CHAPTER 16
NOISE

BIRD IN HAND GOLD PROJECT
MINING LEASE PROPOSAL

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All maps presented in this chapter are in GDA94 / MGA zone 54 (EPSG: 28354) unless otherwise stated.

16 NOISE

The Bird in Hand Gold Project ('the Project' or 'BIHGP') area is located within a rural industry area, with pockets of rural living. Noise is predominantly human induced agricultural noise from machinery, waste water treatment, aircraft as well as road traffic. Naturally occurring wind noise is also present.

This chapter describes how the introduction of new mining related noise sources would affect the existing noise levels in the area at sensitive receptor locations. It provides a comparison of predicted noise levels against regulatory limits, both legislative and proposed. Design measures and management strategies that will be implemented during mining operations have been outlined, as well as potential impact events associated with noise which could reasonably occur through construction, underground development and ore production. Closure has been considered, however will be of lesser impact than construction, as it involves very minimal earthworks, and the removal of some mining infrastructure, while other infrastructure is planned to remain as a commercial asset.

AECOM Australia Pty Ltd (AECOM) was engaged by Terramin to assess the effect of construction and operational noise from the proposed BIHGP upon neighbouring noise sensitive receptors.

The Pre-construction Noise Monitoring Reports are located in Appendix O1, O2 and O4

The Noise Impact Assessment is located in Appendix O3.

The potential effects of noise from the project on fauna is addressed in Chapter 18.

16.1 APPLICABLE LEGISLATION AND STANDARDS

The Environment Protection (Noise) Policy 2007 (Noise EPP) provides noise criteria in order to comply with the general environmental duty as defined by Section 25 of the South Australian *Environment Protection Act 1993* (SA) (EP Act), based on the land uses principally promoted by the relevant development plan.

Noise sensitive receptors are broadly defined in the Noise EPP as *premises that are in separate occupation from the noise source and used for residential or business purposes; or constitute a quiet ambient environment set aside as a park or reserve or for public recreation or enjoyment.*

In the area surrounding the proposed site, sixteen residential properties have been included in this assessment. Two additional wineries and a cellardoor have been included as noise sensitive receptors for the day time noise assessment.

The receptors that have been assessed have been identified in section 16.5: Sensitive Receptors.

The proposed Mining Lease (ML) and the nearest noise-sensitive receptors are all located within the Watershed (Primary Production) Zone with Onkaparinga Valley Policy Area, as defined under the Adelaide Hills Council Development Plan.

The Watershed (Primary Production) Zone makes reference to both Rural Industry and Rural Living land uses but the Onkaparinga Valley Policy Area specifically excludes rural living. Therefore, the land use principally promoted by the development plan is Rural Industry.

Under the Noise EPP, the applicable noise criteria for all businesses located in this area is presented in Table 16-1.

TABLE 16-1 | ADELAIDE HILLS RURAL INDUSTRY NOISE CRITERIA

Receptor zone	Noise level at noise-sensitive receptors	
	Day[1]	Night[1]
Watershed (Primary Production)	L_{Aeq} 57 dB(A)	L_{Aeq} 50 dB(A)

Note:

1. The Noise EPP defines day time as between 7.00 am and 10.00 pm on the same day and night time as between 10.00 pm on one day and 7.00 am on the following day.

The Noise EPP also requires that the measured source noise level must be adjusted by the following amounts if the noise source contains modulation, tonal, impulsive or low-frequency characteristics:

- 1 characteristic: +5 dB(A);
- 2 characteristics: +8 dB(A); and
- 3 or 4 characteristics: +10 dB(A).

Under Part 5, Section 20 of the Noise EPP, where a development application is being sought under the *Development Act 1993* the predicted source noise level for the development should not exceed the relative indicative noise level from Section 5 (as outlined in Table 16-1), less 5 dB(A) (i.e. 52 dB(A) during the day and 47 dB(A) during the night).This Section of the Noise EPP does not apply to the BIHGP as approval is being sought under the *Mining Act 1971*, not the *Development Act 1993*; however, Terramin are electing to adopt this noise level criteria for the ore production (operational) phase of the project in order to provide a better acoustic amenity outcome for the surrounding community.

The acoustic assessment for the BIHGP has been broken down into three scenarios, which have been listed with their associated noise criteria in Table 16-2. This noise criteria is consistent with the Noise EPP recommendations for Rural Industry during surface construction (Year 0-1) and underground development (Year 1-2), and consistent with the Noise EPP recommendations development applications under the *Development Act 1993* during ore production (Year 2-7).

TABLE 16-2 | LIST OF MODELLED SCENARIOS AND THE ASSOCIATED NOISE CRITERIA

Scenario Description	Time Period	Project Noise Criteria $L_{Aeq, 15min}$
Surface construction (Year 0-1)	Day time only	57 dB(A)
Underground development (Year 1-2)	Day time	57 dB(A)
	Night time	50 dB(A)
Ore production (Year 2-7)	Day time	52 dB(A)
	Night time	45 dB(A)

16.2 EXPLANATION OF NOISE TERMS AND UNITS

As explained in the *Guidelines for the Use of the Environment Protection (Noise) Policy 2007* (EPA 2009), noise is commonly defined as unwanted sound. Sound is produced by small fluctuations in air pressure. The loudness of a sound is predominantly related to the size of the fluctuations, but is also

related to their frequency, or the rate at which they are produced. This description is more commonly known as soundwaves.

The loudness of sounds can range from those which the human ear can just detect (the threshold of hearing) to those that exceed a threshold of pain. Given that sound is produced by changes in air pressure, the international standard unit of sound pressure is a pressure measurement, the micropascal (µPa).

The range between the faintest audible sound and the loudest sound the human ear can stand is so large (20 µPa to 63 million µPa), it is preferred to express sound pressure fluctuations on a logarithmic scale, more commonly known decibel (dB).

Given the logarithmic scale, a doubling of the sound pressure, say from 20 µPa to 40 µPa, produces an increase of 6 dB. In subjective terms, a 3 dB increase is often described as a just noticeable difference.

The frequency of a sound is the rate at which the fluctuations are produced per second. Practically all sounds contain a mixture of frequencies and the mix of frequencies affects the perceived loudness. A high-frequency sound (e.g. screeching or whistling) at the same sound pressure level as a low frequency sound (e.g. thunder) will be perceived to be louder. This is because the human ear is most sensitive to mid-range and high frequencies and is less sensitive to the lower frequencies.

To ensure measured levels approximate the human response, a weighting scale is used. It is known as the 'A' scale and the units are referred to as 'A' weighted decibels and written as dB(A). The dB(A) scale discriminates between sounds in much the same way as people do. Some examples of typical sound levels in dB(A) are shown in Figure 16-1.

Analysis of existing and predicted noise levels are expressed in dB(A) within this chapter.

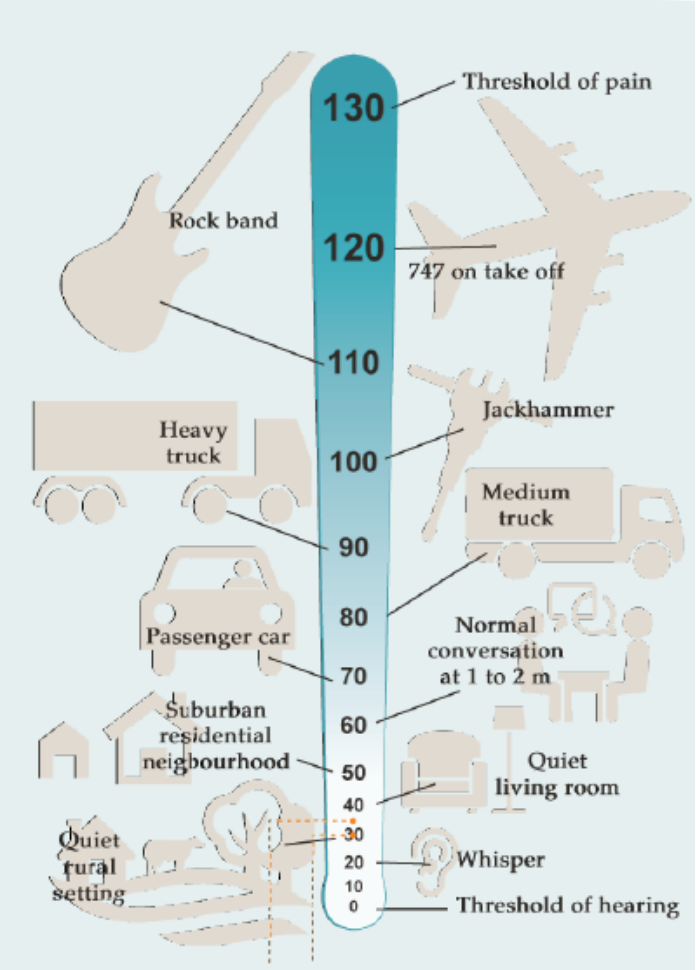

FIGURE 16-1 | DECIBEL NOISE SCALE

16.3 ASSESSMENT METHOD

The methodology includes baseline noise monitoring, acoustic modelling, and assessment against the proposed noise measureable criteria for the Project stages.

16.3.1 BASELINE NOISE ASSESSMENT

The noise baseline program included the deployment of four remote standalone noise loggers for two one-week long periods in September-October 2014, February-April 2015, March 2016 and April 2018. The locations of the noise loggers are shown in Figure 16-2. In addition, attended noise measurements utilising handheld portable noise loggers were undertaken at the four monitoring locations on Thursday, 9 October 2014 and on Thursday, 5 March 2015.

