MARSHALL DAY Acoustics

OCEANA GOLD NEW ZEALAND – WAIHI NORTH PROJECT
ASSESSMENT OF NOISE EFFECTS

Rp 002 R03 20240606 | 18 February 2025

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Project: **WAIHI NORTH PROJECT**

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SUMMARY

We have investigated and assessed proposed noise emissions from the Waihi North Project (WNP) under the provisions of the Fast Track Approvals Act 2024 (FTAA). WNP is broadly made up of Gladstone Open Pit (GOP) and other ancillary operations, the Northern Rock Stack (NRS), Tailings Storage Facility 3 (TSF3) and the Wharekirauponga Underground Mine (WUG) (including additional exploratory drilling sites, ventilation raises and increased associated helicopter activity).

Our assessment is based on the activities proposed to be undertaken, the existing noise environment, the currently consented operations and the mitigation that can be implemented. Overall, our assessment indicates that generally noise levels would be compliant with the recommended criteria

An important aspect in our considerations relates to what we consider is construction activity and what is operational. Following discussions with OceanaGold NZ Ltd (OGNZL), we defined the construction activities to which less stringent noise criteria would apply.

Construction noise levels remain compliant in almost all circumstances. There may be some limited localised exceedances, but these would be managed through appropriate mitigation and management plans, as provided for in the proposed conditions.

There are some receivers where the operational noise levels without mitigation are slightly above 50 dB L_{Aeq}. For these receivers, there would be a small adverse impact on the level of amenity for these people. We note that the proposed conditions OGNZL is committing to would not allow that to occur so remedial action (mitigation) prior to operations commencing is necessary. This is discussed in Section 12.0.

Our overarching conclusion is that the noise limits we propose (as set out in the proposed conditions) can be complied with using appropriate mitigation, therefore noise effects as a result of the WNP project are acceptable. The assessment at each location is summarised below.

Gladstone

For identified construction activities, predicted noise levels will be around 45 dB L_{Aeq} at the closest dwellings. This is well below the construction noise limits proposed in the conditions.

Unmitigated operational noise levels from the Gladstone Pit are calculated to be below 50 dB L_{Aeq} at all receivers except for 27 dwellings located on Moore Street, Barry Road and George Street. For these residents, model results show there would be a small exceedance of 50 dB L_{Aeg} in the first two years which would equate to a small adverse impact on the level of amenity these properties experience.

However, the proposed conditions require that a noise management plan (NMP) be prepared to outline the methods to be used to ensure noise levels do not exceed 50 dB at any residence not owned by OGNZL or subject to or with an agreement with OGNZL. The NMP will prescribe a noise mitigation development process that will occur prior to operations commencing, that will set out the options considered, and provide certification that noise levels comply at those residences with which OGNZL does not have an agreement. These options would include (but not be limited to);

- The use of quieter machinery (determined by a noise source characterisation procedure)
- Restrictions on operating hours
- Bespoke screening of individual sources
- Screening of noise sensitive receivers
- Noise monitoring programmes (including noise modelling and measurement regimes)

On this basis and with the above measures in place, we consider the Gladstone noise emissions would be able to comply with the noise limits in the proposed conditions, and therefore would be reasonable from a noise effects perspective.

Processing Plant

The Processing Plant will be upgraded to facilitate the additional throughput and extended lifespan resulting from WNP.

The calculations show that there is a general increase in noise levels as a result of the processing plant upgrades but also a small decrease to the south-west. This is a barely discernible to just noticeable increase (3-5 dB). During the day, taking account of the fact that generally, other mining operations often contribute more noise to these receivers, increased processing plant noise levels are unlikely to be discernible for much of the time. Overall, noise emissions for the processing plant are readily compliant during the day.

However, it is possible that noise levels at night may just exceed the night-time noise limit of 40 dB by a small margin. As the processing plant design is not possible to accurately model at this stage because the equipment is relatively unique, being sourced from other OGNZL sites around the country, and is currently not operational so we cannot measure the noise emissions, we have necessarily included some conservatism in the calculations. This means it is possible that once established on site, there is likely to be lower noise levels in practice.

In any event, and as for Gladstone, the proposed conditions require that a noise management plan (NMP) be prepared to outline the methods to be used to ensure noise levels do not exceed 40 dB at any residence not owned by OGNZL or subject to or with an agreement with OGNZL. The mitigation methods would include (but not be limited to);

- Restrictions on operating hours
- Bespoke screening of individual sources (primarily by the use of full enclosures)
- Screening of noise sensitive receivers
- Noise monitoring programmes (including detailed noise modelling of the new plant when installed and measurement regimes)

On this basis and with the above measures in place, we consider the processing plant noise emissions would be able to comply with the noise limits in the proposed conditions, and therefore would be reasonable from a noise effects perspective.

NRS

For identified construction activities, calculated noise levels associated with the construction of the earth bunds will be compliant at the closest dwellings. Operational noise is also compliant with the recommended criteria and the noise effects, in our opinion, are considered reasonable.

TSF3

The overall TSF3 construction activity is sufficiently long and similar in character to normal mining activities that we consider it as an 'operational' activity, rather than 'construction'. However, topsoil stockpiles, the clean water diversion drains and haul road construction are treated and assessed as construction noise.

Further, predicted operational noise levels are below 50 dB L_{Aeq} and are therefore below the proposed compliance limit assessment criteria and the noise effects in our opinion, are considered reasonable.

WUG

We assessed the potential noise effects from the construction and establishment phase of the project, including the WUG access tunnel. Our assessment included consideration of noise effects on rural receivers, and receivers in the DOC conservation area. We have also provided extensive noise level data to help inform the ecological assessment.

For the Willows Road SFA site, with the recommended mitigation in place, construction and operational noise levels received at the nearest rural receivers would comply with the recommended noise limits and we therefore consider to be acceptable overall.

For the ventilation raise and exploratory drilling sites, noise levels from the construction of the raises, both on ground and from helicopter operations would potentially have some small effect on recreational users of the DOC land, but would be of no appreciable significance due to the relatively short duration and the infrequent use by recreational users.

Noise emissions from helicopter operations associated with the operation of the WUG do not exceed a noise level of 50 dB L_{dn} at any noise sensitive receiver. We conclude that noise levels from general helicopter operations as a result of the project are acceptable.

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1.0 INTRODUCTION

Marshall Day Acoustics (**MDA**) has been engaged by OceanaGold NZ Ltd (**OGNZL**) to assess noise associated with the proposed Waihi North Project (**WNP**). The project will have a timeline of approximately 13 years. The full details of the scope of the Project are contained in the Assessment of Environmental Effects prepared by OGNZL and Mitchell Daysh Ltd.

Figure 1 shows the five main components of the WNP:

- The Gladstone Complex which consists of three sub-components:
  - A new pit to the south-west of the existing Processing Plant, known as the Gladstone Open Pit (**GOP**).
  - The later conversion of the GOP into a new Tailings Storage Facility (**Gladstone TSF**).
  - Upgrading of the Processing and Water Treatment Plants to increase throughput.
- A new rock storage facility which will be established to the north of TSF2 – referred to as the Northern Rock Stack (**NRS**).
- A new Portal (named "**WUG Portal**") for the proposed materials handling tunnel connecting the Processing Plant to the Wharekirauponga Underground Mine.
- A new tailings storage facility, known as **TSF3**, which will be established east of TSF1A.
- The new Wharekirauponga Underground Mine (**WUG**) and associated surface infrastructure at Willows Road Farm.
- Surface infrastructure supporting the WUG Portal, including ventilation raises, and additional exploratory activity and drilling sites

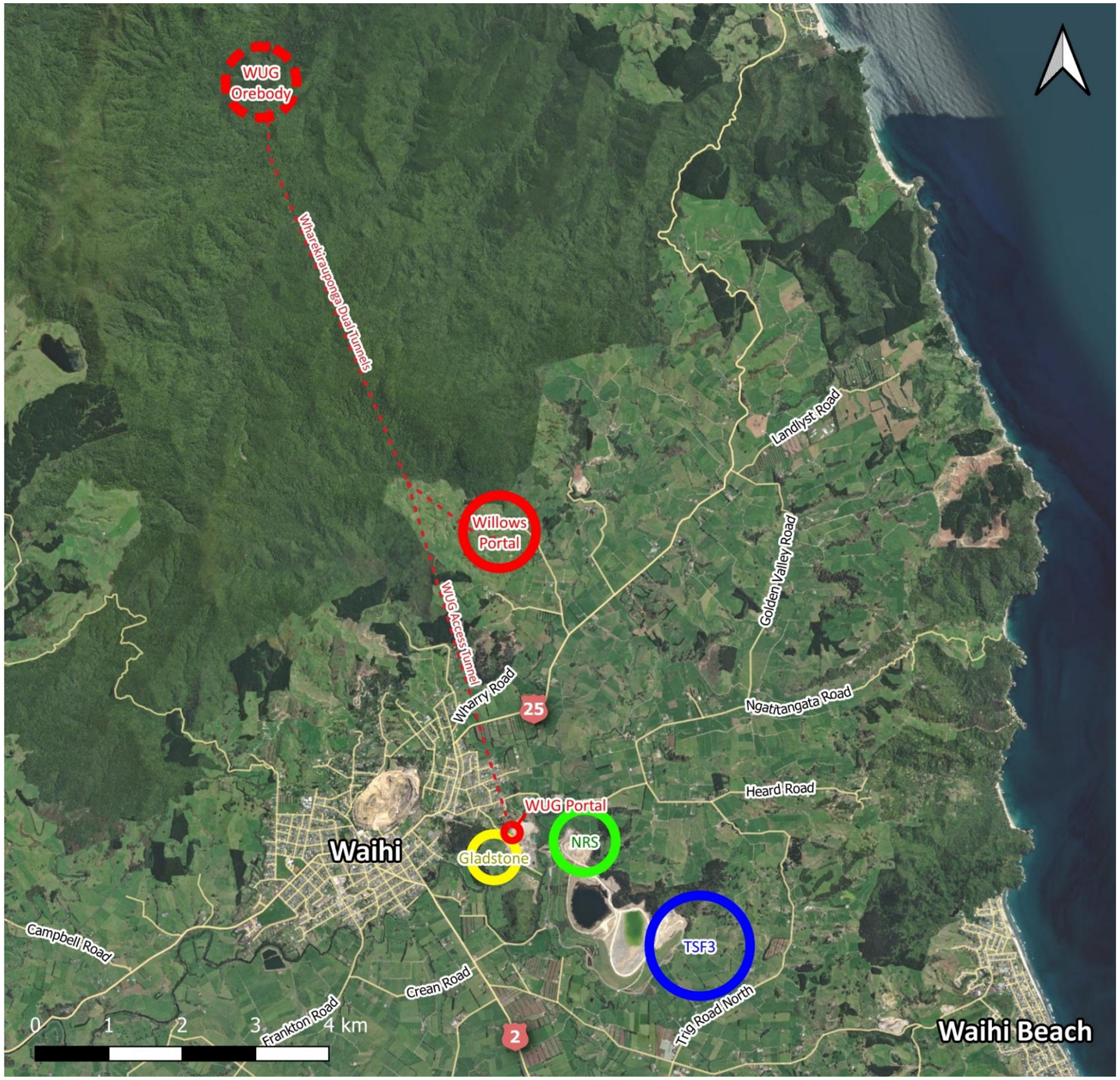
The existing planning framework and noise rules in relation to mining are complex. The rules are discussed in detail in Section 2.0 and noise criteria are proposed for the project in Section 5.0.

