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Vulcan South

Noise Impact Assessment

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Prepared for:

Vitrinite Pty Ltd

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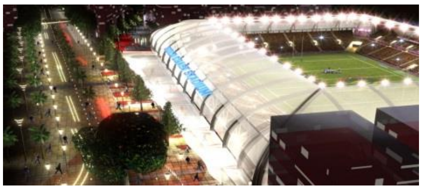

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1. Introduction

Trinity Consultants Australia T/A ASK Consulting Engineers was commissioned by Mining & Energy Technical Services Pty Ltd on behalf of Vitrinite Pty. Ltd., owner of Qld Coal Aust No.1 Pty. Ltd. and Queensland Coking Coal Pty. Ltd. (Vitrinite), to provide noise and vibration consultancy services for the proposed Vulcan South coal mine (the Project).

The proposed Project location is approximately 35 kilometres (km) south east from Moranbah as shown in **Figure 1.1**.

This report presents an assessment of the noise and vibration impacts associated with the proposed coal mine.

This report is based on the following tasks:

- Review the project and the associated potential noise emissions;
- Review existing noise monitoring data applicable to the project site;
- Model the noise emissions based on proposed activities using SoundPLAN to calculate noise levels at sensitive receptors and develop contours over the modelling area for typical operations;
- Analyse the results of noise modelling and compare modelling results with the relevant noise criteria selected to protect the acoustic environment;
- Assess blast information for vibration and airblast; and
- Provide recommendations on control measures, where required.

To aid in the understanding of the terms in this report a glossary is included in **Appendix A**.

Figure 1.1 Vulcan South Location (Image from QLD Globe)

2. Project Description

2.1 Overview

The Project is located between Dysart and Moranbah in Queensland's Bowen Basin (**Figure 1.1**). The Project lies to the immediate west of several established mining operations including BHP's Peak Downs and Saraji mines. The Vulcan Coal Mine (VCM) pit is proposed to the north-east of the Project.

The Vulcan hard coking coal target has been defined and selected for open cut development via 3 separate open cut pits that form the primary mining focus of the Project. The project will operate for approximately nine years, including primary rehabilitation works, following a 2 year construction period and will extract approximately 13.5 Mt of ROM coal consisting predominately of hard coking coal with an incidental thermal secondary product at a rate of up to 1.95 Mtpa. The Project will target the Alex and multiple Dysart Lower coal seams. Truck and shovel mining operations will be employed to develop the pits. A mine infrastructure area (MIA) will be established along with a modular coal handling and preparation plant (CHPP), rail loop and train load-out facility (TLO) at a location between the northern and central pits. The CHPP will include solid bowl centrifuges to maximise water recycling and to produce a dry tailings waste product for permanent storage within active waste rock dumps.

Out-of-pit waste rock dumps will be established prior to commencing in-pit dumping activities that will continue for the life of the operation. Ancillary infrastructure, including a Run of Mine (ROM) pad, offices, roads and surface water management infrastructure will be established to support the operation.

A realignment of the existing Saraji Road and services infrastructure to the eastern boundary of the proposed Mining Lease Application (MLA) area, adjacent to the existing rail easement, is also proposed in a number of locations. The re-alignment will occur within the MLA area.

In-pit dumping will fill the majority of the pit volumes during operations with the remaining final voids to be backfilled upon cessation of mining, resulting in the establishment of low waste rock dump landforms over the former pit areas. Following backfill of the final voids, the remaining material stored in the initial out-of-pit waste rock dumps will be rehabilitated in-situ.

The Project includes a small-scale highwall mining trial program in the north of the MLA. The trial will involve the establishment of 4 highwall mining benches across a number of hillsides to facilitate extraction of coal utilising a CAT HW300 highwall miner. The highwall mining trial will target up to 750 kt of coal which will be transported by truck to the Project CHPP via a dedicated haul road within the MLA area. The trial is scheduled to be completed within the first year of mining operations.

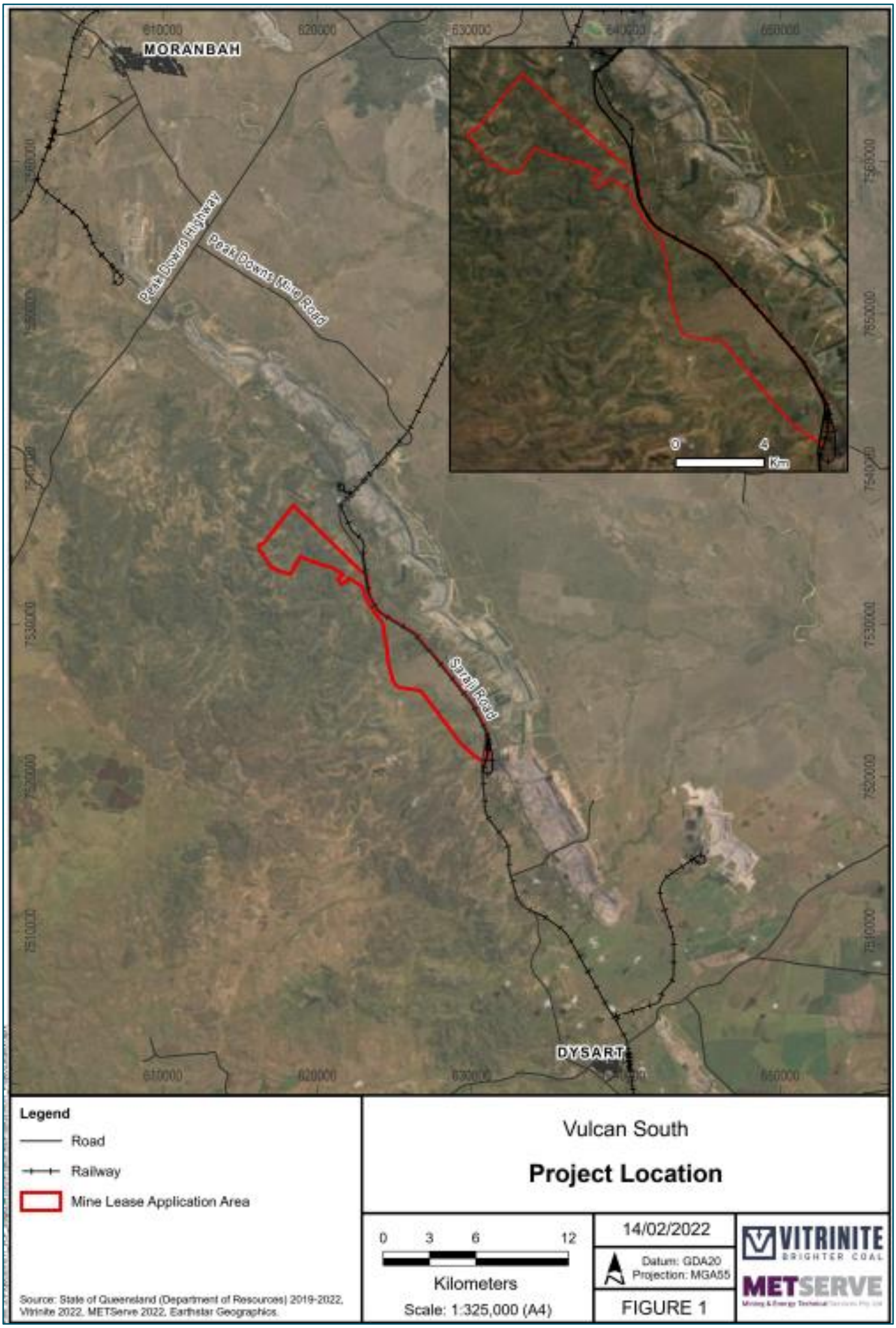


Figure 2.1 Vulcan South Maximum Disturbance Areas

2.2 Project Development Stages

The Project is a small scale mining operation, with coal extraction planned for approximately eight years, followed by completion of primary rehabilitation activities in year nine. Construction of infrastructure associated with the mining operation, including the CHPP and the rail loop, is expected to be completed within 2 years. Construction of the realigned Saraji Road sections will be completed intermittently as the Project progresses, as required. Ongoing establishment of internal road networks, surface water management infrastructure and other ancillary infrastructure will continue to be developed as the pits and in-pit dumps advance. Project stage plans for Years 3, 4 and 7 are presented **Figure 2.2** to **Figure 2.4**.

2.3 Mining Activities

2.3.1 Open Cut Mining

The open cut will extend to a depth of approximately 60 metres (m), following the seam as it dips eastwards. The footprint of the proposed three open cuts (Vulcan North, Vulcan Main and Vulcan South) are approximately 400 hectares (ha). Truck and shovel mining methods will be employed to extract waste rock and coal from the pit.

The open-cut operations are described as follows:

- Topsoil will be removed and hauled to the topsoil stockpile area;
- Drilling and blasting will be undertaken;
- Excavators will load trucks with overburden, which will then be hauled to the overburden dump;
- Dozers will push some overburden back into the pit;
- Excavators will load the mined coal into haul trucks to be transported from the pits to the run-of-mine (ROM) pad;
- Haul trucks will unload ROM coal at the ROM pad;
- The ROM coal will be crushed and screened;
- Rejects from the crushing and screening process will be stockpiled separately and placed within the relevant active dump.

2.3.2 High Wall Mining

The Project includes a small-scale highwall mining trial program in the north of the MLA. The trial will involve the establishment of 4 highwall mining benches across a series of hillsides to facilitate extraction of coal utilising a CAT HW300 highwall miner. The highwall mining trial will target up to 750 kt of coal within the first year of mining operations. Mined coal will be loaded by front-end-loader and transported by truck to the Project CHPP via a dedicated haul road within the MLA.

2.4 Production Rate and Schedule

The Vulcan South Project will commence operations at the Vulcan North and Vulcan Main pits, in close succession. Operations at the Vulcan Main pit will continue for the full 8 year mine life. Mining activities at the Vulcan North pit are anticipated to be completed after three years. Activities at the Vulcan South pit will commence in year 6 of operations and will conclude three years later in year 8. Throughout the project life, the average annual ROM coal production rate is less than 1.7 Mtpa. During peak production periods, the Project will produce up to 1.95 Mtpa. An indicative annual mining schedule is provided in **Table 2.1.**

Table 2.1 Indicative Mining Schedule

Production	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Total (t)
Highway Mining									
Topsoil (t)	622,557								622,557
Waste Rock (t)	6,246,343								6,246,343
ROM Coal (t)	750,000								750,000
Vulcan North Pit									
Topsoil (t)	58,734	313,019	40,004						411,757
Waste Rock (t)	4,001,234	24,117,467	1,616,789						29,735,489
ROM Coal (t)	26,137	1,202,385	585,592						1,814,114
Vulcan Main Pit									
Topsoil (t)	35,686	298,486	298,079	305,290	389,958	183,329	257,856	141,396	1,910,079
Waste Rock (t)	1,261,637	17,067,931	38,929,456	40,431,863	40,855,127	33,106,442	23,798,147	11,652,257	207,102,860
ROM Coal (t)		687,965	1,223,774	1,841,120	1,728,933	1,560,844	1,304,554	1,027,403	9,374,594
Vulcan South Pit									
Topsoil (t)						142,196	198,534	131,741	472,471
Waste Rock (t)						8,100,351	17,179,435	13,883,816	39,163,602
ROM Coal (t)						249,607	647,113	451,034	1,347,754
Annual Total									
Topsoil (t)	716,977	611,505	338,083	305,290	389,958	325,525	456,390	273,137	3,416,865
Waste Rock (t)	11,509,214	41,185,398	40,546,244	40,431,863	40,855,127	41,206,793	40,977,582	25,536,073	282,248,294
ROM Coal (t)	776,137	1,890,350	1,809,366	1,841,120	1,728,933	1,810,451	1,949,667	1,488,437	13,294,461

The following indicative mining equipment fleet is proposed for the Project:

Open cut operations:

- 1 x 400t class excavator
- 1 x 600t class excavator
- 2 x small coal clean-up excavators
- 4 x 90t mine trucks
- 5 x 180t mine trucks
- 4 x 200-220t mine trucks
- 2 x D10 dozers
- 2 x D11 dozers
- 3 x Graders
- 3 x Water trucks
- 2 x Drill rigs
- 2 x Service trucks.

Highwall mining trial:

- HW300 highwall mining system (low height cutter head)
- Push beams x 67 (400 m)
- Diesel generator
- Critical spares.

Highwall trenching and benching equipment:

- EX3600 Excavator
- ZX870
- CAT D11R
- 16M Grader
- CAT 775 Water Cart.

Highwall support equipment:

- 966H Loader (push beam handling)
- 988H Loader (Loading trucks, stockpile management)
- Loader attachments (forks, bucket)
- Stacker belt (stockpiling ROM coal)
- Off road haulage trucks (ROM coal to CHPP)
- Minor ancillary equipment.

2.5 Upset Conditions

Potential upset conditions and their effect on noise emissions are discussed as follows:

- If a piece of equipment malfunctions, this could result in an increased noise level for that item of equipment, although the overall effect on noise emissions from the whole site would likely be minor. When equipment malfunctions, it will be quickly taken out of operation, and adverse noise impacts are not expected to occur. In addition, all equipment will be maintained routinely, and malfunctions that increase noise levels are expected to be rare.
- Severe weather conditions could cause mining activity to reduce or stop. This would result in lower noise emission levels. Strong winds blowing from the mine towards sensitive receptors could

increase the mining noise levels but would also likely increase the background noise levels significantly such that mining noise would be masked.

Overall it is not expected that upset conditions pose a risk of additional noise impact, and further assessment of such cases is not considered to be warranted.