Rion ML21 sound level meters were utilised throughout data collection, as well as B & K 2250 and 4231 sound level meters during 2014, 2015 and 2016. In 2018 ARL Ngara noise monitors were utilised.

Details on the equipment used to collect the data and the calibration certificates of the equipment is included in both Appendix O1, O2, and O4.

FIGURE 16-2 | LOCATIONS OF NOISE LOGGERS AT SENSITIVE RECEPTORS TO THE PROPOSED OPERATION (WSP, 2018)

16.3.2 Modelled Scenarios

The BIHGP has proposed times of operation spanning twenty-four hours per day, seven days per week. Both day time and night time scenarios were modelled as site activities are slightly different for each period (not all operations will be occurring during the night time period).

The Noise EPP defines Day time as being between 7am and 10pm on the same day, while night time is defined as between 10pm on one day and 7am on the following day.

The scenarios that have been modelled include the following:

1. Surface construction (day time only);
2. Underground development (day time);
3. Underground development (night time);
4. Ore production (day time); and
5. Ore production (night time).

Prediction of noise levels from the mine during mine development and operation were undertaken using SoundPLAN version 7.4 environmental noise modelling software.

The following sections outline the inputs that were included in the acoustic model.

16.3.2.1 TERRAIN

The terrain in the model is based on surveyed one-metre elevation contour lines of the project area and five-metre elevation contour lines for the Onkaparinga Valley sourced from AECOM's internal database.

16.3.2.2 GROUND ABSORPTION

All cleared or developed ground onsite has been modelled as 50% acoustically absorptive with the remaining areas and surrounding properties modelled as 80% acoustically absorptive.

16.3.2.3 METEOROLOGICAL CONDITIONS

Meteorological conditions such as the presence of a temperature inversion or light to moderate winds can have a significant effect on sound propagation.

Temperature inversions (i.e. when the normal temperature profile of the atmosphere is reversed such that the air temperature increases with increasing height above ground) typically occur at night and tend to assist the propagation of noise. Likewise, a light to moderate wind (i.e. 1 to 3 m/s) from the source to the receptor tends to assist the propagation of noise to the receptor, while the impact of noise for any receptors in the opposite direction would be reduced. For higher wind speeds, the wind becomes too turbulent to effectively assist the propagation of noise, and background noise levels tend to increase, masking any increases in noise level due to wind-assisted propagation.

Noise levels were predicted with meteorological Category 5 during the day time and Category 6 during the night time as required by the Noise EPP.

16.3.2.4 NOISE SENSITIVE RECEPTORS

Noise levels at each noise sensitive receptor were predicted external to the buildings and at a height of 1.5 metres above ground in accordance with the measurement locations outlined in Section 12 of the Noise EPP.

16.3.2.5 ON-SITE BUILDINGS AND STRUCTURES

On-site structures included in the model:

- Workshop: - 30.0 m long x 20.0 m wide x 7.0 m high, with 2 x (5.0 m wide x 5.0 m high) roller doors on the north-eastern façade.
- Batching Plant: - 6.0 m long x 10.0 m wide x 6.0 m high.
- Dam Water Pump in Shed.
- Water Processing Plant Pump in Shed.
- Wash-down Pad Pump in Shed.
- Administration Office with kitchen, crib and muster space.

More detailed information on the construction materials is located in Appendix O3: Noise Impact Assessment.

16.3.2.6 NOISE SOURCES

Under the Noise EPP, noise from the source is assessed over a continuous 15-minute period. Where a noise source is not expected to operate continuously over a 15-minute period, adjustments are applied to account for duration to calculate an effective noise level over the time period.

The continuous 15-minute period assumes all activities are being undertaken simultaneously onsite at their highest noise level – this is considered as a credible worst case scenario. For example, this includes during construction, 5 trucks, 2 excavators, 2 cranes, a scraper, a grader, a road paver and a roller all operating simultaneously. In reality, this is possible, however very unlikely to all occur at once. The project must therefore meet the noise objectives *even if* all equipment is operating at the same time, making the assessments conservative in nature.

Ore development and ore production includes activities which will run continuously through both day and night time, however then have an extra component of activities which will be undertaken throughout day time additional to the Daytime and Night Time components.

Table 16-3, Table 16-4, and Table 16-5 provide details of each noise source, including their assumed operation times during the modelled worst-case (i.e. highest noise level) 15-minute period for the surface construction, underground development and ore production scenarios respectively.

More detailed information on the noise levels predicted for each piece of equipment is located in Appendix O3: Noise Impact Assessment.

TABLE 16-3 | CONSTRUCTION: WORST CASE MODEL

Item/ Activity	Details	Operation Times
Daytime Surface Construction		
Trucks	2 x trucks located along the site access road	Continuous
Excavators	2 x excavators; 1 x located at the box cut and 1 x located at the dam	Continuous
Franna cranes	2 x franna cranes; 1 x located at the office/workshop and 1 x located at the water treatment plant	Continuous
Scraper	1 x scraper located along the mounds	Continuous
Grader	1 x grader located along the site roads	Continuous
Cement trucks	2 x cement trucks; 1 x located at the office/workshop and 1 x located at the box cut	Continuous
Road paver	1 x road paver located on the site access road	Continuous

Item/ Activity	Details	Operation Times
Water truck	1 x water truck located along the site roads	Continuous
Roller	1 x roller located along the site roads	Continuous

TABLE 16-4 | DEVELOPMENT: WORST CASE MODEL

Item/ Activity	Details	Operation Times
Daytime and Night Time Underground Development		
Ventilation fans	• Twin 110kW mine development fans located at the tunnel entrance. • Fans will be treated with silencer.	Continuous
Articulated dump truck (ADT) movements	2 x ADT will travel between the box cut and the top of the IML.	Each ADT will travel at 10 km/hr and remain at the IML for 1 minute allowing for positioning and unloading.
Integrated Tool Carrier (IT) movements	IT will travel between the tunnel and the workshop.	IT will travel at 10 km/hr and idle at the workshop for 5 minutes.
Cement mixing truck movements	Cement truck will travel between the tunnel and the batching plant.	Cement truck will travel at 10 km/hr and idle at batching plant for 5 minutes for loading.
Additional surface plant	• 2 x light vehicles idling. • Air compressor.	Continuous
Structures	The following structures with dimensions and construction as specified in Appendix O3. • Workshop. • Batching Plant. • Raw Water Pump Shed. • Water Processing Plant Shed. • Wash-down Pad Pump Shed.	Continuous
Additional Daytime Underground Development Activities		
Raise borer	Raise Borer was individually modelled excavating at each of the magazine shaft, primary ventilation shaft and underground escape-way raise.	Continuous
Drill rig (surface / services / longhole)	Drill rig at laydown area.	Continuous
Delivery truck	Delivery truck will travel between site entry and workshop.	Delivery truck will travel at 15 km/hr and idle at workshop/ amenities area for 5 minutes.

Item/ Activity	Details	Operation Times
Front end loader	Front end loader with low sound package located centrally on top of IML.	Continuous
Additional surface plant	• Forklift at workshop. • Water truck at laydown area.	Continuous

TABLE 16-5 | PRODUCTION: WORST CASE MODEL

Item/ Activity	Details	Operation Times
Daytime and Night Time Ore Production		
Ventilation fans	Primary ventilation fans: • Primary fans are located approximately 100 metres below the ground and exhaust vertically at 6 metres above the ground from 4000 mm diameter circular shaft. • Primary fans will be treated with silencers. Magazine ventilation fans: • Magazine fans are located approximately 50 metres below the ground and exhaust vertically at 5 metres above the ground from 1800 mm diameter circular shaft.	Continuous
Articulated dump truck (ADT) movements	Both ore haulage and waste haulage will occur: Ore haulage: • 1 x ADT will travel between the tunnel and the surge bin. Waste haulage: • 1 x ADT will travel between the tunnel and top of the IML.	• Each ADT will travel at 10 km/hr. • Each ADT will remain at the unloading point (surge bin / top of IML) for 1 minute allowing for positioning and unloading.
ROM bin and conveyer	Conveyers are push-button or equivalent operation rather than continuous operation with conveyer drives located at the head of each conveyer.	Assumed the following during the 15-minute period: • Ore dropping into surge bin for 15 seconds.(1) • Conveyer AF2 and CV1 will each operate for 3 minutes.
Integrated tool carrier (IT) movements	IT will travel between the tunnel and the workshop.	IT will travel at 10 km/hr and idle at the workshop for 5 minutes.
Cement mixing truck movements	Cement truck will travel between the tunnel and the batching plant.	Cement truck will travel at 10 km/hr and idle at batching plant for 5 minutes for loading.

