SVT ENGINEERING CONSULTANTS
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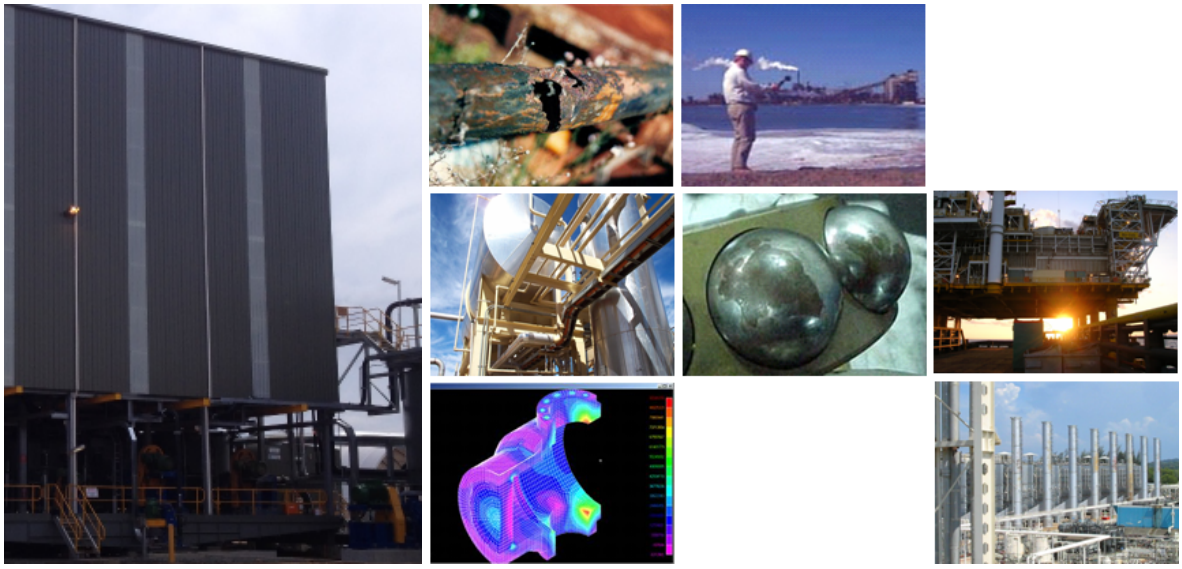
WET CONCENTRATOR PLANT ENVIRONMENTAL NOISE IMPACT ASSESSMENT REPORT



KEYSBROOK LEUCOXENE PTY. LTD.

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EXECUTIVE SUMMARY

Keysbrook Leucoxene Pty. Ltd. (KLPL) are proposing the installation of an additional spiral stage to the existing Wet Concentrator Plant (WCP) at the Keysbrook Mineral Sands Project.

The project involves the installation of an additional annex on the south side of the existing WCP building, to house and additional four banks of heavy mineral separation spirals and installation of a new 132 kW pump located on level 1 within the annex.

A site visit was conducted in August 2016 to characterise noise emissions from ther existing WCP. From this visit sound power levels for the WCP and the pumps were determined, and the nature and charateristics of the WCP noise emissions were observed. The noise was assessed to be continuous in nature with no evidence of impulsiveness or modulation.

SVT has undertaken noise modelling of the Wet Concentrate Plant (WCP) only to predict and assess the change in noise levels at the nearest noise sensitive premises associated with the proposed changes including an assessment of the likelihood that intrusive or dominant noise characteristics will be present in the received noise at the nearest noise sensitive premises.

Three scenarios have been modelled to demonstrate the noise impacts of the proposed changes to the WCP:

- The first scenario was of the existing plant to provide a point of comparison.
- The second scenario was of the existing plant with the proposed new annex constructed the same as the existing WCP. The second scenario demonstrated that the contribution of the expanded WCP to received noise levels increases marginally (up to 1.5 dB) at noise sensitive premises to the south of the building.
- The third scenario consists of the existing plant with proposed new annex including additional cladding to level 1 applied to areas on both the new annex and the existing WCP building. This scenario results in a small reduction in the contribution of the expanded WCP to received noise levels at noise sensitive premises to the south of the building. For this scenario the predicted noise reduction at the closest receptor to the southwest (NSR1) is 2.7 dB.

The study also found that the contribution of the WCP to received noise levels before or after the proposed changes is insignificant. (For NSR1, the predicted contribution of the WCP to received noise levels is approximately 10 dB below the night time L_{A10} assigned noise level.) Therefore, noise emissions from the WCP at noise sensitive receptors are very unlikely to contribute to any tonality.

