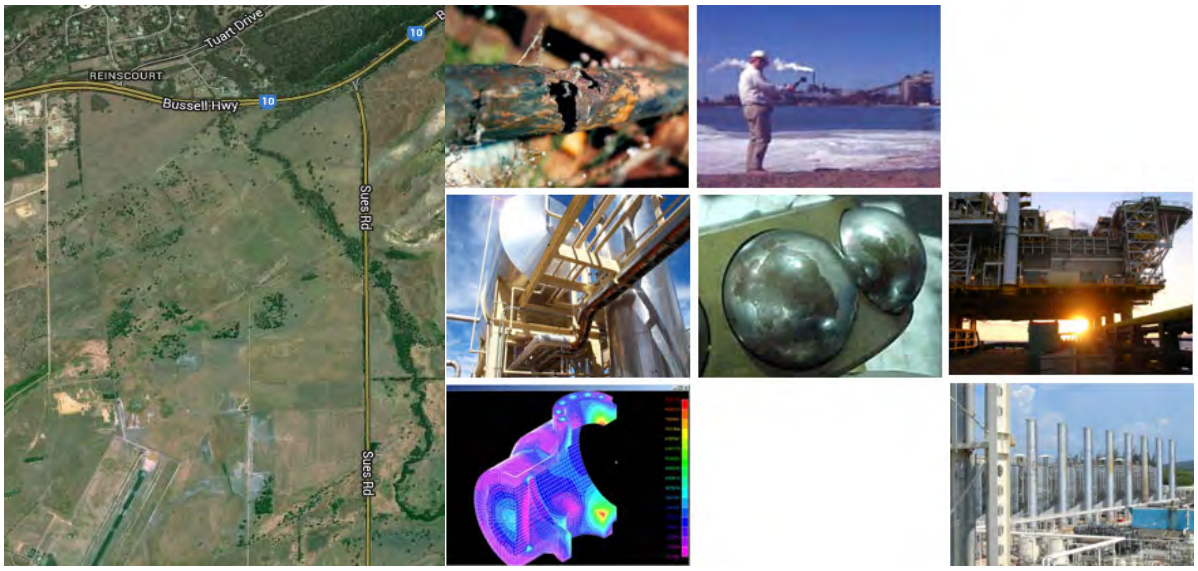
SVT ENGINEERING CONSULTANTS

ENVIRONMENTAL NOISE IMPACT ASSESSMENT FOR THE PROPOSED WONNERUP SOUTH MINING OPERATIONS



CABLE SANDS (WA) PTY LTD

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EXECUTIVE SUMMARY

SVT has been requested by Cable Sands (WA) Pty Ltd (Cable Sands) to undertake an environmental noise impact assessment of its proposed mining operations at Wonnerup South (M70/785). The proposed mine site is located approximately 5 km to the southeast of Busselton and approximately 190 km south of Perth. The proposed mine, situated on the corner of Bussell Highway and Sues Road, is an extension to the adjacent Wonnerup mine site to the east. The Busselton Regional Airport is located immediately to the southwest.

Acoustical Modelling

An acoustic model for the proposed mining activities has been developed using SoundPlan v7.1 and used to predict noise levels at the closest noise sensitive premises to the proposed mine site for day and night time operations under both worst-case and calm meteorological conditions. In addition, noise contours for the worst-case meteorological conditions have also been provided.

To achieve compliance with the *Environmental Protection (Noise) Regulations 1997* (the *Regulations*), the Wonnerup South mining plan has been developed in consultation with SVT in an iterative process throughout the entire project. Eight initial operating scenarios have been modelled without/with noise bunds proposed at locations along the edges of mining pits and/or close to residences R6 and R7. Four operating scenarios (one construction and three mining scenarios, with bunds) have been developed based on the initial modelling results, as shown in Table A below.

Table A: Operating scenarios.

Phase	Scenarios	Activities	Operating Time
Construction	S1	Construction	Day (Monday to Saturday)
Ore Mining	S2	Initial mining in southwest pit	Day/Evening/Night
	S3	Mining south end of main pit	
	S4	Mining in northeast of main pit	

Table B lists the proposed equipment. Appendix B indicates the operating locations of mobile equipment and fixed plant. These operating locations are provided by Cable Sands, and represent actual and typically worst-case positioning for each scenario for purposes of modelling.

Table B: Proposed equipment.

Equipment	S1	S2		S3		S4	
	Days	Days	Evenings Nights	Days	Evenings Nights	Days	Evenings Nights
Wet Plant		1	1	1	1	1	1
Trommels (pair)		1	1	1	1	1	1
Diesel Pumps	4	3		3		2	
Booster Pumps		10	10	9	9	8	8
Electric Pumps		3	3	3	3	3	3
Scrapers	≤10	2					
Watercart	1	1		1		1	
Grader	1	1		1		1	
Loaders		1	1	1	1	1	1
Dozers	2	1		2		1	
Excavators	2						

Modelling Results

Noise levels at the 13 closest noise sensitive premises have been predicted for worst-case and calm day/night time meteorological conditions. Residences R6 and R7 are located in the same property as the proposed mine site, which is accessed on an agreement with the owners and occupiers.

A tonality assessment in received noise levels has been undertaken based on the dominating noise sources and their noise emission contributions. It is shown that tonality is likely to be evident at some of closest residential locations under some operating conditions.

Table C summarizes the point modelling results for worst-case day and night-time meteorological conditions. The results have been adjusted by adding 5 dB if tonality is likely to be evident in the received noise and the adjusted values are expressed in ***bold italic***. Comparison of day and night-time noise levels shows that the day-time noise level is much higher than the night-time noise level at the closest residences. This is because the majority of the mobile equipment is not operating during night shift except for one loader operating in close proximity to the trommels.

Table C: Summary of worst-case noise levels in dB(A) including tonality adjustments.

Closest Residences	S1	S2		S3		S4	
	Days	Days	Nights	Days	Nights	Days	Nights
R1	***42.8***	***39.7***	19.7	29.1	19.1	25.4	18.3
R2	***43.8***	***39.9***	19.9	29.7	20.0	26.5	19.1
R3	***43.8***	31.9	19.2	30.0	21.2	28.9	21.1
R4	***47.2***	***39.5***	22.7	33.7	24.9	33.3	25.2
R5	***45.5***	33.0	22.7	32.5	24.5	32.7	24.8
R6	***50.7***	30.1	21.9	29.5	22.8	31.8	23.0
R7	***53.9***	33.0	24.8	33.4	26.6	35.5	26.6
R8	31.2	29.8	17.2	29.9	18.3	30.5	17.9
R9	32.0	30.6	15.5	30.8	17.2	31.2	16.4
R10	34.7	33.5	17.8	33.8	19.9	34.2	19.0
R11	***40.4***	29.1	18.0	30.0	19.7	30.0	19.3
R12	***41.8***	27.9	19.3	29.4	20.6	28.1	19.8
R13	34.4	30.2	21.3	26.1	17.1	21.8	15.5

Compliance Assessment

Construction Operations

The predicted worst-case noise level from construction activities is below the day-time assigned noise levels at most of the closest noise sensitive premises except at R5, where a half decibel exceedance is predicted. However, according to item 13 of the *Regulations*, no assigned noise levels apply for the construction period (scenario S1) at noise-sensitive premises, as long as "*the construction work is carried out in accordance with control of environmental noise practices set out in section 6 of AS 2436-1981 Guide to Noise control on Construction, Maintenance and Demolition Sites*".

Mining Operations

The noise levels for evening time are not predicted and should be close to but not greater than the night noise levels because the same mining equipment is used.

Tables D and E present comparisons between the assigned noise levels and the adjusted worst-case noise levels in dB(A) at the 13 closest residential locations. The values expressed in ***bold***

italic in Table D are the adjusted values, which have added the 5dB tonality adjustment. Both tables indicate that the adjusted worst-case noise levels from any of the proposed mining operations are below the assigned noise levels at all closest noise sensitive premises. It can be concluded that full compliance will be achieved for all proposed mining operations.

Table D: Comparison between day-time assigned noise levels and day-time adjusted worst-case noise levels.

Closest Residences	Day-time Assigned Noise Levels in dB(A)		Adjusted Worst-case Day-time Noise Levels in dB(A)		
	Mondays to Saturdays	Sundays & Public Holidays	S2	S3	S4
R1	45	40	***39.7***	29.1	25.4
R2	45	40	***39.9***	29.7	26.5
R3	45	40	31.9	30.0	28.9
R4	48	43	***39.5***	33.7	33.3
R5	45	40	33.0	32.5	32.7
R6	61	56	30.1	29.5	31.8
R7	64	59	33.0	33.4	35.5
R8	46	41	29.8	29.9	30.5
R9	46	41	30.6	30.8	31.2
R10	51	46	33.5	33.8	34.2
R11	46	41	29.1	30.0	30.0
R12	45	40	27.9	29.4	28.1
R13	45	40	30.2	26.1	21.8

Table E: Comparison between evening/night-time assigned noise levels and adjusted worst-case noise levels.

Closest Residences	Assigned Noise Levels in dB(A)		Adjusted Worst-case Noise Levels in dB(A)		
	Evenings	Nights	S2	S3	S4
R1	40	35	19.7	19.1	18.3
R2	40	35	19.9	20.0	19.1
R3	40	35	19.2	21.2	21.1
R4	43	38	22.7	24.9	25.2
R5	40	35	22.7	24.5	24.8
R6	56	51	21.9	22.8	23.0
R7	59	54	24.8	26.6	26.6
R8	41	36	17.2	18.3	17.9
R9	41	36	15.5	17.2	16.4
R10	46	41	17.8	19.9	19.0
R11	41	36	18.0	19.7	19.3
R12	40	35	19.3	20.6	19.8
R13	40	35	21.3	17.1	15.5

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1. INTRODUCTION

SVT has been requested by Cable Sands (WA) Pty Ltd (Cable Sands) to undertake an environmental noise impact assessment for proposed mining operations at Wonnerup South (M70/785). The noise emission from the existing mining operations in Wonnerup had been modelled by SVT and the modelling results are presented in previous SVT reports[1,2]. The proposed mine, situated on the corner of Bussell Highway and Sues Road, is an extension to the adjacent Wonnerup mine site to the east. The Busselton Regional Airport is located immediately to the southwest.

The objectives of this assessment are to determine whether or not the noise emissions from the proposed mining operations would result in noise levels exceeding the noise limits (assigned noise levels) imposed under the *Environmental Protection (Noise) Regulations 1997* (the *Regulations*) at the closest noise sensitive premises.

To achieve compliance with the *Regulations* or to minimise the potential for non-compliance, the Wonnerup South mining plan has been developed in consultation with SVT in an iterative process throughout the entire project. Eight initial operating scenarios had been modelled without/with noise bunds proposed at locations along the edges of mining pits and/or close to residences R6 and R7. This report represents the environmental noise impact assessment for the developed (final) mining plan for the Wonnerup South mine.

Figure 1 in Appendix A provides an aerial view of the proposed mine site and surrounding area including the closest residences of interest and noise logging locations. Figure 2 presents the proposed mine site layout while Figure 3 shows the proposed mining schedule.

[1] "Environmental noise impact assessment for the proposed Wonnerup Mine" SVT report (NO: Rpt01-0952333-Rev 0-19 April 2011).

[2] "Environmental noise impact assessment for the Updated Wonnerup Mine Operations" SVT Report (NO: Rpt01-1253601-Rev 0- 3 February 2012).

2. NOISE CRITERIA

Noise management in Western Australia is implemented through the *Environmental Protection (Noise) Regulations 1997* which operate under the Environmental Protection Act 1986. The Regulations specify maximum noise levels (assigned noise levels) which are the highest noise levels that can be received at noise-sensitive (residential), commercial and industrial premises.

Assigned noise levels have been set differently for noise sensitive premises, commercial premises, and industrial premises. For noise sensitive premises, ie residences, an "influencing factor" is incorporated into the assigned noise levels. The influencing factor depends on land use zonings within circles of 100 metres and 450 metres radius from the noise receiver, including:

- the proportion of industrial land use zonings;
- the proportion of commercial zonings; and
- the presence of major roads.

For noise sensitive residences, the time of day also affects the assigned levels.

The regulations define three types of assigned noise level:

- L_{Amax} assigned noise level means a noise level which is not to be exceeded at any time;
- L_{A1} assigned noise level which is not to be exceeded for more than 1% of the time;
- L_{A10} assigned noise level which is not to be exceeded for more than 10% of the time.

The L_{A10} noise limit is the most significant for this study since this is representative of continuous noise emissions from the mine site.

Table 2-1 below presents the assigned noise levels for noise-sensitive premises.