This report comprises:

- A review of the existing noise performance standards
- Details of the existing noise environment in Waihi
- A recommended set of noise criteria
- The findings of our noise calculations and assessment of noise effects for the proposed activities
- A comprehensive assessment of OGNZL's overall noise emissions
- Noise predictions for the ecological effects assessment
- Recommendations on appropriate noise control measures (mitigation) for the project.

A glossary of acoustical terminology used is provided in Appendix A.

Figure 1: Aerial view of project components and locality



2.0 HOW WE HAVE ASSESSED THE PROJECT

Section 3.0 – Section 11.0 addresses noise effects on people, which is the focus of this report. We have also provided information to support the ecological effects assessment, which considers noise effects on fauna. This is addressed in Section 12.0.

2.1 Our Report has a Geographic Focus

The Project Description (refer to the AEE prepared by Mitchell Daysh Limited) document places significant emphasis on development of the WUG.

While we do not mean to downplay the significance of the WUG – and indeed have conducted a thorough assessment of related noise emissions – it is relatively minor in terms of the overall WNP noise emissions. This is because the bulk of works take place underground and in a relatively sparsely populated area, far from the Waihi township.

However, there are some noisy activities in (and above) the forest reserve associated with the WUG and associated exploration that have potential ecological noise effects. Because of this, we have undertaken extensive noise measurements and analysis of noise levels in the forest reserve, with a view to supporting the Project ecological assessment, as well as allowing us to assess the effect on people using the forest reserve for recreation (Section 10).

All of the other components of the WNP are integrated with existing Waihi mining operations and located in relatively close proximity to each other. They are also closer to denser population areas and therefore have the potential to create a greater noise impact on a larger number of people. For this reason, much of this report focusses on noise in the areas around and east of the Waihi township.

2.2 Noise Effects will be Localised to each Project Component

For any given receiver it is generally only the component of the project that is closest to them that will have the potential for any noise effects. While we have considered cumulative noise levels from all parts of WNP combined, the separation between them means that the components can generally be discussed in isolation.

For example, the closest receivers to the NRS will not receive any noise from TSF3 or WUG, etc., so their experience of the WNP noise will be dominated by the NRS. Receivers further from the site will likely receive a broader range of the WNP noise from various components, but the overall level will be much lower by this point.

This report therefore presents the noise levels separately for each of the project components, along with a discussion of the highest potential noise impacts on each area. Cumulative noise emissions and overall effects are then addressed subsequently.

2.3 Cumulative Noise with other OGNZL Activities is Considered

Noise generated from existing consented activities in the area has also been factored into this assessment of the WNP, to ensure a comprehensive assessment of OGNZL's overall noise emissions. The WNP relies on a large amount of existing infrastructure, such as the Processing Plant, conveyors, tailings storage facilities, buildings and services, etc.

The project will also occur alongside ongoing consented activities, including the Martha Underground Mine (MUG) and 'Phase 4' of the Martha Open Pit mining (MOP4) and TSF1A and 2 works.

While these existing aspects are subject to a variety of rules and conditions around noise (as explored in Section 3.0), in reality any concurrent noise emissions from OGNZL operations must be considered holistically in order to adequately assess the potential noise effects.

To this end, we have prepared additional calculations that combine WNP noise levels with a notional level of activity occurring in the Martha pit and associated infrastructure that could represent Phase 4 operations. This is presented in more detail in Section 10.2.

2.4 Noise from Construction vs Operational Phases

Some temporary activities are assessed as being 'construction noise'. This means that they are typically subject to higher (i.e. less restrictive) noise limits that reflect the transient nature of the activity and therefore over a shorter timeframe. More detail is given around the applicable noise standards later in this report.

This principle is long-established in the existing consenting framework governing Waihi operations and is commonly used to assess noise across the mining and quarrying industries in New Zealand.

The following activities are some of those likely to occur across all components of the project and we consider these activities to be defined as construction noise:

- Clearance of vegetation and topsoil from worksites and stockpile footprints
- Excavation of unsuitable materials and backfilling of the excavations where necessary
- Construction of access roads, clean and dirty water drains, underdrains, and collection ponds as required
- Construction of offices, workshops and all related surface facilities at Willows Road, and the services trench linking these with the existing operations at Baxter Road
- Upgrades to the Processing and Water Treatment Plants
- Deconstruction works on closure of the facilities, e.g. removal of infrastructure and earthworks, and rehabilitation for future land use.

Based on advice from the mining experts, beyond these general activities there are individual components of the project that should also be defined as construction, and these are described in Section 5.1.

Both the NRS and Willows Rock Stack (**WRS**) will be constructed in stages. Only the initial stages are considered as construction activities. The construction period ends with completion of the first development stage and the first placement of rock fill onto the liners. All subsequent works will need to comply with the operational noise limits.

2.5 Blasting and Vibration are Considered Elsewhere

These topics are not considered in our assessment and are addressed in the work of Heilig and Partners[1].

2.6 Noise Effects on Fauna are Addressed in the Ecology Assessment

Assessing noise effects on fauna requires input from acousticians and ecologists. We have followed the following standard practice approach:

1. The project ecologist (Boffa Miskell) has provided the species of interest from a noise effects perspective.
2. We have agreed with the ecologist on relevant effects thresholds and have predicted effect zones.
3. We have provided the results to the ecologist for assessing the potential noise effects.

We have provided an overview of our noise predictions in Section 12.0. Appendix F contains the detailed supporting memos that we provided to the ecologist. The overall fauna noise effects assessment is in Section 6 of the ecological assessment[2].

[1] Blasting and Vibration Assessment, Heilig, 2025.

[2] Terrestrial Ecology Values and Effects of the WUG, Boffa Miskell, 2025.

3.0 EXISTING NOISE PERFORMANCE STANDARDS

In this section we describe several documents that provide useful guidance in assessing the proposal's potential for noise effects. We have referred to the applicable local noise limits and then considered these in the context of other guidance and the existing noise environment.

From this, we form our view and recommend what should become conditions of consent. These, whilst based on the existing consents and the Hauraki District Plan (**District Plan**), seek to formalise a more consistent approach to activities associated with mining throughout Waihi. These are presented and discussed further in Section 5.0 of this report.

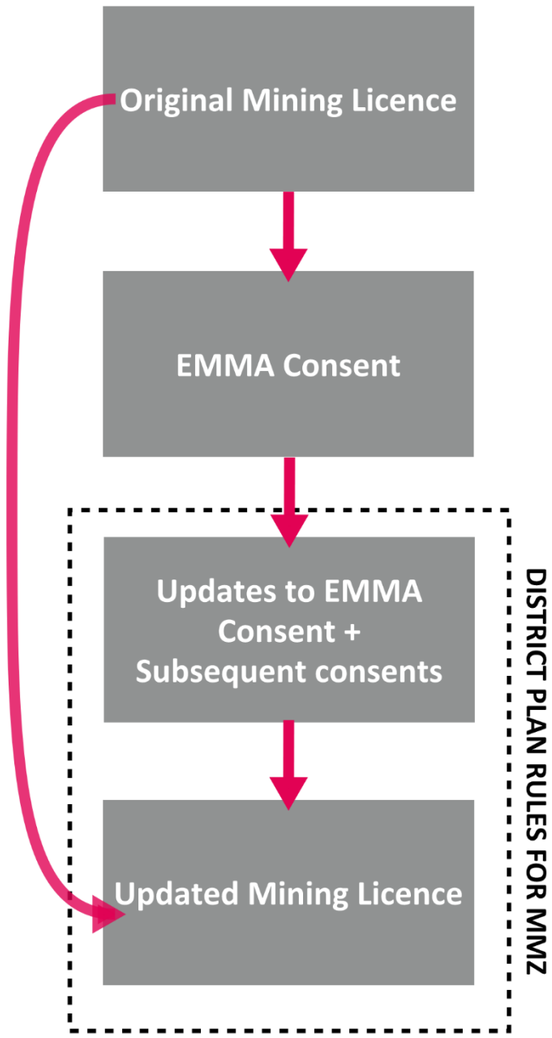
3.1 Current Consents

Mining activity in Waihi has been governed by different consents and licences that have reflected the changing nature of the project since inception. As a summary:

- Mining was originally permitted under the Mining Act 1971, with Mining Licence 32 2388 granted in 1987.
- This licence was subsequently varied on multiple occasions up to and including 2017.
- New expansion after the implementation of the Resource Management Act 1991 required resource consents. The first-generation District Plan adopted:
  - The existing licence area as the Martha Mineral Zone (**MMZ**); and
  - Created the 'Extended Martha Mineral Area' (**EMMA**) overlay for future expansion.
- Consent was granted for the EMMA project in 1999: LUC No. 97/98-105 (with subsequent variations up to 2019).
- 'Project Martha' was granted consent in 2018 for further open pit and underground works (LUC 202.2018.00000857.001).
- The mining licence and EMMA consent have expired, but activities authorised by those instruments are now provided for as permitted activities under a specific-purpose zoning[3].

The boundaries of the operative Martha Mineral Zone (MMZ) broadly align with the mining licence and EMMA consent. The current MMZ rules reference and adopt the conditions of the earlier mining licence and EMMA consent. These areas are all shown overleaf in Figure 2.

In addition there are a number of other historic consents that primarily relate to underground mining and have little relevance to WNP. These include the Favona, Trio and Correnso projects.



3.1.1 Overview of Existing Noise Conditions

Each of the documents above provides some controls on noise generation, directly through noise limits, or indirectly through activity restrictions or other mechanisms.

The Project Martha consent, whilst relating to the Martha Open Pit and Martha Underground for the most part, also provides some noise limits for activities around the Favona portal close to the Processing Plant, so has some relevance.

At present, mining in the MMZ is subject to controls in the documents above and is a discretionary activity in the Rural Zone. Several areas of the Waihi North Project are outside the MMZ (either entirely or in part), primarily GOP, TSF3 and WUG.

The current MMZ rules are discussed further in Section 3.2.3. The key aspect to note is that the two documents it references – the EMMA consent and the Mining Licence – have both now expired but are still retained by explicit reference in the District Plan and that their conditions effectively get rolled over.

Beyond their specific controls, the previous consenting documents help to describe the noise environment created by mining activities in the past, which is by now well-established in the area.

3.1.2 OGNZL Consents Relevant to WNP

The details of the mining licence are explored below. The EMMA and Project Martha consents focus on Martha operations and are not of much relevance to WNP. For completeness, we note the following:

EMMA Consent

In the EMMA consent, some noise controls apply to other areas away from Martha, such as adjacent to the conveyor corridor and other smaller mining operational areas, but only to parts of that area which are outside of the Mining Licence area. As such, they do not apply to most of the Waste Disposal Area (existing tailings storage facilities, etc.) or to the Processing Plant.

Similarly, there are some small areas for which the consent stipulates (at Condition 3.8(b)iii) that the normal District Plan provisions apply (detailed below in Section 2.2).

Project Martha Consent

The Project Martha noise limits drew a distinction between noise levels permitted in most cases (55 dB L_{Aeq}) and those from mining in some distinct areas around the pit that are outside of the Mining Licence area and primarily affected residential areas, which had a 50 dB L_{Aeq} noise limit.

