Lloyd George Acoustics
PO Box 717
Hillarys WA 6923
T: 9401 7770
www.lgacoustics.com.au

Environmental Noise Assessment

Atlas Project, Nambung

Reference: 20105858-03C ENA

Prepared for:
Image Resources

Reference: 20105858-03C ENA

[redacted]

This report has been prepared in accordance with the scope of services described in the contract or agreement between Lloyd George Acoustics Pty Ltd and the Client. The report relies upon data, surveys, measurements and results taken at or under the particular times and conditions specified herein. Any findings, conclusions or recommendations only apply to the aforementioned circumstances and no greater reliance should be assumed or drawn by the Client. Furthermore, the report has been prepared solely for use by the Client, and Lloyd George Acoustics Pty Ltd accepts no responsibility for its use by other parties.

[redacted]

CONTENTS

1. INTRODUCTION 1

2. CRITERIA 2

2.1. Regulations 7, 8 & 9 2

2.2. Regulation 3 4

3. METHODOLOGY 5

3.1. Meteorological Conditions 5

3.2. Topographical Data 5

3.3. Ground Absorption 6

3.4. Source Sound Levels 6

3.5. Day and Night Operations 7

3.6. Nearby Receiving Premises 7

4. RESULTS 9

4.1. All Operations 9

4.2. HMC Trucks 14

5. CONCLUSIONS 17

List of Tables

Table 2-1 Adjustments Where Characteristics Cannot Be Removed 2

Table 2-2 Baseline Assigned Levels 3

Table 3-1: Modelling Meteorological Conditions 5

Table 3-2: Source Sound Power Levels, dB.....6

Table 4-1: All Operations Predicted Levels, dB L_{A10} – South Area 9

Table 4-2: Daytime Predicted Levels, dB L_{A10} – Middle Area..... 10

Table 4-3: Daytime Predicted Levels, dB L_{A10} – North Area..... 10

Table 4-5: Predicted Noise Levels, dB – HMC Truck Haulage 14

Table 4-6: Assessment of HMC Truck Predicted Levels, dB L_{A1} 15

List of Figures

Figure 1-1: Subject Site Location (Source: DPLH PlanWA) 1

Figure 3-1: Mining Project Layout 8

Figure 4-1: Noise Contour Plot – South Area 11

Figure 4-2: Noise Contour Plot – Middle Area..... 12

Figure 4-3: Noise Contour Plot – North Area 13

Figure 4-6: HMC Haulage Noise Levels..... 16

Appendices

Appendix A – Terminology 18

1. INTRODUCTION

Image Resources NL (Image) are planning for the development of the Atlas Project; a mineral sands mine located approximately 170 km north of Perth and 18 km east of Cervantes in the Wheatbelt region of Western Australia - refer *Figure 1-1*.

The proposal includes the progressive development of mine pits, processing facilities, groundwater bores and water management infrastructure, temporary waste dumps, solar drying ponds and associated infrastructure (power supply, communications, workshop, laydown, offices etc.). The mining method is proposed to operate 24 hours a day, 7 days a week (24/7).

Lloyd George Acoustics was engaged to model and assess the noise emissions from the proposed operations.

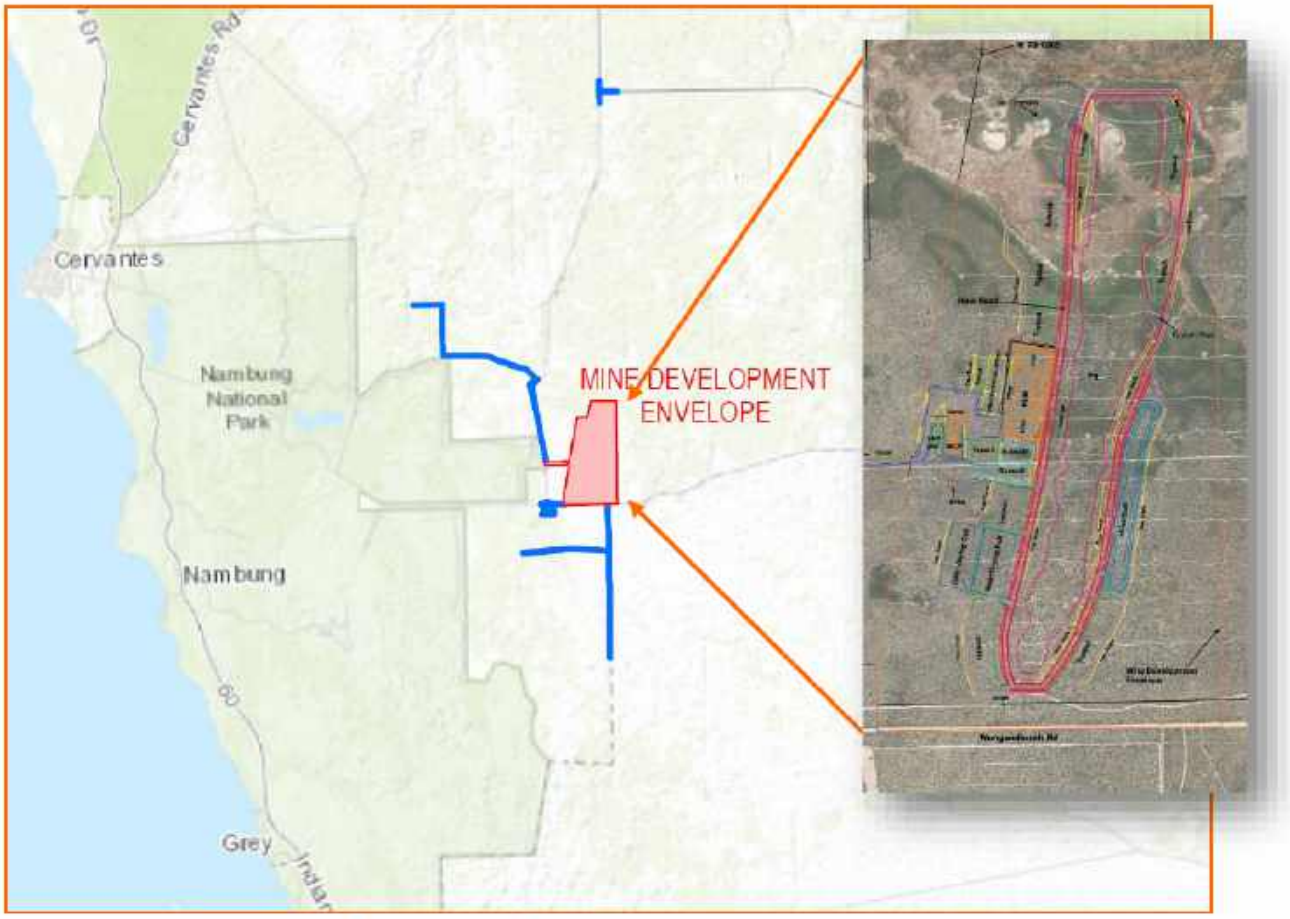


Figure 1-1: Subject Site Location (Source: Image Resources)

Appendix A contains a description of some of the terminology used throughout this report.

