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Vipac Engineers & Scientists

Tattersall Lander Pty Ltd

Bobs Sand Farm EIS DPE Response

Updated Noise Impact Assessment

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8 November 2019

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EXECUTIVE SUMMARY

A noise impact assessment has been undertaken to determine the potential noise impact of the proposed sand mine at Bobs Farm on noise sensitive receptors in the surrounding area of the proposed development site. An initial assessment was conducted in 2016 previously by Vipac (report ref: 29N-14-0048-TRP-472764-2). This updated report assesses a redesign of the mine including updated entrance and exit location while addressing the relevant information requests.

Future potential noise levels at the nearest noise sensitive receivers were predicted using the SoundPLAN noise model for each phase, including peak operation. For each scenario, noise levels were predicted for the day and evening periods during both neutral and worst case weather conditions.

Noise levels are predicted to comply with the day and evening criteria with the exception of five of the closest sensitive receivers during the earlier phases of the development. Reasonable and feasible mitigation measures such as noise bunds/earth mounds and acoustic barriers have been recommended, however the closest sensitive receivers remain non-compliant during those phases. It is expected the role of the NSW Government Voluntary Land Acquisition and Mitigation Policy (VLAMP) and the use of the Operational Noise Management Plan will provide assistance with managing expectations at these sensitive receivers.

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1 INTRODUCTION

Vipac Engineers and Scientists Ltd (Vipac) was commissioned by Tattersall Lander Pty Ltd to conduct a Noise and Vibration Impact Assessment of the proposed Sand Farm located on Deposited Plans DP753204 (40.9ha) and DP1015671 (6.63ha), Bob's Farm NSW. The location of the proposed development site is illustrated in Figure 3-1.

An initial assessment was previously conducted by Vipac in 2016 (report ref: 29N-14-0048-TRP-472764-2). This updated report assesses a redesign of the mine including updated entrance and exit location while addressing the following information requests:

- NSW Environment Protection Authority Request for Comments (ref: DOC18/900871-20; EF14/502) dated 1st February 2019: Attachment, A – Noise
- NSW Department of Planning and Environment Response to Submissions dated 7th February 2019: Attachment A, Item 1 – Noise, inclusive of public comments regarding:
    - Concerns raised by the 'Say No To Sand Mining in Bobs Farm Community Action Group
    - The approved residential development located at 686 Marsh Road.
- NSW Department of Health correspondence dated 22nd January 2019: Noise (Construction) Noise (Operations) (addressed in accompanying Construction and Operational Noise Management plan report (ref: 70Q-18-0276-TRP-8551704-0)).

2 GLOSSARY OF TERMS

A list of commonly used acoustical terms (and their definition) used in this report is provided below in Table 2-1, as an aid to readers of the report.

Table 2-1 - Definition of Acoustical Terms

Term	Definition
$L_{eq,1hr}$	Equivalent Continuous Noise Level - which, lasting for as long as a given noise event, has the same amount of acoustic energy as the given event for the period of one hour.
$L_{A10,1\ hr}$	The noise level, which is equalled or exceeded for 10% of the measurement period of one hour.
$L_{A90,T}$	The noise level, which is equalled or exceeded for 90% of a given measurement period, T. $L_{A90,T}$ is used in Australia as the descriptor for background noise.
$L_{Aeq,T}$	The equivalent continuous A-weighted sound pressure level that has the same mean square pressure level as a sound that varies over time, for a given time period. It can be considered as the average sound pressure level over the measurement period and is commonly used as a descriptor for ambient noise.
L_n	The Sound Pressure levels that is equalled or exceeded for n% of the interval time period. Commonly used noise intervals are L_1, L_{10}, L_{90} and L_{99}%
$L_{A10,18hrs}$	The L_{10} noise level for the time period extending from 6am to midnight.

3 PROJECT DESCRIPTION

3.1 SITE LOCATION

The Bobs Farm site deposit is situated on the northern end of the Stockton Bight Dunal system, approximately 200 km north of Sydney, near Bobs Farm, NSW. The surrounding area is predominately zoned as rural with minimal primary production. The site is located in Bob's Farm approximately 27 km north-east of Newcastle and approximately 14 km south-west of Nelsons Bay. The site is bounded to the south by Nelson Bay Road and to the north by Marsh Road.

3.2 PROPOSED OPERATIONS

The proposed Bobs Farm Sand Mine project comprises of:

- The establishment of a quarry to extract and process sand at a rate of up to 750,000 tonnes per annum, from a total sand resource of 10 million tonnes. The total life of the extraction process is up to 20 years;
- The construction of extractive materials processing and transport infrastructure;
- The transportation of extractive materials off-site via roads; and
- The rehabilitation of the site.

Sand will be extracted from the site by two main mining methods:

- Dry mining utilising excavator and haul trucks to remove dry sand products from the pit areas above the water table for processing prior to export; and
- Wet mining utilising a dredge and pump line system to pump wet raw sand materials for processing prior to export.

A graphical display of the Deposited Plan is presented below in Figure 3-1 also showing the outline of the mine site boundary.

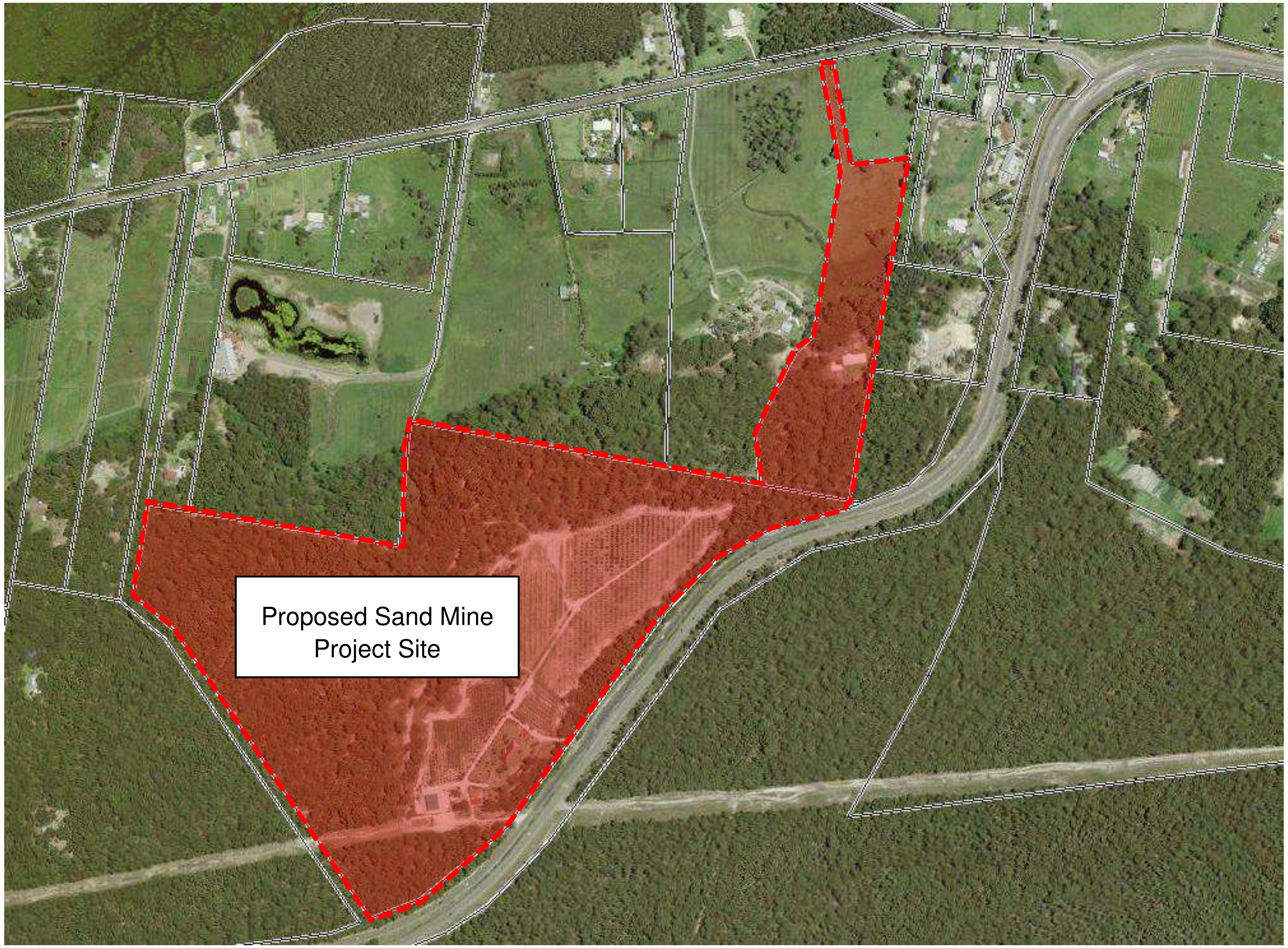

Figure 3-1 - Site Location

An overview of the developmental stages during the Project life is provided in Table 3-1 by phase. A cross-section of the proposed sand mine presents the extent of each production stage in relation to the water table.

Table 3-1 - Overview of Proposed Operations

Phase	Operational Year	Annual Throughput (tonnes)	Method	Location in Relation to Water Table
Phase1	Year 1	150,000	Stripping of topsoil and dry mining (Stripping Phase)	Above
Phase 2	Year 2	250,000	Dry mining Construction Stage and Year 1 Extraction/Production)	Above
Phase 3	Year 3	450,000	Dry mining (Initial Extraction Stage down to water-table)	Above and below
Phase 4	Years 4 - 20	700,000	Wet production (Final Extraction – production below the water-table down to a depth of -15m below the water-table)	Below

The main activities of the Project will be the bulk handling of sand material, utilising mobile plant, general truck movements for the transport of the material to the plant where the sand is screened and washed before being de-watered and stockpiled. The final product will be transported, when necessary from site using trucks.

Entrance to the proposed sand mine will be via a left hand turn off Nelson Bay road at the southern end of the site entering into a sales area where road lorries will fill be filled by two sales loaders.

3.3 OPERATIONAL HOURS

Proposed construction hours are from 7am to 7pm, Monday to Saturday. Operational hours for extraction, loading of vehicles and transportation of material are proposed to be Monday to Saturday 7am to 7pm only.

3.4 EQUIPMENT

The proposed equipment for the Project will comprise of core mobile plant which will change in quantity to reflect the product throughput, as well as ancillary equipment. The proposed equipment includes:

- Chainsaws (initial clearing);
- Mulching equipment;
- Excavators;
- Articulated dump truck (44 tonne capacity);
- Front end loaders;
- Conveyor;
- Screens and hoppers;
- Wash / recovery plant;
- Dredge (Phase 3 and 4); and
- Road trucks.

The proposed concept design is provided below in Figure 3-2.

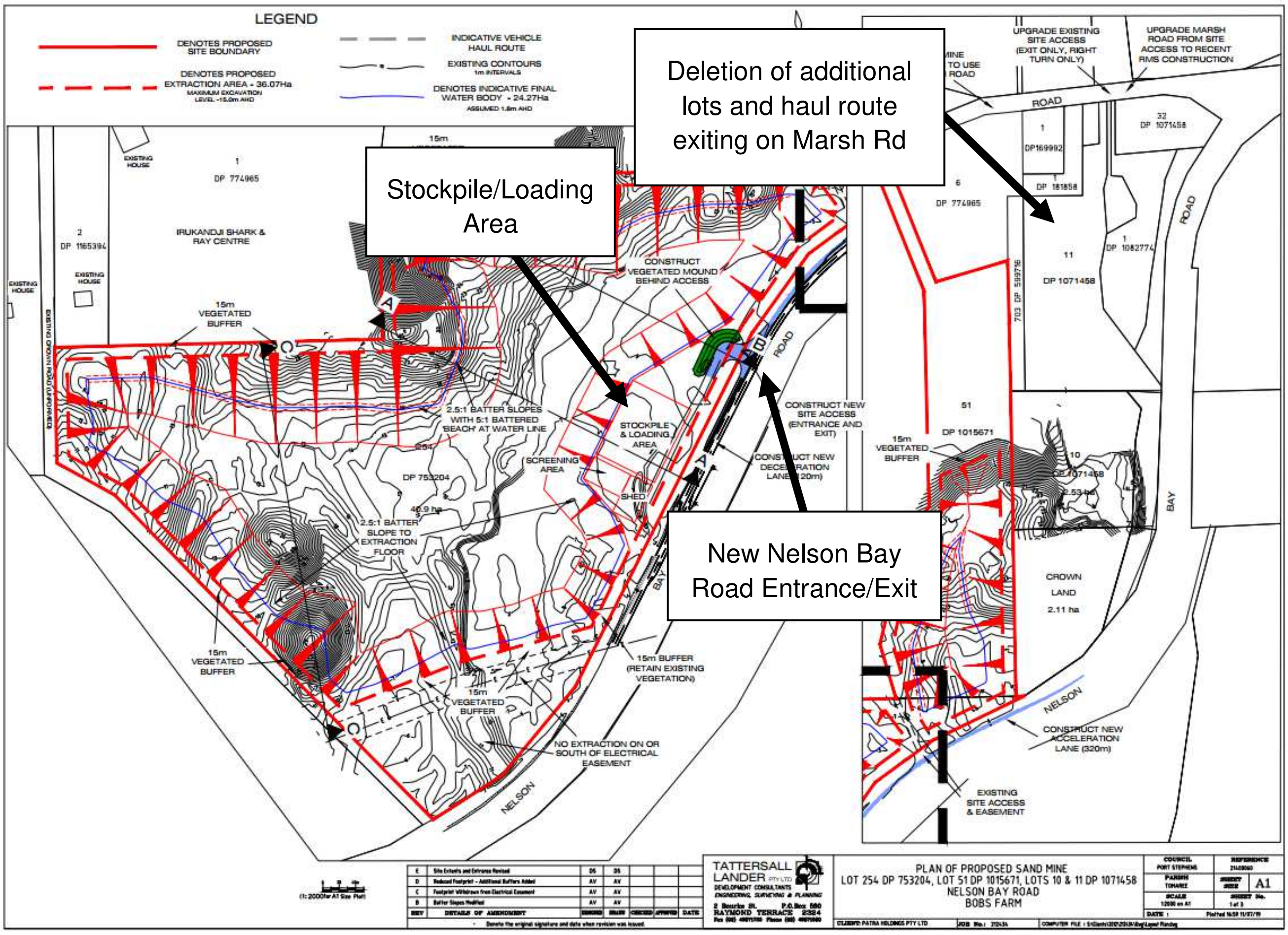

Figure 3-2 - Proposed Mine Design and Configuration

3.5 NOISE SENSITIVE RECEIVERS

The closest dwellings to the extraction area are located approximately 55m to west of the extraction area in the north eastern corner of the site, and 60m from the extraction area in the bottom west corner of the proposed mine. The sensitive receptors considered in this assessment are presented in Table 3-2 below and illustrated in Figure 3-3 and Figure 3-4.

Table 3-2 - Noise Sensitive Receptors

Reference	Description	Distance from Site Boundary (approx.)	UTM Coordinates	
			Easting	Northing
R1	724 Marsh Road - Residential	45m	407080	6373782
R2	776 Marsh Road - Residential	155m	407432	6374056
R3	772 Marsh Road - Residential	180m	407410	6374157
R4	764 Marsh Road (Marsh Road Public School)	120m	407377	6374169
R5	762 Marsh Road - Residential	130m	407313	6374153
R6	760 Marsh Road (Marsh Road Public Hall)	160m	407306	6374183
R7	756 Marsh Road - Residential	115m	407270	6374128
R8	710 & 712 Marsh Road - Residential	350m	406822	6374040
R9	698 Marsh Road - Residential	160m	406807	6373689
R10	666 Marsh Road - Residential	330m	406409	6373926
R11	650 Marsh Road - Residential	365m	406345	6373915
R12	686 Marsh Road (Shark and Ray Centre)	240m	406209	6373694
R13	686 Marsh Road (Tourist Accommodation – Managers Residence)	40m	406497	6373636
R14	686 Marsh Road (Tourist Accommodation – Nearest Eco Cabins)	60m	406444	6373588
R15	644 Marsh Road - Residential	53m	406123	6373508
R16	640 Marsh Road - Residential	103m	406016	6373514
R17	630 Marsh Road - Residential	154m	405912	6373456
R18	3551 Nelson Bay Road - Residential	235m	405906	6373182
R19	3515 Nelson Bay Road - Residential	485m	405758	6372941
R20	723 Marsh Road - Residential	650m	406868	6374185
R21	731 Marsh Road - Residential	500m	407003	6374232
R22	761 Marsh Road - Residential	260m	407322	6374277
R23	767 Marsh Road - Residential	270m	407385	6374280
R24	781 Marsh Road - Residential	320m	407503	6374223
R25	3780 Nelson Bay Road - Residential	345m	407631	6374081
R26	3724 Nelson Bay Road - Residential	380m	407629	6373758
R27	3790 Nelson Bay Road - Residential	315m	407547	6373678
R28	774 Marsh Road - Residential	70m	407339	6373929

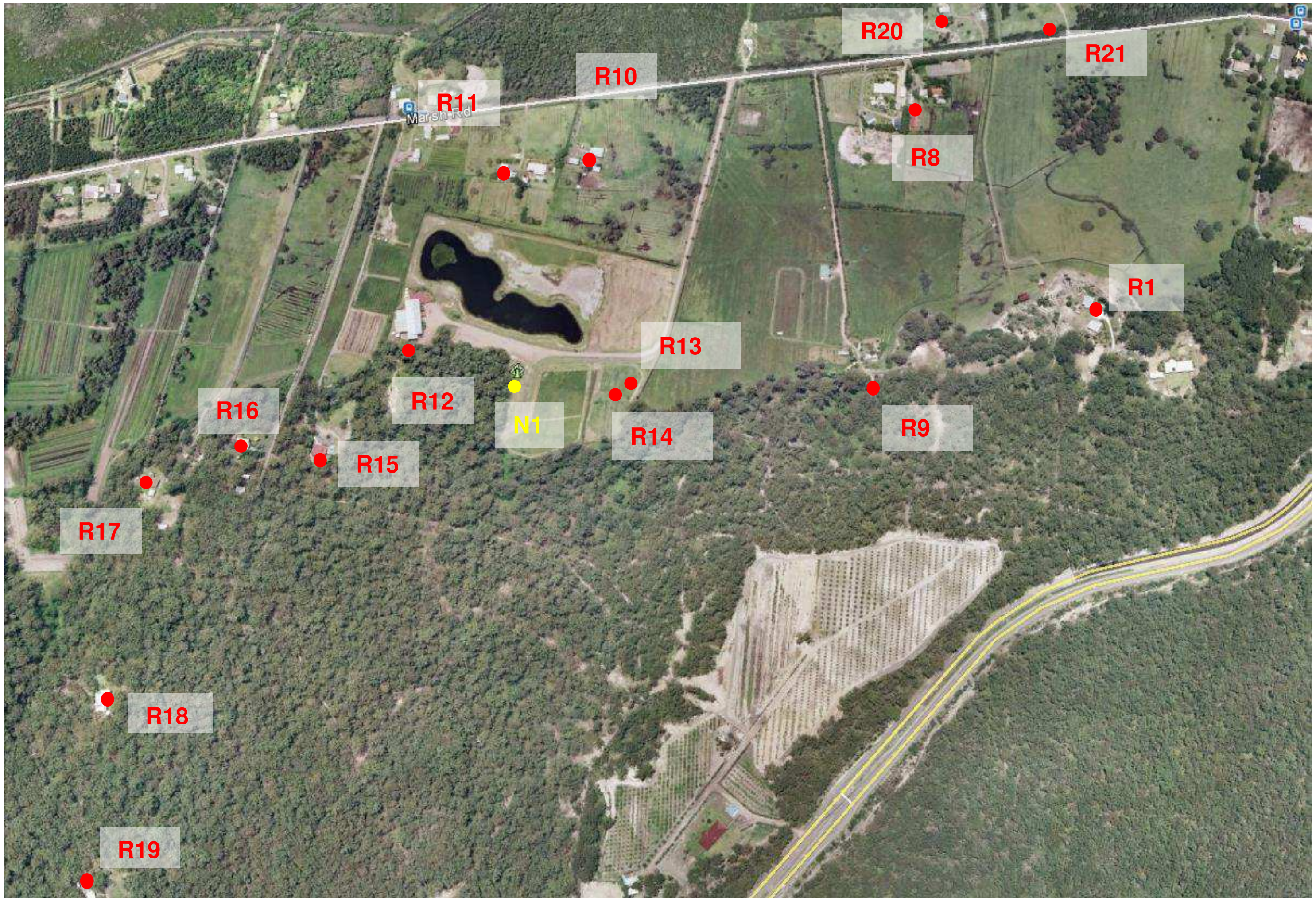

Figure 3-3- Noise Sensitive Receivers (R9 - R17, R20, R21) and Noise Monitoring Location N1

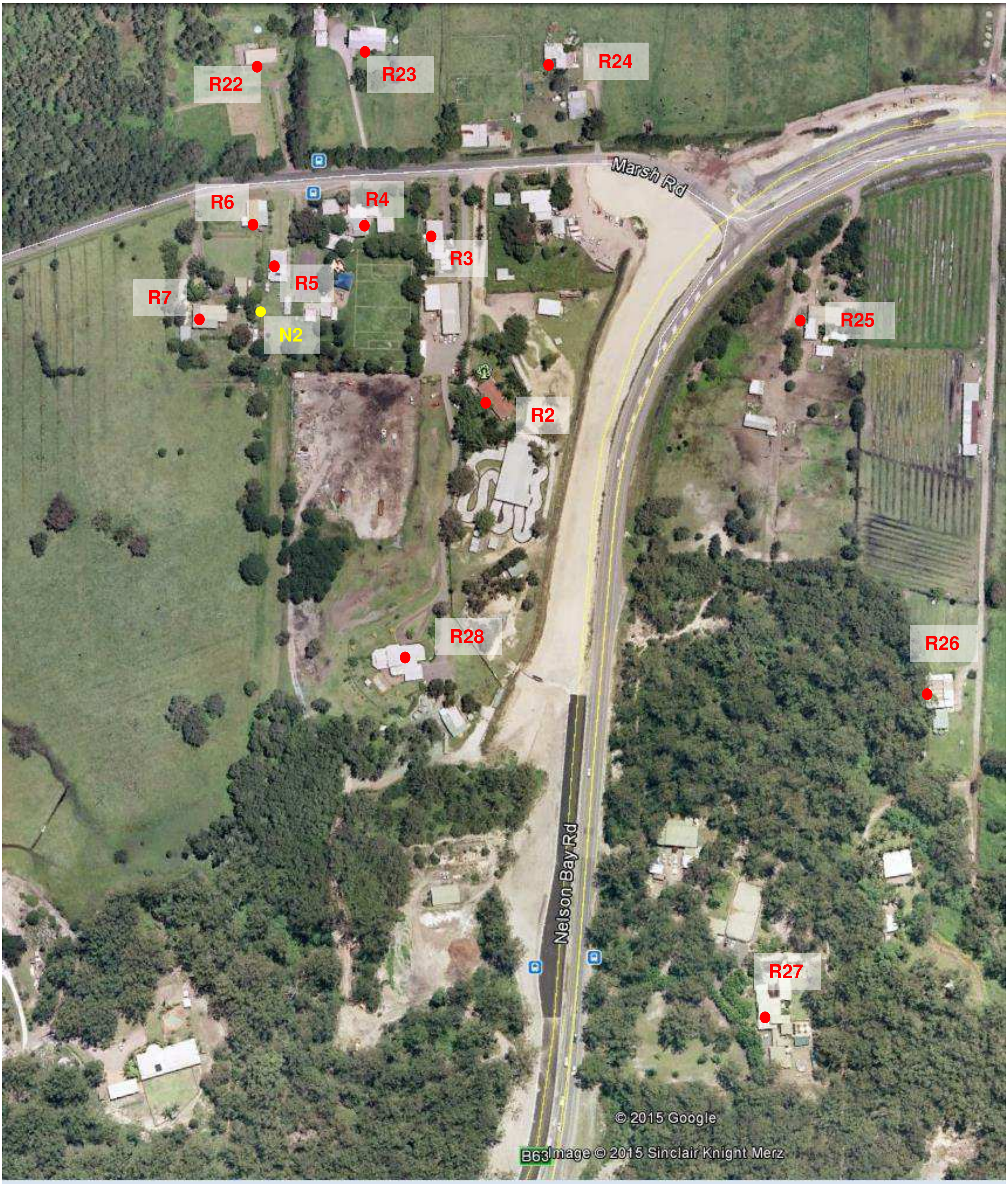

Figure 3-4 - Noise Sensitive Receivers R1-R8 and R22-R28 and Noise Monitoring Location N2

4 EXISTING NOISE ENVIRONMENT

4.1 UNATTENDED NOISE MEASUREMENTS

Vipac installed noise logging equipment at two locations to measure baseline environmental noise levels at representative noise sensitive receptor locations in the vicinity of the proposed sand mine site. The location of the monitoring points are listed in Table 4-1 and shown in Figure 3-3 and Figure 3-4. Monitoring was undertaken for a period of one week between October 1st and October 8th 2019 and conducted in accordance with AS1055:2018 – Acoustics – Description and Measurement of Environmental Noise.