Table 2-1: Table of assigned noise levels in dB(A)

Type of premises receiving noise	Time of day	Assigned Noise Levels dB(A)		
		$L_{A\,10}$	$L_{A\,1}$	$L_{A\,max}$
Noise sensitive premises at locations within 15 metres of a building directly associated with a noise sensitive use	0700 to 1900 hours Monday to Saturday	45+ influencing factor	55+ influencing factor	65+ influencing factor
	0900 to 1900 hours Sundays and public holidays	40+ influencing factor	50+ influencing factor	65+ influencing factor
	1900 to 2200 hours all days	40+ influencing factor	50+ influencing factor	55+ influencing factor
	2200 - 0700 hours on any day Monday to Saturday & 2200 - 0900 hours Sunday and public holidays	35+ influencing factor	45+ influencing factor	55+ influencing factor
Noise sensitive premises at locations further than 15 metres from a building directly associated with a noise sensitive use	All hours	60	75	80
Commercial premises	All hours	60	75	80
Industrial and utility premises	All hours	65	80	90

Corrections for Characteristic of Noise

Noise levels at the receiver are required to be adjusted if the noise exhibits intrusive or dominant characteristics, i.e. if the noise is impulsive, tonal, or modulating. Table 2-2 presents the adjustment incurred for noise that exhibits intrusive or dominant characteristics. That is, if the noise is assessed as having tonal, modulating or impulsive characteristics, then the measured or predicted noise levels are adjusted by the amounts given in Table 2-2. The adjusted noise levels must now comply with the assigned noise levels. *Regulation* 9 sets out objective tests to assess whether the noise is taken to be free of these characteristics.

Table 2-2: Adjustments for intrusive or dominant noise characteristics.

Adjustment where noise emission is not music These adjustments are cumulative to a maximum of 15 dB		
Where tonality is present	Where modulation is present	Where impulsiveness is present
+5 dB	+5 dB	+10 dB

A tonality assessment on noise emissions from the proposed mining activities is undertaken in Section 6.1 based on the point modelling results for each mining scenario at the closest noise sensitive receiver locations.

Influencing Factors

Influencing factors vary from residence to residence depending on the surrounding land use. Thirteen of the nearest noise sensitive (residential) locations surrounding the proposed mine site have been selected for detailed assessment of noise impacts. These residential locations are shown in Figure 1 in Appendix A. The Wonnerup mine site and the proposed Wonnerup South mine site are classified as industrial land. Four of the residences considered in the acoustic model (R1 to R3 & R13) are more than 450m away from the boundaries of the Wonnerup and its South mine sites, while two of them (R6 and R7) fall inside the proposed South Mine site boundaries. The calculated influencing factor ranges from 0 dB to 19 dB at the selected residential locations according to the *Regulations*.

Traffic Factors

According to the traffic flow data of WA Main Roads the nearby Bussell Highway is classified as the secondary road. Residence R4 is approximately 70m from Bussell Highway and the others are more than 100m away from Bussell Highway. The traffic factor is 2 dB for R4 and 0 for the other residences.

Table 2-3 presents the calculated assigned noise levels at the 13 selected residential locations close to the proposed mine site.

Table 2-3: Assigned noise levels (L_{A10}) in dB(A)

Closest Residences	Traffic Factor in dB	Influencing Factor in dB	Assigned Noise levels (L_{A10}) in dB(A)		
			Mondays to Saturdays	Public Holidays, Sundays and Evenings	Nights
R4	2	1	48	43	38
R6	0	16	61	56	51
R7	0	19	64	59	54
R8, R9 & R11	0	1	46	41	36
R10	0	6	51	46	41
Other Residences	0	0	45	40	35

3. BACKGROUND NOISE ASSESSMENT

Background noise levels were monitored for a period of three months at two selected locations from 5 December 2012 to 1 March 2013. The detailed logged noise and weather data are presented in SVT report "Wonnerup Environmental Noise Logging Baseline" (SVT report NO: 1253780 5 March 2013).

Two monitoring locations were selected, as shown as blue dots in Figure 1 in Appendix A. Logger 1 was close to residence R6.

At each monitoring location the noise monitoring equipment was set to continuously record L_{A1}, L_{A10} and L_{A90} noise levels at 15 minute intervals, where:

L_{A1} is the noise level exceeded for 1 % of the time;

L_{A10} is the noise level exceeded for 10 % of the time; and

L_{A90} is the noise level exceeded for 90 % of the time.

"L_{90}" of the L_{A90} noise levels has been analyzed for the day, evening and night-time periods, and is presented in Table 3-1 below. This data provides an indication of the local ambient noise levels.

Table 3-1: L_{90} of L_{A90} for background noise levels measured at the selected logging locations.

Logging Locations	L_{90} of measured L_{A90} in dB(A)		
	Day	Evening	Night
Logger 1 (R6)	36	27	22
Logger 2	33	33	27

The daytime ambient noise level at location of logger 1 is higher than at logger 2 because of the proximity of the Bussell Highway (approximately 200 m from the monitoring position), but lower for evening and night-time periods. There is also some correlation between underlying background levels (L_{A90}) and wind speed.

4. NOISE MODELLING

4.1 Methodology

An acoustic model has been developed using SoundPlan v7.1 program developed by SoundPLAN LLC. This program calculates sound pressure levels at nominated receiver locations or produces noise contours over a defined area of interest around the noise sources. SoundPlan can be used to model different types of noises, such as industrial noise, traffic noise and aircraft noise, and it has been recognised internationally including in Australia. The inputs required in SoundPlan are noise source data, ground topographical data, meteorological data and receiver locations.

SoundPlan provides a range of prediction algorithms that can be selected by the user. The CONCAWE[3,4] prediction algorithm was selected for the previous noise modelling of Wonnerup mining operations and it has been selected for this study. The acoustic model has been used to generate noise contours for the area surrounding the mine site and also to predict noise levels at the nearby noise sensitive (residential) locations.

The acoustic model does not include noise emissions from any source other than the proposed mining operations. Therefore, noise emissions from other neighbouring mining activities and industrial sources, road traffics, aircraft noise, animals, domestic sources, etc are excluded from the modelling.

4.2 Modelling Scenarios

To achieve compliance with the *Regulations*, the Wonnerup South mining plan has been developed in consultation with SVT in an iterative process throughout the entire project. Eight initial operating scenarios have been modelled without/with noise bunds proposed at locations along the edges of mining pits and/or close to residences R6 and R7. Four worst-case operating scenarios, as shown in Table 4-1 below, have been developed based on the initial modelling results. Scenario S1 represents the construction phase while scenarios S2 to S4 represent the mining operations.

Table 4-1: Operating scenarios considered in the acoustic model.

Phase	Scenario	Activities	Operating Time
Construction	S1	Construction	Day (Monday to Saturday)
Mining Operations	S2	Initial mining in southwest pit	Day/Evening/Night
	S3	Mining south end of main pit	
	S4	Mining in northeast of main pit	

[3] CONCAWE (Conservation of Clean Air and Water in Europe) was established in 1963 by a group of oil companies to carry out research on environmental issues relevant to the oil industry.

[4] *The propagation of noise from petroleum and petrochemical complexes to neighbouring communities,* CONCAWE Report 4/81, 1981

Cable Sands has advised:

- During the construction period, there is no fixed plant (Wet Plant, electric pumps and trommels) operating in the Wonnerup South mine site but mobile equipment and diesel pumps will be operating during day-time (Monday to Saturday) hours only.
- During mining periods in scenarios S2 to S4 the fixed plant (Wet Plant, electric pumps and trommels) is assumed to be operating 24 hours per day, 7 days a week. During evenings and nights of the mining periods, Diesel pumps, Dozer, Watercart and Grader will not be operated.

Table 4-2 presents the proposed equipment and its number. Figures 4 to 7 in Appendix B indicate the operating locations of mobile equipment and fixed plant. These operating locations are provided by Cable Sands, and represent actual and typically worst-case positioning for each scenario for purposes of modelling.

Table 4-2: Proposed equipment.

Equipment	S1	S2		S3		S4	
	Days	Days	Evenings Nights	Days	Evenings Nights	Days	Evenings Nights
Wet Plant		1	1	1	1	1	1
Trommels (pair)		1	1	1	1	1	1
Diesel Pumps	4	3		3		2	
Booster Pumps		10	10	9	9	8	8
Electric Pumps		3	3	3	3	3	3
Scrapers	≤10	2					
Watercart	1	1		1		1	
Grader	1	1		1		1	
Loaders		1	1	1	1	1	1
Dozers	2	1		2		1	
Excavators	2						

4.3 Input Data

4.3.1 Ground Topography

Topographical information for the noise model was provided by Cable Sands in Auto-CAD dxf file format. An absorptive ground is assumed for the land surrounding the proposed mining operations while a totally reflective surface is assumed for the sea and rivers in the acoustic model.

4.3.2 Noise Sensitive Premises

The locations of noise sensitive premises have been provided by Cable Sands in Auto-CAD dxf-file format. Figure 1 in Appendix A shows the 13 representative residences close to the proposed Wonnerup South mine site.

Residences R6 and R7 are located in the same property as the proposed mine site, which is accessed on an agreement with the owners and occupiers.

4.3.3 Source Sound Power Levels

In June 2012 and May 2013 SVT measured the sound power levels of mobile equipment which are intended to be operated on the proposed mine site. In order to select quieter machines for the mining operations more machines were tested than required. During the measurements, it was noticed that the two new loaders have lower noise emission levels due to exhaust and engine modifications.

Cable Sands has advised that the quieter machines will be selected for their proposed mining operations. Table 4-3 presents the measured L_{A10} sound power levels for the proposed mining equipment and fixed plant.

Table 4-3. L_{A10} sound power levels for proposed fixed plant and mobile equipment.

Names	Octave Frequency Band Sound Power Levels in dB(A)								Overall
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	dB(A)
Wet Plant	77.6	84.1	86.8	94.0	96.1	95.3	91.7	83.7	**101**
Trommels (pair)	82.7	86.9	91.4	97.5	99.4	100.2	99.5	95.6	**106**
Diesel Pump	94.8	96.5	95.4	98.3	102.3	100	95.6	89.6	**107**
Booster Pump	72.4	77.0	76.1	82.5	84.3	82.5	79.1	74.5	**89**
Electric Pump	64.0	71.5	70.8	80.7	80.3	79.0	76.6	73.3	**86**
Scrapers	81.1	101.2	99.9	106.3	108.4	106.7	102.6	93.0	**113**
Watercart for Construction	72.8	90.7	97.5	107.7	108.7	106.5	101.3	91.0	**113**
Watercart for Mining	74.8	90.0	95.6	96.8	106.2	105.1	96.8	90.4	**110**
Grader	74.2	88.8	95.9	98.7	106.3	100.9	94.9	85.3	**109**
Dozer	79.3	99.0	96.1	103.4	104.6	104.2	99.3	91.1	**110**
Loader	74.6	92.5	93.1	94.9	96.7	94.1	88.5	83.4	**102**
Excavator for construction	74.4	92.1	96.9	94.2	96.1	92.7	89.7	80.5	**102**

4.4 Meteorology

SoundPlan calculates noise levels for defined meteorological conditions. In particular, temperature, relative humidity, wind speed and direction data are required as input to the model.

For the noise modelling SVT has used the worst case meteorological conditions suggested by the EPA (*Environmental Protection Act 1986*) Guidance note No 8 for assessing noise impact from new developments as the upper limit of the meteorological conditions investigated. Table 4-4 presents the worst-case meteorological conditions for noise emission from the proposed mining operations.

Table 4-4: Worst-case meteorological conditions for noise emission from the proposed mining operations

Time of day	Temperature Celsius	Relative Humidity	Wind speed	Pasquill Stability Category
Day (0700 --- 1900)	20° Celsius	50%	4 m/s	E
Evening (1900 --- 2200)	20° Celsius	50%	4 m/s	E
Night (2200 --- 0700)	15° Celsius	50%	3 m/s	F

Since the day and evening meteorological conditions are the same, only the day-time and night-time conditions have been considered in the model.

5. MODELLING RESULTS

5.1 Point Calculations

Point calculations have been performed at 13 of the closest residential locations, as shown in Figure 1 in Appendix A, for calm and worst-case day/night-time meteorological conditions given in Table 4-4.

Table 5-1 summarises the A-weighted noise levels predicted at the closest residential locations for the four operating scenarios under worst-case day and night-time meteorological conditions. The predicted worst-case day and night-time noise levels in dB(A) represent the maximum noise levels likely to be observed at the closest residential locations. It is shown that the predicted day-time noise level is higher than the night-time noise level at every one of the closest residences. This is because the majority of the mobile equipment is not operating during night shift except for loader, which will be operating in close proximity to the trommels. The results indicate that the day-time noise levels at residential locations are dominated by the emission from operating mobile mining equipment.

Table 5-1: Worst-case noise levels in dB(A) predicted at the closest residential locations.