Of specific relevance to WNP, Condition 23 of the Project Martha consent applied the 55 dB L_{Aeq} limit to *'use of the cement aggregate fill plant, Favona portal and polishing pond stockpiles and the pit lake filling pipeline corridor'*.

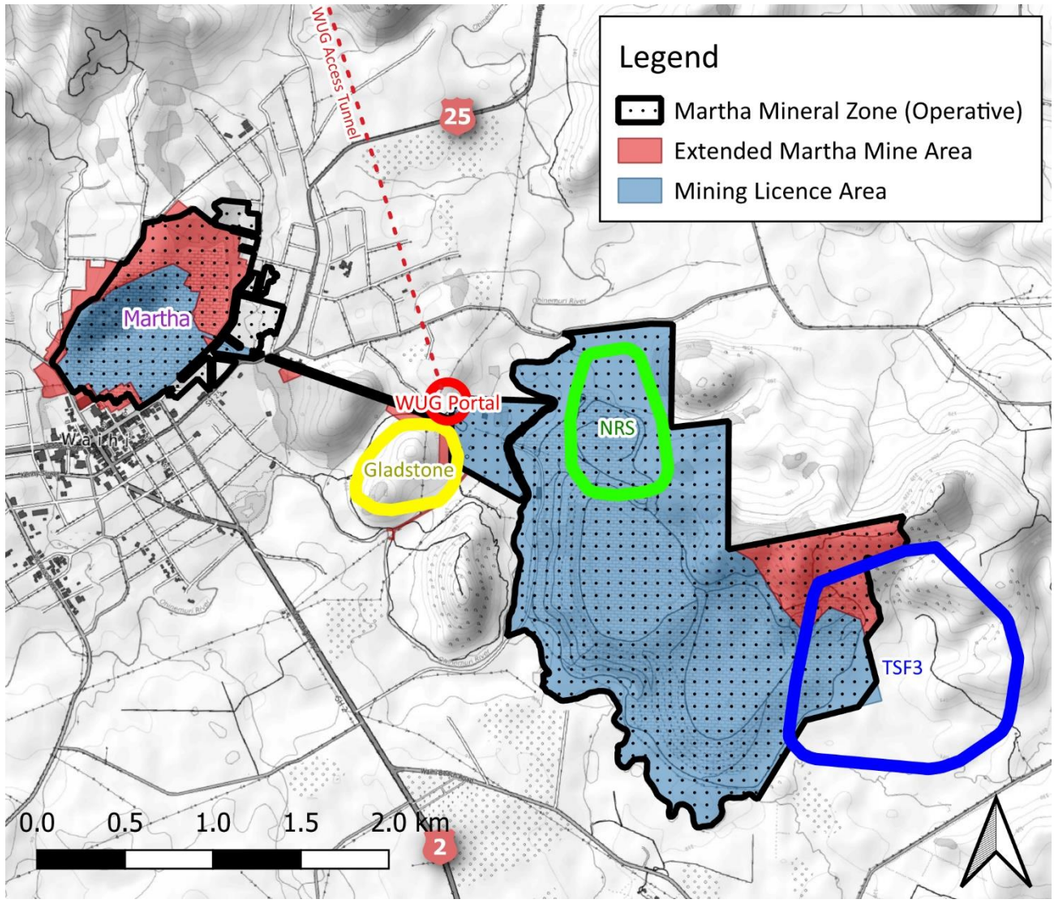
[3] Hauraki District Plan, Section 5.17.1(4)

3.1.3 Mining Licence Conditions

The licence, granted in 1987, covers activities in the main Martha Pit and across most of the OGNZL's Waihi operations. It was last updated in 2016 ahead of its expiry the following year.

The original licence area and subsequent developments from it are shown in Figure 2.

Figure 2: Established mining areas, with proposed WNP activities



In relation to operational noise from the Mining Licence area (blue shade in Figure 2), Condition 21(a) states that:

> *"All activities provided for by the Mining Licence taking place on any site within the Mining Licence area shall not exceed the following limits when measured at or within the boundary of any residentially zoned site or the notional boundary of any occupied dwelling in the Rural Zone and measured over the periods specified below:*
>
> | | | |
> |---|---|---|
> | *Monday-Friday* | *0700 - 2100* | *55 dB L_{Aeq}* |
> | *Saturday* | *0700 - 1200* | *55 dB L_{Aeq}* |
> | *All other times* | | *40 dB L_{Aeq}* |
> | *2100 - 0700 (the following day)* | | *70 dB L_{AFmax}* |
>
> *All noise shall be measured within or close to the boundary of any residentially zoned site or the notional boundary of any occupied rural dwelling site not owned by the licence holder or related Company or not subject to an agreement with the licence holder or related Company.*
>
> *In the event that a property is sold and ceases to be subject to an agreement between the licence holder (or related Company) and the purchaser, or in the event that there is no longer an agreement between the licence holder (or related Company) and the landowner, the location for the measurement of noise shall revert to being on or close to the boundary of that residentially zoned site or the notional boundary of the occupied rural site."*

Part D of the condition requires that noise be measured and assessed in accordance with the 2008 versions of New Zealand's environmental noise standards (discussed in Section 3.3.1 of this report), while Part E of the condition requires that a Noise Management Plan be prepared that should *'detail the methods used to comply with Conditions 21 and 30'*.

General Matters

Condition 30a requires that noise monitoring be undertaken on a weekly basis during construction and at least biannually for normal operations.

OGNZL is also required to prepare and maintain a Noise Management Plan (NMP) that details the methods used to comply with the noise limits (Condition 30b). We understand that the most recently certified version of this was issued in November 2023[4]. This document brings together all of the conditions and obligations from the various consents and permits, not just those discussed in the Mining Licence.

There are various conditions (e.g. Condition 7D) that primarily relate to noise mitigation for Martha pit works and are therefore not discussed further here.

Overall, the updated licence conditions (issued 27 March 2017) mostly brought the noise standards into alignment with more contemporary guidance, which at the time were the updated EMMA conditions (discussed above) and the 2014 District Plan review. This update therefore adopted the best practice provisions of the time, such as moving to the use of L_{eq} rather than L_{10} as the primary noise assessment parameter.

Construction Noise

Conditions 8 and 9 stipulate the timing and noise limits for construction activities. With the exception of Waihi Central School, which is not affected by the WNP construction, all other areas are governed by the construction noise limits that are commensurate with the NZS 6803:1999 construction noise limits for regular duration works, described later in Section 2.2.2.

However, the rule differs from NZS 6803:1999 in that the noise limit at 'all other times', including Sundays and Public Holidays, is 40 dB L_{Aeq} (rather than 45 dB L_{Aeq} in the Standard) and because the limits apply at residential boundaries or rural notional boundaries (NZS 6803:1999 applies the limits at the façades of sensitive buildings, rather than at boundaries).

Condition 3 defined the scope of construction operations, with these limited to 'initial construction activities' (removal of vegetation and topsoil; initial cutbacks and benching; demolition of surface facilities; creation of noise bunds; site clearance; and plant upgrades or installation) and 'other construction activities' (disestablishing noise bunds at end of life; removing plant and equipment; land rehabilitation; and lake outlet construction).

[4] OGNZL Document Ref: WAI-200-PLN-014, available from OGNZL website.

3.2 Hauraki District Plan

3.2.1 General Noise Limits (Section 8.3)

Zone Specific Noise Standards

The District Plan provides district-wide rules for the assessment of noise in Section 8.3.1. The noise standards outlined in Rule 8.3.1.3 apply to noise received at different sites both within the same zone (part A) and between zones (part B).

The relevant noise standards for this project are summarised in Table 1. Figure 3 overleaf presents the District Plan zoning[5] over the project area. As well as residential zones, the WNP will generate noise in the Martha Mineral Zone, Rural Zone, Reserve Zones (both Active and Passive), and Conservation (Indigenous Forest) Zone.

We note that Part B of the Rule, for noise between zones, does not provide any noise limits that are relevant to this project. There is no specific limit on noise from activities in Rural Zones received in other zones. Noise from within the MMZ is discussed opposite.

Table 1: Summary of District Plan noise standards from Rule 8.3.1.3(1)

Site Zoning/Use		Noise Level		
Noise Generator	Noise Receiver	Time Period	dB $L_{Aeq\ (15\ min)}$	dB L_{AFmax}
Part A (within zones)				
Residential/ Low Density	Boundary of any other residential site	Day	50	-
		Night	40	65
Rural	Notional boundary of any rural zoned dwelling	Day	50	-
		Night	40	65
Part B (between zones)				
No rules apply to this project		-	-	-

Assessment Matters

The District Plan requires (in Rule 8.3.1.3) that noise is measured in accordance with New Zealand Standard NZS 6801:2008 *"Acoustics – Measurement of environmental sound"* and assessed in accordance with New Zealand Standard NZS 6802:2008 *"Acoustics - Environmental Noise"*. These are the most recent iterations of these Standards and consistent with the National Planning Standards.

The District Plan also refers to any operator's overarching duty to ensure ongoing compliance with the provisions of the Resource Management Act 1991 (discussed later in Section 3.3.2) and the Health Act 1996.

Exemptions

Some specific noise sources are exempt from compliance with the noise standards, as specified Rule 8.3.1.3 (1)(d). For the avoidance of doubt, we do not consider that any of these are relevant to WNP.

3.2.2 Construction Noise and NZS 6803:1999

Rule 8.3.1.3 (3) provides limits for construction noise and requires management, measurement and assessment in accordance with New Zealand Standard NZS 6803:1999 *"Acoustics - Construction Noise"*.

Of relevance to this project, the Rule applies the 'Table 2' limits from NZS 6803:1999, which are reproduced in Table 2 below, to noise received in the following zones that are relevant to this application:

- Rural
- Residential
- Low Density Residential
- Marae Development
- Reserve (Passive)
- Reserve (Active)

Table 2: Recommended upper limits for construction noise received in residential zones and dwellings in rural areas (Table 2 of NZS 6803)

Time of week	Time period	Short-term duration (dB)		Typical duration (dB)		Long-term duration (dB)	
		L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}	L_{Aeq}	L_{Amax}
Weekdays	0630-0730	65	75	60	75	55	75
	0730-1800	80	95	75	90	70	85
	1800-2000	75	90	70	85	65	80
	2000-0630	45	75	45	75	45	75
Saturdays	0630-0730	45	75	45	75	45	75
	0730-1800	80	95	75	90	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

The Standard defines the duration of works as follows:

- "Short-term" means construction work at any one location for up to 14 calendar days
- "Typical duration" means construction work at any one location for more than 14 calendar days but less than 20 weeks
- "Long-term" means construction work at any one location with a duration exceeding 20 weeks.

For completeness, we note that the Standard provides the following footnotes to the above (paraphrased in brief):

Clause 7.2.6 Where there is a relatively high background sound level (L_{90}) due to noise from sources other than construction work, limits should be based on a determination of the existing level of noise in the area (a "background plus" approach).

Clause 7.2.7 Where noise cannot be measured outside a building, the upper limits for noise measured inside the building shall be the levels stated minus 20 dBA.