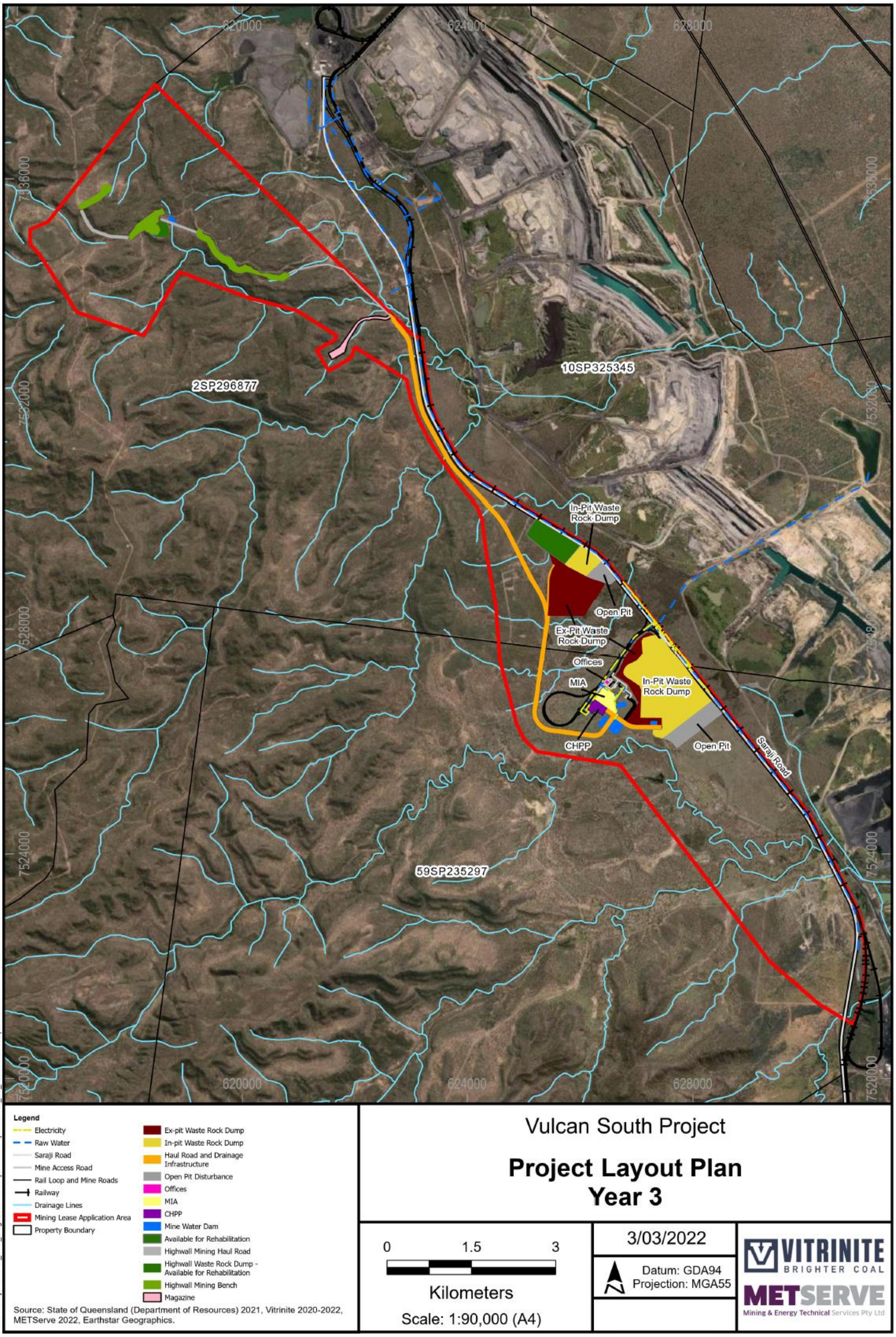


Figure 2.2 Year 3 Indicative Project Layout Plan

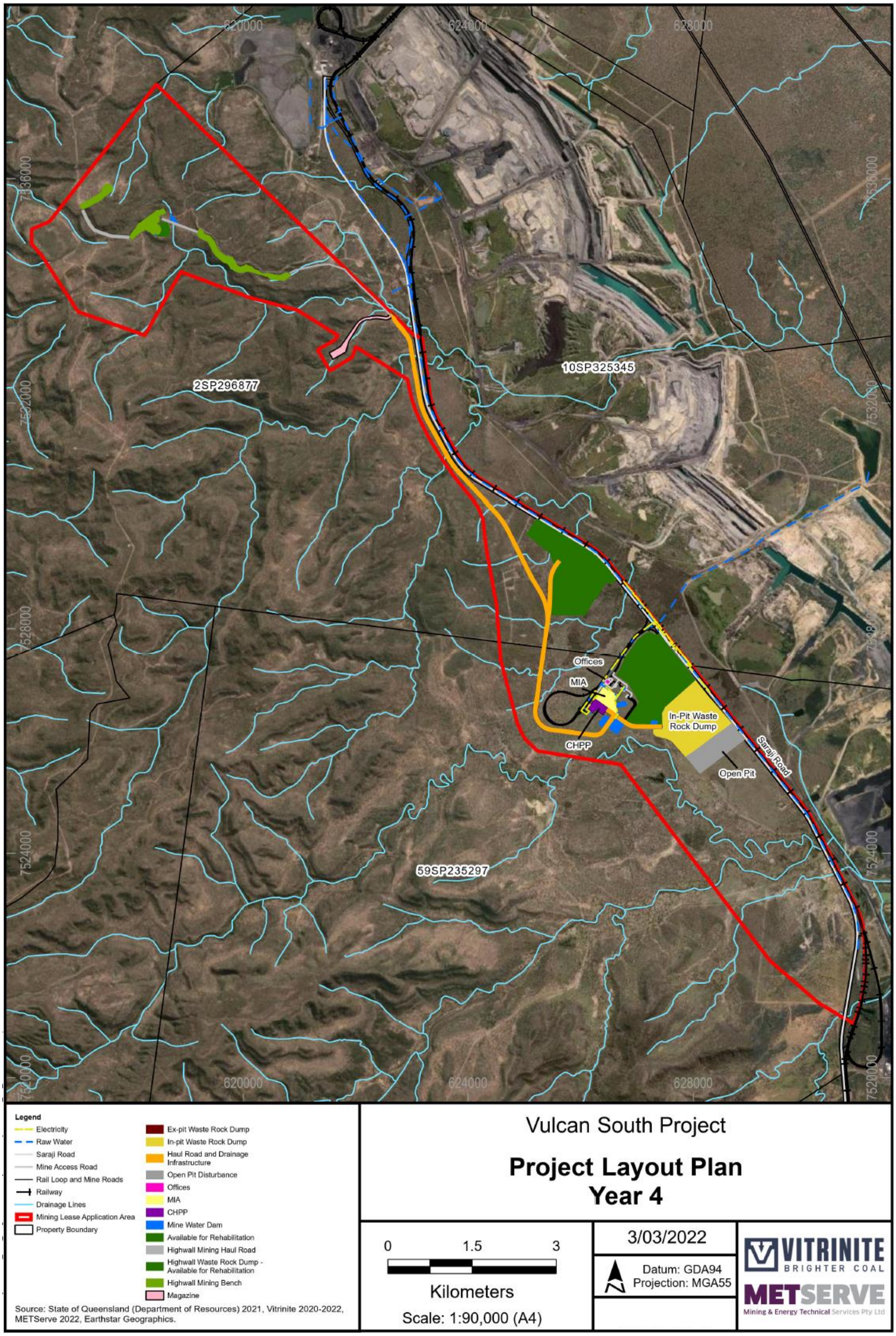


Figure 2.3 Year 4 Indicative Project Layout Plan

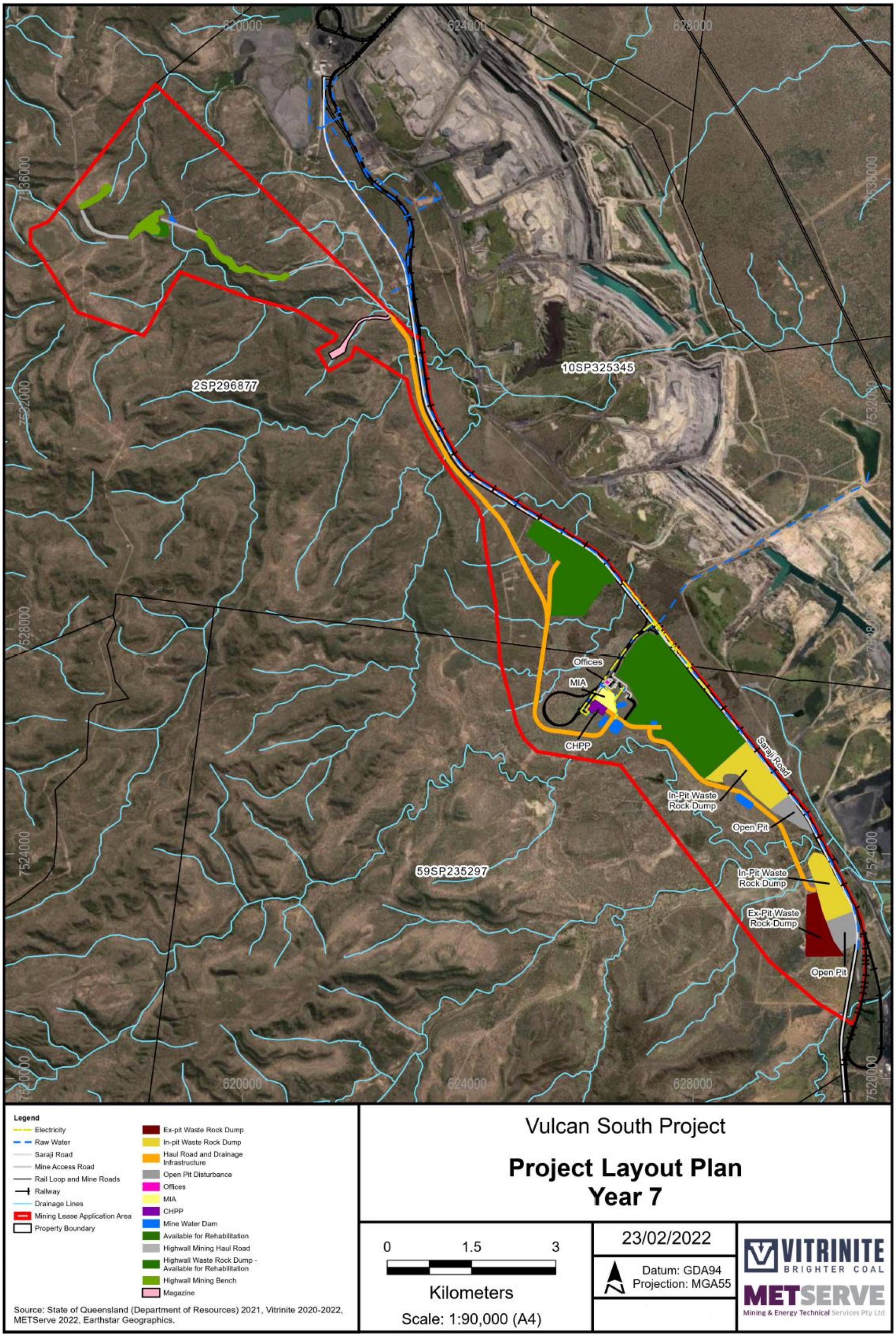


Figure 2.4 Year 7 Indicative Project Layout Plan

3. Study Area Description

3.1 Overview

The site is located in a rural area. The closest town is Moranbah which is located approximately 35 km north-west from the proposed site.

3.2 Receptors

The nearest receptors are summarised in **Table 3.1** including their locations (Latitude and Longitude) and are shown in **Figure 3.1**. The list includes commercial receptors and sensitive residential receptors, where the definition of a sensitive place required to be considered by operators of environmentally relevant activities is provided by the Department of Environment and Science (DES 2019). This definition is a place that could include but is not limited to:

- A dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises;
- A Motel, Hotel or Hostel;
- A Kindergarten, School, University or other Educational Institution;
- A Medical centre or Hospital;
- A protected area under the Nature Conservation Act 1992, the Marine Parks Act 2004 or a World Heritage Area;
- A Public park or garden; and
- A place used as a Workplace including an office for business or commercial purposes.

Table 3.1 Commercial and Sensitive Residential Receptors (Residential are Shaded Blue)

#	Receptor Name	Receptor Description	Location (Latitude and Longitude)	Distance (m) from nearest Project Disturbance Area	Direction from the Project	Distance (m) from nearest BHP Mine Operations
1	BMA Peak Downs	Commercial- Sustaining projects construction support and geological services buildings	-22.276062 148.177274	1,365	North to East	850
2	BMA Peak Downs	Commercial- Field workshop and field office/crib area	-22.27497 148.18670	1,850	North to East	Within existing operations (Adjacent to Goonyella System Rail (100m) and main haul road (400m)
3	BMA Peak Downs	Commercial- Field office/crib area	-22.27351 148.18567	2,020	North to East	Within existing operations (Adjacent to Goonyella System Rail (80m), hardstands (10m) and main haul road (350m)

#	Receptor Name	Receptor Description	Location (Latitude and Longitude)	Distance (m) from nearest Project Disturbance Area	Direction from the Project	Distance (m) from nearest BHP Mine Operations
4	BMA Peak Downs	Commercial- Main offices area and workshop area	-22.26044 148.17860	3,060	North to East	Within existing operations (400m from CHPP)
5	Property Manager Residence	Residential- Property managers residence	-22.390147 148.267067	Within MLA	Within MLA	410
6	Workers Residence	Residential- Workers residence	-22.394204 148.269578	Within MLA	Within MLA	480
7	BMA Saraji	Commercial- Main office area and workshop	-22.418965 148.277679	1,960	South	Within existing operations (300m from CHPP)
8	Saraji Station Residence	Residential	-22.42916 148.259057	2,970	South	-
9	Luxor Residence	Residential	-22.527639 148.122611	>15,000	South-west	-
10	Cheeseboro Residence	Residential	-22.427361 148.023250	>20,000	West	-

Note: All distances should be considered approximate.

It is noted that Receptors 5 and 6 are located on the MLA area. The commercial/industrial receptors are associated with BMA Peak Downs and those receptors are closer to the established BHP mine operations than the Project, and therefore would likely already be exposed to higher noise levels than produced by the Project.

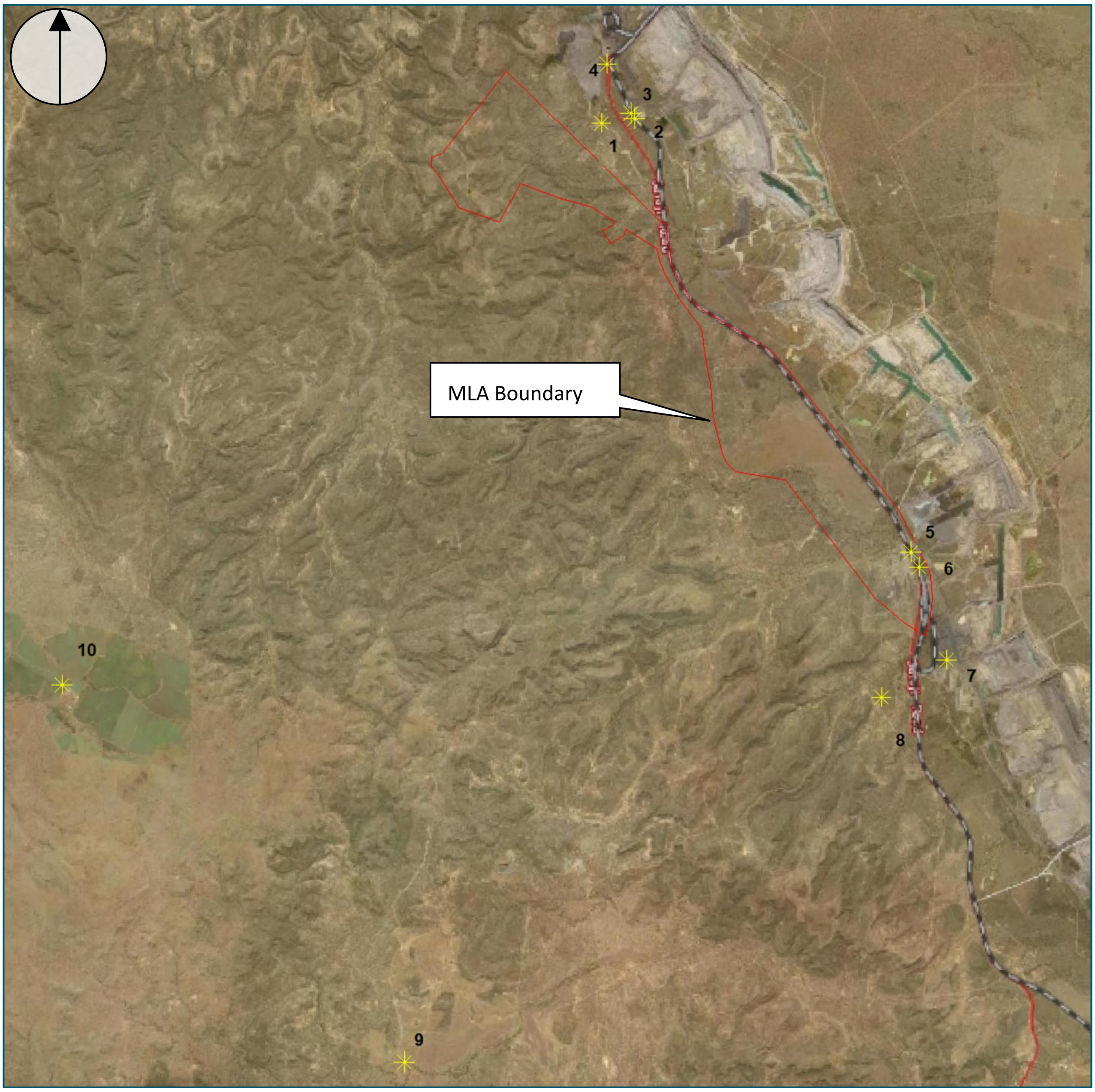


Figure 3.1 Location of MLA (Mine Lease Area) and Receptor Locations 1 to 10

4. Acoustic Criteria

4.1 Overview

Noise and vibration criteria are required to assess the potential impacts of the proposed mine operations on sensitive receptors.

The relevant Department of Environment and Science (DES) noise and vibration criteria have been considered and are listed as follows:

- Environmental Protection Act 1994;
- Environmental Protection (Noise) Policy 2019;
- Guideline "Planning For Noise Control", Department of Environment and Science;
- Guideline "Noise and Vibration from Blasting", Department of Environment and Science; and
- Guideline "Model Mining Conditions", Department of Environment and Science.

4.2 Environmental Protection Act

In Queensland, the environment is protected under the *Environmental Protection Act 1994* (EP Act).

Section 3 of the EP Act states that the object of the Act is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).

Section 12 of the EP Act defines noise as including *"vibration of any frequency, whether emitted through air or another medium"*.

Section 319 of the EP Act relates to General Environmental Duty and states that a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm.

Section 14(1) of the EP Act defines environmental harm as any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance.

Section 15 of the EP Act defines environmental nuisance as an unreasonable interference or likely interference with an environmental value caused by (a) noise.

The EP Act refers to the Environmental Protection Policies as being subordinate legislation to the Act.

4.3 Environmental Protection (Noise) Policy

4.3.1 Overview

With respect to the acoustic environment, the object of the EP Act is achieved by the Environmental Protection (Noise) Policy 2019 (EPP (Noise)). This policy identifies environmental values to be enhanced or protected, states acoustic quality objectives, and provides a framework for making decisions about the acoustic environment.

4.3.2 Acoustic Quality Objectives

The EPP (Noise) contains a range of acoustic quality objectives for a range of receptors. The objectives are in the form of noise levels, and are defined for various periods of the day, and use a number of acoustic parameters.

Schedule 1 of the EPP(Noise) includes the following acoustic quality objectives to be met at residential dwellings:

- Outdoors
  - Daytime and Evening: 50 dBA $L_{Aeq,adj,1hr}$, 55 dBA $L_{A10,adj,1hr}$ and 65 dBA $L_{A1,adj,1hr}$
- Indoors
  - Daytime and Evening: 35 dBA $L_{Aeq,adj,1hr}$, 40 dBA $L_{A10,adj,1hr}$ and 45 dBA $L_{A1,adj,1hr}$
  - Night: 30 dBA $L_{Aeq,adj,1hr}$, 35 dBA $L_{A10,adj,1hr}$ and 40 dBA $L_{A1,adj,1hr}$

Based on a conservative 5 dBA façade reduction (5 dBA reduction in noise levels from outside a house to inside a house when windows are fully open), the indoor noise objectives noted above could be converted to the following external objectives (with windows open):

- Daytime and Evening: 40 dBA $L_{Aeq,adj,1hr}$, 45 dBA $L_{A10,adj,1hr}$ and 50 dBA $L_{A1,adj,1hr}$
- Night: 35 dBA $L_{Aeq,adj,1hr}$, 40 dBA $L_{A10,adj,1hr}$ and 45 dBA $L_{A1,adj,1hr}$

4.3.3 Background Creep

The current 2019 version of the EPP (Noise) no longer contains criteria for background creep, but states that background creep should be prevented or minimised, to the extent that it is reasonable to do so.

Background creep is defined as "a gradual increase in the total amount of background noise in the area or place as measured under the document called the 'Noise measurement manual' published on the department's website" (Section 9(4) of EPP Noise). This is understood to require consideration of cumulative impacts, including other developments.

4.4 Guideline – Planning for Noise Control

DES had previously published a guideline titled "Planning for Noise Control". The Planning for Noise Control guideline is currently listed as being "under review" according to the DES website. As such, it is not proposed to utilise the noise criteria contained within the document.

The document contains a method for determining the minimum background noise level using the lowest tenth percentile methodology.

4.5 Guideline – Noise & Vibration from Blasting

The DES Guideline "Noise and vibration from blasting" contains criteria and procedures that are applicable to noise and vibration emitted from blasting. It applies to activities such as mining, quarries, construction and other operations which involve the use of explosives for fragmenting rock.

The criteria are presented in **Table 4.1**. These criteria address human comfort and apply at residential and commercial receptors.

Table 4.1 Blasting Vibration and Airblast Criteria

Issue	Criteria
Airblast	Airblast overpressure of 115 dB (linear peak) for nine (9) out of ten (10) consecutive blasts initiated and not greater than 120 dB (linear peak) at any time.
Vibration	5 mm/s peak particle velocity for nine (9) out of ten (10) consecutive blasts and not greater than 10 mm/s peak particle velocity at any time.

It is noted that higher limits would typically be used for prevention of structural damage.

4.6 Guideline – Assessment of Low Frequency Noise

The DES Guideline "Assessment of Low Frequency Noise" contains methods and procedures that are applicable to low frequency noise emitted from industrial premises and mining operations for planning purposes. Items such as boilers, pumps, transformers, cooling fans, compressors, oil and gas burners, foundries, wind farms, electrical installations, diesel engines, ventilation and air-conditioning equipment, wind turbulence and large chimney resonance may comprise sources of high level noise having frequency content less than 200 Hz.

These sources may exhibit a spectrum that characteristically shows a general increase in sound pressure level with decrease in frequency. Annoyance due to low frequency noise can be high even though the dBA level measured is relatively low. Typically, annoyance is experienced in the otherwise quiet environments of residences, offices and factories adjacent to or near low frequency noise sources. Generally, low level/low frequency noises become annoying when the masking effect of higher frequencies is absent. This loss of high frequency components may occur as a result of transmission through the fabric of a building, or in propagation over long distances.

Where a noise immission occurs exhibiting an unbalanced frequency spectrum, the overall sound pressure level inside residences should not exceed 50 dBZ to avoid complaints of low frequency noise annoyance. A spectrum is considered unbalanced when the un-weighted overall noise level is more than 15 dB higher than the A-weighted overall noise level.

4.7 Proposed Criteria

4.7.1 Noise Emissions

In accordance with the EPP (Noise) and based on the calculated external limits as discussed in **Section 4.3.2**, the resulting noise objectives for the site to protect the acoustic environment and to be proposed as noise limits for the operation are presented in **Table 4.2**.

Table 4.2 Proposed Noise Limits for Sensitive Receivers

Period	Noise Limit $L_{Aeq,adj,1hr}$ dBA
Day (7am to 6pm)	Outdoor 40 dBA $L_{Aeq,adj,1hr}$ and Indoor 50 dBZ $L_{eq,adj,1hr}$ (and dBZ-dBA > 15 dB)
Evening (6pm to 10pm)	Outdoor 40 dBA $L_{Aeq,adj,1hr}$ and Indoor 50 dBZ $L_{eq,adj,1hr}$ (and dBZ-dBA > 15 dB)
Night (10pm to 7am)	Outdoor 35 dBA $L_{Aeq,adj,1hr}$ and Indoor 50 dBZ $L_{eq,adj,1hr}$ (and dBZ-dBA > 15 dB)

4.7.2 Blasting

It is proposed to adopt the blasting criteria from the Guideline "Noise and vibration from blasting". The criteria are presented in **Table 4.3**.