Closest Residences	S1	S2		S3		S4	
	Days	Days	Nights	Days	Nights	Days	Nights
R1	37.8	34.7	19.7	29.1	19.1	25.4	18.3
R2	38.8	34.9	19.9	29.7	20.0	26.5	19.1
R3	38.8	31.9	19.2	30.0	21.2	28.9	21.1
R4	42.2	34.5	22.7	33.7	24.9	33.3	25.2
R5	40.5	33.0	22.7	32.5	24.5	32.7	24.8
R6	45.7	30.1	21.9	29.5	22.8	31.8	23.0
R7	48.9	33.0	24.8	33.4	26.6	35.5	26.6
R8	31.2	29.8	17.2	29.9	18.3	30.5	17.9
R9	32.0	30.6	15.5	30.8	17.2	31.2	16.4
R10	34.7	33.5	17.8	33.8	19.9	34.2	19.0
R11	35.4	29.1	18.0	30.0	19.7	30.0	19.3
R12	36.8	27.9	19.3	29.4	20.6	28.1	19.8
R13	34.4	30.2	21.3	26.1	17.1	21.8	15.5

The noise levels for evening time are not predicted and should be close to but not greater than the night-time noise levels because the same mining equipment is used.

Table 5-2 to Table 5-8 present the predicted noise levels in dB(A) at the closest residential locations for the four operating scenarios under calm and 8 worst-case cardinal wind directions. It can be seen from these tables that wind direction has a big impact on the predicted noise levels at any given receiving location for the same operating conditions. The day-time noise levels mainly depend on the operating locations of mobile mining equipment, while the night-time noise levels are influenced by the noise emission from either the mobile equipment (loader) or the fixed plant depending on the receiver locations.

Table 5-2: Day-time noise levels in dB(A) for scenario S1 for calm and 8 worst-case cardinal winds.

Closest Residences	Day-time noise levels in dB(A) for scenario S1 for calm and 8 worst-case cardinal winds								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	31.3	37.8	37.8	37.8	35.0	25.8	24.9	25.1	32.3
R2	29.8	38.5	38.8	38.8	37.5	27.8	25.9	25.9	33.3
R3	25.9	29.0	38.4	38.8	38.8	38.0	28.3	25.9	33.3
R4	29.0	30.2	39.6	42.1	42.2	42.0	35.8	29.3	36.7
R5	27.4	27.7	35.1	40.4	40.5	40.4	36.7	28.1	35.0
R6	32.7	33.8	42.7	45.6	45.7	45.4	40.4	33.2	40.4
R7	36.1	36.5	43.3	48.6	48.9	48.8	45.9	37.2	43.8
R8	19.8	18.8	18.8	23.0	31.2	31.0	31.0	30.2	25.3
R9	22.6	19.6	19.6	21.5	31.1	32.0	32.0	31.7	26.2
R10	27.1	21.8	21.7	23.3	32.4	34.7	34.7	34.6	29.0
R11	31.8	23.2	22.6	23.2	31.3	35.4	35.4	35.3	29.7
R12	34.5	25.2	23.9	24.0	29.5	36.8	36.8	36.8	31.2
R13	34.4	34.4	30.6	22.4	21.8	22.1	29.4	34.4	28.7

Table 5-3: Day-time noise levels in dB(A) for scenario S2 for calm and 8 worst-case cardinal winds.

Closest Residences	Day-time noise levels in dB(A) for scenario S2 for calm and 8 worst-case cardinal winds								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	25.1	34.3	34.7	34.7	34.1	24.4	22.1	22.1	29.4
R2	24.1	32.8	34.9	34.9	34.6	27.2	22.6	22.6	29.7
R3	19.4	22.6	30.3	31.9	31.9	31.5	23.6	19.4	26.6
R4	21.8	24.9	31.3	34.4	34.5	34.2	30.2	22.2	29.3
R5	20.4	24.0	28.2	33.0	33.0	32.6	30.2	21.1	27.9
R6	19.1	24.4	27.3	30.1	30.0	29.1	26.3	18.9	25.1
R7	22.5	27.0	29.8	33.0	32.8	32.2	29.4	22.0	28.3
R8	19.0	18.6	18.7	24.4	29.8	29.8	29.7	26.7	25.0
R9	25.1	18.7	18.5	19.0	27.4	30.5	30.6	30.6	25.6
R10	32.4	25.1	21.4	21.6	26.6	32.0	33.5	33.5	28.6
R11	27.2	25.3	17.6	17.1	22.7	26.8	29.0	29.1	23.9
R12	25.4	20.5	16.6	16.2	21.0	27.4	27.9	27.9	22.6
R13	30.2	30.1	22.0	18.1	18.1	19.3	29.0	30.2	24.8

Table 5-4: Night-time noise levels in dB(A) for scenario S2 for calm and 8 worst-case cardinal winds.

Closest Residences	Night-time noise levels in dB(A) for scenario S2 for calm and 8 worst-case cardinal winds								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	14.9	19.7	19.7	19.7	19.6	15.1	10.6	10.5	19.6
R2	14.5	19.8	19.9	19.9	19.8	17.4	11.2	10.4	19.7
R3	11.4	16.6	19.2	19.2	19.2	18.1	13.6	10.0	19.1
R4	15.3	20.3	22.6	22.7	22.7	21.3	19.0	13.9	22.4
R5	14.9	20.4	22.4	22.7	22.7	21.6	18.9	14.0	22.4
R6	17.2	21.1	21.8	21.9	21.8	18.2	15.7	13.4	21.4
R7	21.3	24.1	24.6	24.8	24.6	21.0	18.8	16.9	24.3
R8	10.9	7.8	8.5	14.1	17.2	17.2	17.2	17.2	17.1
R9	12.0	6.7	6.2	9.9	15.2	15.4	15.4	15.5	15.5
R10	15.1	9.9	8.5	11.3	17.1	17.8	17.8	17.8	17.7
R11	16.4	11.3	8.5	10.4	17.0	18.0	18.0	18.0	17.9
R12	19.0	13.5	10.0	11.2	18.2	19.2	19.3	19.3	19.2
R13	21.3	21.3	18.9	12.9	11.7	14.2	21.0	21.3	21.0

Table 5-5: Day-time noise levels in dB(A) for scenario S3 for calm and 8 worst-case cardinal winds.

Closest Residences	Day-time noise levels in dB(A) for scenario S3 for calm and 8 worst-case cardinal winds								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	21.6	29.0	29.1	29.1	27.3	17.5	16.4	16.5	23.8
R2	20.4	29.5	29.7	29.7	29.0	19.0	17.0	17.1	24.4
R3	17.2	21.9	29.8	30.0	30.0	29.3	19.0	17.1	24.8
R4	20.8	24.6	32.5	33.7	33.7	33.3	25.7	20.6	28.5
R5	19.8	23.8	29.2	32.5	32.5	32.1	26.7	19.8	27.4
R6	18.8	24.4	28.4	29.5	29.3	28.2	22.1	18.0	24.6
R7	22.5	27.1	30.9	33.4	33.1	32.5	27.1	21.4	28.5
R8	19.1	18.7	18.9	24.6	29.9	29.9	29.9	26.4	25.1
R9	25.1	18.9	18.8	19.4	27.8	30.8	30.8	30.8	25.9
R10	32.5	25.3	21.8	22.1	27.7	32.4	33.8	33.8	28.9
R11	27.9	25.6	18.6	18.1	22.7	28.2	29.9	30.0	24.8
R12	28.4	21.5	18.0	17.7	20.5	28.9	29.3	29.4	24.1
R13	26.1	26.1	21.7	14.5	14.2	14.4	21.0	26.1	20.6

Table 5-6: Night-time noise levels in dB(A) for scenario S3 for calm and 8 worst-case cardinal winds.

Closest Residences	Night-time noise levels in dB(A) for scenario S3 for calm and 8 worst-case cardinal winds								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	16.9	19.1	19.1	19.1	18.9	11.8	9.2	10.6	19.0
R2	16.1	20.0	20.0	20.0	19.9	13.7	10.4	11.0	19.8
R3	13.0	18.4	21.2	21.2	21.2	20.5	14.3	11.6	21.0
R4	16.8	21.4	24.8	24.9	24.9	24.1	20.2	16.0	24.5
R5	16.2	21.1	24.4	24.5	24.5	23.8	21.4	16.0	24.2
R6	17.6	21.5	22.8	22.8	22.8	20.2	16.6	14.4	22.3
R7	21.9	24.6	26.4	26.6	26.4	24.4	22.2	18.6	26.0
R8	12.0	8.9	9.6	14.9	18.3	18.3	18.3	18.3	18.2
R9	13.5	8.4	7.7	10.8	17.0	17.2	17.2	17.2	17.2
R10	17.8	12.0	10.5	12.9	19.4	19.9	19.9	19.9	19.7
R11	19.6	13.3	10.2	11.3	17.7	19.7	19.7	19.7	19.6
R12	20.5	15.4	11.4	11.5	15.7	20.5	20.6	20.6	20.4
R13	17.0	17.0	17.1	9.3	7.2	8.9	16.7	17.0	17.1

Table 5-7: Day-time noise levels in dB(A) for scenario S4 for calm and 8 worst-case cardinal winds.

Closest Residences	Day-time noise levels in dB(A) for scenario S4 for calm and 8 worst-case cardinal winds								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	20.1	25.4	25.4	25.4	20.4	13.2	12.9	13.0	20.0
R2	19.0	26.5	26.5	26.5	24.3	15.0	14.0	14.1	21.2
R3	16.5	23.9	28.9	28.9	28.9	26.4	17.0	16.0	23.7
R4	20.7	27.3	32.9	33.3	33.2	31.8	22.8	20.3	28.2
R5	19.7	25.5	31.0	32.7	32.7	31.2	24.1	19.5	27.5
R6	20.5	30.1	31.6	31.8	31.6	27.1	20.1	18.8	26.8
R7	24.6	33.3	34.7	35.5	35.1	31.6	25.3	22.3	30.5
R8	19.4	18.8	19.0	24.6	30.5	30.5	30.5	27.9	25.7
R9	25.7	19.0	18.9	19.3	27.6	31.2	31.2	31.2	26.3
R10	33.3	25.4	21.9	22.0	25.7	32.9	34.2	34.2	29.3
R11	29.5	25.7	17.8	17.1	19.3	27.6	29.9	30.0	24.9
R12	28.1	22.8	16.3	15.6	16.8	26.3	28.1	28.1	23.0
R13	21.8	21.8	17.9	9.9	9.4	9.5	15.4	21.8	16.2

Table 5-8: Night-time noise levels in dB(A) for scenario S4 for calm and 8 worst-case cardinal winds.

Closest Residences	Night-time noise levels in dB(A) for scenario S4 for calm and 8 worst-case cardinal winds								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	17.6	18.3	18.3	18.3	18.0	10.5	8.5	10.3	18.2
R2	16.5	19.1	19.1	19.1	18.9	12.2	9.5	10.6	18.9
R3	13.3	19.0	21.1	21.1	21.1	20.3	14.0	11.6	20.8
R4	17.2	21.8	25.2	25.2	25.2	24.5	20.2	16.4	24.8
R5	16.6	21.4	24.6	24.8	24.8	24.2	21.5	16.4	24.4
R6	17.8	21.6	23.0	23.0	23.0	20.5	16.6	14.7	22.5
R7	22.0	24.7	26.4	26.6	26.4	24.4	21.6	18.8	26.0
R8	11.8	8.5	9.1	13.9	17.9	17.9	17.9	17.9	17.8
R9	13.6	7.9	6.9	9.6	16.2	16.4	16.4	16.4	16.3
R10	17.9	11.4	9.5	11.4	18.3	19.0	19.0	19.0	18.7
R11	19.2	13.3	9.8	10.4	15.7	19.3	19.3	19.3	19.1
R12	19.8	15.3	10.8	10.4	13.8	19.7	19.8	19.8	19.6
R13	15.4	15.4	15.5	7.6	5.4	7.1	14.9	15.4	15.6

5.2 Noise Contours

Noise contours have been prepared for the worst-case meteorological conditions given in Table 4-4 for day and night time sound propagation. The noise contours are presented in Figures 8 to 14 in Appendix C, starting from 25 dB(A) to 60 dB(A) with a 5 dB interval. These noise contours represent the worst-case noise propagation envelopes, ie, worst-case propagation in all directions simultaneously. Detailed locations of the operating mobile equipment are presented in Figures 4 to 7 in Appendix B.

6. COMPLIANCE ASSESSMENT

6.1 Tonality Assessment

Assessment of tonality in received noise emissions depends on the existing level of ambient noise (i.e. whether tonality is likely to protrude above background noise) as well as the severity and duration of any tonality. The *Regulations* specify two criteria for assessing tonality, (*Regulation* 9(1)). The first is based on instantaneous sound pressure levels and the second is based on average sound pressure levels. Very strong tonality which protrudes significantly above background noise may satisfy the first criteria. Less severe tonality may satisfy the second criteria provided that it persists for at least 10% of the representative assessment period.

Many of the items of mobile equipment proposed for the Wonnerup South mine will have some degree of tonality when measured close to source. However, this tonality may not always be evident at the receiver for the following reasons:

- Tonality may not protrude above ambient noise.
- Tonality from particular items of equipment may be masked by noise received from other equipment.
- The level of noise emissions from items of mobile equipment will vary depending on their locations (which may be continuously changing).
- The severity and pitch of the tonality from mobile equipment will change depending on operating conditions.