2. CRITERIA

Environmental noise in Western Australia is governed by the *Environmental Protection Act 1986*, through the *Environmental Protection (Noise) Regulations 1997* (the Regulations).

2.1. Regulations 7, 8 & 9

This group of regulations provide the prescribed standard for noise as follows:

"7. Prescribed standard for noise emissions

(1) Noise emitted from any premises or public place when received at other premises –

(a) must not cause, or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind; and

(b) must be free of –

(i) tonality; and

(ii) impulsiveness; and

(iii) modulation,

when assessed under regulation 9.

(2) For the purposes of subregulation (1)(a), a noise emission is taken to significantly contribute to a level of noise if the noise emission … exceeds a value which is 5 dB below the assigned level at the point of reception."

Tonality, impulsiveness and modulation are defined in regulation 9 (refer *Appendix A*). Under regulation 9(3), *"Noise is taken to be free of the characteristics of tonality, impulsiveness and modulation if -*

(a) the characteristics cannot be reasonably and practicably removed by techniques other than attenuating the overall level of noise emission; and

(b) the noise emission complies with the standard prescribed under regulation 7(1)(a) after the adjustments in the table [Table 2-1] … are made to the noise emission as measured at the point of reception."

Table 2-1 Adjustments Where Characteristics Cannot Be Removed

Where Noise Emission is Not Music*			Where Noise Emission is Music	
Tonality	Modulation	Impulsiveness	No Impulsiveness	Impulsiveness
+ 5 dB	+ 5 dB	+ 10 dB	+ 10 dB	+ 15 dB

* These adjustments are cumulative to a maximum of 15 dB.

The assigned levels (prescribed standards) for all premises are specified in regulation 8(3) and are shown in *Table 2-2*. The L_{A10} assigned level is applicable to noises present for more than 10% of a representative assessment period, generally applicable to "steady-state" noise sources. The L_{A1} is for short-term noise sources present for less than 10% and more than 1% of the time. The L_{Amax} assigned level is applicable for incidental noise sources, present for less than 1% of the time.

Table 2-2 Baseline Assigned Levels

Premises Receiving Noise	Time Of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises: highly sensitive area[1]	0700 to 1900 hours Monday to Saturday (Day)	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays (Sunday)	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days (Evening)	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80

1. ***highly sensitive area*** means that area (if any) of noise sensitive premises comprising —
   (a) a building, or a part of a building, on the premises that is used for a noise sensitive purpose; and
   (b) any other part of the premises within 15 metres of that building or that part of the building.

It is noted that all nearby sensitive receivers are more than 450 metres from any commercial or industrial uses, including the proposed pit development, therefore the influencing factor is 0 dB and as such, the baseline assigned levels of *Table 2-2* apply.

It must be noted the assigned levels above apply outside the receiving premises and at a point at least 3 metres away from any substantial reflecting surfaces, but within 15 metres of a residential building, not a shed or other types.

The assigned levels are statistical levels and therefore the period over which they are determined is important. The Regulations define the Representative Assessment Period (RAP) as "*a period of time of not less than 15 minutes, and not exceeding 4 hours*, *determined by* an *inspector* or *authorised person to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission"*. An inspector or authorised person is a person appointed under Sections 87 & 88 of the *Environmental Protection Act 1986* and include Local Government Environmental Health Officers and Officers from the Department of Water Environmental Regulation. Acoustic consultants or other environmental consultants are not appointed as an inspector or authorised person. Therefore, whilst this assessment is based on a 4-hour RAP, which is assumed to be appropriate given the nature of the operations, this is to be used for guidance only.

2.2. Regulation 3

"3. Regulations do not apply to certain noise emissions

(1) Nothing in these regulations applies to the following noise emissions –

(a) Noise emissions from the propulsion and braking systems of motor vehicles operating on a road;

(b) Noise emissions from a safety warning device, other than a reversing alarm, fitted to a motor vehicle operating on a road."

If every reasonable and practicable measure has been taken to reduce the effect of the noise emission consistent with providing an audible warning to people;

….

(h) Noise emissions from –

(i) reversing alarm fitted to a motor vehicle, mobile plant, or mining or earthmoving equipment; or

(ii) startup or movement alarm fitted to plant,

if

(iii) it is a requirement under another written law that such an alarm be fitted; and

(iv) it is not practicable to fit an alarm that complies with the written law under which it is required to be fitted and emits noise that complies with these Regulations;

The site will be operated as a mine within the meaning of the Work Health and Safety (Mines) Regulations 2022 and therefore, audible warning alarms fitted to plant and equipment may be exempt under the Regulations. However, it must be noted that commonly used fixed noise output tonal alarms such as reversing beepers or plant start-up alarms emit, by their very nature, tonal and modulating noise at high levels. This type of alarm can cause annoyance even at distant receivers. It is understood that equipment have been fitted with a broadband signal in-lieu of a tonal 'beep'.

Trucks (HMC) using the access road to the site off Munbinea Road are considered to be using a private road and therefore noise emissions from propulsion systems are not exempt once they leave the public road. A study of these noise impacts has been included separate to the mining operations, and for the nearest receivers only.

3. METHODOLOGY

Computer modelling has been used to predict the noise emissions from the development to all nearby receivers. The software used was *SoundPLAN 8.2* with the CONCAWE algorithms selected, as they include the influence of meteorological conditions. Input data required in the model are listed below and discussed in *Section 3.1* to *Section 3.4*:

- Meteorological Information;
- Topographical data;
- Ground Absorption; and
- Source sound power levels.

3.1. Meteorological Conditions

Meteorological information utilised is provided in *Table 3-1* and is considered to represent worst-case conditions for noise propagation. At wind speeds greater than those shown, sound propagation may be further enhanced, however background noise from the wind itself and from local vegetation is likely to be elevated and dominate the ambient noise levels.

