise levels. The maximum ambient noise level within an area should not exceed the acceptable noise levels specified in Table 3-1.

Table 3-1: Amenity Noise Levels

Receiver	Noise Amenity Area	Time of Day	L_{Aeq}, dB(A)
Residential	Rural	Day (7am-6pm)	50
		Evening* (6pm-10pm)	45
		Night* (10pm-7am)	40

* The quarry proposes to operate under the operating hours presented in Section 0. All hours of operating are between 7am and 6pm and therefore only the day period has been considered for assessment.

3.1.3 Intrusiveness Noise Criteria

The intrusiveness criterion states that the equivalent continuous noise level of the source should not be more than 5 decibels above the rated background level when measured over a 15 minute period. It aims to control intrusive noise impacts in the short term for residences.

$$L_{Aeq,\ 15\ minute} \leq \text{rating background level} + 5\ \text{dB}$$

The NSW NPI states that where the rating background noise level (RBL) is found to be less than 35dB(A) for the daytime periods, then the RBL should be set to 35dB(A). No noise monitoring was carried out at the Dorrigo Quarry but from previous noise monitoring work carried out by Vipac on similar quarry sites in the region, it is unlikely the RBL at the nearest NSRs is greater than 35 dB(A). Therefore, the RBL has assumed to be 35 dB(A) which sets the intrusiveness criterion at 40dB(A).

3.1.4 Project Specific Noise Levels

The project specific noise criterion was determined in accordance with the NPI using background data logged at the most exposed noise sensitive receptor.

Table 3-2: Project Specific Noise Levels (dB (A))

Receptor	Time of Day	Rating Background Level (RBL)	Intrusiveness Criterion	Amenity Criterion	Project Specific Noise Level
All	Day	35*	40	50	**40**

* The NSW NPI states that where the rating background noise level is found to be less than 35dB(A) for the daytime periods, then it is set to 35dB(A).

3.2 NSW Road Noise Policy (RNP)

The requirements of the *NSW Road Noise Policy 2011* (RNP) are applicable to this assessment. Table 3-3 summarises the road category to establish the noise assessment criteria based on the type of roads proposed for use. The criteria for the applicable categories of the roads surrounding the project site are detailed in Table 3-3. Note: These criteria are for assessment against façade- corrected noise levels when measured in front of a building façade.

Table 3-3 - Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of project / land use	Assessment Criteria/ Target Noise Level, dB(A)	
		Day (7am-10pm)	Night [2] (10pm-7am)
Local Roads	Existing residences affected by additional traffic on existing local roads generated by land use developments.	$L_{Aeq,\ (1\ hour)}$ 55 (external)	*$L_{Aeq,\ (1\ hour)}$ 50 (external)*
Freeway/arterial/sub-arterial Road[1] (Castlereagh Highway)	Existing residences affected by additional traffic on existing local roads generated by land use developments.	$L_{Aeq,\ (15\ hour)}$ 60 (external)	$L_{Aeq,\ (9\ hour)}$ 50 (external)

[1] Principal haulage routes are to be assessed against the criteria for arteria/sub-arterial roads in accordance with Section 2.2.2 of the RNP.

[2] The quarry only operates during the daytime period only, night-time criteria is therefore not applicable.

In addition to the criteria detailed in the table above, the magnitude of increase in the total traffic noise level at a location due to a proposed project or traffic-generating development must be considered. Residences experiencing increases in total traffic noise level above the relative increase criteria in Table 3-4 should also be considered for mitigation.

Table 3-4 Relative Increase Criteria for Residential Land Uses

Road Category	Type of project / land use	Total traffic noise level increase, dB(A)	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/arterial/sub-arterial Road	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road	Existing traffic $L_{Aeq, (15\ hour)}$ + 12 dB (external)	*Existing traffic $L_{Aeq, (9\ hour)}$ + 12 dB (external)*

A relative increase of 12 dB represents slightly more than an approximate doubling of perceived loudness (AS2659.1–1988) and is likely to trigger community reaction, particularly in environments where there is a low existing level of traffic noise.

3.3 Operational Vibration Criteria

The NSW DEC guideline *Assessing Vibration: A Technical Guideline* (2006) is based on guidelines contained in British Standard BS 6472-2008 'Evaluation of human exposure to vibration in buildings (1-80Hz)'.

The guideline provides preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration levels are still beyond the maximum level, it is recommended the operator negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the DEC guideline provides examples of the three vibration types and are summarised as continuous vibration, impulsive vibration and intermittent vibration. The relevant type of vibration for this project is intermittent vibration. Intermittent vibration (as defined in the DEC guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time. Intermittent vibration is representative of activities such as impact hammering, rolling or general excavation work (such as an excavator tracking). Section 2.4 of the guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted root mean square (rms) acceleration levels over the frequency range 1 Hz to 80 Hz; the criteria are presented in Table 3-5.

Table 3-5: Acceptable Vibration Dose Values (VDV) for Intermittent Vibration ($m/s^{1.75}$).

Location	Daytime (7am-10pm), VDV		Night time (10pm-7am), VDV	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60
Critical areas (e.g. hospital operating theatres)	0.10	0.20	0.10	0.20

Structural vibration criteria for building damage due to blasting is considered the same as that induced by transient groundborne vibration due to general construction activities. Vibration levels for potential building damage contained in *British Standard BS 7385-2:1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration* are referenced in *British Standard BS 5228-2:2009* and *Australian Standard AS 2187.2:2006*. The vibration levels in BS 7385-2:1993 are adopted as building damage criteria from construction activities and have been reproduced in Table 3-6:

Table 3-6: Transient Vibration Guide for Values of Cosmetic Damage (Table J4.4.2.1 of BS 7385-2:1993)

Line	Type of Building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures. Industrial and heavy commercial buildings	50mm/s at 4Hz and above	
2	Unreinforced or light framed structure. Residential or light commercial type buildings	15mm/s at 4Hz increasing to 20mm/s at 15 Hz	20mm/s at 15 Hz increasing to 50mm/s at 40Hz and above

Notes:

- Values referred to are at the base of the building.
  For line 2, at frequencies below 4 Hz, a maximum displacement of 0.6mm (zero to peak) should not be exceeded)

3.4 Blasting Vibration and Airblast Overpressure

3.4.1 ANZEC – Blasting Guidelines

The Australian and New Zealand Environment Council (ANZEC) Guidelines (Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration) provides the following guidance to minimise the annoyance due to blasting overpressure and ground vibration.

- The recommended maximum level for airblast overpressure is 115 dBL. This level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 120 dBL at any time.
- The recommended maximum level for ground vibration is 5 mm/s peak particle velocity. This level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 10 mm/s peak particle velocity at any time.

3.4.2 AS2187.2-2006 Explosives – Storage and Use

At sufficiently high levels, blast overpressure may, in itself, cause structural damage to some building elements such as windows. Appendix J of Australian Standard 2187.2-2006 (Explosives – Storage and use, Part 2: Use of Explosives) provides information on ground vibration and airblast overpressure from blasting. Guidance is provided for the measurement, prediction and control of blast impacts. The importance of blast management and blast monitoring records in minimising blast impacts is stated.

Appendix J of AS2187.2-2006 also provides information regarding research from Australia and Internationally which indicates that damage, even of a cosmetic nature is unlikely and has not been found to occur at airblast (overpressure) levels below 133dB.

With regard to assessment of potential damage due to ground vibration, Appendix J of AS2187.2-2006 recommends frequency dependent criteria for vibration damage, based on data derived from BS 7385-2 and the United States Bureau of Mines Standard RI 8507. BS 7385: Part 2-1993 Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from groundborne vibration and the United States Bureau of Mines Standard RI 8507 provide guidance values for building damage, as well as guidance on vibration measurement and data analysis.

The guidance set out in these documents regarding assessment criteria are less stringent than the human comfort criterion of 5mm/s as outlined above. In terms of the assessment criteria applicable to blast vibration and for the frequencies that are typically associated with blasting, a value of 10mm/s peak particle velocity is representative of a conservatively low estimate, beyond which structural damage may possibly occur.

4 Noise Modelling

Noise modelling has been undertaken using the SoundPLAN 8.2 computational noise modelling software package. The use of the SoundPLAN software and referenced modelling methodology is accepted for use in the State of NSW by the EPA for environmental noise modelling purposes. Vipac have undertaken numerous noise modelling and impact assessments previously using SoundPLAN for a range of projects, including infrastructure development and industrial projects.

4.1 Reference Information

Outline Planning Consultants have supplied the following documents and drawings to be used plans for the noise prediction model.

- 'GULONG QUARRY STAGE DESIGNS V4' dxf file containing ground elevation data of the quarry for each stage, sent to Vipac on the 19th of September, 2024.
- '23-1311 Location Plan – Elvis Lidar w Aerial REV2' dxf file containing ground elevation data for the surrounding terrain including all NSRs in Section 2.1, sent to Vipac on the 12th of July, 2024.
- DRAFT Environmental Impact Statement, prepared by Outline Planning Consultants and sent to Vipac on the 12th of July, 2024.
- DRAFT Gulgong Quarry Traffic Impact Assessment, prepared by Streetwise Road Safety & Traffic Services and sent to Vipac on the 19th of September, 2024.

4.2 Noise Sources

Noise sources for all stages of the quarry have been detailed in Sections 4.2.1 and 4.2.2 and have been modelled as operating simultaneously for 100% of the time over the 15 minute assessment period.

Predicted octave band results show no tonality at any receptor. Additionally, no intermittency characteristics were observed when conducting the attended measurements of the Quarry plant and equipment. As a result, noise from the Quarry:

- Does not exhibit any prominent (tonal) sound frequency that would have the potential to result in greater annoyance,
- Does not exhibit any notable, intermittent fluctuations (i.e. does not increase rapidly by 5-10dB, depending on time of day, on at least two occasions during a 30 minute period, then maintaining that noise level for at least 60 seconds) that would have the potential to result in greater annoyance, and
- Does not exhibit any impulsive characteristics that would have the potential to result in greater annoyance, with the exception of the excavator.

4.2.1 Construction Noise Sources

Details of the construction plant and equipment has been provided by Outline Planning Consultants on behalf of the client and is detailed in Table 4-1. Sound Power Levels (SWL) have been primarily taken from measurements conducted by Vipac of the machinery that were in operation at McCormack's Pit in Gunnedah, on the 7th June 2022 unless stated otherwise. Note that the bulldozer and excavator are not operating at the same time and construction noise has been modelled in separate scenarios (one with a bulldozer and one with an excavator operating). Both scenarios include the haul truck.

Table 4-1: Sound Power levels of Construction Equipment & Plant

Plant / Equipment	Sound Power Level dB(A)	Source Height	Reference
Haul Truck	91	2m	Vipac measurement of Kenworth Rigid Tipper driving at low speeds
CAT D8 Bulldozer with Reverse Beeper	116	2m	Vipac measurement from McCormack's pit (07/06/2022)
Kobelco 38/50t Excavator	110	2m	British Standard BS5228-1:2009 Table C1 (228kW / 44t excavator)

4.2.2 Operational Noise Sources

Operational plant and equipment details for stages 1 and 2 have been provided by Outline Planning Consultants on behalf of the client and is detailed in Table 4-2. These noise sources are in addition to the construction plant and equipment, all of which will be used in quarry operation. Note that the excavator and bulldozer have been modelled to operate simultaneously in operational stages 1 and 2 as a worst case scenario.

Table 4-2: Sound Power levels of Construction Equipment & Plant

Plant / Equipment	Sound Power Level dB(A)	Source Height	Reference
Kleeman MC110 Jaw Crusher (or similar)	119	2m	Vipac measurement from Mary's Mount Landfill Project (May 2021)
Metso LT-220 Cone Crusher with Screen	121	2m	
CAT 972/950 Front End Loader	99	2m	
Generator	101	1m	Datasheet for Cummins C500D6E 500 kW Generator with Doors Closed

4.2.3 Noise Source Locations

Noise modelling has been conducted separately for each stage of the quarry as described in Section 2. Quarry plant and equipment were modelled in the worse-case location for each stage to ensure a conservative assessment.

Note that Stage 1 commences in the southern section of the quarry after initial blasting has been conducted. The quarry wall will be over 15m after initial blasting and will provide significant noise attenuation for receptors that aren't within line-of-sight of plant/equipment operating near the base of the quarry wall.

The worst case noise source locations for the construction stage and operational Stages 1 and 2 are shown in Figure 4-1, Figure 4-3 and Figure 4-3 respectively. All maps show the Stage 2 (final) quarry outline in yellow.

