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Gemini Project

Noise Impact Assessment

Report: 197401.0181.R01V04

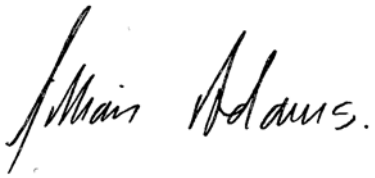
Prepared for:

Magnetic South Pty Ltd

2 October, 2019

Document Control

Document Ref	Date of Issue	Status	Author	Reviewer
197401.0181.R01V01_draft	6 September, 2019	Draft	Tim Osborne	Gillian Adams
197401.0181.R01V01	26 September, 2019	Final	Tim Osborne	Gillian Adams
197401.0181.R01V02	26 September, 2019	Updated Final	Tim Osborne	Gillian Adams
197401.0181.R01V03	30 September, 2019	Updated Final	Tim Osborne	Gillian Adams
197401.0181.R01V04	2 October, 2019	Updated Final	Tim Osborne	Gillian Adams

Document Approval	
Approver Signature	
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1. Introduction

ASK Consulting Engineers (ASK) was commissioned by Magnetic South Pty Ltd to provide a noise and vibration impact assessment for the Gemini Project.

The Gemini Project consists of a greenfield open cut mine to produce Pulverised Coal Injection (PCI) coal and Coking Coal products for export for steel production. The Project is located within EPC 881 and the proposed Mining Lease Application (MLA) boundary in the Bowen Basin, Central Queensland. The site is located approximately 15 km east of Bluff and 3 km west of Dingo. The site location and surrounds are shown in **Figure 1.1**.

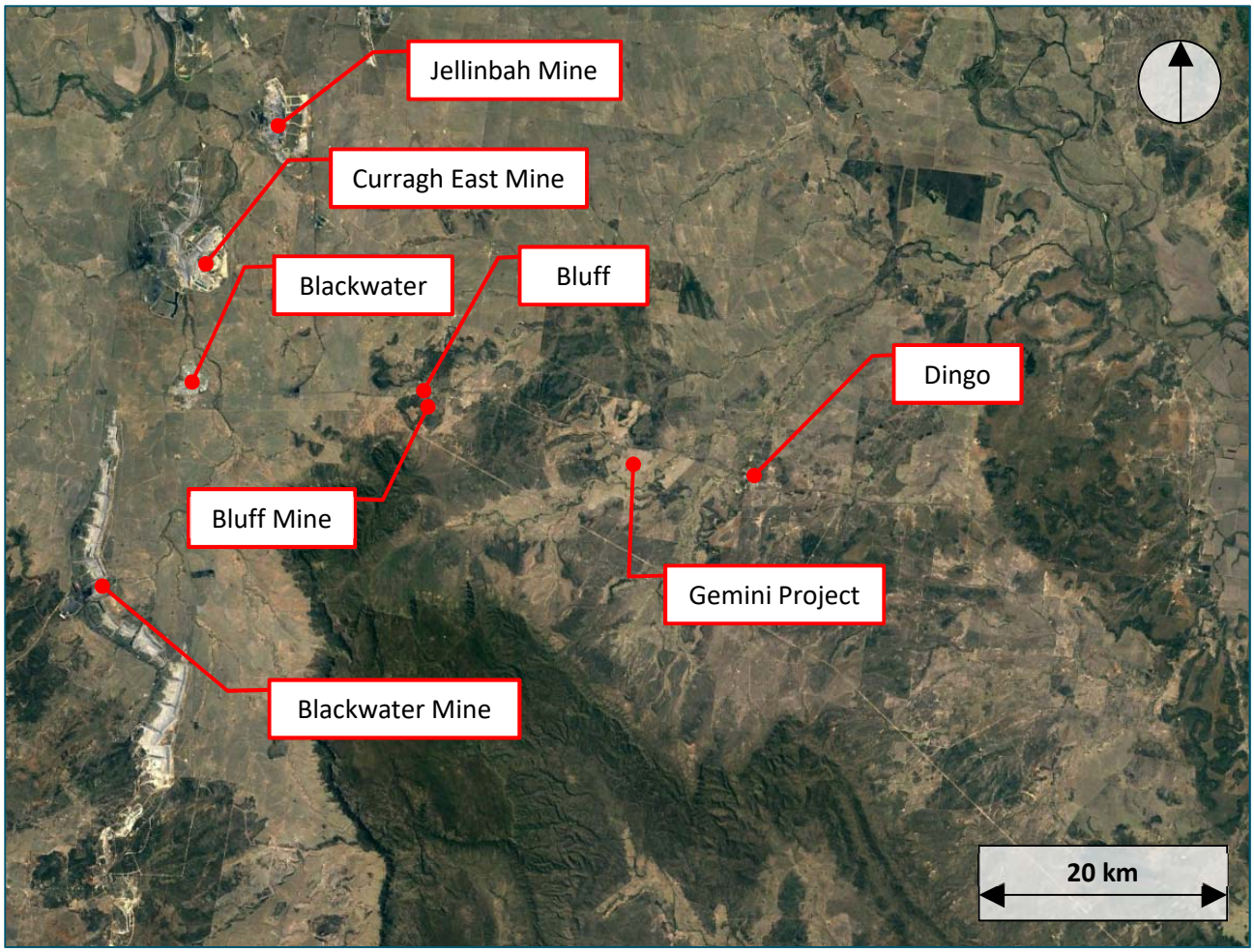

Figure 1.1 Site Location & Surrounds

The purpose of this report is as follows:

- Present the results of noise monitoring data of the existing environment at selected sensitive receptors.
- Propose appropriate noise and vibration criteria.
- Determine noise emission levels from the proposed fixed and mobile plant.
- Determine airblast and vibration levels due to blasting operations.
- Assess noise and vibration impacts for three scenarios of mining operations under adverse and neutral meteorological conditions in accordance with the nominated noise and vibration criteria.

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

2. Study Area Description

The Gemini Project is located approximately 3 km west of Dingo.

The nearest residential sensitive receptors are summarised in **Table 2.1**.

Table 2.1 Sensitive Receptors

Sensitive Receptor ID	Receptor type	Real Property Description	Easting (m)	Northing (m)	Location
SR01	Residential	3SP165527	721380	7386940	4.9 km W
SR03	Residential	6SP152759	737915	7382328	3.2 km E
SR05	Residential	2HT388	721937	7382077	4.3 km W
SR07	Residential, facilities (sports oval, tennis court, school) & businesses (Post Office, hotel, shops, sawmills, etc.)	Dingo Township	737777	7383220	3.0 km E
SR08	Residential	1RP801280	722022	7384327	4.2 km W
SR09	Residential	2RP904099	731988	7385624	Within MLA
SR10	Residential	28HT87	736181	7382995	1.4 km E
SR13	Residential	29HT489	737113	7382802	2.4 km E
SR14	Residential	3HT139	728569	7374873	2.5 km S
SR15	Residential	4HT165	729144	7388750	0.3 km N
SR16	Residential	8HT536	735273	7388705	3.0 km NE
SR17	Residential	2RP616780	722415	7384928	3.8 km W
SR18	Residential	1HT424	729626	7384531	Within MLA
SR19	Residential	2HT138	732684	7377515	1.4 km SE
SR20	Residential	2HT138	732671	7377581	1.4 km SE
SR21	Residential	2HT138	732614	7377700	1.4 km SE
SR22	Residential and Camp Accommodation	100RP882349	726499	7386357	Within MLA
SR23	Residential	47H406	734446	7383534	Within MLA
SR24	Residential	20H4017	735824	7384500	1.2 km NE
SR26	Residential	20SP217269	739747	7382306	5.1 km E
SR27	Residential	20SP217269	739278	7383145	4.5 km E
SR28	Residential	21SP217269	739157	7383337	4.4 km E
SR30	Residential	25SP217269	739319	7383894	4.6 km E
SR31	Residential	-	725109	7385743	1.1 km NW
SR32	Residential	-	725075	7386813	1.2 km NW

It is noted that SR07 represents the Dingo township. The following sensitive receptors are located within the Mining Lease Application (MLA) Area:

- SR09
- SR18
- SR23

At the time of report preparation, Magnetic South is the landowner of the property 3HT139, on which sensitive receptor 14 is located, and Lot 2, HT138, on which sensitive receptors SR19, SR20 and SR21 are located. Discussions between Magnetic South and landowners of properties located within the MLA are ongoing.

The Capricorn Highway and the Blackwater-Gladstone rail network extend through the northern section of the MLA. A number of the sensitive receptors are located within 1 km of the highway and rail line.

The site location and sensitive receptors are shown in **Figure 2.1**.

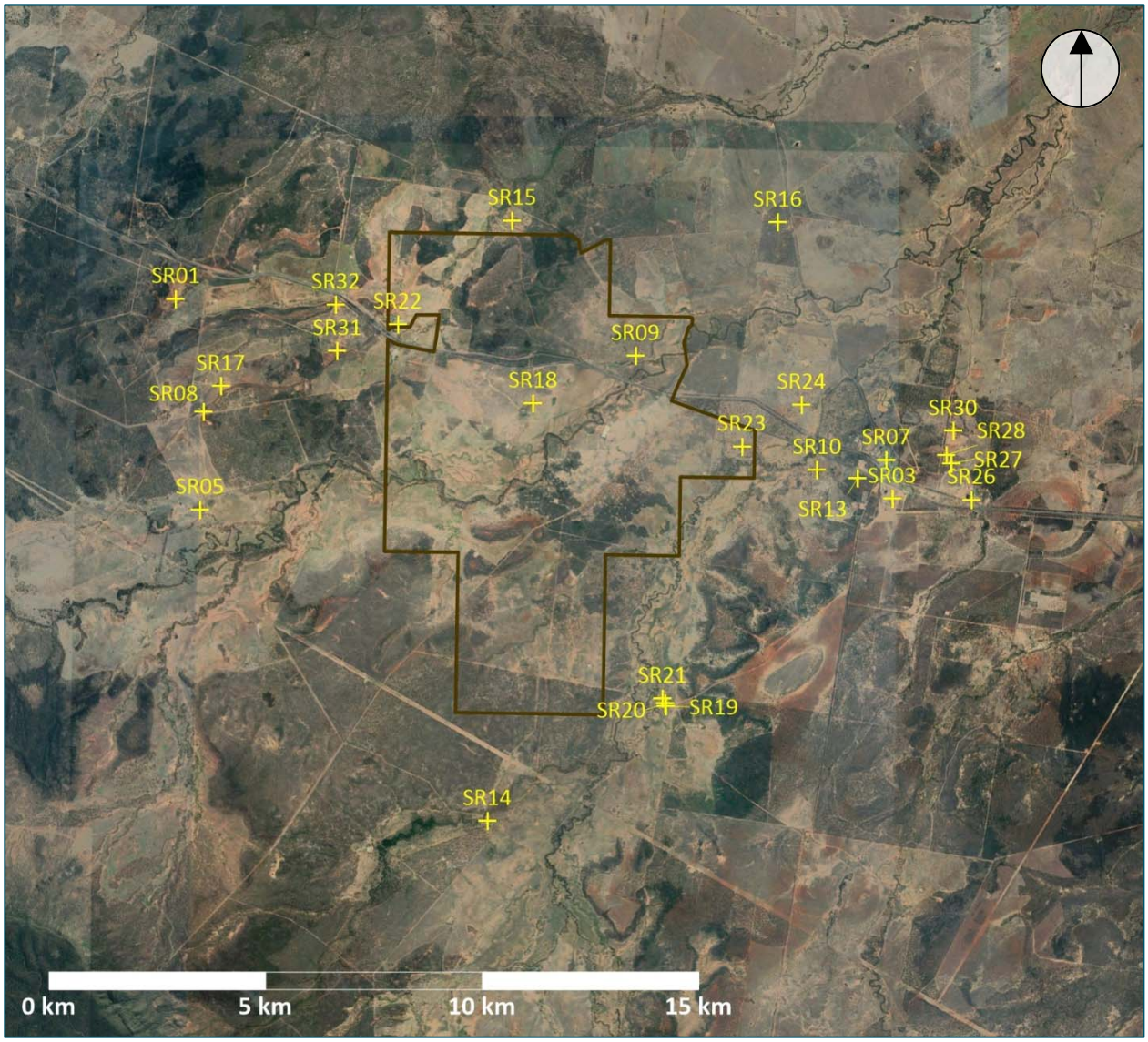

Figure 2.1 Site Location (MLA shown with brown line) & Sensitive Receptors

According to the Department of Natural Resources, Mines and Energy's MinesOnlineMaps system, the nearest mine to the Gemini Project is Bluff Mine, which is located approximately 15 km west of the Gemini Project's proposed ROM pad. There are a number of other mines further to the west, but no other mines within 50 km to the north, south or east.

3. Proposed Development

3.1 Project Description

The Gemini Project is a greenfield, open-cut metallurgical coal mine producing Pulverised Coal Injection (PCI) coal and coking coal for export to the international steel making industry. The Project term is anticipated to be 25 years from grant of the Mining Lease (ML) with this term including initial construction, mine operation and rehabilitation activities.

Mine construction activities are scheduled to commence in July 2021 subject to granting of the Project ML and EA. It is anticipated that it will take approximately six months to establish the necessary infrastructure to commence overburden removal and 18 months to commence coal production.

The main activities associated with the Project include:

- Exploration activities continuing in order to support mine planning
- Development of a Mine Infrastructure Area (MIA) including mine offices, bathhouse, crib rooms, warehouse/stores, workshop, fuel storage, refuelling facilities, wash bay, laydown area, sewage, effluent and liquid waste storage, and a heli-pad.
- Construction and operation of a Coal Handling Preparation Plant (CHPP) and coal handling facilities adjacent to the MIA (including Run-of-Mine (ROM) coal and product stockpiles, and rejects bin/overflow [coarse and fine rejects]).
- Construction and operation of a surface conveyor from the product stockpiles to a Train Load Out (TLO) facility and rail loop connecting to the Blackwater-Gladstone Branch Rail to transport product coal to coal terminals at Gladstone for export.
- Construction of access roads from the Capricorn Highway to the MIA, and from the accommodation facility to the TLO facility.
- Installation of a raw water supply pipeline to connect to the Blackwater Pipeline network.
- Construction of a 66 kV transmission line and switching/substation to connect to the existing regional network.
- Other associated minor infrastructure, plant, equipment and activities.
- Development of mine areas (open cut pits) and out-of-pit waste rock emplacements.
- Drilling and blasting of competent waste material.
- Mine operations using conventional surface mining equipment (excavators, front end loaders, rear dump trucks, dozers).
- Mining up to 1.9 Mtpa ROM Coal – average 1.8 Mtpa for a construction/production period of approximately 20 years.
- Progressive placement of waste rock in:
- Emplacements, adjacent to and near the open cut voids.
- Mine voids, behind the advancing open cut mining operations.
- Progressive rehabilitation of waste rock emplacement areas and mined voids.
- Progressive establishment of soil stockpiles, laydown area and borrow pits (for road base and civil works). Material will be sourced from local quarries where required.
- Disposal of CHPP rejects (coarse and fine rejects) in out of pit spoil dumps, and in-pit behind the mining void.
- Progressive development of internal roads and haul roads including a causeway over Charlevue Creek to enable coal haulage and pit access.

- Development of water storage dams and sediment dams, and the installation of pumps, pipelines, and other water management equipment and structures including temporary levees, diversions and drains.

The proposed mine layout is shown in **Figure 3.1**.

