MARSHALL DAY Acoustics

BARRYTOWN MINERAL SAND MINE ASSESSMENT OF NOISE EFFECTS

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Project: **BARRYTOWN MINERAL SAND MINE**

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SUMMARY

This report provides an assessment of the potential noise effects arising from the proposed mineral sand mining activity near Barrytown, West Coast.

We have measured existing ambient noise in the area which confirm relatively elevated levels of surf noise during the day and at night.

Mining activities include processing operations, which will occur 24 hours a day, but mineral extraction will only take place during the day. We have modelled a conservative worst-case situation where all mining plant and equipment is operating at the same time at the closest practical point to the existing dwellings. Noise levels will be lower than predicted when mining is occurring in other parts of the site away from the boundaries. Noise levels will also be lower than predicted once mobile plant is operating within the excavated area up to a depth of 14 metres and the pit wall at the perimeter will act as a noise barrier.

The proposed Eastern Bund (as shown in Figure 2) will serve as an effective noise barrier for mining activities that occur to the west of the bund. We have also assessed the conservative situation with the Eastern Bund removed during the final stages of mining.

Noise levels from the mining and processing activities are predicted to comply with the Grey District Plan (GDP) daytime and night-time permitted activity noise limits of 55 and 45 dB L_{A10} respectively. The exception is during the day on Sundays when a 45 dB L_{A10} daytime limit currently applies.

The site comfortably complies with the permitted activity noise levels within the proposed Te Tai o Poutini Plan, which better reflect the recommended criteria set out in New Zealand Standard NZS 6802:2008 and the World Health Organisation published guidance.

Site establishment includes several construction activities such as the construction of bunds and site buildings. The final contouring of the site and disestablishment of processing equipment can also be reasonably considered as construction noise. Our analysis shows worst-case construction activities will comfortably comply with the applicable noise limits from New Zealand Standard NZS 6803: 1999 *Acoustics - Construction Noise*. Moreover, construction activity noise emissions are consistent with the noise environment anticipated by the GDP permitted activity noise limits and will have a similar character and magnitude to day-to-day operational noise on site.

Trucks will primarily transport material from the site during the day but will commence operations at 0500 hours, which is considered night-time in the District Plan. Noise on public roads is exempt from compliance with the District Plan permitted activity noise limits. Waka Kotahi data shows that State Highway 6 vehicle movements steadily increase past the site from 0500 hours and we calculate average existing minimum traffic noise levels are in the order of 50 dB $L_{Aeq(1\ hour)}$. The proposed truck activity will result in a 3 dB noise level increase between 0500 and 0600 hours – a 3 dB change is just perceptible. As the existing traffic volumes on SH6 increase between 0600 and 0700 hours and the successive hours of the day, the relative increase in noise level from quarry trucks is reduced, with a corresponding diminishing noise effect.

As a result, we consider that noise effects from the proposed trucking activity will be acceptable in the context of the existing traffic noise environment.

We have provided suggested wording for conditions that we recommend be incorporated into the consent, if granted, to ensure noise from the activity is adequately controlled throughout the life of the mine.

As a result of our analysis, we consider noise effects from the proposed mining and processing activities will result in acceptable noise effects at nearest dwellings with respect to the permitted activity noise levels and existing noise environment.

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1.0 INTRODUCTION

Marshall Day Acoustics has been engaged by TiGa Minerals and Metals Ltd to assess the potential noise effects of their proposed mineral sand mining activity near Barrytown, West Coast.

This report provides:

- An overview of the proposed activity and key sources of noise generation;
- Details of the existing noise environment;
- Relevant noise performance standards;
- Proposed noise mitigation measures;
- Predicted noise levels from the proposed activity;
- An assessment of the potential noise effects; and
- Recommended consent conditions relating to noise.

A glossary of the technical terminology used in this report is provided in Appendix A.

2.0 SITE & ACTIVITY DESCRIPTION

2.1 Site Location

The proposed mine site is located approximately four kilometres north of Barrytown on State Highway 6 near Canoe Creek, as shown in Figure 2 on the following page. The nearest dwellings are indicated by white circles in Figure 2 and are distributed along State Highway 6.

Under the operative Grey District Plan (GDP), the mine site and surrounding land is zoned *Rural*. Under the proposed Te Tai o Poutini Plan (TTPP) the site is zoned for *Mineral Extraction* and the adjoining dwellings are zoned *General Rural* or *Rural Lifestyle*.

2.2 Proposed Activity

The Applicant has provided a written description of the mine development, and in the following paragraphs we highlight those activities that will generate notable levels of noise and assess their potential adverse noise effects later in the report. We note the Applicant has committed to implementing a Noise Management Plan (NMP) for the site that addresses noise generation over the life of the project. We have prepared a draft NMP which is appended to the Application.

The activity site can be broken down into three distinct stages:

1. Pre-mining
2. Mining and processing of material
3. Post mining and contouring

2.2.1 Pre-Mining

The key components of the mine will be established during this phase, including water facility construction, access roads, processing plant and buildings and will take approximately 8 months to complete.

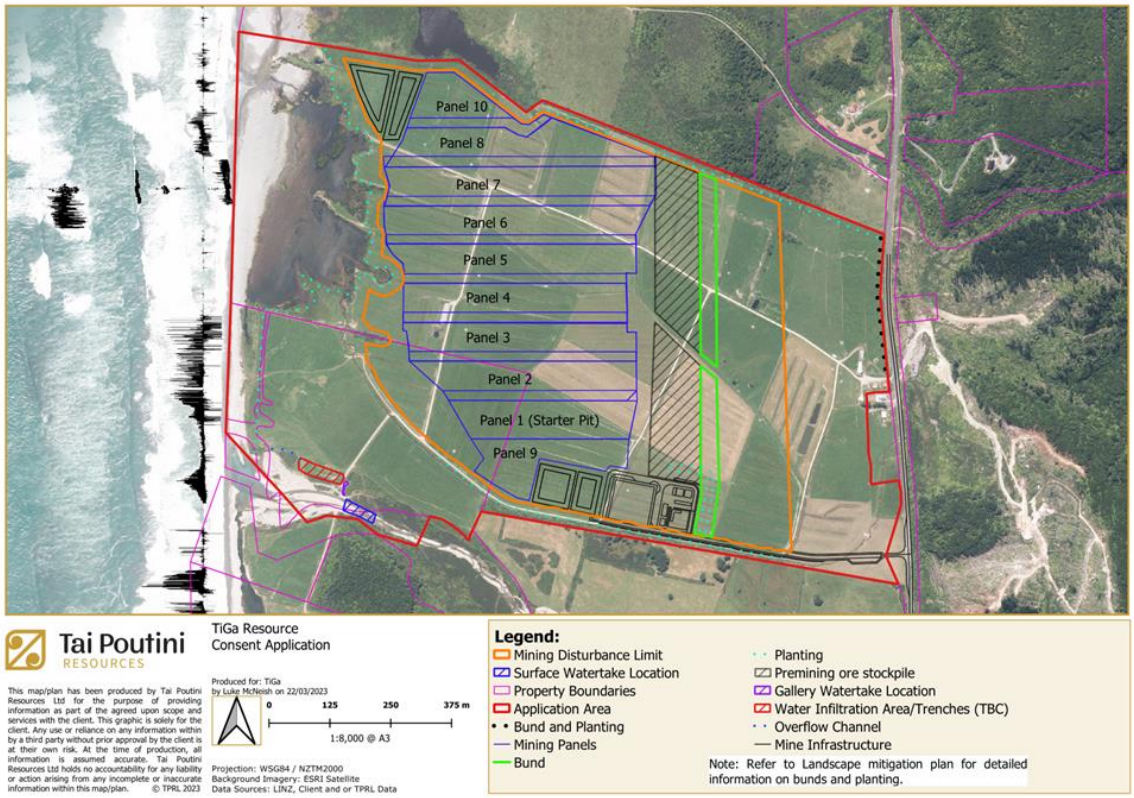
Much of the topsoil and waste material will be used to form a bund to the east of the mining area with a maximum height of 4.5 metres (hereafter the Eastern bund). The Eastern Bund will serve as an effective noise control barrier as all extraction activities will occur to the west of the bund thereby mitigating noise emissions to the dwellings to the east.

Mineralised sand from the excavated dams will be stockpiled to the western side of the Eastern Bund for later processing.

The location of the Eastern Bund, processing plant, etc is shown in Figure 1.

We consider that the works during this phase of the mine are appropriate to assess under the New Zealand Standard NZS 6803:1999 *Acoustics - Construction Noise*.

Figure 1: Key mine features



2.2.2 Mining Sequence

Mining will commence in Panel 1 as shown in Figure 1 and will gradually progress through the sequence of mining panels. Each panel will take approximately 4 to 6 months to be mined and rehabilitated. Mining will only occur during daylight hours.