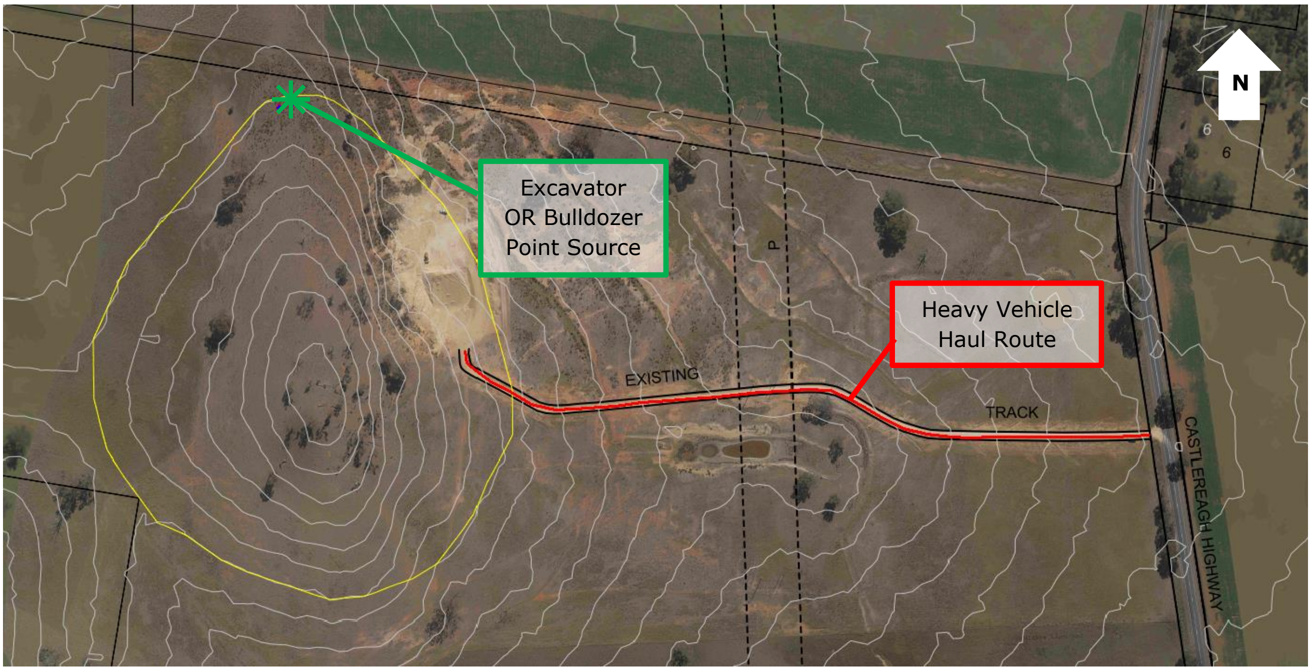


Figure 4-1: Construction Stage Noise Source Locations

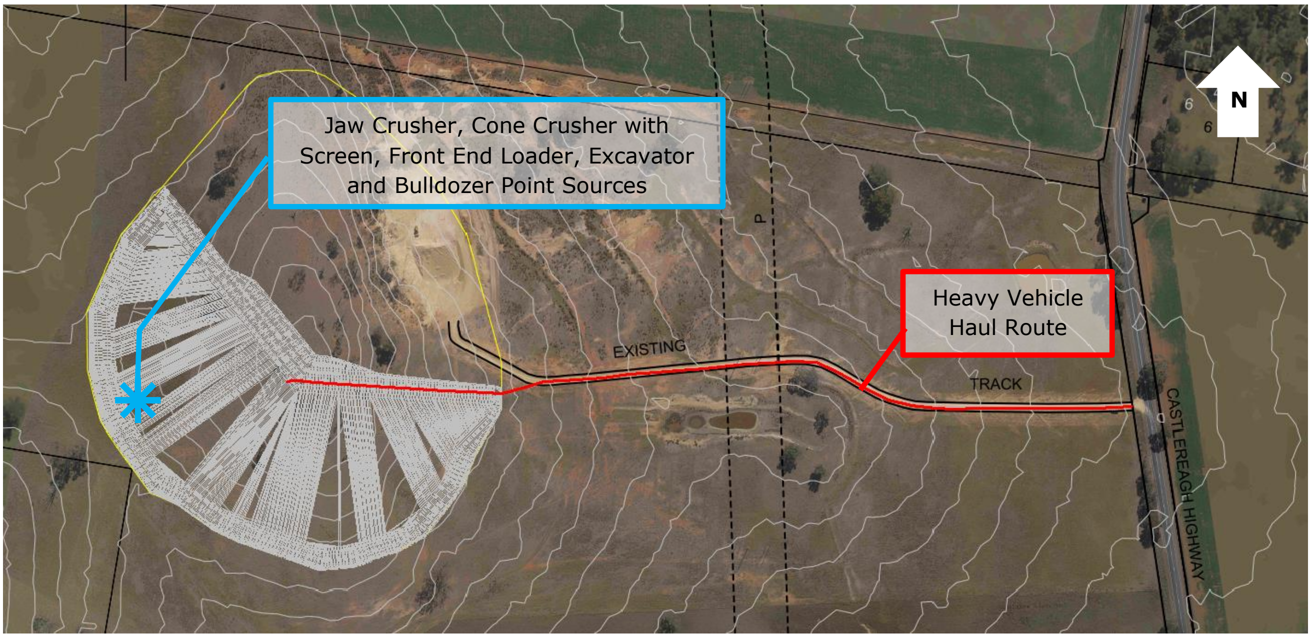


Figure 4-2: Stage 1 Noise Source Locations

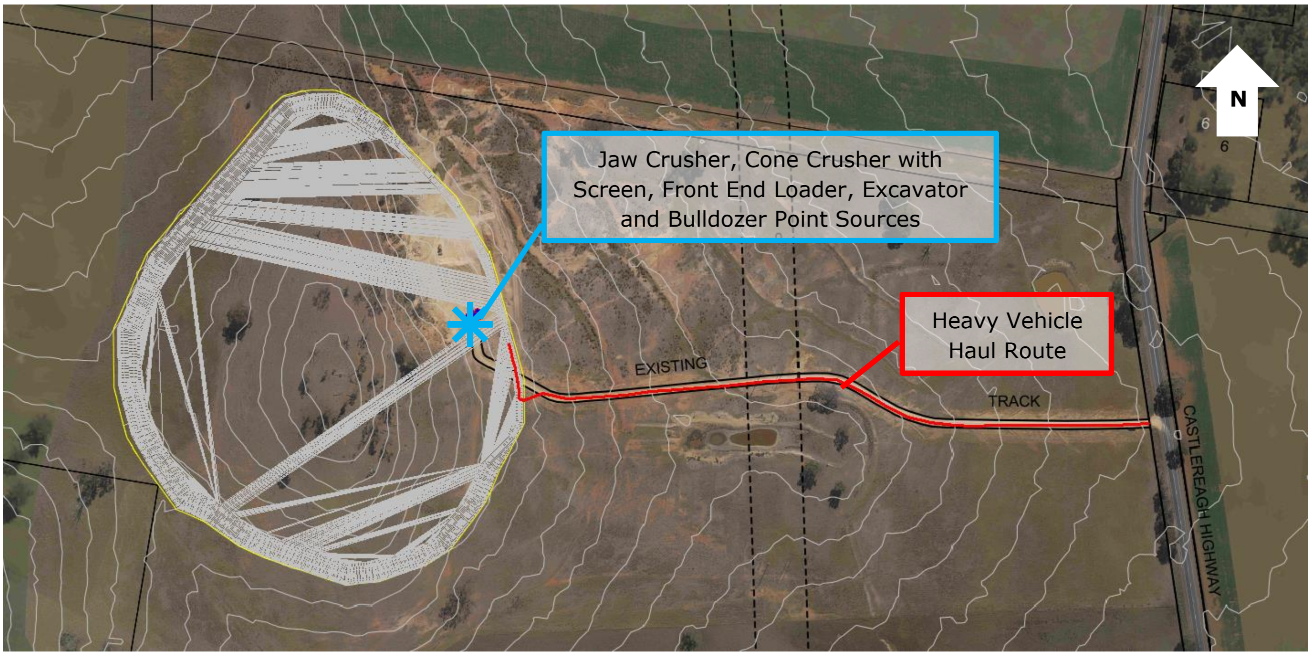


Figure 4-3: Stage 2 Noise Source Locations

4.3 Weather Conditions

Noise propagation over long distances can be significantly affected by the weather conditions, mainly source-to-receiver winds and temperature inversions, as both these conditions can increase noise levels at sensitive receptors.

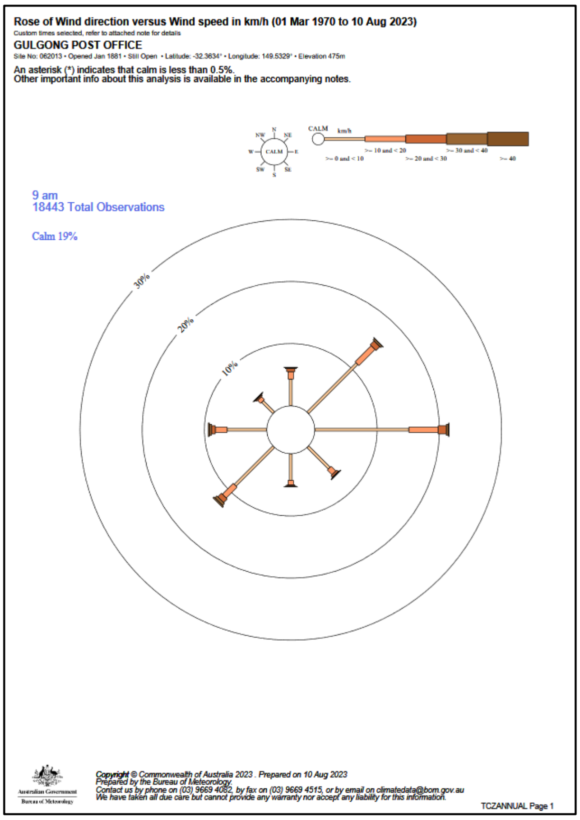
The CONCAWE methodology can predict to one of six meteorological categories (CAT). To determine which category is modelled, the Pasquill Stability Classes need to be determined for the Quarry. For this assessment the weather conditions, including stability class frequencies at the Quarry have been obtained from The Air Pollution Model (TAPM). TAPM is a three-dimensional prognostic model developed and verified by Commonwealth Scientific and Industrial Research Organisation (CSIRO). TAPM data was generated for the air quality assessment has been used for uniformity. The wind parameters were compared for the Bureau of Meteorology (BOM) and TAPM data and were found to be very similar.

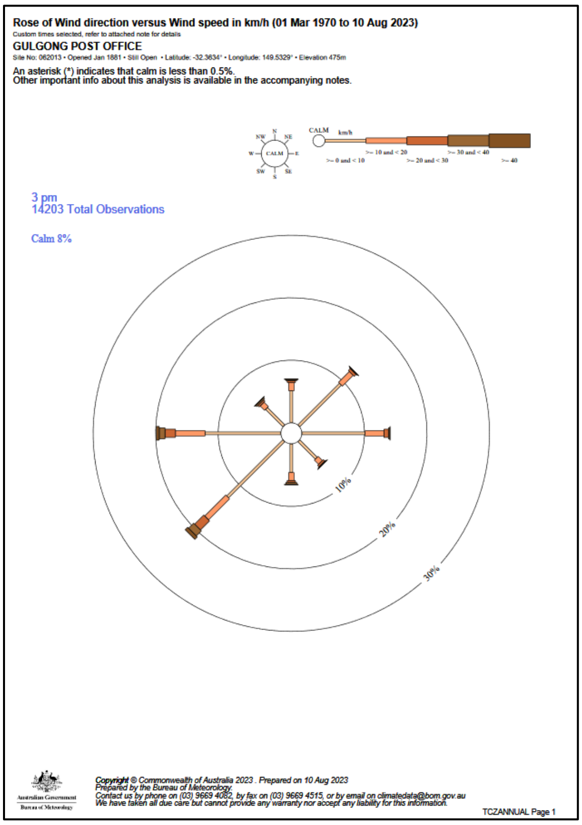
Atmospheric stability refers to the tendency of the atmosphere to resist or enhance the motion of noise. The Pasquill-Gifford Stability Classes define the amount of turbulence in the air, of which the most widely used categories are Classes A-F. The TAPM generated meteorology determined the stability class for each hour of the year. The frequency of each stability class occurrence is shown in Table 4-3. Temperature inversions are defined as Class F. These conditions only occur with clear and calm conditions during the evening and night time periods. During temperature inversions noise emissions from distant sources can be amplified.