Therefore, in order to assess the likelihood of tonality being evident in received noise it is necessary to review which equipment dominates noise levels at each receiver. Table 6-1 to Table 6-6 present an assessment of whether or not tonality is likely to be evident at the receiving location where the overall noise level is greater than 35dB(A) for day-time operations and 25dB(A) for night-time mining operations. The assessment has been undertaken for worst-case sound propagation conditions at each location.

No tonality adjustment is made in cases where noise from Watercart and/or Grader dominates predicted noise levels. Watercart or Grader does not generally operate in a confined area and is more likely to be deployed over a large area. Consequently any tonality will be transient and unlikely to be persisting for 10% of the representative assessment period.

Although the tonality assessment was undertaken for worst-case conditions, it is assumed that the findings apply for all prevailing conditions. According to the *Regulations*, predicted and measured noise levels should be adjusted by adding 5 dB if they contain tonal components. Therefore, some values presented in Table 5-1 to Table 5-8 for these locations for particular wind directions will also need to be adjusted before comparing predicted levels with the assigned noise limits.

Table 6-7 summarizes the adjusted worst-case day and night time noise levels. The adjusted values are expressed in ***bold italic***.

Table 6-1 : Tonality Assessment – Day-time Scenario S1

Scenario S1 – Day-time				
Location	**Contributor**	**Level**	**Tonal**	**Comment**
R1	Scrapers	36.8	Yes	The overall noise contribution from scrapers dominates. The tonality of scrapers likely to be distinguished.
	Dozers	26.4		
	Diesel Pumps	25.5		
R2	Scrapers	37.8	Yes	
	Dozers	26.8		
	Diesel Pumps	26.2		
R3	Scrapers	37.8	Yes	
	Watercart	28.3		
	Diesel Pumps	25.3		
R4	Scrapers	41.1	Yes	
	Watercart	32.7		
	Diesel Pumps	28.8		
R5	Scrapers	39.2	Yes	
	Watercart	31.4		
	Diesel Pumps	27.8		
R6	Scrapers	44.6	Yes	
	Watercart	36.0		
	Diesel Pumps	32.0		
R7	Scrapers	40.7	Yes	The overall noise contribution from scrapers dominates. Watercart comes and goes. The tonality of scrapers likely to be distinguished.
	Watercart	39.3		
	Dozers	35.6		
R11	Scrapers	34.2	Yes	The overall noise contribution from scrapers dominates. The tonality of scrapers likely to be distinguished.
	Watercart	24.5		
	Diesel Pumps	23.9		
R12	Scrapers	35.8	Yes	
	Watercart	25.0		
	Diesel Pumps	24.9		

Table 6-2 : Tonality Assessment – Day-time Scenario S2

Scenario S2 – Day-time				
Location	**Contributor**	**Level**	**Tonal**	**Comment**
R1	Scrapers	33.4	Yes	Scrapers are the dominant source.
	Watercartr	24.0		
	Diesel Pumps	23.4		
R2	Scrapers	33.7	Yes	
	Watercartr	25.3		
	Dozer	22.5		
R4	Watercart	30.9	Yes	Watercart is transient noise source Scrapers are the dominant source.
	Scrapers	30.5		
	Diesel Pumps	22.8		

Table 6-3 : Tonality Assessment - Night-time Scenario S2

Scenario S2 – Night-time				
Location	**Contributor**	**Level**	**Tonal**	**Comment**
R7	Wet Plant	22.5	No	Wet Plant is the dominant source. Noise from the Wet Plant does not show tonality.
	Booster Pumps	19.1		
	Trommels	13.1		

Table 6-4 : Tonality Assessment - Night-time Scenario S3

Scenario S3 – Night-time				
Location	**Contributor**	**Level**	**Tonal**	**Comment**
R4	Trommels	20.8	No	The contributions from dominant noise sources are in similar levels. Noise from the Wet Plant & Trommels does not show tonality.
	Loader	18.3		
	Wet Plant	18.3		
R5	Trommels	19.6	No	
	Wet Plant	19.6		
	Loader	17.3		
R7	Wet Plant	22.5	No	
	Trommels	20.7		
	Booster Pumps	19.1		

Table 6-5 : Tonality Assessment – Day-time Scenario S4

Scenario S4 – Day-time				
Location	**Contributor**	**Level**	**Tonal**	**Comment**
R7	Watercart	32.5	No	Watercart and Grader are transient noise sources. Dozer is a dominant source but its noise level is below background level.
	Grader	28.0		
	Dozers	26.7		
	Diesel Pumps	23.5		

Table 6-6 : Tonality Assessment - Night-time Scenario S4

Scenario S4 – Night-time				
Location	**Contributor**	**Level**	**Tonal**	**Comment**
R4	Trommels	22.9	No	Trommels and Wet Plant are the dominant sources, and they do not radiate tonal noise.
	Wet Plant	18.4		
	Booster Pumps	16.8		
R5	Trommels	21.7	No	
	Wet Plant	19.6		
	Booster Pumps	16.2		
R7	Wet Plant	22.5	No	
	Trommels	22.2		
	Booster Pumps	19.3		

Table 6-7: Summary of worst-case noise levels in dB(A) – Adjusted for tonality (5dB penalty).

Closest Residences	S1	S2		S3		S4	
	Days	Days	Nights	Days	Nights	Days	Nights
R1	***42.8***	***39.7***	19.7	29.1	19.1	25.4	18.3
R2	***43.8***	***39.9***	19.9	29.7	20.0	26.5	19.1
R3	***43.8***	31.9	19.2	30.0	21.2	28.9	21.1
R4	***47.2***	***39.5***	22.7	33.7	24.9	33.3	25.2
R5	***45.5***	33.0	22.7	32.5	24.5	32.7	24.8
R6	***50.7***	30.1	21.9	29.5	22.8	31.8	23.0
R7	***53.9***	33.0	24.8	33.4	26.6	35.5	26.6
R8	31.2	29.8	17.2	29.9	18.3	30.5	17.9
R9	32.0	30.6	15.5	30.8	17.2	31.2	16.4
R10	34.7	33.5	17.8	33.8	19.9	34.2	19.0
R11	***40.4***	29.1	18.0	30.0	19.7	30.0	19.3
R12	***41.8***	27.9	19.3	29.4	20.6	28.1	19.8
R13	34.4	30.2	21.3	26.1	17.1	21.8	15.5

6.2 Compliance Assessment

6.2.1 Construction Operations

Cable Sands has advised that the construction activities will occur during day-time (Monday to Saturday) only.

Table 6-8 presents a comparison between the day-time assigned noise levels and the adjusted worst-case noise levels in dB(A) from construction activities at the 13 closest residential locations. The values expressed in ***bold italic*** are the adjusted values, which have added the 5dB tonality adjustment. Table 6-8 indicates that the adjusted worst-case noise levels from construction activities are below the day-time assigned noise levels at most of the closest noise sensitive premises except at R5, where a half decibel exceedance is predicted.

However, according to item 13 of the *Regulations*, no assigned noise levels apply for the construction period (scenario S1) at noise-sensitive premises, as long as "*the construction work is carried out in accordance with control of environmental noise practices set out in section 6 of AS 2436-1981 Guide to Noise control on Construction, Maintenance and Demolition Sites*".

Table 6-8: Comparison between the assigned noise levels and the adjusted worst-case noise levels.

Closest Residences	Day-time Assigned Noise Levels in dB(A)	Adjusted Worst-case day-time Noise Levels in dB(A)
R1	45	***42.8***
R2	45	***43.8***
R3	45	***43.8***
R4	48	***47.2***
R5	45	***45.5***
R6	61	***50.7***
R7	64	***53.9***
R8	46	31.2
R9	46	32.0
R10	51	34.7
R11	46	***40.4***
R12	45	***41.8***
R13	45	34.4

6.2.2 Mining Operations

The noise levels for evening time are not predicted and should be close to but not greater than the night-time noise levels because the same mining equipment is used.

Table 6-9 and Table 6-10 present comparisons between the assigned noise levels and the adjusted worst-case noise levels in dB(A) from proposed mining operations at the selected closest residential locations. The values expressed in ***bold italic*** in Table 6-9 are the adjusted values, which have added the 5dB tonality adjustment. Both tables indicate that the adjusted worst-case noise levels from any of the proposed mining operations are below the assigned noise levels at all of the 13 closest noise sensitive premises. It can be concluded that full compliance will be achieved for all proposed mining operations.

Table 6-9: Comparison between day-time assigned noise levels and day-time adjusted worst-case noise levels.

Closest Residences	Day-time Assigned Noise Levels in dB(A)		Adjusted Worst-case Day-time Noise Levels in dB(A)		
	Mondays to Saturdays	Sundays & Public Holidays	S2	S3	S4
R1	45	40	***39.7***	29.1	25.4
R2	45	40	***39.9***	29.7	26.5
R3	45	40	31.9	30.0	28.9
R4	48	43	***39.5***	33.7	33.3
R5	45	40	33.0	32.5	32.7
R6	61	56	30.1	29.5	31.8
R7	64	59	33.0	33.4	35.5
R8	46	41	29.8	29.9	30.5
R9	46	41	30.6	30.8	31.2
R10	51	46	33.5	33.8	34.2
R11	46	41	29.1	30.0	30.0
R12	45	40	27.9	29.4	28.1
R13	45	40	30.2	26.1	21.8

Table 6-10: Comparison between evening/night-time assigned noise levels and adjusted worst-case noise levels.

Closest Residences	Assigned Noise Levels in dB(A)		Adjusted Worst-case Noise Levels in dB(A)		
	Evenings	Nights	S2	S3	S4
R1	40	35	19.7	19.1	18.3
R2	40	35	19.9	20.0	19.1
R3	40	35	19.2	21.2	21.1
R4	43	38	22.7	24.9	25.2
R5	40	35	22.7	24.5	24.8
R6	56	51	21.9	22.8	23.0
R7	59	54	24.8	26.6	26.6
R8	41	36	17.2	18.3	17.9
R9	41	36	15.5	17.2	16.4
R10	46	41	17.8	19.9	19.0
R11	41	36	18.0	19.7	19.3
R12	40	35	19.3	20.6	19.8
R13	40	35	21.3	17.1	15.5

APPENDIX A : PROPOSED MINE SITE

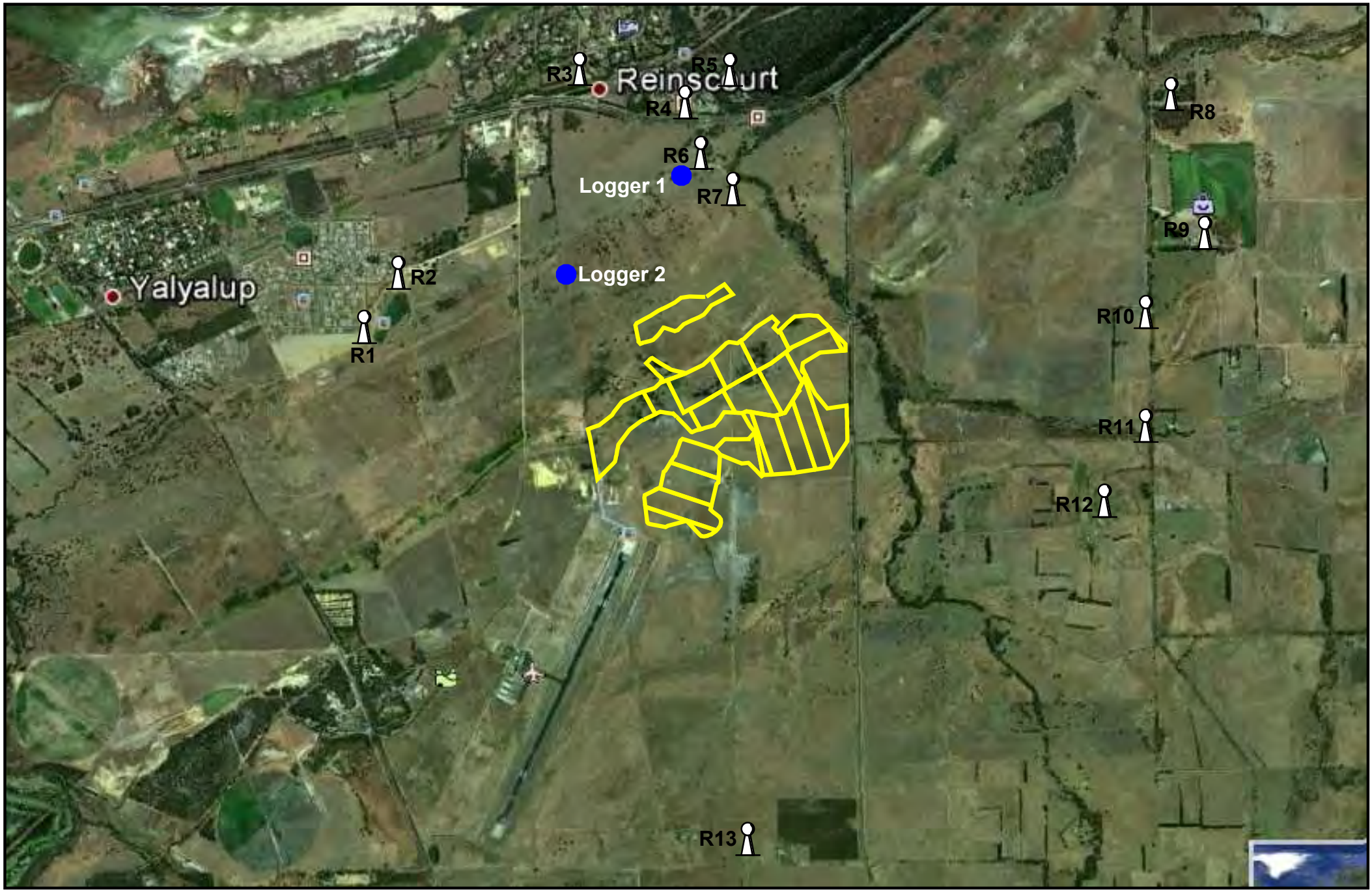

Figure 1: Aerial view of the Wonnerup South Mine site and surrounding area.