Overburden and topsoil will be stripped starting in the west of each panel and move in an easterly direction. An excavator will place mined ore into the Mining Field Unit and will then be pumped to the processing plant. The mining void will be replaced with tailings from the processing plant. Mining will occur during the day. We understand the Applicant is seeking to conduct mining activities between 0630-2130 hours from 1 November – 31 January to avoid night-time mining during the peak fledgling season for Taiko. The period 0630 to 0700 hours falls within the night-time period as defined by the District Plan and we discuss the potential effects of this in Section 5.3.

Tailings will be levelled and contoured ready to receive the pre stripped overburden and soil. The mining void will be progressively rehabilitated as the mining void advances. The final contouring of Panels 8, 9 and 10 will use recovered material from the Eastern Bund.

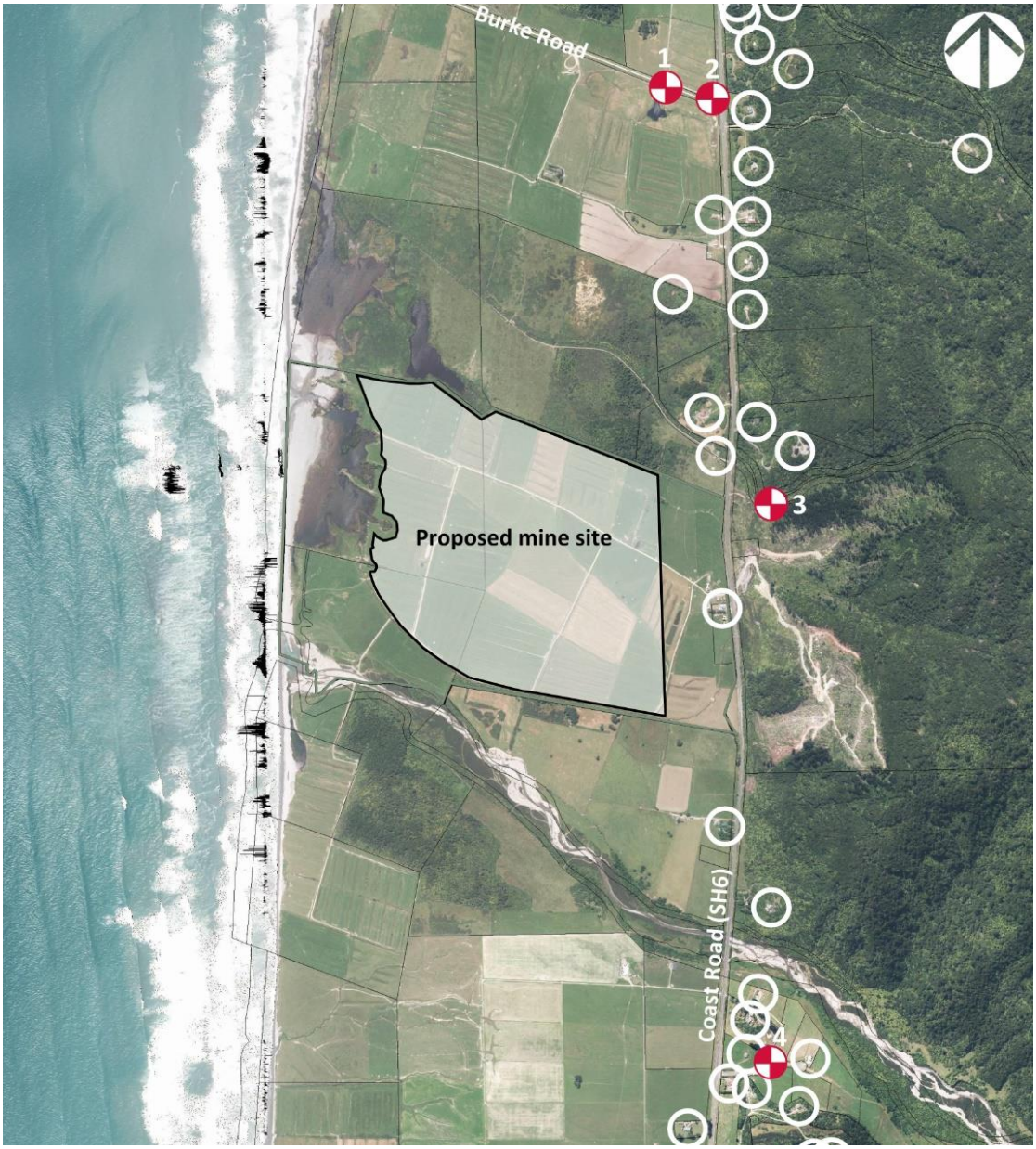
2.2.3 Post Mining

At the completion of mining, recovered material from the Eastern Bund will be used to fill water treatment dams, except those required as part of the final landform.

Final contouring of the land will occur including blending of the unmined and mined area. During this phase, earth moving machinery may operate within the mining disturbance limit.

The processing plant and offices will be deconstructed.

Figure 2: Proposed mine site, nearest dwellings (circled in white) and noise measurement positions



3.0 EXISTING AMBIENT NOISE ENVIRONMENT

To assess the existing ambient noise environment in the vicinity of the proposed mine site, we undertook attended and unattended ambient noise surveys for a previous application at this site. Noise measurements were conducted in February and March 2020 and we consider this data will still be representative of the current ambient noise environment. An unattended noise logger was deployed during the February noise survey and retrieved after the March noise survey in order to measure trends in typical ambient noise levels over a three-week period.

Our attended noise surveys and the noise logger results are discussed in the following sections.

3.1 Attended Noise Surveys

On 19, 20 and 21 February 2020 and on 12 and 13 March 2020, attended noise measurements were performed at the four positions shown in Figure 2. The noise surveys were undertaken during fine conditions with light winds. Further information such as equipment and calibration details are provided in Appendix B.

The ambient monitoring positions are described below:

- Position 1: Approximately 150 metres west of State Highway 6. This position is intended to capture ambient noise levels similar to those experienced at dwellings that are well set-back from the road, such as 3323 Coast Road.
- Position 2: Approximately 25 metres from the edge of State Highway 6. This position is intended to capture ambient noise levels similar to dwellings close to State Highway 6, such as 3195 and 3261 Coast Road.
- Position 3: Approximately 150 metres east of State Highway 6. This elevated position is intended to capture ambient noise levels similar to those experienced at elevated dwellings along the east side of State Highway 6.
- Position 4: Approximately 150 metres from the edge of State Highway 6 on Prospector Place. This position is intended to capture ambient noise levels similar to those experienced at the surrounding dwellings on Prospector Place.

A summary of our attended ambient noise survey results is provided in Table 1. The duration of each measurement was generally 15 minutes. Details of each measurement are listed in Appendix B.

Table 1: Summary of attended ambient noise survey results

Position	Range of measured noise levels				Comments
	dB L_{Aeq}	dB L_{A10}	dB L_{A90}	dB L_{AFmax}	
Daytime					
1	39-44	41-47	33-41	55-58	SH6 traffic generally dominant. Sea, cicadas and bird calls typically audible during lulls in traffic.
2	53-58	52-60	33-41	72-81	SH6 traffic dominant. Cicadas and sea contribute during lulls in traffic.
3	46-50	47-53	43-46	62-68	SH6 traffic generally dominant. Sea and nearby stream contributes.
4	42-44	44-48	38-38	58-62	SH6 traffic generally dominant. Sea contributes during lulls in traffic.
Night-time					
1	50-51	51-52	47-48	58-60	Sea dominant. Birds contribute at times.
2	50-51	49-52	34-48	54-73	Sea generally dominant.
3	49-50	49-52	48-49	51-55	Sea generally dominant. Nearby stream contributes.
4	47	49	45	59	Sea generally dominant. Single measurement only.

Our measurements at Position 2 suggest that dwellings in close proximity to State Highway 6 are exposed to ambient noise levels of around 55 dB L_{Aeq} during the day, though background noise levels can be significantly lower, at 33-41 dB L_{A90}. At night, ambient noise levels are around 50 dB L_{Aeq} and dominated by sea noise.

At locations well set back from the State Highway (Positions 1, 3 and 4), ambient noise levels received during the day are typically 40-50 dB L_{Aeq} and generally dominated by traffic noise with some contribution from sea noise during lulls in traffic. Background noise levels are typically 33-46 dB L_{A90}.