Table 4-3: Annual Stability Class Distribution Predicted [TAPM, 2019]

Stability Class	Description	Frequency of Occurrence (%)	Average Wind Speed (m/s)
A	Very unstable low wind, clear skies, hot daytime conditions	2.8	1.3
B	Unstable clear skies, daytime conditions	14.3	2.2
C	Moderately unstable moderate wind, slightly overcast daytime	19	3.7
D	Neutral high winds or cloudy days and nights	29.9	6.0
E	Stable moderate wind, slightly overcast night-time conditions	13	4.1
F	Very stable low winds, clear skies, cold night-time conditions	21	1.9

The long term wind roses recorded daily at the Gulgong weather station (station ID: 062013) at 9am and 3pm are provided in Figure 4-4. Winds are shown to be primarily from the east at 9am and from the southeast directions at 3pm.





Location: **Gulgong BoM Station** **Data Period: 1970 to 2023** **Data Type: Measured Data**

Figure 4-4: Annual Wind Roses for Gulgong Weather Station (1970-2023)

Figure 4-5 shows the wind roses for the time of day during the 2023 for the modelled data at a site as close as possible to the Gulgong BoM Station site. It can be seen that easterly winds are dominant at both times with some westerly and north westerly influences also apparent. These wind patterns are generally consistent with those shown for the long term measured data at the Gulgong BoM Station in Figure 4-4

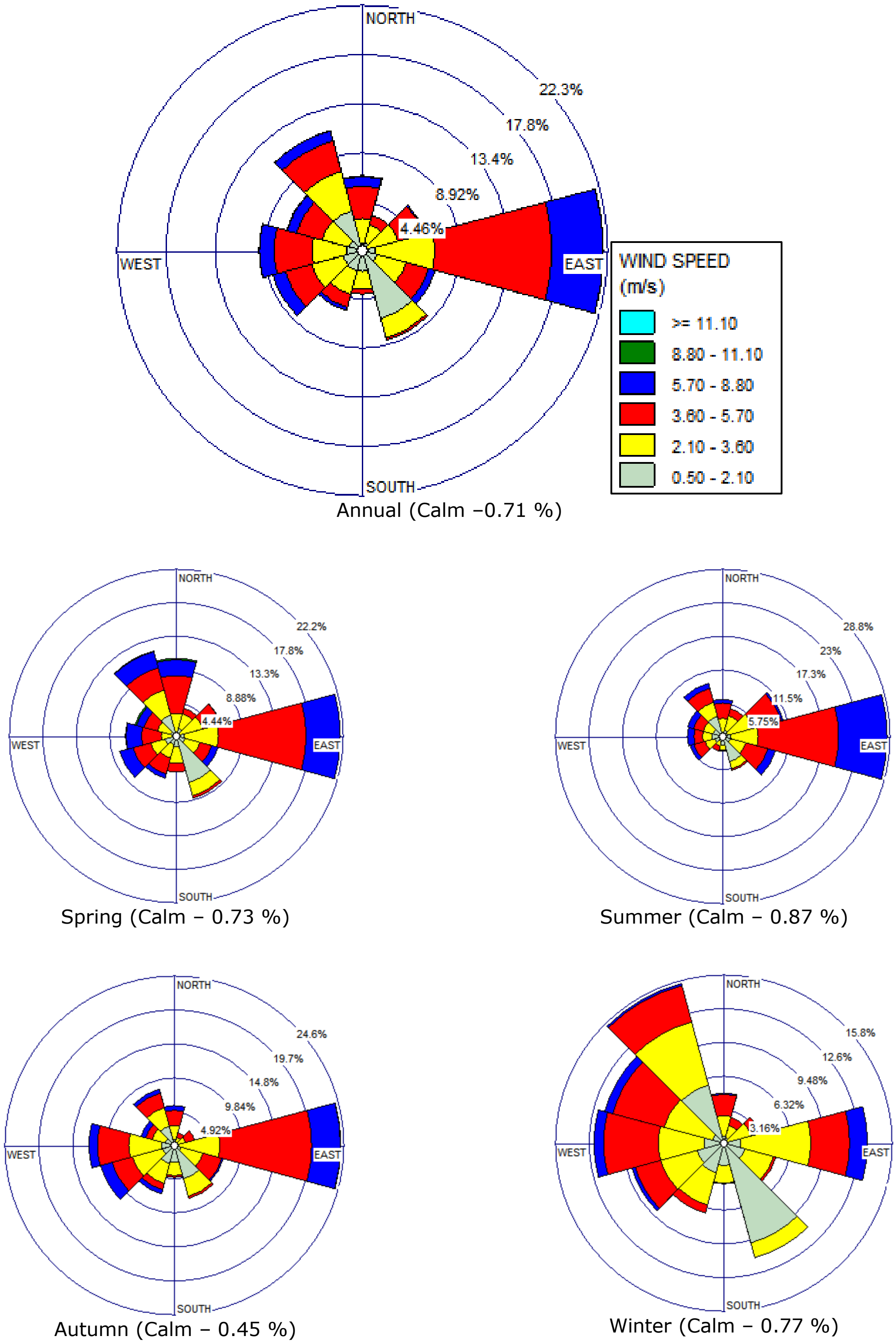


Figure 4-5: Site-specific wind roses by season for the TAPM-CALMET derived dataset, 2023

4.3.1 Modelled Weather Scenarios

Taking into consideration the time of day the Quarry is proposing to operate, the following weather scenarios have been assessed:

Average/Neutral Climatic Conditions:

- Class D has been modelled for the average climatic condition scenarios for day, with 0m/s wind speeds.

Worst Case Climatic Conditions:

- Worst case climatic conditions during the day period have been assessed as per Class D, but with 3m/s wind speeds blowing towards the receivers.

5 Predicted Noise Impact

Noise prediction modelling has been carried out to assess the potential impact associated with the Quarry construction and operations at the nearest noise sensitive receptors when subject to neutral and adverse weather conditions during the day-time period.

5.1 Construction Noise

The predicted noise level from the construction stage is in Table 5-1 and noise contour maps can be found in Appendix B. Note that the excavator and bulldozer aren't operating at the same time and they have been modelled separately. All scenarios include the haul truck operating.

Table 5-1: Predicted Construction Noise Levels

Receptor	Noise Limit	Predicted Noise Level with Bulldozer $L_{Aeq,15mins}$ dBA		Predicted Noise Level with Excavator $L_{Aeq,15mins}$ dBA	
		Neutral Weather	Adverse Weather	Neutral Weather	Adverse Weather
R1	40 dBA	24	29	25	31
R2		19	25	20	27
R3		32	37	35	40
R4		22	27	23	29
R5		23	29	26	31
R6		23	29	25	31

5.2 Operational Noise

Table 5-2 contains the predicted noise level from Operational Stages 1 and 2 of the proposed Gulgong Quarry. Noise contour maps can be found in Appendix B and source contributions at the most exposed receptors during stage 2 (adverse weather) are in Appendix C.

Table 5-2: Predicted Operational Noise Levels

Receptor	Noise Limit	Stage 1 Predicted Noise Levels $L_{Aeq,15mins}$ dBA		Stage 2 Predicted Noise Levels $L_{Aeq,15mins}$ dBA	
		Neutral Weather	Adverse Weather	Neutral Weather	Adverse Weather
R1	40 dBA	15	29	20	27
R2		11	24	16	18
R3		23	35	27	34
R4		16	28	22	22
R5		15	26	20	22
R6		14	28	20	22

6 Traffic Noise Impact Assessment

6.1 Traffic Noise Impact Methodology

The Calculation of Road Traffic Noise (CoRTN) method of traffic noise prediction has been used, which is a method approved by the EPA. The assessment considers two worst-case scenarios, both assuming all quarry truck movements are on the Castlereagh Highway. This is equal to an additional 120 truck movements per day (i.e. laden and unladen) as a 'worst case'.

The traffic data presented in the Draft Gulgong Quarry Traffic Impact Assessment (prepared by StreetWise Road Safety & Traffic Services, sent to Vipac 19/09/2024) included the average annual daily traffic (AADT) volumes on the surrounding road networks measured for a 2022 Traffic Impact Assessment of the CWO-REZ. Results have been reproduced below:

- AADT of 725 on Castlereagh Highway, North of the Intersection with Tucklan Road.
- AADT of 1445 on Castlereagh Highway, South of the Intersection with Tucklan Road

Traffic volumes on the Castlereagh Highway, north of Tucklan Road, are currently below the minimum threshold for CoRTN to predict road traffic noise levels reliably. Section 2, paragraph 30 of CoRTN stipulates that a minimum of 1,000 vehicles in an 18-hour period are required to predict noise levels (inclusive of a low traffic flow correction). Calculations using traffic flow data that is below 1,000 vehicles in an 18-hour period are considered unreliable, and CoRTN recommends noise measurements be conducted when evaluating such cases.

Noise measurements of the surrounding road network have not been undertaken, however as a proof of concept, any low traffic flow correction that results from calculating noise impacts from a road with a minimum AADT of 1,100 (18-hour volume of 1,034) has been applied to the predicted results for this assessment.

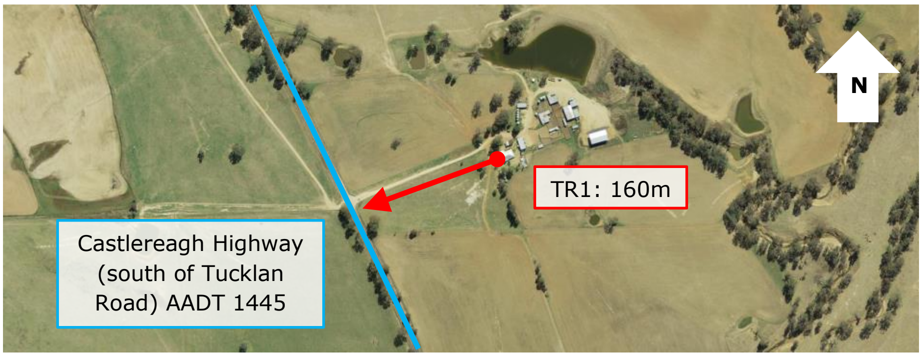
It is noted that this correction is conservative, as a low traffic flow correction decreases as traffic flow numbers increase. For example:

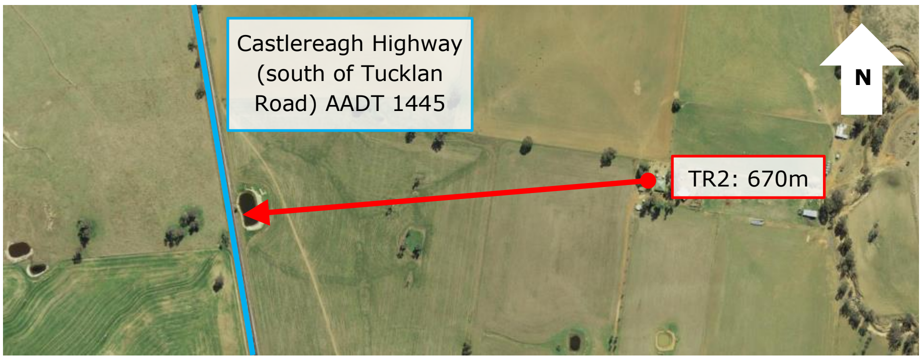
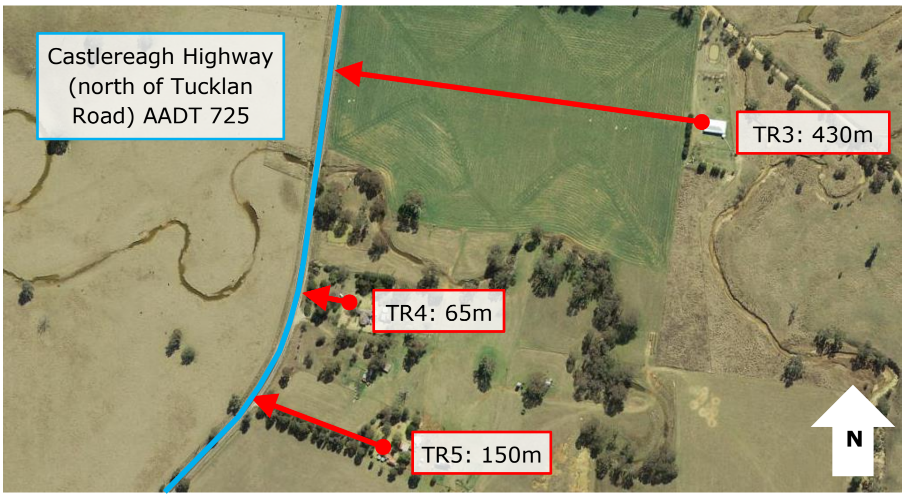
- The low traffic flow correction is applicable to roads with 1000 to 4000 vehicles in an 18-hour period where receptors are within 30m of the road.
- The low traffic flow correction for 1,034 vehicles (mentioned above) equates to a -2dB(A) correction for receptors within 30m of the road.
- As the traffic flow increases, the correction reduces i.e. 4,000 vehicles equates to no correction required.
- As the existing and future numbers are below 1,000, it is expected that should a correction be applied for these numbers, it would be greater than a -2dB(A) correction, and therefore a -2dB(A) correction applied to these values would be considered conservative.