Table 4.3 Proposed Blasting Vibration and Airblast Criteria for Sensitive Receivers

Issue	Criteria
Airblast	Airblast overpressure of 115 dB (linear peak) for nine (9) out of ten (10) consecutive blasts initiated and not greater than 120 dB (linear peak) at any time.
Vibration	5 mm/s peak particle velocity for nine (9) out of ten (10) consecutive blasts and not greater than 10 mm/s peak particle velocity at any time.

5. Existing Noise Environment

5.1 Overview and Location

Attended noise measurements and noise logging were undertaken at the following locations:

- Location A – Located back yard of the property (-22.394338, 148.269479). This is the adjacent sensitive receptor 6 in **Figure 5.1** and **Figure 3.1**.
- Location B – Located front yard of the property adjacent the fence (-22.527639, 148.122611). This is the adjacent sensitive receptor 9 in **Figure 5.1**.
- Location C – Located centre of the property under the trees (-22.427361, 148.023250). This is the adjacent sensitive receptor 10 in **Figure 5.1**.
- Location D – Located centre of the property (-22.429444, 148.259111). This is the adjacent sensitive receptor 8 in **Figure 5.1** and **Figure 3.1**.

The noise monitoring was undertaken in general accordance with Australian Standard AS1055 Acoustics – Description and measurement of environmental noise and the EHP Noise Measurement Manual 2013.

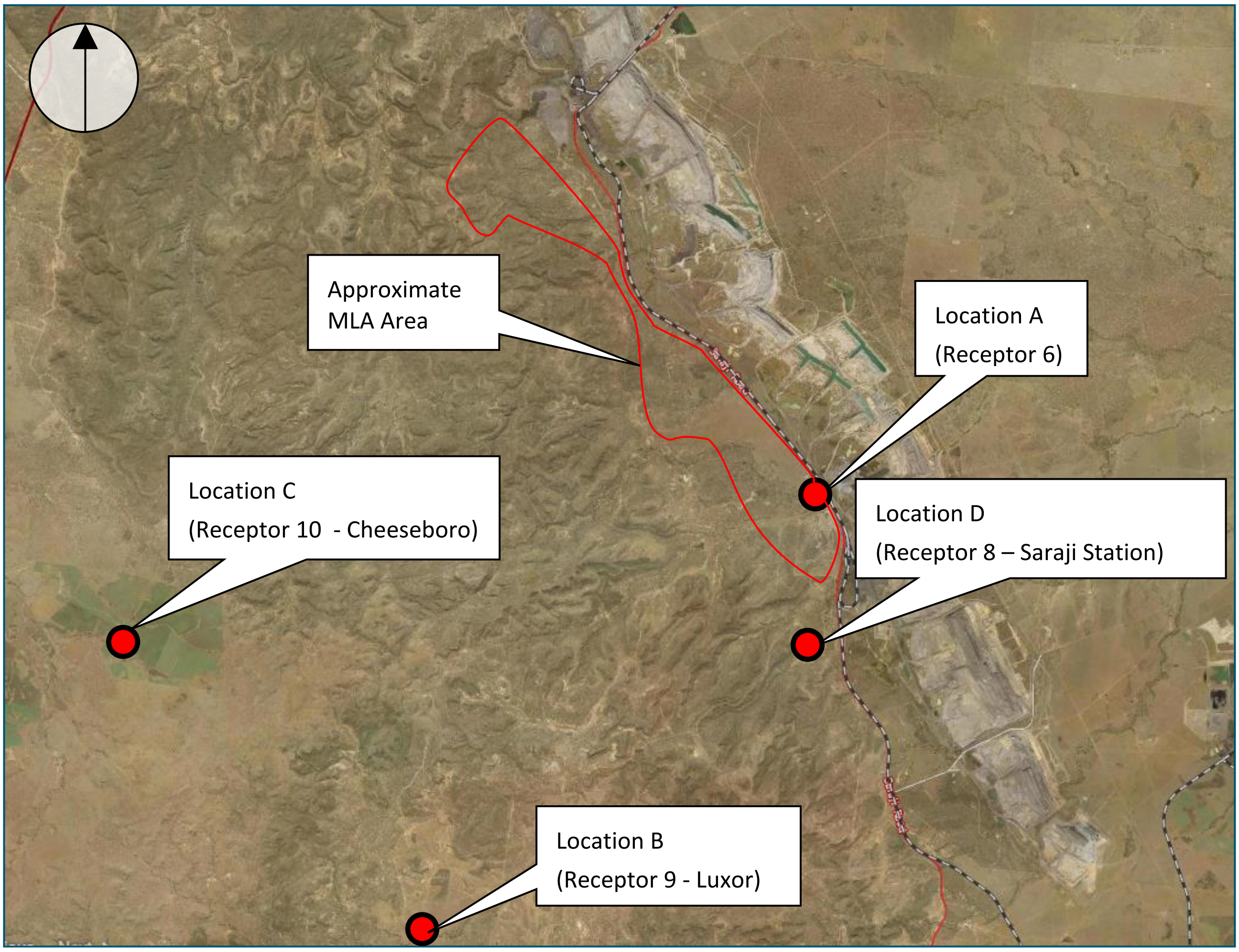


Figure 5.1 Aerial View of Monitoring Locations A to D.

5.2 Attended Noise Measurements

Attended noise measurements were undertaken at Locations A, B, C and D. The measurements were undertaken on 6th November 2019 over 15 minute periods using a field and laboratory calibrated Norsonic sound level meter. The microphone height was approximately 1.3 m above natural ground level and was located in the free field. Weather during the time of monitoring was generally moderate with a breeze in the daytime, and still at night. The conditions were as follows:

- Daytime: Approximately 30 °C to 35 °C with a 0 m/s to 1.5 m/s slight breeze and no cloud cover.
- Night time: Approximately 25 °C with calm and no cloud cover.

Noise measurements were only conducted at Locations A and D at night as they were expected to be affected by existing mine noise. Location B and C were expected to have low background noise levels which would be adequately demonstrated by noise logging. The measured noise levels are summarised in **Table 5.1**.

Table 5.1 Attended Noise Measurement Results

Location	Date & Time	Period (Minutes)	Results & Notes
Day			
A (Receptor 6)	02:12pm 06/11/19	15	Statistical noise levels: L_{10} 44 dBA, L_{eq} 42 dBA, L_{90} 34 dBA Road traffic 40 to d4 dBA Distance mine noise 32 to 43 dBA
B (Receptor 9)	04:39pm 06/11/19	15	Statistical noise levels: L_{10} 40 dBA, L_{eq} 45 dBA, L_{90} 26 dBA Birds 27 to 70 dBA
C (Receptor 10)	12:26pm 06/11/19	15	Statistical noise levels: L_{10} 44 dBA, L_{eq} 41 dBA, L_{90} 30 dBA People walking/talking 32 to 49 dBA Garden watering 35 to 36 dBA Distance weigh drop 36 to 39 dBA Wind through trees 38 to 51 dBA Birds 40 to 42 dBA
D (Receptor 8)	03:09pm 06/11/19	15	Statistical noise levels: L_{10} 38 dBA, L_{eq} 43 dBA, L_{90} 29 dBA Distance traffic 31 to 40 dBA Horse noise 41 to 71 dBA Workshop activities 41 to 46 dBA Birds 31 to 51 dBA
Night			
A (Receptor 6)	10:47pm 06/11/19	15	Statistical noise levels: L_{10} 43 dBA, L_{eq} 39 dBA, L_{90} 32 dBA Mine noise 32 to 49 dBA
D (Receptor 8)	10:08pm 06/11/19	15	Statistical noise levels: L_{10} 36 dBA, L_{eq} 35 dBA, L_{90} 32 dBA Mine noise 31 to 43 dBA

Note: * The reported noise levels, excluding the statistical noise levels, are the instantaneous levels read from the sound level meter, and generally represent the range in noise levels or maximum noise levels for a particular noise source.

5.3 Noise Logging

Noise logging was undertaken at Locations A, B, C and D. Logging was undertaken from Tuesday 5th to Tuesday 12th November 2019 using field and laboratory calibrated Larson Davis LD831 environmental noise loggers. Noise logging was undertaken in the free field.

Data from the Bureau of Meteorology (BoM) (Iffley) indicates that weather during the monitoring period was generally fine and warm. Overall, the noise monitoring data is considered acceptable for use in this report.

Photos of the noise monitoring locations are shown in **Figures B.1** to **B.2** in **Appendix B**.

The measured noise levels are shown graphically in **Figures C.1** to **C.8** in **Appendix C**. The statistical results from the noise logging have been summarised in **Tables C.1** to **C.4** in **Appendix C**.

The background noise levels at Locations A to D were calculated using the lowest tenth percentile method (as per **Section 4.4**) and the results for Locations A, C and D are shown in **Table 5.2**.

Table 5.2 Background Noise Levels at Locations A, C and D

Period	Background Noise Level L_{90} dBA		
	Location A (Receptor 6)	Location C (Receptor 10)	Location D (Receptor 8)
Day (7am to 6pm)	32	30	29
Evening (6pm to 10pm)	31	24	33
Night (10pm to 7am)	31	18	32

The background noise level at Location B (Receptor 9) was affected by insect noise. As the insect noise is likely a seasonal influence, the noise level data has been filtered to remove the insect noise. The resulting background noise levels calculated using the lowest tenth percentile method are shown in **Table 5.3**.

Table 5.3 Background Noise Levels at Location B (Receptor 9) - Measured and with Insect Noise Removed

Period	Measured Background Noise Level L_{90} dBA	Filtered (Less Insect Noise) Background Noise Level L_{90} dBA
Day (7am to 6pm)	24	24
Evening (6pm to 10pm)	28	18
Night (10pm to 7am)	17	15

From the results above, the following comments on background noise are made:

- Location A (Receptor 6): Continuous mine noise from nearby operating mines is audible at this location and road traffic noise from Saraji Road was audible at this location at day and night.
- Location B (Receptor 9) & Location C (Receptor 10): Overall, the measurement results indicate the area is very quiet, as is typical of a rural environment. The major noise sources are natural (birds, wind in trees) and farm related (farm machinery, livestock, dogs).
- Location D (Receptor 8): Continuous mine noise from nearby operating mines is audible at this location at night. Other noise sources are natural (birds, wind in trees), farm related (farm machinery, livestock, dogs) and distant road traffic.

5.4 Seasonal Variability

Ambient noise levels are affected by many noise sources including wind, rustling grass and leaves, distant highway traffic, insects, birds and other animals.

The noise monitoring was conducted in Spring (November) when insect noise levels can be relatively high. During colder months, the noise from insects will tend to be quieter. However, it is not normally necessary to conduct monitoring across warmer and cooler months as insect noise can be filtered from the noise data, as has occurred in **Section 5.3**. In this instance, significant insect noise was only identified at Location B and was removed accordingly as shown in **Table 5.3**.

6. Noise Assessment

6.1 Model Description

Noise modelling was carried out using the SoundPLAN v8.2 computer program using the CONCAWE algorithm, which are widely used and accepted for noise modelling and is approved by DES.

The SoundPLAN program was used to develop a three-dimensional digital terrain noise model of the Project and the surrounding area including the location of sensitive receptors. The model incorporates terrain data for the proposed Project and the surrounding natural topography.

6.2 Meteorology

The mining noise levels at residential receptors can vary significantly depending upon the meteorology and the mining activities. Meteorology has a significant effect on the noise levels, particularly due to wind speed and direction and vertical temperature gradients, which include temperature inversions.

It is possible to measure noise variations of the order of 15 to 20 dBA due to changes in meteorology. Assessment is required under worst-case meteorological conditions according to the Planning for Noise Control guideline.

The SoundPLAN model was setup to predict noise levels under neutral and adverse meteorological conditions. The conditions used in the noise model are shown in **Table 6.1**.

Table 6.1 Meteorological Scenarios

Parameter	Day Meteorological Scenarios		Night Meteorological Scenarios	
	Scenario D1	Scenario D2	Scenario N1	Scenario N2
Pasquill Stability Class	D	D	F	F
Temperature (°C)	25	25	10	10
Wind Speed (m/s)	0	2	0	2
Wind direction	-	Towards receivers	-	Towards receivers
Relative Humidity (%)	40	40	70	70

The neutral meteorological conditions are most likely to occur during the daytime and adverse conditions is most likely to occur during the night-time, particularly temperature inversions. It is noted that neutral conditions could occur during the night, and adverse conditions could occur to some extent during the day and evening.

These meteorological scenarios are presented to give an indication of the range of noise levels from neutral to adverse conditions and are assessed against the criteria corresponding to the periods when they will be most likely to occur. The most critical predictions are the night scenarios, since this assessed the highest predicted noise levels against the most stringent night-time criteria.

The SoundPLAN model assumes the wind direction is from the source to each receptor and thus modelling for multiple wind directions is not required.

6.3 Noise Source Data

The model uses the sound power level (L_w) of each noise source to predict noise emissions. The sound power levels used in the model were based on noise source data obtained from previous mining projects.

The sound power levels for the mobile and fixed equipment proposed for the Project are presented in **Table 6.2**.

Table 6.2 Noise Source Sound Power Levels

Equipment	Data Source	Octave Band Sound Power Level $L_{W,eq}$ dBZ								Overall $L_{W,eq}$	
		63	125	250	500	1k	2k	4k	8k	dBZ	dBA
Excavator – 600t class	4	134	129	119	124	116	111	109	104	136	123
Excavator – 400t class	1,2,3	129	124	114	119	111	106	104	99	131	118
Excavator – 120t class	3,4	109	119	114	114	111	109	103	98	122	116
Excavator – EX3600	3,4	118	120	116	116	112	110	105	100	124	118
Dozer D10	3,4	85	103	108	116	113	115	106	92	120	119
Dozer D11	3,4	85	103	108	116	113	115	106	92	120	119
Dozer CATD11R	3,4	98	98	98	103	101	102	94	84	108	107
Drill	4	109	111	111	110	110	109	106	101	118	115
Pump	2,4	105	103	99	98	99	98	93	89	109	109
Crusher	1	125	122	116	114	108	110	104	98	127	117
Screen	4	80	91	97	104	107	110	106	99	114	114
Stacker Belt	3	114	118	112	109	104	100	92	83	121	111
Train loading	3	108	117	114	117	112	110	102	93	122	118
200-220t mine truck (793)	3,4	89	109	111	115	113	112	105	95	120	118
180t mine truck (789)	3,4	89	109	111	115	113	113	105	95	120	118
90t mine truck (777)	3,4	84	96	101	108	111	110	102	95	115	115
Grader	3,4	108	115	112	104	104	102	98	90	118	110
Water truck	3,4	110	112	110	111	111	109	101	96	119	115

The sources of data used to compile the sound power level data in **Table 6.2** are presented in **Table 6.3**.

Table 6.3 Source of Data for Equipment Sound Power Levels

Source #	Data Source
1	Data based on measurements undertaken by ASK at another coal mine.
2	Manufacturer's noise data.
3	ASK database, based on sound power level calculated from measurements at another coal mine for the same/similar equipment.
4	Data for these sources was extracted from another similar coal mine project. Generally this data is similar to noise data for similar equipment at other mine sites and is considered suitable for noise modelling purposes.

The equipment modelled has been chosen to closely reflect the anticipated mining fleet. However, there is potential for alternate makes and models of equipment to be used in the operating mine. If the equipment model is changed, the sound power level of the alternative model should be reviewed to determine if noise level increases are expected.

6.4 Modelling Scenario

Mining noise emissions from the Project have been predicted for year 3, 4 and 7 of mine life.

Modelling of the nominated mine scenarios have included mine ground elevations, equipment numbers and equipment locations based on information provided by Mining & Energy Technical Services Pty Ltd. Subsequent to this modelling, the ex-pit dump elevations have changed, but these changes are not considered to affect the modelling presented in this report.

The mobile equipment numbers and locations are presented in **Table 6.4** and the source locations and path of the mobile equipment are shown in **Appendix D**.

Table 6.4 Equipment Fleet and locations

Equipment	Map Reference
1 x Excavator – 600t class	South of open pit
1 x Excavator – 400t class	In-Pit dump
1 x Excavator – 120t class	Open pit
1 x Excavator – EX3600	In-Pit dump
2 x Dozer D10	In-Pit dump
2 x Dozer D11	In-Pit dump
1 x Dozer CATD11R	In-Pit dump
2 x Drill	South of open pit
3 x Pump	MIA, CHPP
Crusher. Screen, Stacker Belt	CHPP
Train loading	CHPP
5 x 200-220t mine truck (793)	Pre-strip waste to ex-pit waste dump
5 x 180t mine truck (789)	In-pit waste to in-pit dump
4 x 90t mine truck (777)	Open pit to ROM
2 x Grader	All roads
3 x Water truck	All roads

Based on the equipment fleet in **Table 6.4** and the individual equipment sound power levels in **Table 6.2**, the overall plant sound power level is calculated as per **Table 6.5**. The sound power levels are presented for mobile plant (i.e. trucks), fixed plant (i.e. everything but trucks) and all plant equipment combined.

Table 6.5 Overall Equipment Sound Power Level

Equipment	Octave Band Sound Power Level $L_{W,eq}$ dBZ								Overall $L_{W,eq}$	
	63	125	250	500	1k	2k	4k	8k	dBZ	dBA
Mobile	117	124	123	126	125	124	116	108	132	130
Fixed	136	132	126	128	124	124	117	111	139	130
All	136	133	128	130	127	127	120	112	139	133

From **Table 6.5** it can be seen that overall sound power level of the equipment is 133 dBA $L_{Aw,eq}$.

6.5 Predicted A-Weighted Noise Levels & Assessment

6.5.1 Noise from Project

The predicted noise levels at nearby sensitive receptors for the Year 3, 4 and 7 of the Project are presented in **Table 6.6**. The noise contours are presented in **Appendix E**.

The results at sensitive receptors are compared against the proposed noise limits of 35 dBA L_{eq} and 40 dBA L_{eq} for the night and daytime/evening respectively, as per **Table 4.2**. Where the result exceeds the limit, the cell is shaded pink in **Table 6.6**.

The predicted noise levels are also shown graphically as noise contours in **Appendix E**, as follows:

- **Figure E.1** Year 3 Scenario D2
- **Figure E.2** Year 4 Scenario D2
- **Figure E.3** Year 7 Scenario D2
- **Figure E.4** Year 3 Scenario N1
- **Figure E.5** Year 4 Scenario N1
- **Figure E.6** Year 7 Scenario N1

Note: Noise contours have not been prepared for the D1 and N2 scenarios, as they would have less noise impact than the results included in the figures (as shown by the tabulated results in **Table 6.6**).

Receptors 5 and 6 are presumed not to exist in the Year 7 scenario since these receptors will be in the open pit.

Based on the tabulated results, no exceedances are recorded during day/evening operations. Predicted night exceedances are listed in following:

- Year 3:
  - Receptor 5: 5 dBA
  - Receptor 6: 3 dBA
- Year 4:
  - Receptor 5: 6 dBA
  - Receptor 6: 4 dBA
- Year 7:
  - Receptor 8: 5 dBA

It is proposed that a noise management plan be considered to determine the operational constraints for the mine to achieve the noise limits at receptors 5, 6 and 8.

6.5.2 Noise at Commercial Receptors

The noise level at commercial receptors (1 to 4 and 7) are predicted to be 8 to 45 dBA L_{Aeq}. Given typical indoor office ambient noise levels are 40 to 45 dBA, an external noise level of up to 45 dBA is considered acceptable.

6.5.3 Cumulative Noise from the Project and Other Nearby Mines

Cumulative noise from this mine and other existing and proposed mining projects is difficult to accurately predict due to lack of information about the future of the other mining projects and the noise limits which may have been imposed/agreed on those other mining projects.