The study concludes that the extended WCP is unlikely to have any noticeable impact on noise emissions from the Keysbrook Mineral Sands Project.

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1. INTRODUCTION

Keysbrook Leucoxene Pty. Ltd. (KLPL) are proposing the installation of an additional spiral stage to the existing Wet Concentrator Plant (WCP) at the Keysbrook Mineral Sands Project located near to North Dandalup, about 70km south of Perth. Details of the proposed changes are contained within the *Keysbrook Mineral Sands Project Environmental Licence Amendment Application L8918/2015/1* (August 2016, MBS Environmental) and these changes are summarised in Section2 of this report. SVT have been commissioned by KLPL to conduct an environmental noise impact assessment of the proposed changes to the WCP.

1.1 Scope

The scope of work includes the following:

- Noise modelling of the Wet Concentrate Plant (WCP) to determine the change in noise levels at the nearest noise sensitive premises associated with the proposed changes to the WCP;
- Prediction of the contribution of the WCP to the noise levels received at the nearest noise sensitive locations for worst case night-time meteorological conditions;
- Assessment of the significance of noise emissions from the proposed changes to the WCP in relation to the Keysbrook Mineral Sands Project's ability to comply with the assigned noise levels imposed under the Environmental Protection (Noise) Regulations 1997 at the nearest noise sensitive premises; and
- Assessment of the likelihood that intrusive or dominant noise characteristics will be present in the received noise at the nearest noise sensitive premises.

1.2 Applicable Documents

The following are the applicable documents:

[1] *Keysbrook Mineral Sands Project Environmental Licence Amendment Application L8918/2015/1* (August 2016, MBS Environmental).

[2] Environmental Protection Act 1986

[3] Environmental Protection (Noise) Regulations 1997

[4] DER Draft Guideline on Environmental Noise for Prescribed Premises, May 2016

[5] Ministerial Statement No. 810, 19 October 2009, Statement That a Proposal May Be Implemented Pursuant to the Provisions of the Environmental Protection Act 1986

[6] Works Approval W5386/2013/1

2. DESCRIPTION OF PROPOSED CHANGES TO WCP

The current WCP building is pictured in Figure 2-1.

The principal noise sources in the existing WCP building are the process pumps on level 1 (unclad area). Flow noise is also generated in the spiral circuit, but this is less significant and is effectively attenuated by the cladding applied to the upper levels of the building.

The main components of the proposed changes relevant to noise emissions include:

- Installation of an additional annex on the south side of the existing WCP building, clad on the walls and roof to the same standards as the existing building;
- Addition of four banks of heavy mineral separation spirals within the upper levels of the additional annex; and,
- Installation of a new 132 kW pump located on level 1 within the additional annex.

The new pump on level 1 has been identified as the most significant source of noise emissions associated with the new annex. (As per the existing plant, flow noise in the new spiral circuit will be effectively contained by the cladding applied to the upper levels.)

Figure 2-1 : Existing Wet Concentrator Plant building (south side shown)

2.1 Proposed Noise Controls

In order to reduce noise emissions associated with the proposed changes to the WCP, additional cladding (similar to that installed on the upper levels of the existing plant) will be extended to the lower levels of the following plant facades:

A. South face of the new annex;
B. 50% of the south west face of the new annex (allowing access for a maintenance crane beam); and
C. South face of the existing building to the west of the new annex.

Figure 2-2 presents a plan view schematic of the WCP annex extension, and indicates areas where additional cladding will be applied on Level 1 (lower level, currently unclad).

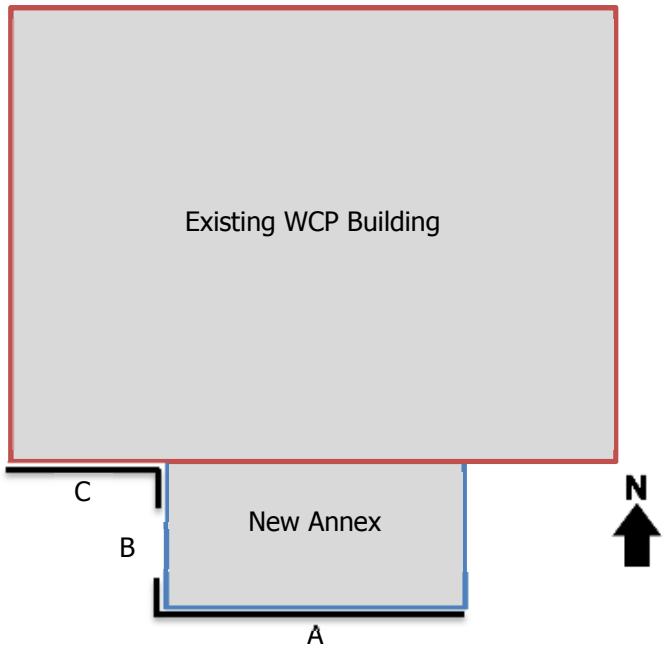

Figure 2-2 : Schematic plan of WCP annex extension and proposed cladding on Level 1