Item/ Activity	Details	Operation Times
Additional surface plant	• 2 x light vehicles idling. • Air compressor.	Continuous
Structures	The following structures with dimensions and construction as specified in Appendix O3. • Workshop. • Batching Plant. • Sheds for Raw Water Pump. • Water Processing Plant Shed. • Wash-down Pad Pump Shed.	Continuous
Additional Daytime Ore Production Activities		
Haul truck movements	2x Haul trucks will each enter site, drive to the loading point and exit site.	Each haul truck will travel at 15 km/hr and idle at the loading point for 2 minutes allowing for loading. One haul truck will idle for an additional 2 minutes waiting for first truck.
Additional conveyer and bin operation	Conveyers are push-button or equivalent operation rather than continuous operation with conveyer drives located at the head of each conveyer.	Assumed the following during the 15-minute period: • Bin 3 and 4 each loading ore into trailers for 10 seconds per trailer. • Conveyer AF3 and CV2 will each operate for 3 minutes.
Delivery truck	Delivery truck will travel between site entry and the workshop.	Delivery truck will travel at 15 km/hr and idle at workshop/ amenities area for 5 minutes.
Front end loader	Front end loader with low sound package located centrally on top of IML.	Continuous
Additional surface plant	• Forklift at workshop • Water truck at laydown area	Continuous

16.4 EXISTING ENVIRONMENT

Terramin commenced the baseline collection of noise measurements in September 2014. The purpose of the noise monitoring program was to characterise the background noise environment in the vicinity of the proposed project site, prior to the commencement of operations.

The noise baseline program included the deployment of four remote standalone noise loggers for two one-week long periods in September-October 2014, February-April 2015, March 2016 and April 2018. The locations of the noise loggers are shown in Figure 16-2. In addition, attended noise measurements utilising handheld portable noise loggers (that is, noise measurements by an independent acoustic professional) were undertaken at the four monitoring locations on Thursday, 9 October 2014 and on

Thursday, 5 March 2015. The timing of the monitoring was selected to correspond with periods, both outside of- and during- the vintage season of the local viticulture industry.

Results have been tabulated for each location, and include the following noise descriptors:

- Highest measured LAeq, 15min, daytime and night time;
- Lowest measured LAeq, 15min, daytime and night time;
- Median LAeq, 15min, daytime and night time;
- Daytime and night-time ABL;
- Highest night time LAmax;
- LAeq, 15hr (day time); and
- LAeq, 9hr (night time).

LAeq	Equivalent (energy averaged) noise level measured over a time period. This noise descriptor is commonly used in environmental noise policies and assessments. The time period the measurement is averaged over may be included in the subscripted, i.e. LAeq,15min.
ABL	Assessment Background Level. The 10th percentile of the LA90 noise levels recorded over the measurement period.
LAmax	The maximum A-Weighted noise level recorded over a measurement period.

Daytime hours are from 7am to 10pm. Night-time hours are from 10pm to 7am, and noise descriptors are reported for the date the measurement started.

The noise logging results are summarised in Table 16-6 (daytime) and Table 16-7 (night time). For further detail see the AECOM report (Appendix N1).

TABLE 16-6 | SUMMARY OF THE MEDIAN NOISE LOGGING RESULTS, DAYTIME, IN DB(A)

Location	$L_{Aeq,15hr}$	Highest $L_{Aeq,15min}$	Lowest $L_{Aeq,15min}$	Median $L_{Aeq,15min}$	Daytime ABL
April 2018					
Location 4	50	57	34	48	29
Location 5	47	57	32	44	30
February-March 2016					
Location 1	46	55	35	44	30
Location 2	47	54	35	46	27
Location 3	48	56	31	46	27
Location 4	47	55	36	46	29
February-April 2015					
Location 1	52	59	39	51	31
Location 2	49	57	34	46	28
Location 3	48	59	33	44	28
Location 4	47	57	32	46	30
September-October 2014					
Location 1	46	52	34	43	31
Location 2	48	57	35	46	30
Location 3	48	58	29	43	29
Location 4	47	53	30	46	27

TABLE 16-7 | SUMMARY OF THE MEDIAN NOISE LOGGING RESULTS, NIGHT TIME, IN DB(A)

Location	$L_{Aeq,9hr}$	Highest $L_{Aeq,15min}$	Lowest $L_{Aeq,15min}$	Median $L_{Aeq,15min}$	L_{Amax}	Night time ABL
April 2018						
Location 4	39	50	26	31	73	23
Location 5	36	47	26	31	73	23
February-March 2016						
Location 1	38	47	30	35	69	27
Location 2	41	46	30	40	68	25
Location 3	41	51	27	33	78	24
Location 4	41	50	29	37	70	26
February-April 2015						
Location 1	44	53	28	38	73	26
Location 2	38	45	28	35	68	23
Location 3	40	49	28	35	75	25
Location 4	40	49	27	31	69	25
September-October 2014						
Location 1	43	52	29	36	70	28
Location 2	45	56	28	36	76	25
Location 3	39	48	26	33	74	26
Location 4	44	53	24	33	77	22

16.5 SENSITIVE RECEPTORS

As the Project is located within a rural area, which is scattered with rural living as well as rural industry, sensitive receptors include residences as well as industrial wineries, cellar door facilities and operating vineyards.

A receptor is defined as a residence, commercial or industrial business, or listed fauna located within the remnant vegetation block (including the native vegetation heritage agreement area), which may have the potential to experience increased noise as a result of the proposed Project. Table 16-8 outlines the noise sensitive receptor around the Project site and Figure 16-3 shows the location of all nearby receptors identified in the Noise Impact Assessment.

TABLE 16-8 | NOISE SENSITIVE RECEPTORS

Sensitive Receptor	Summary	Impact ID
R13	Residence	PIE_16_01
R12	Residence	PIE_16_02
R3	Residence	PIE_16_03
R17	Winery and bottling facility	PIE_16_04
R2	Residence	PIE_16_05
R14	Residence and cellar door	PIE_16_06
Local Community	Defined as the broader region surrounding the Project	PIE_16_07 PIE_16_08
Listed species - Fauna	Located within the remnant vegetation and native vegetation heritage agreement area	PIE_18_05

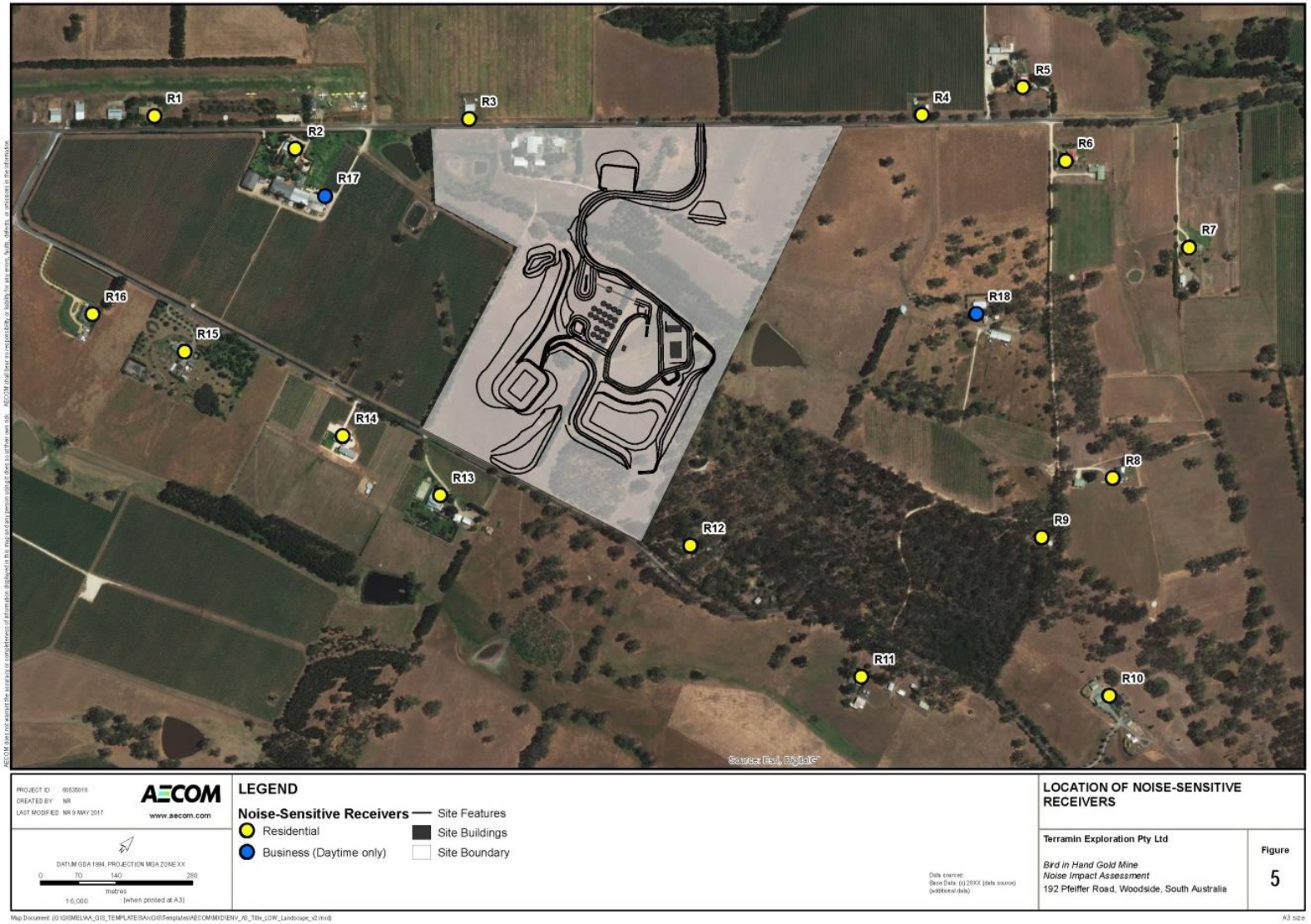

FIGURE 16-3 | RECEPTORS IDENTIFIED IN THE NOISE IMPACT ASSESSMENT

16.6 POTENTIALLY IMPACTING EVENTS

Potentially impacting events describes the major sources of noise impacting upon various residential, commercial and industrial sources within the immediate proximity of the Project, see Table 16-9.