The primary aim of the noise logging survey was to determine the existing environmental noise levels of the potentially affected area and to enable an assessment of the potential noise impacts on the receiving environment. Logger Location 1 (N1) is considered representative of the ambient environment experienced by sensitive receivers North West and West of the site while Logger Location 2 (N2) is representative of receivers North East and East of the site.

Table 4-1 - Monitoring Locations

Loc.	Noise Survey Dates	Location / Address	Instrument	Serial No.
N1	1st – 8th October 2019	686 Marsh Road	RION NL-42	00521660
N2	1st – 8th October 2019	762 Marsh Road	RION NL-42	00621927

The microphones were installed in a free field location and 1.5m above ground level. The instruments were programmed to accumulate noise data continuously over sampling periods of 15-minutes for the entire monitoring period. Internal software then calculates and stores the Ln percentile noise levels for each sampling period, which can later be retrieved for detailed analysis.

All equipment was calibrated by a National Association of Testing Authorities (NATA) accredited laboratory. The instruments were field calibrated using an Onno-Sokki calibrator immediately before and after monitoring.

Table 4-2 presents a summary of the current ambient noise levels at the monitoring locations. Graphical representation of the monitoring results are presented in Appendix B.

Table 4-2 - Summary of Current Ambient Noise Levels (dB (A))

Loc.	Period	L_{Aeq}	L_{A90}	RBL[1]
N1 (R9-19)	Day	49	40	35
	Evening	50	45	42
	Night	44	37	28
N2 (R1-8, R20-28)	Day	51	45	40
	Evening	49	43	34
	Night	43	37	26

Weather during the monitoring period was mostly fine with light winds, temperatures ranging between 7 and 35 degrees Celsius (source: Bureau of Meteorology – Williamtown RAAF Station (ID: 061078) with rainfall occurring on the morning of the 5th of October between 9am and1pm. This weather affected data has been excluded from the analysis.

[1] RBL is the median of the overall assessment background noise level calculated using OEH Industrial Noise Policy methodology as defined in the glossary of acoustic term

5 ASSESSMENT METHDOLOGY, NOISE AND VIBRATION CRITERIA

5.1 NSW EPA NOISE POLICY FOR INDUSTRY (NPI)

The previous noise impact assessment report prepared for the EIS assessed the proposed sand mine in accordance with the NSW Industry Noise Policy (INP) (2000). This legislation has since been superseded by the NSW Noise Policy for Industry (NPI) (2017). This updated report assesses the development in accordance with the current legislation.

The NPI sets limits on the noise that may be generated by a wide array of facilities and includes guidance that is applicable for the assessment of potential noise impacts from the operational stages of developments such as the proposed sand mine. These limits are dependent upon the existing noise levels at the site and are designed to ensure changes to the existing noise environment are minimised and deal with the intrusiveness of the noise and the amenity of the environment. The most stringent of the limits is taken as the Project Specific Noise Level which is the most stringent of the amenity criteria or the intrusiveness criteria for the location.

The amenity criteria for this project are recommended acceptable $L_{Aeq,T}$ noise levels for residences in rural areas as provided in Table 2.2 of the NPI. Amenity criteria are formulated to protect against cumulative impacts.

The intrusiveness noise criterion requires that the $L_{Aeq,15minutes}$ for the noise source, measured at the most sensitive receiver under worst-case conditions, should not exceed the Rated Background Level (RBL) by more than 5dB, represented as follows:

- $L_{Aeq,15minutes} < RBL+ 5dB$

Noise levels associated with the proposed sand mine at nearby noise sensitive receptors (located in the surrounding area) should not exceed the Project Specific Noise Levels detailed in Table 5-1, which have been determined from the lower of the amenity and intrusiveness criteria.

Table 5-1 - Project Specific Noise Levels at Noise Sensitive Receptors dB(A) - Residential

Location	Period	L_{Aeq}	RBL	Recommended Acceptable L_{Aeq}[2]	Intrusiveness Criteria Level	Project Specific Noise Level
N1 (R9-19)	Day	49	35	50	40	40
	Evening	50	42	45	47	45
	Night	44	28 (30*)	40	33 (35*)	35
N2 (R1-8, R20-28)	Day	51	40	50	45	45
	Evening	49	34	45	39	39
	Night	43	26 (30*)	40	31 (35*)	35

*NSW NPI states that where the rating background noise level is found to be less than 30dB(A) for the evening and night periods, then it is set to 30dB(A); where it is found to be less than 35dB(A) for the daytime periods, then it is set to 35dB(A).

Table 5-2: Project Specific Noise Levels for Non - Residential - dB(A)

Loc.	Period	Recommended Amenity Level
R4 - Marsh Road Public School	When in Use	40[3] $L_{Aeq\ (1hr)}$(external)
R6 - Marsh Road Public Hall	When in Use	55 $L_{Aeq\ (1hr)}$
R12 - Shark and Ray Centre	When in Use	55 $L_{Aeq\ (1hr)}$

[2] Recommended Acceptable L_{Aeq} noise level for residence in Rural and Suburban area from Table 2.2 in NPI.

[3] The recommended amenity noise level for school classrooms is an internal level of 35db(A). Vipac have assumed 5dB transmission loss through an open window to assess the impact as an external level.

5.2 SLEEP DISTURBANCE ASSESSMENT APPROACH

The NPI refers to the NSW Road Noise Policy for criteria when assessing sleep disturbance. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages. The NPI states that:

Where the subject development/premises night-time noise levels at a residential location exceed:

- $L_{Aeq,\ 15min}$ 40dB(A) or the prevailing RBL plus 5dB, whichever is greater, and/or
- L_{AFmax} 52dB(A) or the prevailing RBL plus 15dB, whichever is the greater,

A detailed maximum noise level event (sleep disturbance) assessment should be undertaken.

Guidance indicating the potential for sleep disturbance is set out in the NSW Road Noise Policy (RNP) and is summarised as follows:

> The NSW Office of Environment and Heritage (OEH) reviewed research on sleep disturbance in the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999). This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.
>
> From the research, OEH recognised that current sleep disturbance criterion of an $L_{A1,\ (1\ minute)}$ not exceeding the L_{A90}, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, OEH will continue to use it as a guide to identify the likelihood of sleep disturbance.
>
> This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.
>
> The detailed analysis should cover the maximum noise level or $L_{A1,\ (1\ minute)}$, that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the appendices to the ECRTN. Other factors that may be important in assessing the extent of impacts on sleep include:
>
> - How often high noise events will occur
> - Time of day (normally between 10pm and 7am)
> - Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

The $L_{A1,\ (1\ minute)}$ descriptor is meant to represent a maximum noise level measured under ‘fast’ time response. The NSW Department of Environment, Climate Change and Water (DECCW) will accept analysis based on either $L_{A1,\ (1\ minute)}$ or $L_{A(Max)}$.

Table 5-3 details the criteria for sleep disturbance for each of the individual noise receiver locations.

Table 5-3 - Sleep Disturbance Noise Criteria at Noise Sensitive Receptors dB(A) - Residential

Location	Period	L_{A90}	Criteria (L_{A90} + 15)
N1 (R9-19)	Night	37	L_{A1} 52dB(A)
N2 (R1-8, R20-28)		37	

5.3 NSW ROAD NOISE POLICY (RNP)

The requirements of the NSW Road Noise Policy (RNP) published by the Department of Environment, Climate Change and Water (DECCW) are also applicable to this assessment. Table 5-4 summarises the road category to establish the noise assessment criteria based on the type of road and the land use developments. The proposed development has the potential to generate additional traffic on Nelson Bay Road that can potentially impact on the nearby noise sensitive receivers.

Table 5-4 - Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of project / land use	Assessment Criteria/ Target Noise Level, dB(A)	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/arterial/sub-arterial Road (Nelson Bay Road)	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments.	$L_{Aeq, (15hour)}$ 60 (external)	$L_{Aeq, (9 hour)}$ 55 (external)

Note: These criteria are for assessment against façade- corrected noise levels when measured in front of a building façade. Hence, a correction factor of 2.5 dB is added to the predicted noise levels

Section 3.4 of the RNP states where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable mitigation measures to meet the criteria. In assessing these measures, any increase in total traffic noise level should be limited to 2dB above that of the corresponding 'no build option'.

In addition to the criteria detailed in the table above, the magnitude of increase in the total traffic noise level at a location due to a proposed project or traffic-generating development must be considered. Residences experiencing increases in total traffic noise level above the relative increase criteria in Table 5-5 below should also be considered for mitigation.

Table 5-5 Relative Increase Criteria for Residential Land Uses

Road Category	Type of project / land use	Total traffic noise level increase, dB(A)	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/arterial/sub-arterial Road (Nelson Bay Road)	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road	Existing traffic $L_{Aeq, (15 hour)}$ + 12 dB (external)	Existing traffic $L_{Aeq, (9 hour)}$ + 12 dB (external)

A relative increase of 12 dB represents slightly more than an approximate doubling of perceived loudness (AS2659.1–1988) and is likely to trigger community reaction, particularly in environments where there is a low existing level of traffic noise.

The noise assessment criterion for non-residential land use is listed in Table 5-6. This criterion is applied when assessing the impact and determining mitigation measures in the following situations:

- When there is a new road or road development;
- When there is a land use development with the potential to generate additional traffic on local, sub-arterial or arterial roads.

Table 5-6 - Road traffic noise assessment criteria for non-residential land uses

Existing sensitive land use	Assessment criteria- dB(A)		Additional Consideration
	Day (7am – 10pm)	Night (10pm – 7am)	
School classrooms	$L_{Aeq,1hr}$ 40 (Internal) When in use	-	In the case of a building used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000).
Places of worship	$L_{Aeq,1hr}$ 40 (Internal)	$L_{Aeq,1hr}$ 40 (Internal)	The criteria are internal, i.e. the inside of a Church. Areas outside the place of worship, such as Churchyard or Cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what in these areas may be affected by road traffic noise.
Childcare facilities	Sleeping rooms $L_{Aeq,1hr}$ 35 (Internal) Indoor Play areas $L_{Aeq,1hr}$ 40 (Internal) Outdoor Play areas $L_{Aeq,1hr}$ 55 (External)	-	Multi-purpose spaces, e.g. shared indoor play/sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
Commercial and Industrial Premises	Shopping Mall L_{Aeq},45-55 (Internal) Small Retail Stores (general) L_{Aeq} 45-50 (Internal) Hotels and motels (sleeping areas) L_{Aeq} 35-40 (Internal)	Shopping Mall L_{Aeq},45-55 (Internal) Small Retail Stores (general) L_{Aeq} 45-50 (Internal) Hotels and motels (sleeping areas) L_{Aeq} 35-40 (Internal)	Information on desirable internal noise levels is contained in Australian Standard 2107:2000.

Where internal noise levels were specified for the applicable criteria outlined in Table 5-6 above, +10dB was added to approximate to an external noise level, for the purposes of the traffic noise assessment which is undertaken to assess noise levels externally to noise sensitive properties.

5.3.1 PRACTICE NOTE 3 (SLEEP DISTURBANCE IMPACT)

A substantial portion of the DECC NSW Road Noise Policy (RNP) discusses a review of international research on the subject of sleep disturbance associated with noise. The guidance outlined with regard to road traffic noise and potential impacts on sleep disturbance expands on previous guidance set out in the RTA Environmental Noise Management Manual (ENMM) and earlier guidance set out in the Environmental Protection Authority Environmental Criteria for Road Traffic Noise (ECRTN).

The most recent guidance set out in the RNP states that "*there appears to be insufficient evidence to set new indicators for potential sleep disturbance due to road traffic noise*". The RNP refers to the RTA Practice Note 3 protocol as the method for assessing and reporting on maximum noise levels that may cause sleep disturbance. The guidelines indicate that:

- Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions, and
- One or two noise events per night with maximum internal noise levels of 65-70 dB(A) are not likely to significantly affect health and well-being.

5.4 VIBRATION CRITERIA – HUMAN RESPONSE TO VIBRATION

The effects of construction vibration upon buildings can be separated into three main categories:

- Perceptibility of the occupants to the vibration, and the possibility of them being disturbed or annoyed;
- Vulnerability of the building structures to vibration induced damaged;
- Vulnerability of the contents of the building that includes types of equipment, activities and processes.

Humans are very sensitive to vibration, and they can be disturbed, annoyed, and have their work activities interfered with if the levels are too high. The DECC "Assessing Vibration – Technical Guideline" (2006) and British Standard 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings, Part 1 – Vibration sources other than blasting provides guidance on human response to vibration in buildings. The guidelines set down base vibration levels at which there would be minimal interference to occupants.

BS6841:1987 Guide to measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock also sets out guidance on the effects of physical health from sustained exposure to vibration. However it is unlikely that such levels would be encountered from construction, demolition or sand mining activities. The frequency weighting to be applied to the vibration levels are obtained from BS6841.

The criteria and guidelines relating to human response are summarised below.

5.4.1 DECC ASSESSING VIBRATION: A TECHNICAL GUIDELINE

The DECC "*Assessing Vibration – Technical Guideline*" (2006) provides evaluation methods to assess the human response from continuous, impulsive and intermittent vibration in buildings from 1Hz to 80Hz which is based on British Standards 6472:1992 "*Evaluation of the Human Exposure to Vibration in Building (1Hz to 80Hz)*".

For continuous and impulsive vibration, assessment of impact should be considered on the basis of weighted RMS acceleration values. For intermittent vibration, assessment of impact should be considered on the basis of vibration dose values (VDV).

The DECC guidelines also include a section on mitigation when the predicted vibration value exceeds the criteria. Vibration mitigation may be achieved by way of:

- Controlling the vibration at the source, using the application of Best Management Practice (BMP) and Best Available Technology Economically Achievable (BATEA).
- Controlling the transmission of vibration.
- Controlling the vibration at the receiver

5.4.2 BRITISH STANDARD 6472:2008- EVALUATION OF HUMAN EXPOSURE TO VIBRATION IN BUILDINGS

BS6472:1992 was updated in 2008 by BS6472:2008 Parts 1 and 2. BS6472:2008 Part 1 sets out vibration levels at which minimal comment is likely to be provoked from the occupants of a building subject to vibration (BS6472:2008 Part 2 relates to Blast-induced vibration). BS 6472 takes into account the fact that humans perceive vertical vibrations to a greater extent than horizontal vibrations, although the effect is reversed at very low frequencies, below 4 Hz.

The evaluation of building vibration with respect to annoyance and comfort for occupants, over all weighted values of vibration is the preferred method of evaluation.

Continuous vibration would be generated for typical construction work. The curves in Figure 5-1 represent the magnitudes of continuous vibration in buildings for Z-axis acceleration, below which adverse comments or complaints are rare. Multiplication factors are applied to the base level curve to define criteria for residential or office spaces. There are similar curves for x and y-axes.

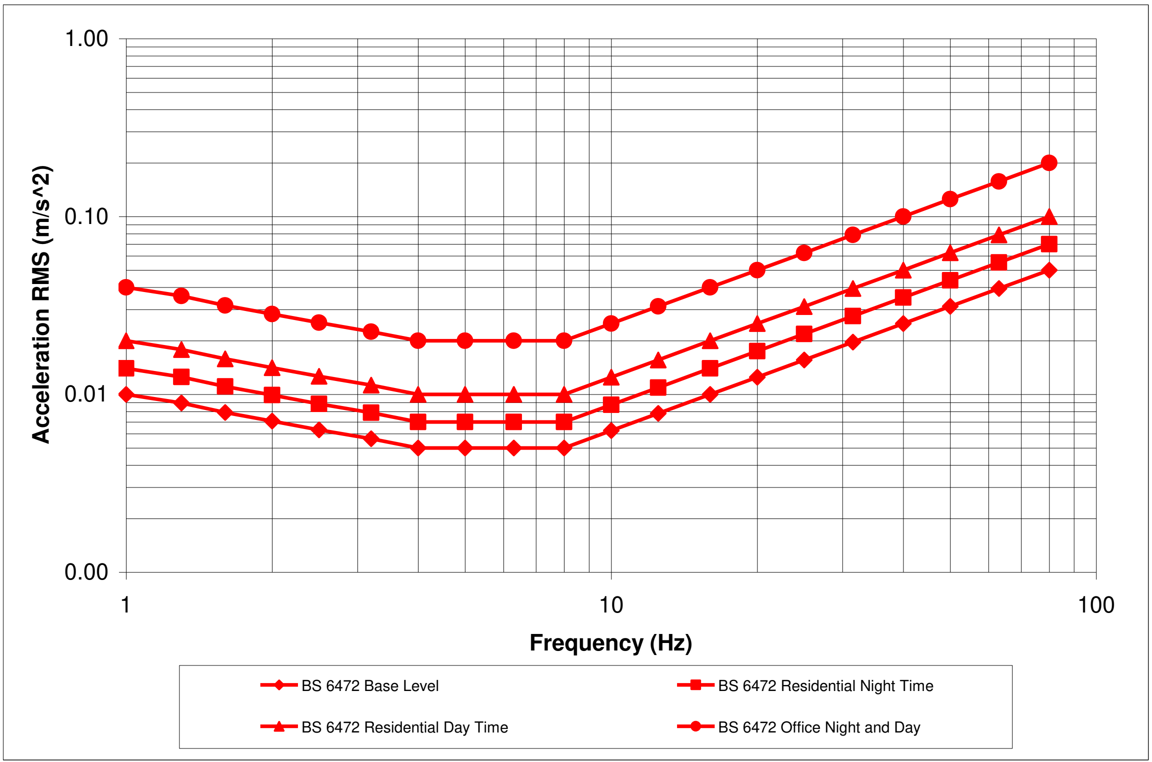

Figure 5-1 - BS 6472 building vibration levels. Z-axis

The Vibration Dose Value in BS 6472 is a concept used to evaluate the cumulative effects of bursts of both intermittent vibration and impulsive vibrations. Vibration Dose Value or the VDV represents a single value amount used to quantify the level of vibration.

The recommended VDV levels outlined in the OEH Vibration Guidelines (based on the BS6472:1992 Standard) which specifies levels of VDV expressed in daytime, night-time and typical human response are presented in Table 5-7. Table 5-8 presents levels of VDV expressed in daytime, night-time and typical human response, based on the updated BS6472:2008 Part 1.

Table 5-7 - Acceptable vibration dose values for intermittent vibration in various buildings (m/s1.75)

Location	Daytime[1]		Night-time	
	Preferred Value m/s$^{1.75}$	**Maximum Value** m/s$^{1.75}$	**Preferred Value** m/s$^{1.75}$	**Maximum Value** m/s$^{1.75}$
Critical areas[2]	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops	0.8	1.6	0.8	1.6

Note 1: Daytime is 07:00 am to 10:00 pm and night-time is 10:00 pm to 07:00 am.

Note 2: Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical cases.

Table 5-8 - Vibration dose value ranges which might result in various probabilities of adverse comment within various buildings (m/s1.75)

Place and time	**Low probability of adverse comment** m/s$^{1.75}$ **Note 1**	**Adverse comment possible** m/s$^{1.75}$	**Adverse comment probable** m/s$^{1.75}$ **Note 2**
Residential buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Office buildings 16h day	0.4 to 0.8	0.8 to 1.6	1.6 to 3.2
Workshop buildings 16h day	0.8 to 1.6	1.6 to 3.2	3.2 to 6.4

Note 1: Below these ranges, adverse comment is not expected.

Note 2: Above these ranges, adverse comment is very likely.

Vibration frequency was assessed in a range from 8Hz - 80 Hz, as predominant frequencies are known to be above 8Hz. Vibration levels below the low probability of adverse comment range presented in Table 5-8 correspond to a low probability of disturbance to building occupants. Adverse comment or complaints may be expected when the VDV approaches the higher range levels in the possible and probable categories. Values up to the maximum level in Table 5-7 can only be used where all reasonable and feasible measures have been implemented and they can be justified.

Criteria for exposure to continuous and impulsive vibration with regard to PPV levels expressed in daytime and night-time (outlined in the OEH Vibration Guidelines) is provided in Table 5-9.

Table 5-9 - Peak Particle velocity for z-axis

Place	Time	Peak Particle velocity (mm/s) for z-axis vibration - Frequency range 8Hz-80Hz	
		Exposure to continuous vibration (16h day, 8h night)	**Impulsive vibration excitation with up to three occurrences**
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day Night	0.14 to 0.28 0.14 to 0.28	0.14 to 0.28 0.14 to 0.28
Residential	Day Night	0.28 to 0.56 0.2 to 0.4	8.6 to 17.0 2.8 to 5.6

Place	Time	Peak Particle velocity (mm/s) for z-axis vibration - Frequency range 8Hz-80Hz	
		Exposure to continuous vibration (16h day, 8h night)	Impulsive vibration excitation with up to three occurrences
Office	Day Night	0.56 to 1.1 0.56 to 1.1	18.0 to 36.0 18.0 to 36.0
Workshops	Day Night	1.1 to 2.2 1.1 to 2.2	18.0 to 36.0 18.0 to 36.0

5.5 STRUCTURAL RESPONSE TO VIBRATION

The response of a building to vibration is affected by several factors that include its type of foundation; the underlying ground conditions, its construction and the state of the building.

BS 7385: Part 2-1993 *Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from ground borne vibration* provides guidance values for building damage, as well as guidance on vibration measurement and data analysis. The German Standard DIN 4150: Part 3-1999 *Structural vibration - Effects of vibration on structures* also provides guidelines for evaluating the effects of vibration on structures.

5.5.1 GERMAN STANDARD DIN 4150-3:1999 – STRUCTURAL VIBRATION – EFFECTS OF VIBRATION ON STRUCTURES

The German Standard DIN 4150: Part 3-1999 *Structural Vibration Part 3: Effects on buildings and structures* is commonly used in Australia to evaluate the effects of vibration on structures primarily used for static loading.

Short-term vibration is defined as vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated.

Table 5-10 provides guideline limits for short-term vibration to ensure that damage reducing the serviceability of a building will not occur provided vibration levels do not exceed these limits. This is also shown graphically in Figure 5-2. Vibration at the foundation is taken as the maximum absolute value in the x, y, and z directions, and vibration at the highest floor is the maximum of the in plane components.