The additional cladding provides screening for both the plant in the new annex as well as plant in the existing building, and will be most effective in reducing noise at noise sensitive premises located to the southwest of the WCP.

3. NOISE SENSITIVE RECEPTORS

Figure 3-1 shows the location of the nearest noise sensitive receptors in relation to the Wet Concentrator Plant (WCP).

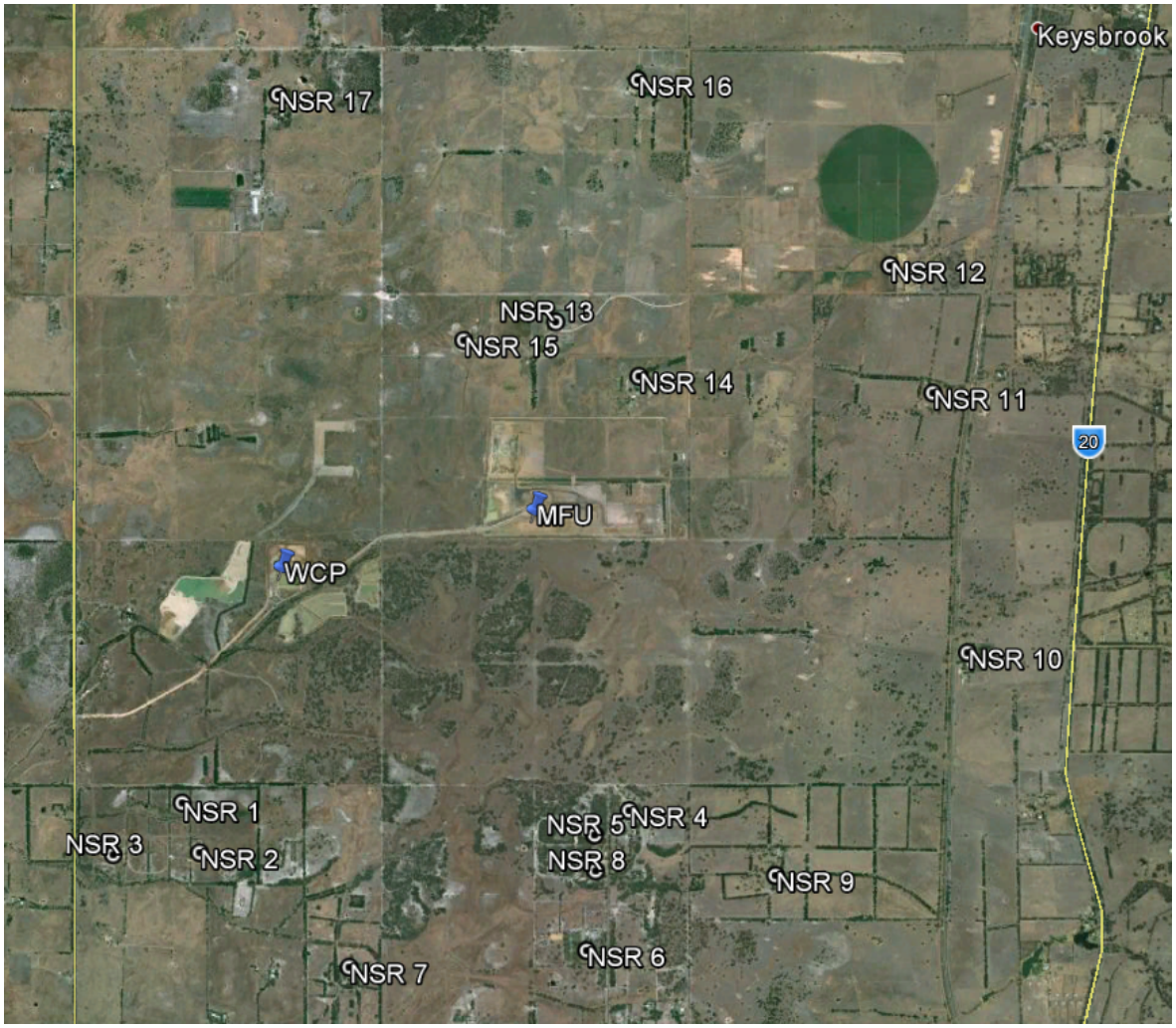

Figure 3-1 : Noise Sensitive Premises

Receptor NSR1 is the closest receptor to the southwest of the WCP and is likely to be the most affected by the proposed changes to the plant.