With mitigation, no sensitive receptors are expected to experience noise louder than the proposed outcome criteria, of 52 dB(A) during the day and 47 dB(A) during the night (10pm to 7am), however, Terramin have identified potentially impacting events which have a specific community interest or have a higher requirement for effective design and management strategies. These include activities which have modulation, tonal, impulsive or low-frequency characteristics such as placement of mullock on the IML, reverse alarms on mobile equipment, or the continuous noise associated with pumps and fans onsite.

TABLE 16-9 | POTENTIALLY IMPACTING EVENTS | NOISE

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Noise impacts to local residents as a result of use of drill rigs	Operation	Noise from drill rigs	Soundwave transmission	Local community	Yes	PIE_16_01
Noise impacts to local residents as a result of infrastructure removal and decommissioning	Closure	Noise from infrastructure removal and decommissioning	Soundwave transmission	Local community	Yes	PIE_16_02
Noise impacts to local residents as a result of construction activities	Construction	Noise from construction activities	Soundwave transmission	Local community	Yes	PIE_16_03
Noise impacts to local residents as a result of stackers / conveyors / vehicles / workshops / cement silo / alarms / operational noise	Operation	Noise from stackers / conveyors / vehicles / workshops/ cement silo/ alarms / operational noise	Soundwave transmission	Local community	Yes	PIE_16_04
Noise impacts to local residents as a result of truck loading	Operation	Noise from truck loading	Soundwave transmission	Local community	Yes	PIE_16_05
Noise impacts to local residents as a result of final landform shaping and earthworks activities (i.e. grading, spreading and ripping) affects public amenity	Closure	Noise generated by closure earthworks	Soundwave transmission	Local community	Yes	PIE_16_06

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Noise impacts to local residents as a result of placement of mullock on the IML or ore into bin	Operation	Noise generated from placing mullock on IML or ore in bin	Soundwave transmission	Local community	Yes	PIE_16_07
Noise impacts to local residents as a result of constancy of the ventilation fan, conveyor and/orgroundwater pumping	Operation	Constancy of noise sources (ventilation fan, conveyor and groundwater pumps)	Soundwave transmission	Local community	Yes	PIE_16_08

16.7 CONTROL MEASURES TO PROTECT ENVIRONMENT

NOTES ON CHOSEN OBJECTIVE FOR CONTROL MEASURES

Terramin have spent considerable time in determining a noise objective which is considered to be both reasonable to surrounding landholders and achievable. The project area is located within a rural industry area, with pockets of rural living. The Watershed (Primary Production) Zone makes reference to both Rural Industry and Rural Living land uses but the Onkaparinga Valley Policy Area specifically excludes rural living.

Regardless, Terramin understand that due to the pockets of rural living and cellardoor businesses in the area, a project production objective which is lower than the Rural Industry legislative criteria would be more appropriate, and an early warning, or leading indicator, criteria which aligns with Rural Living would align with the some of the surrounding land use in the area. This also aligns with the current existing noise environment, which has a median daytime range of between 43 and 51 dB(A) and median night time range of 31 and 40 dB(A) – as outlined in section 16.4.

Similarly, although other construction activities (i.e. non-mining related construction activities) are not limited on their noise generation, Terramin are voluntarily choosing to adopt the Rural Industry noise criteria as the project objective through construction.

Noise modelling of the control measures has demonstrated that *even when every piece of equipment is operating*, these noise objectives can be achieved through every phase of the project. This aligns with the South Australian Government's Multiple Land Use Framework.

These design objectives are proposed as measurement criteria to be adopted during the PEPR for this project.

TABLE 16-10 | PROJECT OBJECTIVES FOR CONTROL MEASURES

Project description	Noise level at noise-sensitive receptors	
	Day[1]	Night[1]
Construction and underground development - criteria	L_{Aeq} 57 dB(A)	L_{Aeq} 50 dB(A)
Production - criteria	L_{Aeq} 52 dB(A)	L_{Aeq} 45 dB(A)
Production – early warning/leading indicator	L_{Aeq} 47 dB(A)	L_{Aeq} 40 dB(A)

16.7.1 Design Measures

Design measures to limit noise propagation are largely controlled by implementing landscape bunding and shielding around the operating area. Other design measures include constructing infrastructure with insulation around it, for example, insulating sheds around pump stations. The underground ventilation fans are designed to have two silencers installed around them to reduce, if not remove, any continuous hum of the ventilation system. The other significant design measure is the rubber lining of the ore silo to reduce noise associated with filling the silo with ore. The ROM bin and conveyor system design measures includes an enclosure around the truck unloading point and surge bin, and an open-ended enclosure around the haul truck loading area.

Summary of design measures are included below in Table 16-11.

Table 16-11 | Design measures

Design Measures	Impact ID
Site design to use bunding and cut outs to reduce noise impacts to residential and commercial properties on the west, south and east of the project.	PIE_16_01 PIE_16_05 PIE_16_02 PIE_16_06 PIE_18_05
Location of the primary vent raise – within Goldwyn rather than other potential locations closer to other sensitive receptors.	PIE_16_08 PIE_18_05
Location of the IML – moved from south west to central east of Goldwyn and landscape bunding installed around three sides to reduce noise propagation to residential and commercial properties on the west and south of the project.	PIE_16_07 PIE_18_05
Silencers on the ventilation fans (both temporary and permanent above and underground).	PIE_16_08 PIE_18_05
Batching plant to have noise insulation installed (internally lined).	PIE_16_04 PIE_18_05
The conveyor system to the ROM silo will be covered, on/off operation rather than continuous operation	PIE_16_04 PIE_16_07 PIE_16_08 PIE_18_05
Surge bin designed into conveyor/ ROM silo system to reduce impulsive noise	PIE_16_04 PIE_18_05
Shielding of noise sources, noise curtains, insulated shedding, etc.	PIE_16_01 PIE_16_05 PIE_16_08 PIE_18_05
Temporary acoustic screening for raise borer	PIE_16_01 PIE_16_03 PIE_18_05
30m Buffer zone to NVHA area	PIE_18_05

16.7.2 Management Strategies

Noise impacts have been reduced through the consideration of types of activities, the noise they can generate, and restricting their operating hours appropriately.

This includes restricting the hours of construction between 7am and 10pm in the first instance, as well as ensuring vehicles and mobile equipment is maintained appropriately, and ensuring service and maintenance schedules are adhered to. The ROM silo management plan will include specifications as to the handling of ore in regards to drop/tip heights.

A Noise Trigger Action and Response Plan (TARP) would be finalised as part of the PEPR. A draft has been included in Appendix O6.

Any exploration works would occur during daytime hours and be communicated effectively with neighbours and the wider community. It is noted that exploration activities are considered as part of mining operations once an ML is granted and therefore any exploration work will be subject to the same noise criteria as for all other operational activities.

Summary of management strategies is described below in Table 16-12.

TABLE 16-12 | MANAGEMENT STRATEGIES

Management Strategies	Impact ID
Limited hours of construction (day time as per Noise EPP 7am – 10pm)	PIE_16_02
Noise reduction devices including mufflers and broadband reversing alarms for mobile plant	PIE_16_04
Lowered drop/tip height into ROM silo (ROM silo management plan to be developed to include maintenance plan and replacement of rubber lining in the ore silo)	PIE_16_07
Reduced operational times for ROM silo / conveyor system (ROM silo management plan to be developed)	PIE_16_05
Haulage trucks not be loaded overnight (10pm – 7am)	PIE_16_05
IML management plan provides operating procedures for the front end loader (not operating continuously), reduced loading/unloading times	PIE_16_07
Workshop doors closed overnight	PIE_16_04
Standard delivery times between 7am and 10pm	PIE_16_05
Equipment selection (e.g. ejector dump trucks rather than tip)	PIE_16_05
Equipment and vehicles to be serviced regularly and equipment in need of repair will not be used	PIE_16_05
Site Traffic Management Plan	PIE_16_04 PIE_16_05
Equipment to be shut off or throttled down whenever not in actual use	
Speed limits onsite to be reduced to 10km/hr	
Equipment to be operated and materials handled in a way as to minimise the impact of noise	PIE_16_08
Noise TARP (Appendix O6)	PIE_16_01 PIE_16_02 PIE_16_03 PIE_16_04 PIE_16_05 PIE_16_06 PIE_16_07 PIE_16_08
Noise monitoring system to support the TARP	
Real time noise measurement reporting on public internet site	
Exploration activities to use temporary acoustic screening	PIE_16_01
Enclosed loading area from ROM silo and haulage trucks	PIE_16_07

16.8 IMPACT ASSESSMENT

Predictions of noise levels from the project were undertaken using noise modelling software and assume worst case conditions for noise propagation, corresponding to CONCAWE (Conservation of Clean Air and Water in Europe) Meteorological Category 6 at night and Meteorological Category 5 at day, as required by the Noise EPP.

The equivalent continuous noise level (LAeq) has been predicted for five scenarios:

- Surface construction, day time only;
- Underground development, day time and night time; and

- Ore production, day time and night time.