Night-time ambient noise levels are generally at the higher end of typical daytime ambient noise levels at these positions due to sea noise being more prominent. Average night-time noise levels at

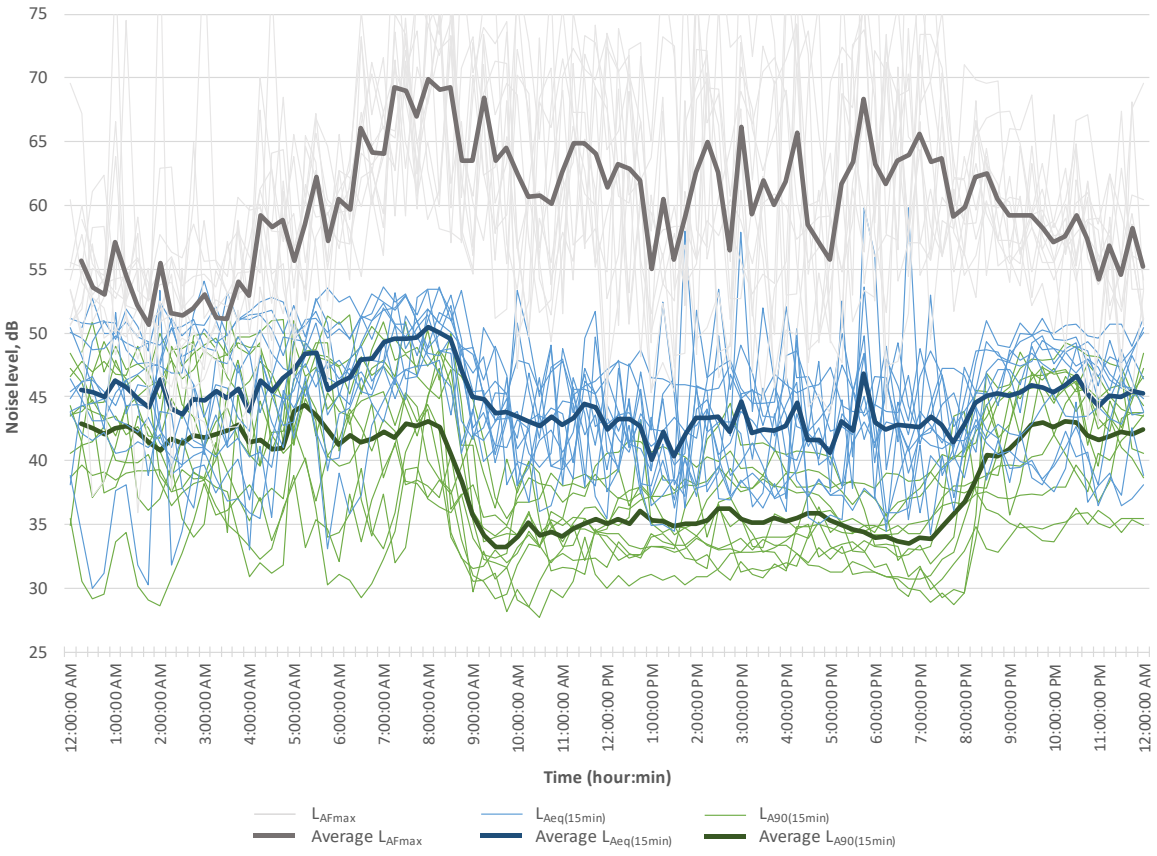
these positions are typically around 50 dB L_{Aeq}. We have explored and discounted the tidal variation as the sole reason for the elevated noise level at night. We expect the increase in sea noise at night is a result of a combination of several factors including the temperature and wind gradient effects. This trend in greater sea noise levels at night was also observed in the noise logger data discussed below.

We note that elevated surf noise at night-time is a relatively common feature of other sites we have measured along the West Coast.

3.2 Unattended Noise Logging

On 19 February 2020, a noise logger was deployed at ambient monitoring Position 1. The noise logger was retrieved on 13 March 2020 and the data was analysed alongside weather conditions. Noise logger data captured on days with wind speeds in excess of 3 m/s or with any rain were discarded due to their influence on ambient noise. Over the three-week noise logging period, there were 11 days with suitable weather conditions for ambient noise recording. The noise data from these 11 days is presented in Figure 3.

Figure 3: Average time history noise logger data at Position 1 during suitable weather conditions



During the day, average noise levels are typically 40-45 dB $L_{Aeq(15min)}$ at this position. Average background noise levels are around 35 dB $L_{A90(15min)}$. Maximum noise levels vary considerably but are typically 55-70 dB L_{AFmax} throughout the day, on average.

Interestingly, the data shows that background noise levels (L_{A90}) are generally lower during the day than at night. This is consistent with our attended noise monitoring results at this position.

At night, average noise levels are typically around 45 dB $L_{Aeq(15\ min)}$ with background noise levels generally above 40 dB L_{A90}, on average. Maximum noise levels are typically 50-60 dB L_{AFmax}.

4.0 NOISE ASSESSMENT CRITERIA

4.1 Operative Grey District Plan Noise Standards

The proposed mine site and surrounding properties are zoned *Rural Environmental Area* under the Grey District Plan (GDP). The relevant District Plan noise standards are provided in Rule 19.7.16 and can be summarised as follows:

Table 2: Summary of applicable Grey District Plan noise limits

	Daytime (0700 – 2200 hours)		Night-time (2200 – 0700 hours)	
	dB L_{A10}	dB L_{Amax}	dB L_{A10}	dB L_{Amax}
At any point within the notional boundary of any dwelling in the *Rural* or *Rural Residential Environmental Area*, other than the site from which the noise is created:				
Monday to Saturday	55	-	45	75
Sunday	45	-	45	75

The Grey District Plan also states that sound shall be measured in accordance with NZS 6801:1999 "*Acoustics – Measurement of Environmental Sound*" and assessed in accordance with NZS 6802:1991 "*Assessment of Environmental Sound*". Construction noise shall be measured and assessed in accordance with NZS 6803:1999 *"Acoustics – Construction Noise"*.

As we discuss in Section 4.3, vehicle noise on public roads is not assessed against these permitted activity standards.

4.2 Proposed Te Tai o Poutini Plan

We understand the Te Tai o Poutini Plan (TTPP) has been notified. Under the TTPP, the proposed site is zoned for *Mineral Extraction* and the adjoining dwellings are zoned *General Rural* or *Rural Lifestyle*.

The applicable provisions for noise generated with the Mineral Extraction Zone are set out in NOISE – R11 under Part 2 of the TTPP as follows.

Table 3: Summary of TTPP noise limits

	Daytime (0700 – 2200 hours)		Night-time (2200 – 0700 hours)	
	dB L_{Aeq}	dB L_{Amax}	dB L_{Aeq}	dB L_{Amax}
The maximum noise generated from activities does not exceed the following limits at any point within the notional boundary of any sensitive activity within any site receiving noise	55	--	45	75

The TTPP requires that sound shall be measured in accordance with NZS 6801:2008 *Acoustics – Measurement of environmental sound* and assessed in accordance with New Zealand Standard NZS 6802:2008 *Acoustics - Environmental Noise*.

4.3 Vehicle movements and mobile noise sources

The GDP requires noise to be assessed in accordance with NZS 6802:1991 which states that transportation noise assessment is outside its scope, if it is not part of the site activity. Consequently, we consider it inappropriate to assess vehicle movements on public roads against the GDP permitted activity standards.

However, as a discretionary activity, it is appropriate to consider the potential adverse noise effects associated with trucks on public roads. We discuss this in Section 5.5.

Under the TTPP the exemption for vehicles on public roads is stated more clearly in rule NOISE-R2.7.

In addition, TTPP Rule NOISE-R1.3 states that "Noise from mobile noise sources shall comply with the noise limits set out in Tables 2 and 3 of NZS 6803:1999 Acoustics – Construction Noise", with reference to "construction noise" taken to refer to "mobile noise sources".

Whilst we find the wording of this Rule to be ambiguous, we interpret it to mean that mobile equipment engaged in construction activities should be assessed against *NZS 6803:1999* and we consider this to be appropriate.

4.4 World Health Organisation Guidelines

The World Health Organisation (WHO) Guidelines for Community Noise (Berglund, Lindvall and Schwela, 1999) provide guidelines for environmental noise exposure. For community or environmental noise, the critical health effects (those effects which occur at the lowest exposure levels) are sleep disturbance and annoyance.

These guideline values are the exposure levels that represent the onset of the effect for the general population.

Table 4: WHO guideline values for the critical health effects of community or environmental noise

Specific Environment	Critical health effect(s)	dB L_{Aeq}	Time base (hours)	dB L_{AFmax}
Outdoor living area	Serious annoyance, daytime & evening	55	16	-
	Moderate annoyance, daytime & evening	50	16	-
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60

4.5 NZS 6802:2008 Guideline Upper Noise Limits

The 2008 version of NZS 6802:2008 *"Acoustics - Environmental Noise"* (note that the District Plan refers to the 1991 version) refers to the following guideline upper limits of sound exposure at or within the notional boundary of a rural dwelling:

- Daytime: 55 dB $L_{Aeq(15min)}$
- Night-time: 45 dB $L_{Aeq(15min)}$ and 75 dB L_{AFmax}

4.6 NZS 6803:1999 Construction Noise Standard

Both the GDP and TTPP require construction noise to be assessed in accordance with New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise"* sets out the following noise limits:

Residential zones and dwellings in rural areas:

Table 2 – Recommended upper limits for construction noise received in residential zones and dwellings in rural areas

Time of week	Time period	Duration of work					
		Typical duration (dBA)		Short-term duration (dBA)		Long-term duration (dBA)	
		L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
Weekdays	0630-0730	60	75	65	75	55	75
	0730-1800	75	90	80	95	70	85
	1800-2000	70	85	75	90	65	80
	2000-0630	45	75	45	75	45	75
Saturdays	0630-0730	45	75	45	75	45	75
	0730-1800	75	90	80	95	70	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75
Sundays and public holidays	0630-0730	45	75	45	75	45	75
	0730-1800	55	85	55	85	55	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75

In table 2:

a) "Short-term" means construction work at any one location for up to 14 calendar days;

b) "Typical duration" means construction work at any one location for more than 14 calendar days but less than 20 weeks; and

c) "Long-term" means construction work at any one location with a duration exceeding 20 weeks.