6.1.1 Traffic Noise Sensitive Receptors

The closest noise sensitive receptors for traffic noise along Castlereagh Highway north and south of the quarry are detailed in Table 6-1. Note that these receptor IDs are specific to traffic noise impacts and are separate to the receptor IDs described in Section 2.1.

Table 6-1: Road Traffic NSRs

NSR	Distance to Road	Aerial Imagery
TR1: 2058 Castlereagh Highway	160m	

TR2: 1848 Castlereagh Highway (also known as R4)	670m	
TR3: 40 Whistons Lane (also known as R2)	430m	
TR4: 2162 Castlereagh Highway (also known as R6)	65m	
TR5: 2152 Castlereagh Highway (also known as R5)	150m	

6.1.2 Traffic Noise Impact Calculation Parameters

The worst-case scenario of a maximum of 120 additional truck (i.e. laden and unladen) movements has been assessed under two scenarios:

- All trucks travelling north on Castlereagh Highway from the quarry site; and
- All trucks travelling south on Castlereagh Highway from the quarry site.

Assessing these two scenarios where 100% of the truck movements pass by any given sensitive receptor on each route (whichever route they take), is considered worst case because the movements in and out of the quarry will likely be split in different directions as the quarry truck movements would be dictated by supply location, effectively dispersing the movements more evenly. This displacement is likely to reduce potential noise impacts on the nearest sensitive receptors, when compared to the worst-case predictions used in this assessment.

Vipac has conducted initial noise calculations for the two worst-case scenarios detailed above. The traffic noise assessment has also considered the following assumptions:

- L_{Aeq} values were calculated from the L_{A10} values predicted by the CoRTN algorithms using the well-validated approximation of $L_{Aeq} = L_{A10} - 3$.
- No low traffic flow correction was applied as all receptors are more than 30m from the road (refer to Table 6-1).
- A conservative assumption of 94% of the AADT values to occur within the 15-hour daytime period.
- Calculated speed limits of 100km/h for Castlereagh Highway (as detailed in Traffic Impact Assessment).
- A heavy vehicle percentage of 19%, based off the CWO-REZ Traffic Impact Assessment.
- An angle of view of 160 degrees for all receptors.
- A conservative assumption of 50% soft ground absorption, where in reality the soft ground perception is expected to be greater.
- No road surface correction has been applied.

- Sensitive receptors are assumed to have direct, unobstructed line of sight to the roads, with no shielding from intervening structures applicable.
- Receptor heights modelled at 1.8m above ground, 1m from the façade (i.e. façade-corrected).

Potential vibration levels from quarry truck movements are likely to be less than 0.5 mm/s PPV (Peak Particle Velocity) for receptors along the adjacent public roads, which is well below all accepted criteria for structural damage and human comfort from ground borne vibration.

6.2 Haul Route Traffic Noise Assessment Results

Calculations were conducted to assess the potential noise impacts associated with the additional quarry truck movements on the proposed haul routes.

Road traffic noise monitoring was not conducted as part of this traffic noise assessment, therefore validation of a traffic noise model used to predict noise levels at the nearest receivers cannot be undertaken, however, it is anticipated that existing traffic noise levels for all other receptors are below the current criteria for both local roads and principal haulage routes.

Table 6-2 below presents the traffic noise predictions for existing traffic, alongside future predicted traffic volumes at the nearest residential receptors. Note that because noise levels of the existing traffic are unknown, the results are intended to provide a conservative indication based on a worst-case scenario of the sole use of heavy vehicles travelling to and from the site.

Table 6-2: Cumulative Indicative Traffic Noise Impact Predicted Results

Receptor	Noise Levels, $L_{Aeq,\ 15\ hour}$ – façade corrected		Criteria	Predicted Compliance?	*Maximum Difference* (Existing v Future) ≤2dB(A)*
	Predicted Existing Traffic Noise, dB(A)	Predicted Future Traffic Noise, dB(A)			
TR1	50.1	51.4	60 dB(A)	✓	*+1.3*
TR2	42.4	43.7		✓	*+1.3*
TR3	41.1	43.3		✓	*+2.2*
TR4	51.8	53.4		✓	*+1.6*
TR5	46.1	49.0		✓	*+2.9*

*Only applicable for receptors where it is anticipated existing traffic noise levels already exceed the criteria.

6.3 Haul Route Traffic Noise Results Discussion

As stated in Section 3.4 of the Road Noise Policy, with regard to existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use development, any increase in total traffic noise level should be limited to less than 2dB above that of the corresponding existing noise level at any residential property. Considering the predicted existing traffic noise levels for each of the closest receptors on each road is below the criteria, this assessment is not applicable, although the increase has been included for transparency.

It can be seen in Table 6-2 that existing and future traffic noise levels at existing residential receptors are predicted to comply with the criteria without the need for acoustic mitigation.

Given the increase in noise levels between existing and future traffic flow are also well below the relative increase criteria detailed in Table 3-4 (existing traffic + 12dB), the increased traffic from the proposed development is predicted to comply with the relevant road traffic noise criteria.

Therefore, traffic noise associated with the additional quarry truck movements on the Castlereagh Highway are predicted to comply with the criteria without the need for acoustic mitigation measures.

7 Vibration Impact Assessment

7.1 Construction/Operational Vibration (Non-Blasting)

Both continuous/quasi-continuous and intermittent vibration has been considered. Most machinery items are likely to generate some continuous or quasi-continuous vibration during their operation, and some intermittent or transient vibration could be caused by machinery during start-up compaction (and possibly during loading of trucks).

Ground-borne vibration resulting from activities on site are compared against the applicable criteria relating to human comfort and potential structural damage (usually in terms of Peak Particle Velocity, PPV). The recommended limits or guide values (refer Section 3.3) for transient vibration to ensure minimal risk of cosmetic damage to residential buildings (and community buildings) are in the range 15 to 20 mm/s PPV (depending on the frequency), with higher limits of 50 mms/ for industrial buildings. The stipulated human comfort criterion (lower limit) for vibration is typically 1 mm/s PPV (to an upper limit of 2 mm/s).

The ground vibration predictions for machinery were based on previously measured data by Vipac or sourced data for construction machinery from various vibration databases and literature references (Ref: *Ground Vibration Engineering* (Srbulov, 2010), *Construction Vibrations* (Dowding, 2000), CALTRANS *Construction Vibration Manual* (US CALTRANS, 2013), US FTA *Transit Noise & Vibration Manual* (2018)).

The calculation formulae used for ground vibration predictions (in terms of Peak Particle Velocity, V_{PPV} in mm/s) for vibratory compaction rollers are given as follows (Ref: BS 5228-2; Hiller & Crabb, 2000):

Table 7-1 :Ground Vibration Prediction Formulae

Normal compaction passes:	V_{PPV} = ks * n^0.5 * (A/(x + w))^1.5	[mm/s]	ks	75	50% exceedance probability
			ks	143	33% exceedance probability
			ks	276	5% exceedance probability
Transient startup/shutdown:	V_{PPV} = kt * n^0.5 * (A^1.5/(x + w)^1.3)	[mm/s]	kt	65	50% exceedance probability
			kt	106	33% exceedance probability
			kt	177	5% exceedance probability
	x	distance along ground from roller to receiver (m)			
	n	number of vibrating drums in roller			
	A	nominal amplitude of vibrating roller (mm)			
	w	width of vibrating drum (m)			

** Note: The exceedance probability represents the level of conservatism in the predictions, where a 5% predicted level would be the most conservative or worst case situation (higher prediction) to represent the maximum level predicted for 95% of possible cases and therefore only 5% of cases likely to exceed the predicted level.*

A conservative prediction of the potential ground-borne vibration impacts associated with the proposed equipment on site has been made (primarily quasi-continuous vibration). Ground vibration levels (in mm/s PPV) from other construction machinery items (e.g. excavator, crusher) are typically in the range of 0.1 to 1 mm/s at distances of 25 to 50 m. Truck traffic (over rough/irregular road surfaces) will typically generate ground vibration levels of 0.1 to 0.5 mm/s (or less) at distances of 25 to 50 m. Considering the nearest sensitive receptors are at far greater distances (>600m) away, predicted vibration levels would meet the human comfort criteria and are well below structural damage criteria for all nearby buildings.

7.2 Blasting Vibration and Airblast Overpressure

Ground vibration and airblast overpressure are two common environmental effects of blasting that can cause human discomfort and damage to buildings and other structures. The quarry is proposing to operate between 7am and 6pm Monday to Saturday, however blasting is only proposed between 9am and 3pm Monday to Friday.

Blasting is to be undertaken within accepted ground vibration and air blast overpressure requirements in Section 3.4. The Australian and New Zealand Environment Conservation Council (ANZECC) provides the guidelines to minimise the annoyance due to blasting overpressure and ground vibration. Vibration criteria are also determined in accordance with the NSW Assessing Vibration: A Technical Guideline (2006) and EPA guidelines.

The EPA standards for blast ground vibration and airblast overpressure from quarries has provided in Section 3.4 have been reproduced in Table 7-2. These limits are applicable at the nearest residence.

Table 7-2: EPA Blasting Standards

	Principal Standard Limit	**Maximum Level Permitted**
	This level can be exceeded on up to 5% of the total number of blasts over a period of 12 months.	*This level cannot be exceeded at anytime.*
Blast Overpressure	115 dBL	120 dBL
Ground Vibration	5 mm/s peak particle velocity	10 mm/s peak particle velocity

Blasting activities associated with the proposed quarry have the capacity to be safely completed within EPA blast vibration and overpressure limits without damage to surrounding structures or nearby sensitive receivers provided that monitoring is conducted during all blasting operations. Accurate modelling of blasting cannot be undertaken given the current uncertainty of the surrounding soil landscape

It is an EPA requirement for monitoring of all blasting operations, to ensure compliance is achieved at the closest receptors.

8 Mitigation Recommendations

Noise levels for the proposed operational scenarios have been predicted to comply with the criteria outlined in Section 3 in neutral and adverse weather conditions at all receptors.

Predicted noise levels from the traffic noise impact assessment complied with the criteria outlined in Section 3.2, therefore, no noise mitigations are required for haul route noise emissions.