Table 5-10 - DIN4150-3 Vibration Limits

Type of structure	Guideline values for velocity in mm/s			
	Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor at all frequencies
	1Hz to 10Hz	10 to 50Hz	50 to 100Hz (and above)	
Buildings for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

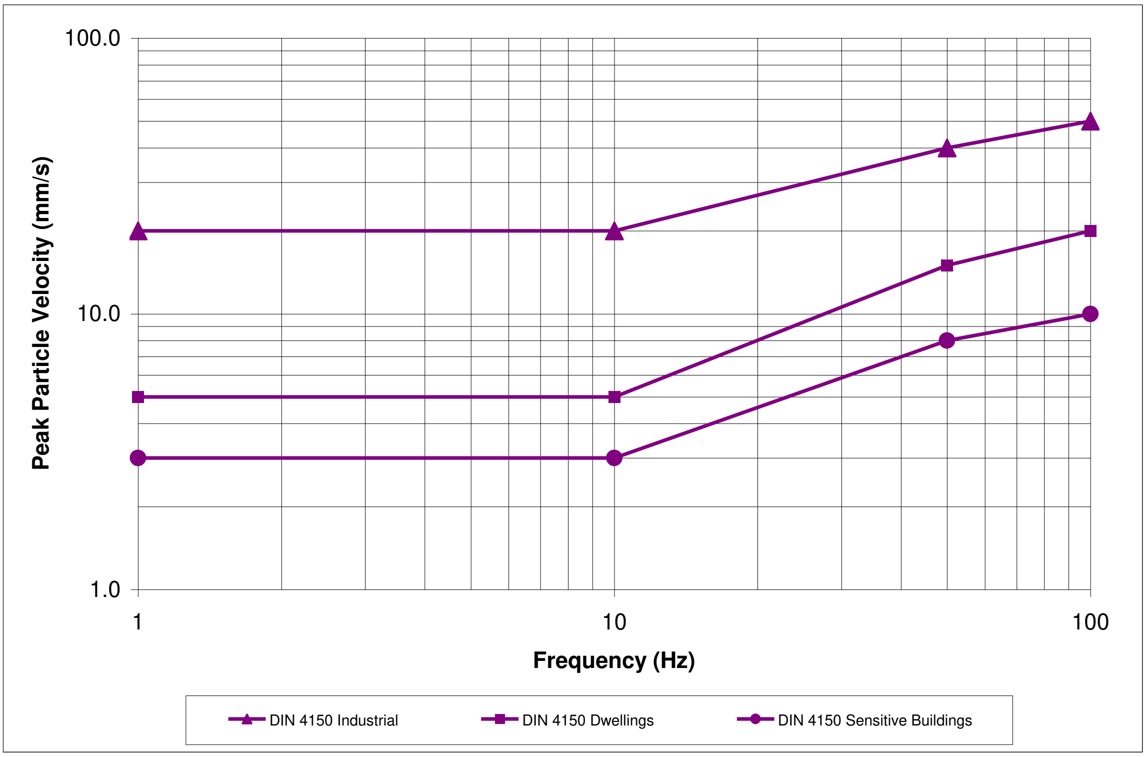

Figure 5-2- DIN 4150-3 Vibration Limits

5.5.2 BRITISH STANDARD 7385 PART 2 – 1993 GUIDE TO DAMAGE LEVELS FROM GROUNDBORNE VIBRATION

The limits for transient vibration, above which cosmetic damage could occur to buildings, are given in Table 5-11 and shown graphically in Figure 5-3.

These guide values however relate predominantly to transient vibration that does not give rise to resonant responses in structures. The guide values in Table 5-11 should be reduced by up to 50%, in the case of dynamic loading caused by continuous vibration. The values presented in BS 7385-2 are frequency dependant levels that are judged to give a minimal risk of vibration-induced damage.

Table 5-11 - Transient vibration guide values for cosmetic damage

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced framed structures, Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Un-reinforced or light framed structures, Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Note 1: Values referred to are at the base of the building Note 2: For the residential buildings group, at frequencies below 4 Hz, a maximum displacement of 0.6mm (zero to peak) should not be exceeded		

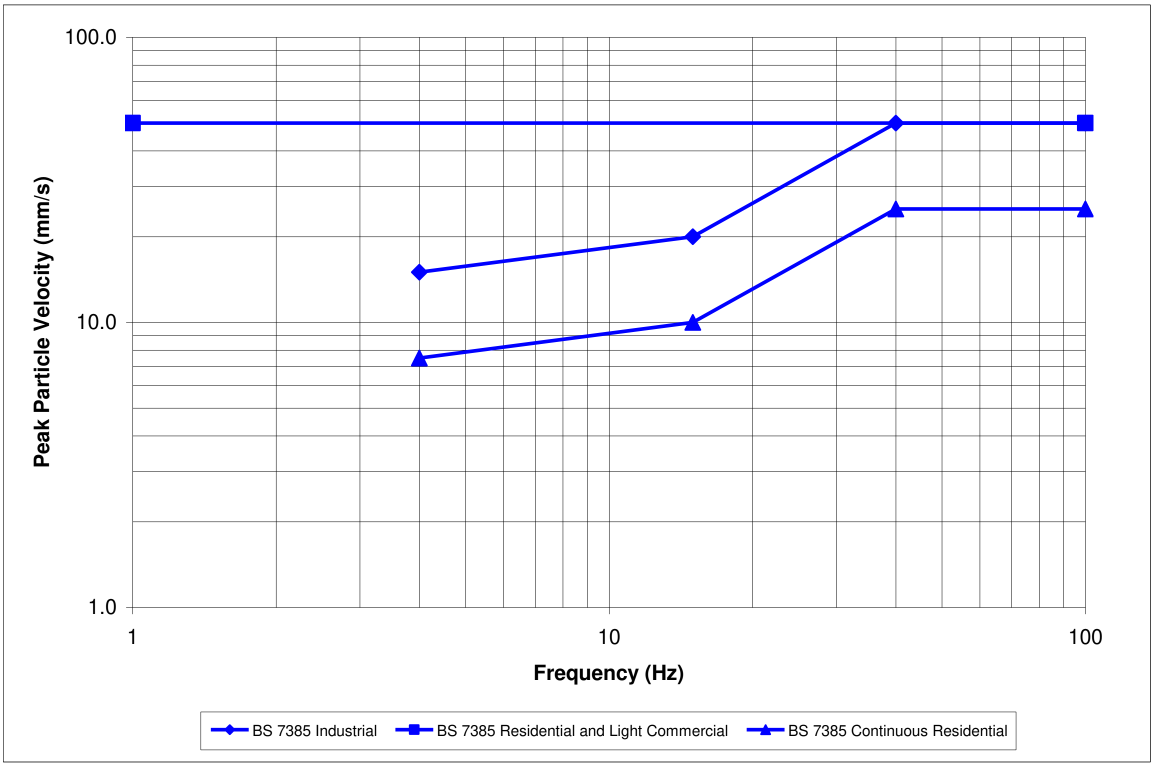

Figure 5-3 - Transient Vibration Guide for Cosmetic Damage

5.5.3 CONSTRUCTION VIBRATION ASSESSMENT CRITERIA SUMMARY

A comparison to the above criteria is shown in Figure 5-4. PPV values have been used for the human disturbance values, in order to compare against building damage guide values.

The human disturbance criterion from BS 6472 for continuous vibration is significantly lower than the various threshold damage levels from DIN 4150 and BS 7385. This is due to humans being able to perceive vibration levels that are well below those that could cause any risk to damage to a building or its contents.

The values in DIN 4150 are levels that if complied with, damage will not occur. If levels are exceeded damage will not necessarily occur, however if they are significantly exceeded, then further investigations will be required.

The vales in BS 7385 are the lowest vibration levels above which damage has been credibly demonstrated. This is the basis on which the values are much higher than those of DIN 4150. Based on the above, the following criterion is deemed most appropriate and is recommended for use in this assessment:

- When the adjacent building subject to vibration is being occupied, continuous vibration levels from BS 6472 will be used to assess human perception. Human perception occurs at lower thresholds than that for building damage and during occupied periods will be the limiting criteria.
- When it is un-occupied, vibration levels from DIN 4150 will be used to protect the building from cosmetic damage.

Table 5-12 provides a summary of vibration management levels criterion at the sensitive receivers (which have been determined in accordance with the *Interim Construction Noise Guideline*).

Table 5-12- Human perception and cosmetic damage criteria (minimum value)

Type	Human Perception and cosmetic damage criteria	
	Human Perception (mm/s)	Cosmetic Damage (mm/s)
Residential	0.28-0.56	5

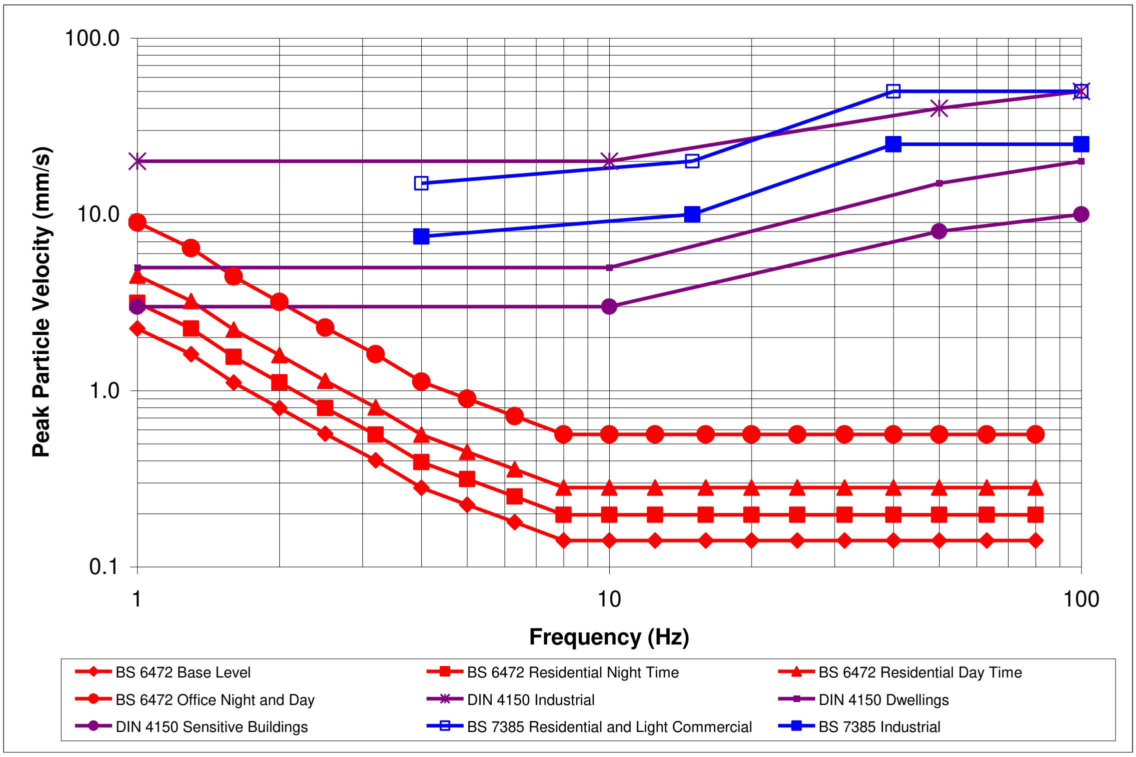

Figure 5-4 - Human Disturbance and Building Damage Guide Values

6 NOISE MODELLING

Noise modelling has been undertaken using the SoundPLAN 8.0 computational noise modelling software package. The use of the SoundPLAN software and referenced modelling methodology is accepted for use in the state of NSW by the EPA for environmental noise modelling purposes. Vipac have undertaken numerous noise modelling and impact assessments previously using SoundPLAN for a range of projects, including infrastructure development and industrial projects.

6.1 GEOGRAPHICAL DATA

Tattersall Lander supplied topographical details of the area to Vipac and Table 6-1 below lists the drawings received and used in the noise prediction model.

Table 6-1 - Drawings Used

Drawing Title	Description	Date
Existing Surface Survey dxf	Current Terrain Layout	11/08/2014
3m Design Surface dxf	3m pit proposed design	11/08/2014
1m Design Surface dxf	1m pit proposed design	11/08/2014
-15m Design Surface dxf	-15m proposed pit design	11/08/2014
Sand Mine Plan (Rev E)	Proposed Mine Layout	23/09/2019

6.2 OPERATIONAL PHASES

6.2.1 NOISE SOURCES

Vipac has been advised by Tattersall Lander that the main noise contributor associated with the proposed sand mine will be the operation of the mobile plant and export Lorries utilised in the mining process. A list of plant for use in the noise modelling has been compiled in conjunction with Tattersall Lander and with details of the mining process and plant as outlined in the mining plan as supplied by Quarry Mining Systems.

Details of the plant and equipment that will be used during the operational phase of the proposed sand mine and indicative sound power levels (i.e. noise emission levels associated with the equipment) are listed in Table 6-2.

Table 6-2 - Sound Power Levels (Lw).

Description	Modelled Quantity per Phase					Sound Power levels, L_w (dB(A))	Sound Power Reference Source	Approx Source Heights
	Phase 1	Phase 2	Phase 3	Phase 4	Peak			
22t Excavator	2	2	-	-	-	106	BS5228-1-2009	2m
35t Excavator	2	2	-	-	-	109	BS5228-1-2009	2m
44t Haul Truck	2	2	0	0	0	118	BS5228-1-2009	2m
Sales Loader	3	3	3	3	3	112	BS5228-1-2009	2m
Conveyor System Head Drive	1	1	1	1	1	97	BS5228-1-2009	3m
Screens	1	1	1	1	1	109	BS5228-1-2009	3m
Pump	2	2	2	2	2	100	BS5228-1-2009	0.5m
32t Export Lorry	24	40	72	112	200	110	BS5228-1-2009	2m
Pump on Dredge	-	-	3	3	3	108	BS5228-1-2009	0.1m

6.2.2 NOISE MODELLING SCENARIO

Vipac understands that the proposed sand mine will operate from 7am to 7pm. A site layout plan of the proposed facility is provided as Figure 3-2.

The mine will progress in phases with Dry mining from current terrain down to the water table and then wet mining commencing by way of dredge down to a final depth of -15m AHD. Vipac has, as worst-case, conservatively modelled the beginning of each phase. Noise modelling for dry mining was conducted at the current terrain levels and at the 3m terrain level as provided by Tattersall Lander, and wet mining was modelled as commencing at the 1m terrain level and -15m terrain level provided.

The model was prepared including all current nearby buildings and known future developments/buildings to accurately predict potential impacts from the mine. The model includes all relevant noise sources as stated in the Quarry Mining System report and detailed in Table 6-2, and assesses the total overall impact on all surrounding receivers at any one time. The modelling of the peak operation of the mine accounts for the maximum rate of sand extraction. Given the size and shape of the mine, some noise sources have been duplicated to reflect the potential worst case locations where plant/machinery may be closest to sensitive receivers. This method allows for a conservative assumption of total noise levels being emitted from the mine.

6.2.3 WEATHER CONDITIONS

Five acoustic modelling scenarios were assessed for the operational phase of the proposed sand mine within the SoundPLAN program using CONCAWE algorithms under both neutral and worst-case weather conditions for the day and night periods. It should be noted that sound will propagate further through the atmosphere under certain weather conditions dependent on air pressure variations, wind speed and direction variations, temperature inversions etc. The ‘worst-case’ weather conditions chosen were those highly conducive to the propagation of sound. These worst case weather conditions are generally experienced when there are wind speeds of 2-3m/s in the direction from the source to the receiver during temperature inversion scenarios in the night time (Pasquill Stability Category F).

Table 6-3 presents the weather parameters used in the CONCAWE calculations based on annual data from the Bureau of Meteorology (BoM) Weather Station at Nelson Bay.

Table 6-3 - SoundPLAN Weather Parameters

Parameter	Day		Night	
	Neutral	Worst-case	Neutral	Worst-case
Pasquill Stability Category	B	D	D	F
Wind Speed (m/s)	0	3	0	3
Humidity (%)	57	57	75	75
Temperature (deg Celsius)	16	16	10	10
Met Category	3	5	4	6

6.3 NOISE IMPACT FROM GENERATED TRAFFIC

The Calculation of Road Traffic Noise (CoRTN) method of traffic noise prediction was used, which is a method approved by the EPA (OEH). The traffic data presented in the “Bobs Farm Sand Quarry Traffic Impact Assessment” (by Seca Solution, dated 24th October 2014) was augmented with automatic traffic counts which were obtained on Nelson Bay Road between Marsh Road and Port Stephens Road in September 2014.

Traffic will enter exit the site via the new entrance off Nelson Bay Road at the southern end of the site. Vehicles will travel along the private road down the ramp to the loading/stockpile area, travel back up the ramp to exit turning left onto Nelson Bay Road. Trucks travelling toward Newcastle will also pass the site heading westbound. As a result, traffic numbers have been updated for both east and westbound directions of Nelson Bay Road.

The Seca Solutions report assumes the site will generate 200 trucks per day during peak periods, increasing the AADT west of the site by 360 vehicles per day, raising it from 15,311 to 15,671 vehicles per day representing an increase of 2.3%.

Vipac has also conducted noise modelling for the four phases of operation, as outlined in the Quarry Mining System reports, based on projected export tonnage specified in the report and an average export load of 30 tonnes per shipment to assess the traffic outside peak times. The increased number of trucks utilising the road is outlined below in Table 6-4.

Table 6-4 - Estimated Truck Movements

Phase	Truck movements per Day
1	24
2	40
3	72
4	112
Peak	200

Table 6-5 provides the following increase of traffic travelling east and westbound on Nelson Bay Road.

Table 6-5 - Traffic Volumes – Nelson Bay Road

Traffic Details	Nelson Bay Road					
	Base Traffic	Base Traffic + Phase 1	Base Traffic + Phase 2	Base Traffic + Phase 3	Base Traffic + Phase 4	Base Traffic + Proposed Peak
Average Daily Traffic	15311	15335	15351	15383	15433	15511
15 hour traffic flows (Day Period)	14323	14343	14358	14390	14430	14518
% Percentage Heavy Vehicles (15 hours)	4	4.4	4.5	4.7	5.0	5.5
9 hour traffic flows (Night Period)	988	992	993	993	933	933
% Percentage Heavy Vehicles (9 hours)	4.6	5.0	5.0	5.0	5.0	5.0
Speed Limit (km/h)	80					

7 RESULTS

7.1 PREDICTED NOISE LEVELS FOR OPERATIONAL PHASES (L_{AEQ}) – NO MITIGATION

Noise prediction modelling has been carried out to assess the potential impact associated with the proposed sand mine at the nearest noise sensitive receptors.

The predicted noise levels representative of each of the operational phases including peak operation for both neutral conditions and worst-case conditions during day, evening and night-time (including sleep disturbance) are presented in Table 7-1 to Table 7-5. A sample of these tables has been reproduced graphically and are shown in Appendix A. Operation has been assessed for 1 hour in the night period (6am-7am) for potential flexibility of operation hours if required.

Table 7-1 – Phase 1 Operation – Overall Predicted Noise Impact without Mitigation – Day, Evening and Night (L_{Aeq})

Rec #	Day Period No Mitigation					Evening Period No Mitigation					Night Period No Mitigation				
	Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant	
R1	45	43	47	✓	×	45	37	41	✓	✓	35	33	37	✓	×
R2	45	25	30	✓	✓	45	19	24	✓	✓	35	15	20	✓	✓
R3	45	36	41	✓	✓	45	30	35	✓	✓	35	26	32	✓	✓
R4	40	34	39	✓	✓	40	28	33	✓	✓	40	24	29	✓	✓
R5	45	35	40	✓	✓	45	28	34	✓	✓	35	25	30	✓	✓
R6	55	28	32	✓	✓	55	21	26	✓	✓	55	18	23	✓	✓
R7	45	35	40	✓	✓	45	29	34	✓	✓	35	26	31	✓	✓
R8	45	32	37	✓	✓	45	26	31	✓	✓	35	23	27	✓	✓
R9	40	34	37	✓	✓	39	28	31	✓	✓	35	24	27	✓	✓
R10	40	32	36	✓	✓	39	26	30	✓	✓	35	22	27	✓	✓
R11	40	32	36	✓	✓	39	26	30	✓	✓	35	22	27	✓	✓
R12	55	34	38	✓	✓	55	28	32	✓	✓	55	25	29	✓	✓
R13	40	29	33	✓	✓	39	23	27	✓	✓	35	20	23	✓	✓
R14	40	37	40	✓	✓	39	30	34	✓	✓	35	27	30	✓	✓
R15	40	42	46	×	×	39	36	40	✓	×	35	33	37	✓	×
R16	40	41	45	×	×	39	34	39	✓	✓	35	31	35	✓	✓
R17	40	39	44	✓	×	39	33	38	✓	✓	35	30	34	✓	✓
R18	40	40	45	✓	×	39	34	39	✓	✓	35	31	35	✓	✓
R19	40	37	42	✓	×	39	31	36	✓	✓	35	27	32	✓	✓
R20	45	31	36	✓	✓	45	25	30	✓	✓	35	22	27	✓	✓
R21	45	35	40	✓	✓	45	29	34	✓	✓	35	26	31	✓	✓
R22	45	33	38	✓	✓	45	27	32	✓	✓	35	24	29	✓	✓
R23	45	33	38	✓	✓	45	27	32	✓	✓	35	23	28	✓	✓
R24	45	27	32	✓	✓	45	21	26	✓	✓	35	17	22	✓	✓
R25	45	32	37	✓	✓	45	26	31	✓	✓	35	23	28	✓	✓
R26	45	37	42	✓	✓	45	31	36	✓	✓	35	27	32	✓	✓
R27	45	38	43	✓	✓	45	32	37	✓	✓	35	28	33	✓	✓
R28	45	30	35	✓	✓	45	24	29	✓	✓	35	20	25	✓	✓

Table 7-2 – Phase 2 Operation – Overall Predicted Noise Impact without Mitigation – Day, Evening and Night (L_{Aeq})

Rec #	Day Period No Mitigation					Evening Period No Mitigation					Night Period No Mitigation				
	Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant	
R1	45	47	51	×	×	45	41	45	✓	✓	35	37	41	×	×
R2	45	28	33	✓	✓	45	22	27	✓	✓	35	18	23	✓	✓
R3	45	35	41	✓	✓	45	29	35	✓	✓	35	26	31	✓	✓
R4	40	32	37	✓	✓	40	26	31	✓	✓	40	22	28	✓	✓
R5	45	35	40	✓	✓	45	29	34	✓	✓	35	26	31	✓	✓
R6	55	27	32	✓	✓	55	21	26	✓	✓	55	17	22	✓	✓
R7	45	36	41	✓	✓	45	30	35	✓	✓	35	26	31	✓	✓
R8	45	28	33	✓	✓	45	22	27	✓	✓	35	19	23	✓	✓
R9	40	34	38	✓	✓	39	28	32	✓	✓	35	25	28	✓	✓
R10	40	39	44	✓	×	39	33	37	✓	✓	35	29	34	✓	✓
R11	40	39	44	✓	×	39	33	37	✓	✓	35	29	34	✓	✓
R12	55	39	44	✓	✓	55	33	38	✓	✓	55	29	34	✓	✓
R13	40	36	40	✓	✓	39	30	33	✓	✓	35	26	30	✓	✓
R14	40	47	51	×	×	39	41	45	×	×	35	38	42	×	×
R15	40	44	49	×	×	39	38	43	✓	×	35	34	39	✓	×
R16	40	42	47	×	×	39	36	41	✓	×	35	33	38	✓	×
R17	40	41	46	×	×	39	35	40	✓	×	35	32	36	✓	×
R18	40	42	47	×	×	39	36	40	✓	×	35	32	37	✓	×
R19	40	38	43	✓	×	39	32	37	✓	✓	35	28	33	✓	✓
R20	45	29	34	✓	✓	45	23	28	✓	✓	35	20	25	✓	✓
R21	45	35	40	✓	✓	45	29	34	✓	✓	35	26	31	✓	✓
R22	45	34	39	✓	✓	45	28	33	✓	✓	35	25	30	✓	✓
R23	45	34	39	✓	✓	45	28	33	✓	✓	35	25	30	✓	✓
R24	45	26	31	✓	✓	45	20	25	✓	✓	35	16	21	✓	✓
R25	45	32	37	✓	✓	45	26	31	✓	✓	35	23	28	✓	✓
R26	45	39	44	✓	✓	45	33	38	✓	✓	35	29	34	✓	✓
R27	45	39	44	✓	✓	45	33	38	✓	✓	35	29	34	✓	✓
R28	45	38	43	✓	✓	45	32	37	✓	✓	35	29	34	✓	✓