NZS 6803 provides some guidance for the type of activities that fall within its scope. It provides the specific examples of "…a noise bund around an open cast mine…" and "…demolition of a structure [and] road reconstruction…" – both of these examples are directly applicable in this instance.

4.7 Discussion of Noise Assessment Criteria

4.7.1 Operational Noise

The GDP and TTPP daytime noise limits are both 55 dB but use different noise metrics – L_{A10} and L_{Aeq} respectively. These noise limits are numerically consistent with the guideline upper value provided in the latest version of NZS 6802, and the WHO guideline value to minimise the onset of serious annoyance.

The GDP provides a 45 dB L_{A10} noise limit on Sundays and we consider this to be unnecessarily stringent. The TTPP, which is more consistent with the guidance set out in NZS 6802:2008, has a 55 dB L_{Aeq} noise limit during the day on Sundays and we consider this to be more appropriate.

NZS 6802 is prescribed as a mandatory reference in the *National Planning Standards 2019*, and provides the following timeframes[1] for daytime and night-time as:

- Daytime 0700 to 2200 hours
- Night-time 2200 to 0700 hours

Daytime ambient noise levels during fine, calm conditions were measured to be 53-58 dB L_{Aeq} (52-60 dB L_{A10}) at locations representative of the dwellings near State Highway 6, which suggests that a noise limit of 55 dB L_{Aeq} would be appropriate at these dwellings.

Regarding night-time noise limits, the GDP/TTPP noise limit of 45 dB $L_{A10/Aeq}$ is again consistent with the relevant guidance provided by the WHO and in the latest version of NZS 6802.

Our night-time noise measurements show that average ambient noise levels in the area are generally greater than this at around 45-50 dB L_{Aeq}, even during fine, calm conditions.

On consideration of the published guidance, we consider the following noise limits will result in acceptable noise effects at the notional boundary of neighbouring dwellings:

- Daytime: 55 dB $L_{Aeq(15\ min)}$
- Night-time: 45 dB $L_{Aeq(15\ min)}$ and 75 dB L_{AFmax}

  when measured and assessed in accordance with the latest New Zealand noise standards: NZS 6801:2008 "*Acoustics – Measurement of environmental sound*" and NZS 6802:2008 *"Acoustics - Environmental Noise"*.

4.7.2 Construction Noise

NZS 6803:1999 *"Acoustics - Construction Noise"* is the appropriate standard for assessing noise from the construction phase of the project. NZS 6803 provides some guidance on what constitutes construction activity and therefore fall within its scope.

The Standard covers sound from construction work which is of a limited duration. It provides the specific examples of "…a noise bund around an open cast mine…" and "…demolition of a structure [and] road reconstruction…" – both of these examples are directly applicable in this instance.

However, the Standard is clear that where construction activity is part of ongoing land use activity, then the sound be assessed using NZS 6802 as referred to above.

For the current project, we consider the Pre-Mining phase as described in Section 2.2.1 could reasonably be considered construction noise as it will include the construction of buildings, access roads and the formation of earth bunds for noise control purposes.

Similarly, the Post-Mining phase described in Section 2.2.3 which includes the deconstruction of the site and final land contouring, could reasonably be considered as construction noise.

[1] NZS 6802 also provides an evening period as an alternative: 1900 to 2200 hours

5.0 PREDICTED NOISE LEVELS

The following paragraphs describe the noise modelling process to demonstrate compliance with the proposed noise limits.

5.1 Prediction Methodology

To accurately predict noise levels, the noise modelling package SoundPLAN has been used. Calculations in SoundPLAN are based on ISO 9613-2:1996 "*Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*". This method has the scope to consider a range of factors affecting the sound propagation including:

- The magnitude of the noise source in terms of sound power;
- The distance between source and receiver;
- The presence of obstacles such as screens or barriers in the propagation path;
- The presence of reflecting surfaces;
- The hardness of the ground between the source and receiver;
- Attenuation due to atmospheric absorption; and
- Meteorological effects such as wind gradient, temperature gradient and humidity.

In ISO 9613, the effect of meteorological conditions is significantly simplified by calculating the average downwind sound pressure level. The Standard adopts the conservative approach of assuming that wind is always blowing from the noise sources to the receiver locations. The equations and calculations also hold for average propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights.

5.2 Input Noise Source Data

The Applicant has provided a site layout in addition to a schedule of stationary and mobile mechanical plant. Table 5 provides the anticipated sound levels for the proposed equipment based on measurements at other mine sites around New Zealand, including a West Coast mineral sands mine.

Table 5: Sound power levels of mining plant and equipment

Plant and equipment	Quantity	Source noise data
80 tonne excavator	2	111 dB L_{WA} (L_{A10} basis)
Diesel Generator (enclosed)	2	93 dB L_{WA} (L_{A10} basis)
6 ft trommel/screen (including hopper and conveyor)	1	108 dB L_{WA} (L_{A10} basis)
20 tonne bulldozer	2	105 dB L_{WA} (L_{A10} basis)
16 tonne grader	1	113 L_{WA} (L_{A10} basis)
20 tonne wheeled front end loader	7	108 dB L_{WA} (L_{A10} basis)
40 tonne dump truck drive-by (average)	3	89 dB L_{AE} at 10m
Road truck and trailer drive-by on gravel road (average)	3 per hour	84 dB L_{AE} at 10m
Pumps (de-watering, slurry etc)	5	101 dB L_{WA} (L_{A10} basis)

Noise levels are presented on an L_{A10} basis in order that predictions can be directly compared to the operative GDP permitted activity standards. We have also provided predicted levels on an L_{Aeq} basis

for comparison to the proposed project/TTPP noise limits. L_{Aeq} values will typically be 2 to 3 dB lower than the L_{A10} values.

We have assessed other noise sources such as employee light vehicle movements and use of office and amenity buildings on site to be negligible in the context of overall noise emissions from the mining activity and have therefore been excluded from our model.

The processing plant and storage will be housed in buildings; however, our modelling assumes no noise reduction for mobile machinery. This is a worst-case assessment.

Our model assumes that no site vehicles will have tonal reversing alarms and we have proposed a consent condition to this effect.

5.3 Mining Sequence – predicted noise levels

During the Mining Sequence activities described in Section 2.2.2, the highest noise levels from the site are anticipated when mobile plant is operating closest to dwellings to the northeast and southeast of the site. For the mining phase, we have modelled noise from mining occurring with and without the Eastern Bund in place:

Table 6: Daytime and night-time mining sequence predicted scenarios

Ref	Description	Activity areas shaded RED
Daytime Panel 7	Mining occurring in Panel 7 during the normal mining sequence at the closest point to northern dwellings. All plant in Table 5 is operating. All processing equipment is operating	
Daytime Panel 9	Mining occurring in Panel 9 during the normal mining sequence at the closest point to southern dwellings. All plant in Table 5 is operating. All processing equipment is operating	
Daytime Final mining phase - North	Stockpiled ore is being mined at the northern part of the site. Assumes Eastern Bund is removed and does not provide any noise mitigation. All plant in Table 5 is operating. All processing equipment is operating.	

Ref	Description	Activity areas shaded RED
Daytime Final mining phase - South	Stockpiled ore is being mined at the southern part of the site. Assumes Eastern Bund is removed and does not provide any noise mitigation. All plant in Table 5 is operating. All processing equipment is operating.	
Night-time Processing plant	Processing plant operational and trucks using site access road	

Worst case predicted noise levels for the day and night situations are presented in Table 7. Noise contour plots for these scenarios are provided in Appendix C.