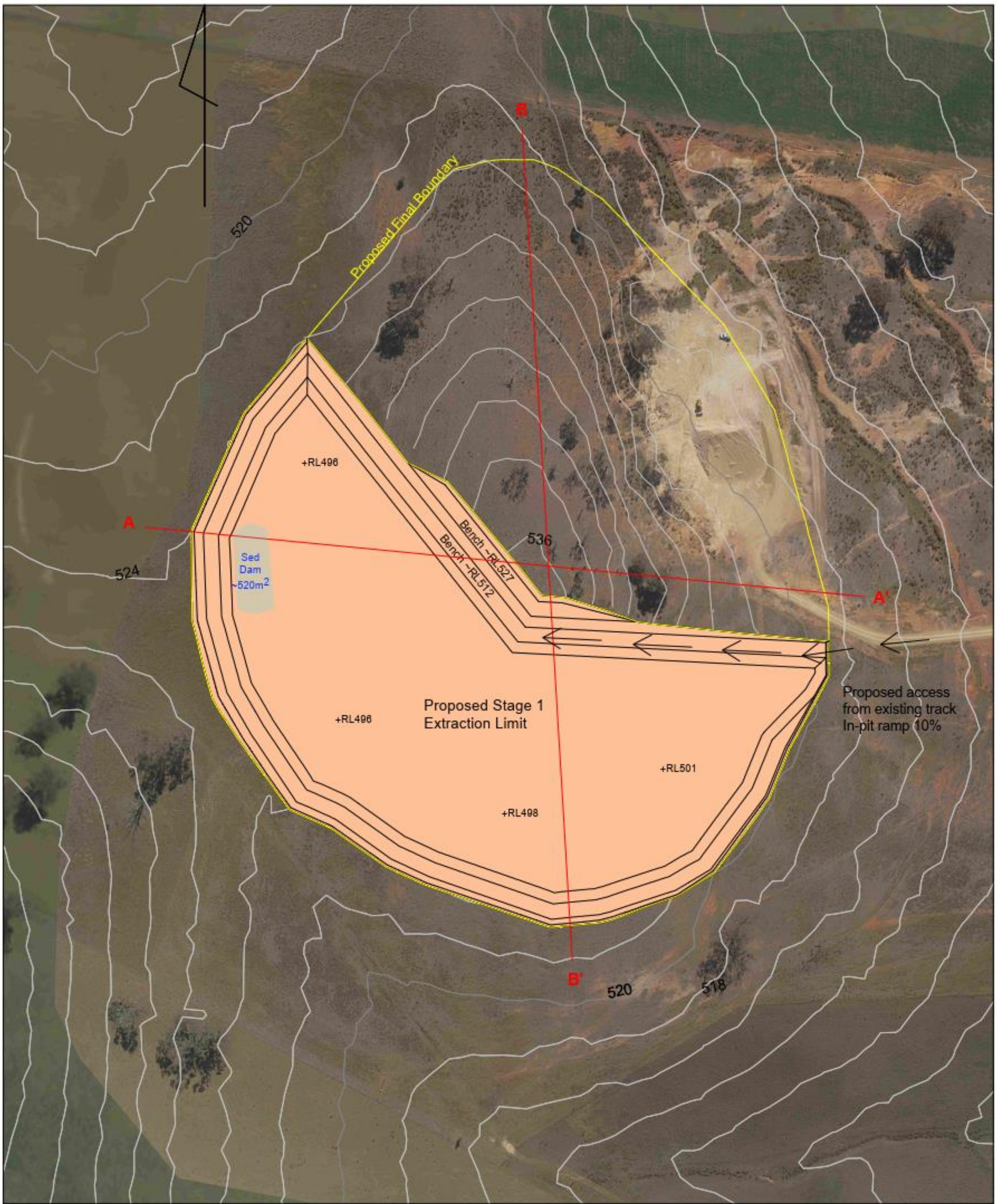
Air overpressure and ground vibration impacts from blasting are to be monitored during all blasting operations to ensure compliance at the closest receptors.

9 Conclusion

A noise and vibration impact assessment has been carried out to support the establishment for the proposed Gulgong Quarry to be located at 1848 Castlereagh Highway Gulgong, NSW. Future noise levels were predicted using SoundPLAN modelling software for the proposed scenarios where crushing and ancillary equipment would operate during daytime hours of operation.

Mitigation measures have been recommended within this report and it is expected that noise and vibration emissions from the Quarry during operation can be adequately managed at the nearest noise sensitive receptors.

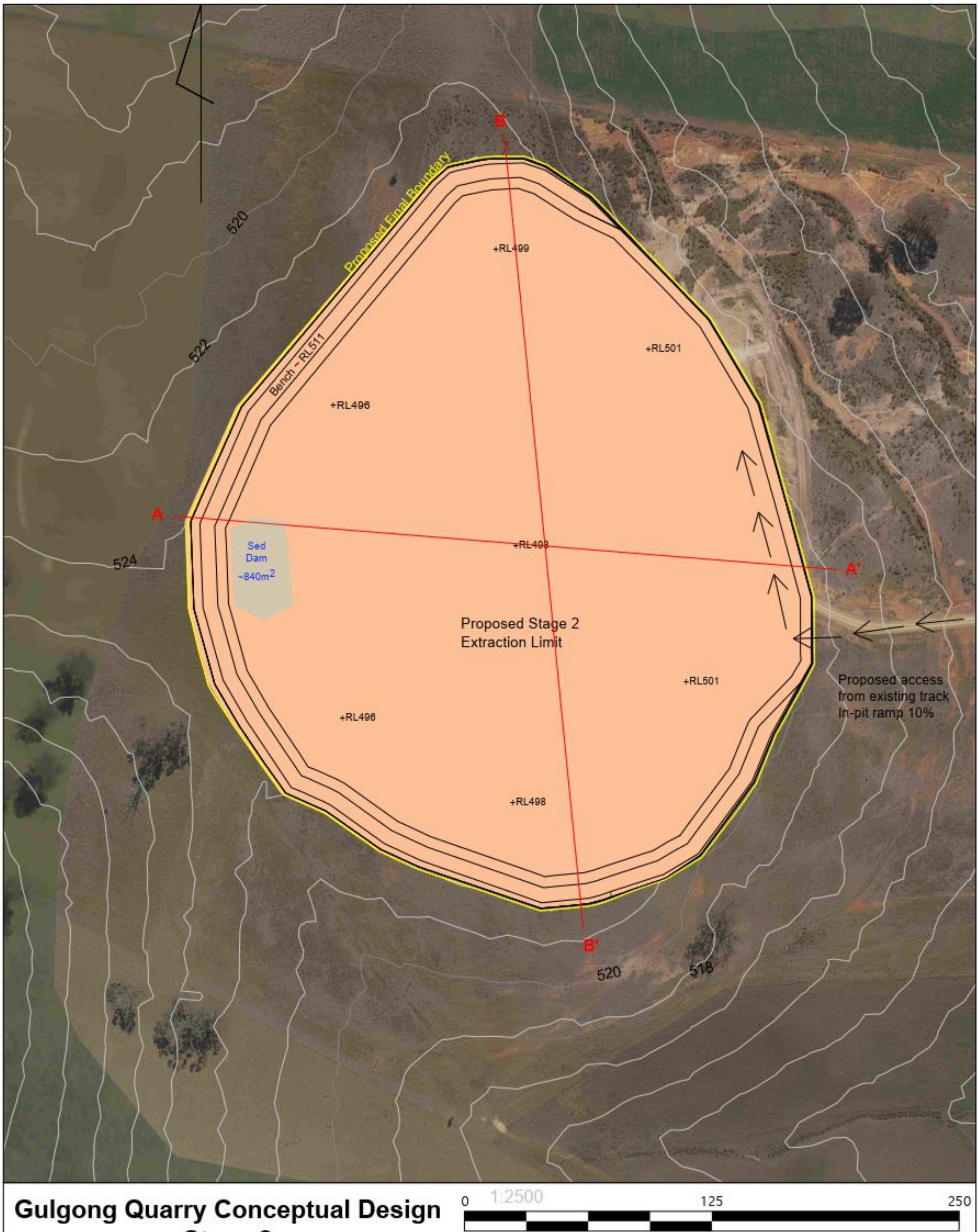
Appendix A Gulgong Quarry Conceptual Design Drawings



Gulgong Quarry Conceptual Design Stage 1

0 1:2500 125 250

Disclaimer: - This plan is a conceptual design only - This plan is not suitable for operational use - This plan should be used for visual reference only	Drawn by: A Richards	Date: 06/09/2024
	Approved by:	Date:
	Date of Survey: unknown	
	Project: Gulgong Quarry Conceptual Design	