Table 7-3 – Phase 3 Operation – Overall Predicted Noise Impact without Mitigation – Day, Evening and Night (L_{Aeq})

Rec #	Day Period No Mitigation					Evening Period No Mitigation					Night Period No Mitigation				
	Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant	
R1	45	40	44	✓	✓	45	34	38	✓	✓	35	31	35	✓	✓
R2	45	22	27	✓	✓	45	16	21	✓	✓	35	13	17	✓	✓
R3	45	32	38	✓	✓	45	26	32	✓	✓	35	23	28	✓	✓
R4	40	28	33	✓	✓	40	22	27	✓	✓	40	19	24	✓	✓
R5	45	32	37	✓	✓	45	26	31	✓	✓	35	23	28	✓	✓
R6	55	25	30	✓	✓	55	19	24	✓	✓	55	15	20	✓	✓
R7	45	33	37	✓	✓	45	27	31	✓	✓	35	23	28	✓	✓
R8	45	25	30	✓	✓	45	19	24	✓	✓	35	16	20	✓	✓
R9	40	30	34	✓	✓	39	24	28	✓	✓	35	21	24	✓	✓
R10	40	39	44	✓	×	39	33	38	✓	✓	35	30	34	✓	✓
R11	40	39	44	✓	×	39	33	38	✓	✓	35	30	34	✓	✓
R12	55	30	34	✓	✓	55	24	28	✓	✓	55	20	25	✓	✓
R13	40	34	37	✓	✓	39	28	31	✓	✓	35	24	28	✓	✓
R14	40	48	52	×	×	39	42	46	×	×	35	38	42	×	×
R15	40	52	55	×	×	39	46	49	×	×	35	42	45	×	×
R16	40	46	50	×	×	39	40	44	×	×	35	36	40	×	×
R17	40	38	43	✓	×	39	32	37	✓	✓	35	29	33	✓	✓
R18	40	39	43	✓	×	39	33	37	✓	✓	35	29	34	✓	✓
R19	40	34	39	✓	✓	39	28	33	✓	✓	35	24	29	✓	✓
R20	45	24	29	✓	✓	45	18	23	✓	✓	35	15	19	✓	✓
R21	45	33	38	✓	✓	45	27	32	✓	✓	35	24	29	✓	✓
R22	45	31	36	✓	✓	45	25	30	✓	✓	35	22	27	✓	✓
R23	45	31	36	✓	✓	45	25	30	✓	✓	35	21	26	✓	✓
R24	45	21	26	✓	✓	45	15	20	✓	✓	35	12	17	✓	✓
R25	45	31	36	✓	✓	45	25	30	✓	✓	35	21	26	✓	✓
R26	45	35	40	✓	✓	45	29	33	✓	✓	35	25	30	✓	✓
R27	45	36	40	✓	✓	45	30	34	✓	✓	35	26	31	✓	✓
R28	45	34	38	✓	✓	45	28	32	✓	✓	35	24	29	✓	✓

Table 7-4 – Phase 4 Operation – Overall Predicted Noise Impact without Mitigation – Day, Evening and Night (L_{Aeq})

Rec #	Day Period No Mitigation					Evening Period No Mitigation					Night Period No Mitigation				
	Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant	
R1	45	38	42	✓	✓	45	32	36	✓	✓	35	28	33	✓	✓
R2	45	22	27	✓	✓	45	16	21	✓	✓	35	13	18	✓	✓
R3	45	34	39	✓	✓	45	27	33	✓	✓	35	24	29	✓	✓
R4	40	28	33	✓	✓	40	22	27	✓	✓	40	19	24	✓	✓
R5	45	33	38	✓	✓	45	27	32	✓	✓	35	23	28	✓	✓
R6	55	24	29	✓	✓	55	18	23	✓	✓	55	15	20	✓	✓
R7	45	33	38	✓	✓	45	27	32	✓	✓	35	24	29	✓	✓
R8	45	25	29	✓	✓	45	19	23	✓	✓	35	15	19	✓	✓
R9	40	30	34	✓	✓	39	24	28	✓	✓	35	21	25	✓	✓
R10	40	38	43	✓	✗	39	32	37	✓	✓	35	28	33	✓	✓
R11	40	38	43	✓	✗	39	32	37	✓	✓	35	28	33	✓	✓
R12	55	26	31	✓	✓	55	20	25	✓	✓	55	17	22	✓	✓
R13	40	32	36	✓	✓	39	26	30	✓	✓	35	22	26	✓	✓
R14	40	43	47	✗	✗	39	37	41	✓	✗	35	33	38	✓	✗
R15	40	45	48	✗	✗	39	39	42	✓	✗	35	35	39	✓	✗
R16	40	38	43	✓	✗	39	32	37	✓	✓	35	28	33	✓	✓
R17	40	37	42	✓	✗	39	31	36	✓	✓	35	27	32	✓	✓
R18	40	37	42	✓	✗	39	31	36	✓	✓	35	28	32	✓	✓
R19	40	34	39	✓	✓	39	28	33	✓	✓	35	25	30	✓	✓
R20	45	24	29	✓	✓	45	18	23	✓	✓	35	15	19	✓	✓
R21	45	34	39	✓	✓	45	28	33	✓	✓	35	25	30	✓	✓
R22	45	32	37	✓	✓	45	26	31	✓	✓	35	22	28	✓	✓
R23	45	31	37	✓	✓	45	25	31	✓	✓	35	22	27	✓	✓
R24	45	22	27	✓	✓	45	16	21	✓	✓	35	12	17	✓	✓
R25	45	31	37	✓	✓	45	25	31	✓	✓	35	22	27	✓	✓
R26	45	34	39	✓	✓	45	28	33	✓	✓	35	24	29	✓	✓
R27	45	35	40	✓	✓	45	29	34	✓	✓	35	26	31	✓	✓
R28	45	34	38	✓	✓	45	28	33	✓	✓	35	24	29	✓	✓

Table 7-5 - Peak Operation – Overall Predicted Noise Impact without Mitigation – Day, Evening and Night (L_{Aeq})

Rec #	Day Period No Mitigation					Evening Period No Mitigation					Night Period No Mitigation				
	Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant	
R1	45	38	42	✓	✓	45	32	36	✓	✓	35	28	33	✓	✓
R2	45	22	27	✓	✓	45	16	21	✓	✓	35	13	18	✓	✓
R3	45	34	39	✓	✓	45	27	33	✓	✓	35	24	29	✓	✓
R4	40	28	33	✓	✓	40	22	27	✓	✓	40	19	24	✓	✓
R5	45	33	38	✓	✓	45	27	32	✓	✓	35	23	28	✓	✓
R6	55	24	29	✓	✓	55	18	23	✓	✓	55	15	20	✓	✓
R7	45	33	38	✓	✓	45	27	32	✓	✓	35	24	29	✓	✓
R8	45	25	29	✓	✓	45	19	23	✓	✓	35	15	19	✓	✓
R9	40	30	34	✓	✓	39	24	28	✓	✓	35	21	25	✓	✓
R10	40	38	43	✓	×	39	32	37	✓	✓	35	28	33	✓	✓
R11	40	38	43	✓	×	39	32	27	✓	✓	35	28	33	✓	✓
R12	55	26	31	✓	✓	55	20	25	✓	✓	55	17	22	✓	✓
R13	40	32	36	✓	✓	39	26	30	✓	✓	35	22	26	✓	✓
R14	40	43	47	×	×	39	37	41	✓	×	35	33	38	✓	×
R15	40	45	48	×	×	39	39	42	✓	×	35	35	39	✓	×
R16	40	38	43	✓	×	39	32	37	✓	✓	35	28	33	✓	✓
R17	40	37	42	✓	×	39	31	36	✓	✓	35	27	32	✓	✓
R18	40	37	42	✓	×	39	31	36	✓	✓	35	28	32	✓	✓
R19	40	34	39	✓	✓	39	28	33	✓	✓	35	25	30	✓	✓
R20	45	24	29	✓	✓	45	18	23	✓	✓	35	15	19	✓	✓
R21	45	34	39	✓	✓	45	28	33	✓	✓	35	25	30	✓	✓
R22	45	32	37	✓	✓	45	26	31	✓	✓	35	22	28	✓	✓
R23	45	31	37	✓	✓	45	25	31	✓	✓	35	22	27	✓	✓
R24	45	22	27	✓	✓	45	16	21	✓	✓	35	12	17	✓	✓
R25	45	31	37	✓	✓	45	25	31	✓	✓	35	22	27	✓	✓
R26	45	34	39	✓	✓	45	28	33	✓	✓	35	24	29	✓	✓
R27	45	35	40	✓	✓	45	29	34	✓	✓	35	26	31	✓	✓
R28	45	34	39	✓	✓	45	28	33	✓	✓	35	24	29	✓	✓

7.1.1 DAY/EVENING/NIGHTTIME OPERATION SUMMARY – NO MITIGATION

The results of the noise modelling show that there are a number of exceedances predicted at the closest sensitive receivers to onsite activities at the sand mine. The exceedances are primarily related to the internal articulated dump truck routes and excavators in the mine pit (through phases 1 and 2) and dredge pumps in the final phases. The operation of 200 vehicles per day does not contribute to the levels of exceedance at the nearest sensitive receivers, primarily due to the large distances separating receivers and the location of Lorries loading on the site.

Without any noise mitigation measures, exceedances can be observed at the following:

Table 7-6 - Exceeding Receiver Summary – No mitigation

Phase	Worst Case Conditions without Mitigation		
	Day	Evening	Night
Phase 1	R1, R15-R19	R15	R1, R15
Phase 2	R1, R10, R11, R14-19	R14-18	R1, R14-18
Phase 3	R10, R11, R14-18	R14-16	R14-16
Phase 4	R10, R11, R14-18	R14-15	R14, R15
Peak	R10, R11, R14-18	R14-15	R14, R15

Given exceedances of the noise criteria are predicted, it was necessary to investigate potential mitigation measures to determine whether compliance may be achievable for the proposed operation hours of 7am-7pm.

7.2 RECOMMENDED MITIGATION MEASURES

7.2.1 ACOUSTIC BARRIERS AND BUNDS/EARTH MOUNDS

Vipac proposes a 5m high acoustic barrier is installed to screen the stockpiling and loading/unloading activities at the centre of the site. The recommended barrier location is detailed in Figure 7-1 below, and is to run for approximately 62m. The current proposed location is indicative only and is dependent on final plant/machinery operational layouts. Should the layout require machinery to be located elsewhere at the stockpiling/loading area, a revision of the barrier design may be required. The barrier is required to be:

- The minimum heights as shown, relative to the finished level of the stockpiling/loading area.
- Of solid construction and have no gaps or holes (inclusive of where the barrier meets the ground) for the extent shown
- Any gaps surrounding access gates (if required) are to be overlapped sufficiently so that there are no holes above, below or on the sides of the gate.
- Constructed of a material with a surface mass not less than 12.5kg/m^2.
- Suitable materials include glass, masonry, 25mm thick timber palings overlapped (minimum 40% overlap), 25mm thick plywood, 12mm thick fibre cement sheeting, 6mm compressed fibre cement sheeting, 7mm thick aluminium, 2.5mm thick still, or a combination of the above.

Additionally, Vipac proposes the construction of four acoustic bunds/earth mounds at the height and extents detailed in Figure 7-1 below. The following is required to be constructed prior to commencement of the initial stages.

- Bund 1 – approximately 460m in length and 8m high above NGL to mitigate impacts on Receivers R18 and R19.
- Bund 2 – approximately 220m in length and 8m high above NGL to reduce non-compliant impacts on Receivers R15-R17.
- Bund 3 – approximately 235m in length and 8m above NGL high to mitigate impacts on the approved residential development at 686 Marsh Road (R13, R14).
- Bund 4 – approximately 560m in length and 6m high above NGL to mitigate impacts on Receivers R1.

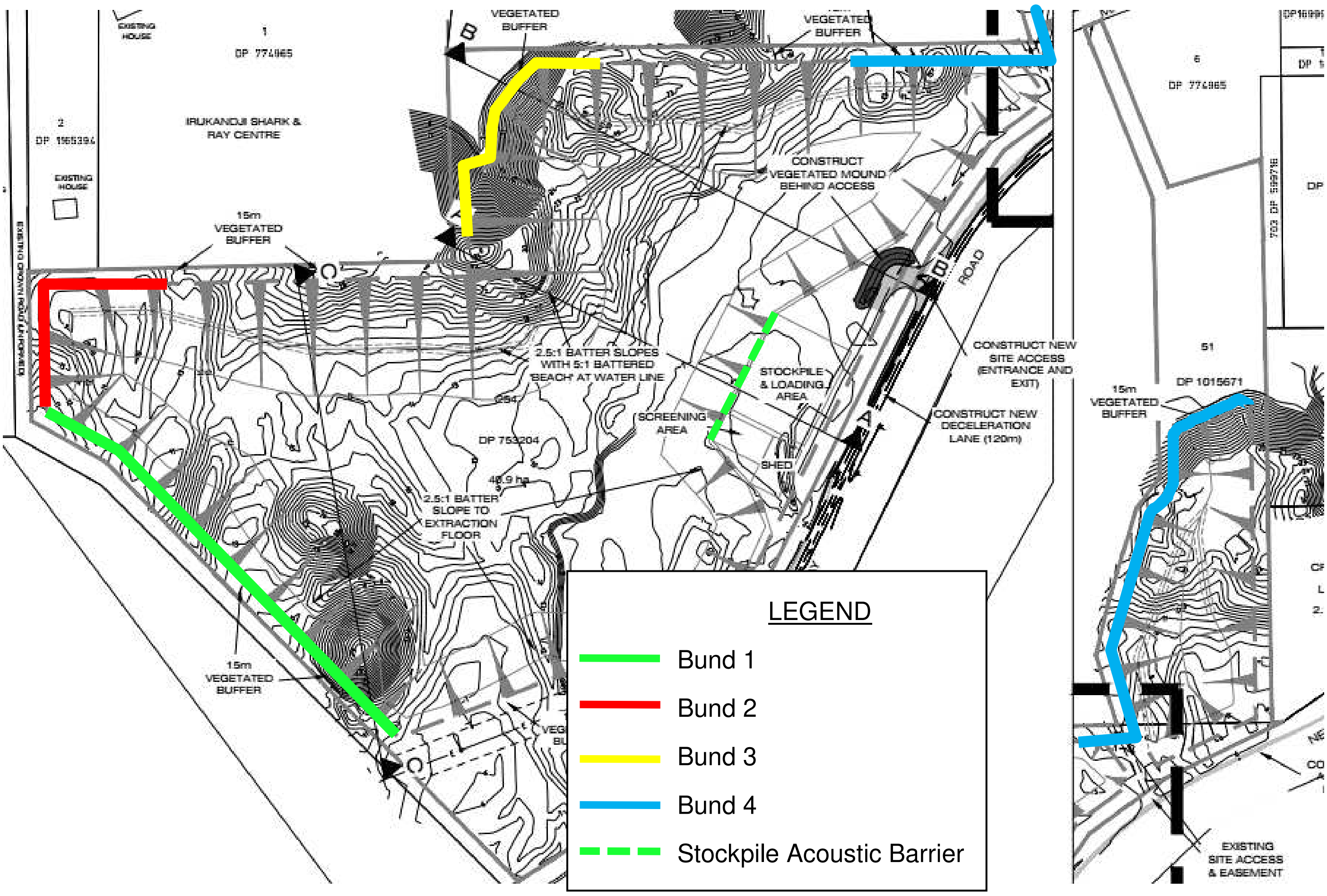

Figure 7-1 – Proposed Mitigation

7.3 PREDICTED NOISE LEVELS FOR OPERATIONAL PHASES (L_{AEQ}) – WITH MITIGATION

Noise prediction modelling has been carried out to assess the potential impact associated with the proposed sand mine at the nearest noise sensitive receptors incorporating the proposed mitigation above.

The predicted noise levels representative of each of the operational phases including peak operation for both neutral conditions and worst-case conditions during day, evening and night-time are presented in Table 7-1 to Table 7-5. A sample of these tables has been reproduced graphically and is shown in Appendix A.

Table 7-7 – Phase 1 Operation – Overall Predicted Noise Impact with Mitigation – Day, Evening and Night (LAeq)

Rec #	**Day Period With Mitigation**					**Evening Period With Mitigation**					**Night Period With Mitigation**				
	Criteria	**Neutral**	**Worst-case**	**Compliant**		**Criteria**	**Neutral**	**Worst-case**	**Compliant**		**Criteria**	**Neutral**	**Worst-case**	**Compliant**	
R1	45	42	46	✓	×	45	36	40	✓	✓	35	32	37	✓	×
R2	45	25	30	✓	✓	45	19	24	✓	✓	35	15	20	✓	✓
R3	45	36	41	✓	✓	45	30	35	✓	✓	35	26	31	✓	✓
R4	40	33	38	✓	✓	40	27	32	✓	✓	40	24	29	✓	✓
R5	45	34	39	✓	✓	45	28	33	✓	✓	35	24	29	✓	✓
R6	55	27	32	✓	✓	55	21	26	✓	✓	55	18	23	✓	✓
R7	45	35	40	✓	✓	45	29	34	✓	✓	35	26	31	✓	✓
R8	45	27	32	✓	✓	45	21	26	✓	✓	35	18	22	✓	✓
R9	40	33	37	✓	✓	39	27	31	✓	✓	35	23	27	✓	✓
R10	40	29	33	✓	✓	39	23	27	✓	✓	35	19	23	✓	✓
R11	40	29	33	✓	✓	39	23	27	✓	✓	35	19	23	✓	✓
R12	55	34	38	✓	✓	55	28	32	✓	✓	55	24	29	✓	✓
R13	40	29	33	✓	✓	39	23	27	✓	✓	35	20	23	✓	✓
R14	40	36	39	✓	✓	39	30	33	✓	✓	35	27	30	✓	✓
R15	40	42	47	×	×	39	36	40	✓	×	35	33	37	✓	×
R16	40	41	45	×	×	39	35	39	✓	✓	35	31	35	✓	✓
R17	40	39	44	✓	×	39	33	38	✓	✓	35	30	34	✓	✓
R18	40	40	45	✓	×	39	34	39	✓	✓	35	31	35	✓	✓
R19	40	35	40	✓	✓	39	29	34	✓	✓	35	26	31	✓	✓
R20	45	29	34	✓	✓	45	23	28	✓	✓	35	19	24	✓	✓
R21	45	35	40	✓	✓	45	29	34	✓	✓	35	25	30	✓	✓
R22	45	33	38	✓	✓	45	27	32	✓	✓	35	23	28	✓	✓
R23	45	33	38	✓	✓	45	27	32	✓	✓	35	23	28	✓	✓
R24	45	26	31	✓	✓	45	20	25	✓	✓	35	17	22	✓	✓
R25	45	32	37	✓	✓	45	26	31	✓	✓	35	23	28	✓	✓
R26	45	37	42	✓	✓	45	31	36	✓	✓	35	27	32	✓	✓
R27	45	38	42	✓	✓	45	32	36	✓	✓	35	28	33	✓	✓
R28	45	30	35	✓	✓	45	24	29	✓	✓	35	20	25	✓	✓

Table 7-8 – Phase 2 Operation – Overall Predicted Noise Impact with Mitigation – Day, Evening and Night (LAeq)

Rec #	Day Period With Mitigation					Evening Period With Mitigation					Night Period With Mitigation				
	Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant	
R1	45	42	46	✓	×	45	36	40	✓	✓	35	32	37	✓	×
R2	45	27	32	✓	✓	45	21	26	✓	✓	35	18	23	✓	✓
R3	45	35	40	✓	✓	45	29	34	✓	✓	35	25	30	✓	✓
R4	40	31	36	✓	✓	40	25	30	✓	✓	40	21	26	✓	✓
R5	45	34	39	✓	✓	45	28	33	✓	✓	35	25	30	✓	✓
R6	55	27	32	✓	✓	55	21	26	✓	✓	55	17	22	✓	✓
R7	45	35	40	✓	✓	45	29	34	✓	✓	35	26	31	✓	✓
R8	45	28	32	✓	✓	45	21	26	✓	✓	35	18	23	✓	✓
R9	40	34	37	✓	✓	39	28	31	✓	✓	35	24	28	✓	✓
R10	40	35	40	✓	✓	39	29	34	✓	✓	35	25	30	✓	✓
R11	40	35	40	✓	✓	39	29	34	✓	✓	35	25	30	✓	✓
R12	55	37	42	✓	✓	55	31	36	✓	✓	55	28	33	✓	✓
R13	40	32	37	✓	✓	39	26	31	✓	✓	35	23	27	✓	✓
R14	40	36	40	✓	✓	39	30	34	✓	✓	35	27	31	✓	✓
R15	40	43	47	×	×	39	37	41	✓	×	35	33	38	✓	×
R16	40	42	46	×	×	39	36	40	✓	×	35	32	37	✓	×
R17	40	37	42	✓	×	39	31	36	✓	✓	35	28	32	✓	✓
R18	40	38	43	✓	×	39	32	37	✓	✓	35	28	33	✓	✓
R19	40	35	40	✓	✓	39	29	34	✓	✓	35	26	31	✓	✓
R20	45	29	34	✓	✓	45	23	28	✓	✓	35	19	24	✓	✓
R21	45	34	39	✓	✓	45	28	33	✓	✓	35	24	30	✓	✓
R22	45	33	38	✓	✓	45	27	32	✓	✓	35	24	29	✓	✓
R23	45	33	38	✓	✓	45	27	32	✓	✓	35	23	28	✓	✓
R24	45	25	30	✓	✓	45	19	24	✓	✓	35	16	21	✓	✓
R25	45	32	37	✓	✓	45	26	31	✓	✓	35	23	28	✓	✓
R26	45	39	44	✓	✓	45	33	38	✓	✓	35	29	34	✓	✓
R27	45	39	44	✓	✓	45	33	38	✓	✓	35	29	34	✓	✓
R28	45	38	43	✓	✓	45	32	37	✓	✓	35	28	33	✓	✓

Table 7-9 – Phase 3 Operation – Overall Predicted Noise Impact with Mitigation – Day, Evening and Night (LAeq)

Rec #	Day Period With Mitigation					Evening Period With Mitigation					Night Period With Mitigation				
	Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant	
R1	45	38	42	✓	✓	45	32	36	✓	✓	35	29	33	✓	✓
R2	45	22	27	✓	✓	45	16	21	✓	✓	35	13	17	✓	✓
R3	45	32	38	✓	✓	45	26	32	✓	✓	35	23	28	✓	✓
R4	40	28	33	✓	✓	40	22	27	✓	✓	40	19	24	✓	✓
R5	45	32	37	✓	✓	45	26	31	✓	✓	35	23	28	✓	✓
R6	55	25	30	✓	✓	55	19	24	✓	✓	55	15	20	✓	✓
R7	45	33	37	✓	✓	45	27	31	✓	✓	35	23	28	✓	✓
R8	45	23	28	✓	✓	45	17	22	✓	✓	35	14	18	✓	✓
R9	40	29	33	✓	✓	39	23	27	✓	✓	35	20	24	✓	✓
R10	40	33	38	✓	✓	39	27	32	✓	✓	35	23	28	✓	✓
R11	40	33	38	✓	✓	39	27	32	✓	✓	35	23	28	✓	✓
R12	55	25	29	✓	✓	55	19	23	✓	✓	55	16	20	✓	✓
R13	40	30	34	✓	✓	39	24	28	✓	✓	35	20	24	✓	✓
R14	40	33	37	✓	✓	39	27	31	✓	✓	35	24	27	✓	✓
R15	40	40	44	✓	×	39	34	38	✓	✓	35	31	34	✓	✓
R16	40	36	40	✓	✓	39	30	34	✓	✓	35	26	31	✓	✓
R17	40	33	38	✓	✓	39	27	32	✓	✓	35	24	28	✓	✓
R18	40	33	37	✓	✓	39	27	31	✓	✓	35	23	28	✓	✓
R19	40	32	37	✓	✓	39	26	31	✓	✓	35	22	27	✓	✓
R20	45	23	28	✓	✓	45	17	22	✓	✓	35	13	18	✓	✓
R21	45	32	37	✓	✓	45	26	31	✓	✓	35	23	28	✓	✓
R22	45	31	36	✓	✓	45	25	30	✓	✓	35	22	27	✓	✓
R23	45	31	36	✓	✓	45	25	30	✓	✓	35	21	26	✓	✓
R24	45	21	26	✓	✓	45	15	20	✓	✓	35	12	17	✓	✓
R25	45	31	36	✓	✓	45	25	30	✓	✓	35	21	26	✓	✓
R26	45	35	40	✓	✓	45	29	34	✓	✓	35	25	30	✓	✓
R27	45	36	41	✓	✓	45	30	35	✓	✓	35	26	31	✓	✓
R28	45	34	38	✓	✓	45	28	32	✓	✓	35	24	29	✓	✓