Table 7: Predicted noise levels at nearest dwellings compared to GDP permitted activity limits

	Predicted noise level at notional boundary, dB L_{A10}				
	Daytime				Night-time
Receiver	Panel 7	Panel 9	North stockpile – no bund	South stockpile – no bund	Processing plant
3364 Coast Road (SH6)	45	39	46	39	30
Lot 1 DP 3375, Coast Road (SH6)	48	40	45	39	31
3342 Coast Road (SH6)	46	39	47	39	32
3323 Coast Road (SH6)	50	43	54	44	35
3320 Coast Road (SH6)	44	42	47	42	34
3316 Coast Road (SH6)	46	45	49	46	37
Lot 3 DP 3375, Coast Road (SH6)	47	44	54	44	36
3195 Coast Road (SH6)	44	49	44	50	43
3172 Coast Road (SH6)	40	45	41	46	39

The results in Table 7 show that predicted noise levels from daytime mining operations are below the GDP permitted activity daytime noise limit of 55 dB L_{A10} at the notional boundaries of all dwellings on

surrounding properties except on Sundays when a 45 dB L_{A10} limit applies. Site activities will comply with the applicable night-time limit of 45 dB L_{A10} at all times.

Table 8 shows the predicted noise levels in terms of the L_{Aeq} noise metric for comparison against our proposed project noise limits of 55 and 45 dB L_{Aeq} during the day and night respectively. Our proposed noise limits match those in the TTPP.

Table 8: Predicted noise levels at nearest dwellings compared to Project / TTPP limits

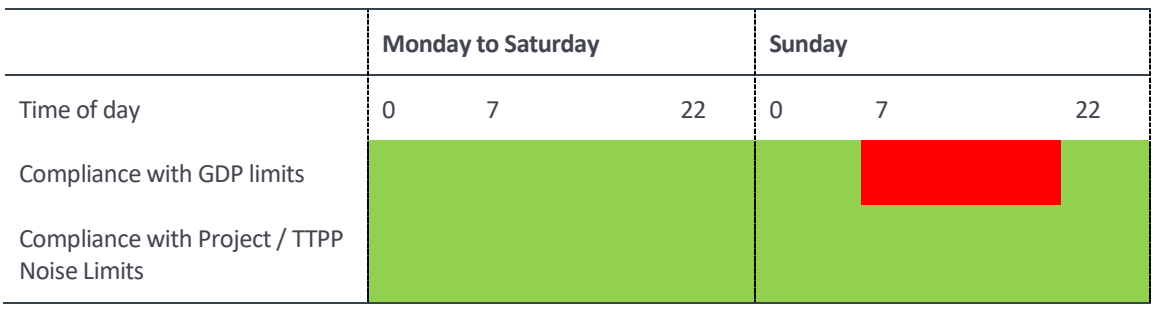
	Predicted noise level at notional boundary, dB L_{Aeq}				
	Daytime				Night-time
Receiver	Panel 7	Panel 9	North stockpile – no bund	South stockpile – no bund	Processing plant
3364 Coast Road (SH6)	43	37	44	37	28
Lot 1 DP 3375, Coast Road (SH6)	46	38	43	37	29
3342 Coast Road (SH6)	44	37	45	37	30
3323 Coast Road (SH6)	48	41	52	42	33
3320 Coast Road (SH6)	42	40	45	40	32
3316 Coast Road (SH6)	44	43	47	44	35
Lot 3 DP 3375, Coast Road (SH6)	45	42	52	42	34
3195 Coast Road (SH6)	42	47	42	48	41
3172 Coast Road (SH6)	38	43	39	44	37

The results in Table 8 show the site activities can comfortably comply at all times with the proposed project and TTPP noise limits of 55 and 45 dB L_{Aeq}. We expect the 75 dB L_{Amax} night-time maximum noise limit will be achieved at all dwellings.

If mining was to occur during the night-time period between 0630 and 0700 hours from 1 November to 31 January in order to accommodate the peak fledgling season for Taiko, our conservative assessment indicates this could feasibly occur in some parts of the site and comply with the applicable limit of 45 dB L_{Aeq} but it would not be feasible at all locations. Therefore, prior to mining operations occurring at 0630 hours, we recommend a condition of consent requiring noise measurements to confirm the operational conditions that will ensure compliance with the 45 dB L_{Aeq} limit.

To illustrate the degree of noise level compliance, we have prepared the graphic in Figure 4. This shows noise level compliance at all times except during the day on Sundays.

Figure 4: Compliance with GDP and project / TTPP noise limits



5.4 Pre- and Post-Mining Sequence – predicted noise levels

Noise generated during the establishment of several mine components such as the Eastern Bund and site buildings are most appropriately assessed against NZS 6803:1999 *Acoustics - Construction Noise*. Similarly, the final contouring of the land once mining is complete can also reasonably be considered as construction noise.

In order to consider the likely highest levels of noise generation during these activities, we have predicted noise levels for the scenarios described in Table 9 using the noise sources listed in Table 10.

The predicted noise levels are provided in Table 11 for the closest dwellings to the construction activity.

Table 9: Construction noise sources during Pre- and Post-Mining Sequence

Ref	Description	Activity areas shaded RED
Pre-mining – Bund construction	Noise generation during construction of both the planted bund along the State highway boundary and the Eastern Bund, immediately to the east of the mining area. We have assumed all the equipment in Table 10 will be in use.	
Post-Mining- Final contouring	Final contouring of property extended to the mining disturbance limit. The work will occur across the extent of the site but we have focussed on the area closest to dwellings. We have assumed all the equipment in Table 10 will be in use.	

Table 10: Sound power levels of mining plant and equipment

Plant and equipment	Quantity	Source noise data
80 tonne excavator	2	109 dB L_{WA}
20 tonne bulldozer	2	103 dB L_{WA}
16 tonne grader	1	111 dB L_{WA}
40 tonne dump truck drive-by (average)	3	89 dB L_{AE} at 10m

Table 11: Predicted construction noise levels at nearest dwellings compared to NZS 6803:1999 limits

Receiver	Predicted noise level at nearest dwellings, dB L_{Aeq}		
	Daytime Construction		Complies with 70 dB limit?
	Pre-mining – Bund construction	Post-Mining-- Final contouring	
3323 Coast Road (SH6)	54	51	Yes
3320 Coast Road (SH6)	52	48	Yes
3316 Coast Road (SH6)	52	47	Yes
Lot 3 DP 3375, Coast Road (SH6)	57	52	Yes
3195 Coast Road (SH6)	43	46	Yes

Our calculations show that construction activities will comfortably comply with the most stringent daytime construction noise limit of 70 dB L_{Aeq} (refer Section 4.6) for long duration construction. Moreover, noise levels will generally be below the project noise limit of 55 dB L_{Aeq} and the GDP permitted activity daytime noise limit of 55 dB L_{A10}.

Based on this analysis, noise effects during construction will be similar to those during the operational phase of the mine and consistent with the noise environment anticipated by the GDP permitted activity noise limits.

5.5 Heavy Vehicle Movements on State Highway 6

Whilst transportation noise on public roads is exempt from assessment under the GDP and TTPP noise standards, the potential effects associated with such activity is a valid consideration. The proposed vehicle movements associated with the mine are described in NovoGroup's Integrated Transport Assessment.

Whilst there is no agreed methodology in New Zealand for assessing heavy vehicle movements in isolation from other traffic on the State Highway network, we consider the following aspects of truck activity have a bearing on the potential adverse noise effects:

1. There will be no truck movements to or from the site at night-time between 2200 and 0500 hours.
2. Based on Waka Kotahi data, approximately 1,156 vehicles per day pass the site, 12.5% of which are heavy vehicles. This equates to 145 heavy vehicle movements per day on State Highway 6, on average.
3. The proposal will generate 50 truck and trailer movements per day. This equates to approximately 3 truck movements per hour over a 17 hour day.
4. We calculate the proposed additional trucks would result in less than a 1 dB change in average daily noise level – this is a negligible difference.
5. Trucks are proposed to operate from 0500 hours which is considered night-time in both the GDP and TTPP - daytime commences at 0700 hours. Below we explore the potential for "night-time" sleep disturbance between 0500 and 0700 hours.

Waka Kotahi has provided the hourly traffic data passing the site for the 2019 12 month period as recorded at their Canoe Creek monitoring station. Table 12 provides a summary of this data for the

hourly periods between 0500 and 0800 hours. We note this is total traffic that pass the site – a split of heavy and light vehicle numbers was not provided.

Table 12: Average, maximum and minimum traffic flows on an hourly basis for 2019 at Canoe Creek

	Night-time		Daytime
No. of vehicles	**05:00 - 06:00**	**06:00 - 07:00**	**07:00 - 08:00**
Average	9	15	31
Maximum	31	36	66
Minimum	0	1	5

The traffic data indicates that the dwellings adjacent SH6 already experience traffic noise at night between 0500 and 0600 hours with an average of 9 vehicles per hour. Between 0600 and 0700 hours, the average increases to 15 vehicles per hour. As a result, we calculate[2] that traffic noise levels from average traffic will be in the order of 50 dB $L_{Aeq(1\ hour)}$ or greater at the closest dwellings to SH6. We note that existing ambient noise levels[3] (not including traffic) are also in the order of 50 to 51 dB L_{Aeq}.