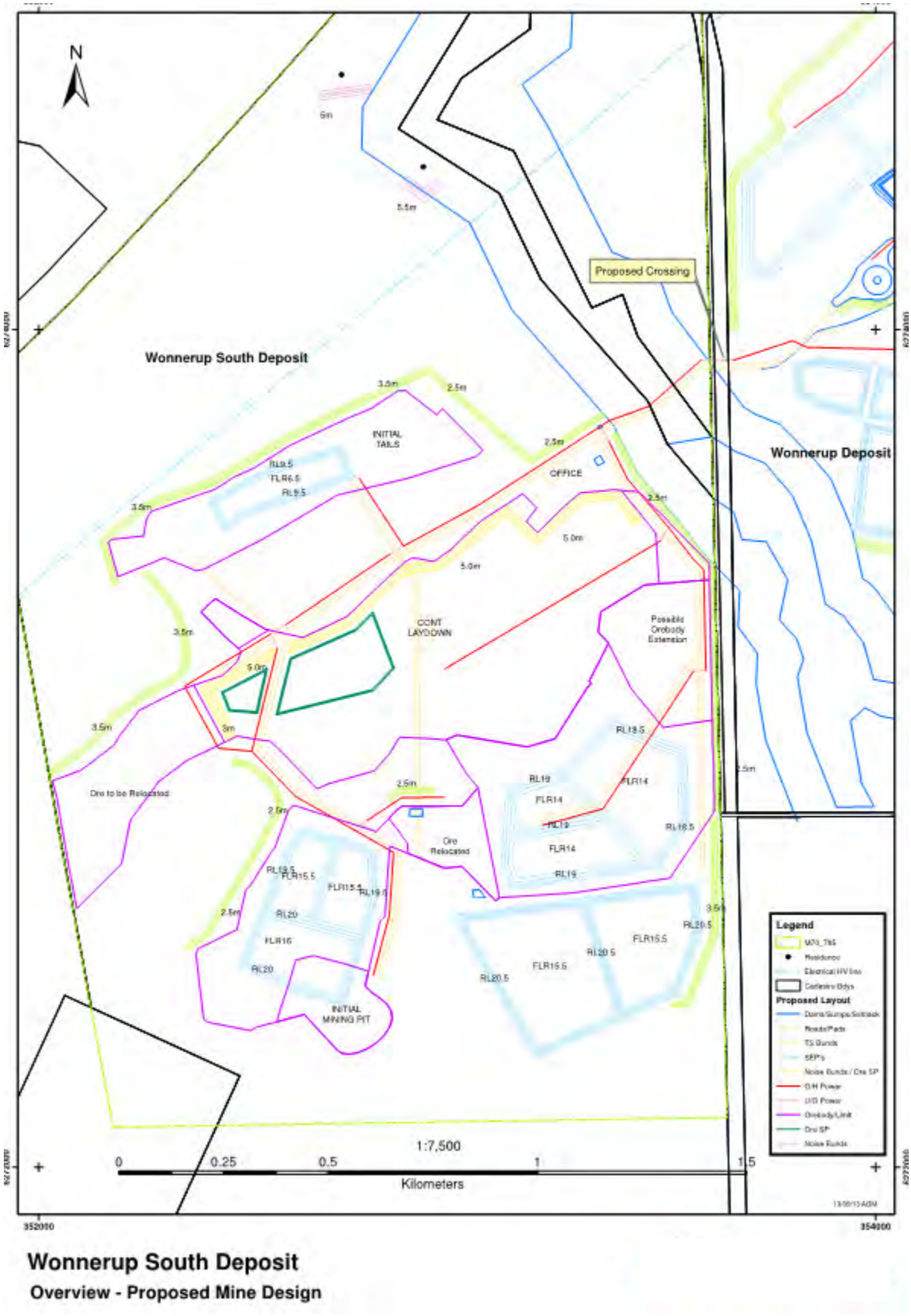

Figure 2: Proposed mine site layout.

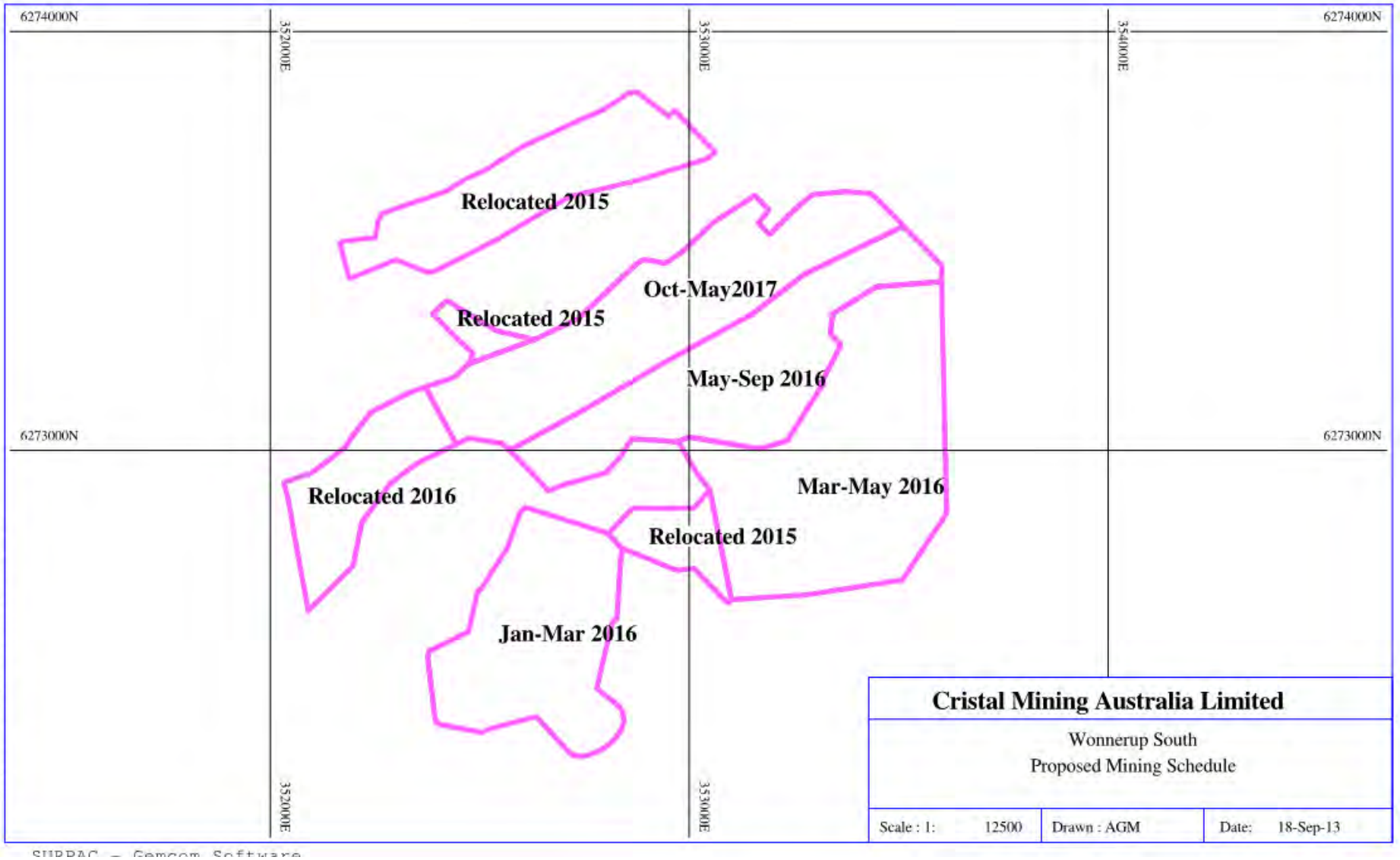

Figure 3: Proposed mining schedule.

APPENDIX B : EQUIPMENT LOCATIONS

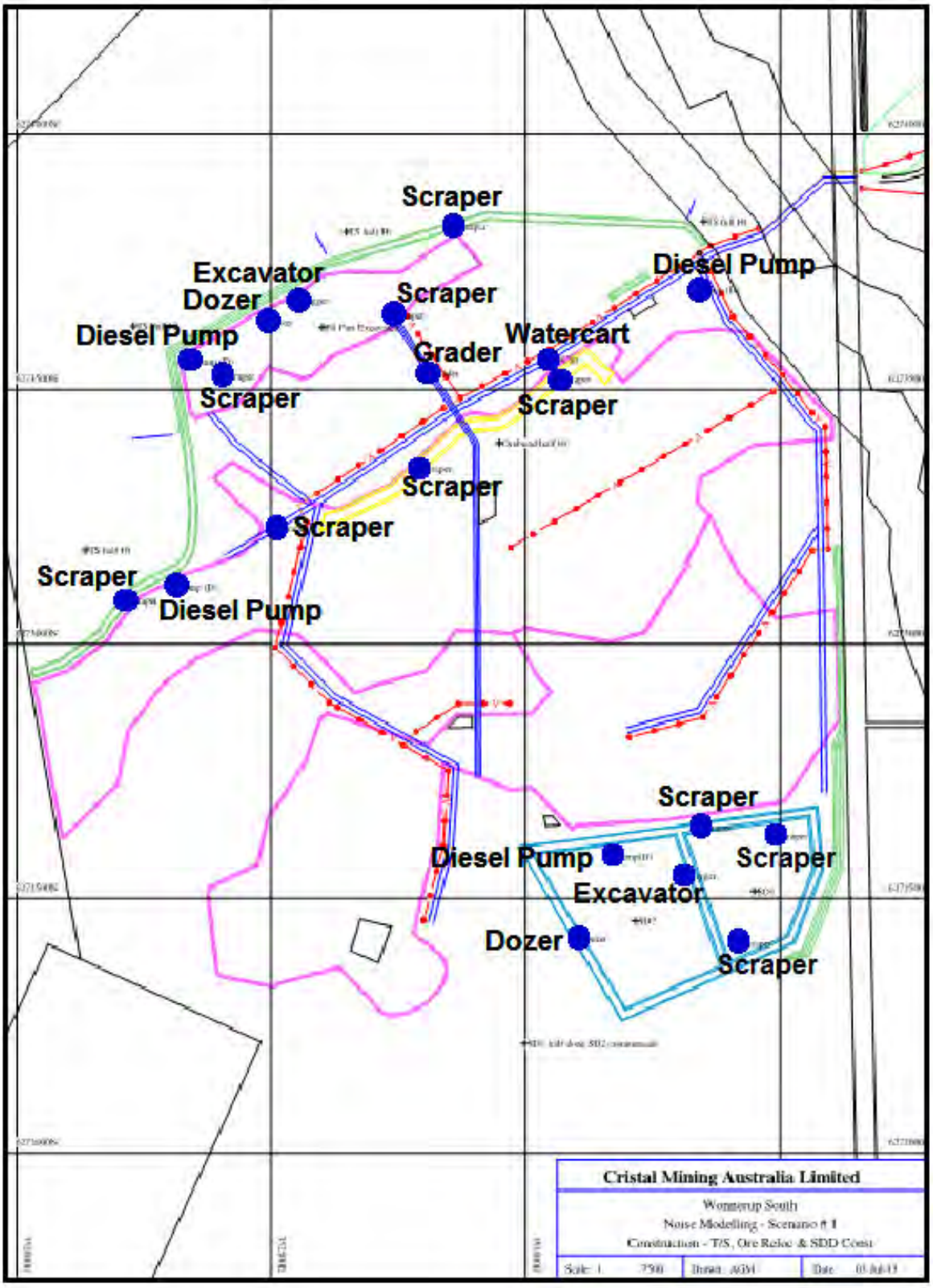

Figure 4: Assumed locations of day-time operating equipment for scenario S1 – construction.