Table 7-10 – Phase 4 Operation – Overall Predicted Noise Impact with Mitigation – Day, Evening and Night (LAeq)

Rec #	Day Period With Mitigation					Evening Period With Mitigation					Night Period With Mitigation				
	Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant	
R1	45	38	42	✓	✓	45	32	36	✓	✓	35	28	33	✓	✓
R2	45	22	27	✓	✓	45	16	21	✓	✓	35	13	18	✓	✓
R3	45	34	39	✓	✓	45	27	33	✓	✓	35	24	29	✓	✓
R4	40	28	33	✓	✓	40	22	27	✓	✓	40	19	24	✓	✓
R5	45	33	38	✓	✓	45	27	32	✓	✓	35	23	28	✓	✓
R6	55	24	29	✓	✓	55	18	23	✓	✓	55	15	20	✓	✓
R7	45	33	38	✓	✓	45	27	32	✓	✓	35	24	29	✓	✓
R8	45	23	28	✓	✓	45	17	22	✓	✓	35	14	19	✓	✓
R9	40	29	33	✓	✓	39	23	27	✓	✓	35	20	24	✓	✓
R10	40	33	38	✓	✓	39	27	32	✓	✓	35	24	29	✓	✓
R11	40	33	38	✓	✓	39	27	32	✓	✓	35	24	29	✓	✓
R12	55	23	28	✓	✓	55	17	22	✓	✓	55	14	18	✓	✓
R13	40	29	33	✓	✓	39	23	27	✓	✓	35	20	24	✓	✓
R14	40	32	36	✓	✓	39	26	30	✓	✓	35	23	27	✓	✓
R15	40	35	39	✓	✓	39	29	33	✓	✓	35	26	30	✓	✓
R16	40	32	37	✓	✓	39	26	31	✓	✓	35	23	27	✓	✓
R17	40	31	35	✓	✓	39	24	29	✓	✓	35	21	26	✓	✓
R18	40	33	38	✓	✓	39	27	32	✓	✓	35	23	28	✓	✓
R19	40	32	37	✓	✓	39	26	31	✓	✓	35	22	27	✓	✓
R20	45	23	28	✓	✓	45	17	22	✓	✓	35	13	19	✓	✓
R21	45	33	39	✓	✓	45	27	33	✓	✓	35	24	29	✓	✓
R22	45	32	37	✓	✓	45	26	31	✓	✓	35	22	28	✓	✓
R23	45	31	37	✓	✓	45	25	31	✓	✓	35	22	27	✓	✓
R24	45	22	27	✓	✓	45	16	21	✓	✓	35	12	17	✓	✓
R25	45	31	37	✓	✓	45	25	31	✓	✓	35	22	27	✓	✓
R26	45	34	39	✓	✓	45	28	33	✓	✓	35	24	29	✓	✓
R27	45	36	41	✓	✓	45	30	35	✓	✓	35	26	31	✓	✓
R28	45	34	39	✓	✓	45	28	33	✓	✓	35	24	29	✓	✓

Table 7-11 - Peak Operation – Overall Predicted Noise Impact with Mitigation – Day, Evening and Night (LAeq)

Rec #	Day Period With Mitigation					Evening Period With Mitigation					Night Period With Mitigation				
	Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant		Criteria	Neutral	Worst-case	Compliant	
R1	45	38	42	✓	✓	45	32	36	✓	✓	35	28	33	✓	✓
R2	45	22	27	✓	✓	45	16	21	✓	✓	35	13	18	✓	✓
R3	45	34	39	✓	✓	45	27	33	✓	✓	35	24	29	✓	✓
R4	40	28	33	✓	✓	40	22	27	✓	✓	40	19	24	✓	✓
R5	45	33	38	✓	✓	45	27	32	✓	✓	35	23	28	✓	✓
R6	55	24	29	✓	✓	55	18	23	✓	✓	55	15	20	✓	✓
R7	45	33	38	✓	✓	45	27	32	✓	✓	35	24	29	✓	✓
R8	45	23	28	✓	✓	45	17	22	✓	✓	35	14	19	✓	✓
R9	40	29	33	✓	✓	39	23	27	✓	✓	35	20	24	✓	✓
R10	40	33	38	✓	✓	39	27	32	✓	✓	35	24	29	✓	✓
R11	40	33	38	✓	✓	39	27	32	✓	✓	35	24	29	✓	✓
R12	55	23	28	✓	✓	55	17	22	✓	✓	55	14	18	✓	✓
R13	40	29	33	✓	✓	39	23	27	✓	✓	35	20	24	✓	✓
R14	40	32	36	✓	✓	39	26	30	✓	✓	35	23	27	✓	✓
R15	40	35	39	✓	✓	39	29	33	✓	✓	35	26	30	✓	✓
R16	40	32	37	✓	✓	39	26	31	✓	✓	35	23	27	✓	✓
R17	40	31	35	✓	✓	39	24	29	✓	✓	35	21	26	✓	✓
R18	40	33	38	✓	✓	39	27	32	✓	✓	35	23	28	✓	✓
R19	40	32	37	✓	✓	39	26	31	✓	✓	35	22	27	✓	✓
R20	45	23	28	✓	✓	45	17	22	✓	✓	35	13	19	✓	✓
R21	45	33	39	✓	✓	45	27	33	✓	✓	35	24	29	✓	✓
R22	45	32	37	✓	✓	45	26	31	✓	✓	35	22	28	✓	✓
R23	45	31	37	✓	✓	45	25	31	✓	✓	35	22	27	✓	✓
R24	45	22	27	✓	✓	45	16	21	✓	✓	35	12	17	✓	✓
R25	45	31	37	✓	✓	45	25	31	✓	✓	35	22	27	✓	✓
R26	45	34	39	✓	✓	45	28	33	✓	✓	35	24	29	✓	✓
R27	45	36	41	✓	✓	45	30	35	✓	✓	35	26	31	✓	✓
R28	45	34	39	✓	✓	45	28	33	✓	✓	35	25	29	✓	✓

7.3.1 DAY/EVENING/NIGHTTIME OPERATION SUMMARY – WITH MITIGATION

With the mitigation measures detailed in Section 7.2 in place, improvements can be observed at the nearest sensitive receivers, but with the following receivers detailed in Table 7-12 predicted to exceed:

Table 7-12 - Exceeding Receiver Summary - Mitigation

Phase	Worst Case Conditions with Proposed Mitigation		
	Day	Evening	Night
Phase 1	R1, R15-18	R15	R1, R15
Phase 2	R1, R15-18	R15-R16	R1, R15-R16
Phase 3	R15	-	-
Phase 4	-	-	-
Peak	-	-	-

The effectiveness of the proposed mitigation can clearly be seen when comparing Table 7-6 and Table 7-12. As the development progresses through each phase, the exceedances gradually dwindle as noise sources move lower into the mine pit despite extraction and vehicle rates increasing. However, given the exceedances despite the mitigation treatments recommended in Section 7.2, further management strategies to manage stakeholder expectations are detailed in Section 7.8 below.

7.4 SLEEP DISTURBANCE ASSESSMENT

Noise prediction modelling has been carried out to assess the potential sleep disturbance impact associated with the proposed sand mine on the existing noise environment at the nearest noise sensitive receptors located in proximity to the site during potential operation in the night period. The predicted noise levels representative of the operational phase for both neutral conditions and worst-case conditions during the night-time are presented in Table 7-13 below.

Table 7-13 – Sleep Disturbance Assessment

Rec #	Predicted Noise Levels L_{A1} dB(A)										
	Criteria	Phase 1 – Night Mitigation Applied		Phase 2 – Night Mitigation Applied		Phase 3 – Night Mitigation Applied		Phase 4 – Night Mitigation Applied		Peak – Night Mitigation Applied	
		Neutral	Worst-case	Neutral	Worst-case	Neutral	Worst-case	Neutral	Worst-case	Neutral	Worst-case
R1	52	54	58	54	58	50	54	50	54	50	54
R2	52	37	45	39	44	34	39	34	39	34	39
R3	52	48	53	47	52	44	50	46	51	46	51
R4	N/A										
R5	52	46	51	46	51	44	49	45	50	45	50
R6	N/A										
R7	52	47	52	47	52	45	49	45	50	45	50
R8	52	39	44	40	44	35	40	35	40	35	40
R9	52	45	49	46	49	41	45	41	45	41	45
R10	52	41	45	47	52	45	50	45	50	45	50
R11	52	41	45	47	52	45	50	45	50	45	50
R12	N/A										
R13	52	41	45	44	49	42	46	41	45	41	45
R14	52	48	51	48	52	45	49	44	48	44	48
R15	52	54	59	55	59	52	56	47	51	47	51
R16	52	53	57	54	58	48	52	44	49	44	49
R17	52	51	56	49	54	45	50	43	47	43	47
R18	52	52	57	50	55	45	49	45	50	45	50

R19	52	47	52	47	52	44	49	44	49	44	49
R20	52	41	46	41	46	35	40	35	40	35	40
R21	52	47	52	46	51	44	49	45	51	45	51
R22	52	45	50	45	50	43	48	44	49	44	49
R23	52	45	50	45	50	43	48	43	49	43	49
R24	52	38	43	37	42	33	38	34	39	34	39
R25	52	44	49	44	49	43	48	43	49	43	49
R26	52	49	54	51	56	47	52	46	51	46	51
R27	52	50	54	51	56	48	53	48	53	48	53
R28	52	42	47	50	55	46	50	46	50	46	51

*Receivers R4, R6, R12 do not have applicable sleep disturbance criteria as they are not residential buildings

7.4.1 SLEEP DISTURBANCE SUMMARY

The predicted noise impact associated with the proposed development of the sand mine on the noise sensitive receivers range between 34 and 59 dB(A) at the façade of the noise sensitive receptors.

The predicted noise levels are above the sleep disturbance criteria during the sand mine operations at receivers R1, R3, R15-18, R26 and R27 during Phase 1; at the receivers R1, R15-18, R26 and R27 during Phase 2; at receivers R1, R15, and R27 during Phase 3; and at receivers R1 and R27 during Phase 4 and Peak operations. The exceedances range from 1dB exceedance to 7dB. Due to the predicted exceedances of the sleep disturbance criteria at these receivers during the varied phases of operation, it is not recommended for the mine to operate during the 6am-7am night time period.

7.5 TRAFFIC NOISE ASSESSMENT

Noise modelling has also been undertaken to assess the potential noise impacts associated with the additional vehicle movements on Nelson Bay Road. The noise model has taken into account all the sources associated with traffic that will be generated by the proposed sand mine as outlined in Section 6.2 to determine the cumulative noise levels in the area.

Given the exceedances of the noise criteria as outlined in Section 7.1 and Section 7.2, no traffic noise modelling has been conducted for potential operation during the night-time period (6am-7am). The results of the traffic noise predictions associated with the proposed sand mine development are presented in Table 7-14.

Table 7-14 - Cumulative Traffic Noise Impact – Day/Evening (7am-10pm)

Rec #		Day/Evening Period ($L_{Aeq,15hr}$)							
	Base Traffic Flow	Base + Phase 1	Base + Phase 2	Base + Phase 3	Base + Phase 4	Base + Peak	Criteria	Compliance	Maximum Difference (Base v Peak)
R1	46.2	46.3	46.7	46.6	46.9	**46.9**	**60**	✓	0.7
R2	58	58.2	58.5	58.5	58.8	**59**	**60**	✓	1
R3	54.7	54.8	55.2	55.2	55.5	**55.7**	**60**	✓	1
R4	52.5	52.6	53.2	53.2	53.5	**53.6**	**50**	✓*	1.1
R5	50.5	50.7	51.1	51	51.3	**51.5**	**60**	✓	1
R6	51	51.2	51.6	51.6	51.9	**52**	**50**	✓*	1
R7	49.2	49.4	50	50	50.3	**50.4**	**60**	✓	1.2
R8	43.2	43.4	43.7	43.7	44	**44.1**	**60**	✓	0.9
R9	43.2	43.4	44	44	44.2	**44.4**	**60**	✓	1.2
R10	40.5	40.6	41.4	41.4	41.7	**41.9**	**60**	✓	1.4
R11	39.6	39.9	40.7	40.7	40.9	**41.1**	**60**	✓	1.5
R12	43.5	43.7	45.1	45	45.6	**45.8**	**55**	✓	2.3
R13	40	40.3	43.3	43.2	43.5	**43.7**	**60**	✓	3.7
R14	40	40.3	42.2	42.2	42.5	**42.7**	**60**	✓	2.7
R15	43.3	43.5	45.2	45	45.9	**46.1**	**60**	✓	2.8
R16	42.6	43	44.4	44.3	45.1	**45.3**	**60**	✓	2.7
R17	41.9	42	43.4	43.3	44.1	**44.4**	**60**	✓	2.5
R18	48	48.2	48.9	48.8	49.4	**49.6**	**60**	✓	1.6
R19	50.5	50.7	51	51	51.3	**51.5**	**60**	✓	1
R20	42.4	42.6	42.8	42.8	43	**43.1**	**60**	✓	0.7
R21	45.5	45.7	46	46	46.3	**46.4**	**60**	✓	0.9
R22	50.5	50.7	51.1	51.1	51.4	**51.5**	**60**	✓	1
R23	52.4	52.6	52.9	52.9	53.2	**53.3**	**60**	✓	0.9
R24	57.1	57.2	57.7	57.7	58	**58.1**	**60**	✓	1
R25	60	60.2	60.5	60.5	60.8	**61**	**60**	✓*	1
R26	56.3	56.5	57.6	57.5	57.8	**57.9**	**60**	✓	1.6
R27	53.7	54	54.5	54.5	54.8	**54.9**	**60**	✓	1.2
R28	58.1	58.3	58.3	58.3	58.6	**58.6**	**60**	✓	0.5

7.5.1 TRAFFIC NOISE SUMMARY

The predicted existing traffic levels at receivers R4, R6 and R25 are slightly higher than the daytime noise criteria for the current traffic flows on the road for some scenarios. As stated in Section 3.4 of the Road Noise Policy, with regard to existing residences and other sensitive land uses affected by additional traffic on existing roads, generated by land use development, any increase in total traffic noise level should be limited to 2dB above that of the corresponding existing noise level at any residential property. As seen from Table 7-14 increases in the predicted traffic noise levels at all locations for Phase 1 to Peak operations are within the acceptable limits with the increases of up to 3.7dBA at the approved residential development at 686 Marsh Road. Given the increases are well below the relative increase criteria detailed in Section 5.3 (Base traffic + 12dB), the increased traffic from the mine along Nelson Bay road is predicted to comply with the relevant road traffic noise criteria.

7.6 VIBRATION ASSESSMENT

Vibration may be generated as a result of the sand extraction works and transport of sand to the processing plant. Vibration has been considered both in respect of potential damage of buildings and potential annoyance to the occupants. This section provides guidance on the vibration impacts that may be expected from the activities associated construction and operation of the sand mine.

In many cases, it is the occupants'/residents' fear of building damage that enhances the potential annoyance. The most common form of vibration measurement is peak particle velocity (PPV) in mm/s. In respect to building damage, a vibration level limit and frequency is normally specified, however, in respect of potential annoyance to receivers, a combination of vibration level frequency and duration is more appropriate. This is normally termed as a dose value.

Table 7-15 summarises the anticipated level of vibration associated with the plant and equipment that is likely to be used. It should be noted that the vibration levels presented in Table 7-15 are indicative levels only. The actual vibration levels that may impact upon properties located in the vicinity of the proposed sand mine may vary. This is due to the fact that vibration magnitudes will dissipate at varying levels dependent on ground conditions and source level variations associated with operational conditions of the plant and equipment.

Table 7-15 - Vibration levels of equipment

Activity	Description	Typical Ground vibration level
Clearing and grubbing	Clearing of vegetation, trunk and root removal, processing of timber waste	In general, the activities carried out during this stage of works generate low levels of vibration and areas close to residences are generally already cleared. Vibration impact is considered unlikely.
	Bulldozers ripping	1mm/s to 2mm/s at distances of approximately 5 metres. At distances greater than 20 metres, vibration is usually below 0.2mm/s.
Earthworks	Backhoe- Excavator	<1mm/s at distances of approximately 10 metres
	Truck traffic (on normal smooth road)	0.01mm/s to 0.2mm/s at the footings of buildings located 10m-20 metres from a roadway (note that very large surface irregularities can cause levels up to five to ten times higher).

The nearest receivers to the proposed sand mine are located approximately 55m (R1) and 60m (R15) from the nearest mining extraction boundary. Based on the vibration levels provided in Table 7-15, it is unlikely that there would be any vibration impacts generated by the excavation plant that would give rise to annoyance or structural damage at any of the nearest receivers. Vibration monitoring would need to be undertaken in the unlikely event that any works were to be carried out within 50 metres of residences where vibration may be generated by equipment. Beyond 100 metres there is a low probability of annoyance for all activities.

7.7 IMPACTS ON FAUNA

There are no current government policies or other accepted guidelines that provide recommended noise and vibration level thresholds or limits in relation to noise impact on terrestrial fauna. In Australia, there are no noise studies presently available that deal with noise impacts on native species for long-term exposure, therefore a general literature review has been carried out for potential fauna impacts.

There is limited knowledge or understanding of the effects of noise on fauna given that the research and studies on animals to date has been limited to small, disconnected, anecdotal or correlational studies as opposed to coherent programs of controlled experiments (Manci et al (1988), Larkin, (1996), Radle, (1998), Wyle (2003), Warren et al, (2006), Dooling and Popper (2007) and (Dooling, Fay, and Popper (2000)). Noise may adversely affect wildlife by interfering with communication, masking the sounds of predators and prey and causing stress or avoidance reactions, and in some cases may lead to changes in reproductive or nesting behaviour. At sufficiently high levels, noise could cause temporary or permanent hearing damage.

In general, Radle (2007) states the consensus that terrestrial animals will avoid any industrial or plant or construction area where noise or vibration presents an annoyance to them. Additionally, Radle (2007) observed many animals react to new noise initially as a potential threat (potentially followed by startle/fright and avoidance), but quickly 'learn' that the noise is not associated with a threat. Most wildlife is generally mobile and will act to avoid noise and vibration if it is perceived to be annoying.

The response to noise by animals can depend on a wide variety of factors including noise level, noise spectrum (frequency distribution), noise characteristics (such as impulsiveness, rate of onset, tonality, modulation etc.), duration, temporal variation, number and type of events, level of ambient noise, time of day/season/year, and the animal's age, sex, type of activity at the time, breeding situation and past experience, and the type of animal species/genera, hearing thresholds, individual differences etc.

Studies have shown the reaction to noise can vary from species to species, including those that are known to have adapted to human activity. Environment Australia (1998) suggests that unusual noise, in combination with close proximity visual stimulation, is enough to disturb any animal, including humans. In addition, any sudden and unexpected intrusion, whether acoustic or of another nature, may also produce a startle or panic reaction.

Studies of the impact of the sonic boom on domestic and wild animals show that these species are unaffected by repeated booms and farmers have reported birds actually perching on scare guns after only a couple of days operation (Environment Australia, 1998). From a literature review, it has been considered that noise levels up to 60 dB(A) do not result in negative or adverse response to impacted animals or livestock. Noise levels up to 80 dB(A) can generate startle responses in birds and animals, and noise levels in excess of 90 dB(A) may cause negative impact such as behavioural responses.

The predicted noise levels from the Project operations are approximately 50-60 dB(A) at the site boundary during the loudest phase (Phase 2) and these noise levels are not expected to cause adverse response to animals or livestock. Typically, animals will avoid high noise areas and it is expected that animals will relocate away from such areas.

To summarise, the impacts of noise on animals is generally inconclusive. In general, there is no or little evidence of cause and effect regarding behavioural or physiological effects on domestic animals, and possibly slight evidence of some effects on some types of wild animals (especially for high or impulsive levels of noise). Finally, it is noted that animals tend to habituate to disturbances over time, particularly when it is steady and associated with non-threatening activity.

7.8 RECOMMENDATIONS – EXCEEDANCE MANAGEMENT

It can be seen that even with the introduction of all reasonable and feasible mitigation measures incorporated into the development, exceedances are still observed at Receivers R1 and R15-18 during the early phases of the development, particularly Phase 2.

7.8.1 HOURS OF OPERATION

The proposed mine will exceed the night time and sleep disturbance criteria at numerous surrounding sensitive receivers if it were to operate in the night time period between 6am-7am. It is recommended to keep the proposed operation hours to 7am-7pm to avoid the potential for sleep disturbance at the nearest sensitive receivers. Operation in the evening period results in fewer receivers exceeding when comparing to the night time results, and does not require a sleep disturbance assessment.

7.8.2 OPERATIONAL MANAGEMENT PLAN

In order to manage the expectations of nearby sensitive receivers, in particular those which still exceed criteria with the inclusion of physical noise barriers, it is recommended the mine adopt an Operational Noise and Vibration Management Plan (ONMP). The primary objectives of an ONMP is to:

- Minimise noise and vibration emissions to the maximum possible extent;
- Provide a process for the investigation of complaints relating to noise and vibration in a timely manner and for derivation of measures that deal effectively with the causes of legitimate complaints;
- Reduce the potential for exceedances relating to noise and vibration emissions;
- Document proactive mitigation measures for each noise and vibration source;
- Identify proposed noise and vibration monitoring locations, equipment and frequency for the Mine's monitoring program;
- Document actions and responsibilities in the event of an exceedance of a noise and vibration trigger level or a legitimate complaint; and

The ONMP prepared by Vipac (report ref: 70Q-18-0276-TRP-8551723-0) accompanies this assessment and is incorporated into the Environmental Impact Statement (EIS) submissions.

7.8.3 VOLUNTARY LAND ACQUISITION AND MITIGATION

It is recommended that the project considers negotiated agreements in accordance with the NSW Government *Voluntary Land Acquisition and Mitigation Policy* (VLAMP) with landowners at receiver locations R1, and R15-18. Negotiated agreements can provide for the implementation of a broader suite of measures, such as financial compensation for impacts, acoustic treatments to buildings and the provision of alternative accommodation (particularly when the exceedances would only occur over short periods).

Note – the introduction of voluntary land acquisition where sensitive receivers still exceed even with the construction of the acoustic barriers/bunds for mitigation will potentially negate the need for bund 2 and part of bunds 1 and 4. This will need to be reassessed and confirmed prior to final approval.

7.8.4 REVISED MINE PHASING

Phase 2 operations (dry mining process) result in the majority of exceedances at the nearest sensitive receivers. This is primarily caused by excavators and articulated dump trucks operating as part of the dry mining process.

A potential alternative option to the mitigation measures detailed in this report is to fast-track the wet mining phases of the operation. Generally, this involves drilling of boreholes at a number of locations on site, and dredging from underneath, thus eliminating the use of excavators and articulated dump trucks.

Note that revised mine phases and layouts will require an updated assessment to confirm updated mitigation measures if required.

8 CONCLUSION

A noise impact assessment has been undertaken to determine the potential noise impact of the proposed sand mine at Bobs Farm on noise sensitive receptors in the surrounding area of the proposed development site.

Future potential noise levels at the nearest noise sensitive receivers were predicted using the SoundPLAN noise model for each phase, including peak operation. For each scenario, noise levels were predicted in the day, evening and night period (including sleep disturbance) during both neutral and worst case temperature conditions.