For comparison, we calculate that 3 trucks per hour using SH6 will generate approximately 50 dB $L_{Aeq(1\ hour)}$ at the nearest dwelling resulting in and overall traffic noise level increase of 3 dB on average. This is a just perceptible change in noise level and is acceptable in the context of the existing noise environment. As the existing traffic volumes on SH6 increase between 0600 and 0700 hours and the successive hours of the day, the relative change in noise level from quarry trucks is less with a corresponding diminishing noise effect.

We note that proposed ecological restrictions may reduce the operational duration for vehicles to approximately 10 hours a day in which case the average truck movements would be approximately 5 vehicles per hour. To avoid a potential increase in our assessed noise effect, we recommend a condition of consent that a maximum of 3 vehicles per hour is permitted between 0500 and 0700 hours.

[2] Calculations based on methodology within TRRL Report 425 "Rural traffic noise prediction – an approximation" published by the UK Transport and Road Research Laboratory

[3] Refer to Table 1 Night-time noise levels

6.0 ASSESSMENT OF NOISE EFFECTS

Our worst-case predicted noise levels show the proposed mine and processing plant is capable of complying with the GDP permitted activity daytime and night-time noise levels at the closest dwellings to the site. The exception is during the day on Sundays when the "night-time" permitted activity noise limit applies.

However, our assessment shows that the proposed mine will readily comply with the proposed TTPP permitted activity noise limits which better reflect WHO guidance and current best practice as set out in NZS 6802.

As we discuss in this report, noise levels are predicted on a conservative worst-case basis and actual noise emissions are likely to be lower in practice.

As a result, we consider that mining and processing activity can occur at the site and result in acceptable noise effects in the context of the existing ambient noise environment and published guidance on the protection of residential amenity.

The Applicant is proposing to restrict truck movements to between 0500 and 2200 hours. Whilst technically in the night-time period, noise effects from truck movements between 0500 and 0700 hours will be acceptable when considered in respect to the existing vehicle noise on State Highway 6 and the underlying ambient noise environment.

Construction noise during the pre-and post-mining phase will comfortably comply with the applicable limits from NZS 6803:1999 and noise effects during construction will be similar to those during the operational phase of the mine.

7.0 RECOMMENDED CONSENT CONDITIONS

To ensure that noise from the mining activity is adequately controlled throughout the life of the consent, we recommend that the following noise related conditions are included in the consent, should it be granted.

1. The consent holder shall ensure that all operational mining and processing activities on the site do not exceed the following noise limits at or within the notional boundary of any dwelling existing at the date consent is granted on any other site except 3261 Coast Road:

    - Daytime: 55 dB $L_{Aeq(15\ min)}$
    - Night-time: 45 dB $L_{Aeq(15\ min)}$ and 75 dB L_{AFmax}

    when measured and assessed in accordance with the latest New Zealand noise standards: NZS 6801:2008 "*Acoustics – Measurement of environmental sound*" and NZS 6802:2008 *"Acoustics - Environmental Noise"*.

    'Notional boundary' is defined as a line 20 metres from any side of a dwelling or the legal boundary where this is closer to the dwelling.

2. Prior to mining operations occurring between 0630 and 0700 hours, the consent holder shall conduct noise measurements to confirm the schedule of mining equipment, its operating locations and any mitigation required to comply with the applicable noise limits.

3. Construction activities such as the formation of access roads, bunds, dams, building construction final land contouring must be planned and managed in accordance with New Zealand Standard NZS 6803:1999 *"Acoustics - Construction Noise"*. For the avoidance of doubt, overburden stripping as part of the operational phase mining sequence shall not be considered construction.

4. Mining operations must utilise the best practicable option to minimise noise at all times. This includes replacement of worn parts, maintenance of mufflers, lubrication of moving machinery to avoid squeaks and squeals, and appropriate operation of all equipment.

5. Vehicles or equipment must not be fitted with tonal reversing alarms. Where reversing alarms are required, strobe light or broadband reversing alarms must be used.
6. A maximum of 3 truck and trailer movements per hour on State Highway 6 is permitted between 0500 and 0700 hours. No truck movements are permitted on State Highway 6 between 2200 and 0500 hours.
7. The consent holder shall prepare a Noise Management Plan (NMP) to control day-to-day noise emissions from the site. As a minimum that Plan shall include:

   a) The person responsible for implementing the NMP

   b) Applicable noise conditions relating to noise

   c) Training of staff relating to how to minimise noise and vibration

   d) Maintenance schedule for site access road surfaces to avoid excessive noise and vibration

   e) Activity risk analysis for noise generation

   f) Method for handling complaints.

   We have prepared a draft NMP which has been submitted with the Application.

APPENDIX A GLOSSARY OF TERMINOLOGY

A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
dB	Decibel The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 μPa i.e. dB = 20 x log(P/Pr)
L_{A10}	The A-weighted noise level equalled or exceeded for 10% of the measurement period. This is commonly referred to as the average maximum noise level.
$L_{Aeq\ (t)}$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{Amax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
Noise	A sound that is unwanted by, or distracting to, the receiver.
NZS 6801:1999	New Zealand Standard NZS 6801:1999 *"Acoustics - Measurement of Environmental Sound"*
NZS 6801:2008	New Zealand Standard NZS 6801:2008 *"Acoustics – Measurement of environmental sound"*
NZS 6802:1991	New Zealand Standard NZS 6802:1991 *"Assessment of Environmental Sound".*
NZS 6802:2008	New Zealand Standard NZS 6802:2008 *"Acoustics – Environmental Noise"*
NZS 6803:1999	New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise"*
SEL or L_{AE}	Sound Exposure Level The sound level of one second duration which has the same amount of energy as the actual noise event measured. Usually used to measure the sound energy of a particular event, such as a train pass-by or an aircraft flyover
SPL or L_P	Sound Pressure Level A logarithmic ratio of a sound pressure measured at distance, relative to the threshold of hearing (20 μPa RMS) and expressed in decibels.
SWL or L_W	Sound Power Level A logarithmic ratio of the acoustic power output of a source relative to 10^{-12} watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.

APPENDIX B NOISE SURVEY DETAILS

The key details of our noise surveys are as follows:

B1 February 2020 Ambient Noise Survey

Date: 19-21 February 2020

Personnel: Markus Schmid, Marshall Day Acoustics

Weather:

Date & time	Average temperature	Cloud cover	Estimated wind speed	Wind direction
19 February 2020				
1730 – 2030 hours	18-20°C	5%	1-2 m/s	NNW
2300 – 2345 hours	13°C	0%	0-2 m/s	W
20 February 2020				
1315 – 1430 hours	17°C	100%	2-4 m/s	NNW / NW
2200 – 2215 hours	15°C	100%	3-5 m/s	E
21 February 2020				
0830 – 0845 hours	17°C	100%	0-4 m/s	N

Instrumentation: Brüel & Kjær Type 2250 analyser, serial 2488377, calibration due 02/08/2020
Brüel & Kjær Type 4231 calibrator, serial 1882775, calibration due 14/02/2021
01dB CUBE Noise Monitoring Terminal, serial 11191, calibration due 30/07/2021

Calibration: Field calibration of the equipment was carried out before measurements, and the calibration checked after measurements. Observed change less than 0.1 dB.

B2 March 2020 Ambient Noise Survey

Date: 12-13 March 2020

Personnel: Aaron Staples, Marshall Day Acoustics

Weather:

Date & time	Average temperature	Cloud cover	Estimated wind speed	Wind direction
12 March 2020				
1800 – 1945 hours	16°C	60%	0-3 m/s	S / SW
13 March 2020				
0000 – 0145 hours	12°C	0%	1-2 m/s	E
1015 – 1215 hours	15°C	100%	Calm	-

Instrumentation: Brüel & Kjær Type 2250 analyser, serial 2683036, calibration due 03/10/2020
Brüel & Kjær Type 4231 calibrator, serial 2574264, calibration due 26/09/2020

Calibration: Field calibration of the equipment was carried out before measurements, and the calibration checked after measurements. Observed change less than 0.1 dB.