Cumulative noise is proposed to be considered where the predicted mining noise levels are within 3 dBA of the nominated noise limits, i.e. greater than 37 dBA in the day/evening and greater than 32 dBA in the night. A margin of 3 dBA has been selected as this would allow the noise contribution from other mines to be equal to the noise from the Project, i.e. 37 dBA from Vulcan South + 37 dBA from other mines = 40 dBA total = day/evening noise limit.

Therefore, cumulative noise is considered a concern for Receptors 5, 6 and 8. It is noted that exceedances are already predicted at these Receptors.

The existing mine noise levels at Locations A (Receptor 6) and Location D (Receptor 8) were measured at 39 dBA $L_{Aeq,15min}$ and 35 dBA $L_{Aeq,15min}$ respectively, which matches or exceeds the proposed night time limit of 35 dBA $L_{Aeq,1hr}$. Based on these measurement results it is possible that existing mine noise limits at these receptors are higher than the proposed limits in **Table 4.2**. It is proposed that the noise limits at Receptors 6 and 8 should be the higher of (i) the Trinity proposed limits in **Table 4.2**; and (ii) the existing mine noise limits contained in the Environmental Authorities of other nearby mine(s). If the existing mine noise limits for Receptors 6 and 8, as contained in the Environmental Authorities of other nearby mine(s), are the same as proposed in **Table 4.2**, then the target noise contribution from the Project at Receptors 6 and 8 is proposed to be 3 dB lower than the limits in **Table 4.2**.

It is proposed that a noise management plan be considered to determine the operational constraints for the mine to achieve reduced noise limits of 37 dBA in the day/evening and greater than 32 dBA in the night at receptors 5, 6 and 8.

6.6 Predicted Low Frequency Noise Emission Levels & Assessment

An assessment of low frequency noise emissions at residential receptors has been included in accordance with the guideline "Assessment of Low Frequency Noise criteria".

The internal noise limit at a residence is an un-weighted noise level of 50 dBZ which is considered to correlate with an external noise limit of 57 dBZ, assuming a 7 dB reduction from outside to inside through a residential building with open windows. If the external noise level exceeds 57 dBZ and the difference between the un-weighted and A-weighted noise levels exceeds 15 dB, then the noise is considered to have unacceptable low frequency content and further assessment is required.

The predicted un-weighted (Z-weighted) noise levels are shown in **Table 6.7**.

From the results in **Table 6.7** it can be seen that there are no results exceeding 57 dBZ and with a dBZ-dBA difference of greater than 15 dB. Therefore, the predicted low frequency noise levels are acceptable.

Table 6.6 Predicted A-Weighted Mining Noise Levels

ID	Type	Sensitive Receptor Name	Predicted Noise Emission Levels, L_{eq} dBA											
			Year 3				Year 4				Year 7			
			D1	D2	N1	N2	D1	D2	N1	N2	D1	D2	N1	N2
1	Commercial	BMA Peak Downs	12	17	21	18	11	17	21	17	10	16	20	16
2	Commercial	BMA Peak Downs	12	18	22	19	12	18	22	18	10	16	21	17
3	Commercial	BMA Peak Downs	12	18	22	19	12	17	22	18	10	16	20	17
4	Commercial	BMA Peak Downs	10	16	20	16	10	15	20	16	8	14	19	15
5	Residential	Property Manager	31	37	40	39	33	39	41	41	-	-	-	-
6	Residential	Workers Accommodation	29	35	38	37	31	37	39	39	-	-	-	-
7	Commercial	BMA Saraji	20	26	30	28	21	27	31	29	37	43	45	45
8	Residential	O'Sullivan Residence	19	25	30	27	20	26	30	27	31	37	40	39
9	Residential	Luxor Residence	4	9	15	10	4	9	15	11	5	10	16	11
10	Residential	Cheeseboro Residence	2	8	14	9	2	8	14	9	2	8	14	9

Note: Residential receptors are shaded blue.

Potential exceedances are shaded red.

Receptors 5 and 6 are presumed not to exist in the Year 7 scenario since these receptors will be in the open pit.

Table 6.7 Predicted Z-Weighted Mining Noise Levels

ID	Type	Sensitive Receptor Name	Predicted L_{eq} dBZ and (dBZ-dBA difference)											
			Year 3				Year 4				Year 7			
			D1	D2	N1	N2	D1	D2	N1	N2	D1	D2	N1	N2
1	Commercial	BMA Peak Downs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Commercial	BMA Peak Downs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	Commercial	BMA Peak Downs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Commercial	BMA Peak Downs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	Residential	Property Manager	47 (16)	50 (13)	51 (11)	51 (12)	49 (16)	52 (13)	53 (11)	53 (12)	-	-	-	-
6	Residential	Workers Accommodation	46 (17)	49 (14)	50 (12)	49 (13)	47 (17)	50 (13)	51 (12)	51 (12)	-	-	-	-
7	Commercial	BMA Saraji	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	Residential	O'Sullivan Residence	38 (19)	42 (17)	43 (14)	43 (16)	39 (19)	42 (17)	43 (14)	43 (16)	48 (17)	51 (14)	52 (12)	51 (12)
9	Residential	Luxor Residence	21 (18)	27 (18)	31 (17)	30 (19)	22 (18)	27 (18)	31 (17)	30 (19)	23 (18)	28 (18)	32 (17)	31 (19)
10	Residential	Cheeseboro Residence	20 (18)	26 (18)	30 (17)	29 (19)	20 (18)	26 (18)	30 (16)	29 (19)	19 (18)	25 (18)	30 (16)	28 (19)

Note: Receptors 5 and 6 are presumed not to exist in the Year 7 scenario since these receptors will be in the open pit.

6.7 Haul Truck Noise Assessment

For a period of approximately 2 years, the transport of coal will be from the Project MLA to an existing coal wash and load out facility along the Peak Downs Highway to the north as shown by the blue line in **Figure 6.1.** Each truck will transport approximately 60 t of coal, with an anticipated average of 80 truck movements per 24 hours each way (i.e. 3.3 trucks per hour).

The proposed haul truck route is on an existing public road (Peak Downs Mine Road and Saraji Road) and a Queensland Globe review indicates the majority of the route (from the existing mine to the Highway) is classified 'PBS 3A (Up to type 1 road trains) RT1' and therefore has been designed for road trains, such as proposed for this project.

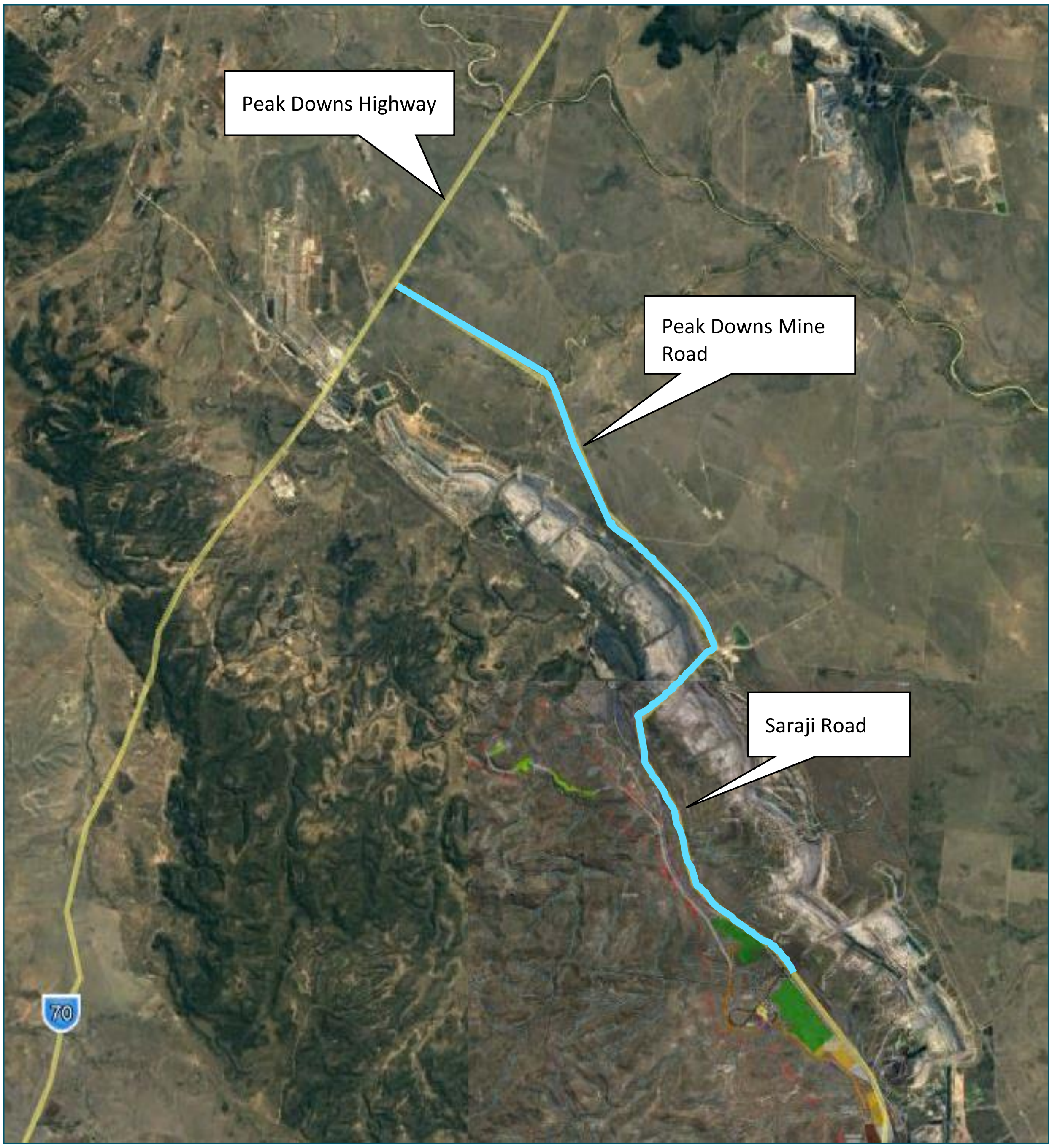


Figure 6.1 Haul Truck Route

The maximum (L_{max}) and average (L_{eq}) noise levels at locations adjacent the road can be calculated from the sound power level and using a standard moving point source calculation. From some recent ASK measurements, sound power level for the truck at higher speed offsite is 118 dBA.

The truck passby noise level would only affect the L_{10} noise level if the passby durations occurred for at least 10 percent of the measurement duration. For a 1 hour measurement, the L_{10} value is based on the noisiest 6 minutes in the hour. Given there are 3.3 trucks per hour, the $L_{10,1hour}$ value would only be affected where each truck passby occurred for a period of at least 1.8 minutes (i.e. 6 / 3.3). The $L_{10,1hour}$ value can thus be determined as the minimum noise level that occurs for the noisiest 1.8 minutes of a truck passby.

The calculated 1 hour L_{max}, L_{eq} and L_{10} noise levels from truck passbys (80 trucks per 24 hours) are shown in **Table 6.8**.

Table 6.8 Haul Truck Passby Noise Levels

Distance from Road, metres	Passby Noise Levels dBA		
	$L_{eq,1hour}$	$L_{10,1hour}$	$L_{max,1hour}$
50	57	50	76
100	52	50	70
200	48	50	64
400	45	49	58
800	41	48	52

From **Table 6.8** it can be seen that the L_{10} noise level is relatively constant due to the low number of truck movements resulting in the L_{10} noise level occurring when the truck is at approximately 1000 metres away from the residence, whereas the L_{eq} and L_{max} noise levels reduce at increased distances from the road.

From a review of Queensland Globe aerial photography, there does not appear to be any residents within 800 metres of the haul road, and thus traffic noise exposure would be less than the levels in **Table 6.8**. There is a residence approximately 200 metres from the Peak Downs Highway, near the intersection with Peak Downs Mine Road (Dysart Road) but it is considered reasonable to expect that this residence would be impacted by a higher number of existing cars and trucks compared to the number of trucks proposed for this project.

Noise levels from trucks on public roads are not assessed against the criteria and noise limits proposed for assessment of noise from mining operations. There is no specific Queensland noise limit for such a scenario, and so instead reference is made to the noise criteria from the Department of Transport and Main Roads (DTMR) Transport Noise Management Code of Practice, November 2013. This document proposes a noise criterion of 68 dBA $L_{A10,18hour}$ for an existing residence adjacent an existing road. Note: The $L_{A10,18hour}$ noise level is the arithmetic average of the $L_{A10,1hour}$ noise levels between 6am and midnight (i.e. 18 hours).

From the results in **Table 6.8** it can be seen that the hourly $L_{10,1hour}$ noise level adjacent the road would be well below the 68 dBA $L_{A10,18hour}$ noise criterion. It is simply the case that a low number of vehicle movements, i.e. 80 per 24 hours from this mine, would not be a sufficient number of vehicle passby events to result in a high $L_{A10,18hour}$ noise level.

Overall, based on the proposed haul truck route and truck numbers, the noise impacts are considered compliant.

7. Blasting Assessment

7.1 Overview

It is anticipated that the existing vibration levels around the mine site and at the location of sensitive receptors will generally be negligible, except at locations which are close (e.g. within 100m) to roads, rail lines or near major items of fixed plant (e.g. diesel generator).

The only vibration source of significance from the proposed mining activities would be blasting. Blasting activities within the pits have been assessed for both ground vibration and airblast. The relevant criteria for ground vibration and airblast have been presented and discussed in **Section 4.7.2**.

7.2 Predictions

Ground vibration and airblast levels caused by blasting activities have been predicted based on the formulas and methodology of Australian Standard AS2187.2 "Explosives - Storage Transport and Use - Use of Explosives", which predicts the peak particles velocity (PPV) in mm/s and the airblast over pressure (peak pressure) in dB.

7.2.1 Ground Vibration

In accordance with the criteria presented in **Section 4.7.2**, ground vibration levels are to achieve 5mm/s PPV for nine out of ten blasts and not greater than 10mm/s PPV at any time. Ground vibration can be calculated at various distances from a blast using the following formula from AS2187.2:

$$V = K\,(R / Q^{1/2})^{-B}$$

Where: V = ground vibration as peak particle velocity (PPV) (mm/s)
K = site constant
R = distance between charge and point of measurement (m)
Q = effective charge mass per delay or maximum instantaneous charge (kg)
B = site exponent or attenuation rate

Ground vibration from blasting generally increases with an increase in charge mass and reduces with distance.

The following site constants have been assumed in this calculation; however, seed hole analysis will be conducted within the Project to confirm site parameters:

- Site exponent (B) (attenuation rate) of 1.6; and
- Site constant (K) in the range 800 to 1600.

The maximum instantaneous charge mass will be 500 to 1000 kg as advised by Mining and Energy Technical Services Pty Ltd. **Table 7.1** contains the calculated ground vibration levels (mm/s) at various distances from the blast.

Table 7.1 Ground Vibration Levels at Various Distances from the Blast

Distance from Blast, km	Vibration Level mm/s	
	K = 800	K = 1600
1.0	3.2	6.4
1.5	1.7	3.3
2.0	1.1	2.1
2.5	0.7	1.5
3.0	0.5	1.1
3.5	0.4	0.9
4.0	0.3	0.7
4.5	0.3	0.6
5.0	0.2	0.5
5.5	0.2	0.4
6.0	0.2	0.4
6.5	0.2	0.3
7.0	0.1	0.3
7.5	0.1	0.3
8.0	0.1	0.2
8.5	0.1	0.2
9.0	0.1	0.2
9.5	0.1	0.2
10.0	0.1	0.2

Table 7.1 shows that the 10 mm/s PPV criterion would not be exceeded at distances greater than 1.0 kilometre from the blast. The 5 mm/s PPV criterion would not be exceeded at distances greater than 1.5 kilometres from the blast.

It is noted that the mine is expanding towards south and getting close the Receptors 5 and 6. When the distance between receptors and blasting site is less than 1.2km and 0.8km it is expected that the vibration levels will exceed the 5mm/s and 10mm/s, respectively. Other nearest residential receptor (Receptor 8) is at least 2km away from the nearest pit and vibration levels will be compliant with the nominated criteria.

Nearest Commercial Receptor 7 is approximately 1 kilometres away from the nearest pit within the proposed project area. Therefore, ground vibration due to blasting may exceed the 5mm/s limit.

Blast parameters will need to be reviewed to ensure that the nominated vibration criteria are met at all locations.

7.2.2 Airblast

In accordance with the criteria presented in **Section 4.7.2**, airblast pressure levels are to achieve 115 dBZ for nine out of ten blasts and not greater than 120 dBZ at any time. For blasting in an open-cut mine, the distance to the 120 dBZ L_{peak} contour line from the blast can be calculated using the following formula:

$$D_{120} = (k * h / \text{maximum}(B, S))^{2.5} * m^{1/3}$$

Where: D_{120} = distance to the 120 dBZ L_{peak} contour (m)
k = a site constant determined from the ratio S/B and S/h which requires local calibration
h = hole diameter (mm)
B = burden (mm)
S = stemming height (mm)
M = charge mass (kg)

The site constant, k, has been assumed to be equal to 180 based on ASK's experience with other mining projects.

The following blast information has been used for these calculations:

- Hole diameter (h) = 203mm to 251mm;
- Stemming height (S) = 5000 mm; and
- Burden (B) = 7000 mm.

Table 7.2 contains the separation distances and the reduction of noise levels due to distance.

Table 7.2 Airblast Noise Levels at Various Distances from the Blast

Distance from Blast, km	Airblast Level, dBZ
1.0	120.7
1.5	115.5
2.0	111.7
2.5	108.8
3.0	106.5
3.5	104.5
4.0	102.7
4.5	101.2
5.0	99.8
5.5	98.6
6.0	97.5
6.5	96.4
7.0	95.5
7.5	94.6
8.0	93.7
8.5	92.9
9.0	92.2
9.5	91.5
10.0	90.8

The distance to the 120 dBZ contour line is calculated to be 1,055 metres. The distance to the 115 dBZ contour line is calculated to be 1,550 metres. Therefore, the distance between receptors and blasting site is less than 1,055 metres and 1,550 metres it is expected that the airblast levels will exceed the 115 dBZ and 120 dBZ, respectively.

Nearest Commercial Receptors 7 is approximately 1 kilometres away from the nearest pit within the proposed project area. Therefore, airblast levels may exceed the 120 dBZ limit.

7.3 Assessment

Based on the blasting calculations presented within this section, the ground vibration and airblast levels from open cut operations may exceed the limits at some instances. The following recommendations are proposed when conducting the blasting activities.

- Receptor 5 and 6 will be most affected during the blasting operations and recommended minimum of distances in **Section 7.2.1** and **Section 7.2.2** should be maintained. However, it is noted that the Receptor 5 and 6 may be purchased in the future and may not be sensitive receptors in this project.
- Blast design and management of blast initiation will need to assess each blast and ensure that the vibration and airblast criteria are met.

8. Noise Management Plan

8.1 Overview

Noise modelling has predicted mine noise levels at sensitive receptors as outlined in **Section 6**. The predicted noise levels are therefore expected to result in noise levels exceeding the EPP (Noise) Acoustic Quality Objectives inside these receptors.