4. SUMMARY OF LEGISLATION

4.1 Assigned Levels

Noise management in Western Australia is implemented through the *Environmental Protection (Noise) Amendment Regulations 2013* which operate under the Environmental Protection Act 1986. The *Regulations* specify maximum noise levels (assigned noise levels) which are the highest noise levels that can be received at noise-sensitive (residential), commercial and industrial premises.

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

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

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

The regulations define three types of assigned noise level:

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

Table 4-1 presents the relevant assigned noise levels for highly sensitive areas of noise-sensitive premises.

Table 4-1: Assigned noise levels in dB(A).

Type of premises receiving noise	Time of day	Assigned Noise Levels dB(A)		
		$L_{A\,10}$	$L_{A\,1}$	$L_{A\,max}$
Noise sensitive premises: highly sensitive area	0700 to 1900 hours Monday to Saturday	45+ influencing factor	55+ influencing factor	65+ influencing factor
	0900 to 1900 hours Sundays and public holidays	40+ influencing factor	50+ influencing factor	65+ influencing factor
	1900 to 2200 hours all days	40+ influencing factor	50+ influencing factor	55+ influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	**35+ influencing factor**	45+ influencing factor	55+ influencing factor

Since the WCP operates continuously on a 24 hour basis, the night-time L_{A10} assigned levels (highlighted in bold in Table 4-1) are most relevant (and stringent) to this assessment.

For most receptors, the influencing factor is zero and the relevant assigned noise level is 35 dB(A) (L_{A10}). For NSR 14, the industrial zone within the 450m radius results in an influencing factor of 2 and a corresponding assigned level of 37 dB(A). For NSR 1, the influencing factor will be 1 due the propotion of industrial zone within the 450m radius resulting in an assigned level of 36 dB(A).

4.2 Corrections for Characteristic of Noise

Noise levels at the receiver are required to be adjusted if the noise exhibits intrusive or dominant characteristics, i.e. if the noise is impulsive, tonal, or modulating, Table 4-2 presents the applicable adjustments if required. That is, if the noise is assessed as having tonal, modulating or impulsive characteristics, then the measured or predicted noise levels are adjusted by the amounts given in Table 4-2. The adjusted noise levels must now comply with the assigned noise levels. *Regulation 9* sets out objective tests to assess whether the noise is taken to be free of these characteristics. These adjustments are cumulative to a maximum of 15 dB.

Table 4-2: Adjustments for intrusive or dominant noise characteristics.

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

5. NOISE MODELLING METHODOLOGY

5.1 Computer Model

A computer model was developed using the SoundPlan v7.4 program. This program calculates sound pressure levels at nominated receiver locations or produces noise contours over a defined area of interest around the noise sources. SoundPlan can be used to model different types of noises, such as industrial noise, traffic noise and aircraft noise, and it has been recognised as accepted software by WA DER. It also provides a range of prediction algorithms that can be selected by the user. The CONCAWE[1,2] prediction algorithms have been selected as most appropriate for this study. The inputs required in SoundPlan are noise source data, ground topographical data, meteorological data and receiver point locations.

The model was used to predict the contribution of the WCP plant to noise levels received at the nearby noise sensitive premises and to generate noise contours for the surrounding area.

The model does not include noise emissions from any source other than the WCP plant building. Therefore, noise emissions from noise sources outside of the WCP building such as pumps, or other mining activities (which are unaffected by the changes to the WCP) are excluded. Similarly, noise emissions from neighbouring industrial sources, road traffic etc. are also excluded from the modelling.

5.1.1 Meteorological Conditions

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

For the noise modelling SVT has used the "default meteorological conditions" (night-time), assuggested by the WA DER Draft Guideline on Environmental Noise for Prescribed Premises. Table 5-1 presents the meteorological conditions for noise assessment.