3.2.3 Martha Mineral Zone (Section 5.17)

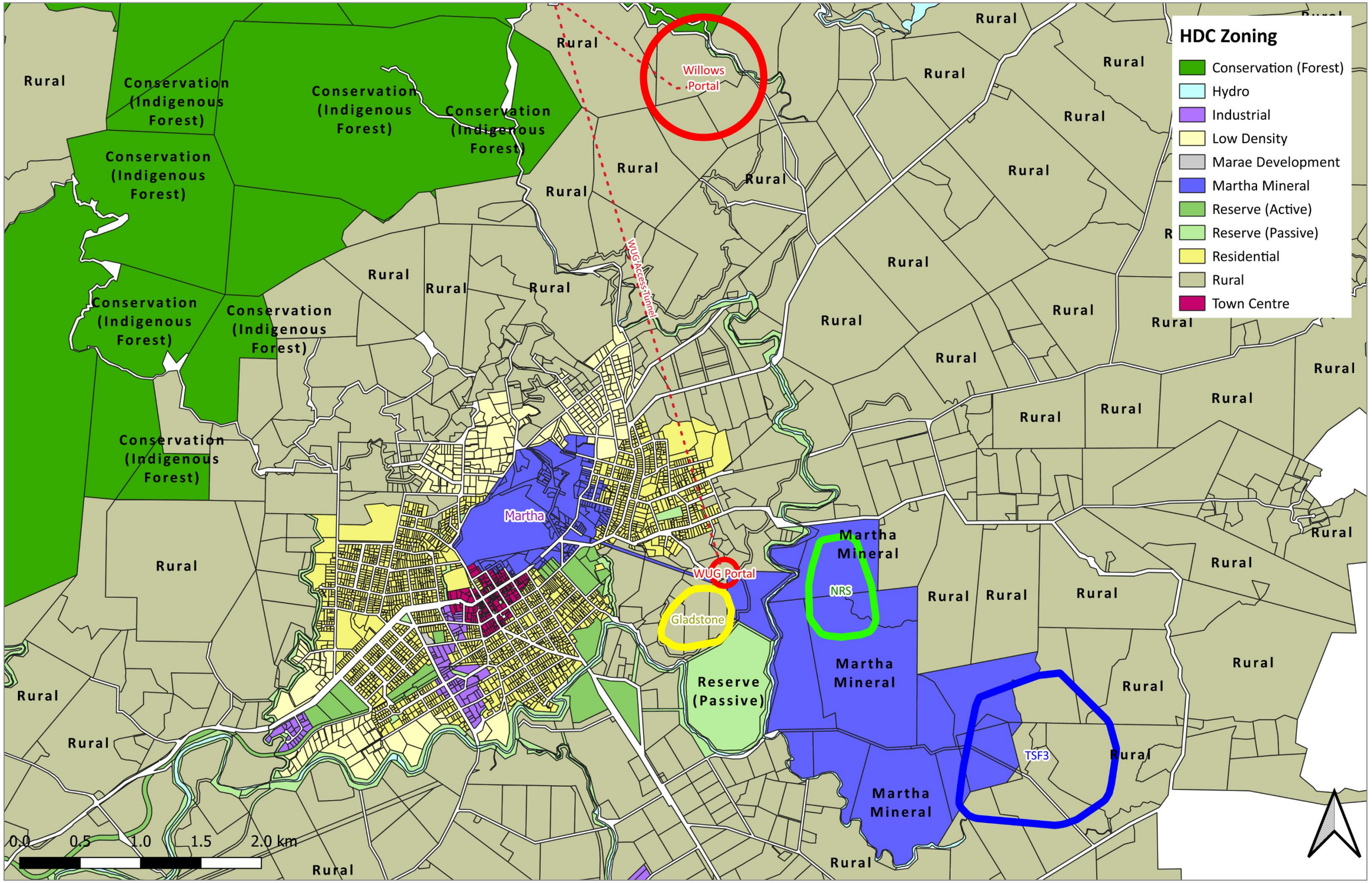
Section 5.17 of the District Plan provides rules for the MMZ. No specific noise limits are provided in this section of the Plan, nor are any limits relevant to the MMZ given in Section 8.3.1.3.

Instead, Rule 5.17.4.1 P1 and P2 allow that any activity is permitted if conducted in accordance with the relevant terms and conditions of, and within the area covered by, the Mining Licence and LUC 97/98-105 respectively. As previously indicated, while these documents have both now expired, their provisions are adopted by the District Plan.

We note that activities covered by these two rules are also exempt from compliance with Rule 8.2.5 (Glare and Lighting) and Rule 8.3.2 (Vibration in the Ground) of the District Plan.

[5] Zone extents obtained from the Waikato LASS Data Portal 'Zone' dataset by HDC.

Figure 3: Planning zones in the Hauraki District Plan with Waihi North works indicated



3.3 General Noise Guidance

3.3.1 NZS 6801 and 6802

The Hauraki District Plan refers to, and requires assessment in accordance with, NZS 6801:2008 and NZS 6802:2008. These Standards represent current industry best practice.

NZS 6802:2008 is commonly used in New Zealand to inform assessments of environmental noise effects. The Standard provides the following guidance on desirable upper limits of sound exposure at or within the boundary of any residential land use:

- Daytime – 55 dB $L_{Aeq\,(15\,min)}$
- Evening – 50 dB $L_{Aeq\,(15\,min)}$
- Night-time – 45 dB $L_{Aeq\,(15\,min)}$ and 75 dB L_{AFmax}

The noise levels provided in the Standard are intended to provide territorial authorities with appropriate guidance for the development of local noise criteria. (It notes that the inclusion of an evening period and its hours of application are a matter for the relevant local authority.)

Clause C8.6.2 of the Standard provides further discussion on these guidelines:

> *'The recommended daytime limit of 55 dB $L_{Aeq\,(15\,min)}$ is consistent with the guideline values for community noise in specific environments published by the World Health Organization. The World Health Organization identifies that during the daytime, few people are seriously annoyed by activities with levels below 55 dB L_{Aeq}. The night-time limit recommended should not exceed 45 dB $L_{Aeq\,(15\,min)}$ outside dwellings so that people can sleep with windows open for ventilation and achieve the desirable indoor 30 to 35 dB $L_{Aeq\,(15\,min)}$ level as a design level to protect against sleep disturbance.'*

3.3.2 Resource Management Act 1991

Regardless of any noise performance standards provided in local legislation or specific land-use consents, the RMA imposes overarching obligations on all generators of noise.

Section 16 of the Act concerns one's duty to avoid unreasonable noise and states that:

> *'Every occupier of land (including any premises and any coastal marine area), and every person carrying out an activity in, on, or under a water body or the coastal marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level.'*

Section 17 also states that every person has a duty to avoid, remedy, or mitigate any adverse effect on the environment arising from an activity carried out by or on behalf of the person.

3.3.3 International Guidance

The key international guidance is that provided by the World Health Organization's (WHO) Guidelines for Community Noise[6]. For community or environmental noise, the critical health effects (those effects which occur at the lower exposure levels) are:

- Sleep disturbance
- Annoyance (slight, moderate, high)
- Speech interference/communication disturbance.

The Guideline Values for these three critical health effects for community or environmental noise are presented in Table 3. These guidelines, based on extensive international research, are the exposure levels that represent the *onset* of the effect for the general population. That is, at these noise levels, critical health effects only begin to appear in a small number of vulnerable or sensitive groups. The WHO regards these as 'ideal' objectives that are not often reached in practice.

Table 3: 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_{Amax}
Outdoor living area	Serious annoyance, daytime & evening	55	16	-
	Moderate annoyance, daytime & evening	50	16	-
Dwellings, indoors	Speech Intelligibility and moderate annoyance, daytime & evening	35	16	-
Inside bedrooms	Sleep disturbance, night-time	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values) night-time	45	8	60

3.3.4 Parks, Conservation Areas and Open Spaces

Although specific health impacts from noise are not an issue for conservation areas, due to the limited exposure time of people in these areas and their general discretionary choice in being present, it is expected that there could be a degree of impact in terms of people's expectations of high amenity. If this is perceived as being impacted there can be subsequent annoyance effects.

Included in the WHO Guidelines is advice relating to Parkland and conservation areas, which is as follows; "*Existing large quiet outdoor areas should be preserved and the signal-to-noise ratio kept low*".

This essentially deems it desirable to ensure that little change to the noise environment occurs in these areas, to ensure that amenity remains high.

The WHO Guidelines are supported by numerous studies on the effects of noise on users of parks, open spaces and wilderness areas. Horonjeff[7] (2005) attempts to define methods quantifying the natural soundscape of wilderness environments in terms of duration of 'quiet time' and the time a visitor has to wait to experience quiet times of certain durations. This 'wait time' can then be used to evaluate the impact of anthropogenic noise sources on areas mainly devoid of human made sounds. The study was based on the effects of aviation noise intrusion.

The author concludes "*… sources relatively low in level, by urban and suburban standards, are distinctly audible in low-ambient environments. And their presence is readily obvious at long distances. During low wind conditions, it was not unusual for the ambient sound level to drop near or below the human threshold of hearing. Under such conditions, motorized sources can be audible for long periods of time".*

Other studies concur and have found that 'back-country' visitors consistently show greater sensitivity to sounds than do 'front-country' visitors (i.e. those who may use easily accessible lookouts etc.).

3.3.5 Department of Conservation Waikato Conservation Management Strategy 2014-2024

The Department of Conservation (DoC) Waikato Conservation Management Strategy 2014-2024 (Waikato CMS) contains policies and guidelines for the management of various effects on the DoC estate. One of those impacts is aircraft use in the Forest Park, and it also briefly covers noise. The CMS contains some guidance on how aircraft use should be managed as reproduced below in general policy 16.3.5.1 and policy 16.3.5.3 (which

[6] Berglund, B. et al, *Guidelines for Community Noise*. World Health Organisation (1999).

[7] Horonjeff, R, D; "*Queuing for Quiet-The Natural Soundscape from a Visitor Perspective*", Presented at the Acoustical Society of America Noise Conference meeting 2005, Minneapolis, October 19, 2005

applies to the Yellow Zone as per Volume 2, Map 4 (Aircraft Access Zones overview) which is relevant to Wharekirauponga:

POLICIES—AIRCRAFT (CGP 9.5(B))

*16.3.5.1 Should apply (but not be limited to) the following criteria when assessing all concession applications for aircraft landings**

a) is consistent with the outcome and policies for the Place in which the activity is proposed to occur (if within a Place) or Policy 16.3.5.10 (if outside a Place);

b) is consistent with the aircraft zoning provisions in this CMS and the aircraft access zones on Map 4;

c) is consistent with the purposes for which the lands and waters concerned are held;

d) adverse effects on conservation values, including adverse effects on natural quiet, are avoided, mitigated or remedied;

e) adverse effects on other visitors (taking into account the size of zone and the proximity of other ground users) are avoided, mitigated or remedied;

f) the requirement to hold and comply with certifications approved by the Department, including those addressing noise management in specified locations;

g) the need for monitoring the activity using new technologies; and h) avoiding landings near tracks, huts, car parks or campsites (unless otherwise specified in an outcome or policy for a Place).

**This includes landings, take-offs and hovering*

16.3.5.3 Should only grant concessions for aircraft landings in the Yellow Zone that meet the limits of:

a) two landings per operator per day at any one site (defined as any landing site within a 1kilometre radius of the initial landing site) and a maximum of 20 landings per site per operator per year.