To achieve the Acoustic Quality Objectives inside the receptors, the following opportunities may be considered:

- Reducing machinery operations at times of the day that are predicted to result in exceedances.
- Reducing machinery operations under meteorological conditions that are predicted to result in exceedances.
- Moving mine equipment further from the receptors.
- Incorporating noise mitigation measures to equipment, particularly the mobile fleet.
- Providing acoustic or ventilation upgrades to the receptors.
- Relocating the receptors further from the mine.

The results in **Table 6.6** indicate there are no day/evening exceedances. Predicted night exceedances are listed in the following:

- Year 3:
  - Receptor 5: 5 dBA
  - Receptor 6: 3 dBA
- Year 4:
  - Receptor 5: 6 dBA
  - Receptor 6: 4 dBA
- Year 7:
  - Receptor 8: 5 dBA

Additionally, as per **Section 6.5.3**, cumulative noise impacts are considered for Receptors 5, 6 and 8, which results in a noise level target 3 dBA less than the limits in **Table 4.2**, and thus will require additional operational constraints. It is noted that these constraints may not be required if the noise contribution from other mines is not significant.

8.2 Review of Noise Management Opportunities

8.2.1 Reducing Operational Equipment in Various Time Periods

Reducing operational machinery in particular time periods (e.g. night) can potentially be considered to reduce noise levels.

8.2.2 Reducing Operational Equipment under Particular Meteorological Conditions

From **Table 6.6,** it can be seen that modelled meteorological conditions affect the noise levels at the residence.

One consideration would be to set up real time noise monitors at highly affected receptors, so that the mine can alter operational equipment as required, and thus react to meteorological conditions. However, it is Trinity's experience that this form of reactive operation is difficult to plan.

8.2.3 Moving Mine Equipment Further from the Receptors

Moving noisy equipment away from the most affected sensitive receptors can be considered to minimise noise effects.

8.2.4 Noise Mitigation of Equipment

Noise mitigation measures can be applied to equipment, including all the mobile equipment which is located near to the receptors. The noise reductions can be of the order of 3 to 8 dBA, and the costs can be of the order of a $250,000 to $750,000 per item of equipment.

8.2.5 Noise Mitigation between Equipment and Receptors

Noise mitigation measures can include bunding constructed between equipment and the receptors. Noise bunding is generally most effective when constructed near the source, e.g. adjacent a haul road, or near the receptors. Noise reduction via this technique is likely to be limited to less than 5 dBA even with quite significant bunding heights and lengths.

8.3 Mitigation Scenarios

Based on the results discussed in **Section 6.5.1** noise affected receptors are 5, 6 and 8. The noise mitigation scenarios 3A, 4A and 7A are outlined in **Table 8.1** for these receptors and focus on removing or relocating equipment.

Cumulative noise is also considered as per the discussion in **Section 6.5.3**, resulting in the development of mitigation scenarios 3B, 4B and 7B in **Table 8.1**.

Table 8.1 Example Mitigated Scenarios

Year	Scenario	Examples Scenarios and Resulting Noise Levels Under Adverse Conditions for Each Time Period	
		Day and Evening (7am to 10pm)	Night (10pm to 7am)
Year 3	Original	37 dBA at Receptor 5 and 35 dBA at Receptor 6, as per **Table 6.6**.	40 dBA at Receptor 5 and 38 dBA at Receptor 6, as per **Table 6.6**.
	Option 3A (Vulcan South Only)	No change to day/evening operations. Results as per Original scenario.	35 dBA at Receptor 5 and 34 dBA at Receptor 6, i.e. compliance achieved when 600t excavator and one D10 dozer are removed.
	Option 3B (Cumulative)	No change to day/evening operations. Results as per Original scenario.	32 dBA at Receptor 5 and 31 dBA at Receptor 6, i.e. compliance achieved when 600t excavator, Komatsu PC5500 excavator, two D10 dozers and 4 of 5 200-220t mine trucks are removed.
Year 4	Original	39 dBA at Receptor 5 and 37 dBA at Receptor 6, as per **Table 6.6**.	41 dBA at Receptor 5 and 39 dBA at Receptor 6, as per **Table 6.6**.
	Option 4A (Vulcan South Only)	No change to day/evening operations. Results as per Original scenario.	35 dBA at Receptor 5 and 33 dBA at Receptor 6, i.e. compliance achieved when 600t excavator and one D10 dozer are removed.
	Option 4B (Cumulative)	37 dBA at Receptor 5, i.e. compliance achieved when 600t excavator and one D10 dozer operate only half of the time.	32 dBA at Receptor 5 and 31 dBA at Receptor 6, i.e. compliance achieved when 600t excavator, one D10 dozer, one drill, all 200-220t mine trucks, 2 of 5 180t trucks are removed.
Year 7	Original	37 dBA at Receptor 8, as per **Table 6.6**.	40 dBA at Receptor 8, as per **Table 6.6**.
	Option 7A (Vulcan South Only)	No change to day/evening operations. Results as per Original scenario.	35 dBA at Receptor 8, i.e. compliance achieved when 600t excavator and one D10 dozer are removed. Activities at Ex-pit waste dump at the south pit may need to be mitigated.
	Option 7B (Cumulative)	No change to day/evening operations. Results as per Original scenario.	32 dBA at Receptor 8, i.e. compliance achieved when 600t excavator, Komatsu PC5500 excavator, one drill, one D10 dozer and 2 of 5 180t trucks are removed. Activities at Ex-pit waste dump at the south pit may need to be mitigated.

It is proposed that the mine could operate compliantly by selecting operating to the optional scenarios in **Table 8.1**. The optional scenarios presented in **Table 8.1** should be considered examples only, and other acoustically equivalent scenarios could be developed if they are considered not appropriate.

8.4 Noise Monitoring

It is recommended that noise level compliance be confirmed by real time noise monitoring at the most noise affected receptor/s, and that monitoring be commenced prior to mine operation.

9. Conclusions

A noise and vibration impact assessment has been conducted for the proposed Vulcan South Project. The following comments are made regarding the assessment:

- Noise monitoring was conducted at four (4) sensitive receptor locations;
- A noise model has been developed for proposed mining activities for typical mining Year 3, 4 and 7 to predict noise emission levels at nearby receptors; and
- Calculations have also been made to predict vibration and airblast levels due to blasting.

From this assessment, the following conclusions are made:

- Noise criteria for the mine have been proposed in **Section 4.7.1**, which includes outdoor noise limits at sensitive receptors of 40 dBA $L_{Aeq,adj,1hr}$ in the day and evening and 35 dBA $L_{Aeq,adj,1hr}$ in the night; and an indoor noise limit at sensitive receptors of 50 dBZ $L_{eq,adj,1hr}$ (and dBZ-dBA > 15 dB).
- From the predicted noise levels in **Section 6.5**, no exceedances are predicted during the day/evening period, except the commercial Receptor 7. Further exceedances of up to 6 dBA are predicted at receptors 5, 6 and 8 during the night-time.
- Given there are exceedances predicted, noise mitigation measure scenarios (3A, 4A and 7A) have been developed as per **Section 8**.
- Cumulative noise impacts are discussed in **Section 6.5.3** and have resulted in the development of additional example noise mitigation scenarios (3B, 4B and 7B) in the Noise Management Plan in **Section 8**.
- An assessment of low frequency noise impacts (**Section 6.6**) indicates that the low frequency noise criterion is compliant at all residential receptors.
- Noise from haul trucks on the public road network are considered compliant as per **Section 6.7**.
- Based on the blasting parameters and calculations in **Section 7**, the ground vibration and airblast levels from blasting are predicted to exceed at some receptors some instances and recommendations are discussed in **Section 7.3**.

References

AS1055: 2018 Acoustics – Description and measurement of environmental noise, Standards Australia.

Department of Environment and Heritage Protection Noise Measurement Manual 2013, The State of Queensland.

Environmental Protection Act 1994 (EP Act).

Model Mining Conditions Guideline 2017, Department of Environment and Science, The State of Queensland.

Noise and Vibration from Blasting Guideline 2016, Department of Environment and Science, The State of Queensland.

Transport Noise Management Code of Practice Volume 1 – Road Traffic Noise, November 2013, Department of Transport and Main Roads, The State of Queensland.

Appendix A Glossary

Parameter or Term	Description
dB	The decibel (dB) is the unit measure of sound. Most noises occur in a range of 20 dB (quiet rural area at night) to 120 dB (nightclub dance floor or concert).
dBA	Noise levels are most commonly expressed in terms of the 'A' weighted decibel scale, dBA. This scale closely approximates the response of the human ear, thus providing a measure of the subjective loudness of noise and enabling the intensity of noises with different frequency characteristics (e.g. pitch and tone) to be compared.
Frequency	The number of vibrations, or complete cycles, that take place in one second. Measured in hertz (Hz), where one Hz equals one cycle per second. A young person with normal hearing will be able to perceive frequencies between approximately 20 and 20,000 Hz. With increasing age, the upper frequency limit tends to decrease.
dB, dB(linear) or dBZ	Noise levels are sometimes expressed in terms of the linear, Z or un-weighted decibel scale – they all take the same meaning. The value has no weighting applied to it and is the same as the dB level.
Octave band	Ranges of frequencies where the highest frequency of the band is double the lowest frequency of the band. The band is usually specified by the centre frequency, i.e. 31.5, 63, 125, 250, 500 Hz, etc.
Day	The period between 7am and 6pm.
Evening	The period between 6pm and 10pm.
Night	The period between 10pm and 7am.
Free-field	The description of a noise receptor or source location which is away from any significantly reflective objects (e.g. buildings, walls).
Free-field	The description of a noise receptor or source location which is away from any significantly reflective objects (e.g. buildings, walls).
Noise sensitive receiver or Noise sensitive receptor	The definition can vary depending on the project type or location, but generally defines a building or land area which is sensitive to noise. Generally it includes residential dwellings (e.g. houses, units, caravans, marina), medical buildings (e.g. hospitals, health clinics, medical centres), educational facilities (e.g. schools, universities, colleges),
L_1	The noise level exceeded for 1% of the measurement period.
L_{10}	The noise level exceeded for 10% of the measurement period. It is sometimes referred to as the average maximum noise level.
L_{90}	The noise level exceeded for 90% of the measurement period. This is commonly referred to as the background noise level.
L_{eq}	The equivalent continuous sound level, which is the constant sound level over a given time period, which is equivalent in total sound energy to the time-varying sound level, measured over the same time period.
$L_{eq,1hour}$	As for L_{eq} except the measurement intervals are defined as 1 hour duration.
$L_{eq,adj,T}$	The L_{eq} adjusted for tonal or impulsive noise characteristics and with a measurement interval of 'T' duration (e.g. 15 minutes, 1 hour).
Sound power level (L_W)	The sound power level of a noise source is its inherent noise, which does not vary with distance from the noise source. It is not directly measured with a sound level meter, but rather is calculated from the measured noise level and the distance at which the measurement was undertaken.

Appendix B Noise Monitoring Photos

Figure B.1 Noise Logger setup at Receptor 6

Figure B.2 Noise Logger setup at Receptor 8 (Luxor)

Figure B.3 Noise Logger setup at Receptor 10 (Cheeseboro)

Figure B.4 Noise Logger setup at Receptor 8 (Saraji Station Residence)