The period Terramin predict to be the most significant impact is during construction and the early underground development phases.

Equipment used during the construction phase largely involves mobile equipment including trucks, excavators, cranes, a scraper and grader, cement trucks and a road paver and roller, all of which have been modelled as operating continuously. Specific activities include installing the BEBO structure into the boxcut.

Underground development activities include above ground ventilation fans operating until underground ventilation is installed, trucks travelling between underground and the IML loaded with excess mullock, a cement truck travelling between the batching plant and underground, as well as very specific activities including the installation of the two ventilation shafts and the emergency escapeway and installing service holes into the underground workings from the laydown area.

Ore production includes more constant noise sources, including ventilation fans and water treatment pumps, but also includes trucks between underground, the IML and the ore bin (which loads the silo), the ore bin and conveyor system (including ore silo), haulage trucks (which travel to Strathalbyn) and deliveries to site.

A concern which has been raised through the community consultation process has been the constancy of noise. This has been addressed where possible, using shielding of constant noise sources, such as pumps, and shielding of the raise bores proposed for developing the ventilation shafts and emergency escapeway. Other mitigation measures have included having ventilation fans located underground with silencers, rather than on surface (as is conventional). Terramin have committed to the conveyor to the ROM silo operating only when a load is required to fill the silo, rather than constantly. Heavy vehicles onsite between the IML, ROM silo and underground will be controlled by the site Traffic Management Plan, which will require equipment to be shut off or throttled down whenever not in actual use, as well as enforceable speed limits onsite. The IML management plan to be developed will provide operating procedures for the front end loader (not to operate continuously).

These strategies have been incorporated into the proposed management of the BIHGP in order to reduce the potential for the constancy of the noise, and are as low as reasonably practical for the different phases and activities. For more details regarding the strategies please refer to Appendix O3.

Different impact ratings will apply for different phases and activities (outlined in the potential impact events in section 16.6) and are discussed in detail below.

16.8.1 Surface Construction Noise Emissions

Surface construction activities will capture the initial works on site including site clearing, road grading, earthworks and construction of surface infrastructure, such as the buildings and the boxcut “bebo” cemented archway structure. These works will only be undertaken during the day and the proposed noise criterion is 57 dB(A). The same noise criterion is proposed for the closure phase of the BIHGP given the similarity of the equipment that will be required and the noise generated. Noise modelling indicates that with the proposed engineered control measures, surface construction noise will be under the proposed noise criterion. No noise character penalties were applied to the surface construction activities.

Terramin consider this change is likely to be perceived as **low**, as it will be a detectable change for some immediate landholders (as shown in Figure 16-4), however it is within the EPA regulatory limits/standards (the Noise EPP).

The noise contour map for construction is included in Figure 16-4.

FIGURE 16-4 | DAYTIME SURFACE CONSTRUCTION NOISE CONTOUR MAP

16.8.2 Underground Development Noise Emissions

The day time and night time underground development scenarios are based on the noise modelling methodology outlined in Section 16.3.2. There are no predicted exceedances of the applicable noise criteria for the night time scenario. For the day time scenario, there is one noise sensitive receptor where the applicable noise criterion is predicted to be exceeded due to the installation of the primary ventilation shaft – however, with shielding installed to the east of the equipment, the noise can be reduced significantly (as can be seen below in Figure 16-5).

With all the engineered mitigation strategies in place including the acoustic shielding, noise levels at all receptors are predicted to comply with the noise criteria for all three modelled raise borer locations, and be within the background similar levels of noise recorded to date. Noise levels are predicted to be between 26 dB(A) and 45 dB(A) through underground development. The area is currently experiencing median ranges between 43 dB(A) and 51 dB(A) (Median $L_{Aeq,15min}$) during the day.

No noise character penalties were applied to the underground development activities.

Terramin consider this change is likely to be perceived as low, as it will be a detectable change for some immediate landholders (as shown in Figure 16-4), however it is within the EPA regulatory limits/standards (the Noise EPP).

Noise contour underground development maps are shown in Figure 16-5 (day) and Figure 16-6 (night).