In relation to aircraft use the Yellow zone is defined as a zone that:

> *"applies where there is a need to restrict aircraft use; either where visitors expect a low level of encounters with aircraft or where values of natural quiet predominate particularly in backcountry and remote areas".*

However, the CMS also recognises that despite the general isolation of the backcountry zones, there may be some acceptance of occasional noise intrusion by back country visitors.

Overall, because the ventilation raises and additional exploratory drilling associated with WUG are proposed in conservation/open space areas, it is recommended that operational noise emissions should be minimised as much as is practicable, and they should ideally not exceed the background noise level at any nearby walkways or campsites. This approach reflects the intent of the WHO Guidelines and the Waikato CMS and is considered an appropriate method to adopt for this project. However, we consider that temporary construction noise does not need to meet this goal.

The recreation report prepared for the WNP (by Greenaway and Associates[8]) notes that there is only one declared back-country track in proximity to the proposed ventilation raises at the orebody site, but that the existing and new drill sites are already close to this track and another track that runs through the back country zone. On top of this, helicopters also currently operate to support existing drilling operations, and additional movements would occur, as discussed below.

3.4 WUG Helicopter Noise

Helicopters currently operate from Baxters Road (Processing Plant helipad), but under the proposal would also operate from Willows Road and Golden Cross, all of which are included in our assessment, along with helicopter noise emissions in the forest reserve itself.

Because helicopters are to be routinely used during both the operational and construction phase, they are subject to the construction noise standards of Section 2.2.2 and should be considered in relation to other operational noise guidance.

For operational noise affecting people in rural and residential areas, noise from helicopters is assessed in a different manner to other sources associated with the project. This is because helicopters normally involve a short duration, intermittent noise event which is quite different to typical environmental noise sources which are much more continuous and consistent in noise level. For this reason, noise from helicopters is commonly assessed in accordance with New Zealand Standard NZS 6807:1994 *"Noise Management and Land Use Planning for Helicopter Landing Areas"*.

NZS 6807 gives useful guidance as to what are generally acceptable noise levels for normal helicopter operations where people are exposed to the noise. The Standard sets out limits of acceptability for helicopter noise for a range of receivers. An acceptable limit is defined as 50 dB L_{dn} (day/night) and 70 dB L_{AFmax} at night for residential and rural receivers

There are also currently agreements in place between OGNZL and DoC authorising helicopters to land in the Forest Park, which may need revisiting.

We understand that helicopters (AS350 'Squirrel' or similar, and occasional S70 'Black Hawk' or similar) are likely to depart from a staging area at the former Golden Cross Mine car park, Willows Road or from the Processing Plant (Baxter Road) helipad. From here they will service the vent raise and exploratory drill sites in the bush, hovering and lowering/raising supplies and equipment. Helipad sites in the Forest Park are likely to be based at previously used drill sites.

Because helicopters will operate above the conservation land, special consideration of their noise effects is required, in terms of potential effects that may occur on recreational users, including reference to the policies in the Waikato CMS (Policy 16.3.5.1 and 16.3.5.3) described above.

[8] *Recreation and Tourism Assessment, Greenaway, 2025*

4.0 EXISTING NOISE ENVIRONMENT

4.1 Existing Township Noise Measurement Data (OGNZL)

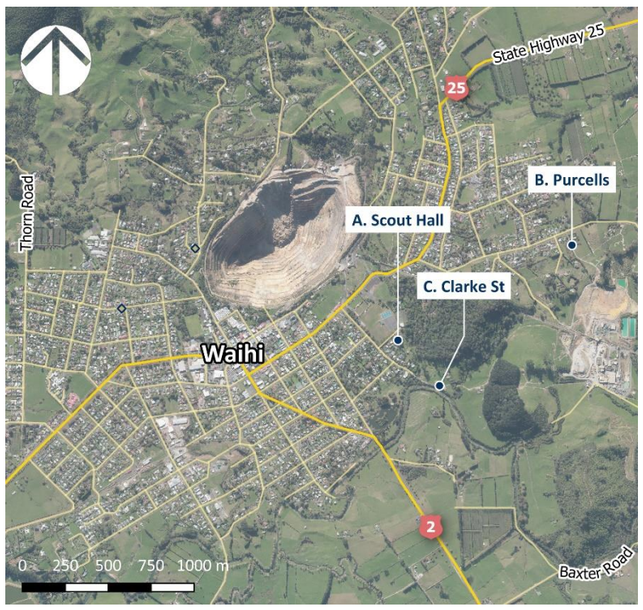
We have been provided with noise measurement data that have occurred at Waihi from the OGNZL archives from 2010 to 2020. These measurements have been undertaken for:

- Complaint response monitoring
- Compliance monitoring.

The results of the compliance monitoring are compiled and issued in a quarterly compliance report to the HDC. The compliance obligations within the District Plan are also summarised in OGNZL's Noise Management Plan.

Recent compliance monitoring mainly occurs at two positions, 'Scout Hall' and 'Purcells', as shown on Figure 4 below. Figure 5 shows the average noise level as well as an indication of the range of all measured noise levels at those positions. Whilst compliance monitoring in the past focused on the Martha Pit, because no works have occurred there since 2015, compliance monitoring has been focussed on the other operations. Measurements have been undertaken both day and night at these locations for compliance purposes.

Figure 4: Regular noise monitoring positions used by OGNZL



Data for the last 10 years at the two main positions are collated in Figure 5 opposite. We note that this data was originally compiled in 2022, but in our opinion remains representative of existing ambient noise levels in the community. This is because there has not been significant changes in the local environment or in levels of mining related activity that has occurred in the intervening years.

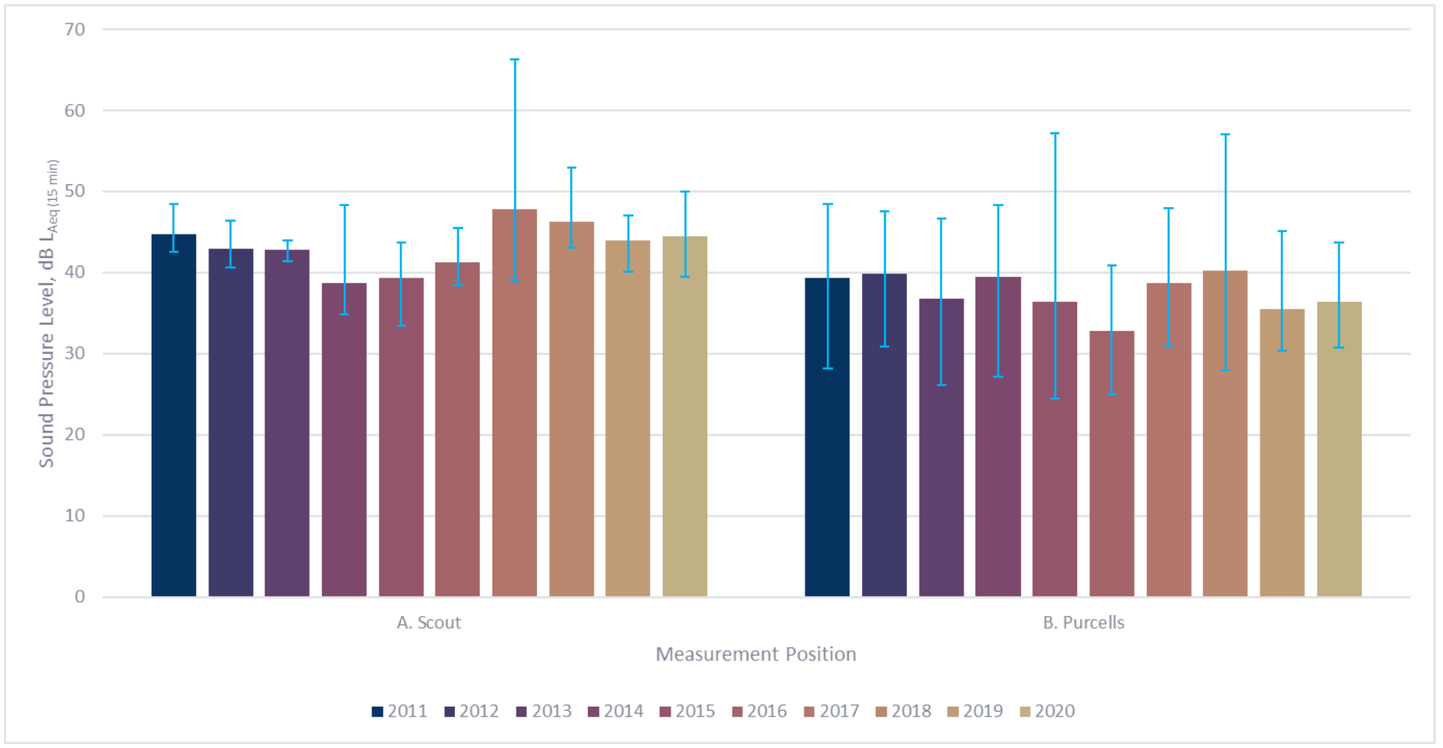
Also shown in Figure 4 is the position 'C' on Clarke Street. Monitoring is conducted here only infrequently, and detailed data has only been gathered since 2019. This position is therefore not included in Figure 5.

The average noise level at the Clarke Street position is 43 dB L_{Aeq} with a measured range from 38 to 50 dB L_{Aeq}. It effectively sits between the two ranges of values shown in Figure 5. This receiver gives good guidance on the localised existing ambient noise levels near the proposed Gladstone Pit.

Generally, our analysis of this data indicates that for receivers potentially adversely affected by WNP, the noise levels are only slightly influenced by whether the Martha mine is operating or not, and whilst mining operations would be audible, other anthropogenic noise sources are also clearly audible and contributing to the overall noise environment.

Noise levels are generally between 35 and 50 dB L_{Aeq}, which is typical of a small regional town environment during the daytime. Noise levels at Purcells (Position B) have mainly been obtained during the night and are generally below 40 dB L_{Aeq}. It is unclear what caused the maximum measured noise level at Scout in 2017, it is possible it could be localised operations occurring very close, or measurements conducted for a particular purpose, or indeed an unrelated noise event not associated with mining.

Figure 5: Chart showing mean noise levels over last 10 years



As can be seen for both locations the noise levels are similar with and without pit operations. Overall, in terms of resultant noise effects from current operations, this means that there is an appreciable contribution from other noise sources to the noise environment, so the impact of mining noise is somewhat reduced.

In our opinion, it is problematic to always determine whether the mining operations are compliant with the controls or not.

We understand that there is some concern that there are times when complaints have been received and there has been a conclusion drawn that noise levels are non-compliant, despite mining noise being below the compliance limit, simply because the measured noise levels (of all sources) are above the compliance limit.

The noise measurement results reported by OGNZL in the annual noise monitoring report do attempt to apply corrections to account for this, however it is not clear whether this adequately addresses the issue.

It can be seen that for much of the time combined noise levels from mining operations *and* extraneous noise sources (that have not been removed from the measurement data set) are lower than the District Plan noise limits. This means mining activity noise must be at or below the prescribed limits. The activities and associated machinery do not vary significantly from day to day, so mining generates a relatively consistent level of noise that is almost always compliant.