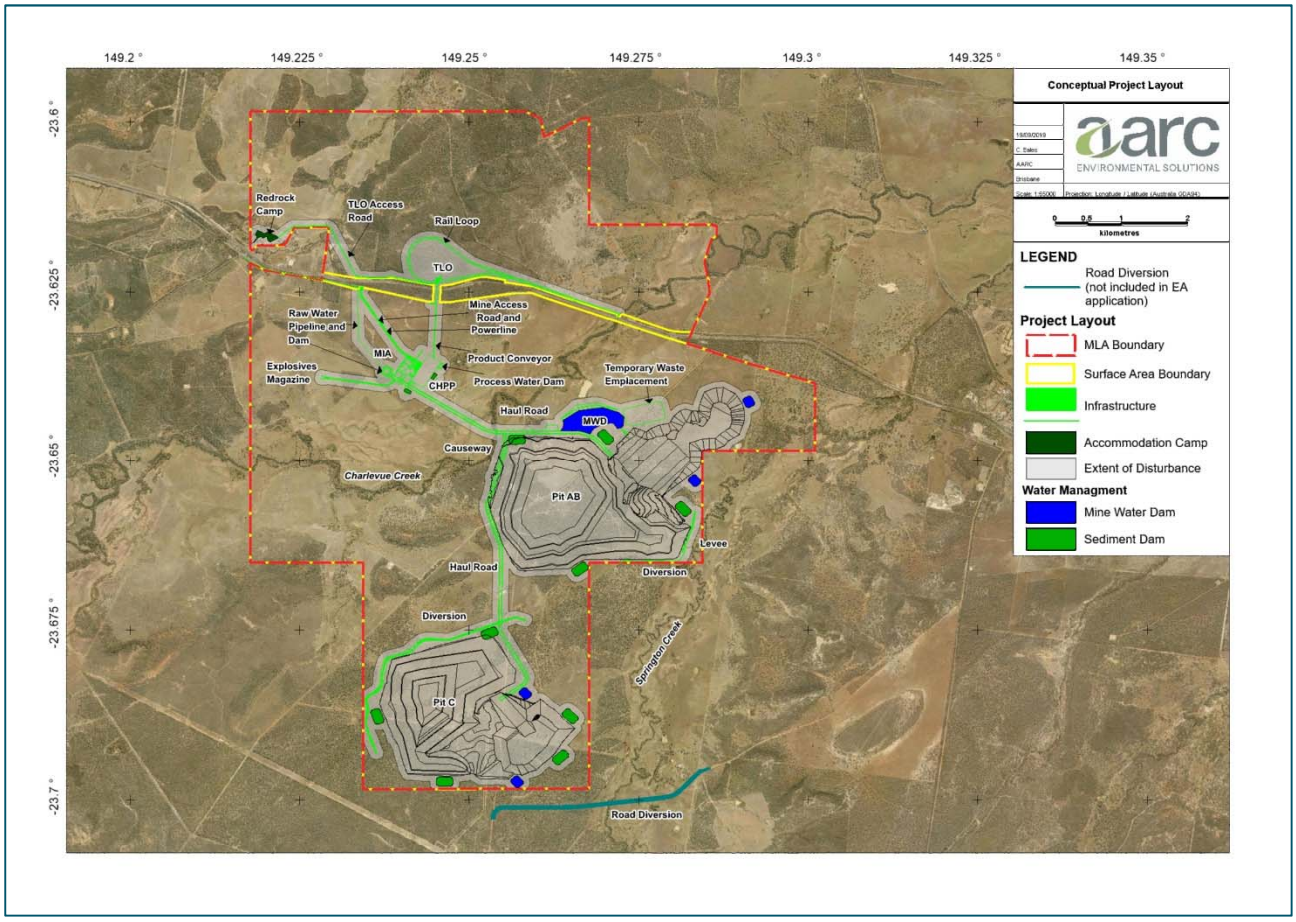

Figure 3.1 Proposed Mine Layout

3.2 Projected Equipment Numbers

To give an indication of the amount of equipment used, the proposed haul truck numbers for the open cut mining operations are presented in **Table 3.1**.

Table 3.1 Haul Truck Fleet in Each Mining Year

Mining Year	Waste Haul Trucks	Coal Haul Trucks
1	6	0
2	12	1
3	12	2
4	13	2
5	14	2
6	15	2
7	15	2
8	15	2
9	15	2
10	15	2
11	15	2

Mining Year	Waste Haul Trucks	Coal Haul Trucks
12	15	2
13	15	2
14	15	2
15	17	3
16	17	3
17	17	3
18	17	3
19	10	3

It is noted that these haul truck numbers are the actual number of trucks in use at any one time, with an additional number of trucks being out of operation for maintenance etc. Further details on the types and numbers of equipment are provided in **Section 6.4**.

The major items of equipment at the ROM pad include a Coal Handling Preparation Plant (CHPP) and a front end loader (FEL). The rail loadout facility is also included in the model, including conveyors, conveyor drives, rail loadout bin and train locomotives.

4. Existing Noise Environment

4.1 Overview and Locations

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

- Location A – Accommodation Facility: Located in an open-field, approximately 360 metres northeast of the railway line and 440 metres northeast of the Capricorn highway (726505.61 E, 7386445.61 N). This is the same location as SR22 (refer **Figure 2.1**).
- Location B – Roadhouse: Located in an open-field location, approximately 220 metres southwest of the Capricorn Highway (738095.59 E, 7382329.42 N). This is approximately the same location as SR03 (refer **Figure 2.1**).
- Location C – Residence: Located in an open-field position, approximately 200 metres northeast of the homestead (732865.98 E, 7377627.44 N). This is approximately the same location as sensitive receptors S19, SR20 and SR21 (refer **Figure 2.1**).

Aerial photos of the measurement locations are included in **Figures B.1**, **B.2** and **B.3** in **Appendix B**.

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

4.2 Weather

Data from the Bureau of Meteorology (Blackwater Airport) indicates that weather for the duration of the noise monitoring period was generally fine and warm with rainfall only recorded for Saturday 08/06/2019 (16.6 mm), Sunday 09/06/2019 (5.4 mm) and Tuesday 11/06/2019 (0.2 mm). Overall, the noise monitoring data has been deemed acceptable for use in this report.

4.3 Attended Noise Measurements

Attended noise measurements were undertaken at Locations A, B and C. The measurements were undertaken over separate 15-minute periods using a field and laboratory calibrated Larson Davis LD831 sound level meter. The microphone height was approximately 1.5m above natural ground level and was located in the free field at each location. Weather during the time of monitoring was generally cool, calm and clear. The conditions were as follows:

- Daytime: Approximately 11 to 15°C with a 2 to 3 m/s breeze and 1/8 cloud cover.
- Night time: Approximately 8 to 10°C, with a 0 to 3 m/s breeze and 1/8 cloud cover.

The measured noise levels are summarised in **Table 4.1**.

Table 4.1 Attended Noise Measurement Results

Location	Date & Time	Period (Minutes)	Results & Notes
A	19/06/2019 11:39pm	15	Statistical noise levels: L_{10} 61 dBA, L_{eq} 55 dBA, L_{90} 21 dBA Coal trains: 54 to 66 dBA Train horn: 58 dBA Distant cattle noise: 24 to 27 dBA Capricorn highway traffic: 45 to 52 dBA
B	19/06/2019 10:03pm	15	Statistical noise levels: L_{10} 61 dBA, L_{eq} 56 dBA, L_{90} 36 dBA Coal trains: 53 to 64 dBA Train horn: 78 to 79 dBA Capricorn highway traffic: 30 to 61 dBA
C	19/06/2019 10:52pm	15	Statistical noise levels: L_{10} 27 dBA, L_{eq} 27 dBA, L_{90} 19 dBA Cattle noise (Distant): 21 to 33 dBA Cattle noise (Closer): 37 to 43 dBA Birds: 33 dBA
A	20/06/2019 08:16am	15	Statistical noise levels: L_{10} 53 dBA, L_{eq} 50 dBA, L_{90} 41 dBA Birds: 39 to 42 dBA Highway trucks: 47 to 56 dBA Capricorn highway traffic: 37 to 50 dBA
B	20/06/2019 09:38am	15	Statistical noise levels: L_{10} 51 dBA, L_{eq} 49 dBA, L_{90} 46 dBA Wind through trees/rustling leaves: 47 to 48 dBA Crows: 54 to 58 dBA Birds: 46 to 51 dBA Truck leaving parking area: 47 to 55 dBA Capricorn highway traffic: 45 to 53 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.

4.4 Noise Logging

Noise logging was undertaken over the following time periods:

- Location A – Accommodation Facility: The measurement period was Friday 7th to Wednesday 19th June 2019.
- Location B – Roadhouse: The measurement period was Friday 7th to Wednesday 19th June 2019.
- Location C – Residence: The measurement period was Friday 7th to Monday 17th June 2019.

Logging was undertaken using field and laboratory calibrated Larson Davis LD831 environmental noise loggers. Noise logging was undertaken in the free-field at each location.

The measured noise levels at Locations A, B and C are shown in **Figure C.1** to **C.6** in **Appendix C**. The statistical results from the noise logging have been summarised in **Tables C.1**, **C.2** and **C.3** in **Appendix C**.

The noise logger at Location C had its wind protector removed when the logger was collected. This could have adversely affected the results with wind noise resulting in increased noise levels. However, the background noise levels remained consistently low throughout the measurement period, including

background noise levels below 20 dBA L_{90}, and therefore the background noise data is still considered to be of use for this review.

The background noise levels were affected by insect noise at Locations A and C. At Location B, insect noise was minimal. As the insect noise is likely a seasonal influence, the noise level data has been filtered to remove the insect noise from Location A and C. The resulting background noise levels, calculated using the lowest 10^{th} percentile method, are shown in **Table 4.2**.

Table 4.2 Background Noise Level with Insect Noise Removed

Period	Background Noise Level (Less Insect Noise) L_{90} dBA		
	Location A	Location B	Location C
Day (7am to 6pm)	33	35	25
Evening (6pm to 10pm)	23	37	29
Night (10pm to 7am)	20	27	22

5. Acoustic Criteria

5.1 Overview

Noise and vibration criteria are required to assess the potential impacts of the proposed Gemini Project 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"
- Guideline "Noise and Vibration from Blasting"

5.2 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"* and thus includes underwater noise.

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.

Section 440 of the EP Act relates to the offence of causing a nuisance, and section 440Q relates to the offence of contravening a noise standard. In both cases, the sections state it does not apply to an environmental nuisance of the variety mentioned in schedule 1, part 1 of the EP Act.

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

5.3 Environmental Protection (Noise) Policy

5.3.1 Overview

In respect of the acoustic environment, the object of the 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.

5.3.2 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 the previously published DES Guideline "Planning For Noise Control" (refer **Section 5.4**) the noise reduction provided by a typical residential building façade is 7 dBA with windows open.

Based on a façade reduction of 7 dBA (7 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) for monitoring:

- Daytime and Evening: 42 dBA $L_{Aeq,adj,1hr}$, 47 dBA $L_{A10,adj,1hr}$ and 52 dBA $L_{A1,adj,1hr}$
- Night: 37 dBA $L_{Aeq,adj,1hr}$, 42 dBA $L_{A10,adj,1hr}$ and 47 dBA $L_{A1,adj,1hr}$

A sensitive receptor is defined as "an area or place where noise is measured".

5.3.3 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". This is understood to require consideration of cumulative impacts, including other developments.

5.4 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 did contain some guidance on noise assessment, measurement and modelling, including the following:

- "Noise levels are calculated at the noise sensitive places for a range of typical operating scenarios and conditions that are representative of the proposed activity, including worst-case meteorological conditions."
- A method for determining the minimum background noise level using the lowest tenth percentile methodology is provided.

5.5 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 address human comfort and are below typical limits for prevention of structural damage. The criteria apply at residential and commercial receivers. The criteria are presented in **Table 5.1**.

Table 5.1 Blasting Vibration and Airblast Criteria

Issue	Criteria
Airblast	Air blast 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.

5.6 Proposed Criteria

5.6.1 Noise Emissions

In accordance with the EPP(Noise) and based on the calculated external limits as discussed in **Section 5.3.2**, the resulting noise limits are presented in **Table 5.2**.

Table 5.2 Proposed Noise Limits

Period	Noise Limit $L_{Aeq,adj,1hr}$ dBA
Day (7am to 6pm)	42
Evening (6pm to 10pm)	42
Night (10pm to 7am)	37

5.6.2 Blasting

It is proposed to adopt the blasting criteria from the Guideline "Noise and vibration from blasting". The criteria are presented in **Table 5.3**.

Table 5.3 Proposed Blasting Vibration and Airblast Criteria

Issue	Criteria
Airblast	Air blast 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.

6. Noise Assessment

6.1 Model Description

Noise modelling was carried out using the SoundPLAN v8.1 computer program using the CONCAWE algorithms, which is 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 Gemini Project and the surrounding area including the location of sensitive receptors. The model incorporates terrain data for the proposed Gemini Project mine 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 has been setup to predict noise levels under neutral and adverse meteorological conditions. The conditions used in the noise model are as follows:

- Neutral
  - Pasquill Stability Class: D (no temperature inversion)
  - Temperature: 25 °C
  - Wind Speed: 0 m/s
  - Relative Humidity: 40%
- Adverse
  - Pasquill Stability Class: F (temperature inversion)
  - Temperature: 10 °C
  - Wind Speed: 2 m/s directed to produce the highest noise level
  - Relative Humidity: 70%

The 'Neutral' scenario is most likely to occur during the daytime, and as such this is referred to as the Day 'Neutral' scenario in the modelling. The 'Adverse' scenario is most likely to occur during the night-time, particularly temperature inversions, and as such this is referred to as the Night 'Adverse' scenario in the modelling. 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 'Adverse', since this assessed the highest predicted noise levels against the most stringent night-time criteria.

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 or published sources. The sound power levels for the mobile and fixed equipment proposed for the Gemini Project are presented in **Table 6.1**.

Table 6.1 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
Hitachi EX5600	1	129	124	114	119	111	106	104	99	131	118
Hitachi EX1900	1,2	127	121	112	116	109	103	101	97	128	116
CAT 793	1,2	115	125	120	118	113	111	104	96	127	120
CAT 777	1,2	110	112	110	111	111	109	101	96	118	115
D11	3	111	119	117	119	113	114	105	93	124	120
D10	3	111	119	117	119	113	114	105	93	124	120
CAT 994 (FEL)	1	103	110	113	109	109	104	98	94	117	113
CAT 777 (Water Cart)	1,2	110	112	110	111	111	109	101	96	119	115
CAT 16M (Grader)	1,2	108	115	112	104	104	102	98	90	118	110
Drill	2	109	111	111	110	110	109	106	101	118	115
CHPP	1,2	125	119	113	113	110	107	101	93	127	115
Conveyor Drive	2	98	97	98	100	99	94	87	78	106	102
Conveyor per 1m	2	75	74	75	77	76	71	64	55	83	79
Rail Loadout Bin	2	105	102	104	105	105	107	104	95	113	112
Train Slow Travel whilst Loading	2	110	105	104	103	104	104	101	94	114	110

The sources of data used to compile the sound power level data in **Table 6.1** are presented in **Table 6.2**.

Table 6.2 Source of Data for Equipment Sound Power Levels

Source #	Data Source
1	ASK database, based on sound power level calculated from measurements at another coal mine for the same/similar equipment.
2	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.
3	Data for the tracked dozers was based on measurements at another coal mine and decreased by 5 dBA based the tracked dozers being limited to first gear only in reverse.

6.4 Modelling Scenarios

Mining noise emissions from the Gemini Project have been predicted for the following three mine year scenarios:

- Year 2
- Year 8
- Year 15

These years were selected to give a representation of mine noise levels near the beginning, middle and end of the project.

Modelling of the nominated mine year scenarios has included mine ground elevations, equipment numbers and equipment locations for each mine year based on information provided by Magnetic South Pty Ltd.

The mobile equipment numbers for the modelled mine years are presented in **Table 6.3**.

Table 6.3 Mobile Equipment Fleet in Modelled Mining Years

Equipment Type	Model #	Number of Items		
		Year 2	Year 8	Year 15
Excavator	EX5600	3	3	3
Excavator	EX1900	1	1	1
OB haul trucks	Cat 793	12	15	17
Coal haul trucks	Cat 777	1	2	3
Track Dozer	Cat D11	4	6	4
Track Dozer	Cat D10	3	3	3
Grader	Cat 16M	2	2	2
Water Cart	Cat 777	2	2	2
Drill	Cat MD6420	2	2	2
Front end loader	Cat 994	1	1	1

The locations of the equipment included in noise modelling as advised by Magnetic South Pty Ltd are provided in **Appendix D**. The location of equipment in the noise model has generally been located where it will spend the majority of time operating. Overburden trucks and dozers have generally been placed at or near the top of the dumps, except for Year 8, when waste will predominantly be dumped in-pit.