B3 Attended Noise Survey Results

Table 13: Summary of ambient noise survey results

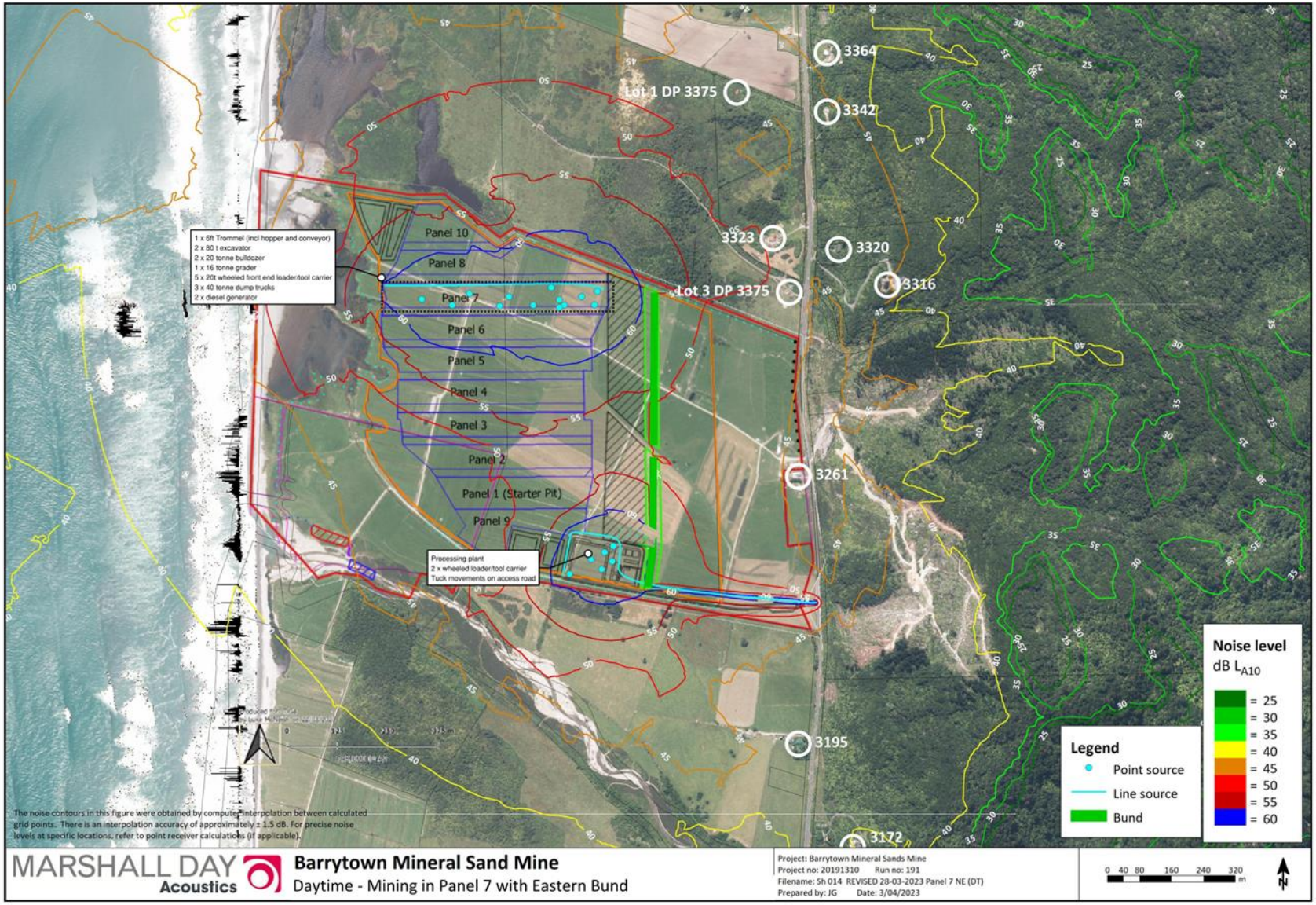
Date	Start time hours	Measured noise levels				Comments
		dB L_{Aeq}	dB L_{A10}	dB L_{A90}	dB L_{AFmax}	
Position 1						
Daytime						
13/3	1035	42	45	33	58	SH6 traffic dominant. Sea and bird calls audible during lulls in traffic.
20/2	1335	44	47	41	57	SH6 traffic generally dominant. Sea and cicadas audible during lulls in traffic.
19/2	1800	39	41	36	57	SH6 traffic and sea dominant.
12/3	1800	40	43	37	55	Sea and bird calls generally dominant. SH6 traffic contributes.
Night-time						
19/2	2325	51	52	48	58	Sea dominant. (No traffic on SH6)
13/3	0030	50	51	47	60	Sea dominant. Birds contribute at times. SH6 traffic responsible for L_{Amax}
Position 2						
Daytime						
21/2	0830	58	60	41	80	SH6 traffic generally dominant. Sea and cicadas audible during lulls in traffic.
13/3	1015	55	54	33	74	SH6 traffic dominant.
20/2	1315	57	59	41	81	SH6 traffic dominant. Cicadas and sea contribute during lulls in traffic.
19/2	1730	53	52	37	72	SH6 traffic dominant. Cicadas dominant during lulls in traffic. Sea audible.
12/3	1825	53	53	37	72	SH6 traffic dominant. Sea audible during lulls in traffic.
Night-time						
20/2	2200	51	49	34	73	SH6 traffic dominant at times. Sea contributes during lulls in traffic.
19/2	2300	50	52	48	54	Sea dominant. (No traffic on SH6)
13/3	0010	50	52	48	56	Sea dominant. Birds audible. (No traffic on SH6)

Date	Start time hours	Measured noise levels dB L_{Aeq}	dB L_{A10}	dB L_{A90}	dB L_{AFmax}	Comments
Position 3						
Daytime						
13/3	1130	50	53	43	68	SH6 traffic dominant. Nearby stream and bird calls contribute during lulls in traffic. Sea audible at times.
12/3	1855	46	47	43	62	SH6 traffic contributes significantly. Sea and nearby stream also contributes. Birds contribute at times.
19/2	1940	48	48	46	64	Sea generally dominant. Nearby steam contributes. SH6 traffic contributes at times.
Night-time						
19/2	2340	49	49	48	51	Sea generally dominant. Nearby steam contributes.
13/3	0120	50	52	49	55	Sea dominant. Nearby stream contributes. Birds audible at times. (No traffic on SH6)
Position 4						
Daytime						
13/3	1150	44	48	38	62	SH6 traffic dominant. Sea and bird calls contribute during lulls in traffic.
12/3	1920	42	44	38	58	Sea generally dominant. SH6 traffic contributes. Bird calls audible.
Night-time						
13/3	0055	47	49	45	59	Sea generally dominant. Nearby horses contribute at times.

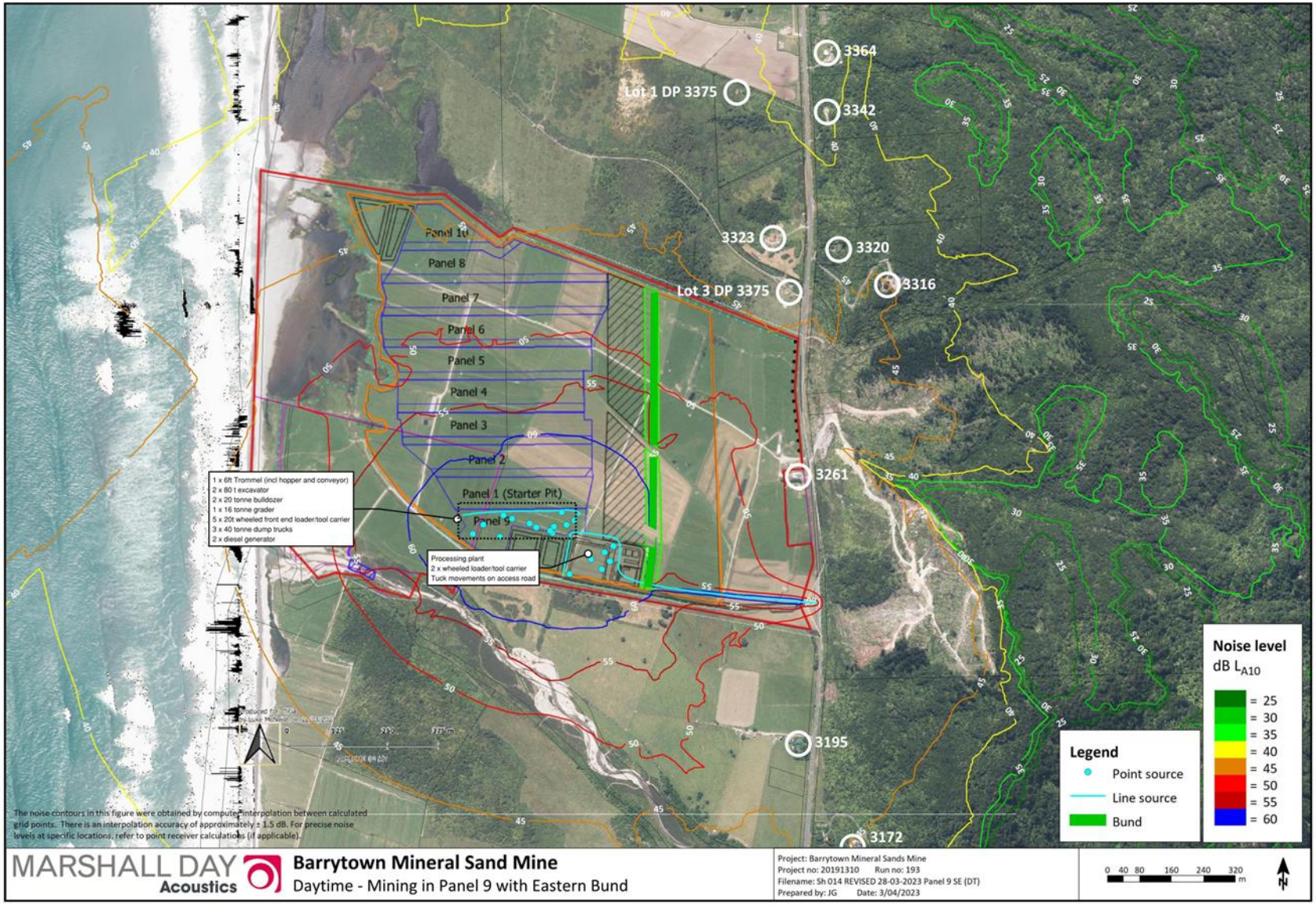
APPENDIX C NOISE CONTOUR PLOTS

Following pages.