Table 5-1: Worst-case meteorological conditions

Time of day	Temperature Celsius	Relative Humidity	Wind speed	Pasquill Stability Category (PSC)
Night (22:00 - 07:00)	15° Celsius	50%	3 m/s	F

The wind direction has been modelled as Worst Case, which assumes the wind is blowing in the direction from source to receiver.

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

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

5.1.2 Topography, Barriers and Ground Absorption

Topographical information for the area surrounding the mining operations was provided by MZI.

No building effects are considered in the model other than the thickener tank located immediately to the southeast of the WCP.

A semi absorptive ground factor (0.6) has been assumed based on the surrounding ground cover.

5.2 Modelling Scenarios

Three scenarios have been modelled to demonstrate the noise impacts of the proposed changes to the WCP:

1) Existing plant;

2) Existing plant with proposed new annex with no additional cladding;

3) Existing plant with proposed new annex including additional cladding to level 1.

5.3 Noise Sources

Appendix A provides octave band sound power levels for the noise sources included in the model.

5.3.1 Existing WCP

The existing WCP building has been modelled as a series of facades (area noise sources) representing the clad and unclad sections of each face of the building. The unclad (lower level areas) extend from ground level to a height of 4.5 m. The upper, clad areas, extend from 4.5 m to 18 m above ground level.

Sound power levels were calculated based on site measurements recorded on 9th August 2016. Sound power levels for the open areas (lower levels) were calculated directly from measured sound pressure levels. Sound power levels for upper, clad areas were calculated from the internal sound pressure level within the building and the transmission loss of the cladding. Sound intensity measurement was used to determine the sound transmission loss for low frequencies. Extraneous ambient noise prevented direct measurement of sound transmission loss at higher frequencies and therefore the transmission loss modelling software "Insul" was used to determine the high frequency transmission loss assuming a corrugated steel panel similar to the cladding installed on the building.

Table 5-2 summarises the sound power levels for each façade element.

Table 5-2: Measured and calculated façade component sound power levels for the WCP building

Component	Sound Power Level [dBA]
Open lower north side	100.2
Open lower east and west sides (per side)	97.6
Open lower south side	101.7
Subtotal of all open areas	**105.6**

Component	Sound Power Level [dBA]
Cladded upper east and west sides	83.7
Cladded upper north and south sides	84.8
Subtotal of all cladded areas	**90.3**
Total of entire building	**105.8**

5.3.2 New Plant

The only significant noise source identified for the new annex is the pump on level 1. This has been modelled as a point noise source with a sound power level of 97.2 dB(A). The sound power level assigned to this pump is based on an evaluation of the sound power level of a similar pump in the existing WCP which was measured during the site visit on 9th August 2016.

The effect of extending the cladding to ground level on several areas of the building (see section 2.1) has been modelled by including noise barriers at the relevant façades.

6. NOISE MODELLING RESULTS

The noise modelling results for each noise sensitive premises are summarised in Table 6-1 for each modelling scenario. Noise contours for each scenario are presented in Appendix B.

Table 6-1 : Noise Modelling Results

Noise Sensitive Receptor	Address	Predicted Worst-case Noise Levels in dB(A)		
		Scenario 1 Existing WCP	Scenario 2 Extended WCP	Scenario 3 Extended WCP with additional cladding
NSR 1	Lot 20 Hopelands Rd	24.6	26.1	21.9
NSR 2	Lot 211 Hopelands Rd	22.5	24.0	19.6
NSR 3	Lot 212 Hopelands Rd	20.9	22.4	18
NSR 4[3]	Lot 505 St Blaise Grove	15.3	16.4	15.9
NSR 5[3]	Lot 506, St Blaise Grove	15.6	15.9	15.2
NSR 6	Lot 508, St Blaise Grove	12.4	12.7	11.7
NSR 7	Lot 1, Readheads Rd	15.6	18.1	11.7
NSR 8	Lot 12 Readheads Rd	14.4	14.7	14.0
NSR 9	Lot 100, Atkins Rd	11.6	12.8	12.5
NSR 10[3]	Lot 301 Atkins Rd	10.0	11.0	11.0
NSR 11[3]	Lot 104 Atkins Rd	10.8	11.1	11.1
NSR 12[3]	Lot 52, Westcott Rd	10.6	10.7	10.7
NSR 13[3]	Lot 101, Westcott Rd	20.4	20.5	20.6
NSR 14[4]	Lot 104 Westcott Rd	19.0	19.0	19.0
NSR 15[3]	Lot 105 Westcott Rd	23.9	23.9	23.9
NSR 16	Lot 57 Elliott Rd	12.5	12.5	12.5
NSR 17	Lot 64 Hopelands Rd	16.6	16.6	16.6

[3] Agreement pursuant Ministerial Statement 810 Condition 14-1 with owner/occupiers in place.