The following additional notes are provided regarding the modelled scenarios:

- Coal haul trucks will not operate during the night (10pm to 7am), and as such, have only been modelled during the day 'neutral' scenario, not the night 'adverse' scenario.
- The rail loadout facility will only operate when a train is being loaded, which is expected to occur on average four times per week. As such, the rail loadout facility noise sources, including conveyor system, rail loadout bin and slow-moving train being loaded, is modelled as part of a separate scenario, i.e. models of the mine only and the mine with the rail loadout facility.

The overall sound power levels of the equipment modelled in the night 'adverse' scenario, excluding the rail loadout sources, are presented in **Table 6.4**.

Table 6.4 Total Scenario Sound Power Levels

Mining Year	Total Octave Band Sound Power Level $L_{W,eq}$ dBA
Year 2	133
Year 8	134
Year 15	134

6.5 Predicted Noise Levels & Assessment

The predicted noise levels at nearby sensitive receptors for the three mining year scenarios are presented in **Table 6.5** for the night 'adverse' scenario, and in **Table 6.6** for the daytime 'neutral' scenario.

The following notes are provided regarding the assessment of the predicted noise levels:

- The results are compared against the proposed noise limits of 37 dBA L_{eq} and 42 dBA L_{eq} for the night and daytime/evening respectively, as per **Table 5.2**. Where the result exceeds the limit, the cell is shaded pink. Where the result does not exceed, the level below the criterion is included in brackets.

Table 6.5 Predicted Night 'Adverse' Noise Levels

Receptor	Predicted Noise Emission Levels for Adverse Night Meteorological Conditions, L_{eq} dBA								
	Year 2			Year 8			Year 15		
	Mine Only	Mine & Rail Loadout	Exceedance of 37 dBA Night Criterion	Mine Only	Mine & Rail Loadout	Exceedance of 37 dBA Night Criterion	Mine Only	Mine & Rail Loadout	Exceedance of 37 dBA Night Criterion
SR01	24	24	(-13)	22	22	(-15)	23	23	(-14)
SR03	32	32	(-5)	33	33	(-4)	25	25	(-12)
SR05	26	26	(-11)	25	25	(-12)	28	28	(-9)
SR07	32	32	(-5)	33	33	(-4)	24	25	(-12)
SR08	25	25	(-12)	23	24	(-13)	25	25	(-12)
SR09	43	43	6	40	41	4	32	34	(-3)
SR10	37	37	(0)	38	38	1	28	28	(-9)
SR13	34	34	(-3)	35	35	(-2)	26	26	(-11)
SR14	29	29	(-8)	28	28	(-9)	42	42	5
SR15	31	33	(-4)	30	32	(-5)	27	30	(-7)
SR16	30	30	(-7)	29	29	(-8)	21	21	(-16)
SR17	27	27	(-10)	25	25	(-12)	27	27	(-10)
SR18	49	50	13	48	49	12	47	48	11
SR19	38	38	1	39	39	2	43	43	6
SR20	39	39	2	39	39	2	43	43	6
SR21	39	39	2	40	40	3	43	43	6
SR22	35	36	(-1)	33	35	(-2)	33	35	(-2)
SR23	43	43	6	44	44	7	30	30	(-7)
SR24	37	37	(0)	37	37	(0)	26	26	(-11)
SR26	27	27	(-10)	28	28	(-9)	21	22	(-15)
SR27	28	28	(-9)	29	29	(-8)	22	22	(-15)
SR28	28	28	(-9)	29	29	(-8)	22	22	(-15)
SR30	28	28	(-9)	28	28	(-9)	22	22	(-15)
SR31	32	33	(-4)	30	31	(-6)	31	32	(-5)
SR32	30	31	(-6)	29	30	(-7)	29	30	(-7)

Table 6.6 Predicted Day 'Neutral' Noise Levels

Receptor	Predicted Noise Emission Levels for Neutral Day Meteorological Conditions, L_{eq} dBA								
	Year 2			Year 8			Year 15		
	Mine Only	Mine & Rail Loadout	Exceedance of 42 dBA Day Criterion	Mine Only	Mine & Rail Loadout	Exceedance of 42 dBA Day Criterion	Mine Only	Mine & Rail Loadout	Exceedance of 42 dBA Day Criterion
SR01	18	18	(-24)	15	16	(-26)	17	17	(-25)
SR03	25	25	(-17)	26	26	(-16)	18	18	(-24)
SR05	20	20	(-22)	18	18	(-24)	22	22	(-20)
SR07	25	25	(-17)	25	25	(-17)	18	18	(-24)
SR08	19	19	(-23)	17	17	(-25)	18	18	(-24)
SR09	35	35	(-7)	33	33	(-9)	25	27	(-15)
SR10	30	30	(-12)	31	31	(-11)	21	21	(-21)
SR13	27	27	(-15)	28	28	(-14)	20	20	(-22)
SR14	22	22	(-20)	21	21	(-21)	34	34	(-8)
SR15	24	25	(-17)	22	24	(-18)	20	23	(-19)
SR16	23	23	(-19)	22	22	(-20)	14	15	(-27)
SR17	20	21	(-21)	18	18	(-24)	20	20	(-22)
SR18	43	44	2	43	44	2	42	43	1
SR19	31	31	(-11)	31	31	(-11)	35	35	(-7)
SR20	31	31	(-11)	32	32	(-10)	35	35	(-7)
SR21	32	32	(-10)	32	32	(-10)	36	36	(-6)
SR22	28	29	(-13)	26	28	(-14)	26	28	(-14)
SR23	36	36	(-6)	37	37	(-5)	23	23	(-19)
SR24	29	29	(-13)	30	30	(-12)	20	20	(-22)
SR26	20	20	(-22)	20	21	(-21)	15	15	(-27)
SR27	21	21	(-21)	22	22	(-20)	16	16	(-26)
SR28	21	21	(-21)	22	22	(-20)	16	16	(-26)
SR30	21	21	(-21)	21	21	(-21)	16	16	(-26)
SR31	25	25	(-17)	23	24	(-18)	24	24	(-18)
SR32	23	24	(-18)	21	22	(-20)	22	23	(-19)

The predicted noise levels are also shown graphically as noise contours in **Appendix E**.

From the night 'adverse' results in **Table 6.5**, the highest exceedance is 13 dBA in Year 2 at SR18 (12 dBA in Year 8 and 11 dBA in Year 15). This sensitive receptor is within the MLA and is very close to the ROM pad.

Excluding SR14, SR19, SR20 and SR21, the properties owned by Magnetic South at the time of report preparation, the additional exceedances are listed as follows:

- Year 2:
  - SR 09: 6 dBA
  - SR 23: 6 dBA
- Year 8:
  - SR 09: 4 dBA
  - SR 10: 1 dBA
  - SR 23: 7 dBA

SR10 is located to the east of the Gemini Project, whilst SR09 and SR23 are located within the MLA.

From the day 'neutral' results in **Table 6.6**, the only exceedance is at SR18, which is very close to the ROM pad. Compliance is predicted at all other sensitive receptors.

6.6 Discussion & Recommendations

6.6.1 Noise Monitoring, Management & Mitigation

Given that there are exceedances predicted, it is recommended that a noise monitoring program be established for properties that are not purchased by Magnetic South.

Noise monitoring should be conducted at the location of sensitive receptor of interest, or at an acoustically equivalent location selected in consultation with an acoustic consultant. The noise monitoring should be undertaken in accordance with the DES Noise Measurement Manual 2013 (or the current version of the Manual).

Where exceedances of the criteria are found, the following measures could be considered in order to reduce noise emissions:

- Management of mining equipment locations, such as operating at lower elevation or shielded areas during the night. Noise modelling with equipment relocated to shielded locations at lower elevation (e.g. in-pit) indicates that a 1 to 3 dBA reduction could be achieved.
- Reducing the number of equipment in operation during the night. Reducing the haul truck fleet by 50% at night and removing at least two dozers is calculated to reduce noise levels by 3 dBA.
- Attenuation of equipment. With attenuation packages for the major mobile equipment items, including haul trucks, dozers and excavators, it is expected that a reduction in the order of 5 dBA could be achieved.
- Construction of a bund wall. A bund of sufficient height and in a location which provides a high level of shielding to the loudest equipment (waste haul trucks and dozers), could be considered.

If noise monitoring establishes that exceedances are occurring, based on the modelling and estimated noise reductions described above, it is expected that compliance can be achieved with noise management and/or attenuation measures.

6.6.2 Cumulative Noise Impacts

As described in **Section 2**, the nearest other existing mine is Bluff Mine to the west. The sensitive receptors that have the most potential to be impacted by the Gemini Project to the west are SR22, SR31 and SR32. The

Bluff Mine is over 10 km from these receptors. Given the significant distance and that adverse wind conditions cannot occur for both mines simultaneously at these receptors since they are in opposite directions, it is unlikely that cumulative noise impacts from both mines will be an issue.

At locations close to the Capricorn Highway and rail line, road traffic and trains are significant noise sources. From the noise monitoring data, $L_{eq,15\ min}$ noise levels were 51 dBA and 49 dBA on average during the night at Locations A and B respectively. These noise levels are well above the predicted mine noise levels at night, and the Gemini Project would have negligible impact relative to the noise levels from road and rail. The road and rail noise sources are also relatively intermittent, whilst the mining noise would typically be relatively steady. As such, additional assessment of the cumulative effects of the Gemini Project with existing road and rail noise is not warranted.

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 to roads, rail lines or near major items of fixed plant.

The only vibration source of significance from the mining of the Gemini Project 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 5.6.2**.

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 5.6.2**, 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.

A site exponent (-B) (attenuation rate) of –1.6 has been estimated for the site based on ASK's experience with similar mining projects. The site constant (K) was assumed to be in the range 800 to 1600. The maximum instantaneous charge mass will be 900 kg as advised by Magnetic South 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	2.9	5.9
1.5	1.5	3.1
2.0	1.0	1.9
2.5	0.7	1.4
3.0	0.5	1.0
3.5	0.4	0.8
4.0	0.3	0.6
4.5	0.3	0.5
5.0	0.2	0.4
5.5	0.2	0.4
6.0	0.2	0.3
6.5	0.1	0.3
7.0	0.1	0.3
7.5	0.1	0.2
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	0.1

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.

The nearest sensitive receptor is approximately 1.9 kilometres away from the nearest pit within the proposed Gemini Project area. Therefore, ground vibration due to blasting is predicted to be compliant with the nominated criteria at all sensitive receptors.

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 5.6.2**, 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 provided by Magnetic South Pty Ltd:

- h = 270 mm
- S = 8000 mm
- B = 8000 mm
- m = 900 kg

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	118.3
1.5	113.0
2.0	109.3
2.5	106.4
3.0	104.0
3.5	102.0
4.0	100.3
4.5	98.8
5.0	97.4
5.5	96.2
6.0	95.0
6.5	94.0
7.0	93.0
7.5	92.2
8.0	91.3
8.5	90.5
9.0	89.8
9.5	89.1
10.0	88.4

The distance to the 120 dBZ contour line is calculated to be 880 metres. The distance to the 115 dBZ contour line is calculated to be 1,290 metres.

Based on these calculations and blast parameters, the airblast criteria would not be exceeded at any sensitive receptors.

7.3 Assessment

Based on the blasting calculations presented within this section, the ground vibration and airblast levels from open cut operations within the Gemini Project are predicted to be acceptable at the nearest sensitive receptors based on the nominated criteria.

8. Conclusions

A noise and vibration impact assessment has been conducted for the proposed Gemini Project. Noise monitoring was conducted at three sensitive receptor locations. A noise model has been developed for proposed mining activities for mining years 2, 8 and 15 to predict noise emission levels at nearby sensitive receptors. Calculations have also been made to predict noise and vibration levels due to blasting.

From this assessment, the following conclusions are made:

- Noise criteria for the mine have been proposed in **Section 5.6**, which includes noise limits of 42 dBA $L_{Aeq,adj,1hr}$ in the day and evening and 37 dBA $L_{Aeq,adj,1hr}$ in the night.
- From the predicted noise levels in **Section 6.5**, of the properties that are not owned by Magnetic South at the time of report preparation, exceedances are predicted at SR09, SR18 and SR23 in Year 2, SR09, SR10, SR18 and SR23 in Year 8, and at SR18 in Year 15 under night-time adverse conditions. Discussions between Magnetic South and landowners of properties within the MLA and surrounds are ongoing.
- From the day 'Neutral' results, the only exceedance is at SR18, which is very close to the ROM pad. Compliance is predicted at all other sensitive receptors.
- Given there are exceedances predicted, it is recommended that a noise monitoring program be established.
- Where exceedances are measured, amelioration treatments to reduce noise levels could include management of mining equipment locations, reducing the number of equipment in operation during the night, attenuation of equipment and/or construction of bund walls. As discussed in **Section 6.6.1**, based on the modelling and estimated noise reductions, it is expected that compliance can be achieved with noise management and/or attenuation measures.
- Cumulative noise impacts are discussed in **Section 6.6.2**. Cumulative impacts from other mines are not expected to be an issue. Noise from road and rail are considerable at sensitive receptors near the Capricorn Highway and rail line, but since these sources are intermittent and will generally result in higher noise levels than those predicted for the mine, additional assessment of the cumulative effects of the Gemini Project with existing road and rail noise is not considered warranted.
- Based on the blasting parameters and calculations in **Section 7**, the ground vibration and airblast levels from blasting are predicted to be acceptable at the nearest sensitive receptors.

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.
dBC	Noise levels are sometimes expressed in terms of the 'C' weighted decibel scale, dB(C). This scale is very similar to the dB, dB, dB(linear), dBZ un-weighted scale. The difference being that some negative weighting is applied below 250Hz and above 1kHz. The magnitude of the weighting is significantly less than the dBA scale.
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 receiver 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.
minL_{90}	The background noise levels calculated using the 'lowest 10th percentile' of the L_{90} levels in each period of the day. This 'lowest 10th percentile' method is defined in the Queensland Department of Environment and Heritage Protection (EHP) guidelines.
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.
$L_{eq,1hr}$	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).