Appendix C Noise Monitoring Results

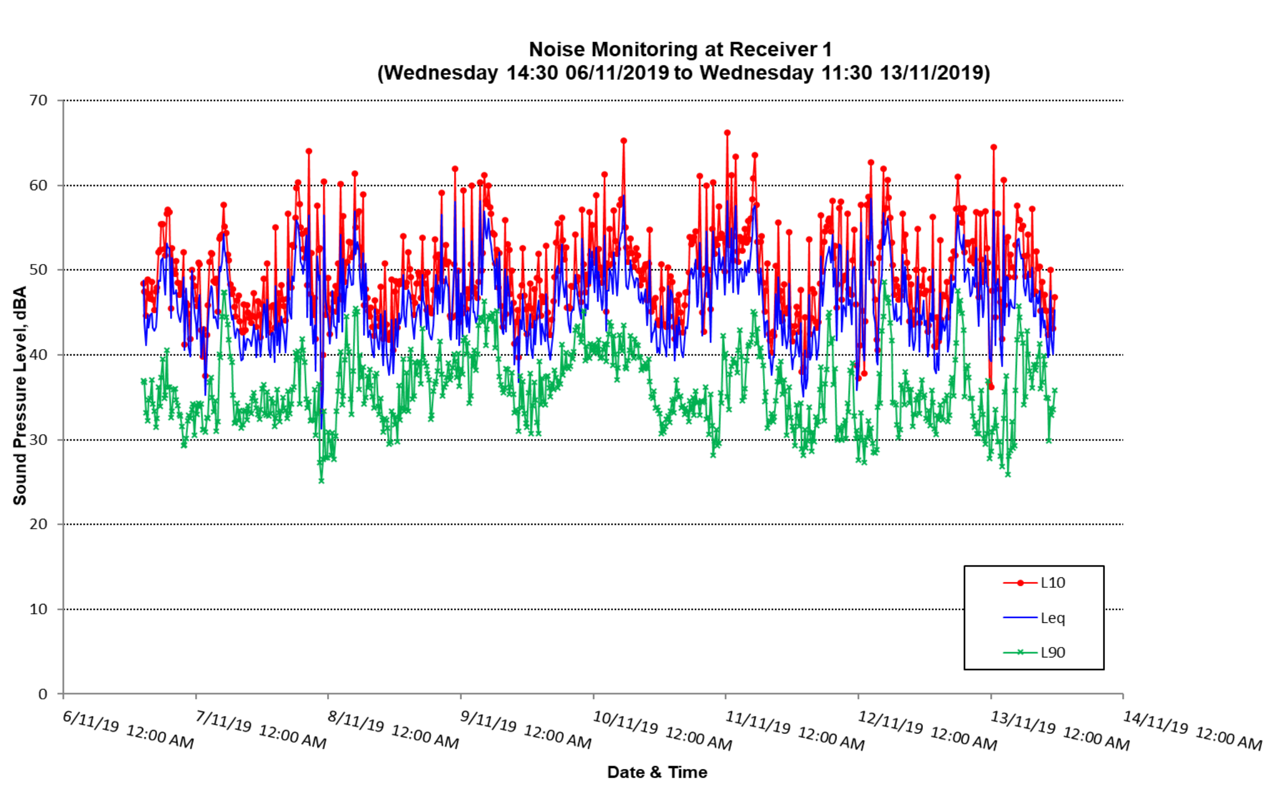


Figure C.1 Graph of Noise Logging Results at Receptor 6

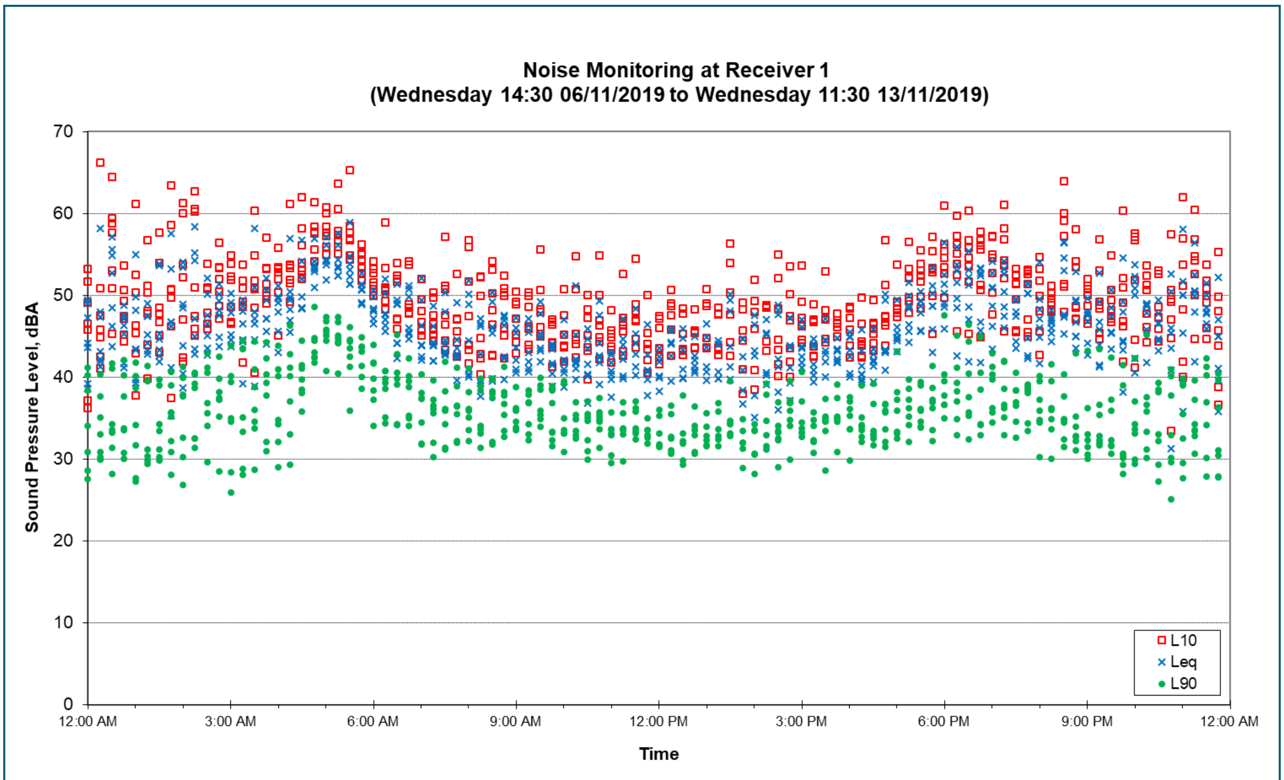


Figure C.2 24 Hour Noise Monitoring Results at Receptor 6

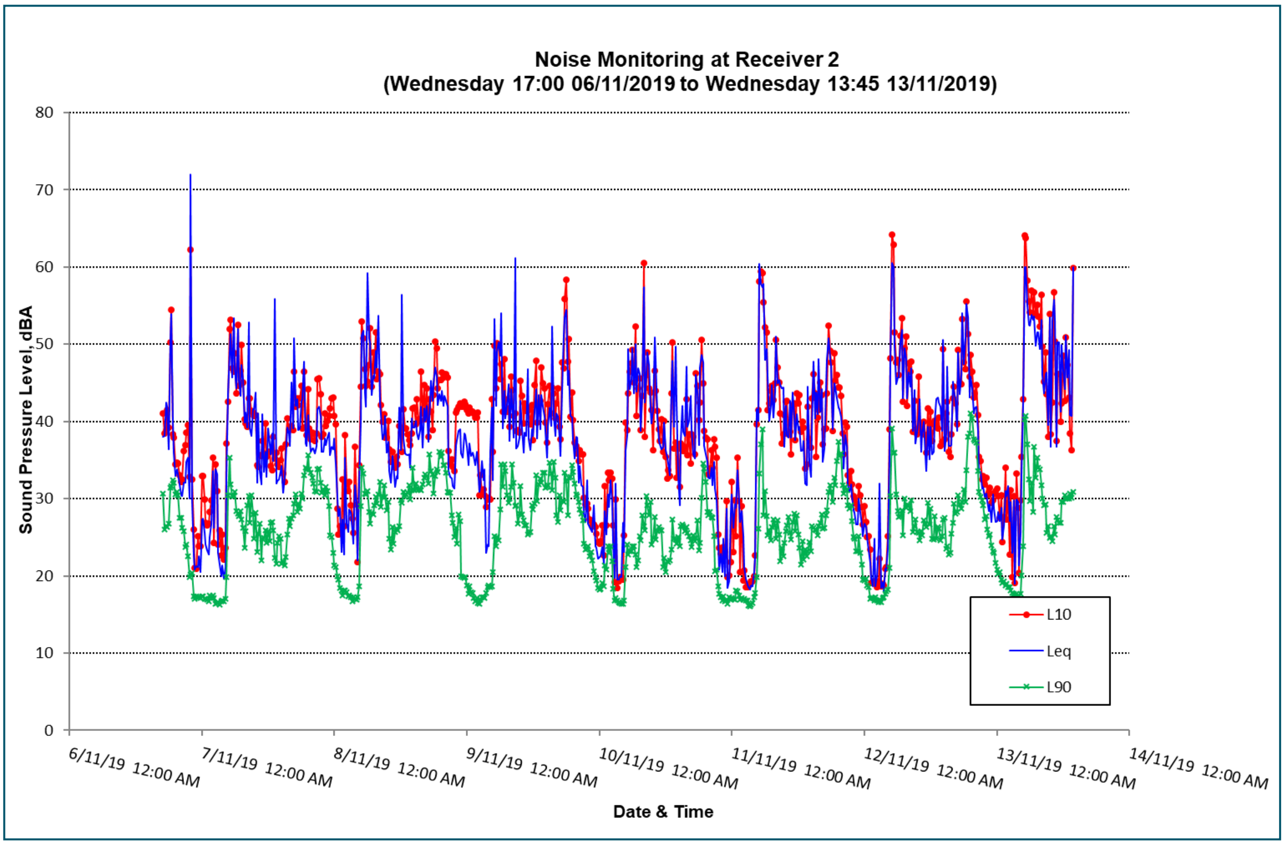


Figure C.3 Graph of Noise Logging Results at Receptor 9

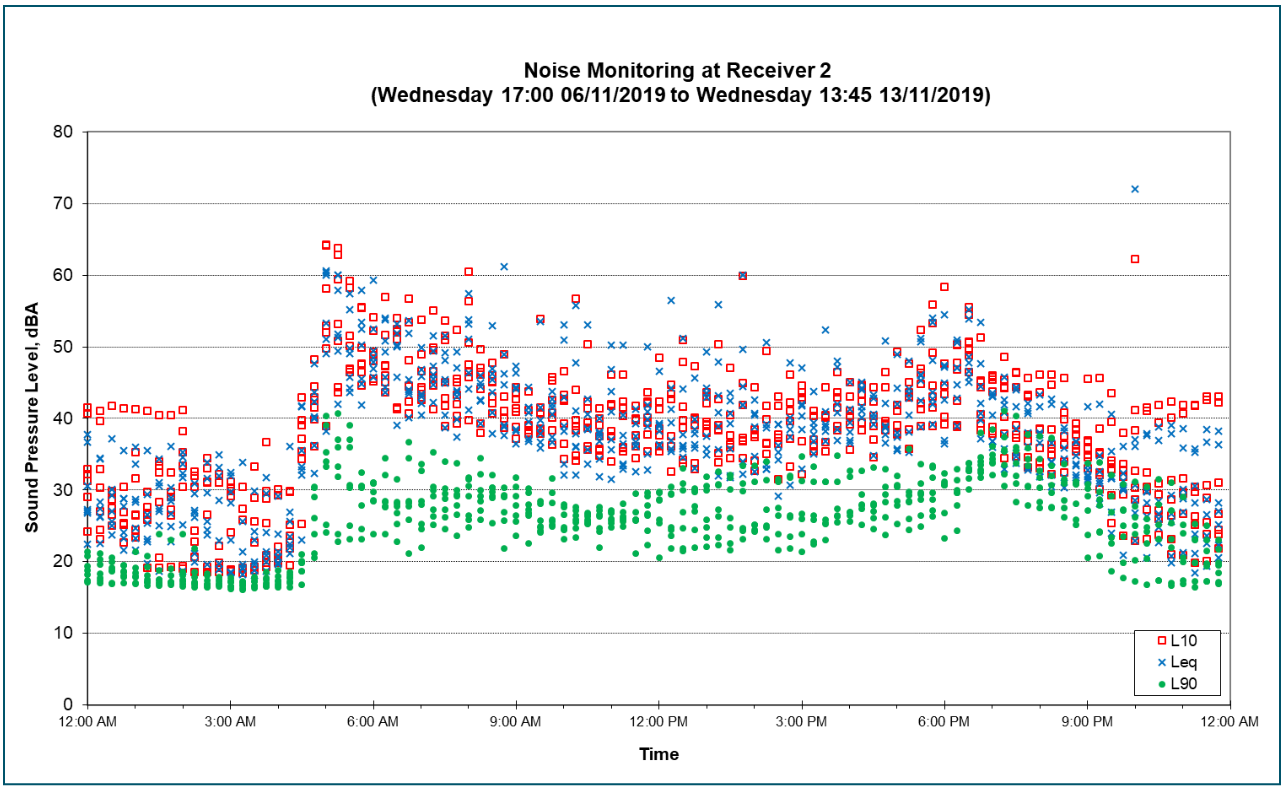


Figure C.4 24 Hour Noise Monitoring Results at Receptor 9

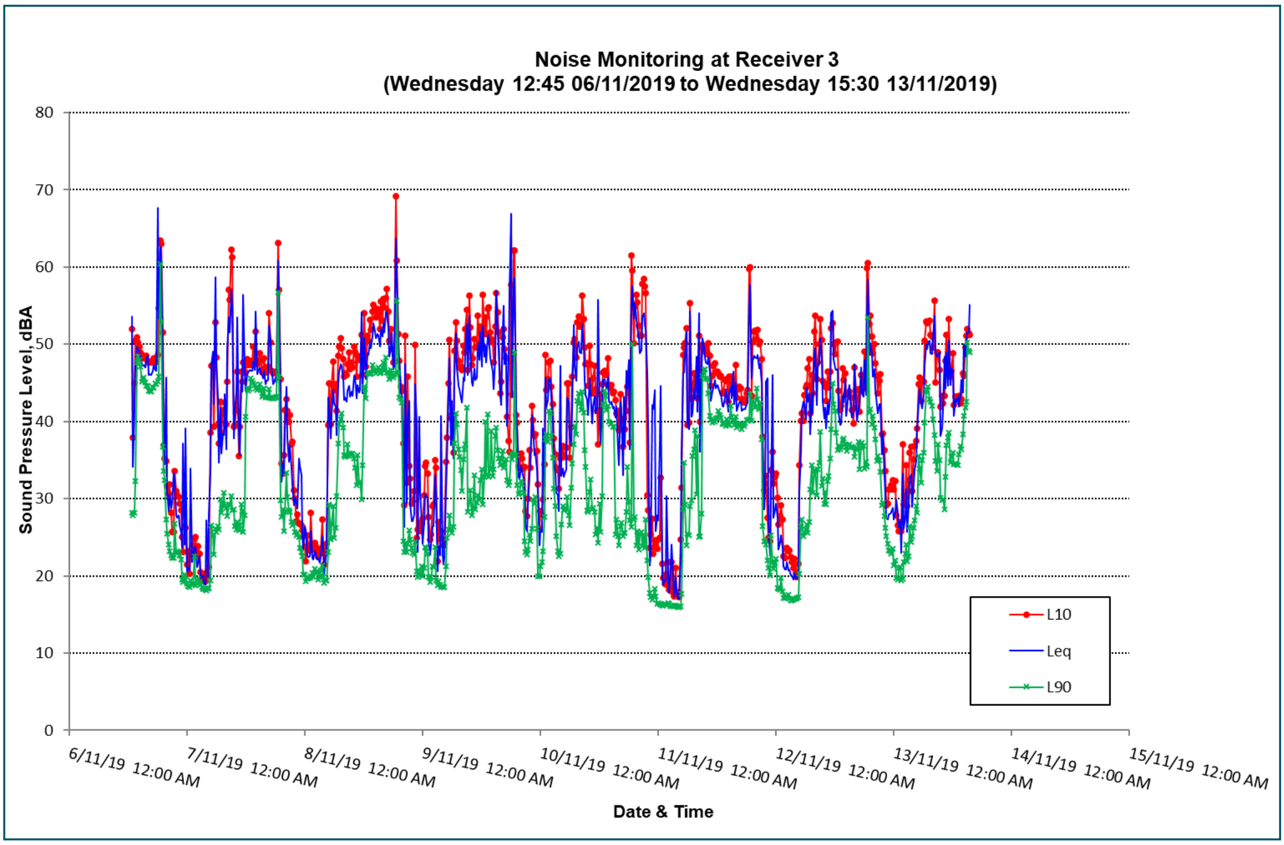


Figure C.5 Graph of Noise Logging Results at Receptor 10

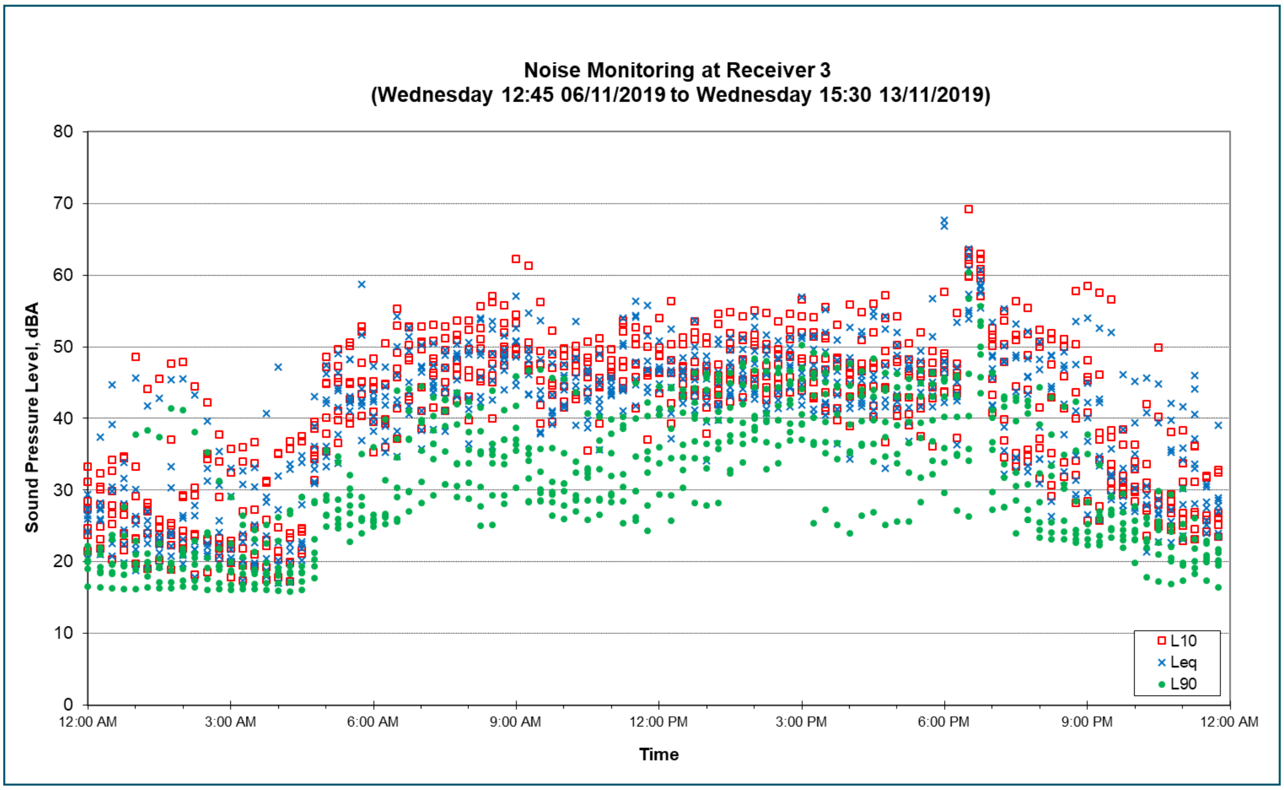


Figure C.6 24 Hour Noise Monitoring Results at Receptor 10

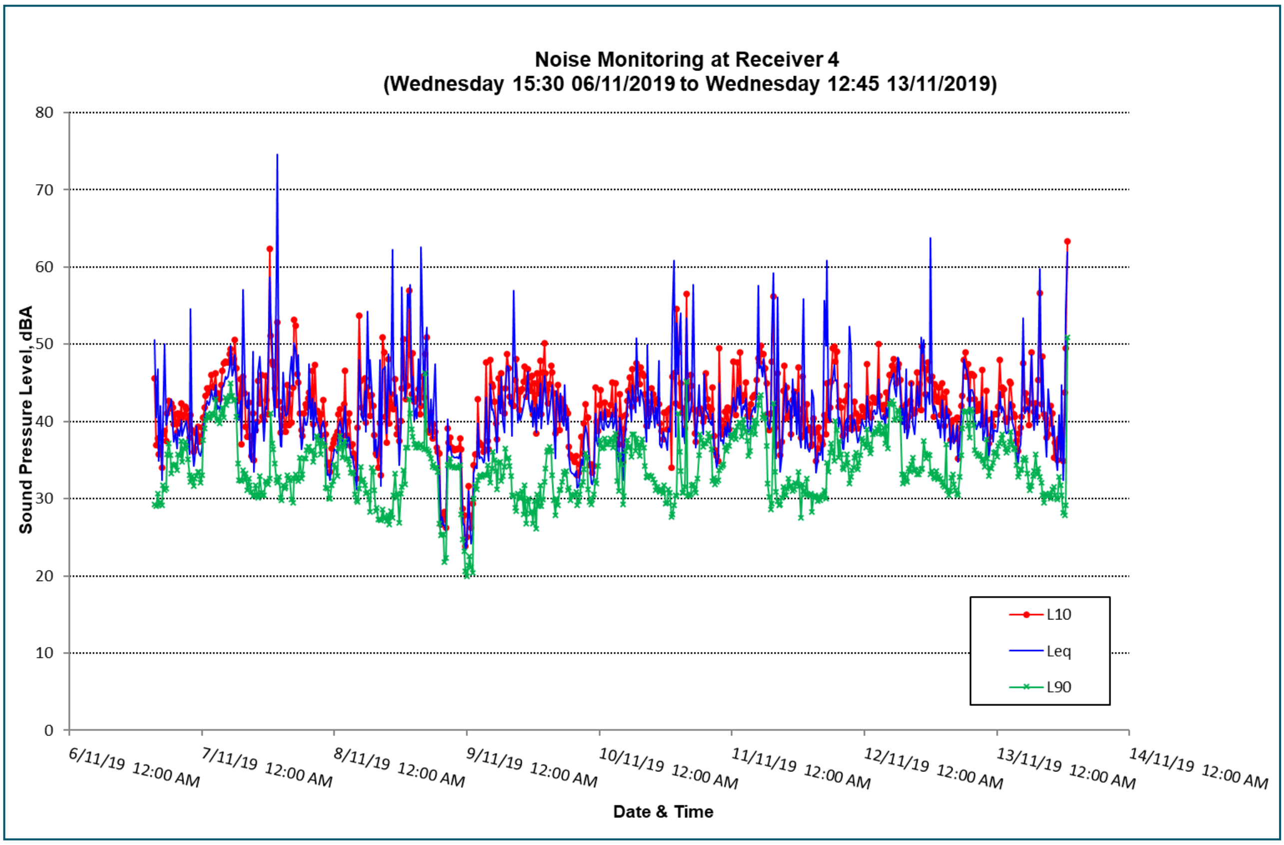


Figure C.7 Graph of Noise Logging Results at Receptor 8

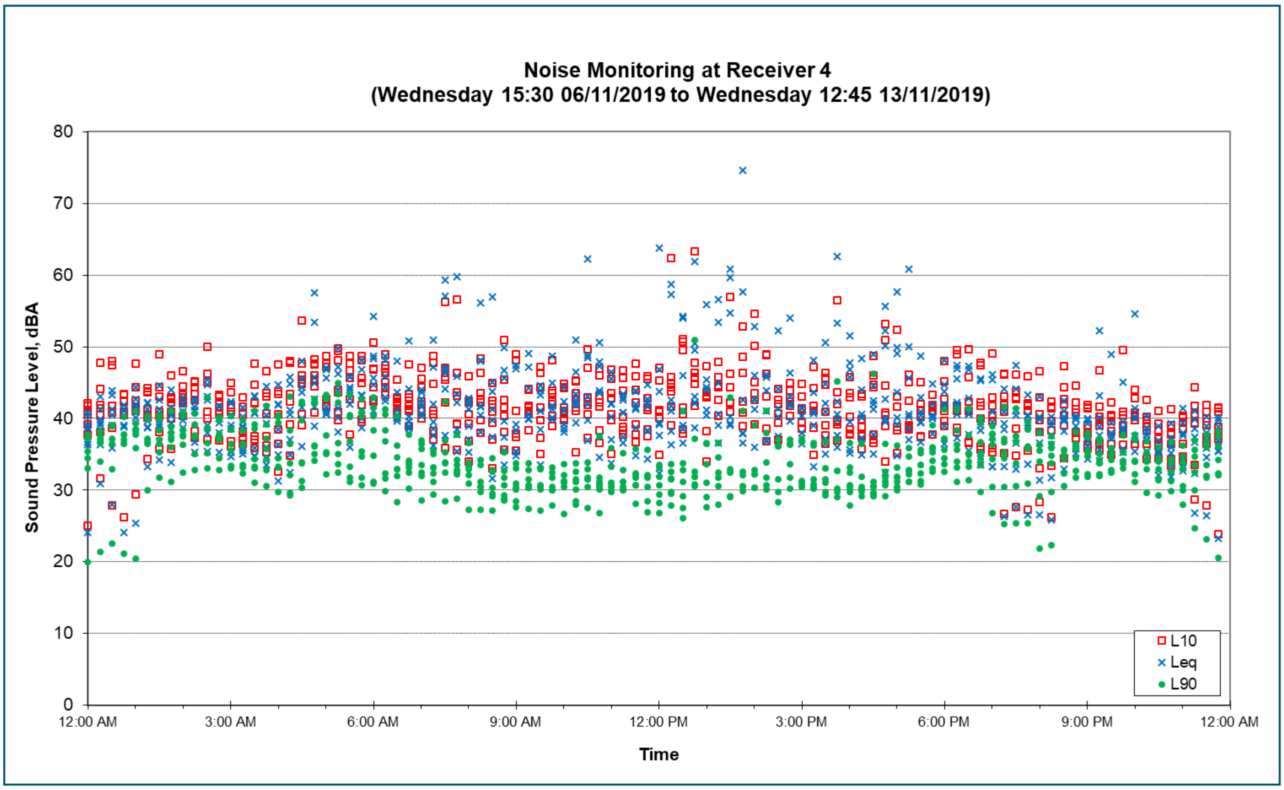


Figure C.8 24 Hour Noise Monitoring Results at Receptor 8

Table C.1 Statistical Noise Levels at Receptor 6

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	80-64-(58)-53-47	72-69-(63)-57-53	81-70-(63)-57-45
L_1	65-58-(53)-49-43	67-64-(58)-53-46	69-64-(58)-52-36
L_{10}	57-52-(47)-43-38	64-57-(52)-46-42	66-58-(51)-45-33
L_{eq}	53-49-(44)-40-35	57-53-(48)-43-38	59-54-(48)-42-31
L_{90}	43-39-(35)-32-28	48-42-(36)-32-28	49-44-(37)-30-25