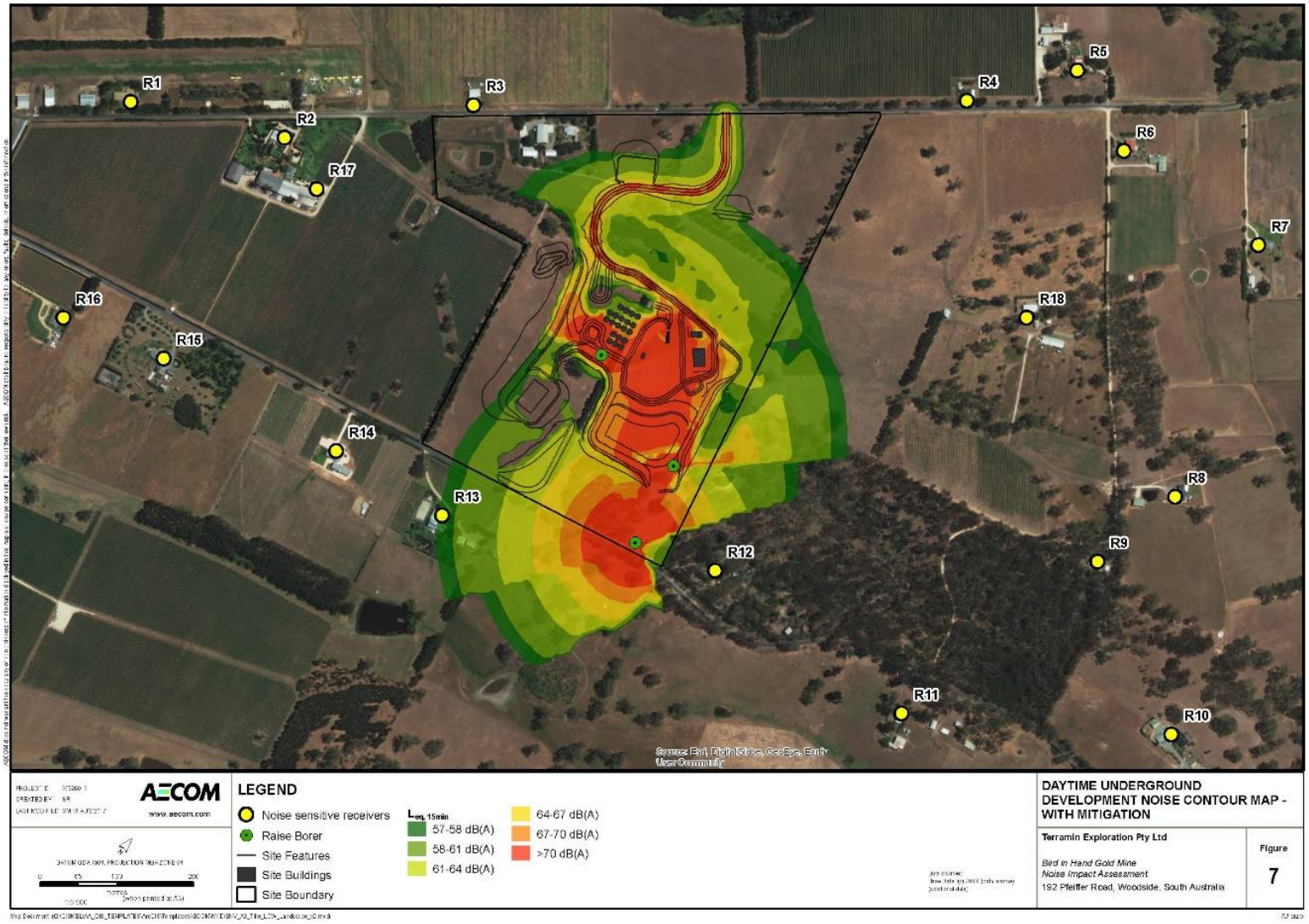

FIGURE 16-5 | DAYTIME UNDERGROUND DEVELOPMENT NOISE CONTOUR MAP - WITH MITIGATION

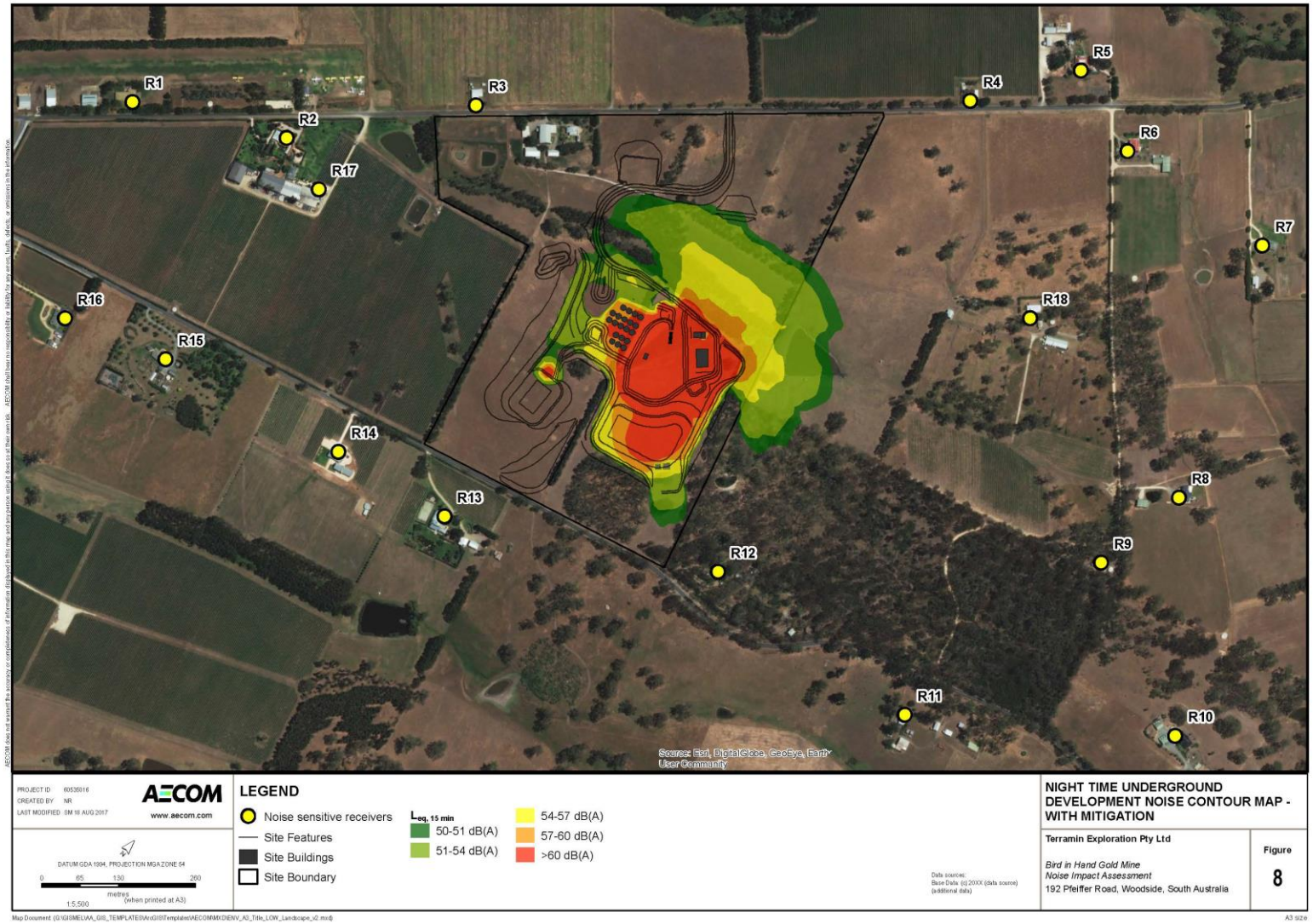

FIGURE 16-6 | NIGHT TIME UNDERGROUND DEVELOPMENT NOISE CONTOUR MAP - WITH MITIGATION

16.8.3 Ore Production Noise Emissions

The day time and night time ore production scenarios are based on the noise modelling methodology outlined in Section 16.3.2. It was identified that an impulsive noise characteristic penalty (+5 dB(A)) applied to ore production modelling for both the day time and night time scenarios due to noise from ore loading into the surge bin and ore loading into haul trucks (that is, an increased 5dB(A) penalty has been applied to the total from each activity).

Modelling has demonstrated, that while Terramin can achieve ordinary business noise compliance levels under the Noise EPP (57 dB(A) during the day and 50 dB(A) during the night), in order to achieve the proposed measureable criteria for the project (52 dB(A) during the day and 45 dB(A) during the night) further noise mitigation is required for ore loading points. For this reason, acoustic insulation enclosures have been proposed around these points (insulated shedding). This change has resulted in all receptors meeting both the lower measurement criteria for the proposed Project.

Additionally, leading indicator targets have been proposed for the project which are 10 dB(A) less than the Noise EPP (i.e. 47 dB(A) during the day and 40 dB(A) during the night), to ensure that action is taken to reduce noise from the site before the noise reaches the proposed measurement criteria level. These additional control measures include stockpiling mullock on the IML during the day, not overnight, and installing acoustic screening along the access way, if required, in order to achieve the proposed leading indicator.

Terramin consider this change in noise levels is likely to be perceived as **negligible** to **low**, as there will be some detectable changes for the most immediate landholders (as shown in Figure 16-4), however it is within background noise currently being experienced in the local area, the proposed measurable criteria and the EPA regulatory limits/standards (the Noise EPP).

Noise contour ore production maps are shown in Figure 16-7 (day) and Figure 16-8 (night).