Parameter or Term	Description
L_{Amax} or max L_{pA}	Maximum A-weighted sound pressure level.
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

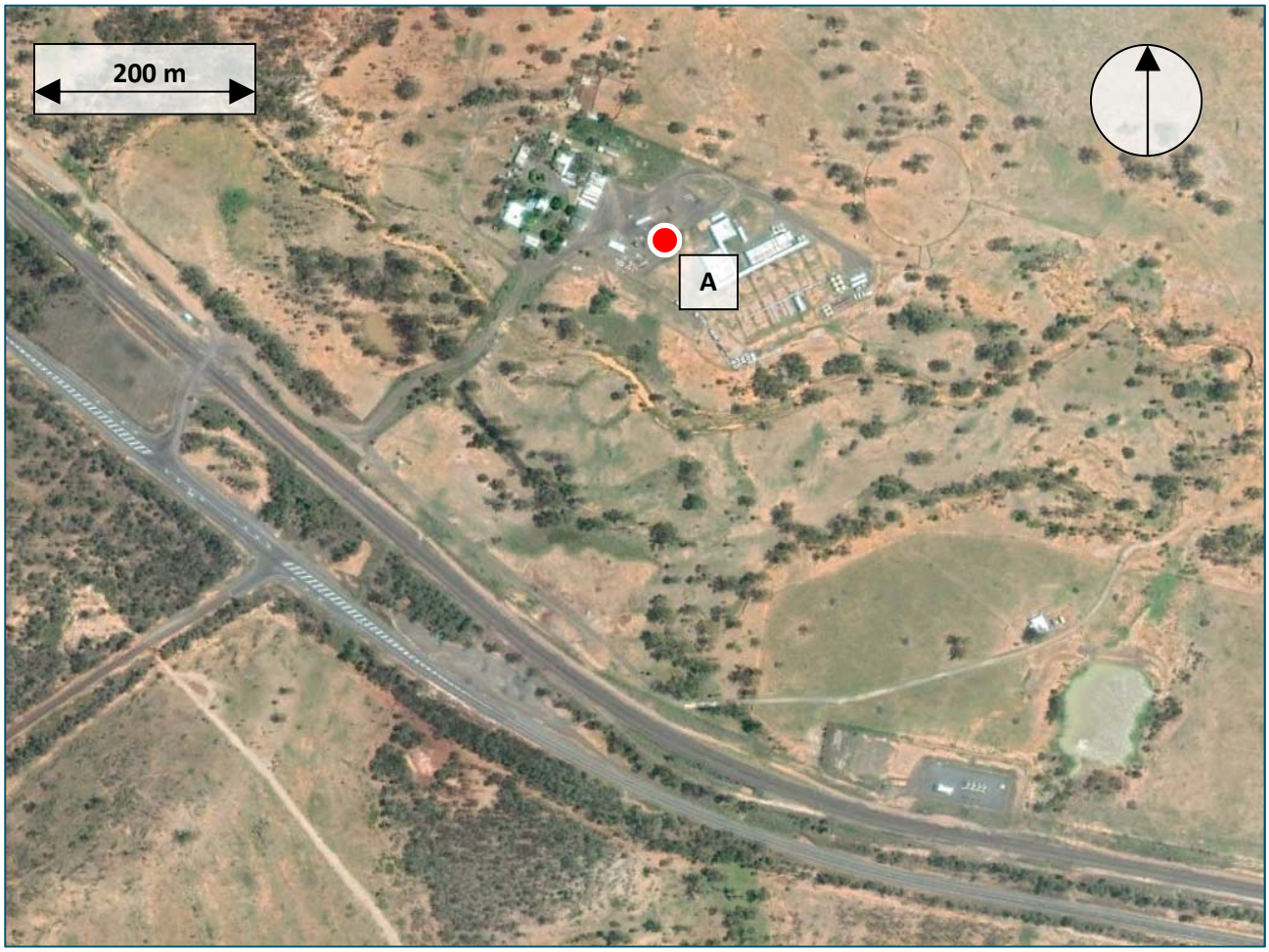

Figure B.1 Aerial Photo of Noise Monitoring Location A – Accommodation Facility

Figure B.2 Aerial Photo of Noise Monitoring Location B – Roadhouse

Figure B.3 Aerial Photo of Noise Monitoring Location C – Residence

Appendix C Noise Monitoring Results

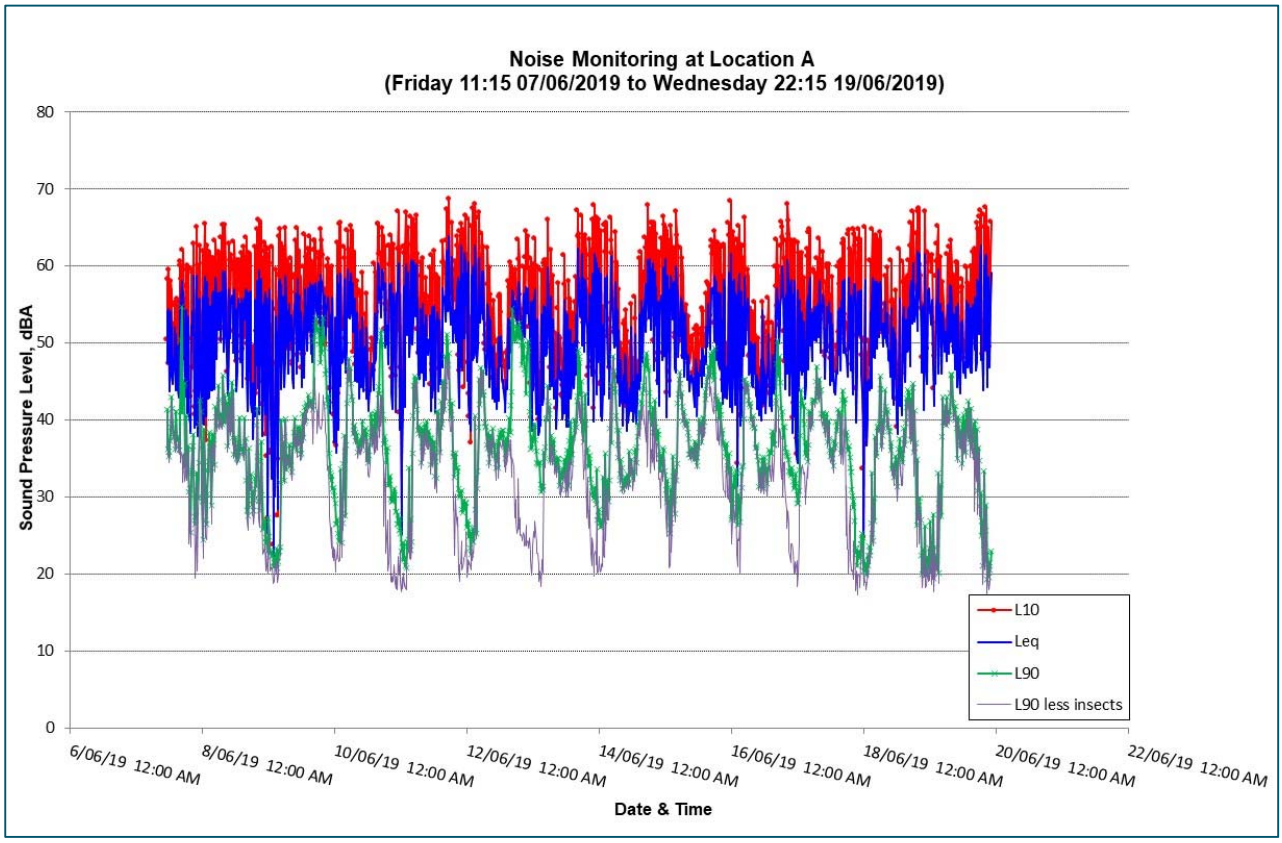

Figure C.1 Noise Monitoring Results at Location A – Accommodation Facility

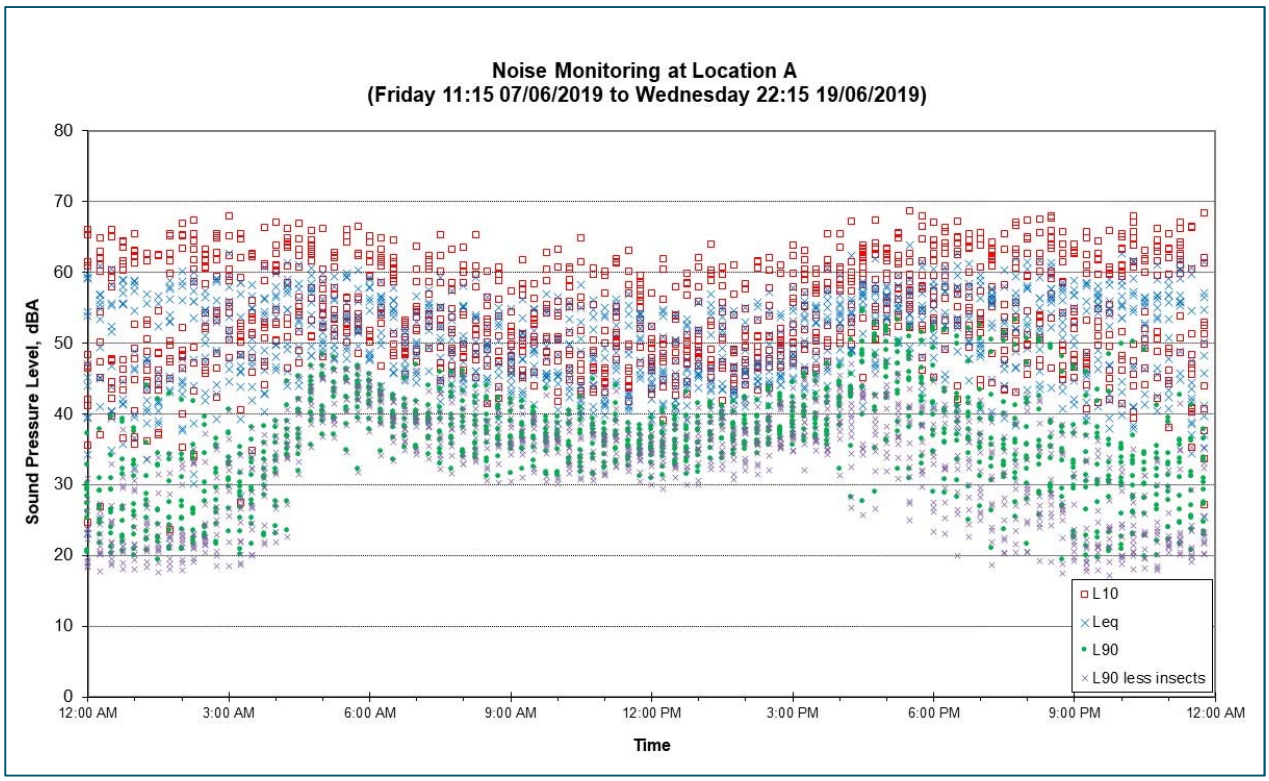

Figure C.2 24 Hour Noise Monitoring Results at Location A – Accommodation Facility