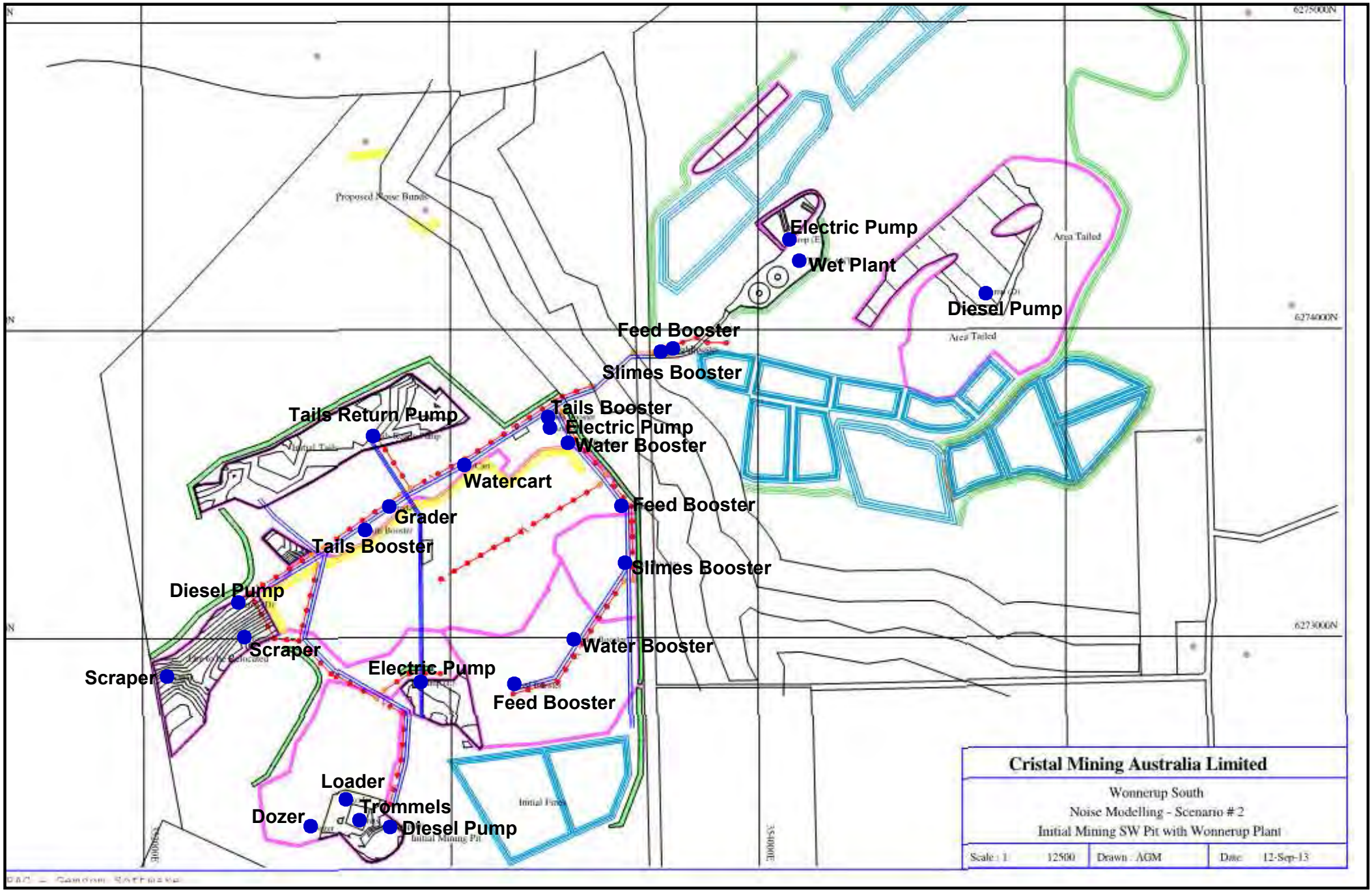

Figure 5: Assumed locations of day-time operating equipment for scenario S2 - Initial mining in southwest pit.

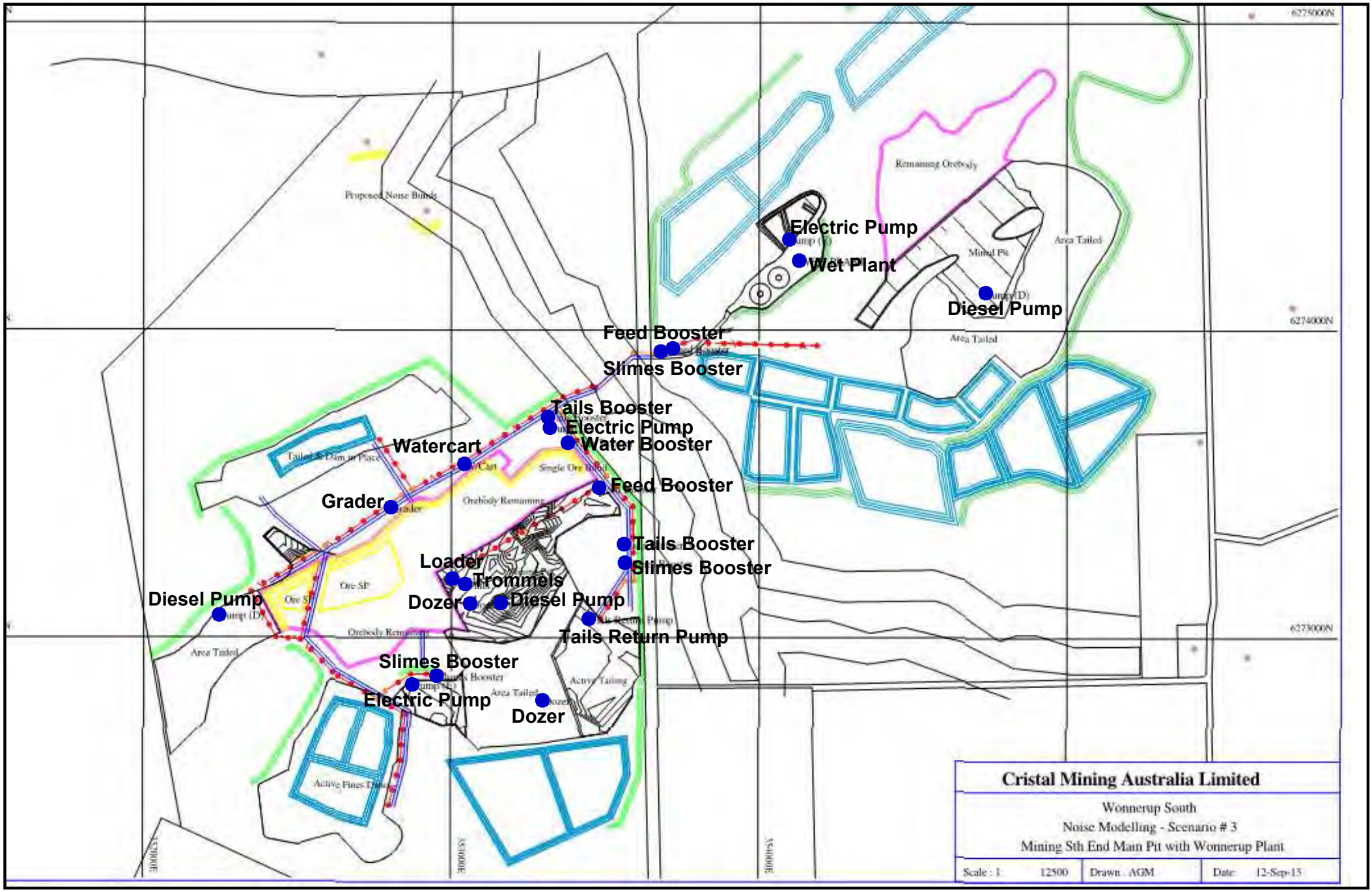

Figure 6: Assumed locations of day-time operating equipment for scenario S3 - Mining south end of main pit.

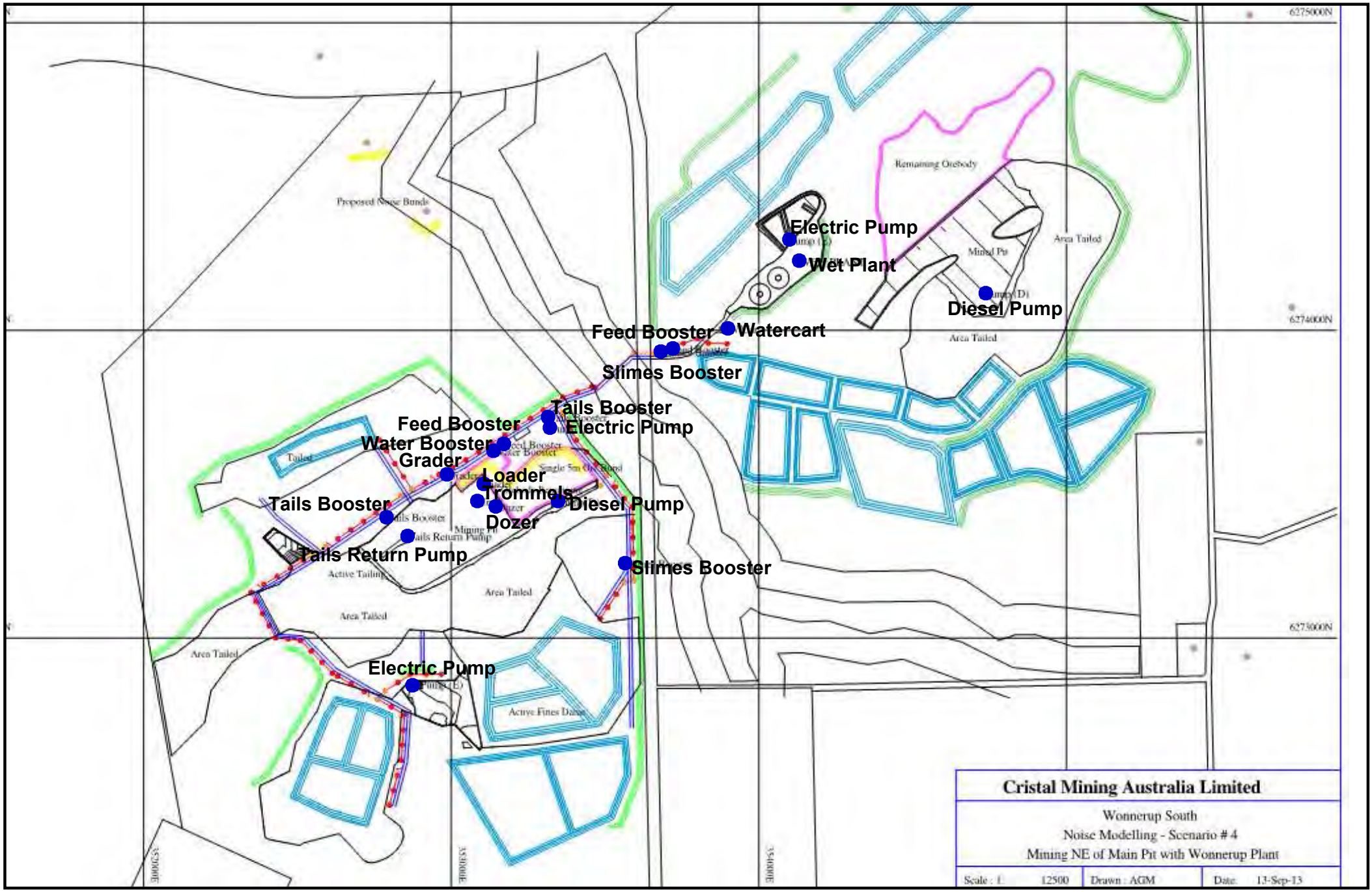

Figure 7: Assumed locations of day-time operating equipment for scenario S4 - Mining in northeast of main pit.