Gulgong Quarry Conceptual Design Stage 2

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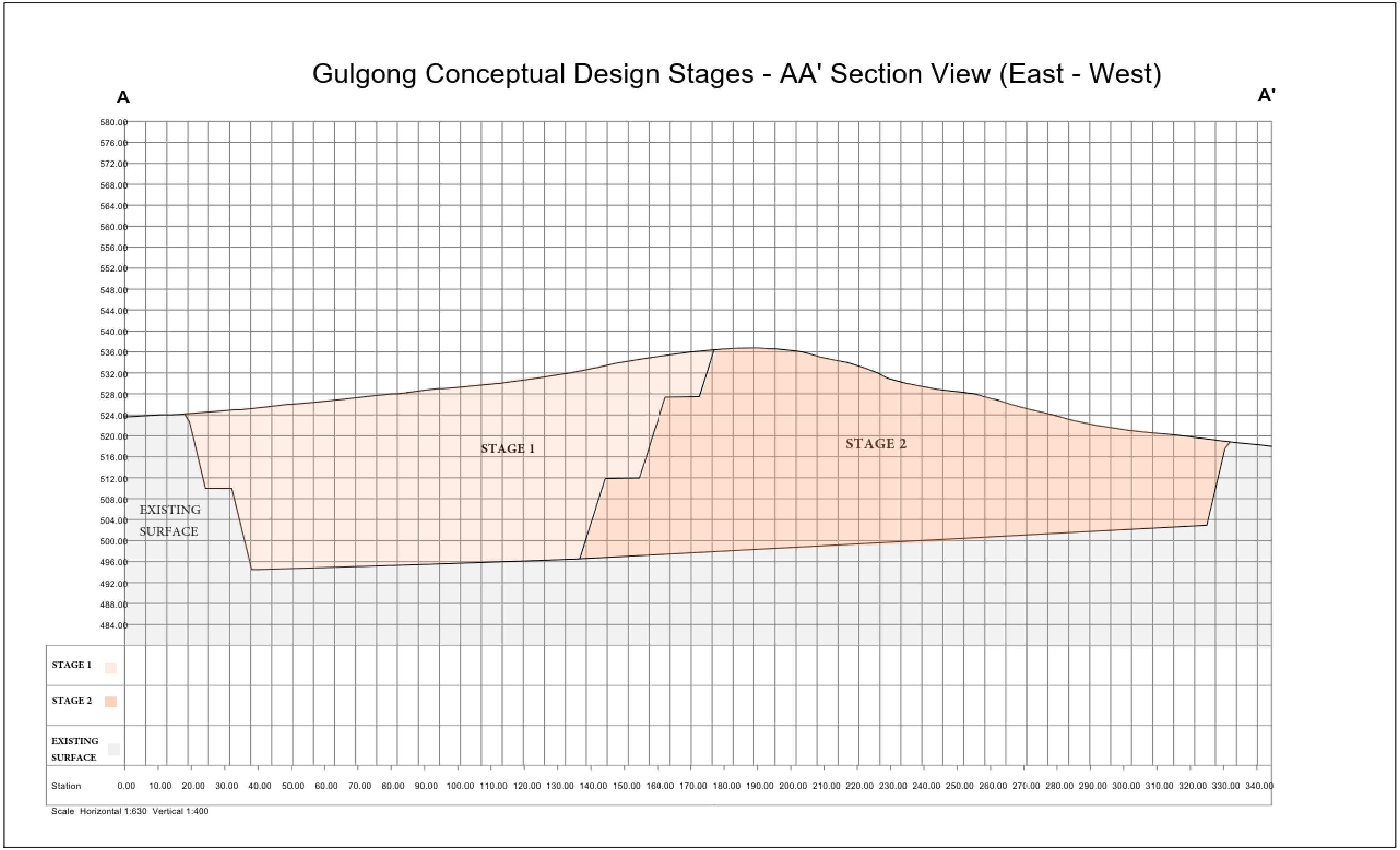
- This plan is not suitable for operational use	Date of Survey: unknown	
- This plan should be used for visual reference only	Project: Gulgong Quarry Conceptual Design	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STAGE 1
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Station
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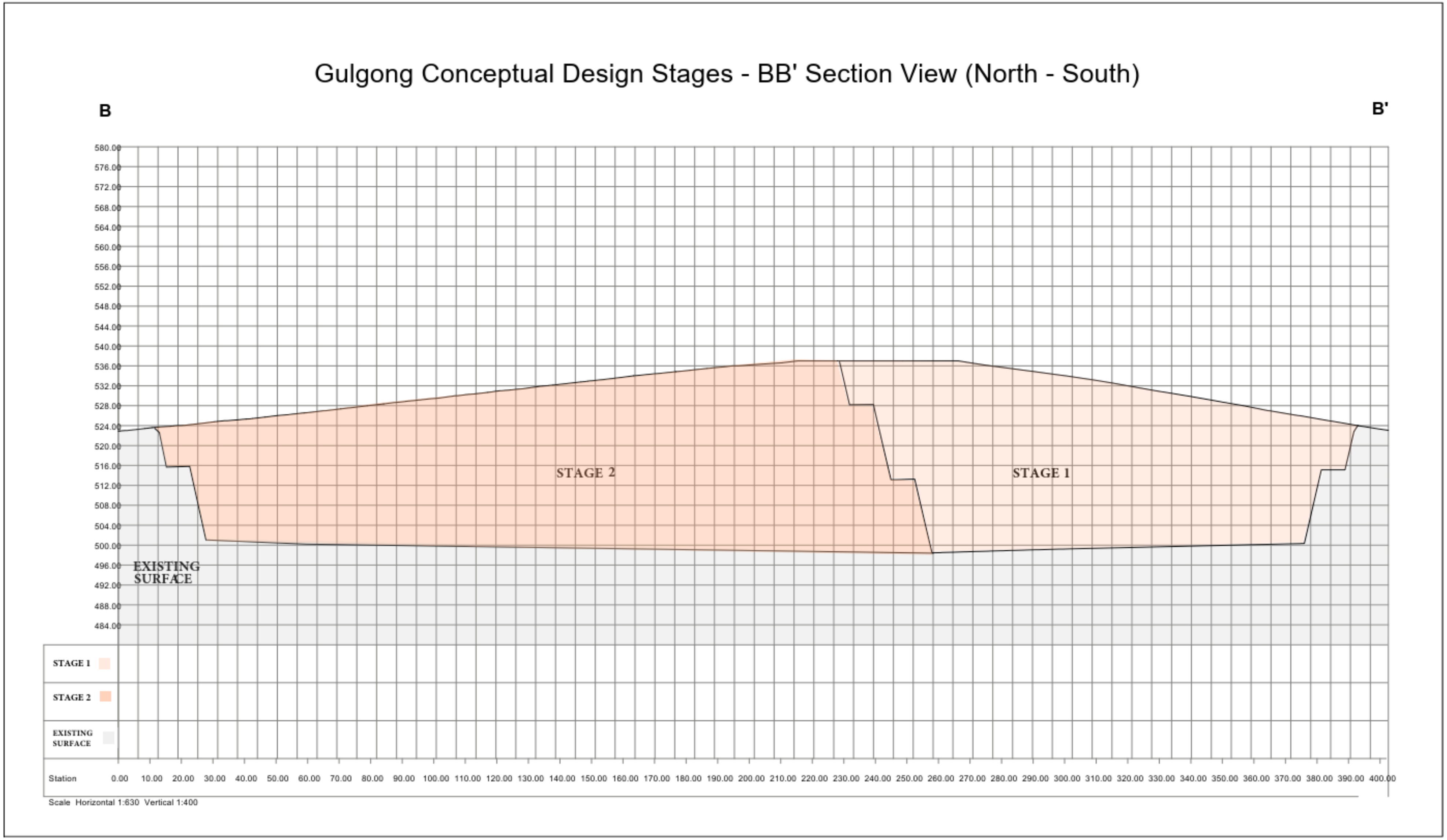
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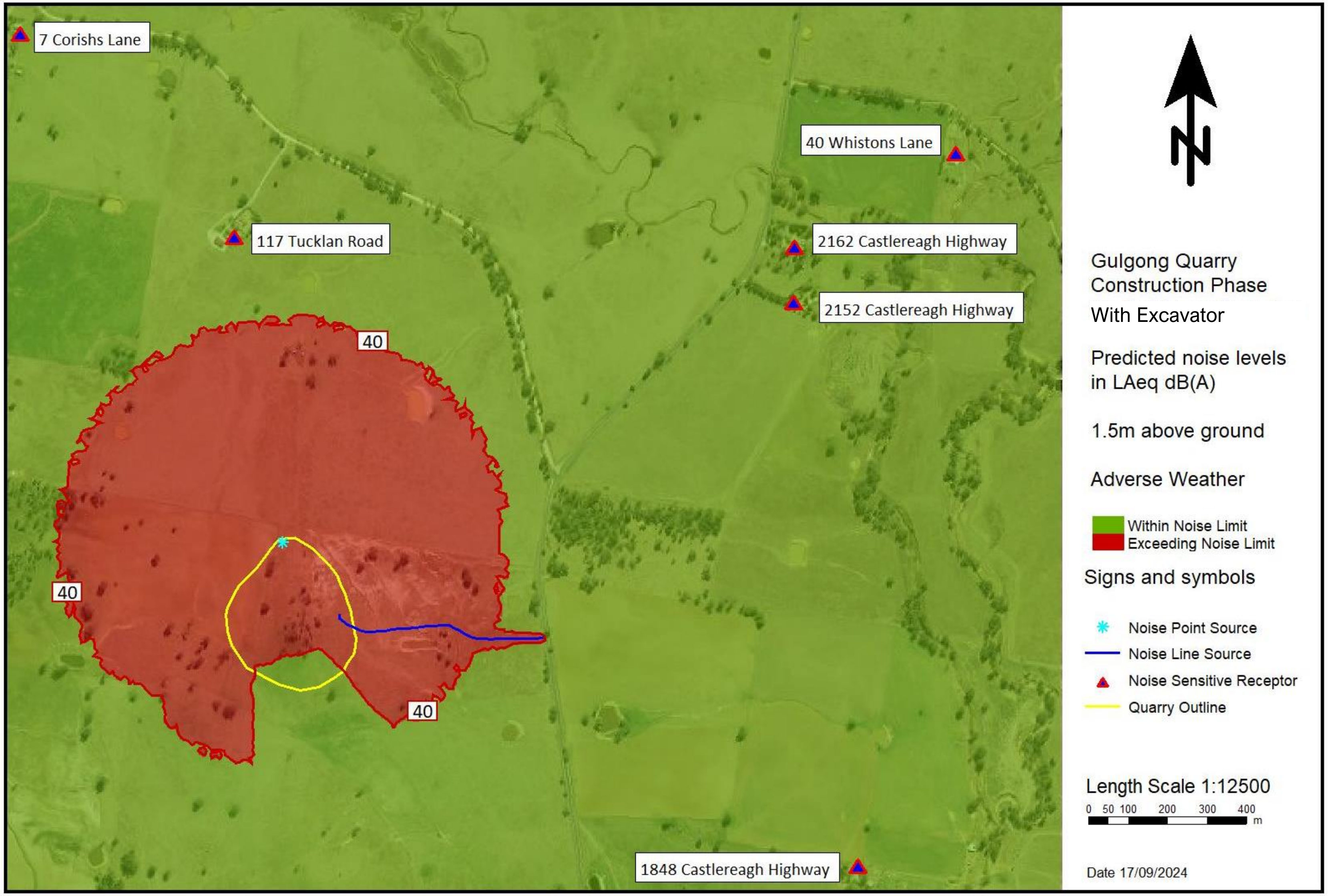
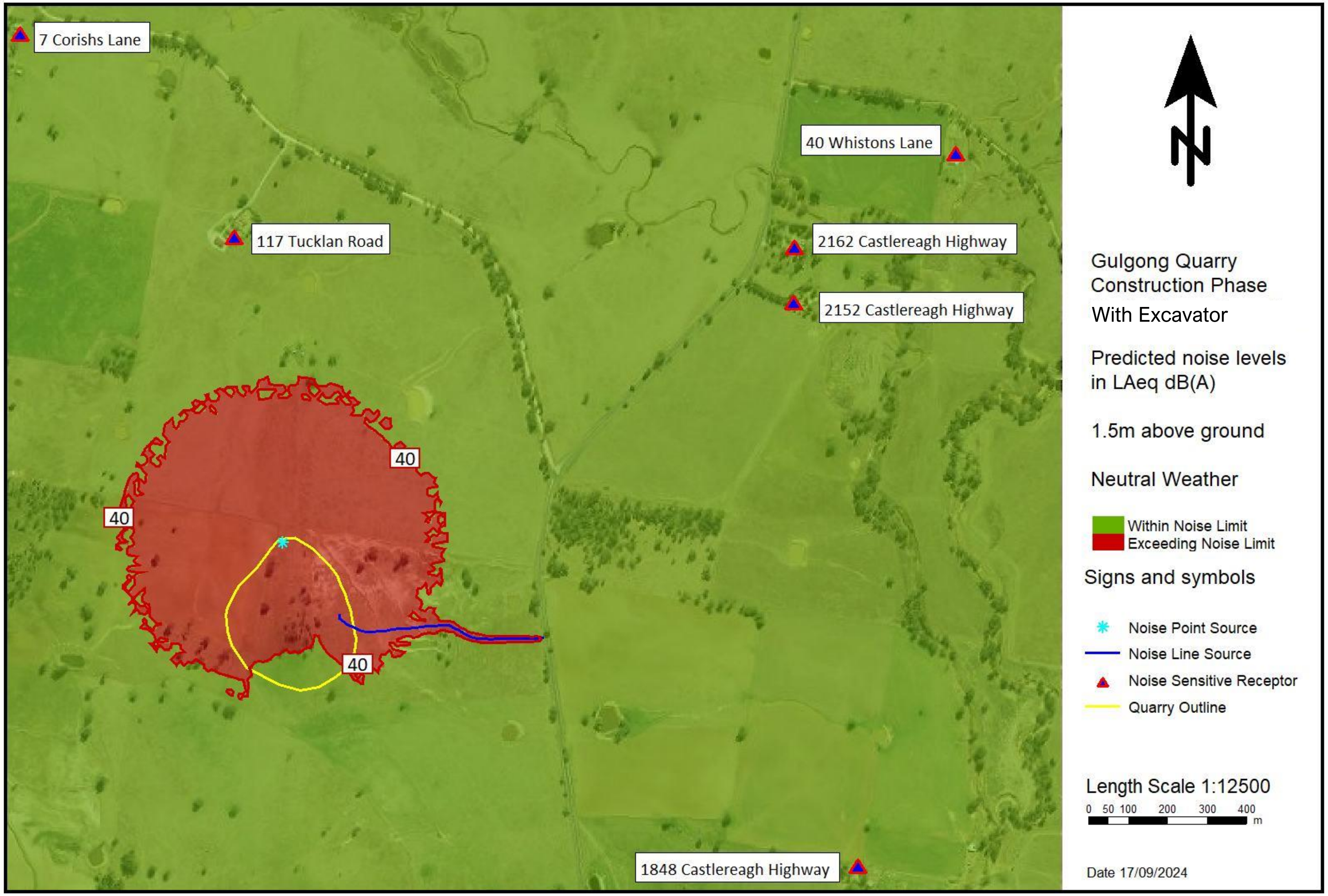
B'
STAGE 2
STAGE 1
EXISTING SURFACE
STAGE 1
STAGE 2
EXISTING SURFACE
Station
Scale Horizontal 1:630 Vertical 1:400