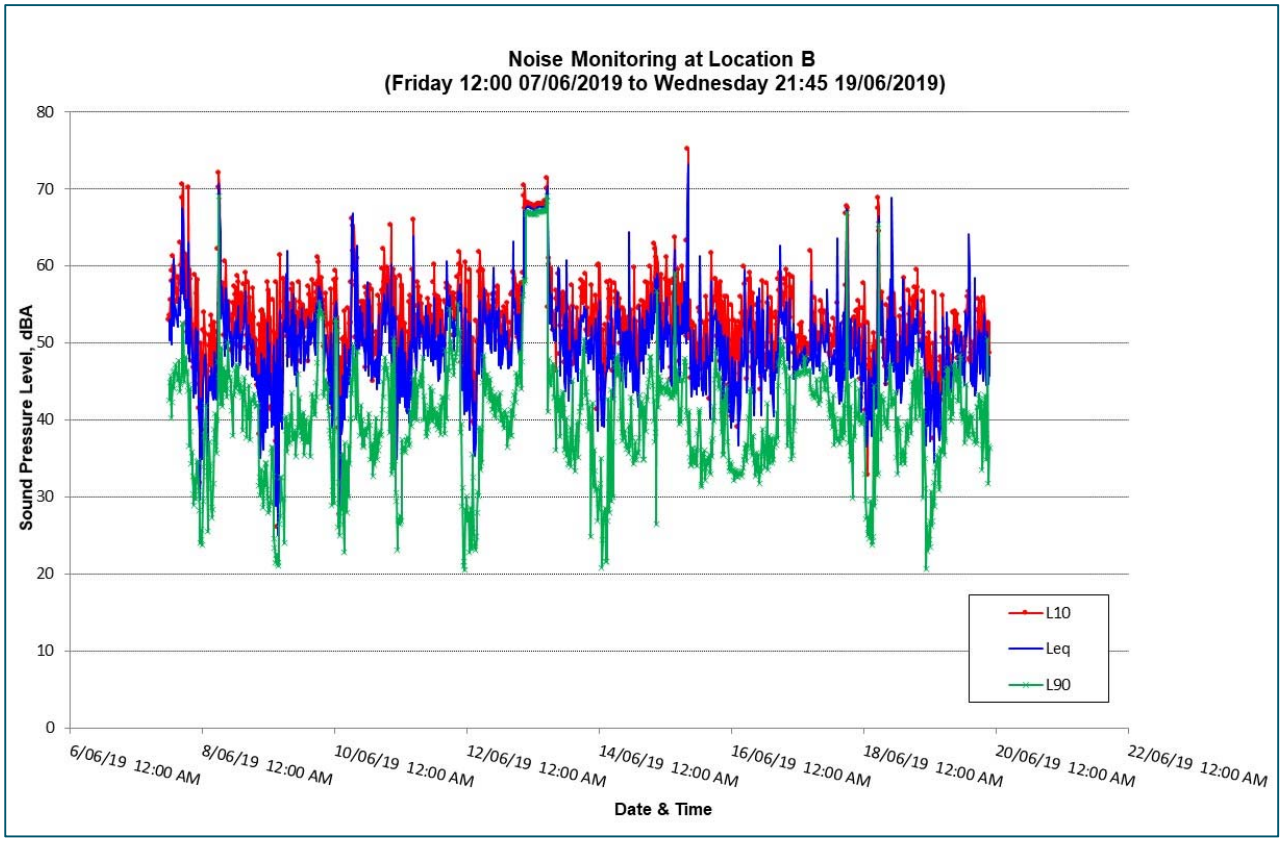

Figure C.3 Noise Monitoring Results at Location B – Roadhouse

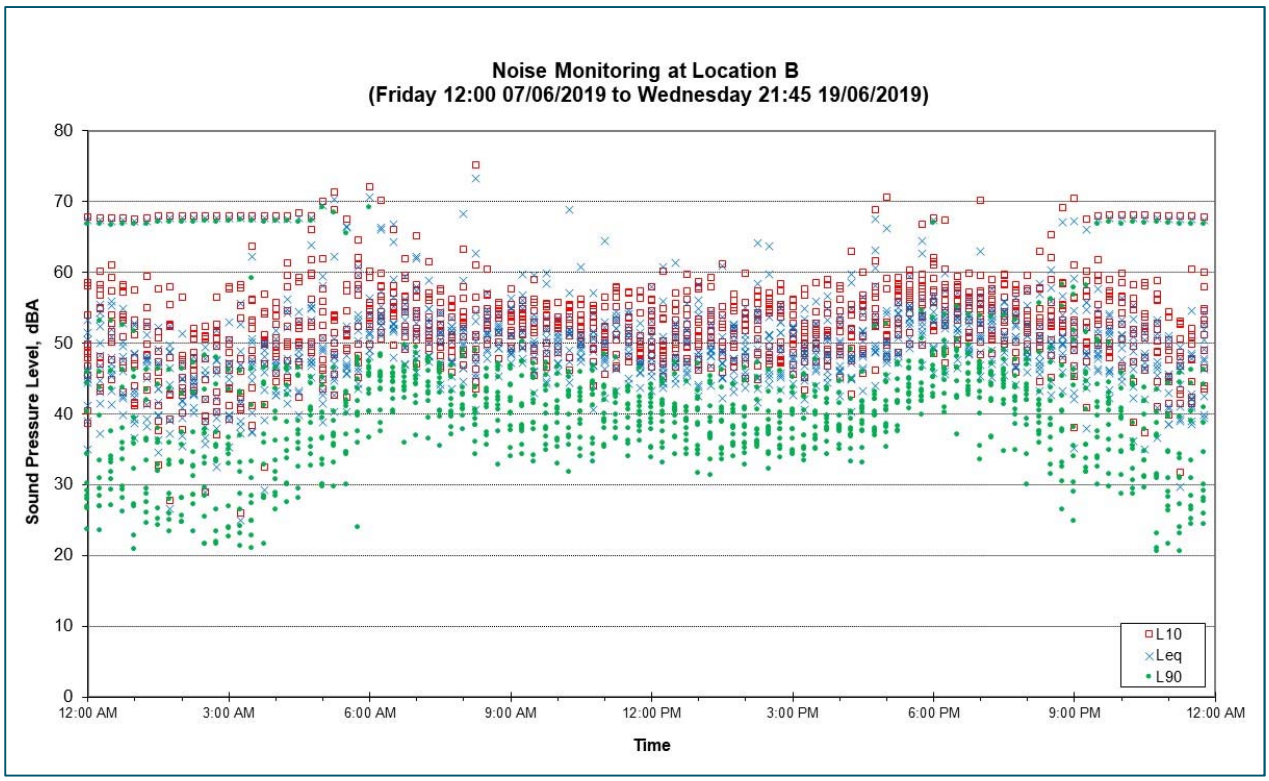

Figure C.4 24 Hour Noise Monitoring Results at Location B – Roadhouse

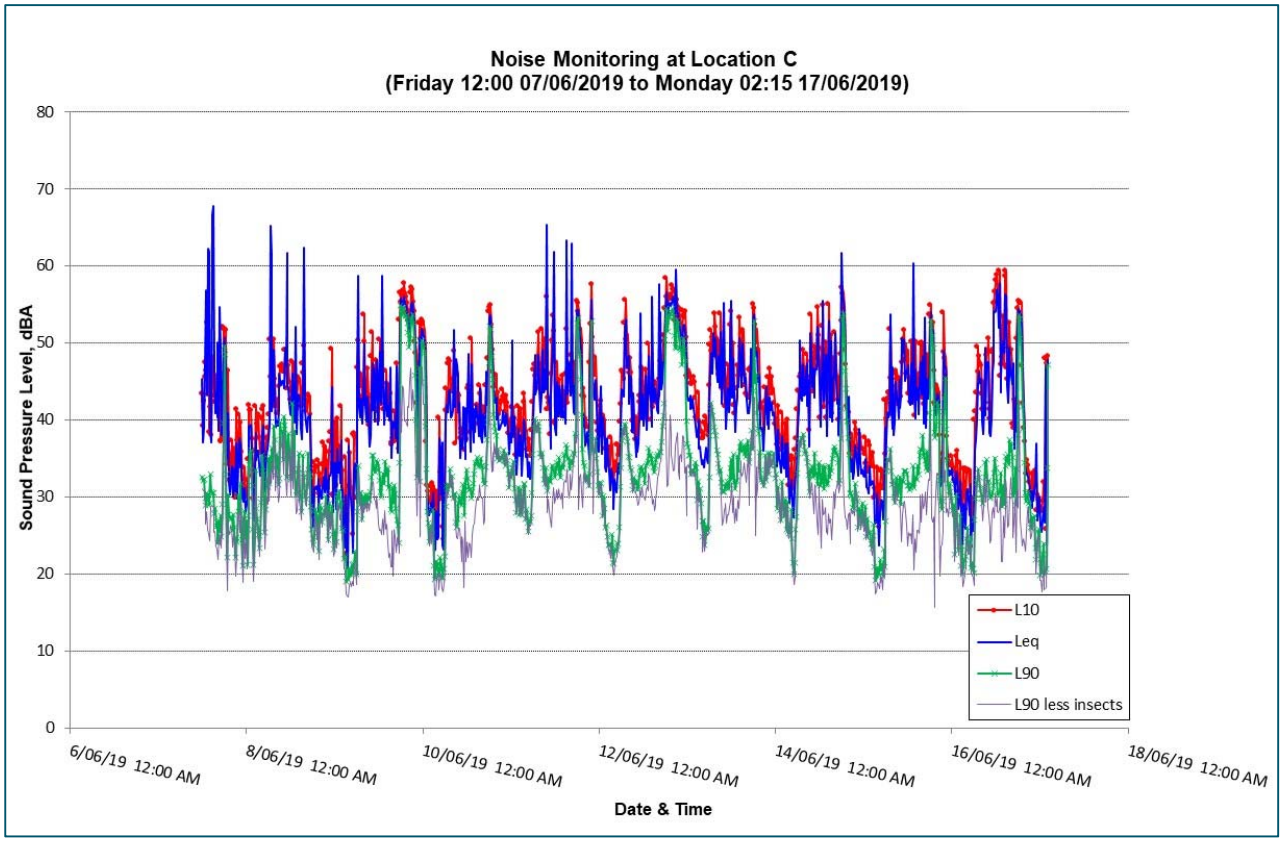

Figure C.5 Noise Monitoring Results at Location C – Residence

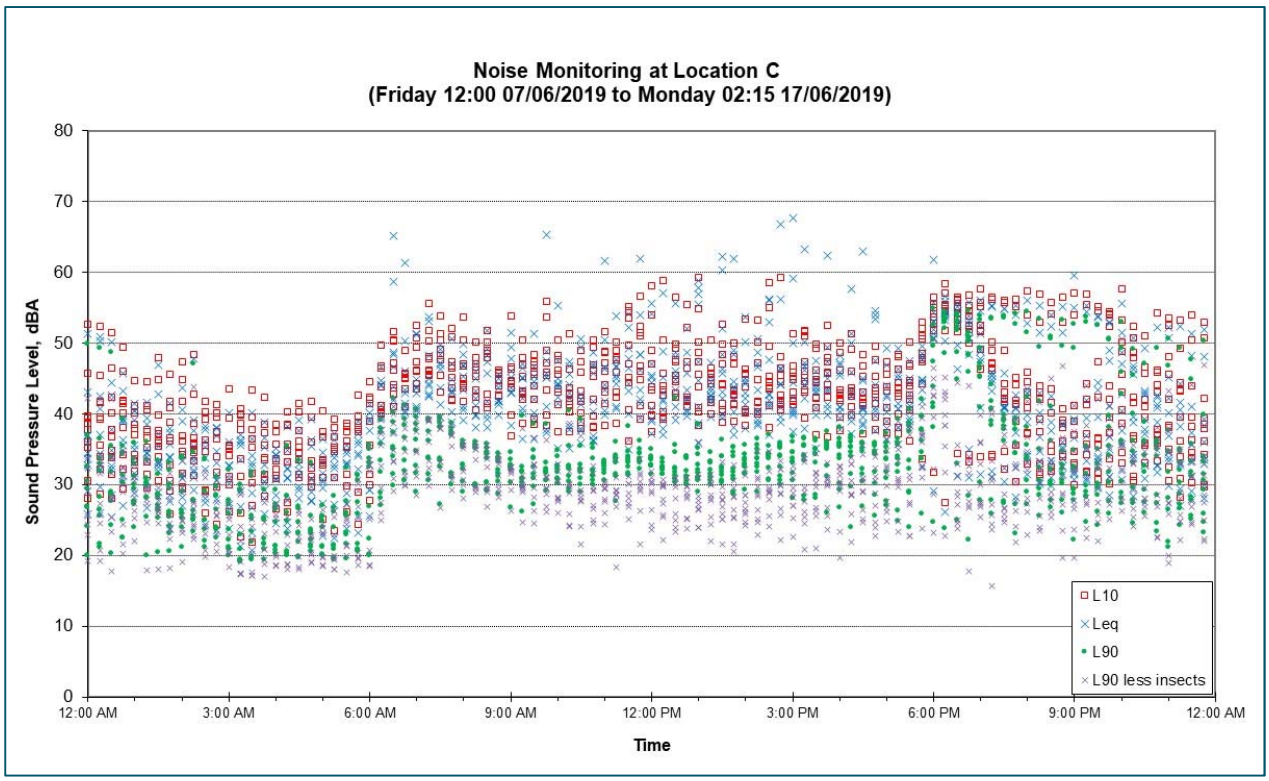

Figure C.6 24 Hour Noise Monitoring Results at Location C – Residence

Table C.1 Noise Monitoring Results at Location A – Accommodation Facility

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	82-71-(64)-58-51	80-72-(65)-56-48	83-72-(65)-56-34
L_1	73-66-(58)-51-46	73-69-(62)-52-46	74-69-(61)-51-25
L_{10}	69-62-(53)-46-39	68-65-(56)-46-41	68-65-(55)-44-24
L_{eq}	64-56-(49)-43-38	63-59-(52)-43-38	63-59-(51)-41-22
L_{90}	55-45-(39)-34-28	53-48-(36)-27-19	50-43-(33)-23-19

Table C.2 Noise Monitoring Results at Location B – Roadhouse

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	95-78-(68)-59-53	87-74-(65)-57-50	91-72-(62)-53-33
L_1	87-67-(60)-53-48	76-64-(58)-53-44	82-68-(56)-49-29
L_{10}	75-57-(53)-48-43	70-60-(55)-49-38	72-61-(52)-42-26
L_{eq}	73-55-(50)-45-40	68-57-(51)-46-35	71-59-(49)-39-25
L_{90}	55-46-(40)-35-31	67-51-(43)-34-25	69-47-(38)-26-21

Table C.3 Noise Monitoring Results at Location C – Residence

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	94-76-(65)-56-48	93-60-(54)-44-38	89-61-(50)-39-29
L_1	82-63-(55)-48-42	62-57-(48)-37-31	80-52-(43)-33-25
L_{10}	59-51-(45)-40-34	58-56-(45)-33-27	58-47-(38)-30-22
L_{eq}	68-51-(44)-39-33	62-55-(43)-31-26	65-45-(36)-28-21
L_{90}	42-37-(33)-30-24	55-53-(39)-27-22	53-37-(29)-21-19

Appendix D Mining Equipment Locations

Figure D.1 Year 2 Equipment Locations

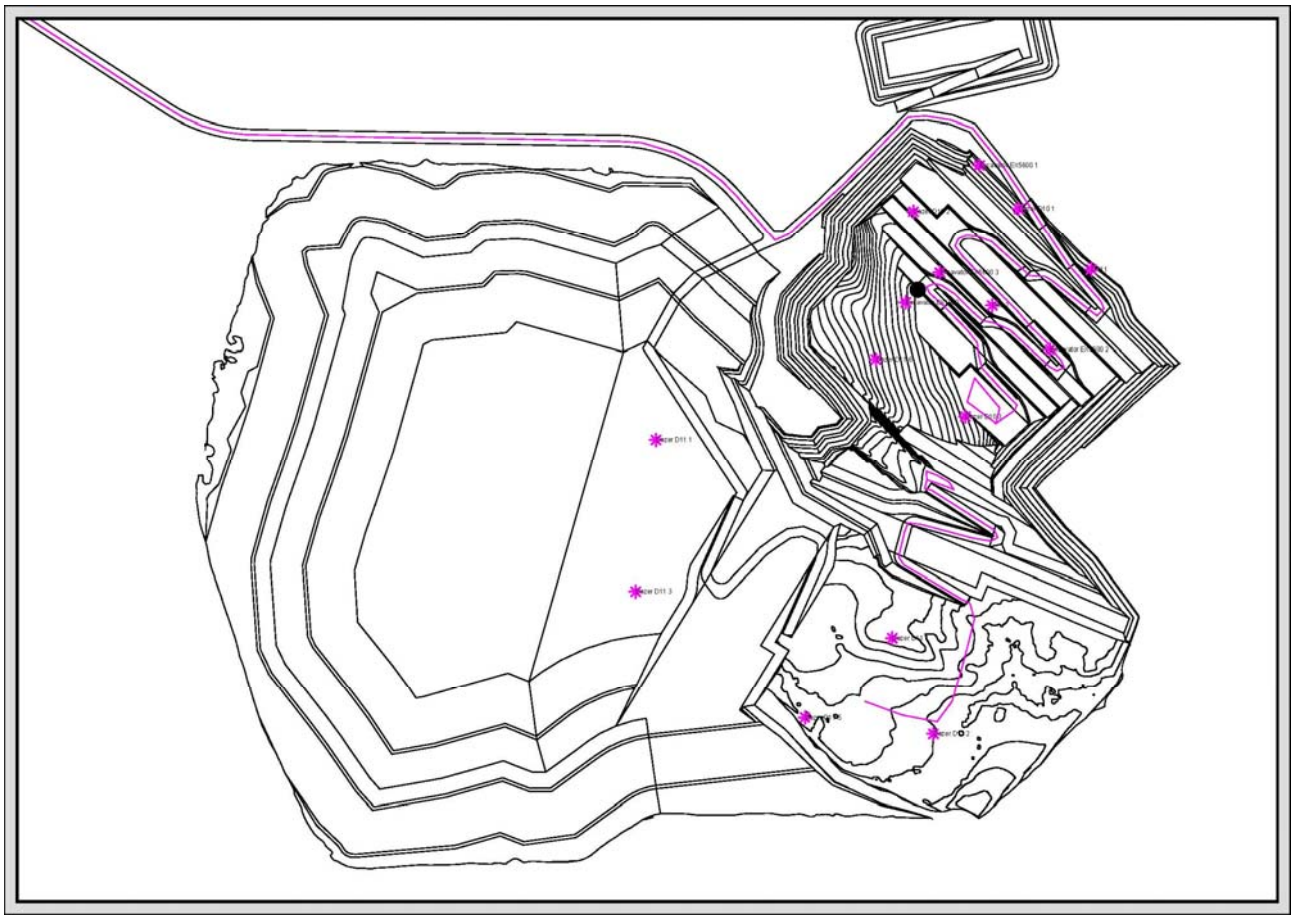

Figure D.2 Year 8 Equipment Locations

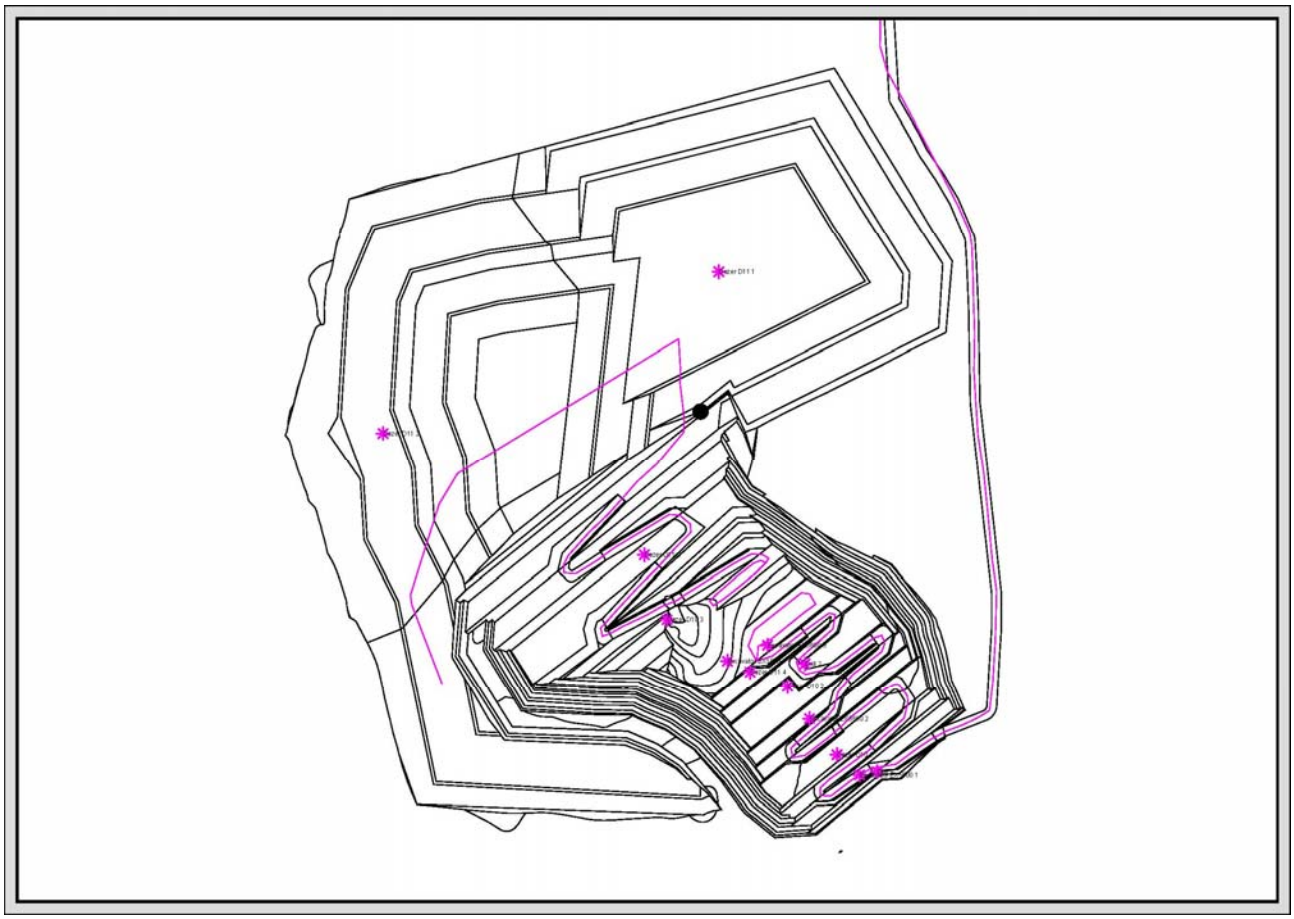

Figure D.3 Year 15 Equipment Locations

Appendix E Predicted Mining Noise Contours

The predicted mining noise contour figures are summarised in **Table E.1**.