Table 3-1: Modelling Meteorological Conditions

Parameter	Day (7.00am to 7.00pm)[2]	Night (7.00pm to 7.00am)[2]
Temperature (°C)	20	15
Humidity (%)	50	50
Wind Speed (m/s)	4	3
Wind Direction[1]	All	All
Pasquil Stability Factor	E	F

Notes:

1. The modelling package allows for all wind directions to be modelled simultaneously.
2. The conditions above are as defined in *Guideline: Assessment of Environmental Noise Emissions*; May 2021

Alternatives to the above default conditions can be used where one year of weather data is available and the analysis considers the worst 2% of the day and night for the month of the year in which the worst-case weather conditions prevail (source: *Draft Guideline on Environmental Noise for Prescribed Premises*, May 2016). In most cases, the default conditions occur for more than 2% of the time and therefore must be satisfied.

3.2. Topographical Data

Topographical data was a combination of publicly available from *Google* in the form of spot heights and project supplied design levels. Ground level is set to be at "start of project" heights with no excavation or overburden removal which is considered worst case.

3.3. Ground Absorption

Ground absorption varies from a value of 0 to 1, with 0 being for an acoustically reflective ground (e.g. water or bitumen) and 1 for acoustically absorbent ground (e.g. grass). In this instance, a value of 0.6 has been used as an average across the study area e.g. wet sandy soil as would occur in winter.

3.4. Source Sound Levels

Source sound levels for equipment on site are listed in *Table 3-2* and are expected to include:

- 1x Cat D9/D8 Dozer for in pit work;
- 1x Excavator for Overburden work (Caterpillar 390);
- 1x Excavator for in-pit work (Komatsu PC1250);
- Water cart (Moxy 30t base);
- 1x Cat 16M graders (both shifts);
- Volvo FH16 Prime Mover HMC Delivery Trucks (3 per day);
- 6x-8x Moxy AH500 trucks (45T Tonne) to haul product between Pit, stockpiles and FPP;
- Wet Concentrator Plant (WCP);
- Cat 980 loader at feed preparation plant (FPP);
- 3x 1,800 KVA Generator Set; and
- Genset DCA-1100 (or equivalent) in silenced enclosure.

Table 3-2: Source Sound Power Levels, dB

Description	Octave Band Centre Frequency (Hz)								Overall dB(A)
	31.5	63	125	250	500	1k	2k	4k	
Genset 1750 KVA Insulated Enclosure with Acoustic Louvres (equivalent to 85 dB(A) at 1-metre)	83	87	86	83	83	86	86	84	**92**
Cat D9/D8 Dozer	101	112	111	108	110	103	101	99	**110**
Komatsu PC1250 Excavator	-	101	116	111	108	104	100	91	**110**
Caterpillar 390 Excavator	-	100	110	110	107	103	99	90	**109**
Cat 16M grader	109	103	104	100	93	95	96	92	**102**
Feed Process Plant (FPP) (*)	112	108	107	101	100	102	98	94	**106**
Wet Concentrator Plant (WCP) (*)	117	113	114	109	111	107	105	103	**113**
Moxy AH500 Articulated Dump Truck	105	101	109	105	101	102	100	94	**106**
HMC Truck Volvo FH16 Prime Mover Triple Wagon 60km/h	106	106	108	100	104	103	100	95	**108**
Water Cart	105	101	109	105	101	102	100	94	**106**

The following is noted in relation to *Table 3-2*:

- Source levels represent L_{10} noise level;
- Data marked (*) was derived from measurements undertaken at Image Resources Boonanarring Operations. All other data taken is from Lloyd George Acoustics library for similar projects;
- The WCP was modelled as a point source located 5 metres above ground level;
- Gensets were positioned near the WCP area, source heights at 2m above ground level;
- The Feed Preparation Plant (FPP) was modelled as a point source located 3 metres above ground level;
- The Gensets, FPP and WCP are generally grouped as "fixed plant" in the noise results; and
  Mobile plant sources were modelled as point sources 2 metres above ground level with the exception of the HMC and haul trucks which were modelled at 3 metres.
- When working in the South-Mid and Middle Areas the mining fleet comprises of 6x Moxy haul trucks and when in the north area this will expand to 8x Moxy haul trucks.

3.5. Day and Night Operations

The site is proposed to operate 24/7 with the same processes proposed to occur throughout the day and night. Such operations may include combinations of:

- Overburden (OB) removal (aka 'stripping') along with in-pit excavation and ore mining, noting that this activity is better performed with daylight (from 6.00am) and also utilises heavy earth moving machinery.
- Processing the ore will occur continuously at the WCP and the FPP.
- General extraction area of the pit (south-mid, middle and north) – refer *Figure 3-1* on following page. Note that these areas are an indicative grouping of actual pit stages for the site.
- When working in the South-Mid and Middle Areas the mining fleet comprises of 6x Moxy haul trucks and when in the north area this will expand to 8x Moxy haul trucks.
- At the time of this report writing, the South-Mid area is the southernmost (and therefore worst-case) work area for the pit and OB removal teams and as the mine progresses the work teams will progress north.

The pit topography is assumed to be at ore depth for a given work area, which is understood to be a minimum 6-metres below natural ground level.

3.6. Nearby Receiving Premises

At the time of preparing this report, Image Resources has been in contact with the land owner of the premises at R3 to the east of the mine site. It is understood to be unoccupied and has been for many years with removed utilities connections by the owner.

Furthermore, it is understood that Receivers R4 and R5 are engaged in a lease agreement with Image Resources such that the land will not be used as a residence during the operation of the mine.

Whilst predictions are provided for all five (5) residences, R1 and R2 remain the only occupied noise sensitive premises for assessment purposes.