[4] Owned by MZI Resources.

7. IMPACT ASSESSMENT

The results presented in Table 6-1 show that without applying any noise reductions measures, (Scenario 2) the contribution of the expanded WCP to received noise levels increases marginally (up to 1.5 dB) at noise sensitive premises to the south of the building.

Extending the cladding on the building to ground levels on selected façades (as described in section 2.1) results in a small reduction in the contribution of the expanded WCP to received noise levels at noise sensitive premises to the south of the building. The predicted noise reduction at the closest receptor to the southwest (NSR1) is 2.7 dB.

In the context of the assigned noise levels, the contribution of the WCP to received noise levels before or after the proposed changes is insignificant. (For NSR1, the predicted contribution of the WCP to received noise levels is approximately 10 dB below the night time L_{A10} assigned noise level.)

7.1 Intrusive or Dominant Noise Characteristics

The noise from the WCP was observed to be continuous in nature during the site visit on 9th August 2016, with no evidence of impulsiveness or modulation.

The predicted contribution of the WCP to received noise levels is significantly below the assigned noise levels and ambient noise levels across the entire frequency spectrum. Therefore, noise emissions from the WCP at noise sensitive receptors are very unlikely to contribute to any tonality.

8. CONCLUSIONS

Noise modelling of the proposed changes to the WCP plant has shown that:

- The contribution of the WCP plant to noise levels at the nearest noise sensitive receptors, both before and after modifications, is significantly below the assigned noise levels.
- Without implementing noise controls the contribution of the WCP plant to overall noise levels is predicted to increase by up to 1.5 dB at the most affected noise sensitive receptor to the southwest of the plant (NSR1).
- Extending the cladding on specific façades of the building to ground level (as described in section 2.1) results in a predicted reduction of 2.7 dB in the WCP's contribution to received noise levels at the most affected receptor to the southwest of the plant (NSR1).
- Noise emissions from the extended WCP are not likely to result in any intrusive or dominant noise characteristics which protrude above ambient noise at the nearest noise sensitive receptors.

It is concluded, therefore, that the extended WCP is unlikely to have any noticeable impact on noise emissions from the Keysbrook Mineral Sands Project.

APPENDIX A SOURCE SOUND POWER LEVELS

Source	SWL dB(A)	Octave Band Sound Power Level (SWL) dB(A)								
		31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Annex Pump	97.2	60.2	77.8	91.1	85	89.5	92.1	87.3	86.9	78.3
East Wall Cladding	83.7	67.3	75.5	76.3	79.6	74.3	71.8	69.1	62.8	68.5
East Wall Opening	97.5	63.5	75.4	84.6	86.9	87.9	91.2	91.7	91.1	82.5
North Wall Cladding	84.8	68.3	76.5	77.3	80.7	75.4	72.8	70.1	63.8	69.5
North Wall Opening	101.6	66.2	81.2	88.7	91.2	92.9	96.2	94.9	94.2	86.7
South Wall Cladding	84.8	68.3	76.5	77.3	80.7	75.4	72.8	70.1	63.8	69.5
South Wall Opening	100.2	64.7	79.8	87.2	89.7	91.5	94.8	93.5	92.8	85.3
West wall cladding	83.7	67.3	75.5	76.3	79.6	74.3	71.8	69.1	62.8	68.5
West wall opening	97.5	63.5	75.4	84.6	86.9	87.9	91.2	91.7	91.1	82.5

APPENDIX B NOISE CONTOURS

Figure B-1, Figure B-2 and Figure B-3 shows the noise contours for Scenaio 1-3. The noise contours shows the contribution of the WCP in isolation without the noise contribution from other MZI operations such as fixed plant and mobile equipment.