APPENDIX C : NOISE CONTOURS

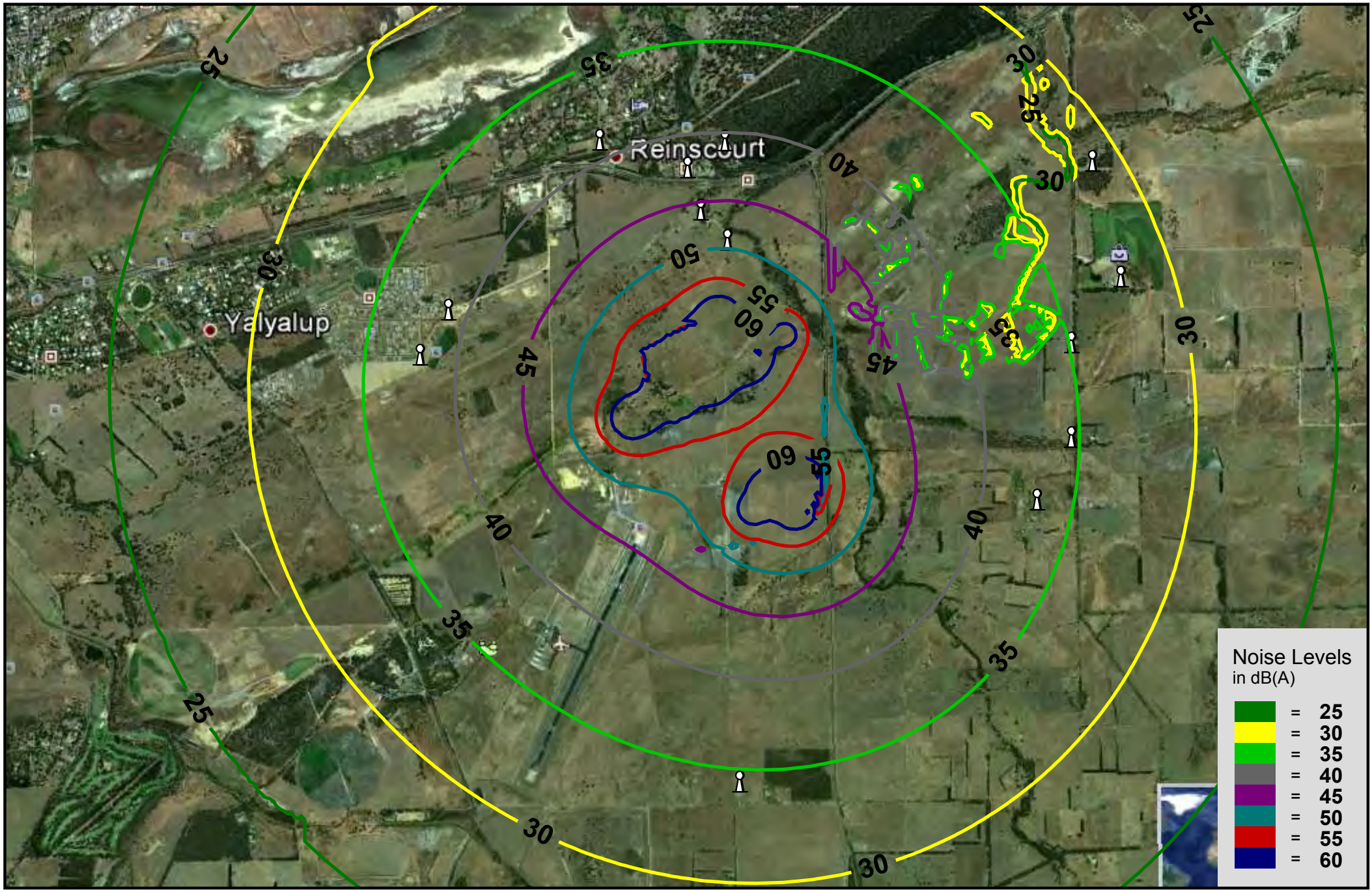

Figure 8: Worst-case day-time noise level contours for scenario S1 - Construction.

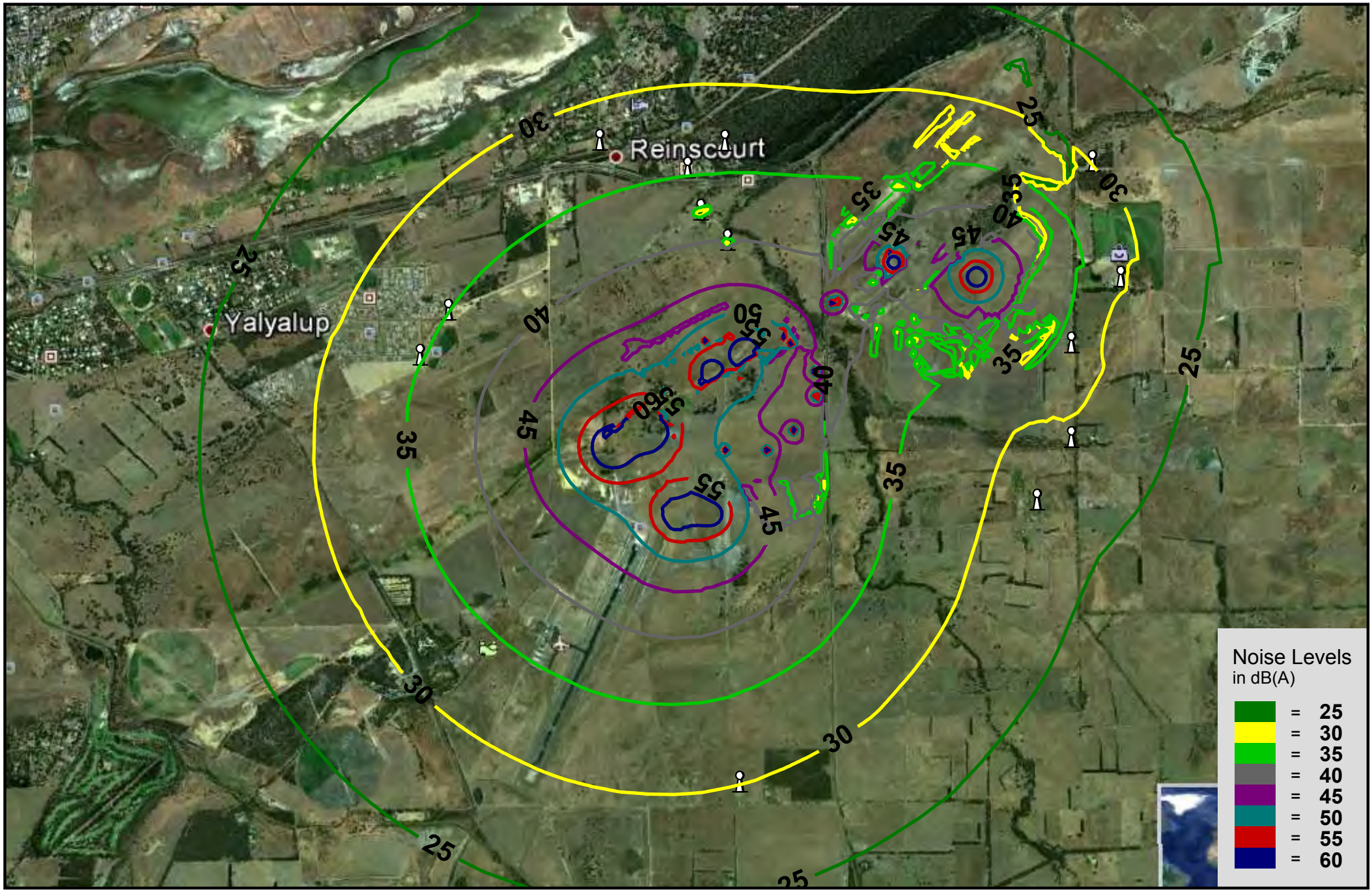

Figure 9: Worst-case day-time noise level contours for scenario S2 - Initial mining in southwest pit.

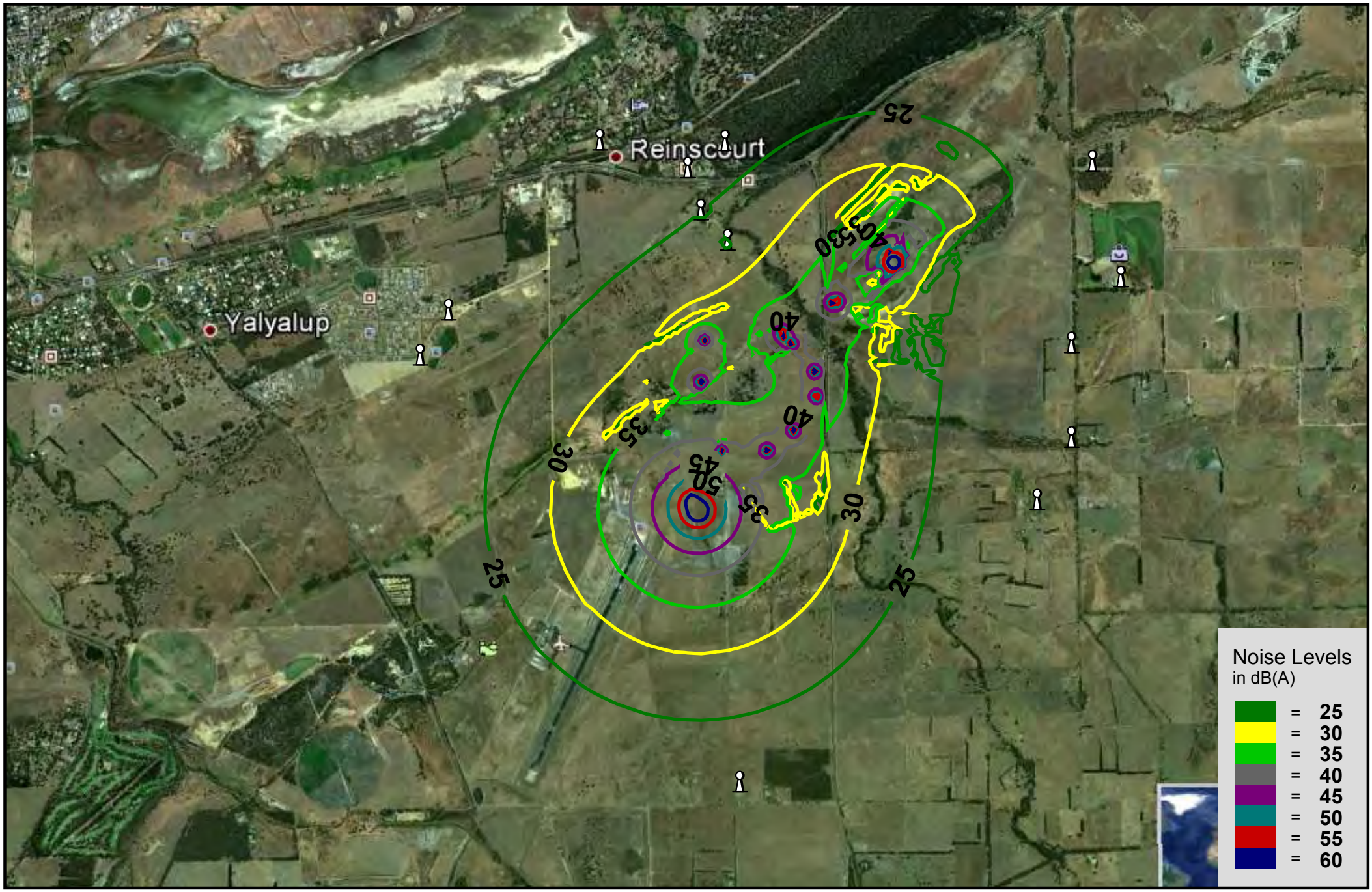

Figure 10: Worst-case night-time noise level contours for scenario S2 - Initial mining in southwest pit.

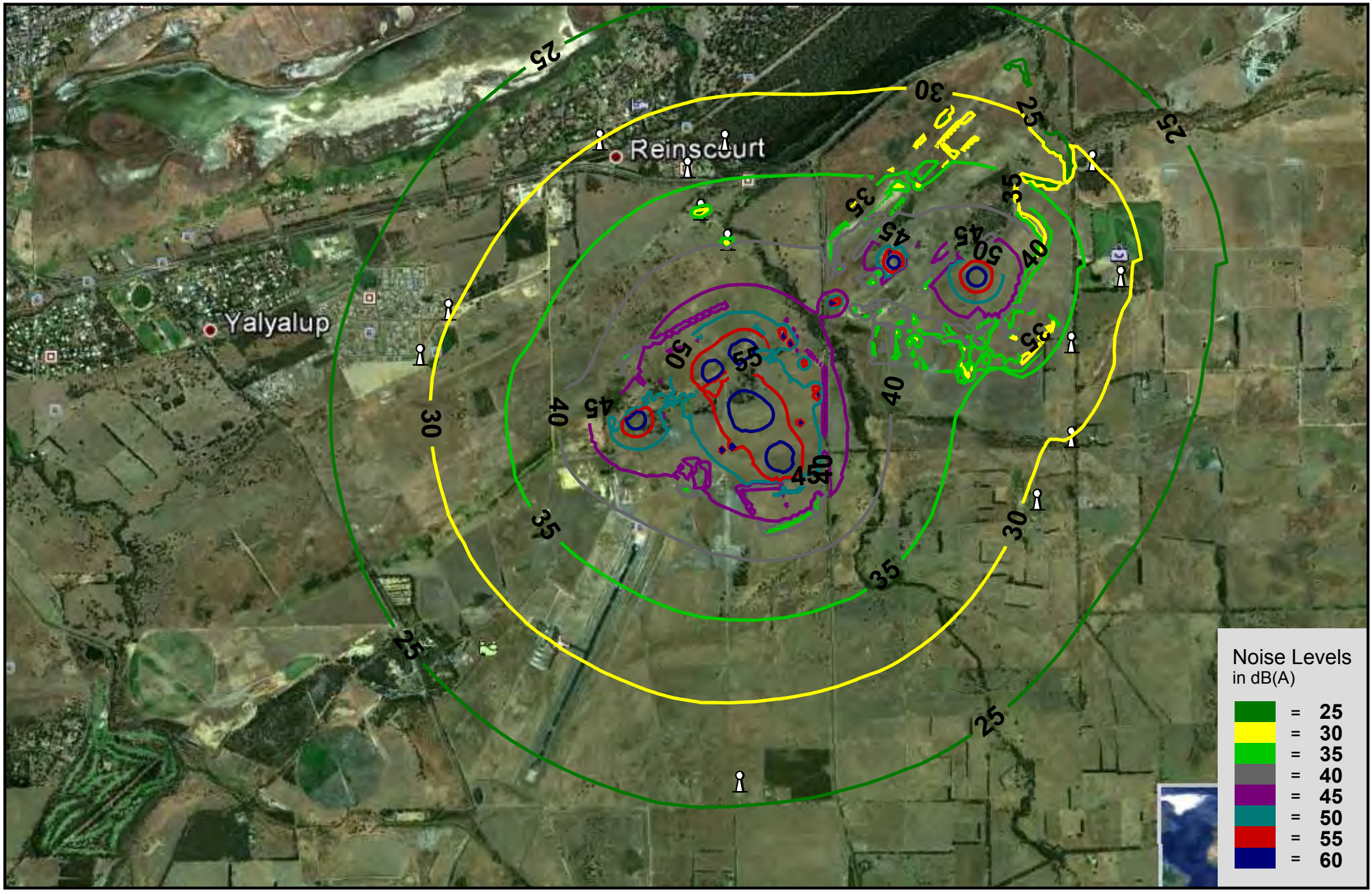

Figure 11: Worst-case day-time noise level contours for scenario S3 - Mining in south end of main pit.