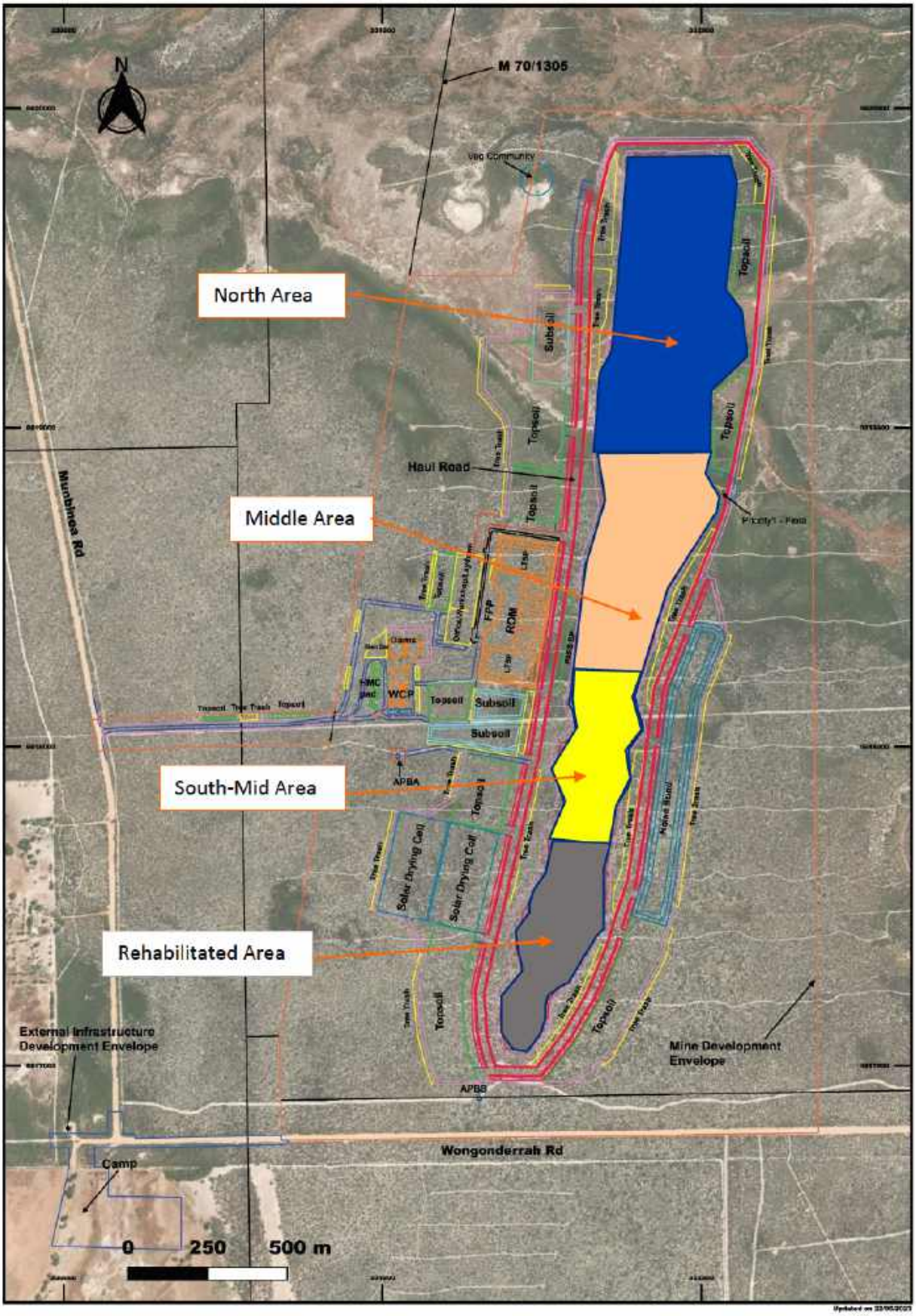


Figure 3-1: Mining Project Layout

4. RESULTS

4.1. All Operations

From advice provided for each pit stage, it is expected that overburden removal and ore extraction operations will occur simultaneously. It is also understood that overburden will be used as backfill for the pits which may occur concurrently with production and extraction. Minor intermittent operations are expected to occur during the daytime, such as vegetation clearing and odd jobs using smaller mobile plant (loader and excavator) for short periods. For the purposes of studying long term noise impacts, these have been excluded.

To represent the conservative scenario, ore mining and overburden works have been modelled simultaneously at all times. In reality, most extraction and overburden removal will start from 6.00am, which is technically during the night-time assessment period of the Noise Regulations.

In-pit plant were assumed to operate at Ore depth level, which is on average 6-metres below top soil level. In some cases Overburden plant may operate at 3-metres below top soil level. Haul trucks were assumed to travel from the excavation area to the soil stockpiles and to the FPP stockpile area and may therefore travel at-grade on access roads.

The results for the "All Operations" Scenario are provided in *Table 4-1 to Table 4-3* for the South-mid, Middle and North areas, respectively. Noise contour plots are also provided in *Figure 4-1* to *Figure 4-3*.

R3, R4, R5 are noted to be unoccupied premises, and are not used for residential purposes. As such, these receivers have been included in the assessment for information purposes only and should therefore not be regarded as a "highly noise sensitive area."

Table 4-1: All Operations Predicted Levels, dB L_{A10} – South-Mid Area

Receiver	Night-time Assigned Level	Overall	Extraction Operations	Fixed Plant	Overburden Removal	Haul Trucks
R1	**35**	**30**	25	25	22	23
R2	**35**	**19**	12	14	11	13
R3*	**60**	**39**	35	28	32	34
R4[+]	**60**	**38**	32	35	29	29
R5[+]	**60**	**37**	31	34	29	30

*R3 is noted to be unoccupied and therefore is included for information purposes (non-highly noise sensitive);

[#]R4 and R5 are currently leased by the mine operator and are not used as residences for the life of the mine;

It is unlikely that tonality would be detectable for a majority of meteorological cases and at the distances concerned. However, the worst noise level is 30 dB L_{A10} at R1 which, even with the +5 Tonality adjustment is compliant at night.

Table 4-2: All Operations Predicted Levels, dB L_{A10} – Middle Area

Receiver	Night-time Assigned Level	Overall	Extraction Operations	Fixed Plant+	Overburden Removal	Haul Trucks
R1	**35**	**29**	22	25	22	22
R2	**35**	**19**	13	14	11	15
R3*	**60**	**38**	32	28	32	34
R4+	**60**	**37**	26	35	28	28
R5+	**60**	**36**	28	34	28	27

*R3 is noted to be unoccupied and therefore is included for information purposes (non-highly noise sensitive);

#R4 and R5 are currently leased by the mine operator and is not used as a residence for the life of the mine;

Once again, it is unlikely that tonality would be detectable for a majority of meteorological cases and at the distances concerned. However, the worst noise level is 30 dB L_{A10} at R1 which, even with the +5 Tonality adjustment is compliant at night.

Table 4-3: All Operations Predicted Levels, dB L_{A10} – North Area

Receiver	Night-time Assigned Level	Overall	Extraction Operations	Fixed Plant+	Overburden Removal	Haul Trucks
R1	**35**	**28**	18	25	21	22
R2	**35**	**25**	20	14	20	20
R3*	**60**	**37**	29	28	33	33
R4+	**60**	**37**	25	35	29	29
R5+	**60**	**36**	24	34	27	28

*R3 is noted to be unoccupied and therefore is included for information purposes (non-highly noise sensitive);

#R4 and R5 are currently leased by the mine operator and is not used as a residence for the life of the mine;

+Fixed plant noise is assumed to be tonal at all receptors and therefore a +5 dB adjustment is applied to this result column.