Noise levels are predicted to comply with the day and evening criteria with the exception of 5 of the closest sensitive receivers through the earlier phases of the development. Reasonable and feasible mitigation measures such as noise bunds/earth mounds and acoustic barriers have been recommended, however the closest sensitive receivers remain non-compliant. It is expected the role of the VLAMP will provide assistance with compliance at these sensitive receivers along with the implementation of the Operational Noise Management Plan.

Traffic noise levels were predicted to account for the additional heavy vehicle traffic the mine is expected to introduce onto Nelson Bay Road, with the results predicted to comply with the relevant day/evening criteria.

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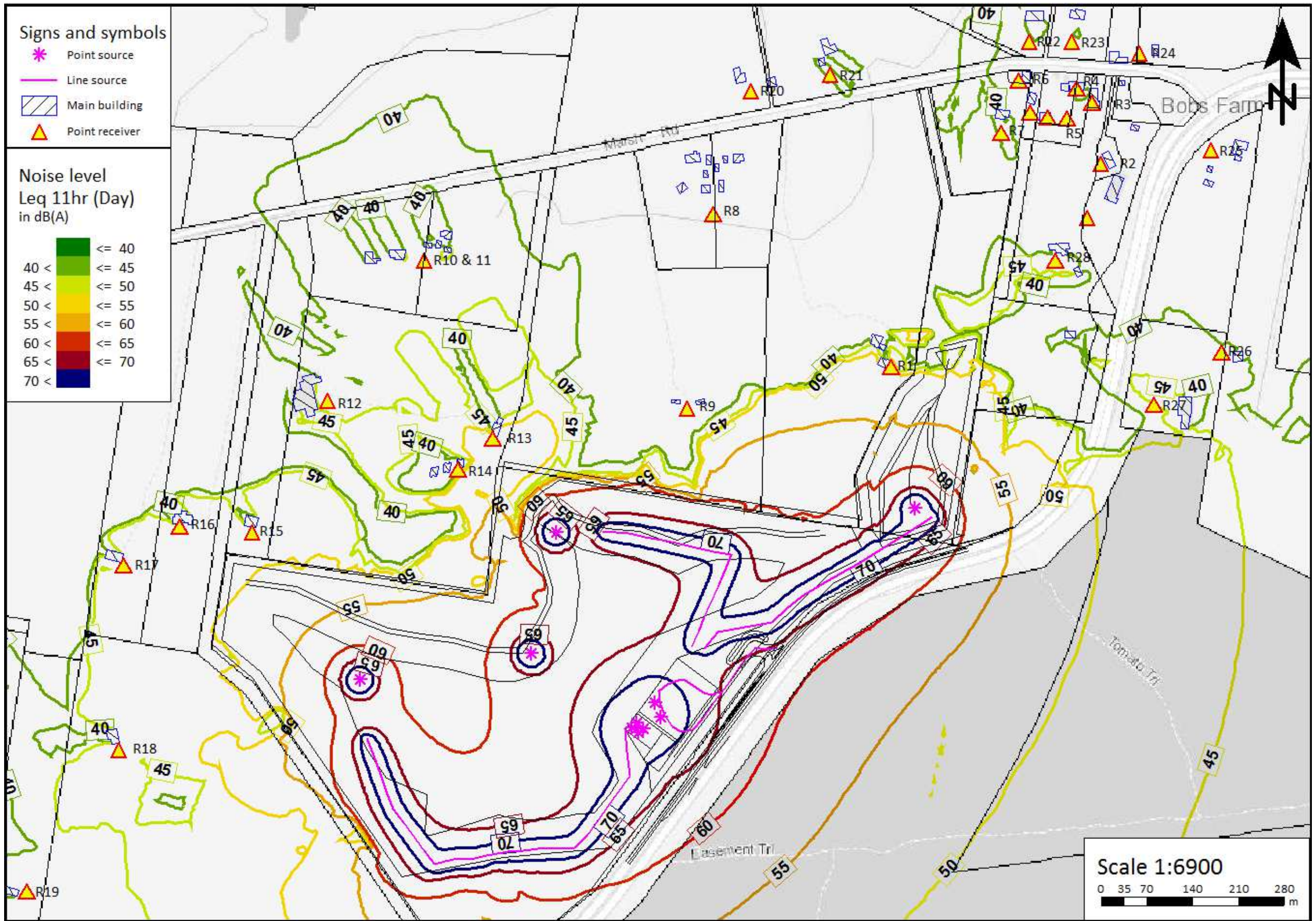
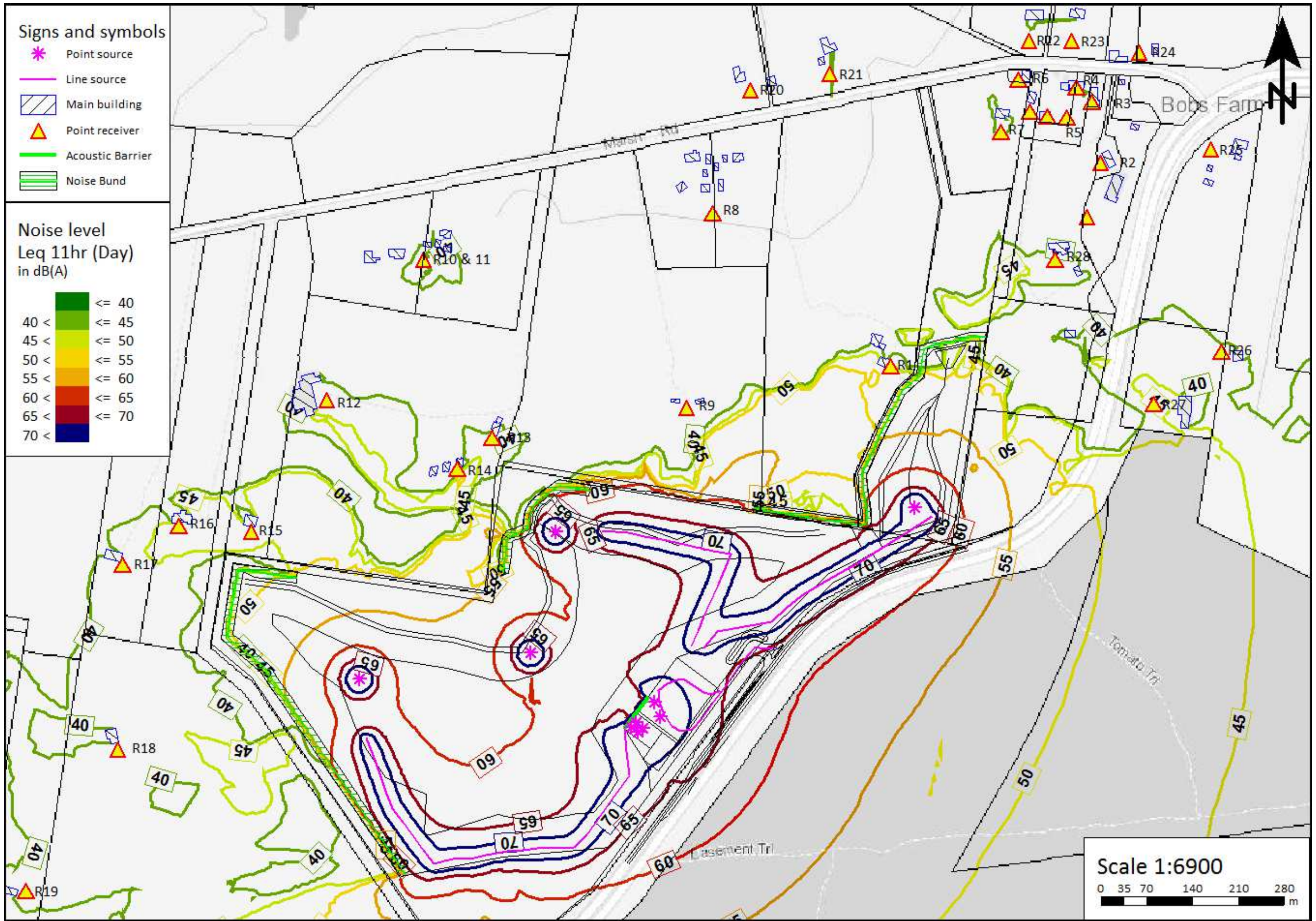
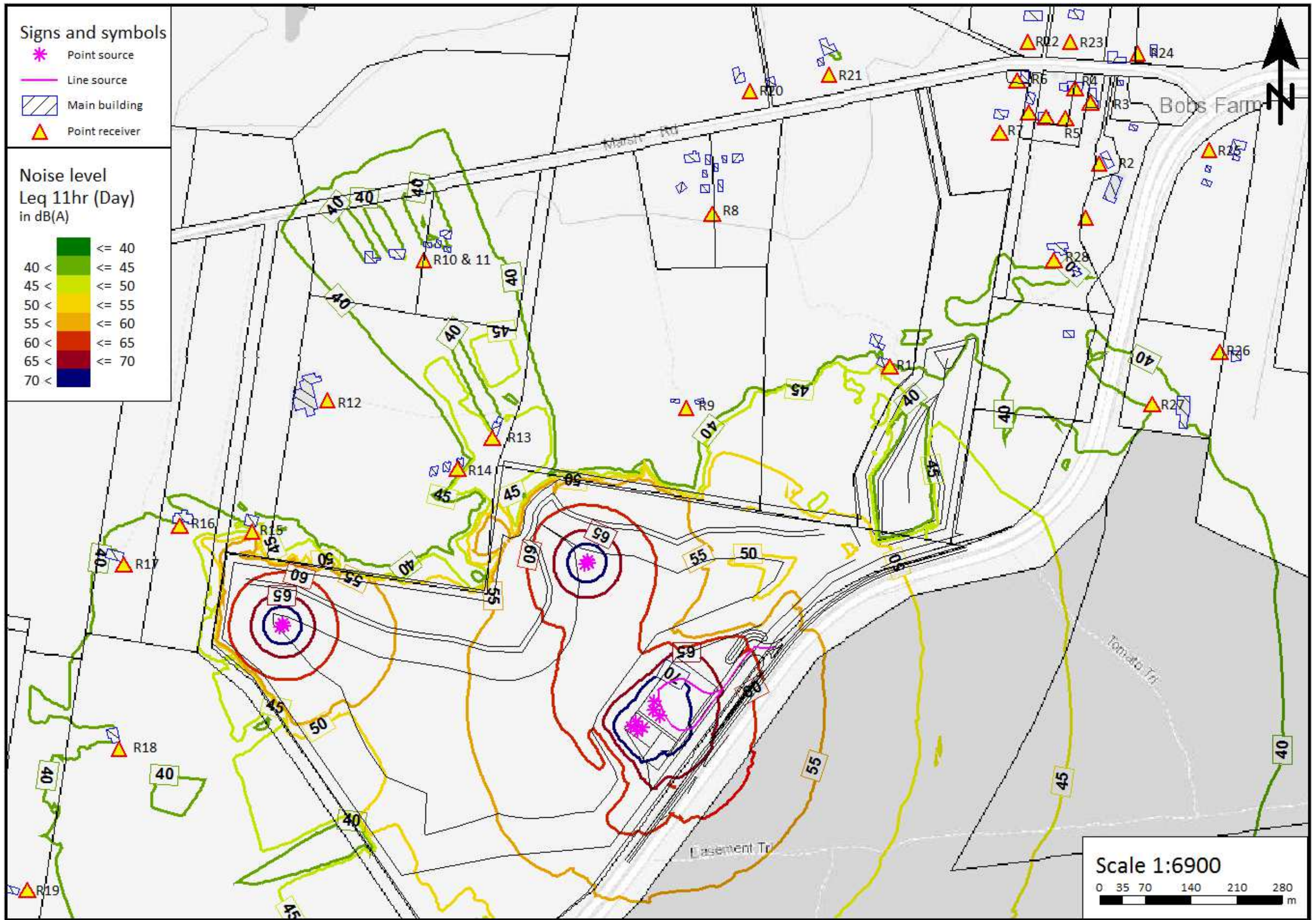
APPENDIX A: NOISE CONTOUR MAPS



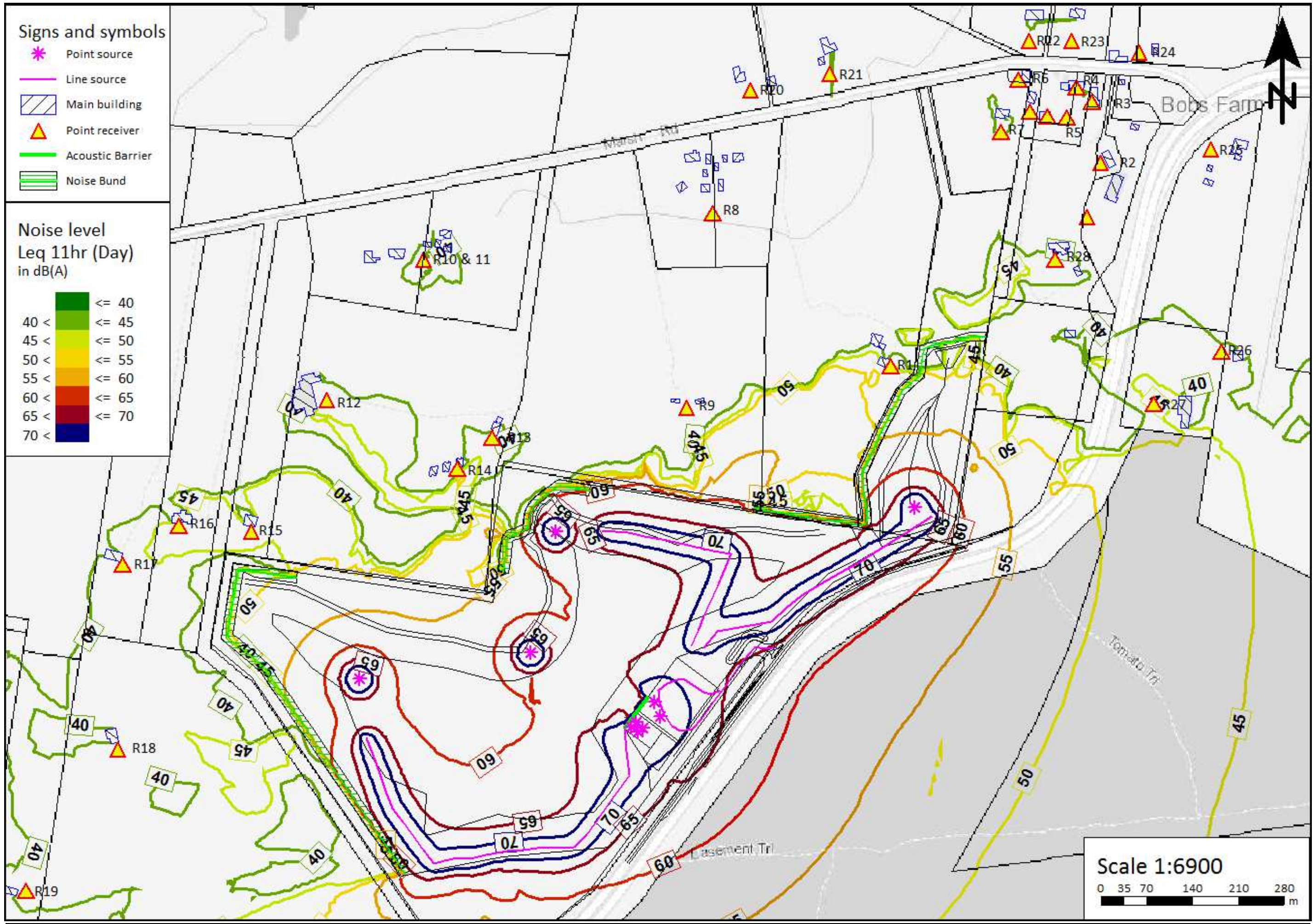
Parameter: L_{Aeq}	**Period:** 7am-6pm	**Assessment Type:** Worst Climatic	**Criteria:** 40-45 dB(A)
Comment: Phase 2 in Worst Climatic Conditions, Without Mitigation			



Parameter: L_{Aeq}	**Period:** 7am-6pm	**Assessment Type:** Worst Climatic	**Criteria:** 40-45 dB(A)
Comment: Phase 2 in Worst Climatic Conditions, With Mitigation			

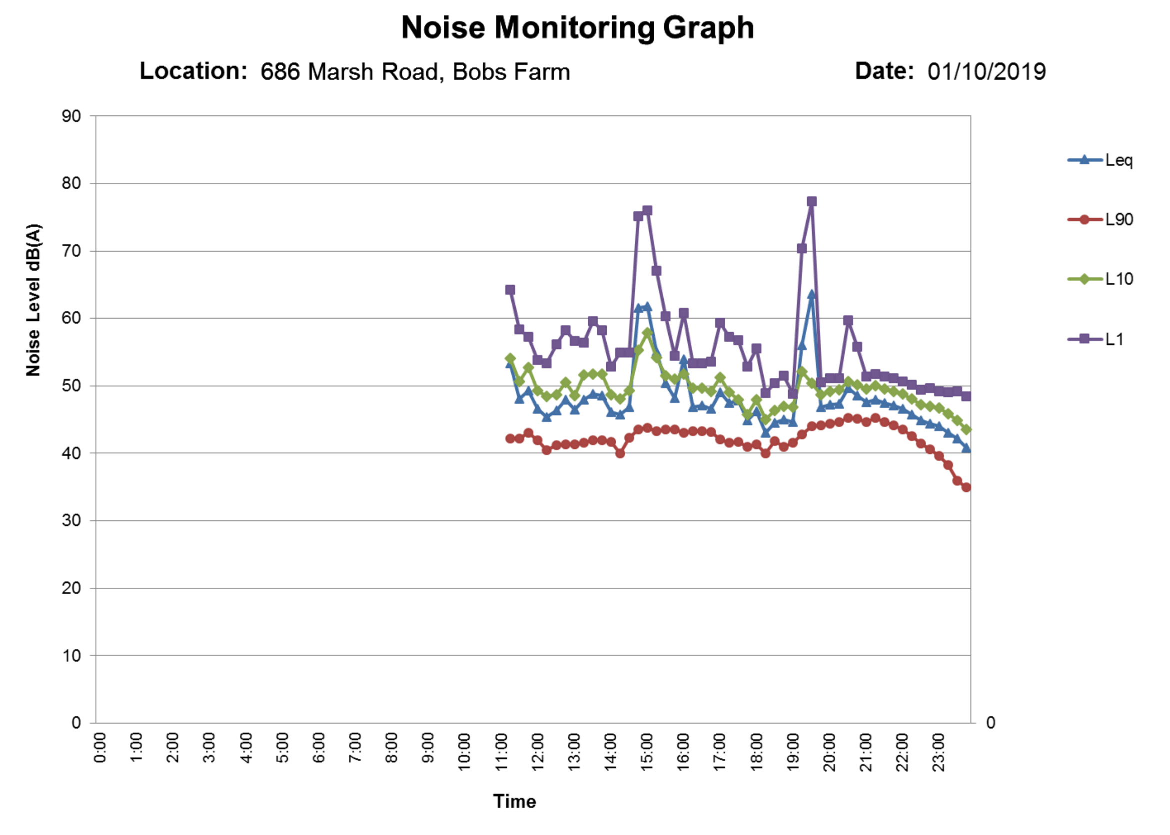


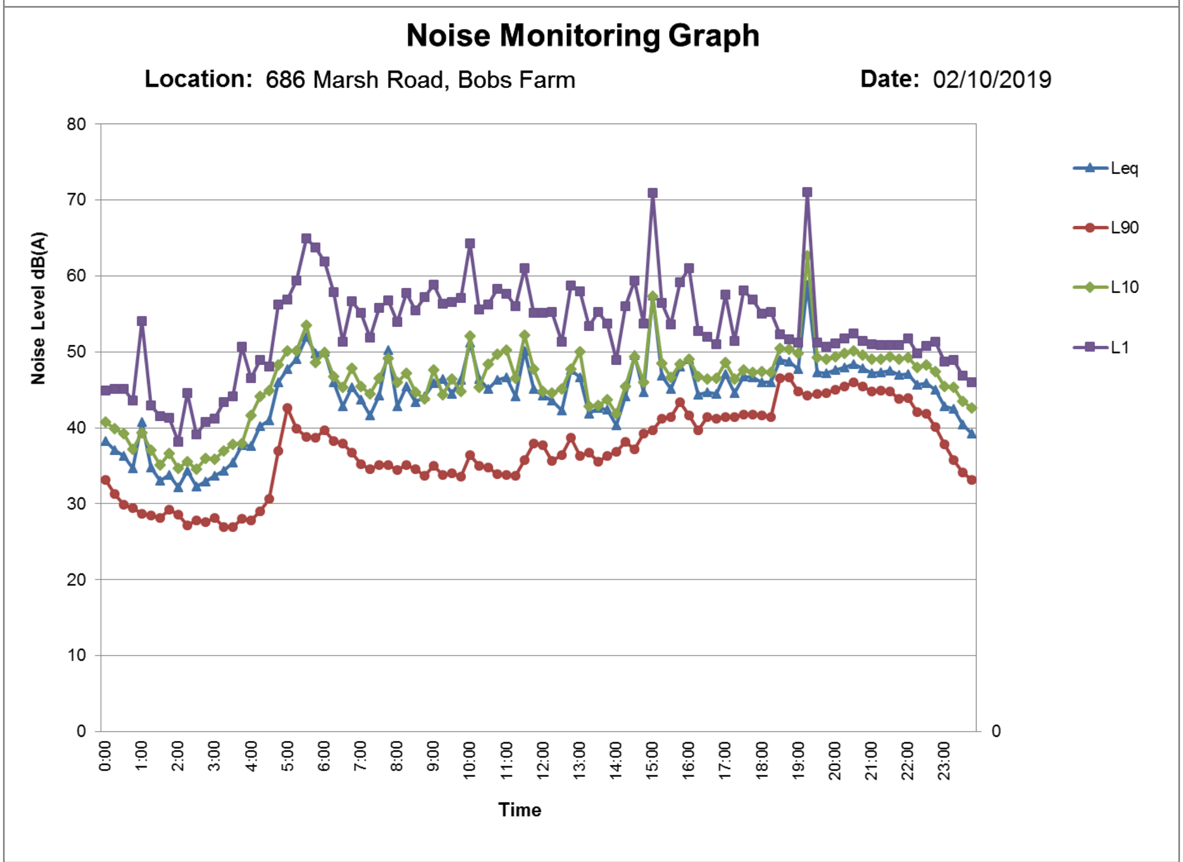
Parameter: L_{Aeq}	**Period:** 7am-6pm	**Assessment Type:** Worst Climatic	**Criteria:** 40-45 dB(A)
Comment: Peak Operation in Worst Climatic Conditions, Without Mitigation			