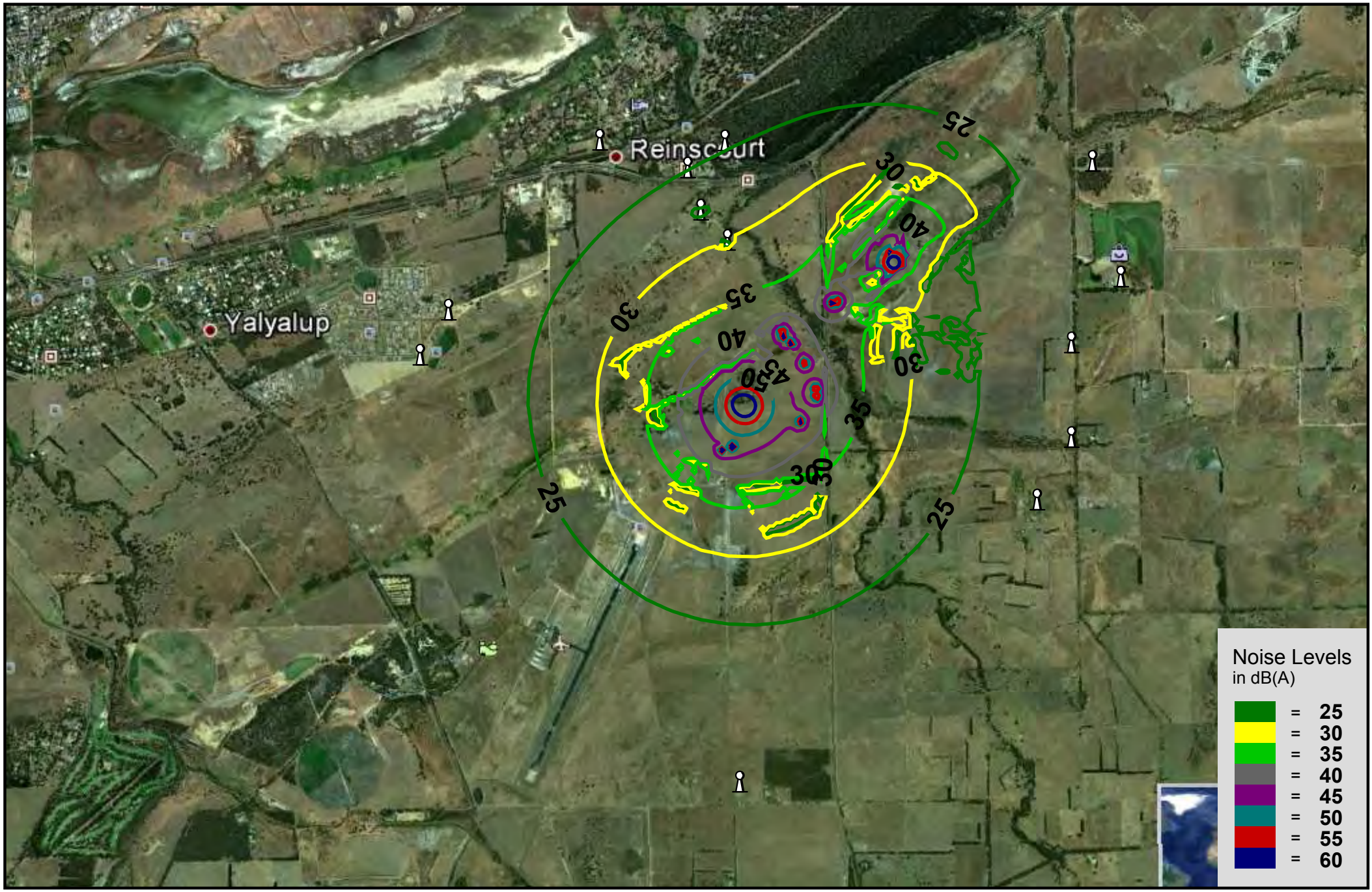

Figure 12: Worst-case night-time noise level contours for scenario S3 - Mining in south end of main pit.

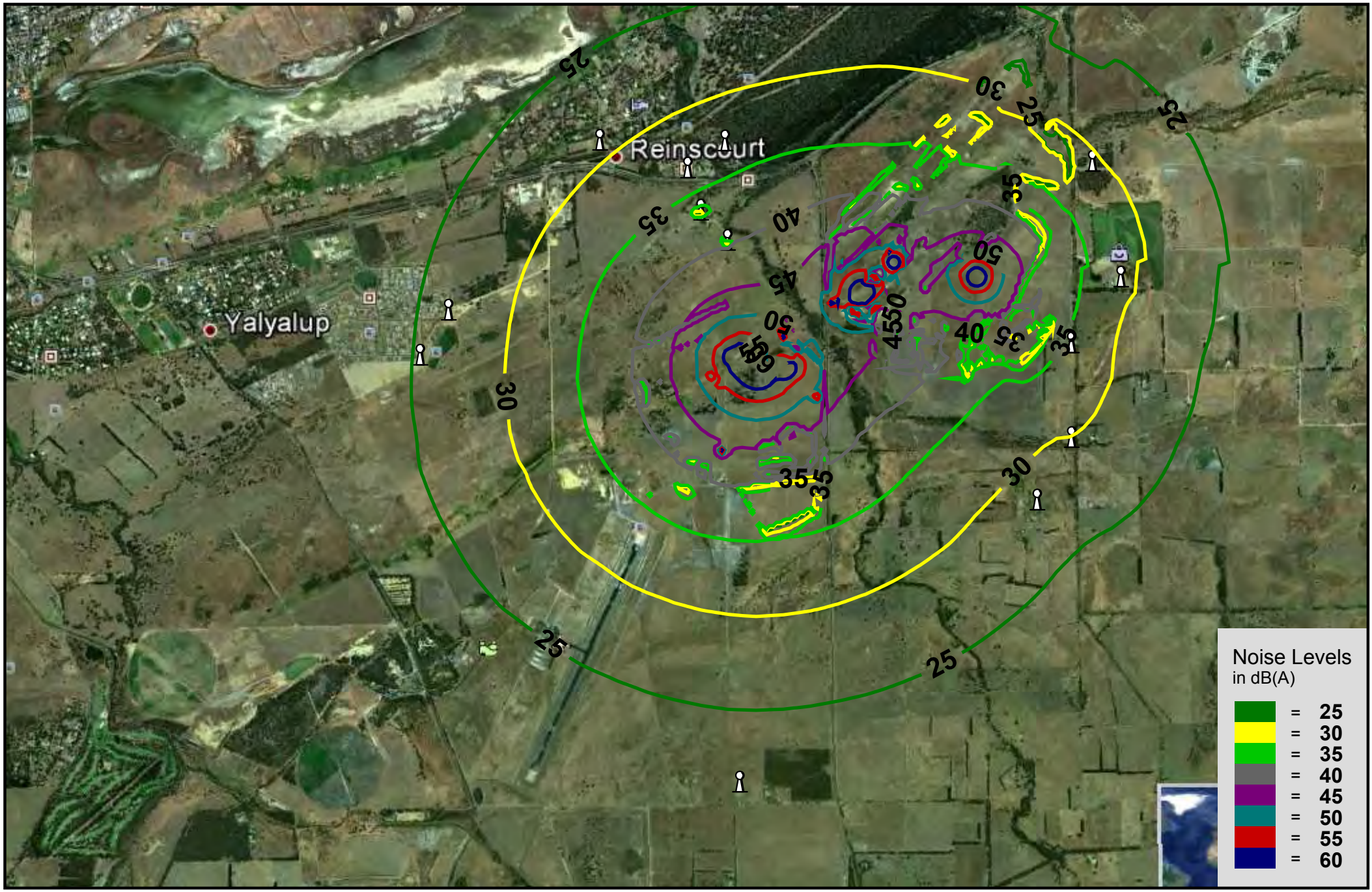

Figure 13: Worst-case day-time noise level contours for scenario S4 - Mining in northeast of main pit.

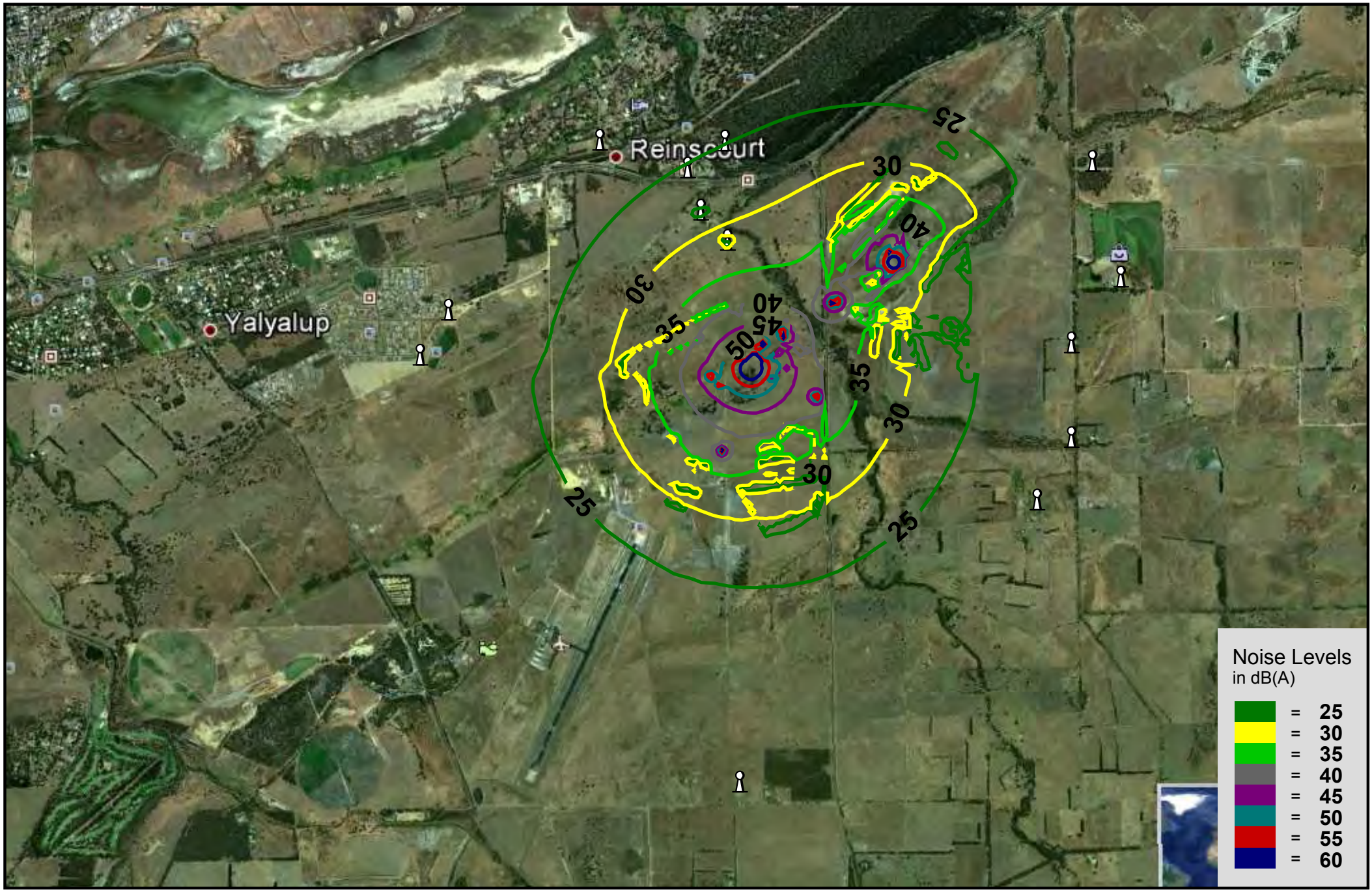

Figure 14: Worst-case night-time noise level contours for scenario S4 - Mining in northeast of main pit.