From the results, mining operations in the South-Mid pit area represent the worst case noise levels. However, the results demonstrate that noise from mining operations in all pit areas comply with assigned levels at all times. It is understood that the pumps associated with the WCP are the greatest noise contributors and while they have been modelled as point sources at 5m above ground level, in reality these are closer to the ground, nominally 1m above ground level and positioned on the east side of the WCP structure. Furthermore, the modelled WCP level is based on noise levels measured at the Boonanarring mineral sands operation, which utilises more pump units. The new WCP at Atlas utilises more modern pump technology and lower power outputs. Therefore, it is considered that the modelling outcome is an overestimation and actual noise levels are expected to be lower. In any case, the modelling demonstrates that fixed plant are compliant at all times.

Figure 4-1 South-Mid Area, Mining Noise Levels, dB L_{A10}

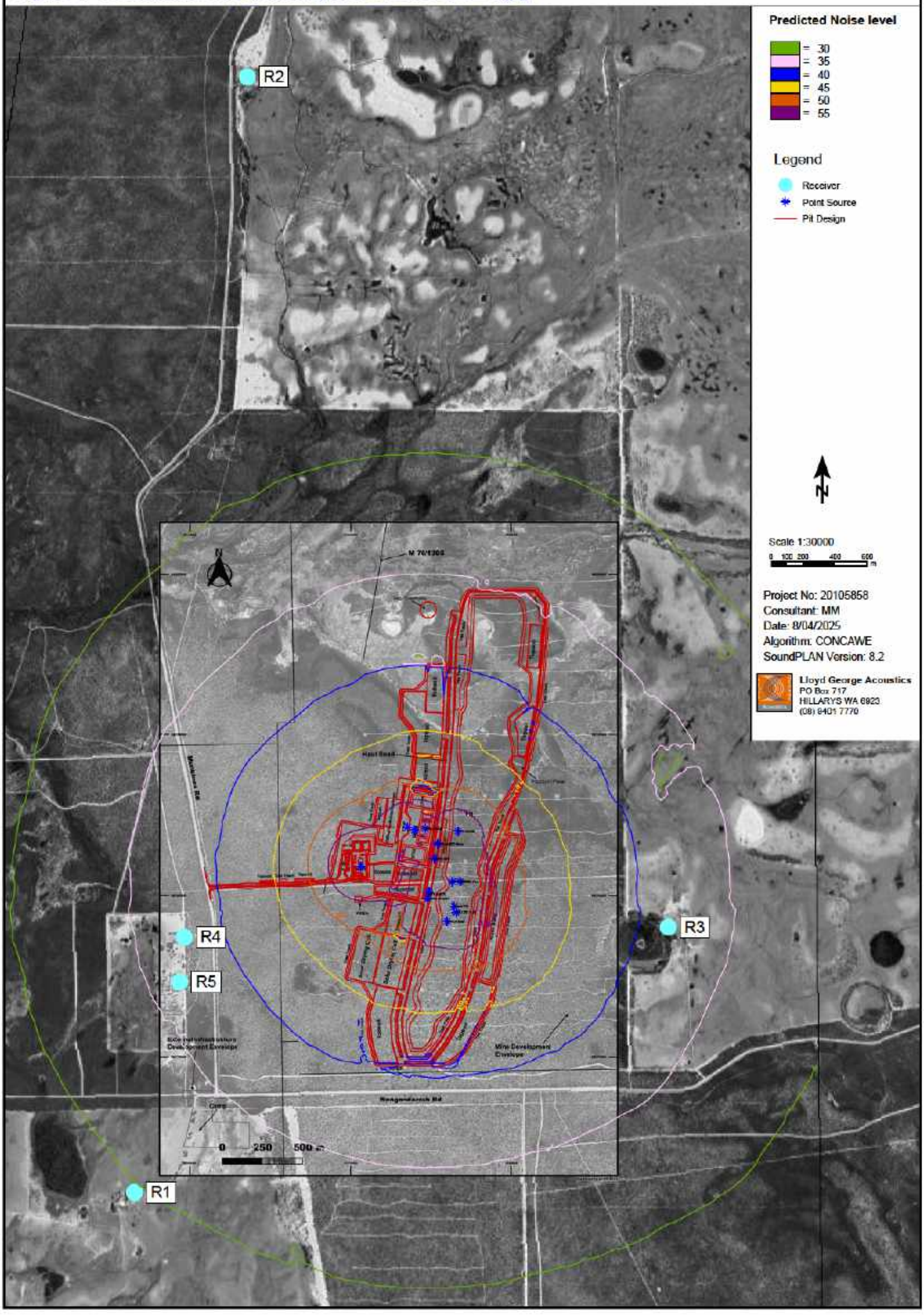


Figure 4-2 Middle Area, Mining Noise Levels, dB L_{A10}

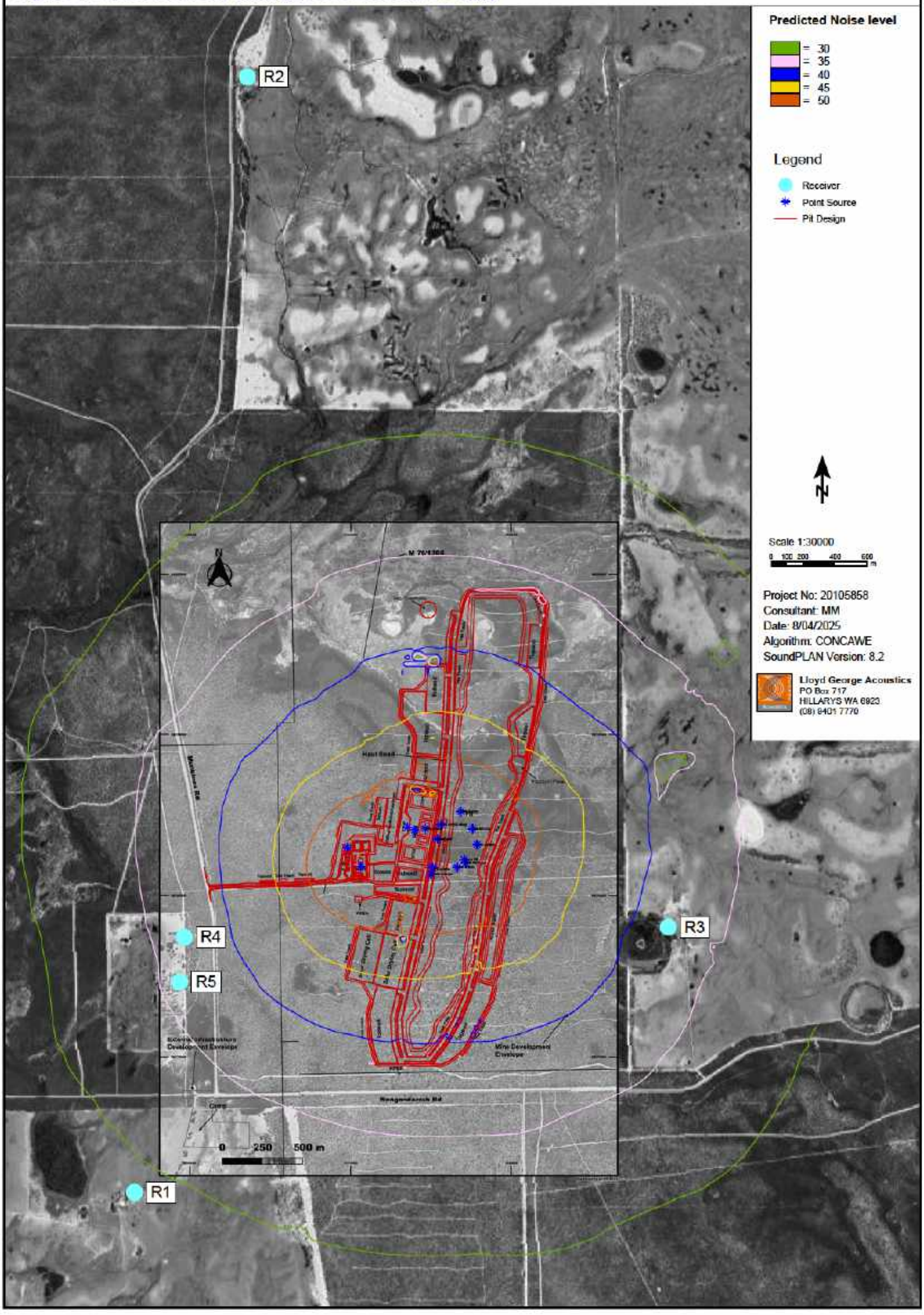