Appendix B-1 Scenario 1

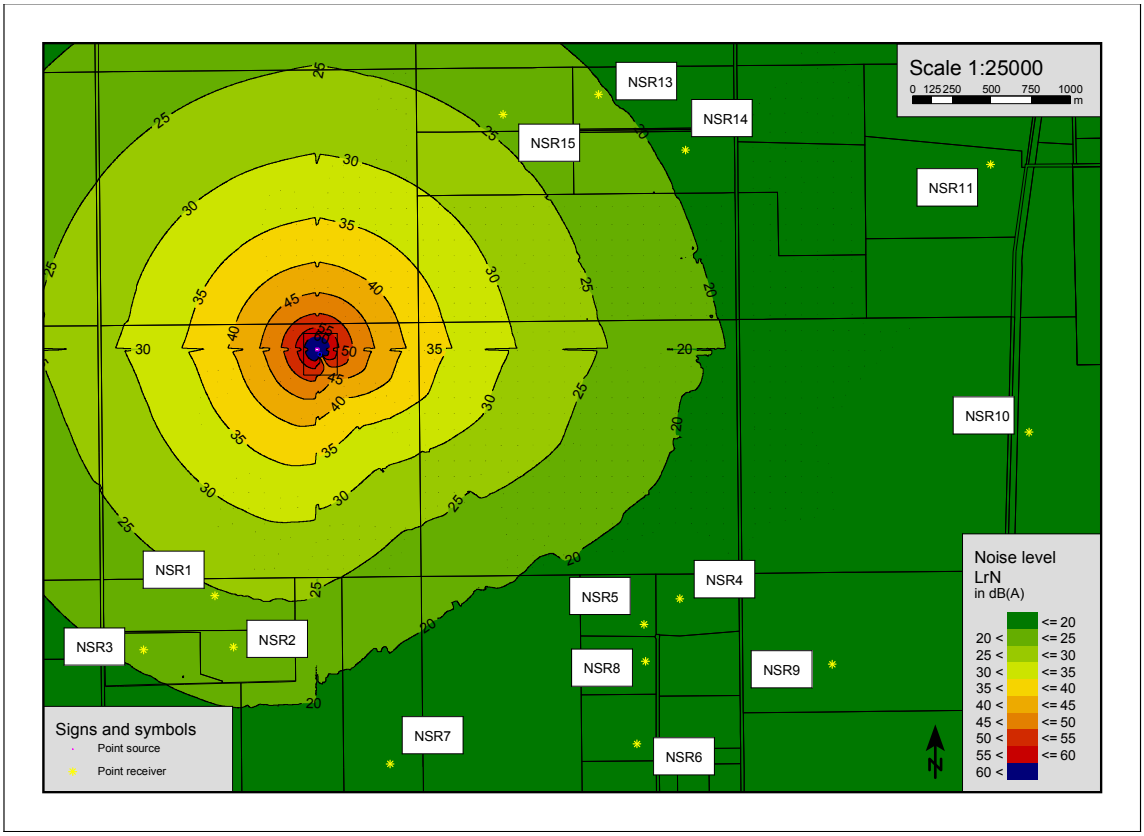

Figure B-1: Scenario 1 (Existing WCP) noise contour in isolation

Appendix B-2 Scenario 2

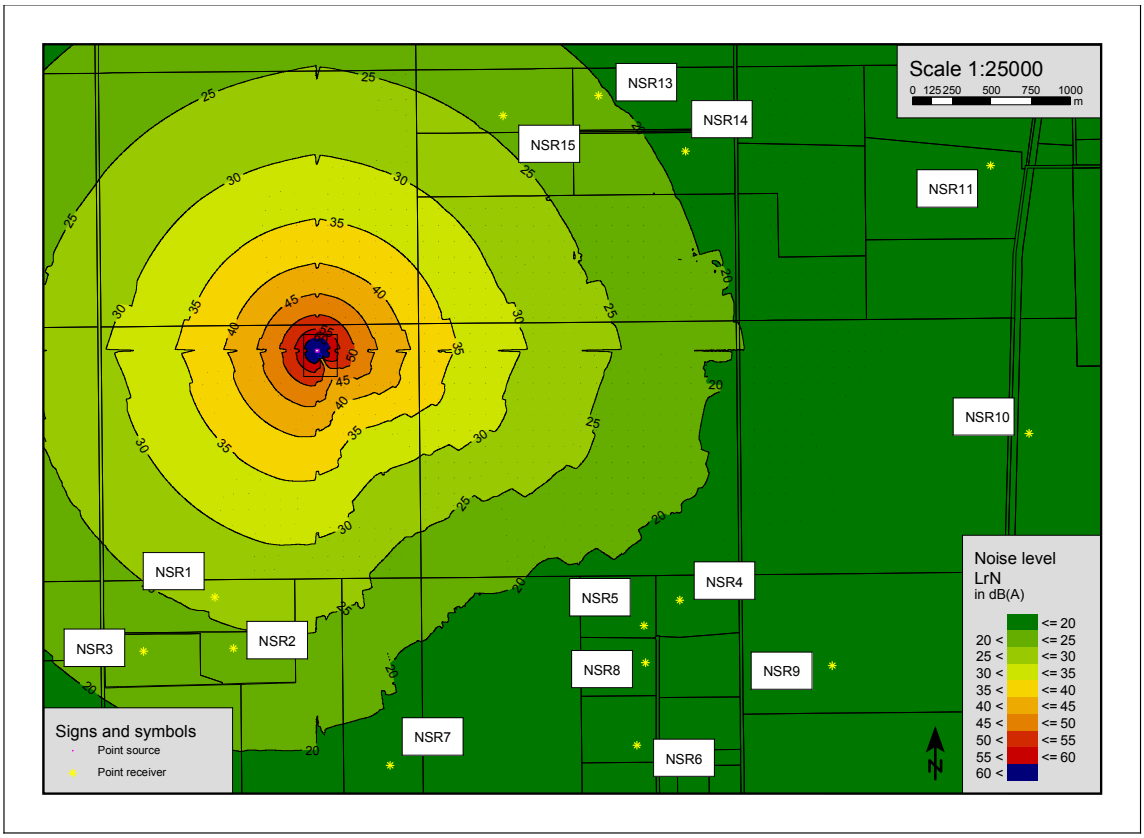