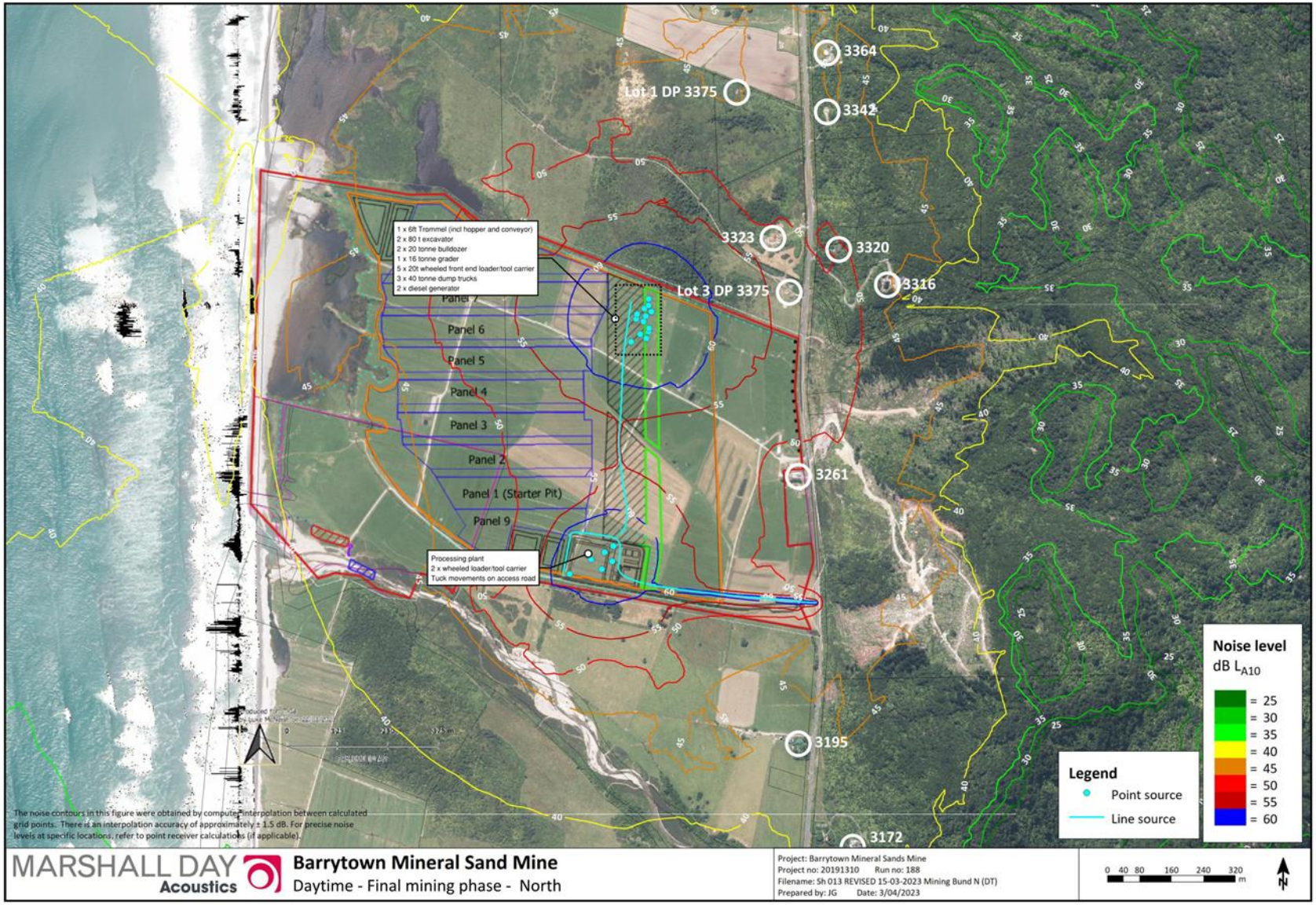
C1 Daytime Panel 7 – Mining, Processing and Truck Movements



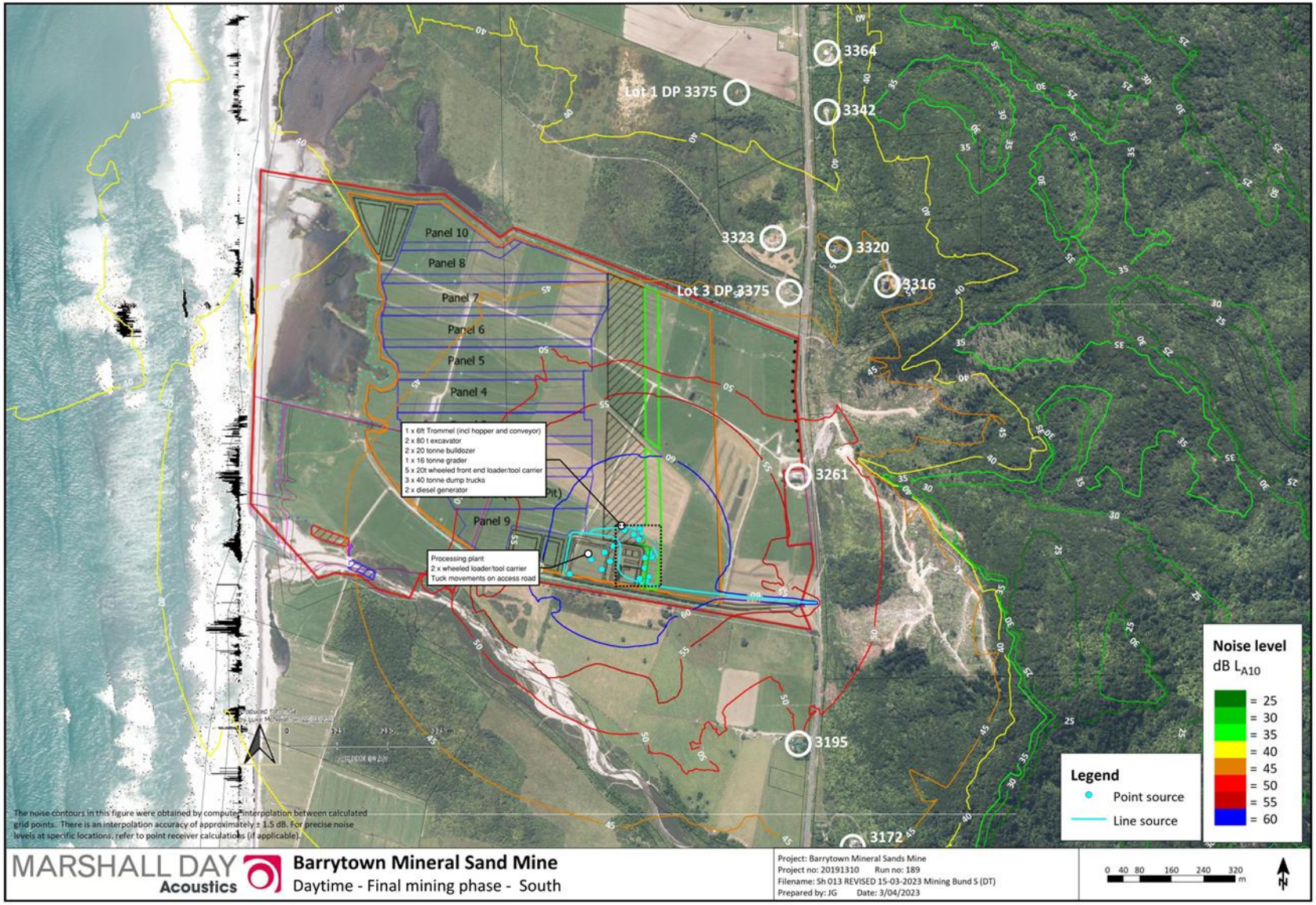
C2 Daytime Panel 9 – Mining, Processing and Truck Movements



C3 Daytime – Final mining phase North – Mining, Processing and Truck Movements



C4 Daytime – Final mining phase South – Mining, Processing and Truck Movements



C5 Night-time –Processing plant, loadout and Truck Movements (along site access road)