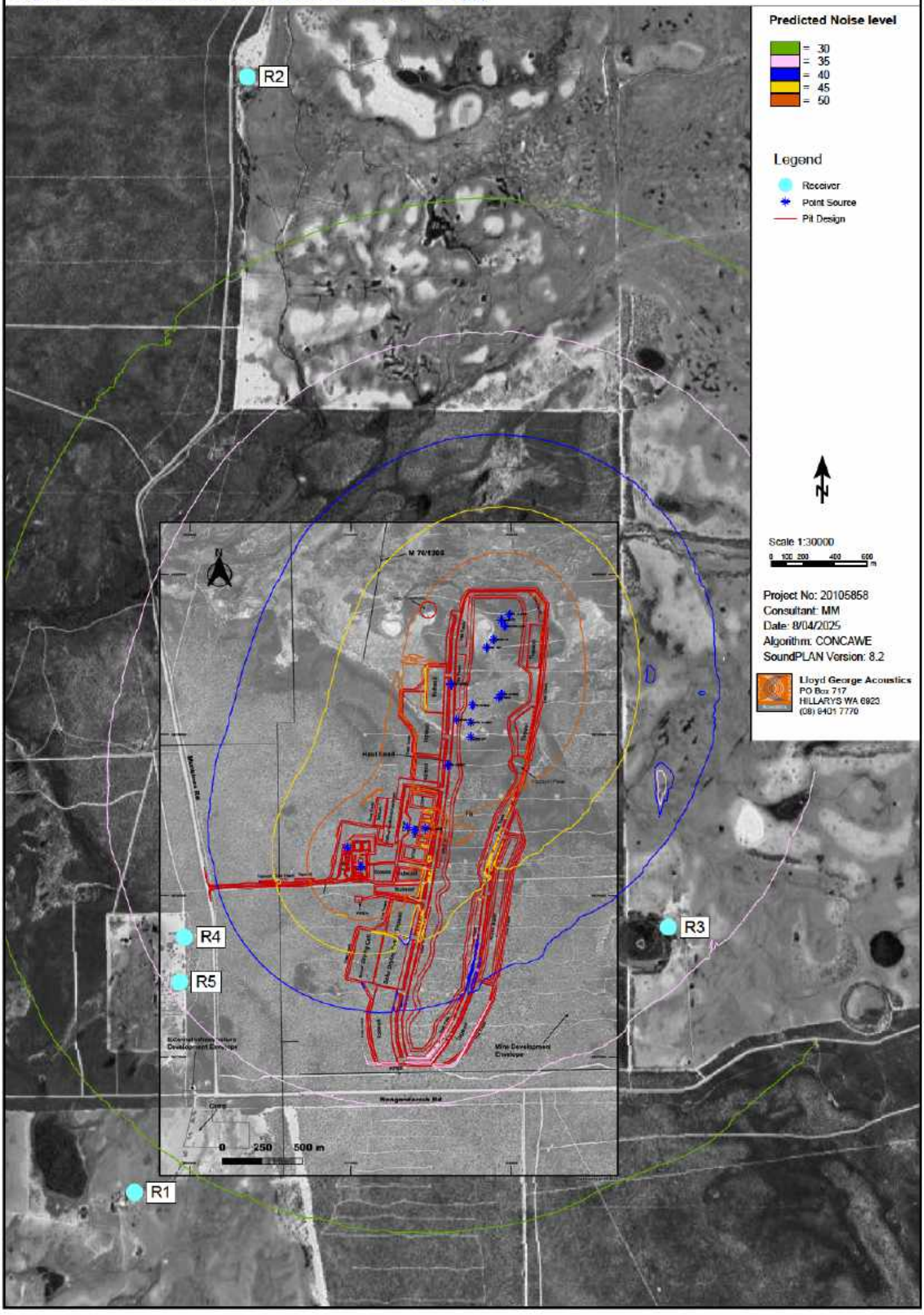


Figure 4-3 North Area, Mining Noise Levels, dB L_{A10}



4.2. HMC Trucks

As ore is processed, 6 to 8 HMC Trucks visit the site in a 24-hour period to cart it off site (staggered such that there are generally no more than 2-3 trucks on site at a given time). An access road of approximately 750m length is proposed to connect the mine site to public roads. This will be an unsealed road, with a speed limit of 60km/h. As the empty trucks enter the site compound, a 25 km/h speed limit is assumed, where upon the trucks are loaded with processed ore and then leave via the same road and onto Munbinea Road.

A study of noise impacts of these trucks has been completed, using a time-history method which allows for a moving source at assumed speeds. From this analysis, noise levels can be determined at the nearest receivers, for the L_{max}, L_1 and L_{10} parameters in a 4-hour representative assessment period. *Table 4-5* outlines the results of this analysis, assuming all trucks arrive in succession, taking 4 minutes to traverse the road and park on site, 10 minutes to load, and 4 minutes to return to the public road.