4.2 Waihi Noise Monitoring Survey (MDA)

We undertook a comprehensive programme of noise surveys across the Waihi area in August 2020 to establish existing noise levels. As discussed above, we consider these remain representative of current noise levels.

Six remote noise monitoring units were installed at the locations shown in Figure 6. These positions were chosen to represent the different noise-receiving environments that each of the various aspects of OGNZL's operations may affect. These positions were:

MP1. 26 Islington Terrace. Representative of the closest dwellings to on the western side of the Martha pit.

MP2. 14 Roycroft Street. Areas in the north-eastern corner of the town that may receive noise from the main processing plant at times.

MP3. 126 Kenny Street. Dwellings close to the south-eastern face of Martha pit.

MP4. 28 Russell Street. Representative of general dwellings in the township that are furthest from WNP works.

MP5. 34 Heath Road. Closest dwellings to the Gladstone Pit and Processing Plant areas.

MP6. 131 Trig Road North. Representative dwellings closest to the TSF3 stockpiling area, being the closest part of the TSF works.

The noise monitors were installed on Thursday 30 July 2020 and generally ran through until either Friday 14 August (MP2 and MP5) or Thursday 20 August (MP3, MP4 and MP6). Unfortunately, data from the unit at MP1 was lost after Sunday 2 August due to the unit being stolen.

We have analysed meteorological records for the survey period to exclude periods of adverse weather from our analysis. Further information on this and the equipment used is provided in Appendix B.

The recorded averaged data at each location is summarised opposite in Table 4, and Figure 7 overleaf provides the hourly ambient noise level at each position by averaging the data over the 14 to 20 days. Figure 8 shows the background noise level (L_{A90}). Full time histories of the recorded ambient noise level data are provided in Appendix B.

Overall, noise levels are considered typical of a small rural town environment. Daytime ambient noise levels are 43-50 dB L_{Aeq}, and daytime background noise levels are 37-45 dB L_{A90} depending on the proximity to local roads and the town centre.

In Waihi township, noise levels are typical of a small rural town with a State Highway passing through. The most significant contribution to daytime noise levels is local road traffic, and it is observed that background noise levels reduce markedly during the night, by approximately 5 to 10 dB.

In the rural areas, noise levels are slightly lower than in town during the day, but background noise levels are slightly higher at night. It is likely this is due to the distant State Highway traffic during the night impacting measured background noise levels. This means the diurnal variation is less in rural locations than in the town.

Figure 6: Waihi ambient noise level monitoring sites

Table 4: Summary of ambient noise monitoring results

Site	Address	Time Period	Measured Noise Level, dB		
			L_{Aeq}	L_{A90} †	L_{Amax} ‡
MP1	26 Islington Terrace	Day (0700 - 2200 hrs)	46	41	83
		Night (2200 - 0700 hrs)	39	36	69
MP2	14 Roycroft Street	Day (0700 - 2200 hrs)	47	39	77
		Night (2200 - 0700 hrs)	39	32	67
MP3	126 Kenny Street	Day (0700 - 2200 hrs)	49	44	92
		Night (2200 - 0700 hrs)	39	30	84
MP4	28 Russell Street	Day (0700 - 2200 hrs)	43	36	75
		Night (2200 - 0700 hrs)	42	33	76
MP5	34 Heath Road	Day (0700 - 2200 hrs)	46	39	78
		Night (2200 - 0700 hrs)	40	35	68
MP6	131 Trig Road North	Day (0700 - 2200 hrs)	50	39	81
		Night (2200 - 0700 hrs)	43	37	74

† *L_{A90} is the mean of the 5 minute noise levels arithmetically averaged over each day or night period.*
‡ *L_{Amax} is the mean of the maximum noise levels recorded in each day or night period through the survey.*

Figure 7: Waihi average measured ambient noise level at each hour of the day

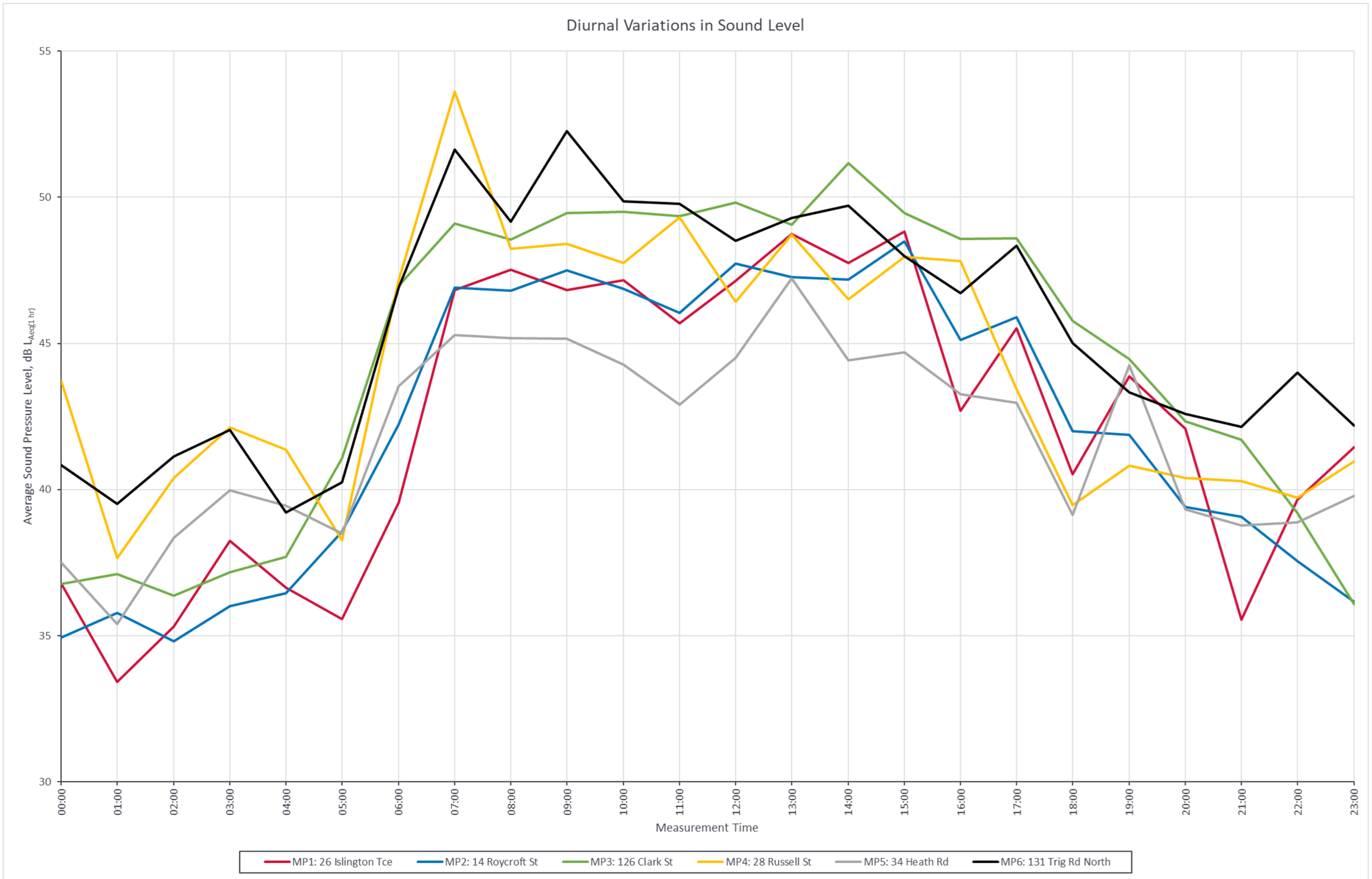
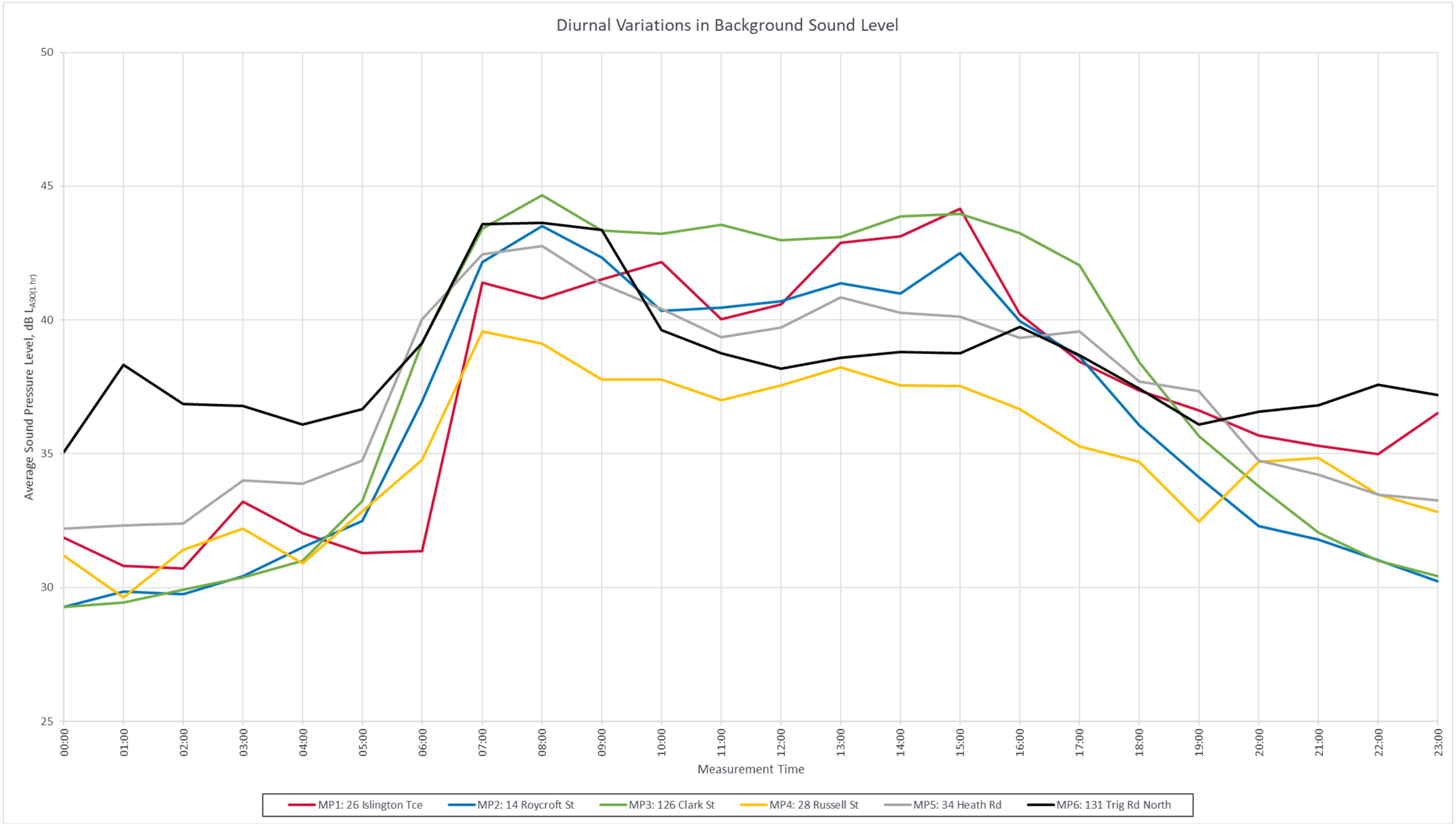


Figure 8: Waihi measured background noise level at each hour of the day



4.3 WUG Surface Facilities Area – Ambient Noise Levels

The WUG Surface Facilities Area (SFA), outside of the Department of Conservation (**DOC**) administered land, is zoned Rural in the Hauraki District Plan. We note that the DOC land is zoned as Conservation (Indigenous Forest) Zone, with a Significant Natural Area overlay.