Appendix B Noise Contour Maps

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117 Tucklan Road
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1848 Castlereagh Highway
Gulgong Quarry
Construction Phase
With Excavator
Predicted noise levels
in LAeq dB(A)
1.5m above ground
Neutral Weather
Within Noise Limit
Exceeding Noise Limit
Signs and symbols
Noise Point Source
Noise Line Source
Noise Sensitive Receptor
Quarry Outline
Length Scale 1:12500
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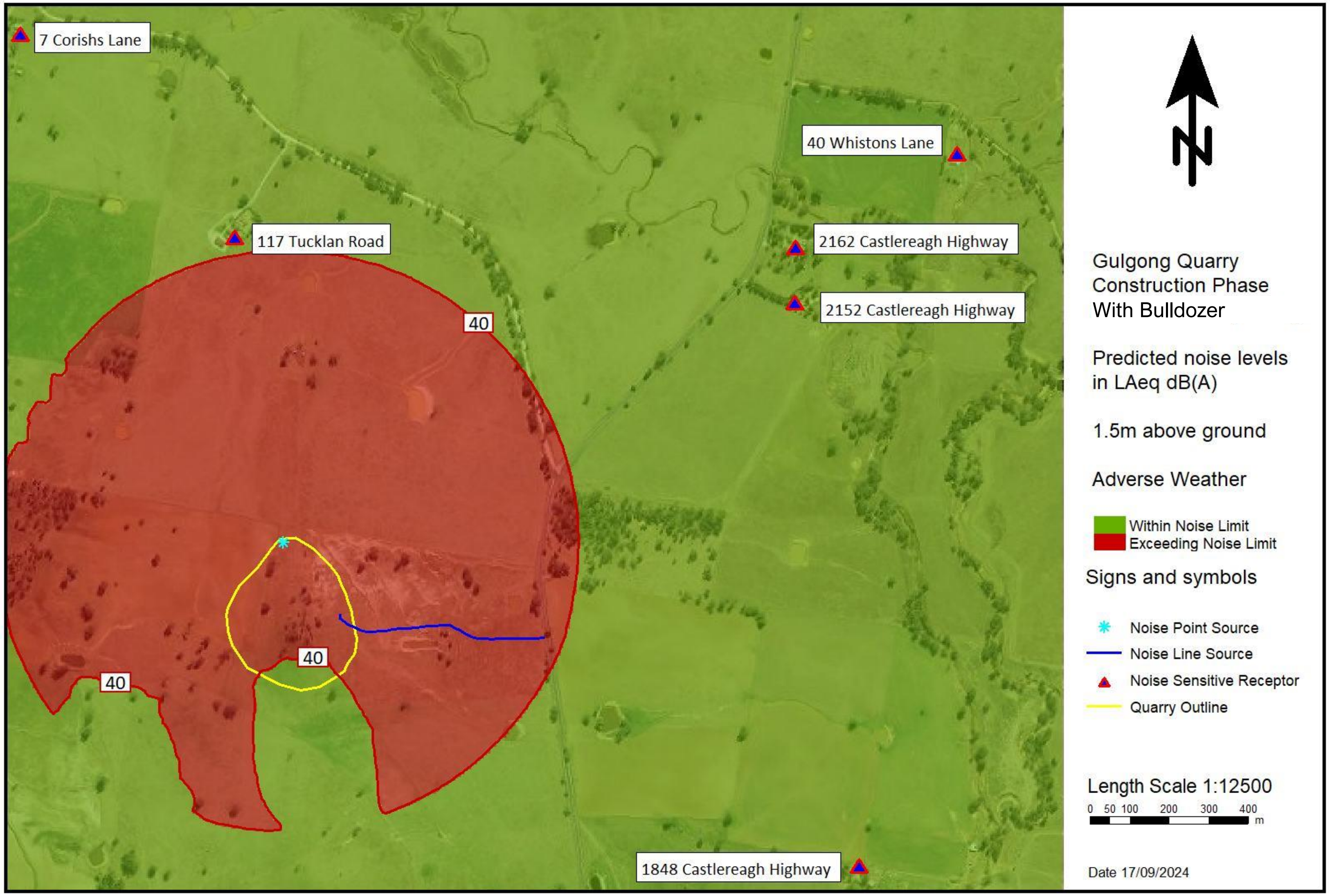
Date 17/09/2024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Gulgong Quarry
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Quarry Outline
Length Scale 1:12500
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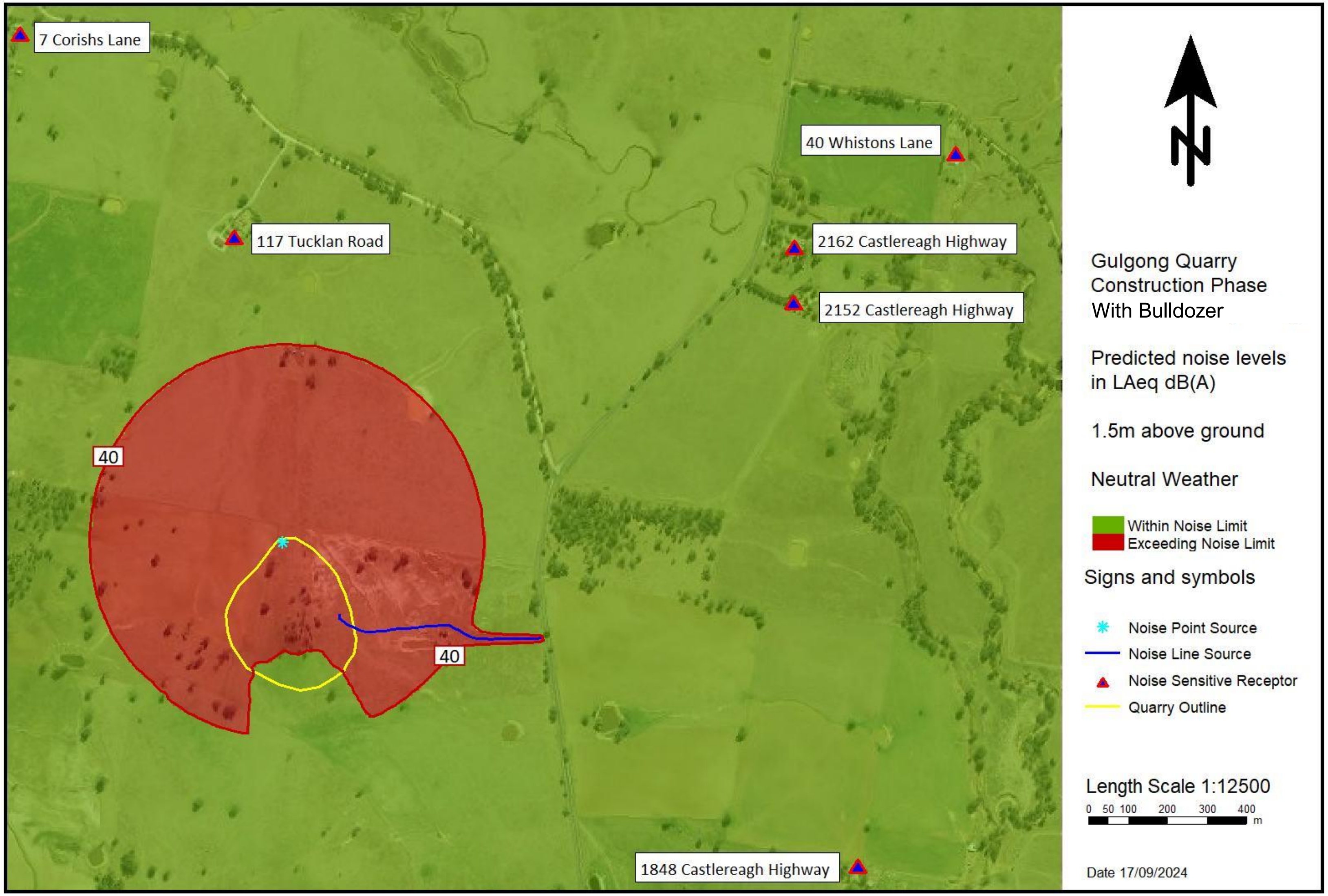
Date 17/09/2024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Gulgong Quarry
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Signs and symbols
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Quarry Outline
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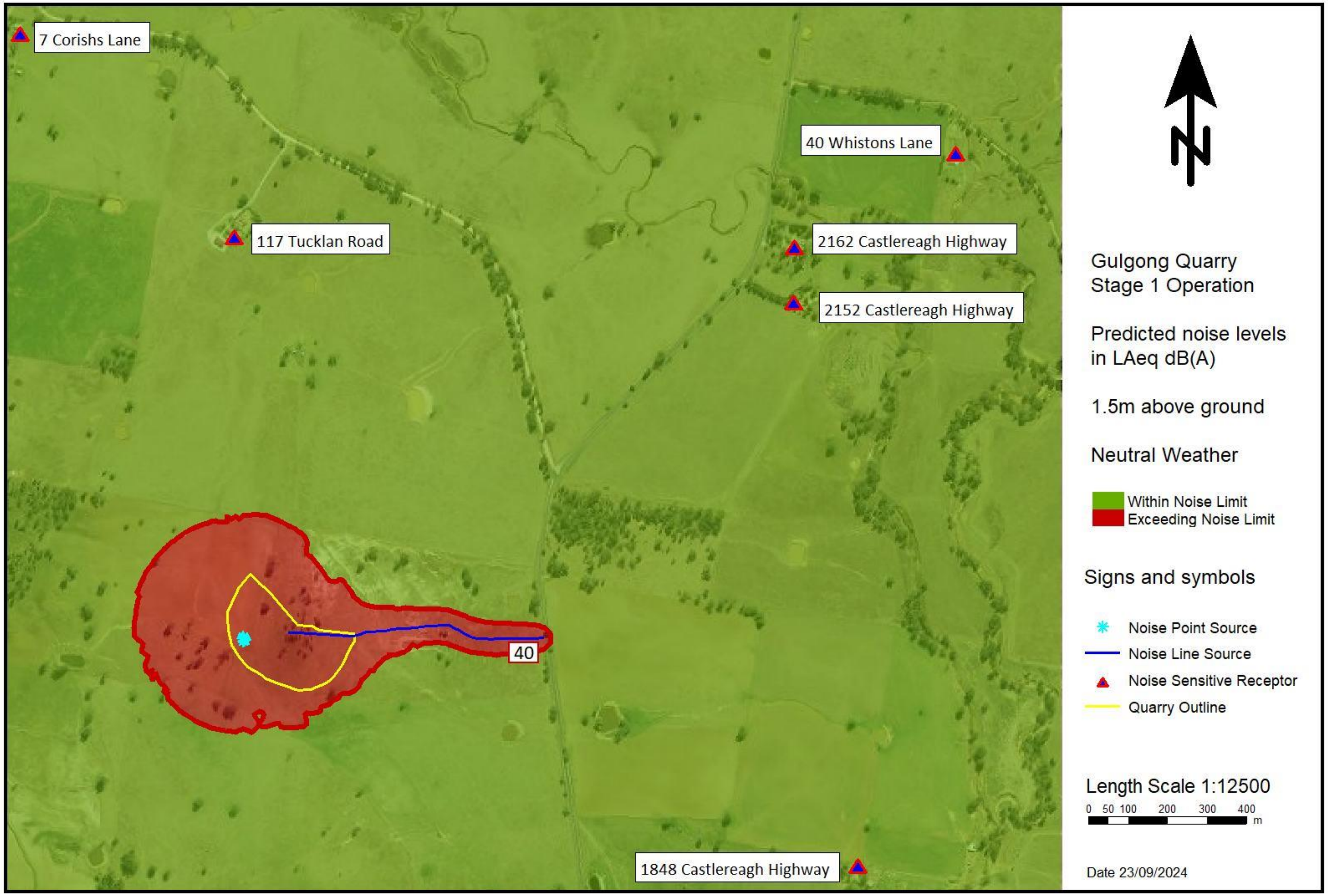
Date 17/09/2024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Gulgong Quarry
Stage 1 Operation
Predicted noise levels
in LAeq dB(A)
1.5m above ground
Neutral Weather
Within Noise Limit
Exceeding Noise Limit
Signs and symbols
Noise Point Source
Noise Line Source
Noise Sensitive Receptor
Quarry Outline
Length Scale 1:12500
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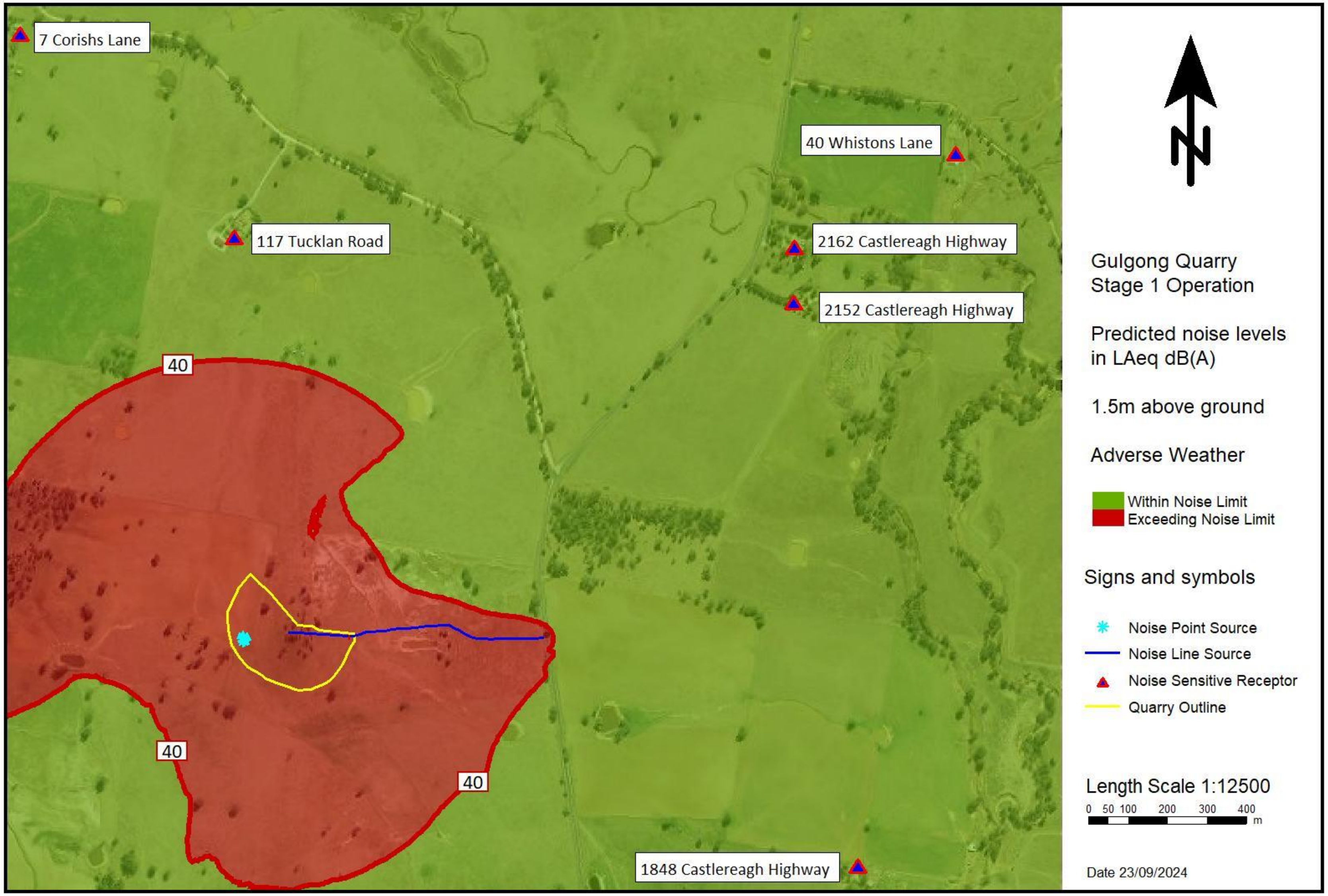
Date 23/09/2024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Gulgong Quarry
Stage 1 Operation
Predicted noise levels
in LAeq dB(A)
1.5m above ground
Adverse Weather
Within Noise Limit
Exceeding Noise Limit
Signs and symbols
Noise Point Source
Noise Line Source
Noise Sensitive Receptor
Quarry Outline
Length Scale 1:12500
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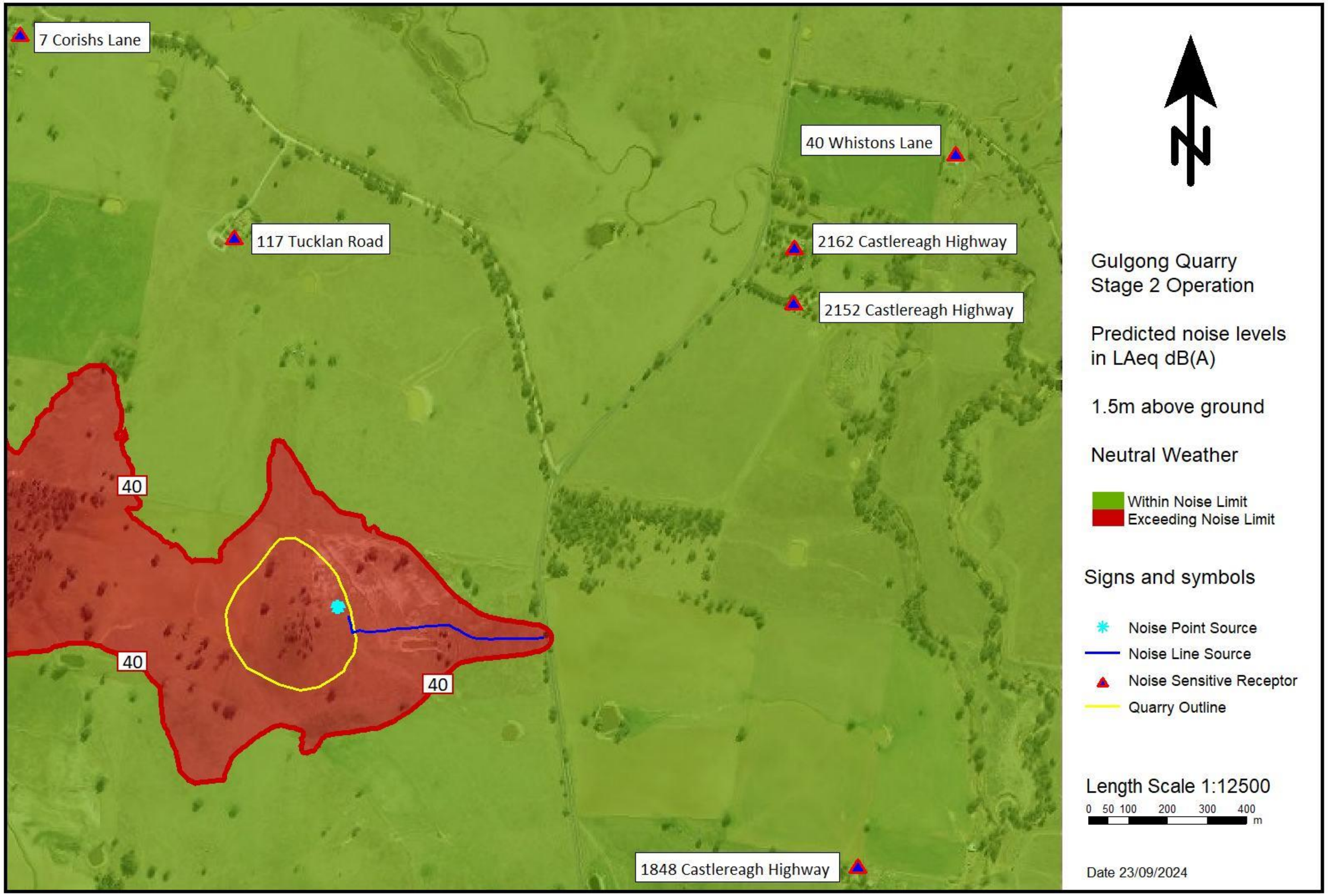
Date 23/09/2024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1848 Castlereagh Highway
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Gulgong Quarry
Stage 2 Operation
Predicted noise levels
in LAeq dB(A)
1.5m above ground
Neutral Weather
Within Noise Limit
Exceeding Noise Limit
Signs and symbols
Noise Point Source
Noise Line Source
Noise Sensitive Receptor
Quarry Outline
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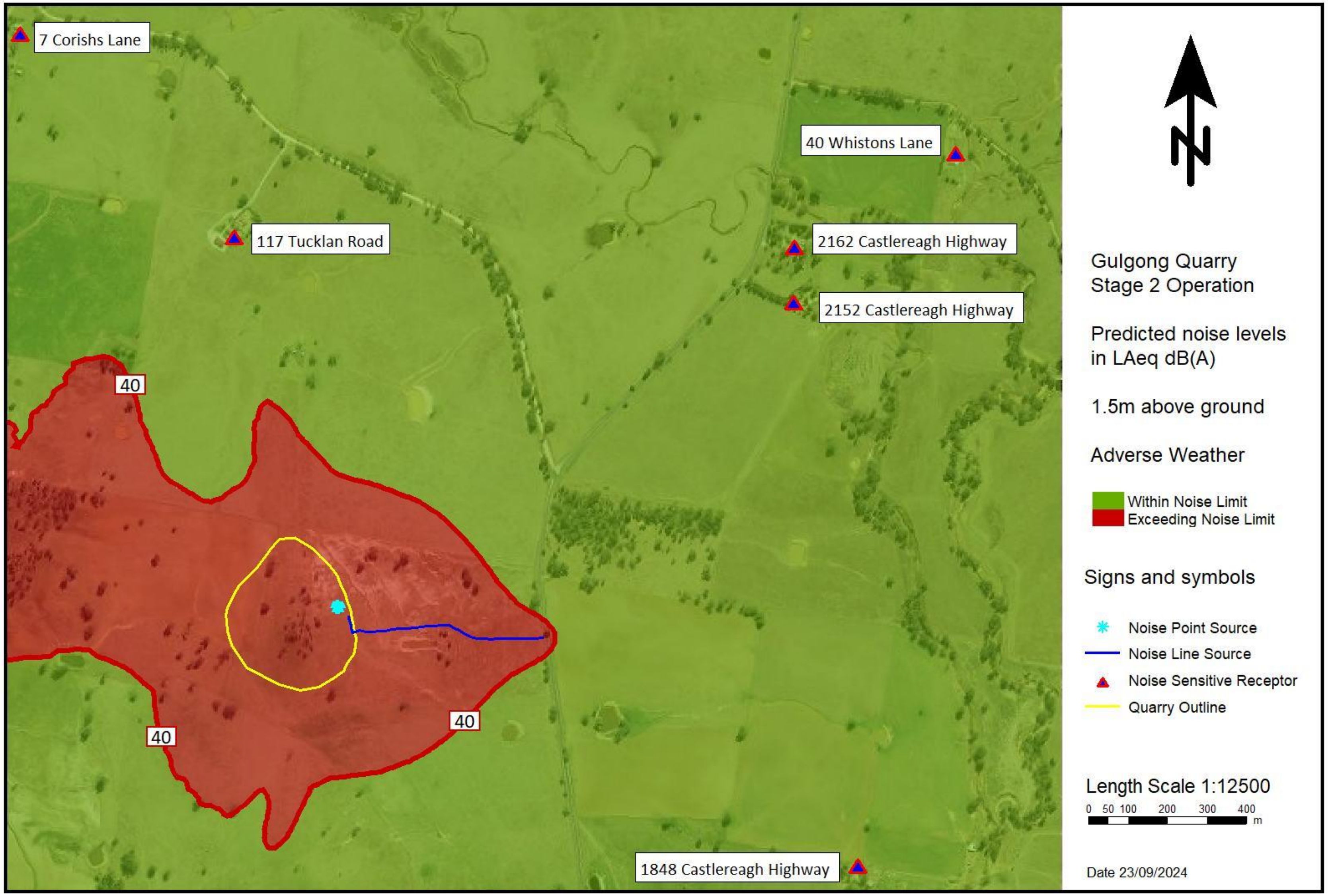
Date 23/09/2024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Gulgong Quarry
Stage 2 Operation
Predicted noise levels
in LAeq dB(A)
1.5m above ground
Adverse Weather
Within Noise Limit
Exceeding Noise Limit
Signs and symbols
Noise Point Source
Noise Line Source
Noise Sensitive Receptor
Quarry Outline
Length Scale 1:12500
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m
Date 23/09/2024