Figure 4-6 shows a contour noise plot (non-cumulative) of the truck source following a path to site to be used for illustrative purposes only.

Table 4-4: Predicted Noise Levels, dB – HMC Truck Haulage

Receiver	L_{A10}	L_{A1}	L_{Amax}
R1	20	23	23
R2	8	9	9
R3*	23	24	24
R4^{+}	31	43	45
R5^{+}	30	38	38

*R3 is noted to be unoccupied and therefore is included for information purposes (non-highly noise sensitive);

#R4 and R5 are currently leased by the mine operator and is not used as a residence for the life of the mine;

The L_{A1} noise level is most critical for assessment since at R4 (residence nearest to site entry) is the highest level relative to assigned level. Therefore, only the L_{A1} level needs to be assessed for compliance in *Table 4-6* below.

Table 4-5: Assessment of HMC Truck Predicted Levels, dB L_{A1}

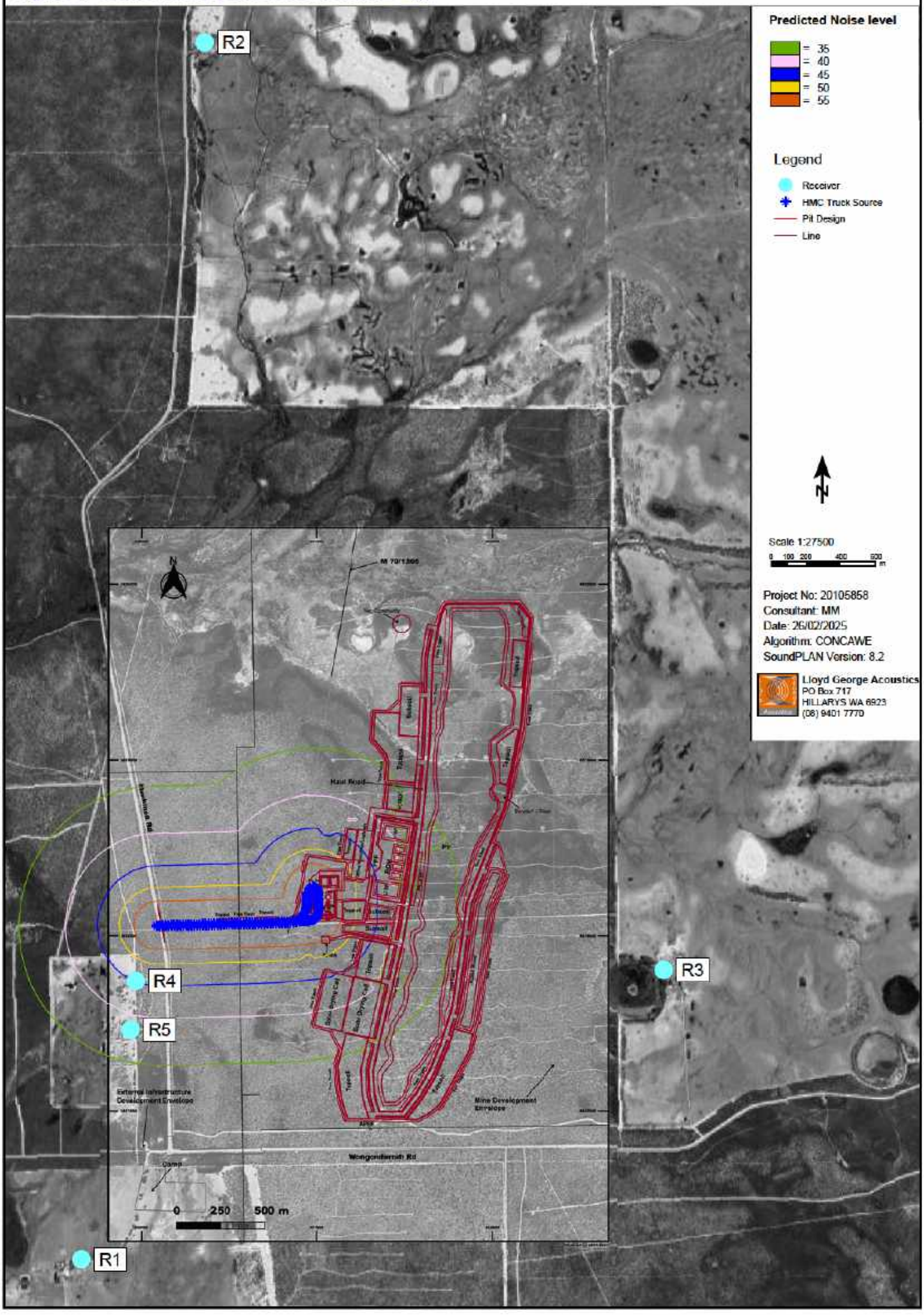
Receiver	Truck Moving, L_{A1}	Day Assigned Level	Evening Assigned Level	Night Assigned Level	Exceedence
R1	**23**	55	50	45	*Complies*
R2	**9**	55	50	45	*Complies*
R3*	**24**	75	75	75	*Complies*
R4[+]	**43**	75	75	75	*Complies*
R5[+]	**38**	75	75	75	*Complies*

*R3 is noted to be unoccupied and therefore is included for information purposes (non-highly noise sensitive);

[#]R4 and R5 are currently leased by the mine operator and is not used as a residence for the life of the mine;

It is demonstrated that noise levels for HMC haulage comply at all times. The truck noise levels are not considered tonal due to the range in RPMs and as an L_1 the 8 dB rule applies.

Figure 4-5 HMC Haulage Noise Levels, dB L_{A1}



5. CONCLUSIONS

An assessment of the noise emissions from the proposed Atlas Project has been undertaken by way of noise modelling including various operational scenarios and HMC truck haulage.

Noise emissions were predicted based on file data for similar equipment, with some data taken from plant already in use at the Boonanarring mine site, including the WCP. Where detailed design of the mine results in equipment and process changes, these should be followed up with additional noise modelling.

The modelling indicates that compliance with the *Environmental Protection (Noise) Regulations 1997* is likely to be achieved at all times. Overburden removal and ore extraction in the pit may occur from 6.00am (night-time) and this is shown to be compliant.

HMC Truck haulage has been analysed and demonstrated to comply on the basis of 3 trucks arriving and exiting the site in a given four-hour period. This is noted to be a noise event that is more intermittent in nature given the long time between haulage to Bunbury and return, but with increased HMC haulage traffic the study may need to be revisited in future.