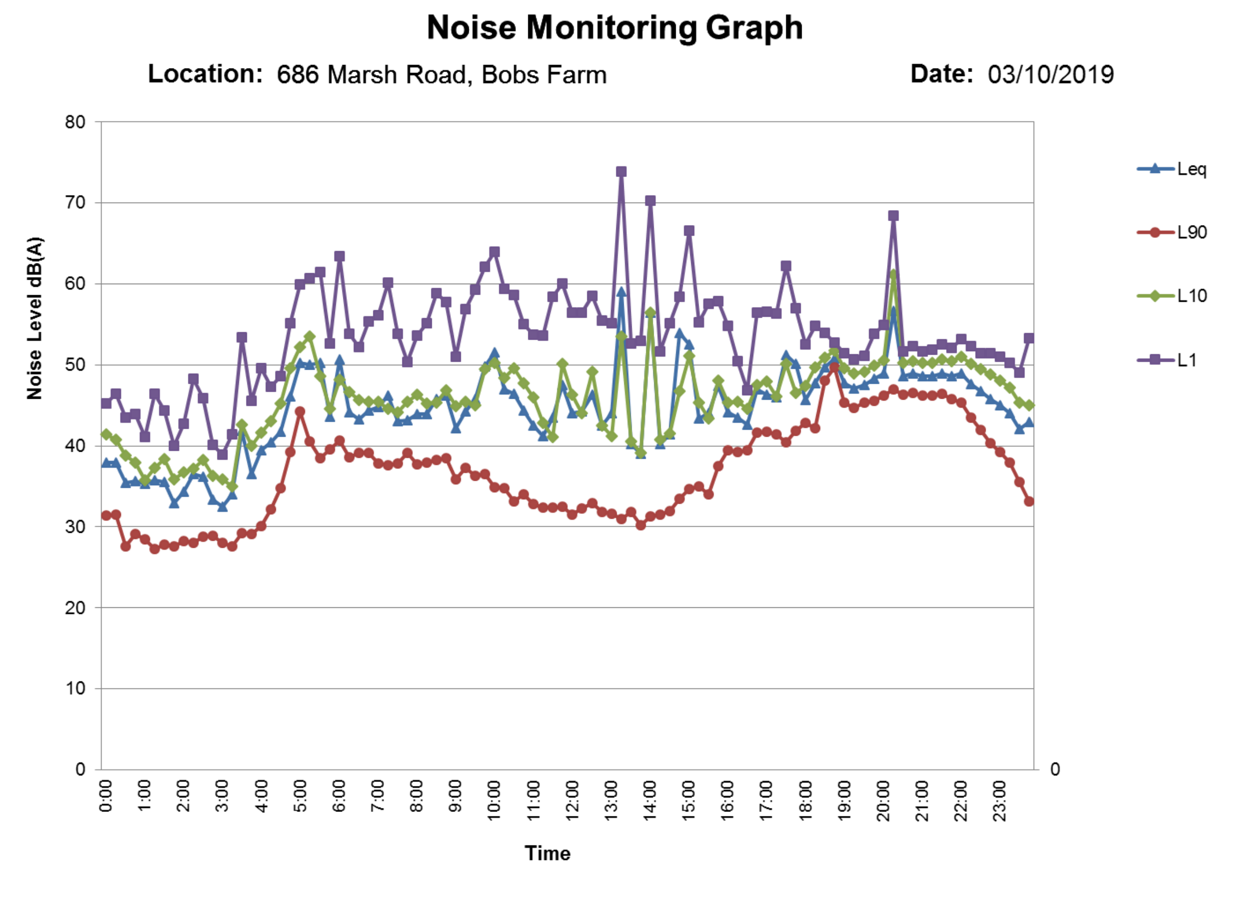


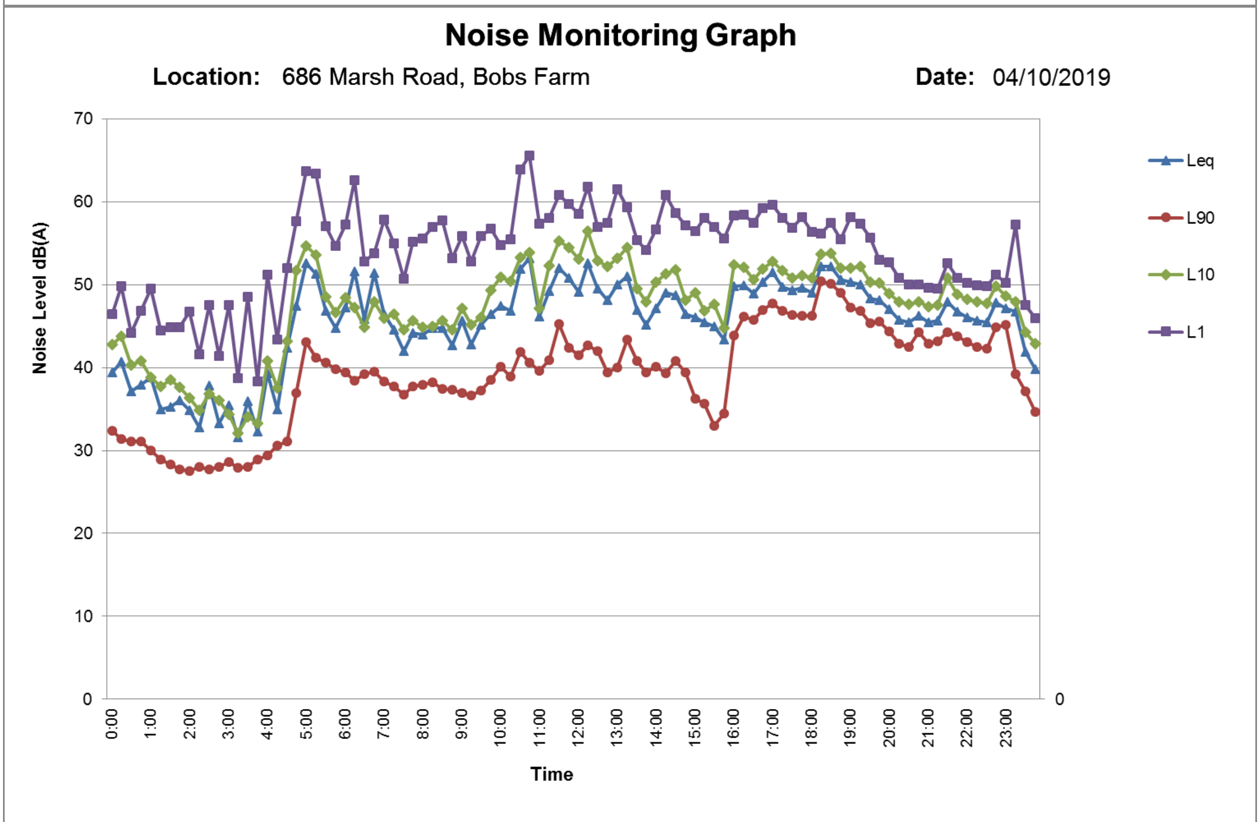
Parameter: L_{Aeq}	**Period:** 7am-6pm	**Assessment Type:** Worst Climatic	**Criteria:** 40-45 dB(A)
Comment: Peak Operation in Worst Climatic Conditions, With Mitigation			

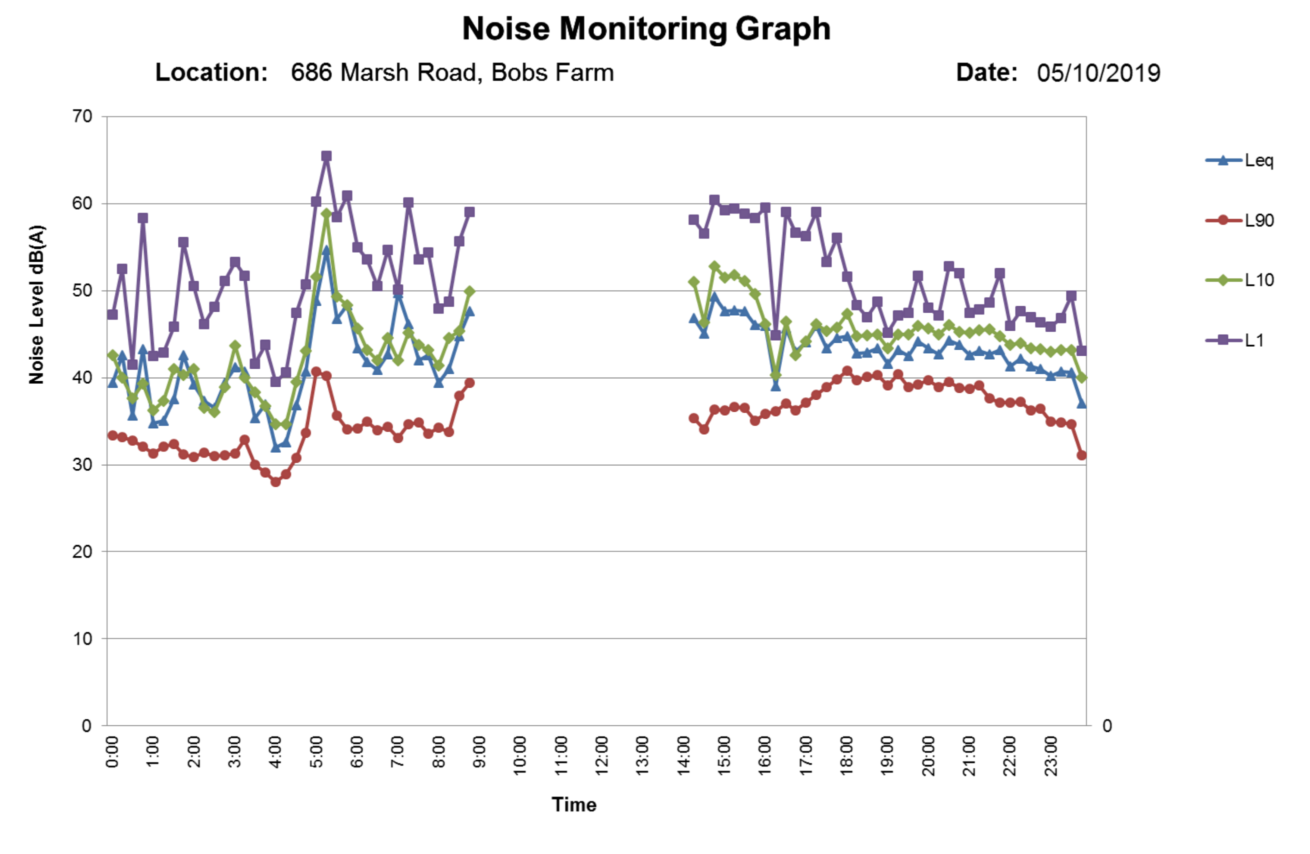
APPENDIX B: NOISE MONITORING RESULTS

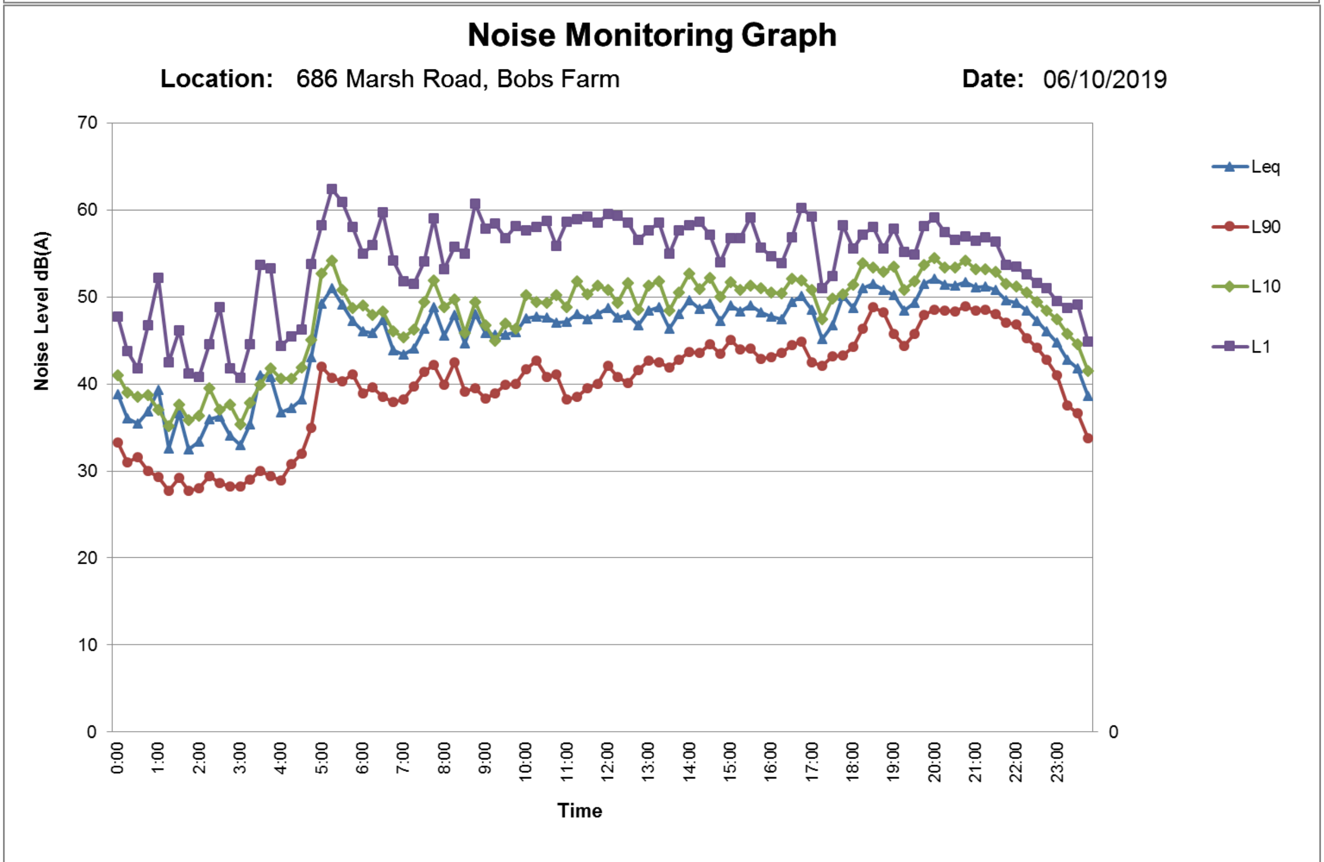

Noise Monitoring Graph
Location: 686 Marsh Road, Bobs Farm
Date: 01/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1

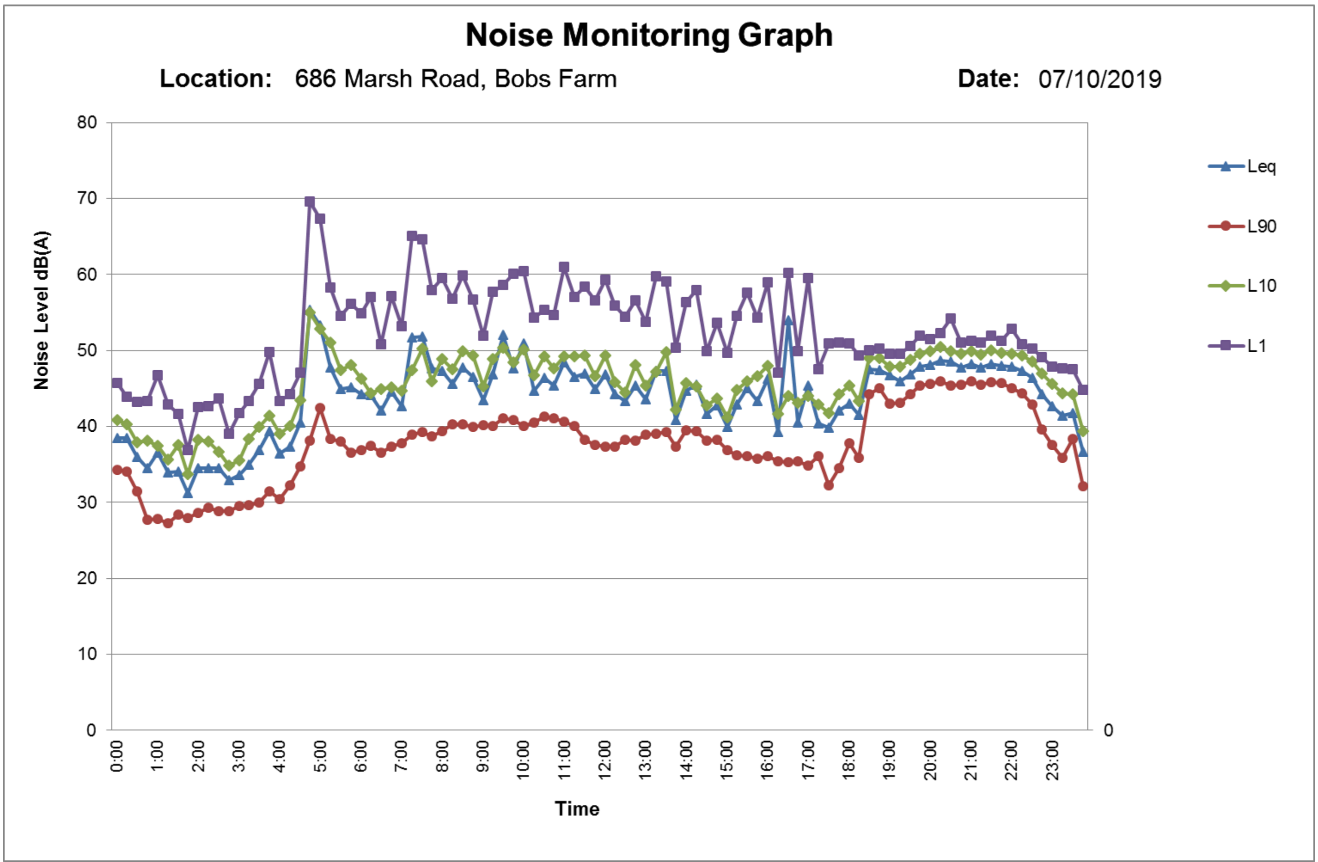

Noise Monitoring Graph
Location: 686 Marsh Road, Bobs Farm
Date: 02/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1

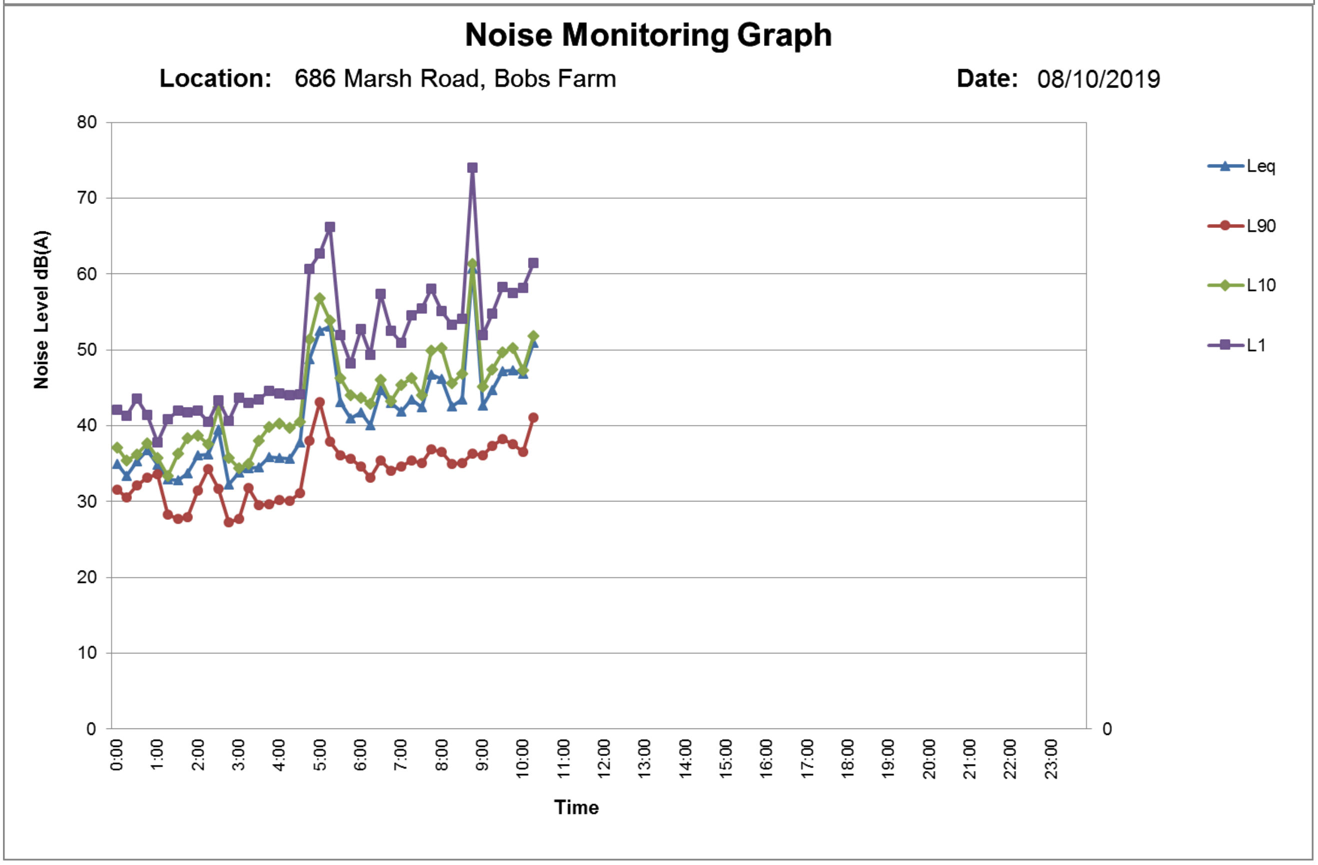

Noise Monitoring Graph
Location: 686 Marsh Road, Bobs Farm
Date: 03/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1

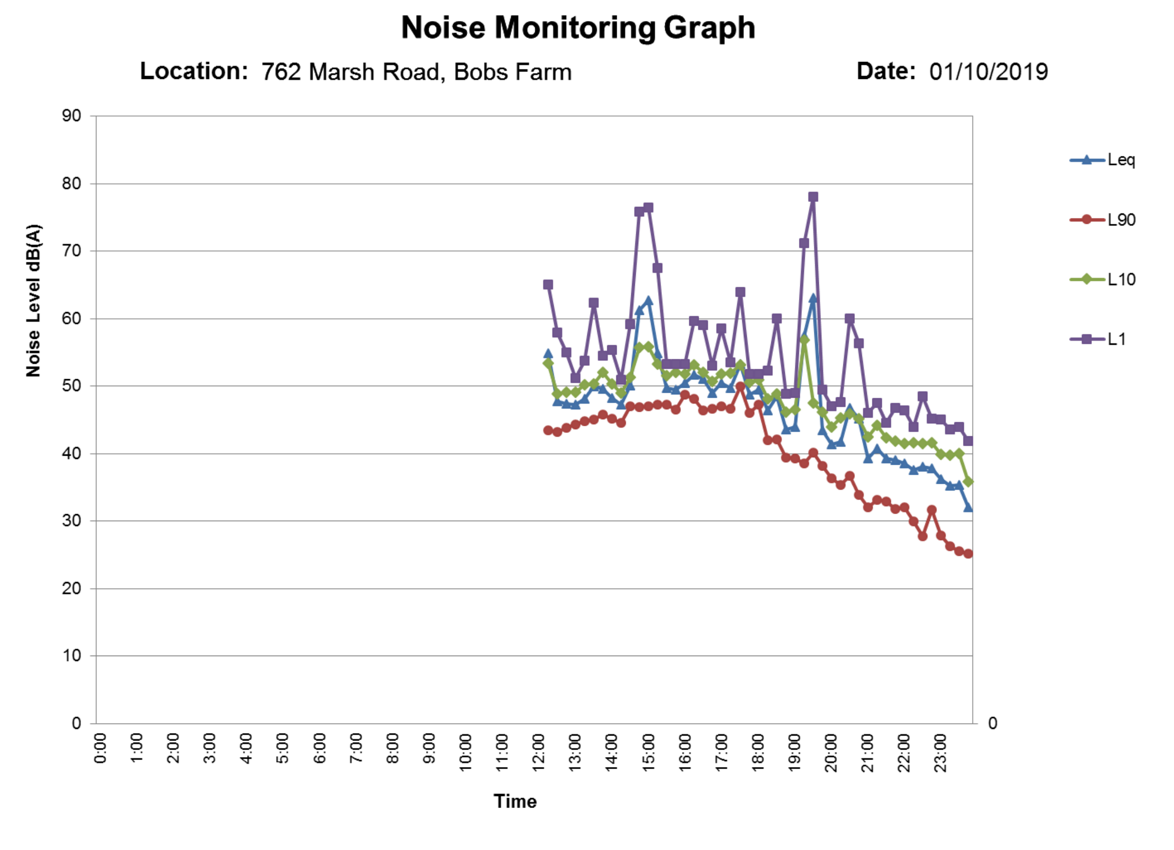

Noise Monitoring Graph
Location: 686 Marsh Road, Bobs Farm
Date: 04/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1