The most significant man-made noise source at the Willows Road SFA is road traffic, primarily from State Highway 25 (Waihi-Whangamata Road). However, noise from other local roads will also contribute to the ambient noise environment at times. There is also an established quarry around 1 km north-east of the portal site, off Corbett Road.

We have undertaken a programme of ambient noise monitoring in the area to establish the typical range of noise levels experienced. Two noise monitors were installed at the locations shown in Figure 9. Noise levels were recorded continuously between 16 and 30 July 2020. Further details of the measurement instrumentation are provided in Appendix B.

Measured noise levels (excluding adverse weather events) are summarised in Table 5, with the complete recorded dataset at each position shown in Appendix B.

The measured noise levels at the DOC land during the day show ambient noise levels are reasonably quiet, indicating that the site is typical of a bush setting. We note that the background noise level is somewhat elevated primarily due to natural sounds in the vicinity of the microphone. This is not unexpected. At night the background noise levels are much lower. The maximum noise levels during the day are likely to be from natural sources, such as birds or wind gusts in trees.

The measured noise levels during the day at the Willows Road site indicate a reasonably quiet rural environment. Background noise levels are slightly lower than at the DOC site during the day, but significantly higher during the night. In our experience these noise levels are typical of a rural environment that is not subject to significant intrusion from nearby roads. Despite being quite close to SH25, the noise levels at Willows Road are not overly dominated by this source of noise during the day. At night however, the area is quiet with minimal local noise sources, mainly comprising of natural sounds in the vicinity (wind in trees, water noise etc.), but with some more significant discrete contribution from the nearby roading network (SH25) (i.e. logging trucks).

In summary, the noise levels in the Conservation Zone and Rural Zone in the vicinity of the project are reasonably low and consistent with our expectations of such areas.

Table 5: Summary of noise measurement data

Site	Measurement Location	Time Period	Measured Noise Level, dB		
			L_{Aeq}	L_{A90} †	L_{Amax} ‡
MP7	MP7 – DOC Land	Day (0700 - 2200 hrs)	41	33	72
		Night (2200 - 0700 hrs)	38	31	69
MP8	MP8 – Willows Rd	Day (0700 - 2200 hrs)	45	37	75
		Night (2200 - 0700 hrs)	46	39	76

† *L_{A90} is the mean of the 5 minute noise levels arithmetically averaged over each day or night period.*
‡ *L_{Amax} is the mean of the maximum noise levels recorded in each day or night period through the survey.*

Figure 9: WUG SFA Ambient noise measurement locations

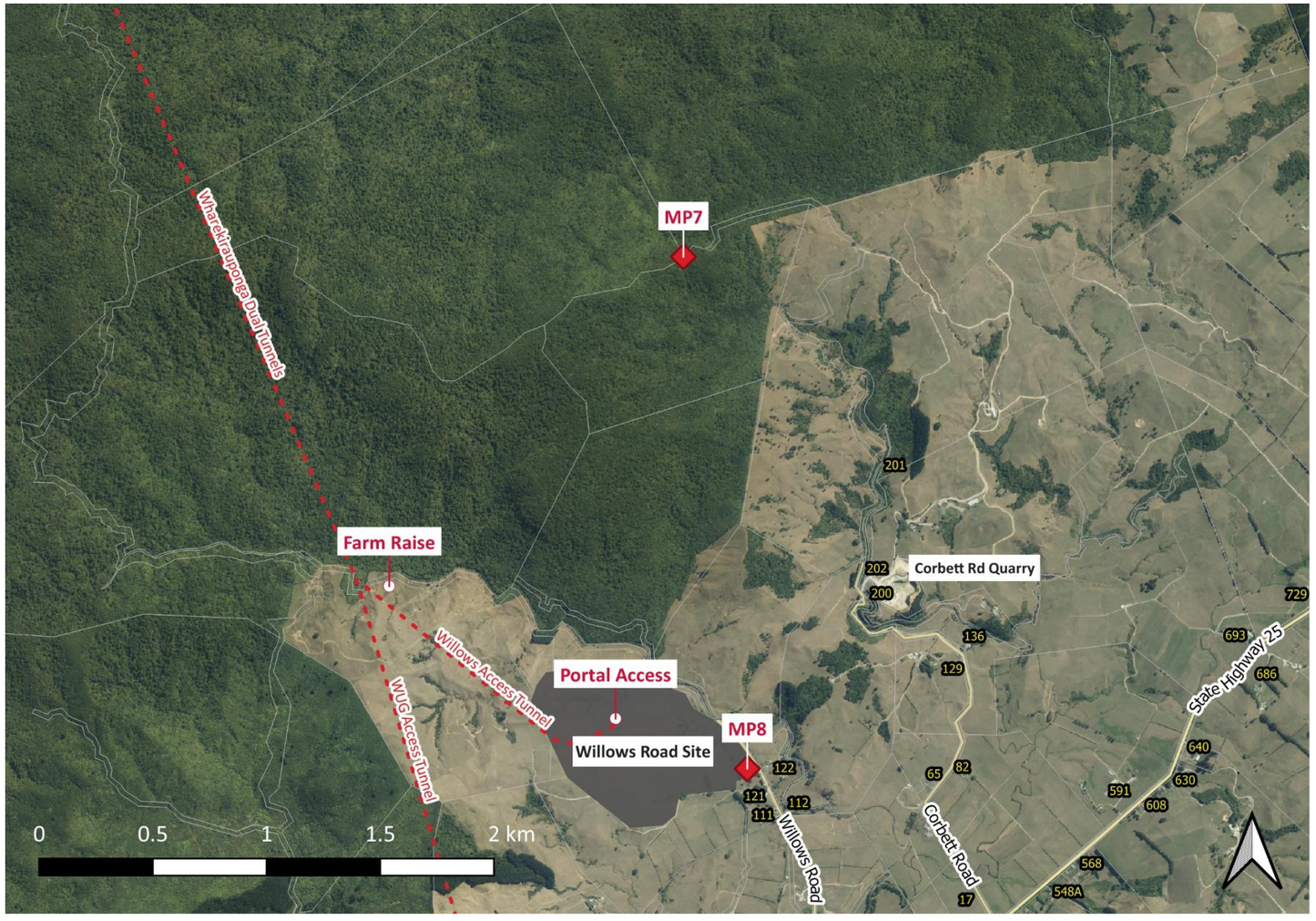
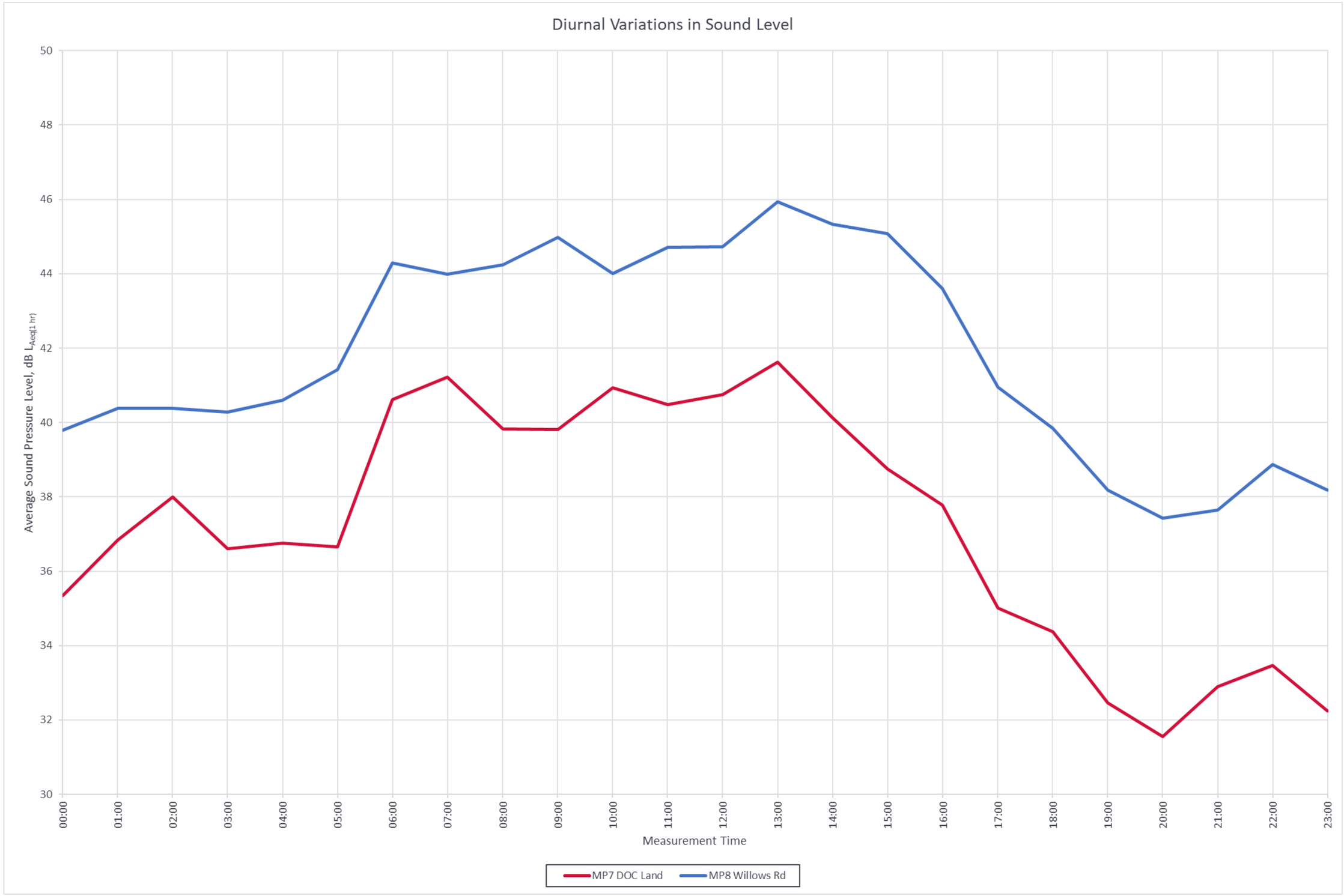


Figure 10: Wharekirauponga average measured noise level at each hour of the day



5.0 RECOMMENDED NOISE CRITERIA

Based on the preceding sections, a slightly revised approach to managing noise emissions from Waihi mining operations is proposed, compared to what has previously been applied through the various consents. The Waihi North Project itself has a broad goal to align the various discrete mining activities undertaken by OGNZL in Waihi. In practice this is likely to mean operational noise emissions are controlled to a lower level than previously, resulting in better outcomes for residents.

As well as this benefit, we note that for residents, it is useful to know that the noise limits that apply are consistent across the project.

Construction noise is recommended to be controlled in general accordance with NZS 6803 (which is also consistent with the District Plan, refer Section 2.2.2).