Note that the modelling has assumed worst case terrain, i.e. the pits are in the first stages of ore extraction so sources are at higher relative levels. As stages progress, the ore level becomes deeper and sources within the pits will become progressively quieter. It is understood that in the South area, for example, extraction will get as low as 12 metres below ground level.

Finally, it is noted that private agreements with some local land ownders have been established, with the view to have properties vacated (and not used for residential purposes) during specific operations or phases of development, or for the duration of the entire project.

Appendix A – Terminology

The following is an explanation of the terminology used throughout this report:

- **Decibel (dB)**

The decibel is the unit that describes the sound pressure levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

- **A-Weighting**

An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A, dB.

- **Sound Power Level (L_w)**

Under normal conditions, a given sound source will radiate the same amount of energy, irrespective of its surroundings, being the sound power level. This is similar to a 1kW electric heater always radiating 1kW of heat. The sound power level of a noise source cannot be directly measured using a sound level meter but is calculated based on measured sound pressure level at known distances. Noise modelling incorporates source sound power levels as part of the input data.

- **Sound Pressure Level (L_p)**

The sound pressure level of a noise source is dependent upon its surroundings, being influenced by distance, ground absorption, topography, meteorological conditions etc. and is what the human ear actually hears. Using the electric heater analogy above, the heat will vary depending upon where the heater is located, just as the sound pressure level will vary depending on the surroundings. Noise modelling predicts the sound pressure level from the sound power levels taking into account ground absorption, barrier effects, distance etc.

- **L_{ASlow}**

This is the noise level in decibels, obtained using the A-frequency weighting and the S (slow) time weighting. Unless assessing modulation, all measurements use the slow time weighting characteristic.

- **L_{AFast}**

This is the noise level in decibels, obtained using the A-frequency weighting and the F (fast) time weighting. This is used when assessing the presence of modulation.

- **L_{APeak}**

This is the greatest absolute instantaneous sound pressure level in decibels using the A-frequency weighting.

- **L_{Amax}**

An L_{Amax} level is the maximum A-weighted noise level during a particular measurement.

- **L_{A1}**

The L_{A1} level is the A-weighted noise level exceeded for 1 percent of the measurement period and is considered to represent the average of the maximum noise levels measured.

- **L_{A10}**

The L_{A10} level is the A-weighted noise level exceeded for 10 percent of the measurement period and is considered to represent the "intrusive" noise level.

- **L_{A90}**

The L_{A90} level is the A-weighted noise level exceeded for 90 percent of the measurement period and is considered to represent the "background" noise level.

- **L_{Aeq}**

The equivalent steady state A-weighted sound level ("equal energy") in decibels which, in a specified time period, contains the same acoustic energy as the time-varying level during the same period. It is considered to represent the "average" noise level.

- **One-Third-Octave Band**

Means a band of frequencies spanning one-third of an octave and having a centre frequency between 25 Hz and 20000 Hz inclusive.

- **Representative Assessment Period**

Means a period of time not less than 15 minutes, and not exceeding four hours, determined by an inspector or authorised person to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission.

- **L_{Amax} assigned level**

Means an assigned level, which, measured as a L_{ASlow} value, is not to be exceeded at any time.

- **L_{A1} assigned level**

Means an assigned level, which, measured as a L_{ASlow} value, is not to be exceeded for more than 1 percent of the representative assessment period.

- **L_{A10} assigned level**

Means an assigned level, which, measured as a L_{ASlow} value, is not to be exceeded for more than 10 percent of the representative assessment period.

- **Tonal Noise**

A tonal noise source can be described as a source that has a distinctive noise emission in one or more frequencies. An example would be whining or droning. The quantitative definition of tonality is:

– the presence in the noise emission of tonal characteristics where the difference between -

(a) the A-weighted sound pressure level in any one-third octave band; and

(b) the arithmetic average of the A-weighted sound pressure levels in the 2 adjacent one-third octave bands,

is greater than 3 dB when the sound pressure levels are determined as $L_{Aeq,T}$ levels where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as $L_{A\ Slow}$ levels.

This is relatively common in most noise sources.

- **Modulating Noise**

A modulating source is regular, cyclic and audible and is present for at least 10% of the measurement period. The quantitative definition of modulation is:

– a variation in the emission of noise that —

(a) is more than 3 dB $L_{A\ Fast}$ or is more than 3 dB $L_{A\ Fast}$ in any one-third octave band; and

(b) is present for at least 10% of the representative assessment period; and

(c) is regular, cyclic and audible.

- **Impulsive Noise**

An impulsive noise source has a short-term banging, clunking or explosive sound. The quantitative definition of impulsiveness means:

– a variation in the emission of a noise where the difference between L_{Apeak} and L_{Amax} is more than 15 dB when determined for a single representative event.

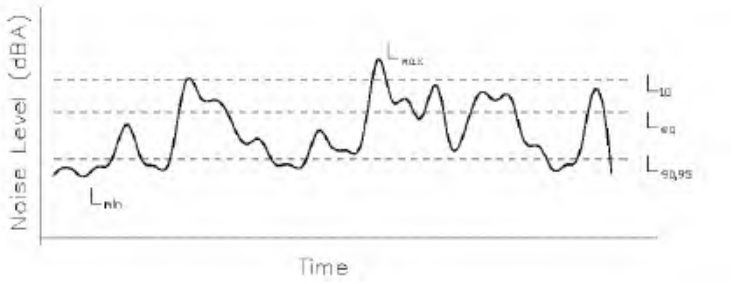
- **Major Road**

Is a road with an estimated average daily traffic count of more than 15,000 vehicles.

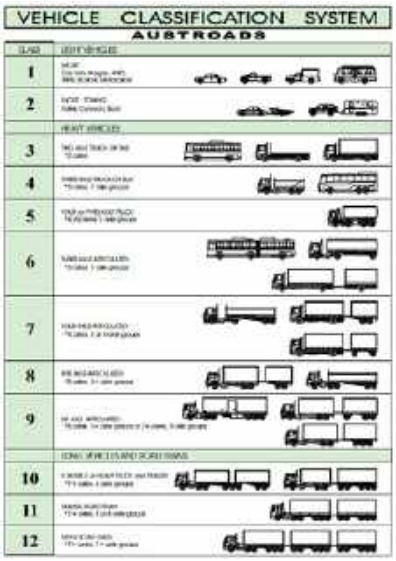
- **Secondary / Minor Road**

Is a road with an estimated average daily traffic count of between 6,000 and 15,000 vehicles.

- **Chart of Noise Level Descriptors**



- **Austroads Vehicle Class**



- **Typical Noise Levels**