Figure B-2: Scenario 2 (Extended WCP) noise contour in isolation

Appendix B-3 Scenario 3

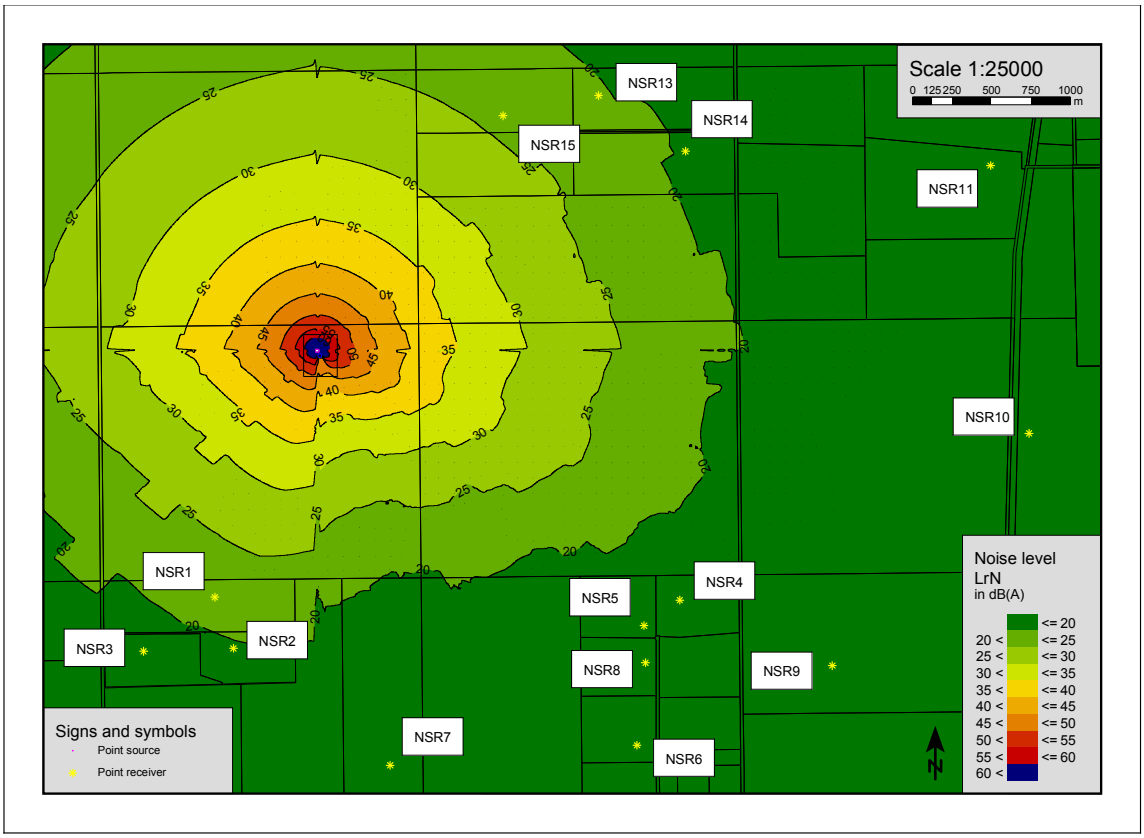

Figure B-3: Scenario 3 (Extended WCP with additional cladding) noise contour in isolation