Table C.2 Statistical Noise Levels at Receptor 9

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	92-74-(64)-53-47	79-69-(55)-41-29	92-74-(64)-53-47
L_1	73-61-(52)-44-36	68-59-(46)-36-25	73-61-(52)-44-36
L_{10}	61-48-(41)-36-32	58-48-(40)-33-24	61-48-(41)-36-32
L_{eq}	61-49-(41)-35-29	55-47-(38)-31-21	61-49-(41)-35-29
L_{90}	36-32-(28)-24-21	41-36-(31)-24-18	36-32-(28)-24-21

Table C.3 Statistical Noise Levels at Receptor 10

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	89-73-(64)-54-47	95-74-(61)-45-37	90-69-(53)-38-30
L_1	69-62-(54)-47-42	82-64-(50)-35-31	72-55-(38)-26-21
L_{10}	62-53-(47)-42-36	69-60-(45)-31-26	55-46-(32)-22-17
L_{eq}	57-52-(46)-41-33	68-57-(43)-29-26	59-45-(31)-20-17
L_{90}	50-46-(37)-28-24	60-46-(34)-23-22	44-30-(23)-17-16

Table C.4 Statistical Noise Levels at Receptor 8

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	96-81-(66)-55-47	80-67-(55)-45-37	87-65-(55)-46-36
L_1	90-61-(53)-45-38	64-54-(45)-37-29	66-54-(46)-39-30
L_{10}	63-47-(42)-37-33	50-46-(40)-35-26	54-47-(41)-36-24
L_{eq}	75-51-(43)-37-32	52-45-(39)-33-26	58-46-(40)-35-23

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
L_{90}	51-36-(32)-29-26	42-38-(35)-31-22	45-41-(36)-31-20

Appendix D Model Source Locations

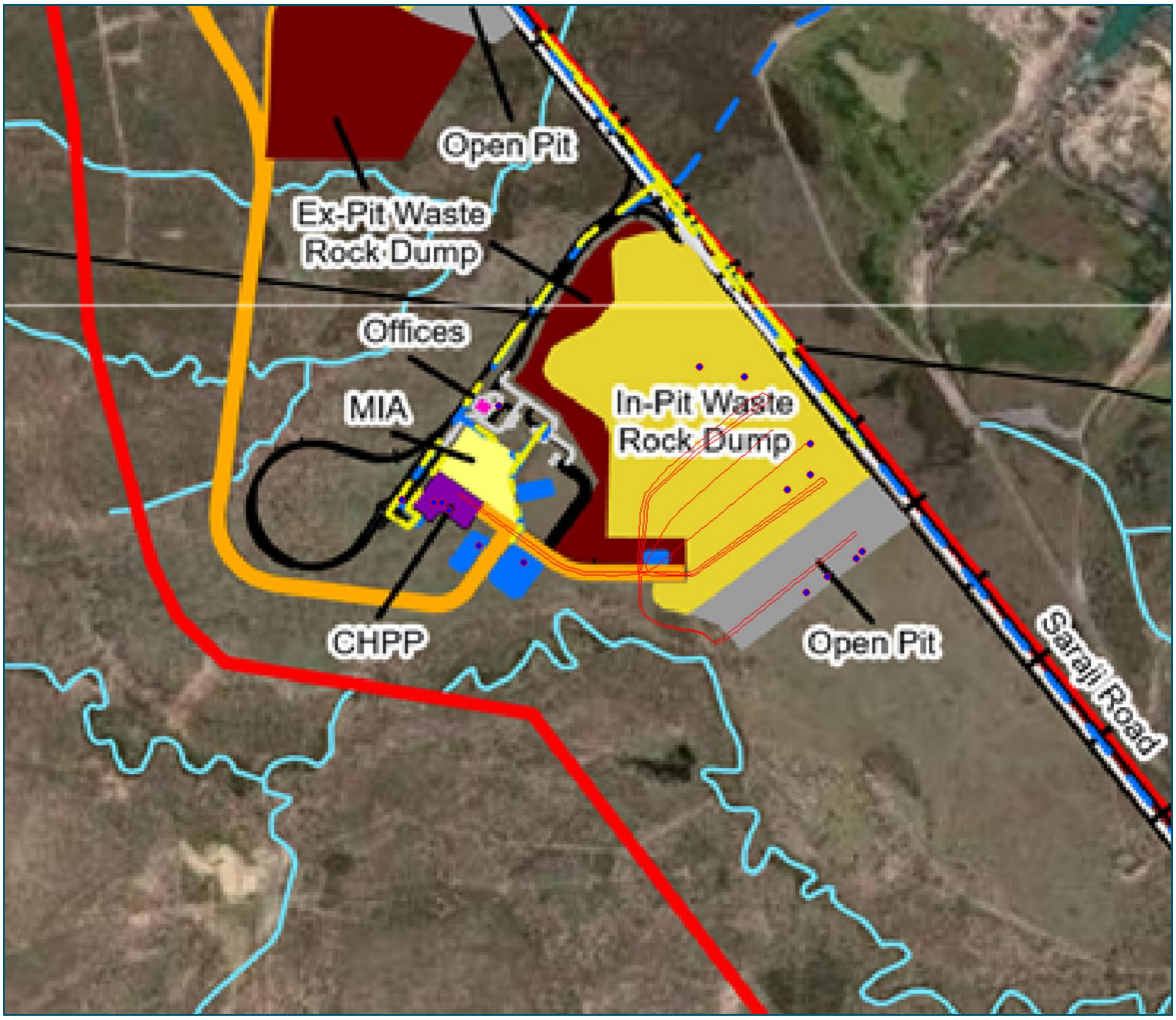


Figure D.1 Year 3 Equipment Locations in Noise Model (Note: Equipment shown as blue dots and truck paths shown as red lines)

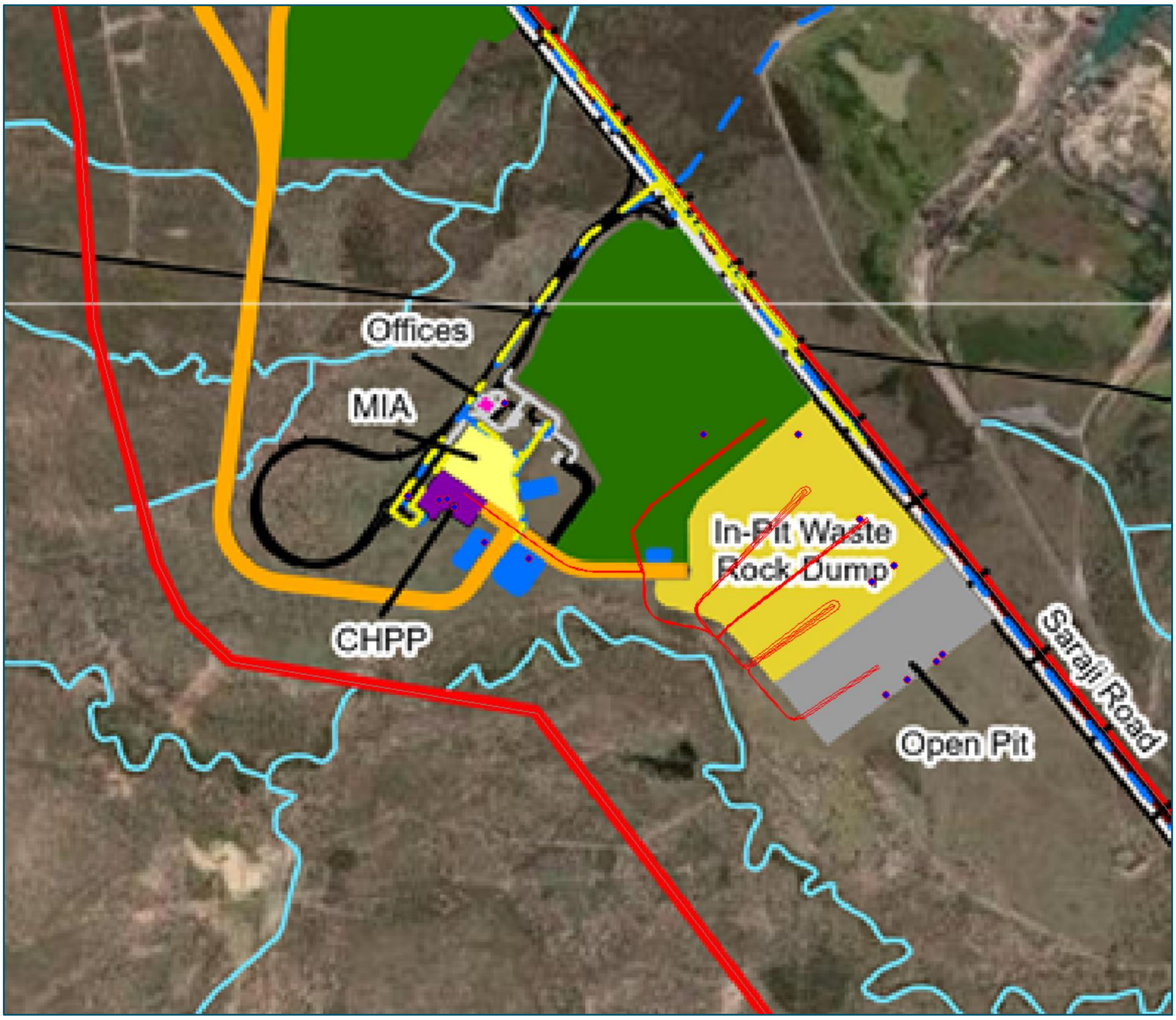


Figure D.2 Year 4 Equipment Locations in Noise Model (Note: Equipment shown as blue dots and truck paths shown as red lines)

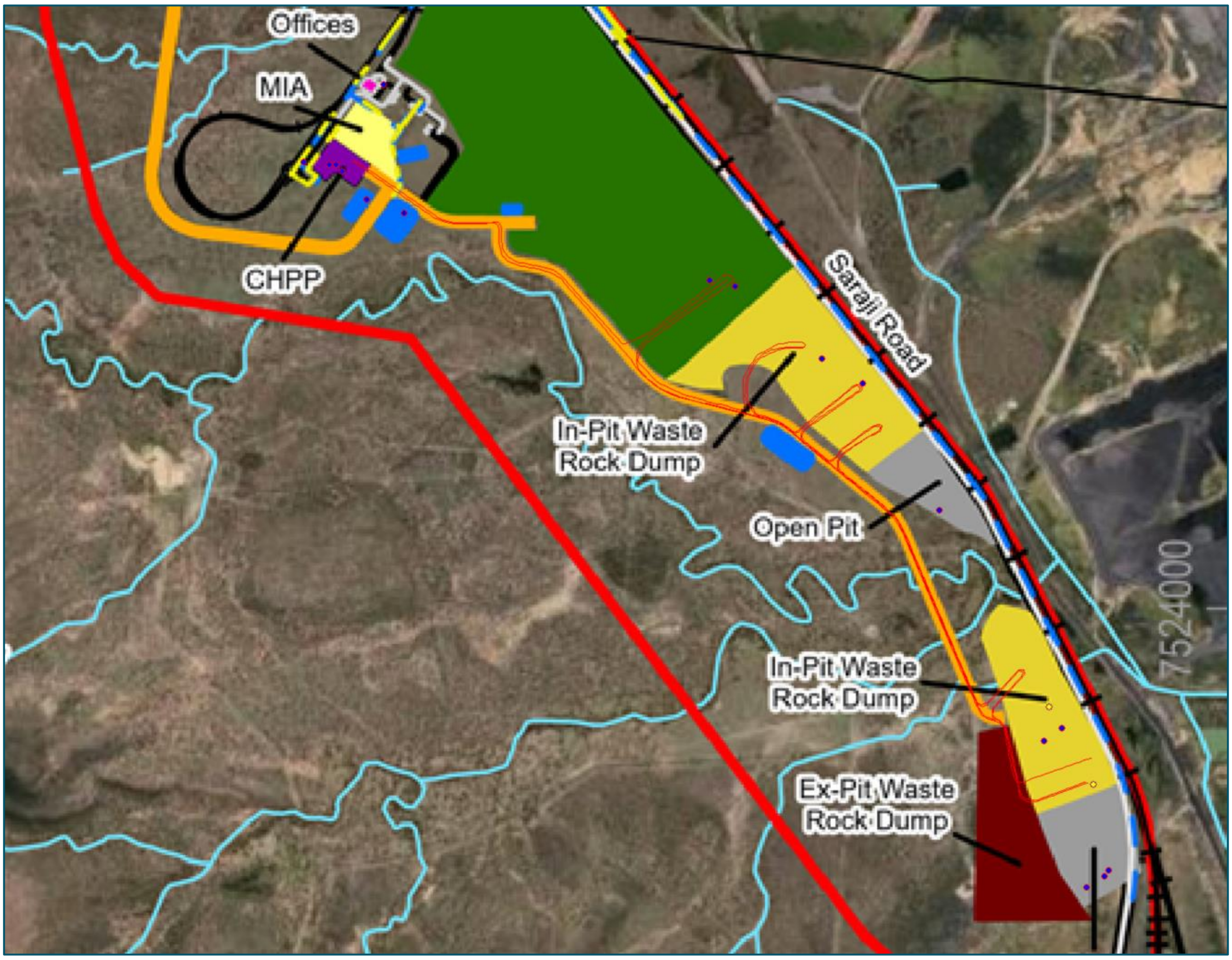
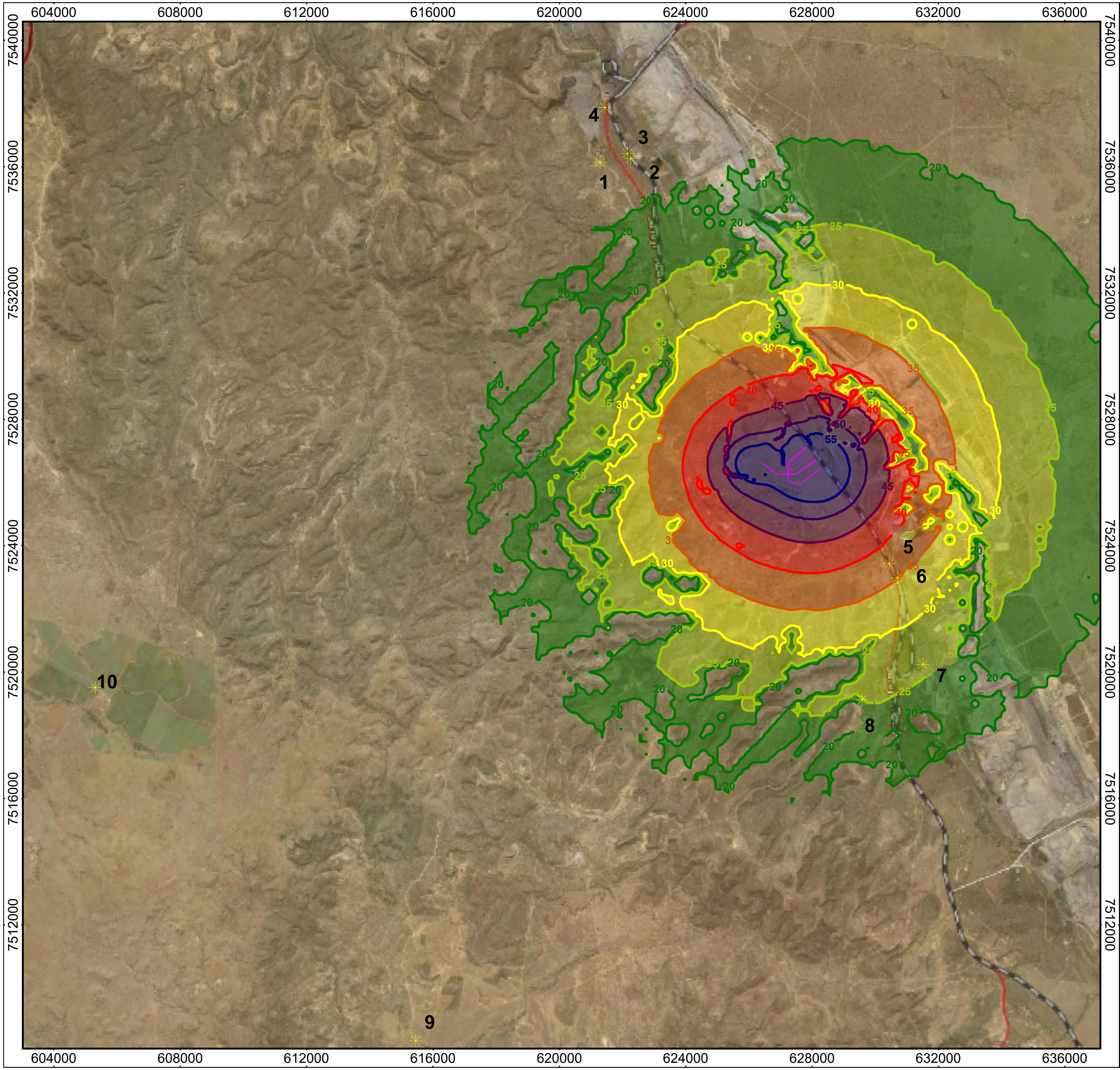


Figure D.3 Year 7 Equipment Locations in Noise Model (Note: Equipment shown as blue dots and truck paths shown as red lines)

Appendix E Predicted Noise Contours



Vulcan South
Project Number: 197401.0210

Figure

E.1

Year 3 Noise Contours
Day - Scenario D2

Date: 7/04/2022
Drawn By: PJ
Prepared For: Mining & Energy Technical Services Pty Ltd

Noise Levels Leq (1hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

Dark green	=	20
Light green	=	25
Yellow	=	30
Orange	=	35
Red	=	40
Maroon	=	45
Purple	=	50
Dark blue	=	55

Signs and Symbols

- Point receiver
- Point source
- Line source

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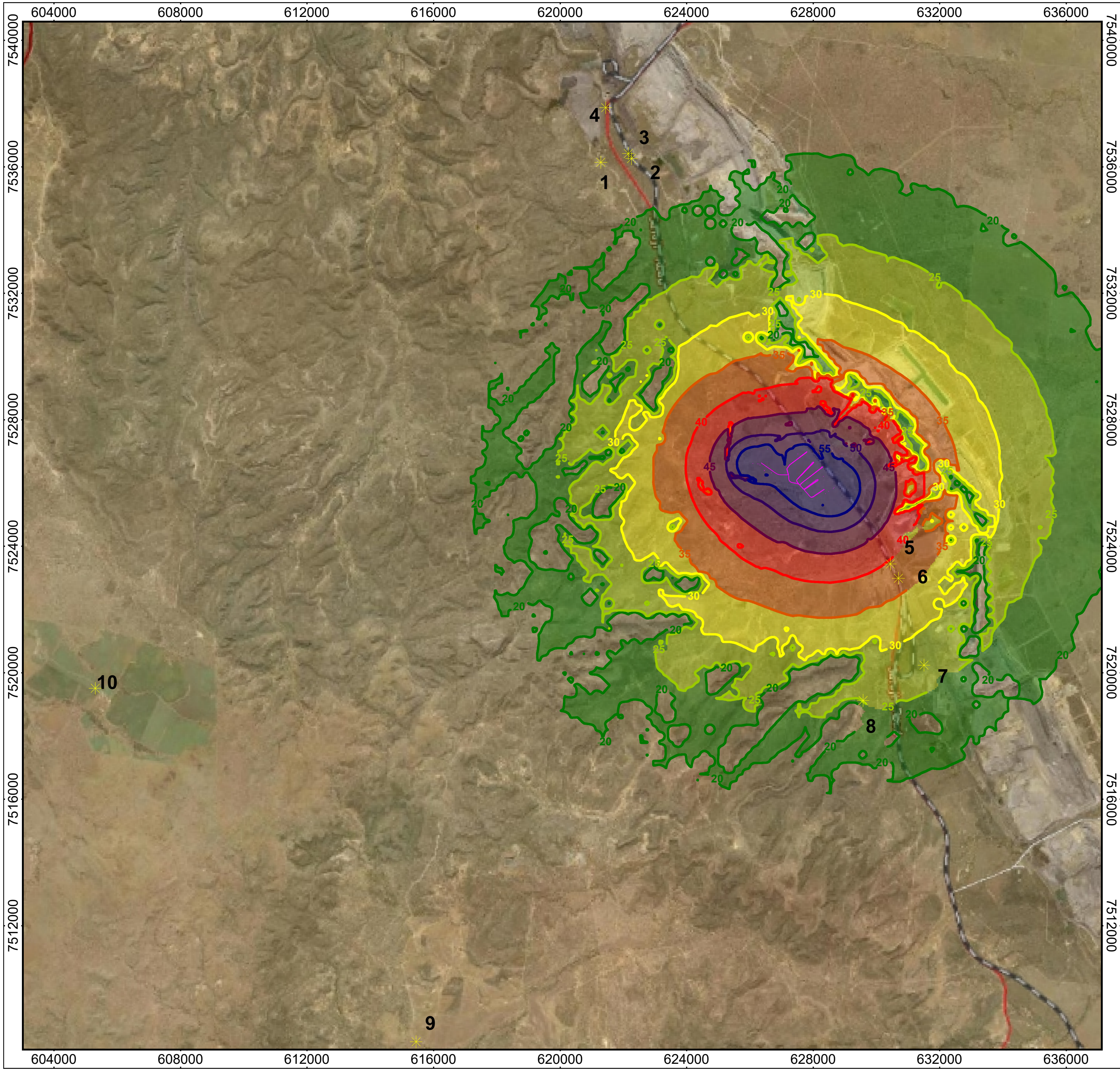