Table E.1 Noise Contour Figure Summary

Figure #	Mining Year	Mine Only/Mine & Rail Loadout	Meteorological Scenario
E.1	2	Mine Only	Night Adverse
E.2	2	Mine & Rail Loadout	Night Adverse
E.3	8	Mine Only	Night Adverse
E.4	8	Mine & Rail Loadout	Night Adverse
E.5	15	Mine Only	Night Adverse
E.6	15	Mine & Rail Loadout	Night Adverse
E.7	2	Mine Only	Day Neutral
E.8	2	Mine & Rail Loadout	Day Neutral
E.9	8	Mine Only	Day Neutral
E.10	8	Mine & Rail Loadout	Day Neutral
E.11	15	Mine Only	Day Neutral
E.12	15	Mine & Rail Loadout	Day Neutral

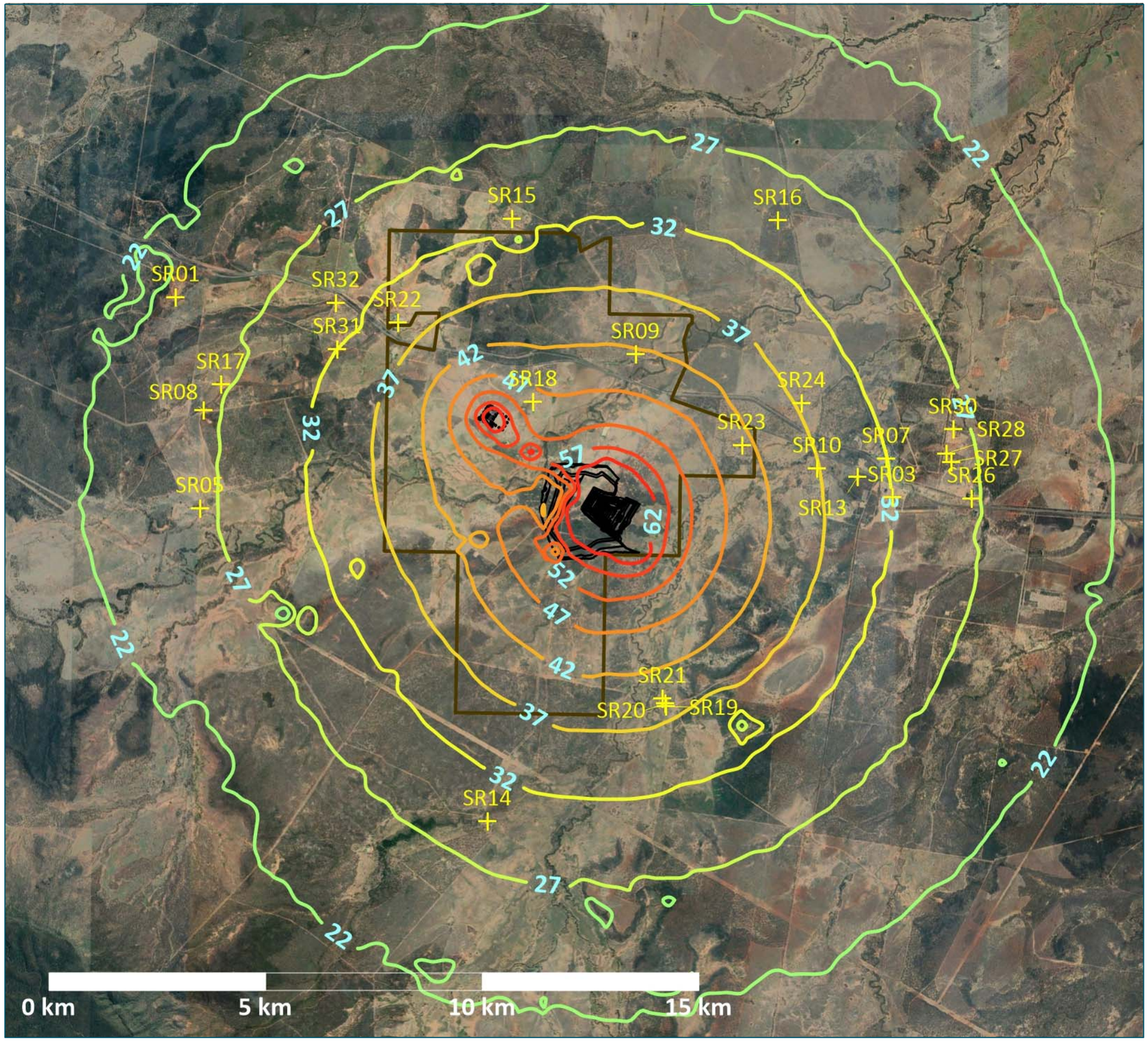

Figure E.1 Year 2 Mine Only Night Adverse

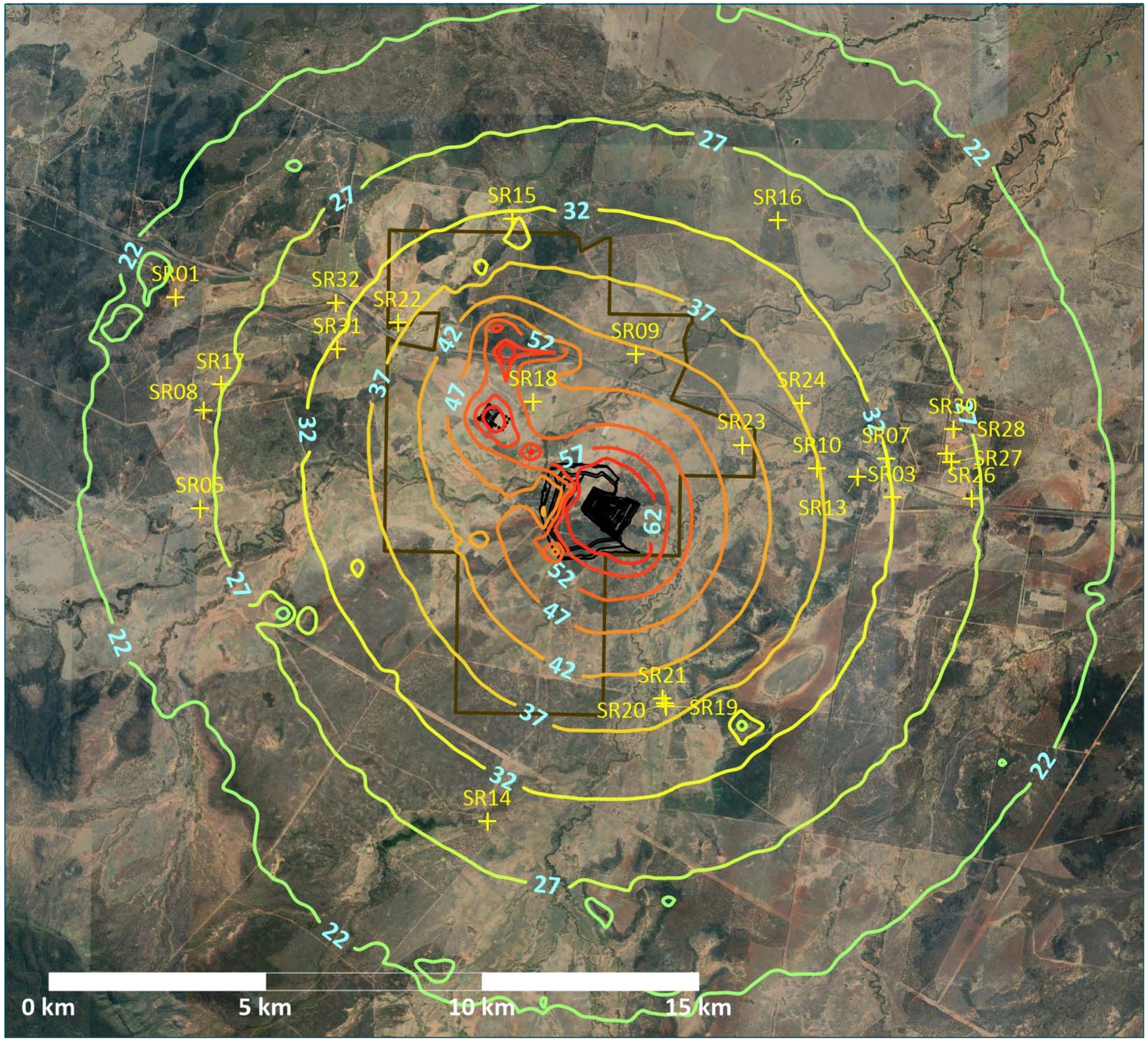

Figure E.2 Year 2 Mine & Rail Loadout Night Adverse

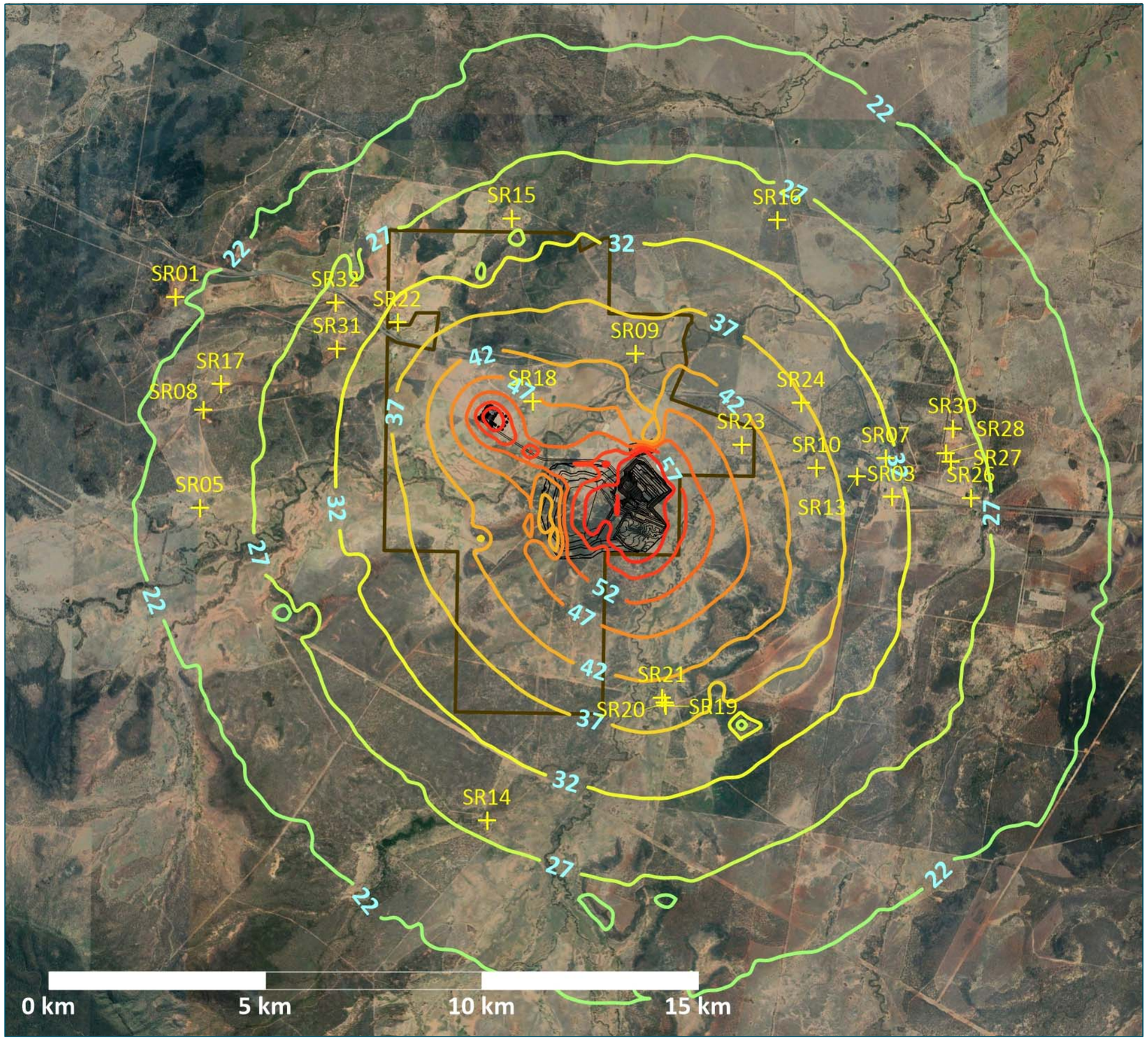

Figure E.3 Year 8 Mine Only Night Adverse

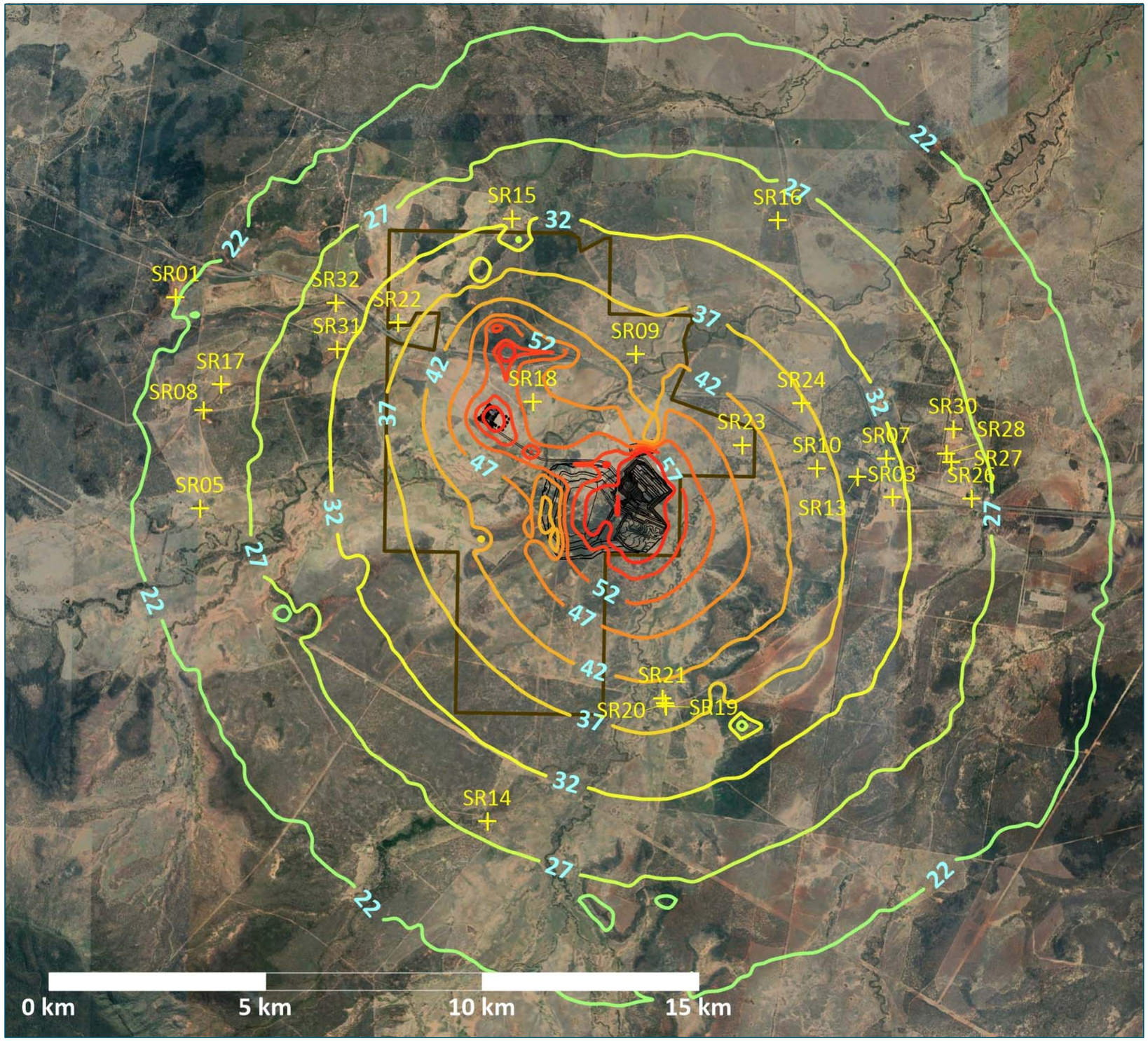

Figure E.4 Year 8 Mine & Rail Loadout Night Adverse

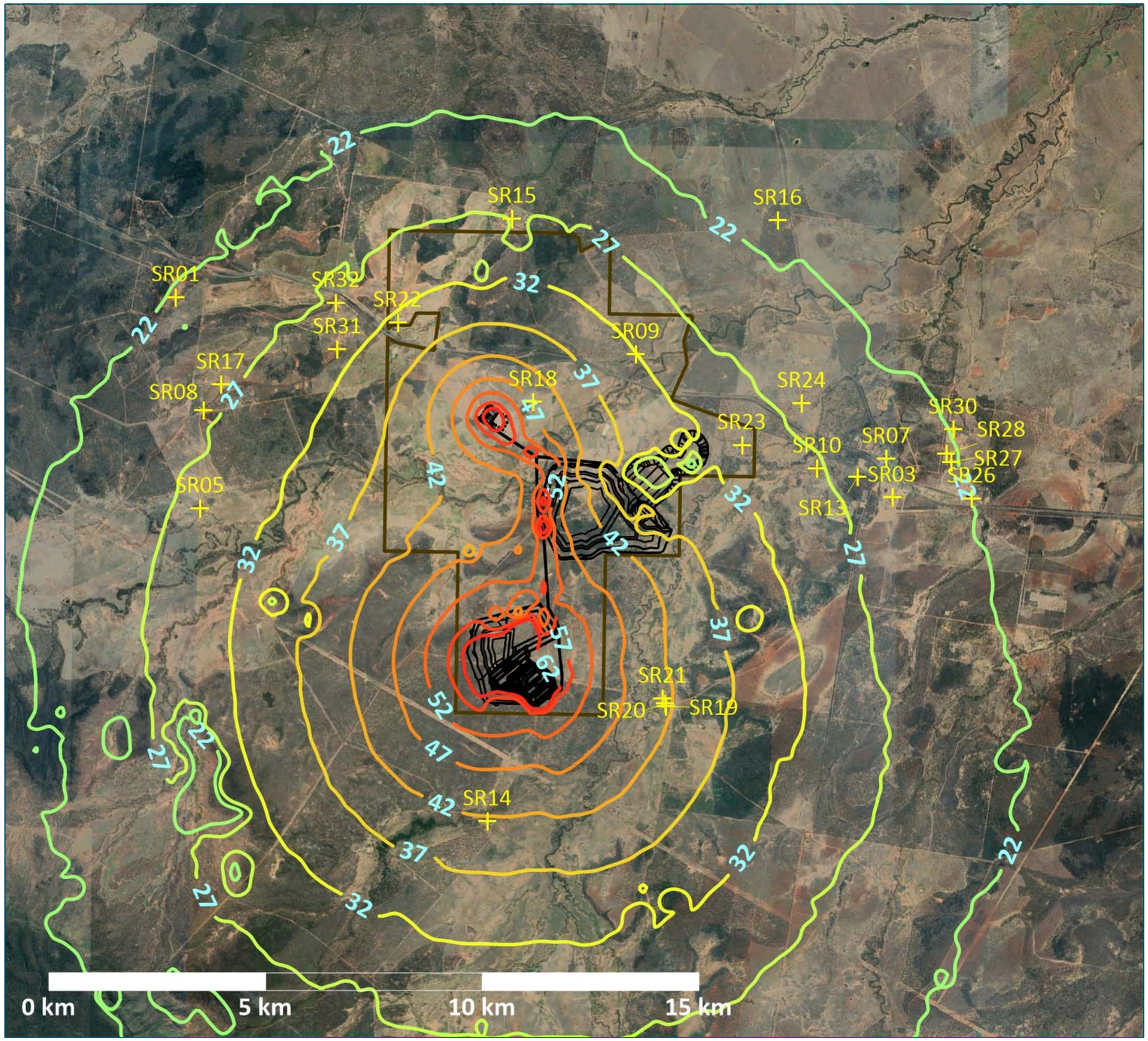

Figure E.5 Year 15 Mine Only Night Adverse

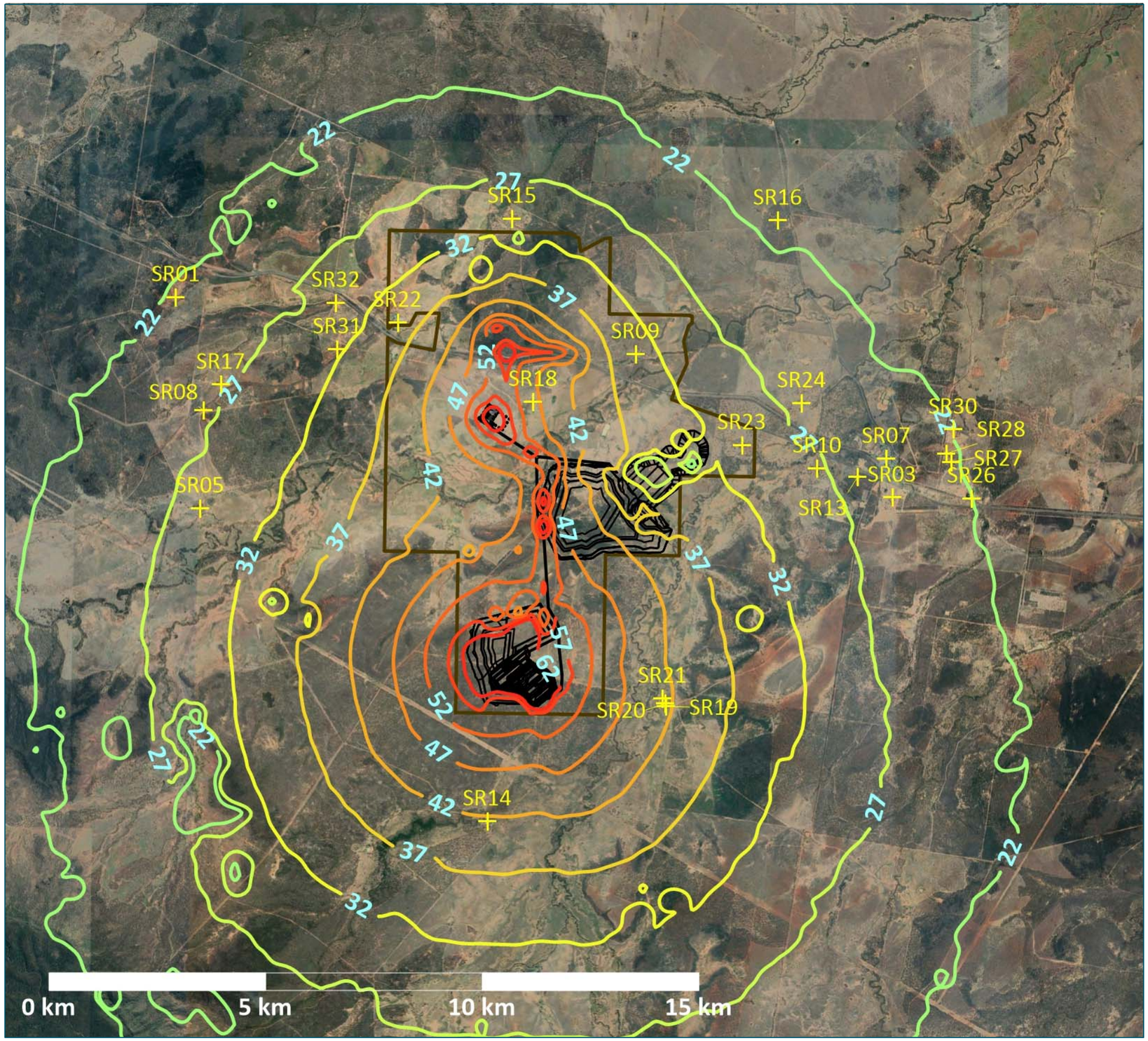

Figure E.6 Year 15 Mine & Rail Loadout Night Adverse