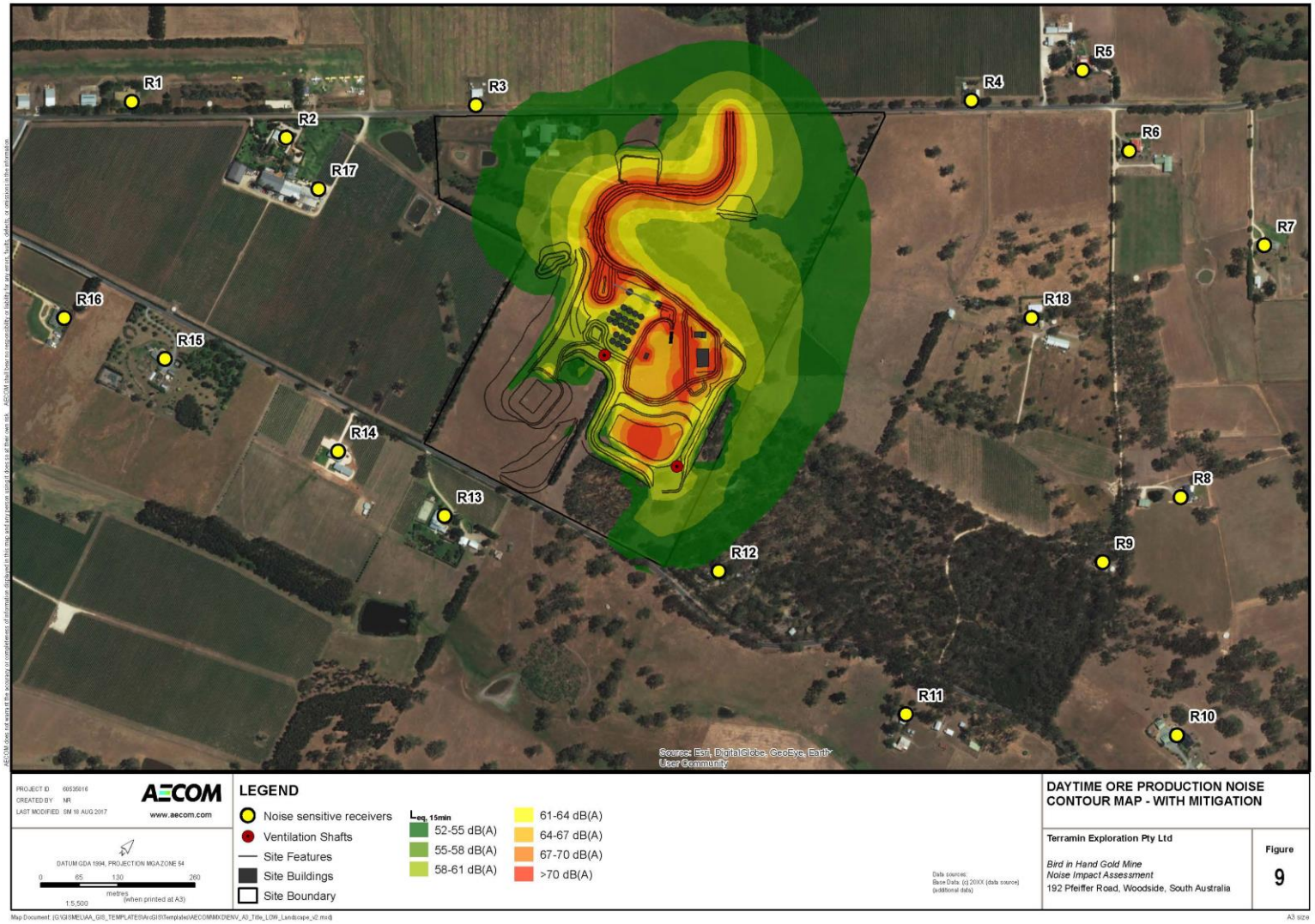

FIGURE 16-7 | DAYTIME ORE PRODUCTION NOISE CONTOUR MAP - WITH MITIGATION

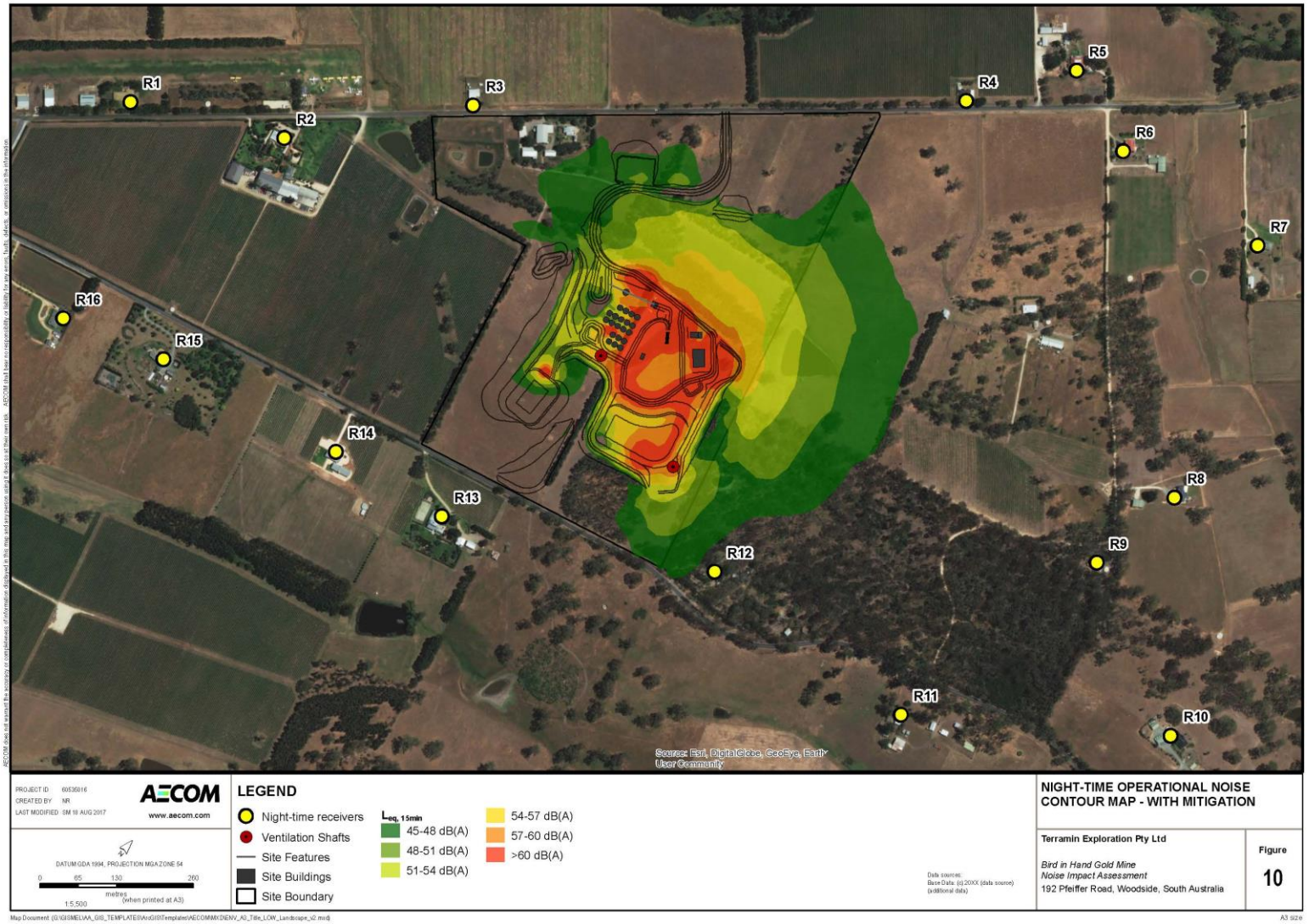

FIGURE 16-8 | NIGHT-TIME OPERATIONAL NOISE CONTOUR MAP - WITH MITIGATION

16.8.3.1 ADDITIONAL MITITGATION TO ACHIEVE PROPOSED LEADING INDICATOR CRITERIA

Terramin have identified that additional mitigation measures may be required in order to achieve the proposed leading indicator criteria of 47 dB(A) during the daytime and 40 dB(A) during the night.

With the acoustic treatments implemented as outlined in the Acoustic Report for the Ore Production phase, there are only two receptors that would exceed the leading indicator noise level targets, these are R3 and R12.

During the day time scenario, the predicted noise level at receptors R3 and R12 are 51 dB(A) which is greater than the proposed 47 dB(A) leading indicator target. The noise at receptor R3 is controlled by heavy vehicles accessing the site via the site access road, and the noise at receptor R12 is controlled by the front end loader and articulated dump trucks located on the mullock landform.

During the night time scenario, the predicted noise level at receptors R3 and R12 are 41 dB(A) and 44 dB(A) respectively, which are greater than the proposed 40 dB(A) leading indicator target. The noise at both receptors R3 and R12 are controlled by articulated dump trucks on the mullock landform

As such, additional noise mitigation treatments have been derived to address these noise sources. Additional noise mitigation treatments proposed to reduce daytime noise sources could include:

- Constructing a noise wall and/or berm (earth mound) along the side of the site access road (detailed in Appendix O5). The noise wall and/or berm would need to be between 2-3 meters tall. The construction of the noise wall and/or berm would enable the leading indicator target to be achieved at receiver R3.
- Constructing a shed to cover the mullock landform (as detailed in Appendix O5). The shed would contain the front end loader and also the articulated dump truck whilst it is unloading. The construction of the shed would enable the leading indicator target to be achieved at receiver R12.

Additional noise mitigation treatments proposed during the night time would include:

- Prevent articulated dump trucks from travelling to and unloading on the mullock landform during the night time. As such this will require the mullock to be stockpiled overnight underground and then brought to the surface during the daytime period. By stockpiling at night it will enable the leading indicator target to be achieved at both receivers R3 and R12.

The noise contour ore production map to achieve the proposed leading indicator is shown in Figure 16-9 and Figure 16-10.

The AECOM memorandum to support this work is located in Appendix O5.