Vulcan South
Project Number: 197401.0210

Figure

E.2

Year 4 Noise Contours
Day - Scenario D2

Date: 7/04/2022
Drawn By: PJ
Prepared For: Mining & Energy Technical Services Pty Ltd

Noise Levels Leq (1hour)
Free Field dB(A)
Ground Contour Calculation Height = 1.8m

= 20
= 25
= 30
= 35
= 40
= 45
= 50
= 55

Signs and Symbols
Point receiver
Point source
Line source

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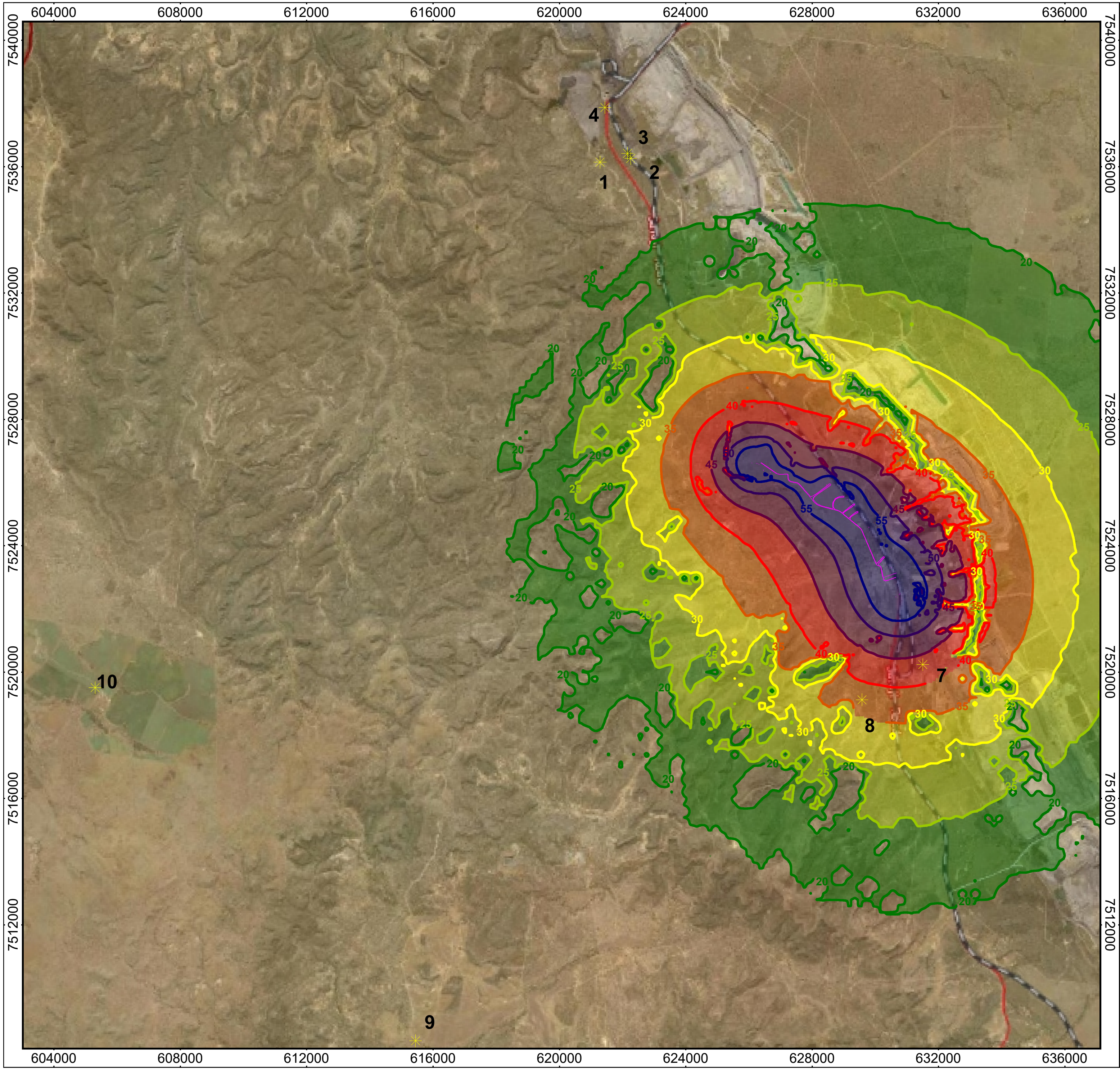

Vulcan South
Project Number: 197401.0210

Figure
E.3

Year 7 Noise Contours
Day - Scenario D2

Date: 7/04/2022
Drawn By: PJ
Prepared For: Mining & Energy Technical Services Pty Ltd

Noise Levels Leq (1hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

= 20
= 25
= 30
= 35
= 40
= 45
= 50
= 55

Signs and Symbols

Point receiver
Point source
Line source

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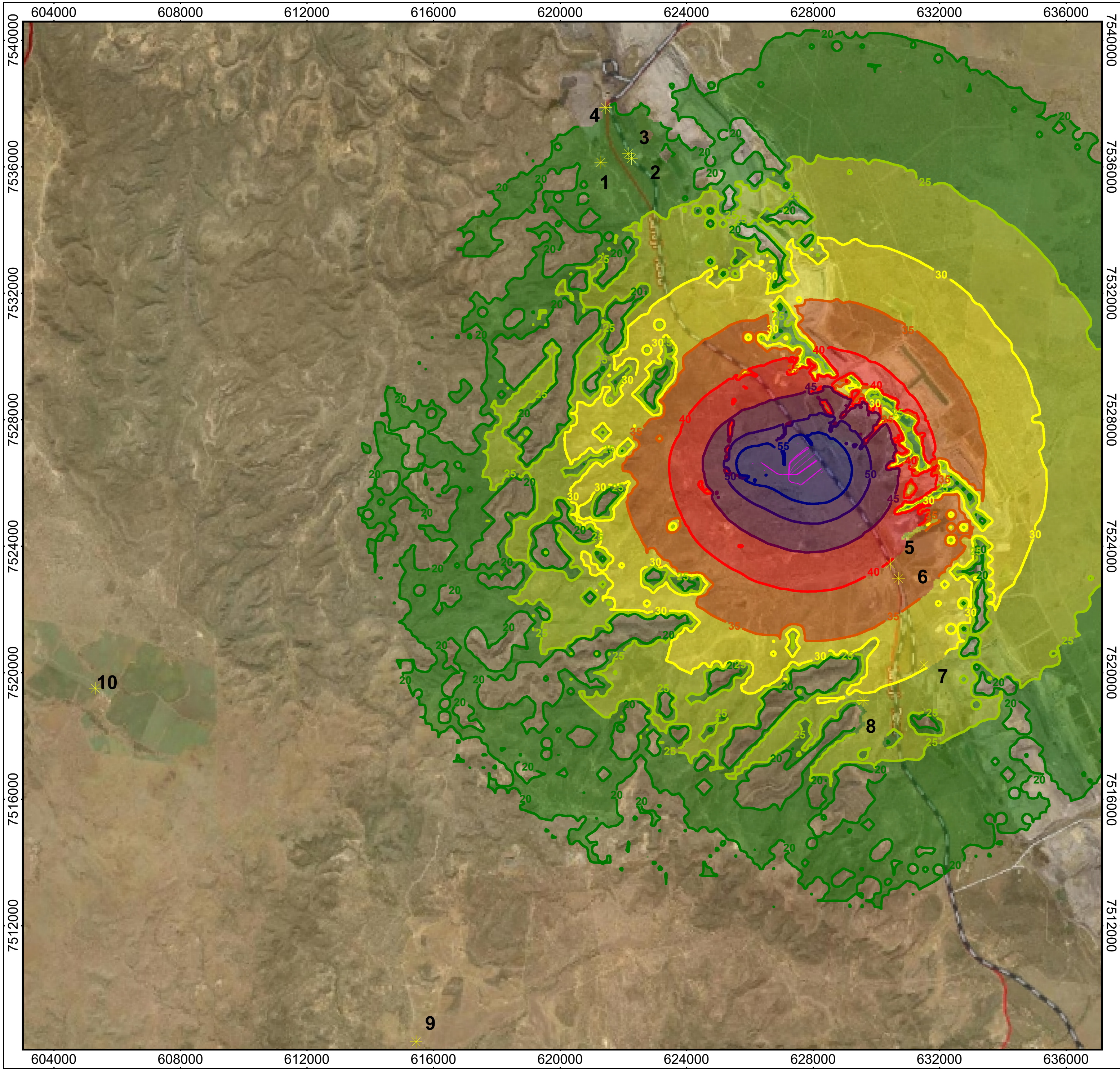

Vulcan South
Project Number: 197401.0210

Figure

E.4

Year 3 Noise Contours
Night - Scenario N1

Date: 7/04/2022
Drawn By: PJ
Prepared For: Mining & Energy Technical Services Pty Ltd

Noise Levels Leq (1hour)
Free Field dB(A)
Ground Contour Calculation Height = 1.8m

= 20
= 25
= 30
= 35
= 40
= 45
= 50
= 55

Signs and Symbols
Point receiver
Point source
Line source

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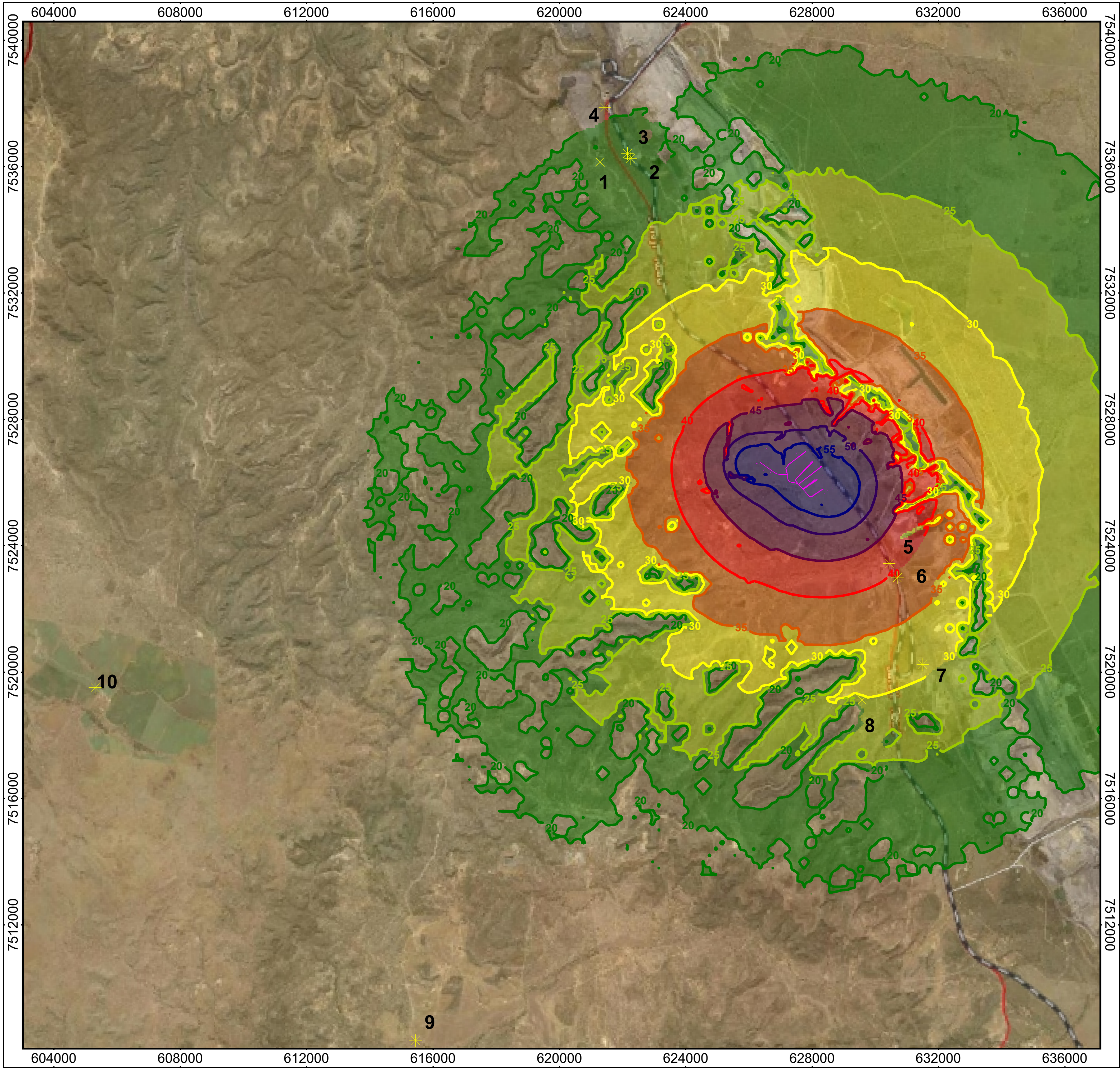

Vulcan South
Project Number: 197401.0210

Figure

E.5

Year 4 Noise Contours
Night - Scenario N1

Date: 7/04/2022
Drawn By: PJ
Prepared For: Mining & Energy Technical Services Pty Ltd

Noise Levels Leq (1hour)
Free Field dB(A)
Ground Contour Calculation Height = 1.8m

=	20
=	25
=	30
=	35
=	40
=	45
=	50
=	55

Signs and Symbols
Point receiver
Point source
Line source

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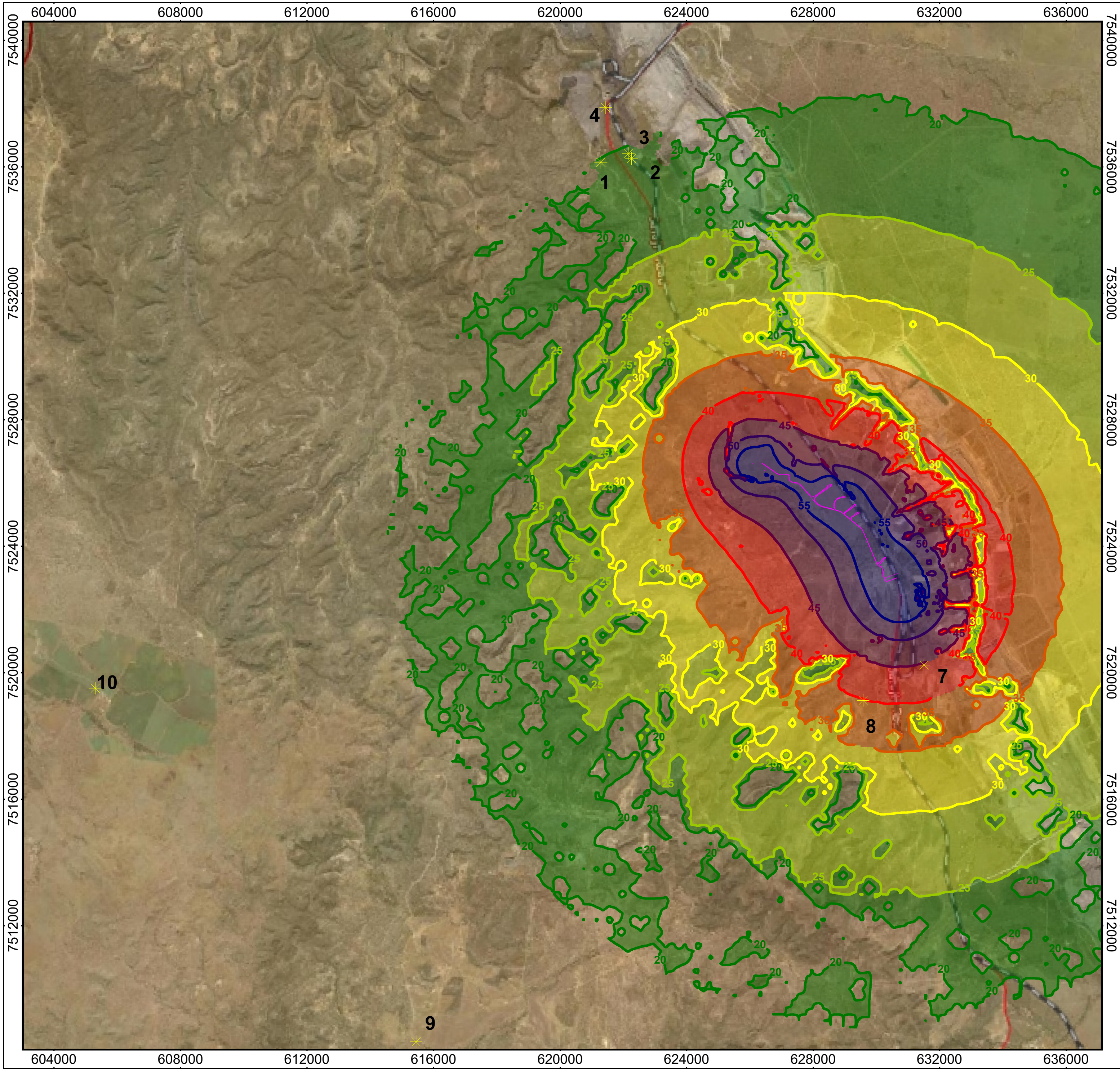

Vulcan South
Project Number: 197401.0210

Figure
E.6

Year 7 Noise Contours
Night - Scenario N1

Date: 7/04/2022
Drawn By: PJ
Prepared For: Mining & Energy Technical Services Pty Ltd

Noise Levels Leq (1hour)
Free Field dB(A)
Ground Contour Calculation Height = 1.8m

= 20
= 25
= 30
= 35
= 40
= 45
= 50
= 55

Signs and Symbols
Point receiver
Point source
Line source

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