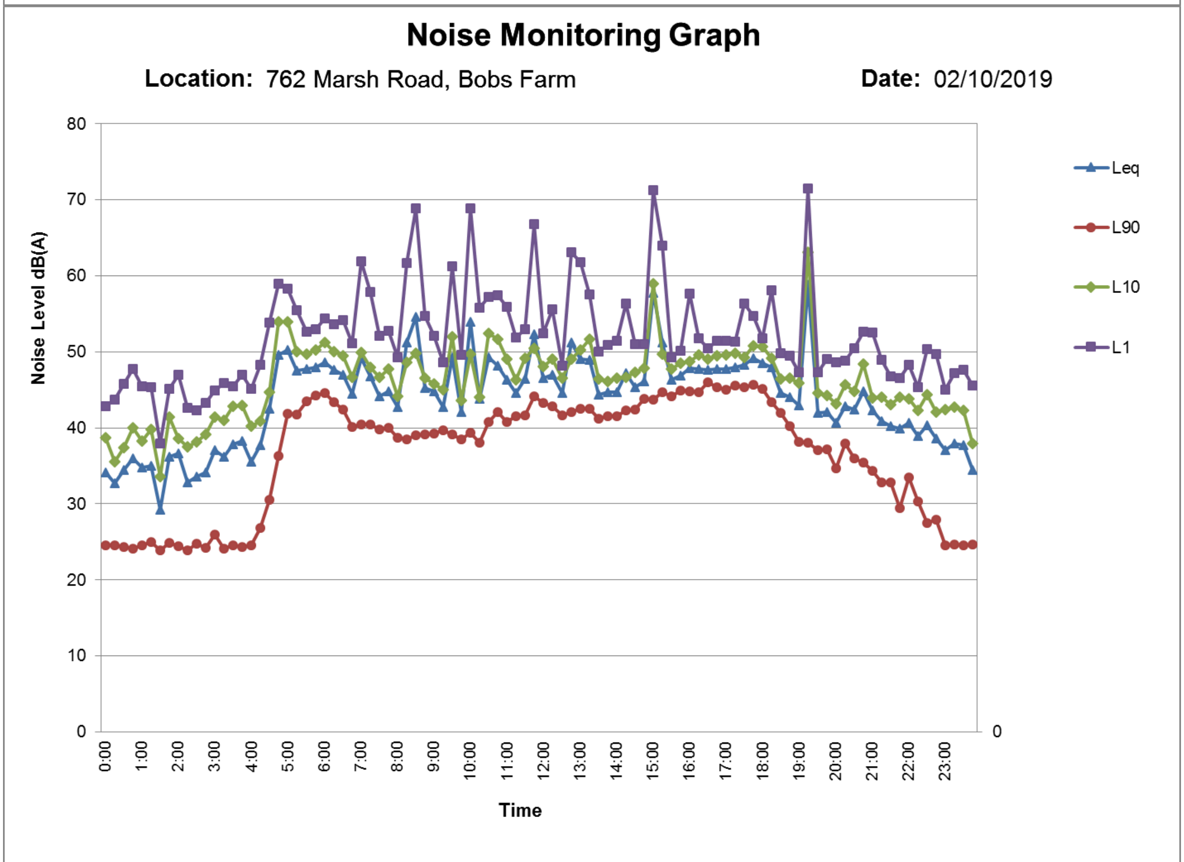

Noise Monitoring Graph
Location: 686 Marsh Road, Bobs Farm
Date: 05/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1

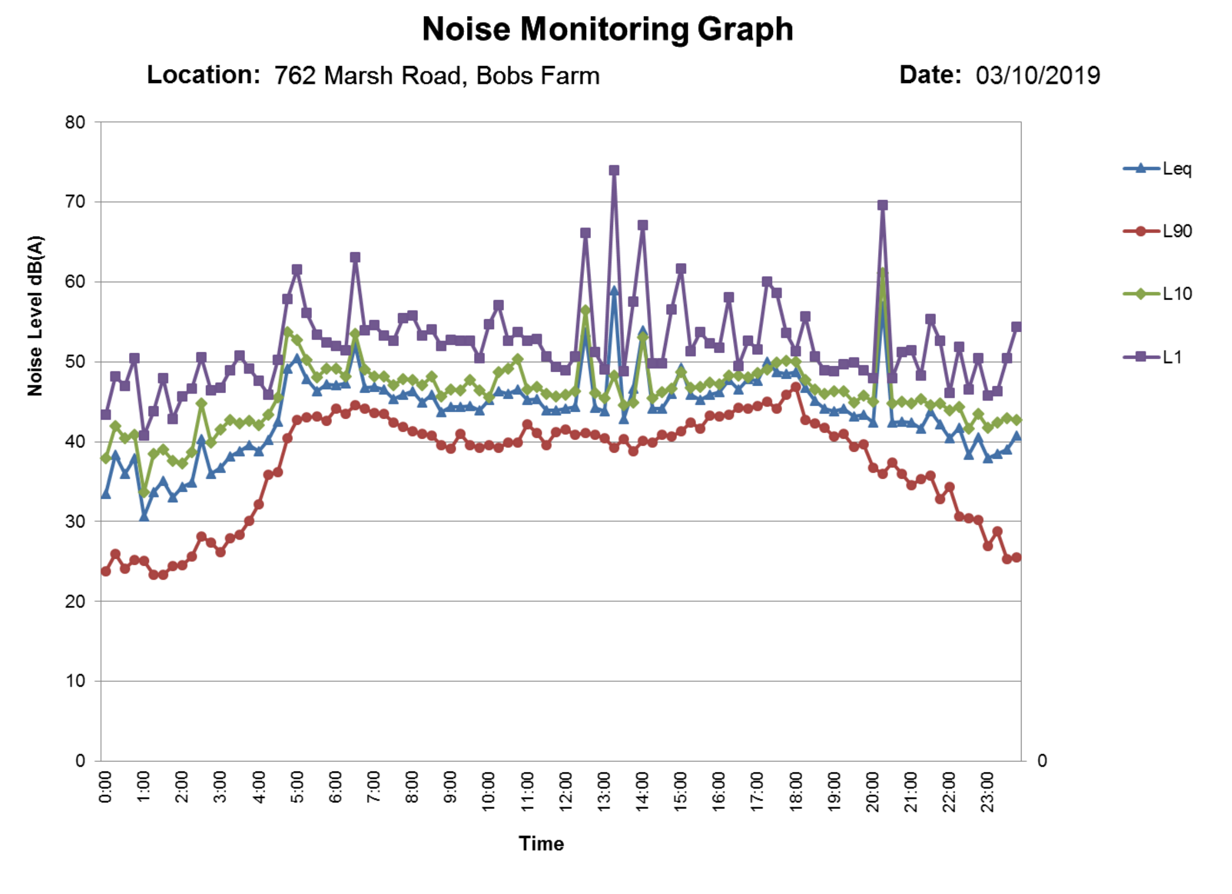

Noise Monitoring Graph
Location: 686 Marsh Road, Bobs Farm
Date: 06/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1

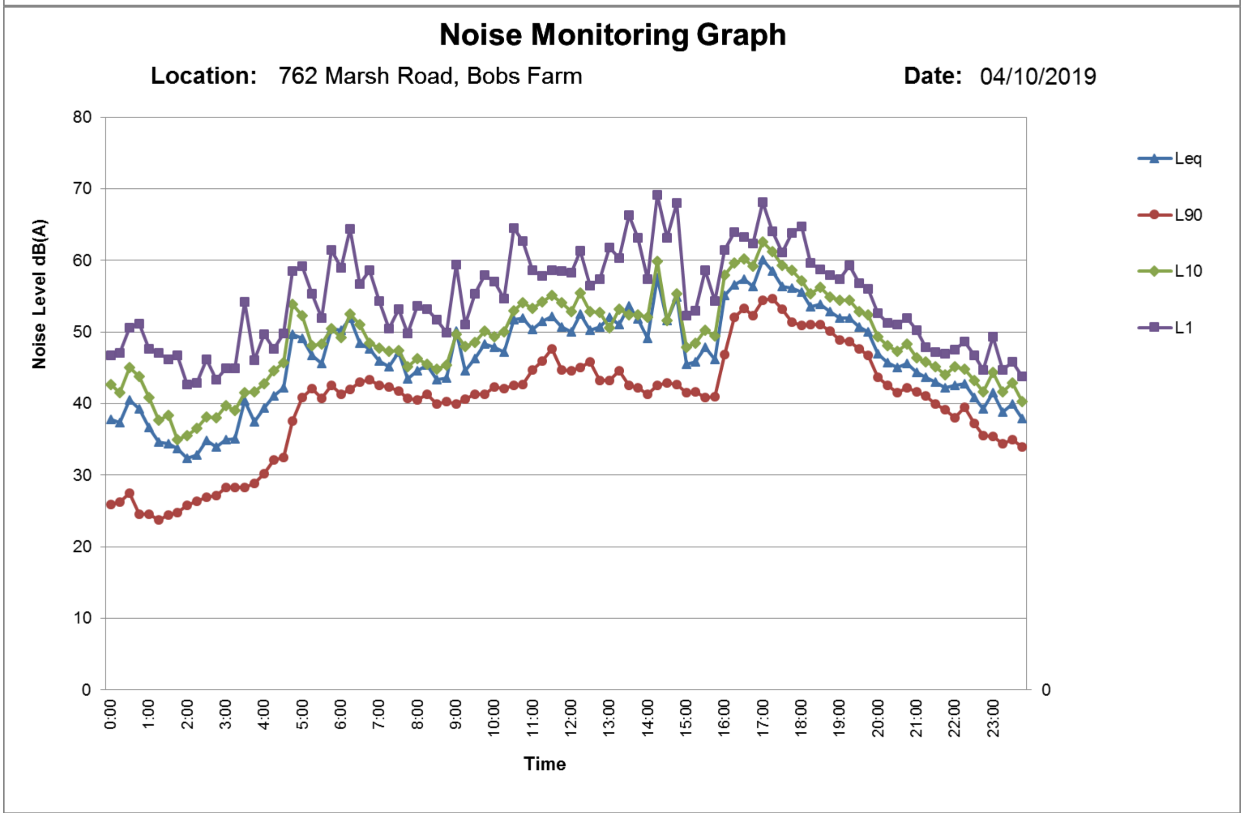

Noise Monitoring Graph
Location: 686 Marsh Road, Bobs Farm
Date: 07/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1


Noise Monitoring Graph
Location: 686 Marsh Road, Bobs Farm
Date: 08/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1


Noise Monitoring Graph
Location: 762 Marsh Road, Bobs Farm
Date: 01/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1

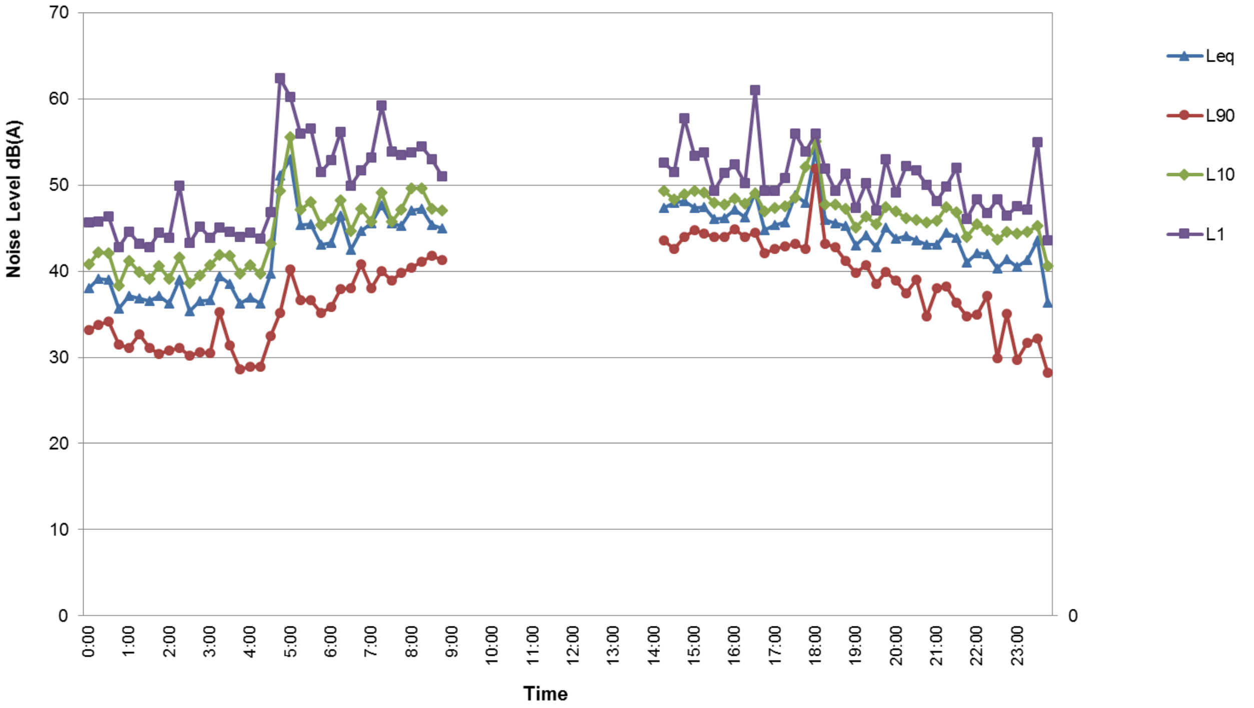

Noise Monitoring Graph
Location: 762 Marsh Road, Bobs Farm
Date: 02/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1


Noise Monitoring Graph
Location: 762 Marsh Road, Bobs Farm
Date: 03/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1


Noise Monitoring Graph
Location: 762 Marsh Road, Bobs Farm
Date: 04/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1

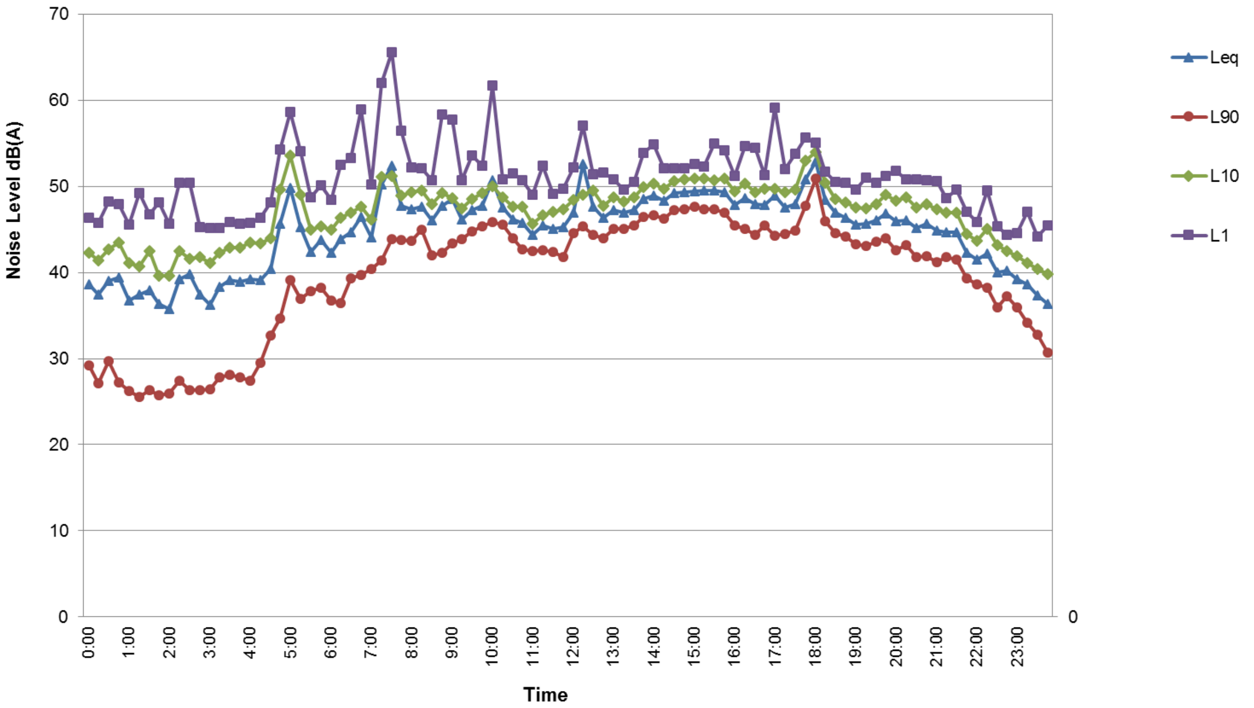
Noise Monitoring Graph

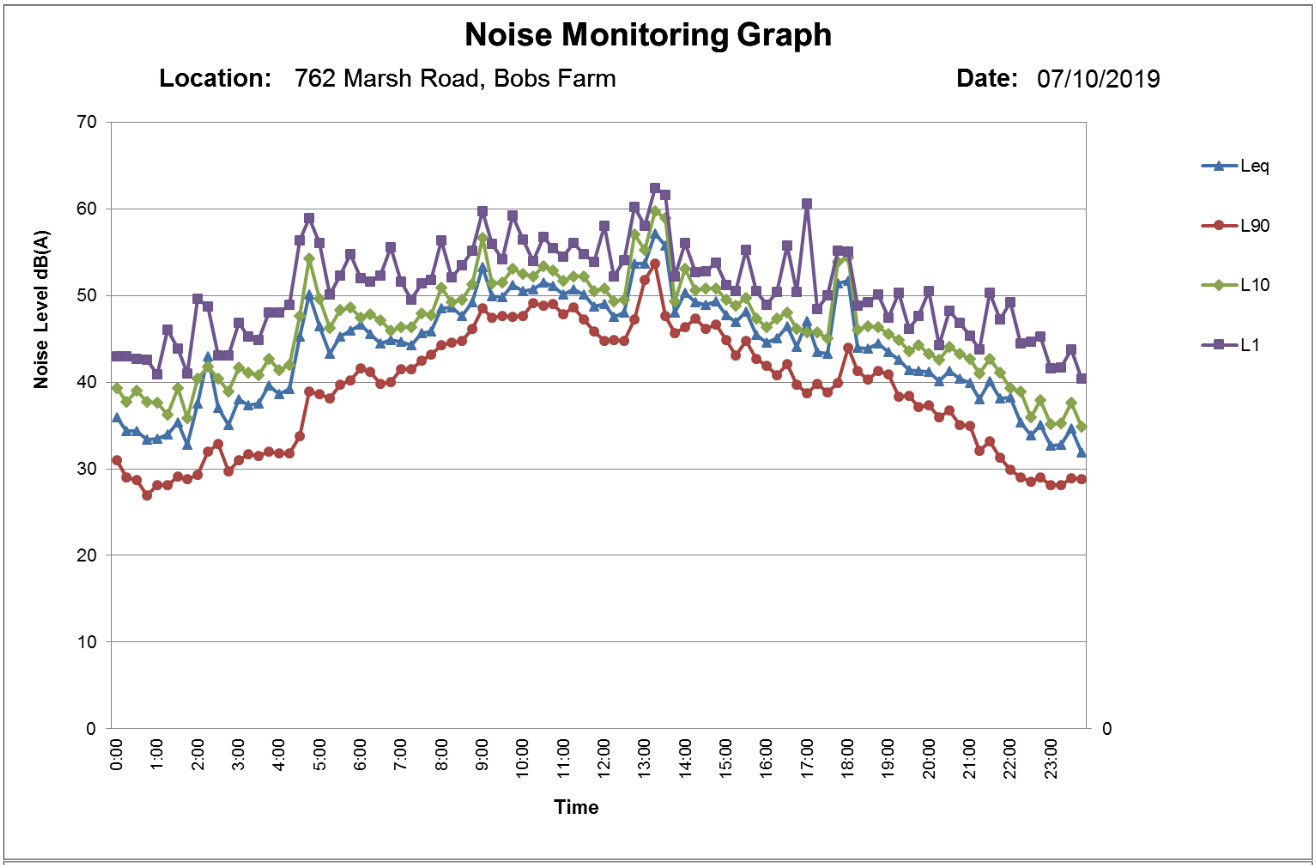
Location: 762 Marsh Road, Bobs Farm **Date:** 05/10/2019



Noise Monitoring Graph

Location: 762 Marsh Road, Bobs Farm **Date:** 06/10/2019




Noise Monitoring Graph
Location: 762 Marsh Road, Bobs Farm
Date: 07/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1
0
10
20
30
40
50
60
70
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
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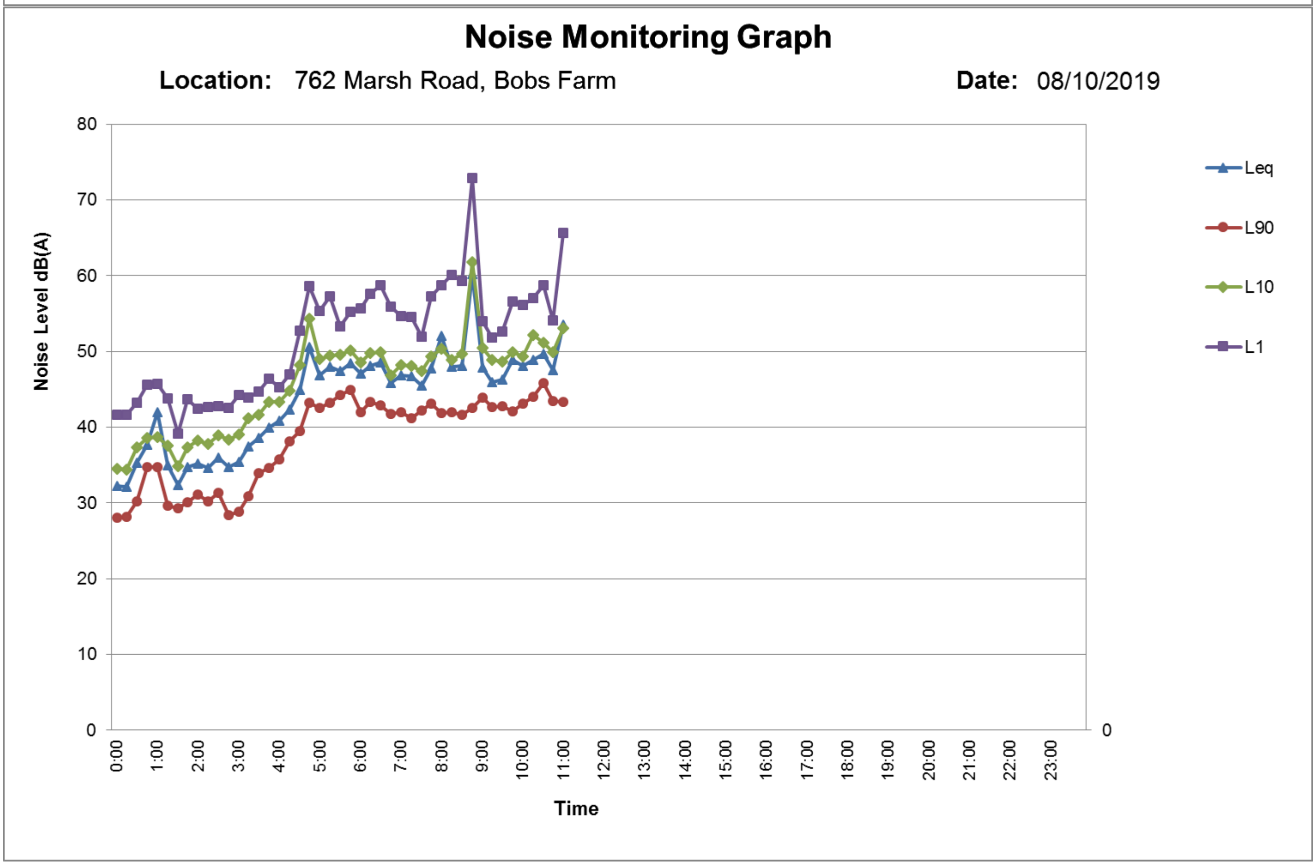
21:00
22:00
23:00


Noise Monitoring Graph
Location: 762 Marsh Road, Bobs Farm
Date: 08/10/2019
Noise Level dB(A)
Time
Leq
L90
L10
L1
0
10
20
30
40
50
60
70
80
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
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