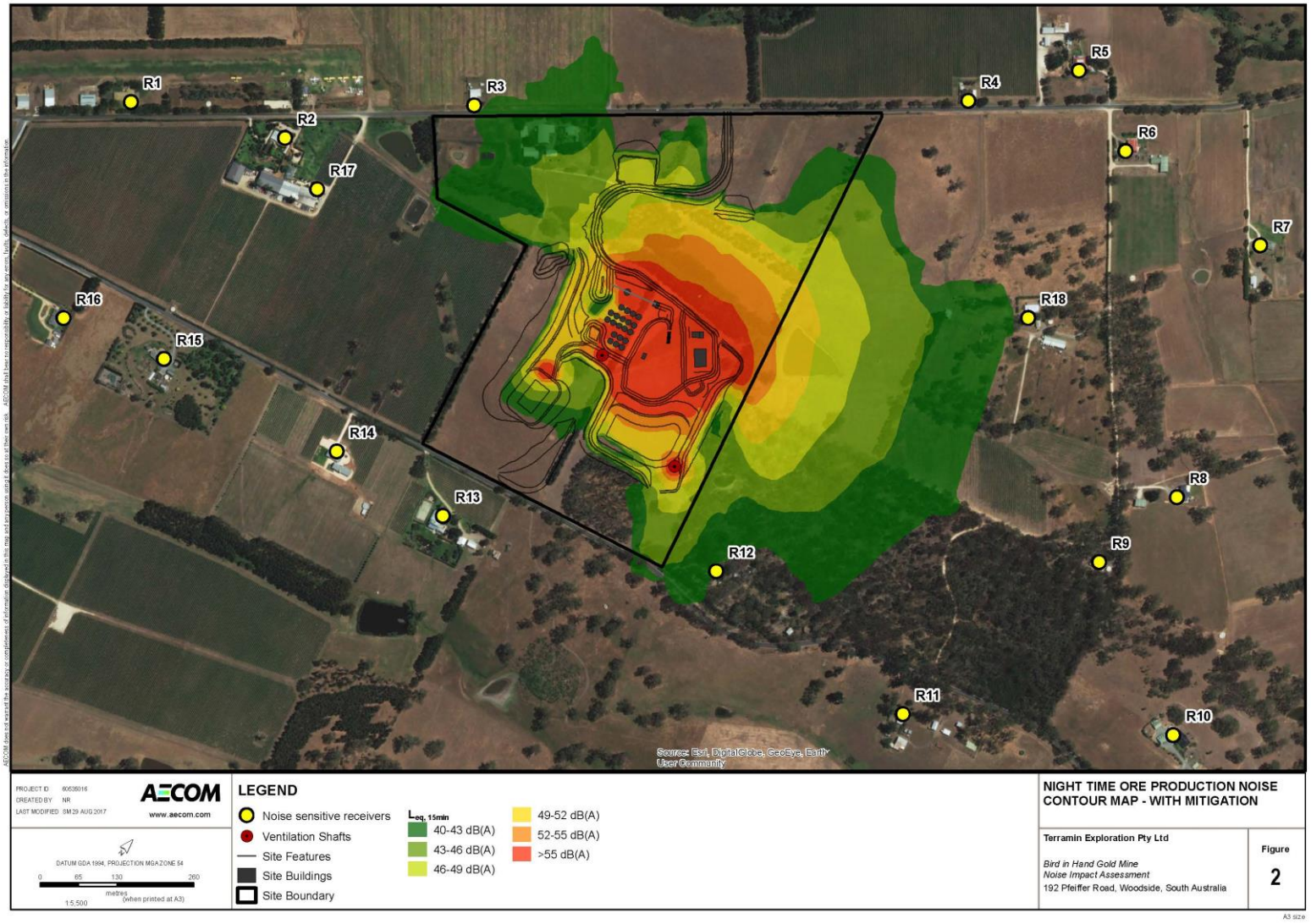

FIGURE 16-9 | DAY-TIME OPERATIONAL NOISE CONTOUR MAP TO ACHIEVE PROPOSED LEADING INDICATOR CRITERIA - WITH MITIGATION

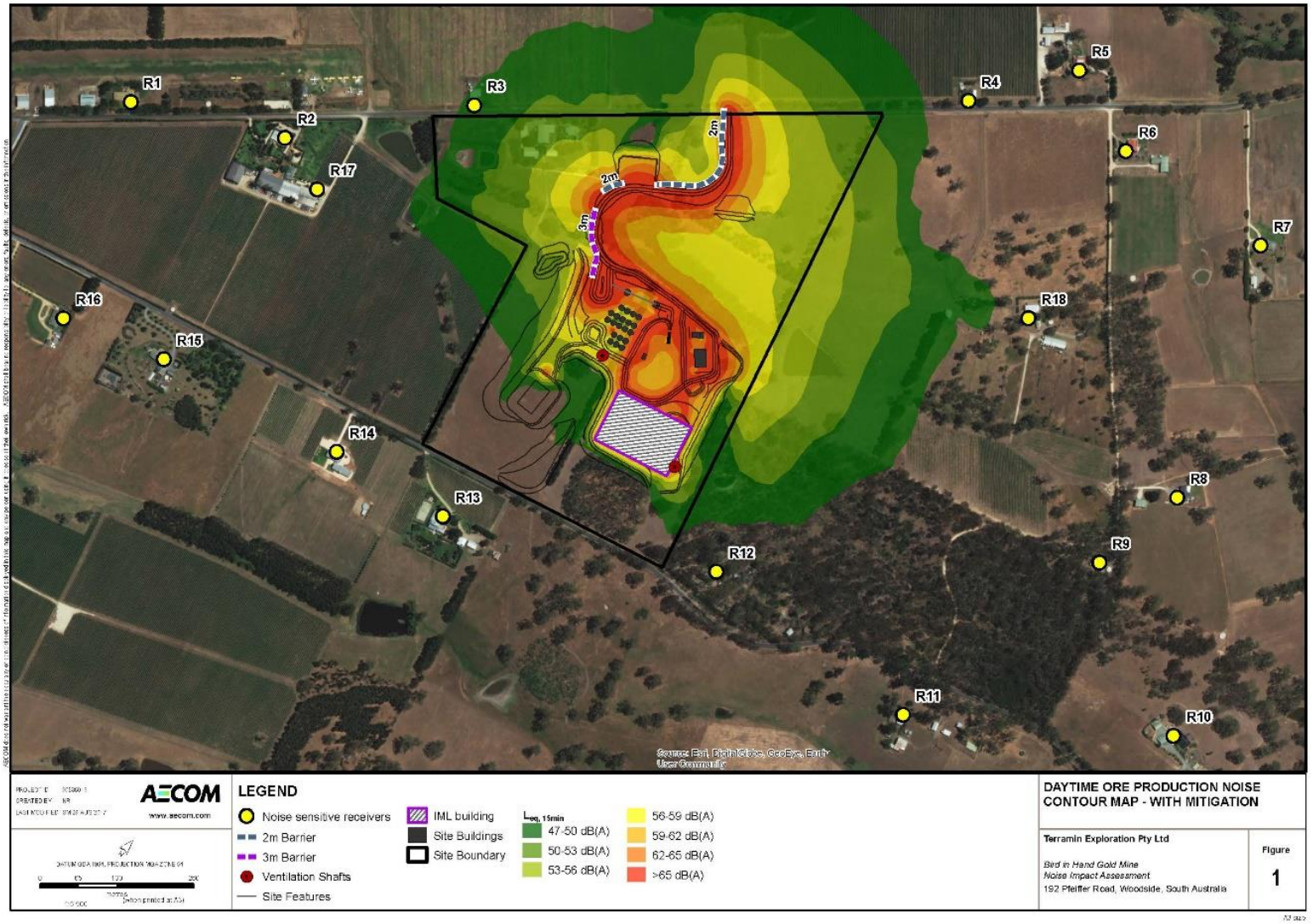

FIGURE 16-10 | NIGHT-TIME OPERATIONAL NOISE CONTOUR MAP TO ACHIEVE PROPOSED LEADING INDICATOR CRITERIA - WITH MITIGATION

16.8.4 FAUNA

The effect of noise on wildlife can be similar to the effects observed in humans. Noise can adversely affect wildlife by interfering with communication, masking the sounds of predators and prey, cause stress or avoidance reactions and (in the extreme) result in temporary or permanent hearing damage. Experiments have shown that exposure to noise impulses throughout the night-time sleep period resulted in poorer daytime task performance by animals (Fletcher & Busnel, 1978).

The learning ability of many animal species, in regard to familiarisation, is discussed by Fletcher & Busnell. An animal's initial reaction to a new noise source is fright and avoidance but if other sensory systems are not stimulated (for instance optical or smell), the animal learns quite quickly to ignore the noise source, particularly when it exists in the presence of man.

Migratory birds have the potential to be influenced by noise from the project. Studies of birds (Larkin, 1996) have shown that they will habituate to loud noises that are not biologically meaningful for them. For example if the noise is associated with possible harm such as thunder on a cloudy day, birds will avoid it, but routine noises such as traffic will not disturb them. Examples are provided of sea-birds that voluntarily co-exist with relatively loud noise environments, such as around airports, and birds roosting on light-posts above busy motorways.

Attempts at using noise to deliberately scare birds away from an area, for example to protect farming crops, have been shown to grow less effective over time as birds habituate to the noise. Larkin suggests that keeping the noise as consistent as possible both in the sound produced and the frequency with which it occurs may also help mitigate its effects on birds. Poole (Poole, 1982) and Algers et. al. (Algers, Ekesbo, & Stroemberg, 1978) shows that birds tend to adapt to steady state noise levels, even of a relatively high level (in the order of 70 dB(A)). Given the predicted steady noise levels around the BIHGP are expected to be much less than this level and largely within existing baseline noise values (section 16.4), noise impacts on birds surrounding the project is not considered a credible risk.

16.9 DRAFT OUTCOME(S) AND MEASUREMENT CRITERIA

In accordance with the methodology presented in Chapter 6, an outcome has been developed for noise impact events with a confirmed link between a source, pathway and receptor (S-P-R linkage), see Table 16-13.

All outcomes are supported by draft measurement criteria which will be used to assess compliance against the draft outcomes during the relevant phases (construction, underground development, ore production and closure), and where relevant draft leading indicator criteria.

Outcomes for the entire project are presented in Appendix D1.

TABLE 16-13 | DRAFT OUTCOMES AND MEASURABLE CRITERIA

Draft Outcome	Draft Measurement Criteria	Draft Leading Indicator Criteria
No public nuisance impacts from mining activities from noise caused by mining activities	Noise generated from the mining lease during operation activities, measured live at predefined monitoring points[1] demonstrates noise at sensitive receptors is in accordance with the Environment Protection (Noise) Policy 2007, and does not exceed the following noise limit (averaged over 15 minutes): Construction & closure - 57 dB(A) 7am-10pm Underground development - 57 dB(A) 7am-10pm - 50 dB(A) 10pm-7am. Ore production - 52 dB(A) 7am-10pm - 45 dB(A) 10pm-7am. The above noise levels may only be exceeded if the Chief Inspector of Mines: - is satisfied, on the basis of information provided to him/her by an acoustic engineer, that the noise will not cause an adverse impact at the sensitive receptor due to the existing influence of ambient noise, or the limited duration and/or frequency of occurrence of the activity; and - provides prior approval for the exceedance.	Noise generated from the mining lease during operation activities, measured at sensitive receptors in accordance with the Environment Protection (Noise) Policy 2007, does not exceed the following noise limit (averaged over 15 minutes): Ore production - 47 dB(A) 7am-10pm - 40 dB(A) 10pm-7am. Demonstrate the Trigger Action Response Plan has been followed.
	Mine records demonstrate all noise complaints (construction, operation and closure) acknowledged within 2 hours and closed out within 14 days to the satisfaction of the complainant or as agreed with the Chief Inspector of Mines.	Demonstrate the Trigger Action Response Plan has been followed.

16.10 FINDINGS AND CONCLUSIONS

Noise criteria are set in accordance with the Noise EPP and are derived based on the land uses principally promoted by the relevant development plan. The equivalent continuous noise level criteria are 57 dB(A) during the day time period and 50 dB(A) during the night time period; however, although

[1] Monitoring locations to be determined by the acoustic model and by an independent suitably qualified and experienced expert

not required, Terramin will adopt a project noise limit 5 dB(A) lower than this in accordance with Part 5, Section 20 of the Noise EPP for the ore production phase of the project in order to provide a better acoustic amenity outcome for the surrounding community.

Surface construction activities will capture the initial works on site including site clearing, road grading, earthworks and construction of surface infrastructure. These works will only be undertaken during the day and the applicable noise criterion is 57 dB(A). As closure activities will be similar it is proposed that the same noise criterion applies during this phase (i.e. 57 dB(A)).

Noise modelling has demonstrated, that with the appropriate design and management strategies in place, noise impacts can be mitigated to a point where operations at the mine site are predicted to meet the requirements of the relevant legislation, as well as proposed noise criteria for ore production which is lower than the legislative limits and proposed outcome and measureable criteria for construction, underground development and ore production. Mine closure earthworks will be less of a noise source than construction and are predicted to comply with the Noise EPP, as closure works are far less intensive than the construction works.

Despite the predicted mine noise levels meeting the noise criteria and being assessed as low impact, it is acknowledged that the mine noise will at times be audible. Outcomes proposed ensure that Terramin will manage the impacts and risks associated with noise to a level which is within the proposed limits and is as low as reasonably practicable.