Appendix C Source Contributions

Gulgong Quarry
Contribution level - Single Points Stage 2, Adverse Weather

9

Source	Source type	LrD dB(A)
Receiver 7 Corishs Lane LrD 30.2 dB(A)		
Excavator	Point	27.4
Cone Crusher	Point	23.8
Jaw Crusher	Point	21.7
Dozer	Point	19.3
Generator	Point	12.4
Front End Loader	Point	6.5
Internal Haul Route	Line	5.8
Receiver 40 Whistons Lane LrD 26.2 dB(A)		
Excavator	Point	25.6
Cone Crusher	Point	14.0
Jaw Crusher	Point	12.0
Dozer	Point	8.2
Internal Haul Route	Line	6.1
Generator	Point	-0.6
Front End Loader	Point	-4.9
Receiver 117 Tucklan Road LrD 36.9 dB(A)		
Excavator	Point	34.1
Cone Crusher	Point	30.7
Jaw Crusher	Point	28.4
Dozer	Point	24.5
Generator	Point	18.3
Internal Haul Route	Line	12.6
Front End Loader	Point	12.2
Receiver 1848 Castlereagh Highway LrD 30.7 dB(A)		
Excavator	Point	30.1
Cone Crusher	Point	18.4
Jaw Crusher	Point	16.4
Dozer	Point	13.3
Internal Haul Route	Line	11.3
Generator	Point	3.7
Front End Loader	Point	-0.5
Receiver 2152 Castlereagh Highway LrD 30.7 dB(A)		
Excavator	Point	30.1
Cone Crusher	Point	18.7
Jaw Crusher	Point	16.8
Dozer	Point	13.4
Internal Haul Route	Line	11.4
Generator	Point	4.0
Front End Loader	Point	-0.5
Receiver 2162 Castlereagh Highway LrD 29.9 dB(A)		
Excavator	Point	29.3
Cone Crusher	Point	17.9

Vipac Engineers & Scientists Pty Ltd

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SoundPLAN 8.2