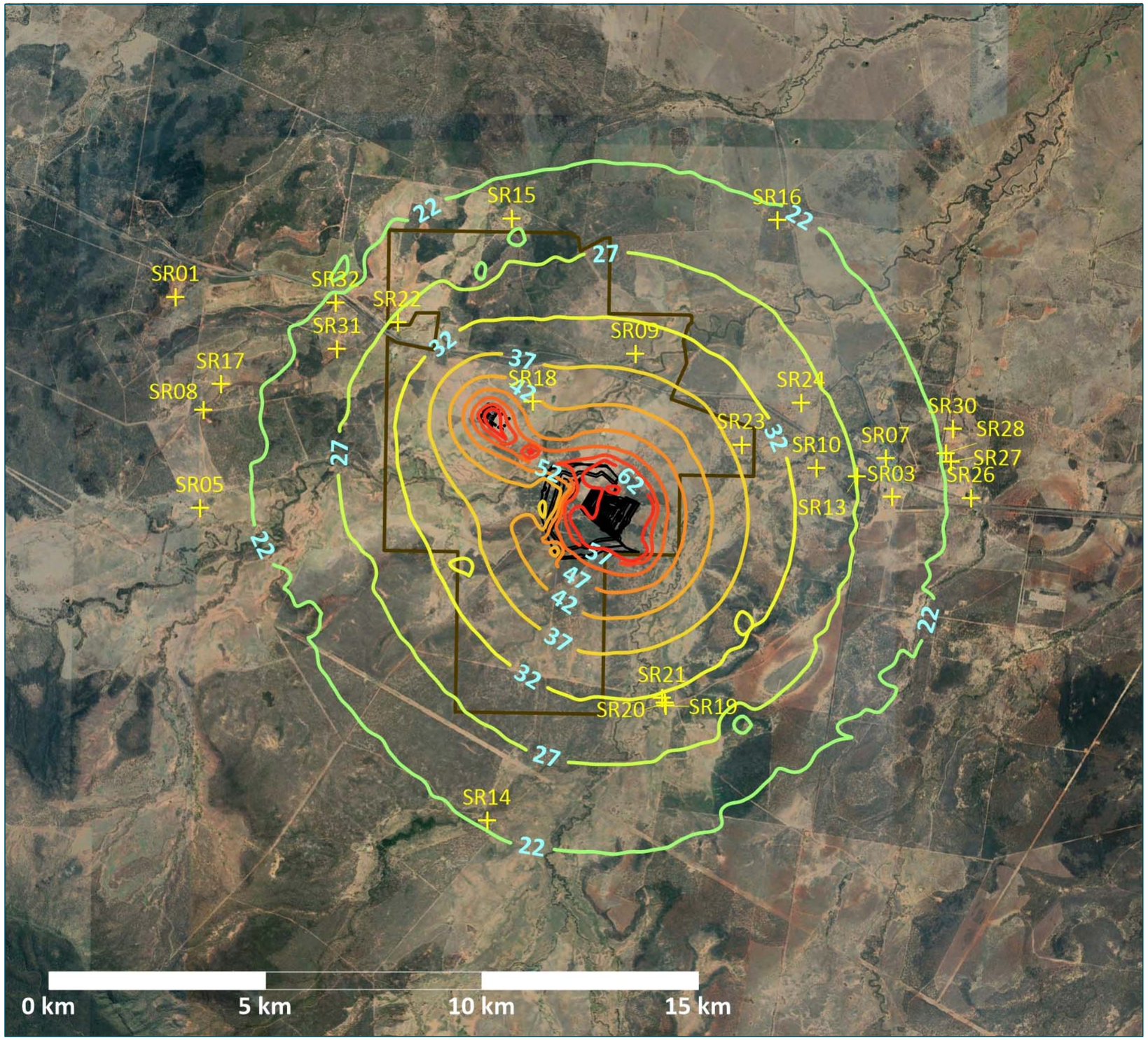

Figure E.7 Year 2 Mine Only Day Neutral

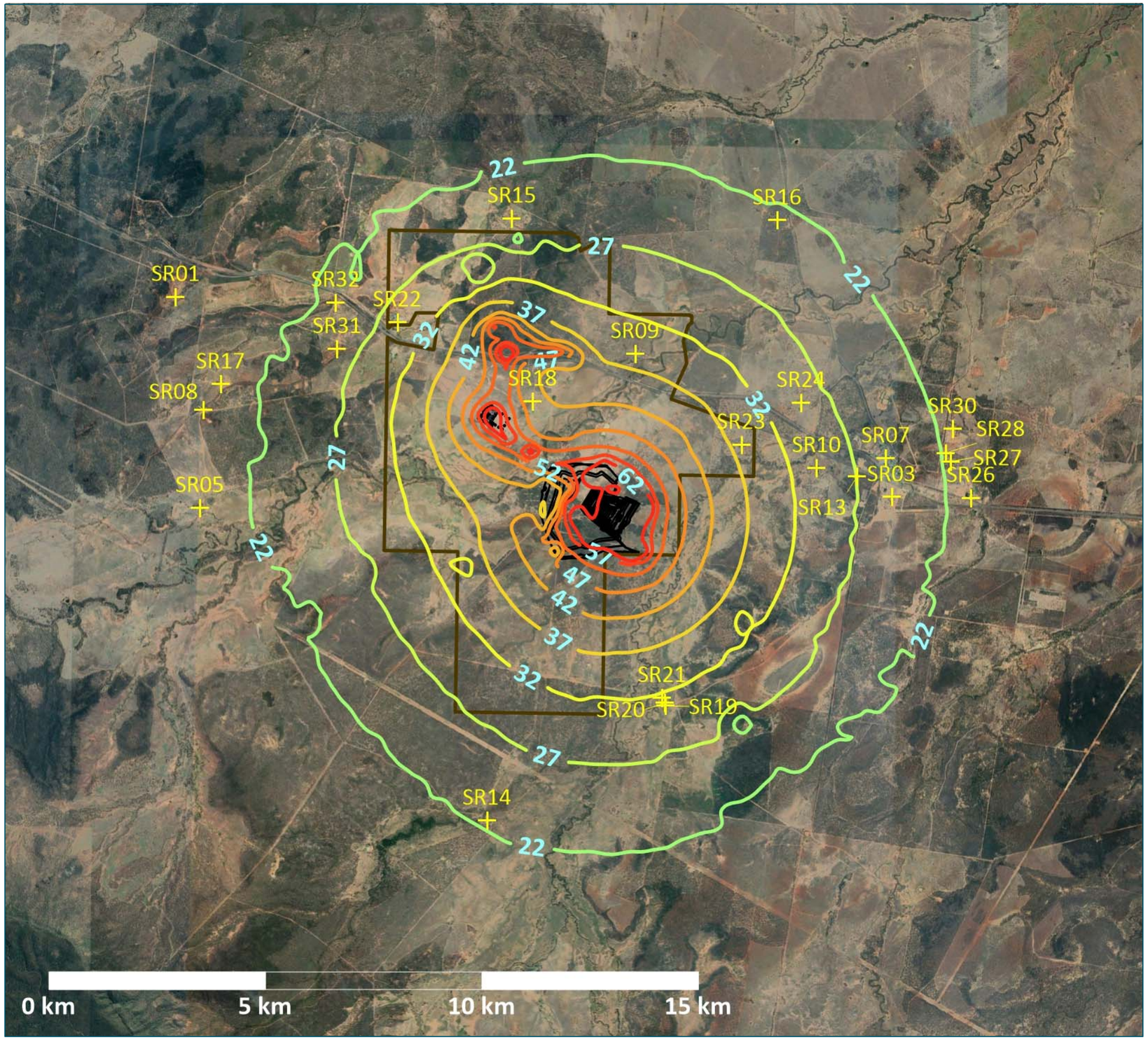

Figure E.8 Year 2 Mine & Rail Loadout Day Neutral

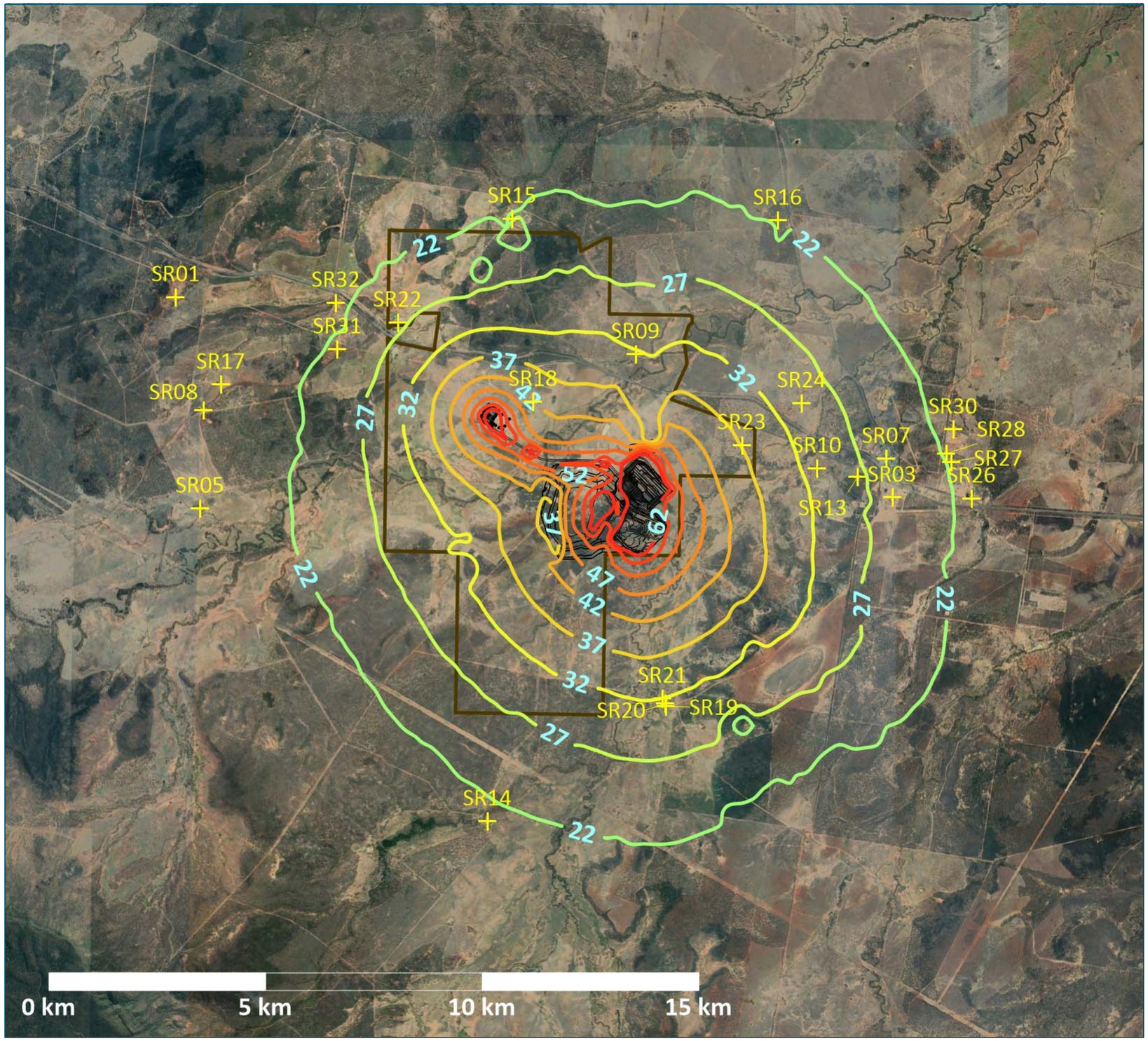

Figure E.9 Year 8 Mine Only Day Neutral

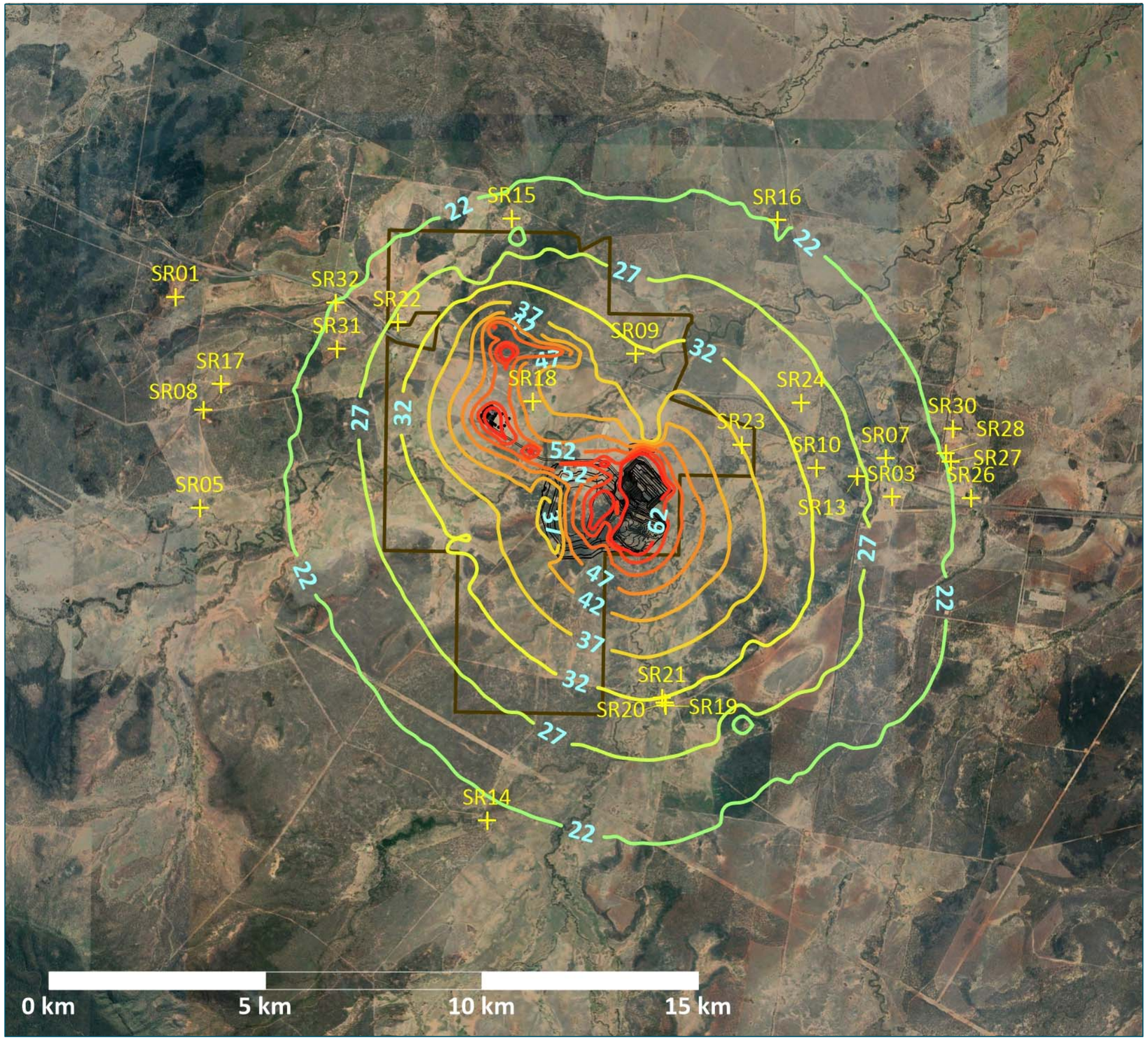

Figure E.10 Year 8 Mine & Rail Loadout Day Neutral

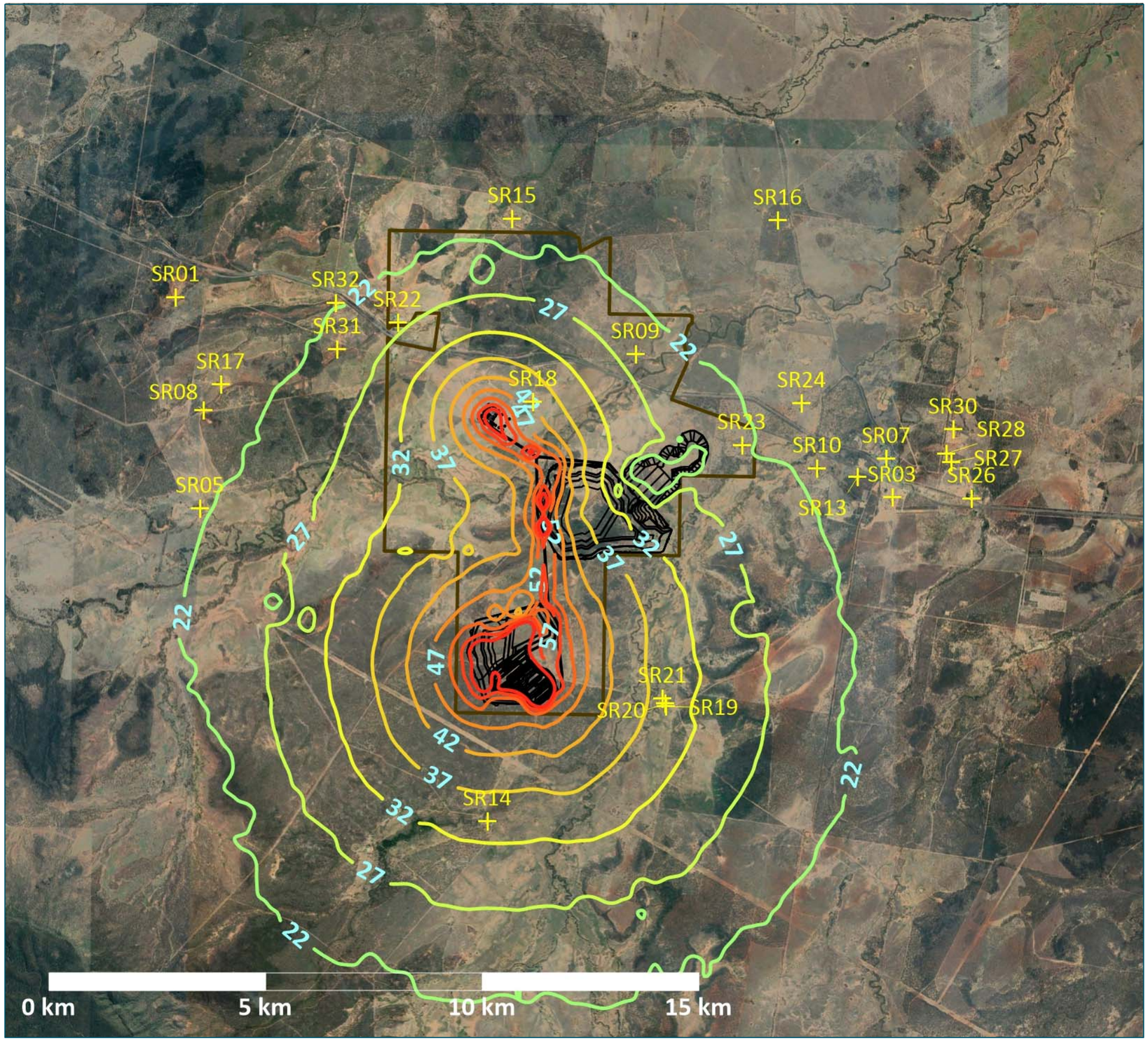

Figure E.11 Year 15 Mine Only Day Neutral

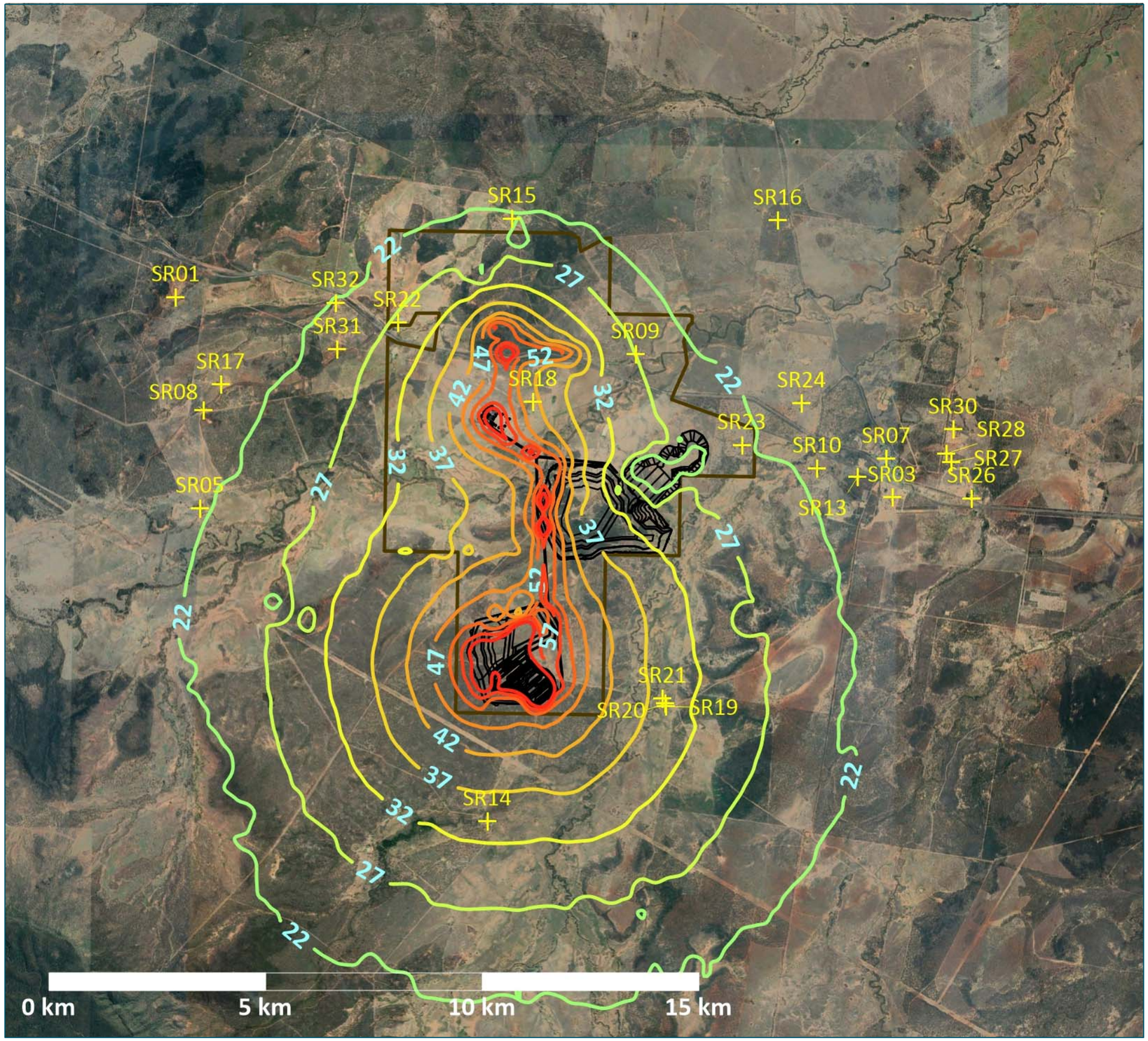

Figure E.12 Year 15 Mine & Rail Loadout Day Neutral