5.1 Recommended Construction Noise Limits

We consider it good practice and appropriate to ensure that construction, maintenance and demolition noise generally complies with New Zealand Standard NZS 6803:1999 "*Acoustics – Construction Noise*" (NZS 6803), which is also consistent with the District Plan.

NZS 6803 provides for higher noise criteria during normal working hours for construction noise received in residential areas to enable construction activity to take place. For commercial and industrial areas, less stringent noise criteria are specified during night-time when it is less likely that persons or business activities would be affected by construction noise.

NZS 6803 specifies more stringent noise criteria for construction activity in residential areas that occurs during Sundays. It is generally accepted that the lower Sunday noise criteria are intended to provide a day of rest from noise, as the 55 dB L_{Aeq} limit is such that only quieter operations would be possible. This approach is considered reasonable for the Project given the long duration of the construction programme and the ambient noise levels in the vicinity. We note that no general night-time construction works are proposed, although if such works do occur, the proposed conditions would provide the mechanism for dealing with any required night works.

Overall, compliance with NZS 6803 would, in our opinion, constitute the adoption of the 'best practicable option' (**BPO**) for the control of construction noise, thus satisfying the requirement of Section 16 of the RMA. The intent of the conditions proposed is that numerical noise limits are applied, complimented by a mechanism whereby if noise limits are likely to be exceeded, noise management measures are implemented to mitigate these noise effects. This is in our opinion consistent with the intentions of NZS 6803.

Overall, we consider that the limits of NZS 6803 should be 'trigger values', where noise levels beyond these should be managed in an appropriate way to ensure the BPO is achieved. This is consistent with the intention of the conditions that we recommend apply to the WNP Project. This approach is essentially adopted in the recent draft Association of Australasian Acoustical Consultants (AAAC) guidelines on the implementation of NZS 6803.

As we discuss in section 1.1.4, there are some specific activities that should be defined as construction (refer Table 6). We note that this list may well not be exhaustive, and that certain other elements of the works may also be defined as construction. Therefore, the conditions of consent should reflect that, by having relevant clauses that do not limit only those activities listed in the table below as being the only construction activities. This is reflected in the wording of the conditions of consent prepared by Mitchell Daysh, of which we have provided input.

We therefore recommend that for all activities listed in Table 6 below, the NZS 6803 long term construction noise limits previously presented in Table 2 apply (referenced in condition 14).

Table 6: Definition of WNP construction activities

Component	Construction Activities
GOP	• Relocation of overhead powerline, existing Favona Portal and associated infrastructure. • Construction of crusher and conveyor system. • Construction of silt or collection ponds, associated drains, and noise barriers (bunds or walls). • Topsoil stripping and construction of a topsoil stockpile. • Initial mining preparation for a period of 12 months, • Construction of MUG and WUG Access portal, initial sections of the underground drives, and associated infrastructure.
NRS	• Construction of the initial clean and dirty water perimeter drains and collection pond. • Rock stack preparatory work, including topsoil stripping and stockpiling, foundations, compacted liner, underdrains, surface water diversion drains and silt ponds. • Relocation of existing facilities: workshop and amenities. • Development of the borrow pits
TSF3	• Construction of the upstream clean water diversion drain. • Placement and compaction of the TSF3 initial embankment foundation and Zone A liner materials. • Foundation preparation for the soil stockpiles and then stripping and consolidating soil from construction activities. • Development of the borrow pits
Processing Plant	• All activities associated with installing replacement and new facilities within the Processing Plant and Water Treatment Plant.
WUG	• All vent shaft and additional exploratory drilling construction and évasé installations (including helicopter operations) • All construction of and within the WUG Surface Facilities Area, and of all site roads and access tracks. • Construction of Willows Portal, initial sections of the underground drives, and associated infrastructure. • Construction of the Services Trench from Willows Road to the Processing Plant (consented separately). • Upgrades required to Willows Road and SH25 intersection.

The construction noise limits also apply to the more general construction, demolition or rehabilitation activities listed in Section 1.1.4.

5.2 Recommended Operational Noise Limits

5.2.1 The District Plan limits are appropriate for activities undertaken as part of the WNP project for all zones (except the conservation area).

The District Plan Noise limits provide a clear and consistent indication of anticipated amenity in the residential zone, and in rural residential settings – all of the rules listed in Table 1 refer to a daytime noise limit of 50 dB L_{Aeq} and night-time noise limits of 40 dB L_{Aeq} and 65 dB L_{Amax} (at the boundary or notional boundaries of dwellings).

These values provide for a relatively high level of amenity in a rural area, where noise limits of 55 and 45 dB L_{Aeq} (for day and night, respectively) are not uncommon in other District Plans. These higher values are also consistent with the upper range of other guidance commonly used in New Zealand, including that in NZS 6802 and the WHO Guidelines discussed above.

As such, we expect that the District Plan noise limits will provide an appropriate degree of protection for local receivers of noise.

In addition, noise effects can be disregarded at dwellings owned by, or that have an agreement with OGNZL and therefore the noise limits would not apply.

Based on the above and Sections 2 and 3, and to harmonise the way noise is managed from the Waihi North mining operations, and to ensure general consistency with the District Plan, we recommend operational noise criteria below apply across all parts of the Waihi North Project. This would mean these would become conditions attached to the resource consents.

We do however recommend a higher L_{Amax} noise limit at night. This is because the District Plan L_{Amax} limit is unusually strict (65 dB L_{Amax}) and based on the existing noise environment a higher noise limit is appropriate. This is also consistent with the guidance contained within NZS 6802. In any case, a night-time L_{AFmax} noise limit of 70 decibels is typical of many districts and zones around the country and offers an appropriate level of protection, even in some of the quietest areas.

The recommended condition is given below

> *All activities associated with WNP shall not exceed the following limits when measured at or within the boundary of any residentially zoned site or the notional boundary of any occupied dwelling in the Rural Zone not owned by POGNZL or where there is an agreement in place with OGNZL and measured over the periods specified below:*
>
> | | |
> |---|---|
> | *0700 - 2200, Monday to Saturday* | *50 dB L_{Aeq}* |
> | *All other times* | *40 dB L_{Aeq}* |
> | *2200 - 0700 (the following day)* | *70 dB L_{AFmax}* |

Regarding night-time works, the approach taken in the proposed conditions is that the night-time activities will be managed and/or limited to ensure compliance with the above noise limits. The Noise Management Plan enshrined in the proposed conditions is the mechanism for confirming what those activities are *before* commencing.

In our opinion there is no need to specify or define what night operations can occur in the consent conditions, because doing so could unnecessarily prevent an unforeseen activity from being undertaken which can occur whilst still complying with these noise limits.

We understand that at most, only minimal low intensity operations may occur at night (or Sundays). This is because the night-time limit of 40 dB L_{Aeq} restricts what is possible, as the limit is set at a level that does not permit high noise emission activity. We also consider this an appropriate night-time noise limit that is typically implemented throughout New Zealand.

When viewing the combined construction noise and operational noise exposure for residents over the life of the WNP, we consider it desirable to limit the total operational noise exposure on residents by not allowing noise at the upper limits of acceptability for normal operations, as referenced in NZS 6802 (being 55 dB L_{Aeq}). This is reflected in our proposed noise limits above being 5 dB more stringent.

5.2.1 There are no specific protections for recreational users of the conservation area affected by WUG

The District Plan noise standards within the Conservation (Indigenous Forest) Zone only apply at designated campsites. The closest site is the Wentworth Valley Campground, which is approximately 6 km north of the WUG orebody and 12 km north-west of the Willows Portal site.

We understand that the area is used for recreational activities such as hunting, with a few established walking tracks. Potential noise effects on these recreational users are likely to be transient as they pass by active sites or helicopters fly overhead. In addition, our measurements show that in the vicinity of streams, where recreational users are often located on the tracks, ambient noise levels are significantly higher, thus providing a degree of masking noise. These effects are discussed further in Section 10.3 and Section 10.4.

We consider that specific noise limits are not appropriate to address these transitory effects, and instead recommend that general best practice to minimise noise levels and duration are implemented. This includes considerations such as noise enclosures, regular maintenance of equipment, minimise number of helicopter flights and times of day where practicable and noise monitoring to validate predictions. Noise mitigation and management is discussed further in Section 11.

6.0 NOISE CALCULATION METHODOLOGY

This section of the report sets out the noise calculation methodology and Sections 6 to 9 deal with discrete sections of WNP individually. These sections of the report present the noise levels from each of the four key areas of the WNP.

Cumulative results for all parts of the WNP are given in Section 11 for each year over the duration of the project.

We have undertaken a significant amount of 3D computer noise modelling to account for the spatial and temporal extent of works.

For each of the discrete activity areas, different scenarios were modelled for each year or activity phase. Combining these ultimately allows us to illustrate how the project's noise envelope will vary over its lifespan.

Cumulative noise from the areas of the project east of the township (i.e. excluding WUG) also requires consideration given the proximity of these activities. Table 7 below demonstrates how the components of the activity, excluding WUG, combine within each year, based on the input data provided by OGNZL. Cumulative noise effects have been calculated on this basis. Dark red shading indicates a unique activity scenario for that year and light red shading indicates a previous year's activity is assumed to continue.

The cumulative noise calculations are therefore a conservative representation because they assume that worst-case noise emissions from each portion of the project will occur concurrently, which is unlikely to be the case in practice.

Table 7: Summary of modelled operational scenarios for each year

Year*	Modelled Operational Activity Scenarios		
	GOP	NRS	TSF3
8			
9			
10			
11			
12			
13	*GOP TSF*		
14	*GOP TSF*		
15	*GOP TSF*		
16			
17			
18			
Legend:	**NEW ACTIVITY**	**PREVIOUS YEAR**	**NO ACTIVITY**

Because noise from the WUG portion of the project will not overlap with the portions closer to the town, we have presented the analysis of these noise levels separately in this report – refer to Section 10.0.

6.1 Noise Modelling Software

Computer noise modelling was undertaken using the SoundPLAN suite of noise modelling software (version 8.2). This software implements calculation procedures described in International Standard ISO 9613-2:1996 *"Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation"*, with adaptions as appropriate from ISO/TR 17534-3:2015 *"Acoustics – Software for the calculation of sound outdoors – Part 3: Recommendations for quality assured implementation of ISO 9613-2 in software according to ISO 17534-1"*.

This method accounts for a range of factors affecting 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
- Meteorological effects such as wind gradient, temperature gradient and humidity.

The effect of meteorological conditions is simplified in ISO 9613 by calculating the average downwind sound pressure level. The Standard adopts the conservative approach of assuming "supportive" propagation conditions, assuming that wind is always blowing from the noise sources to the receiver locations (i.e. in all directions simultaneously).

6.1.1 Assessment Considerations

Noise levels have been predicted to enable an assessment in accordance with NZS 6802:2008. The method described in this Standard requires the derivation of a "rating level" (L_R) that is compared with a given noise limit. This rating level accounts for:

- Adjustments for any special audible characteristics (e.g. tonality or impulsiveness)
- Adjustments for duration (except for activities occurring at night).

NZS 6802 also recommends the use of a "reference time interval" of 15 minutes. This is the time interval over which each individual time-averaged sound pressure level is measured. All noise levels presented in this report are rating levels (L_R) in dB calculated by averaging the $L_{Aeq\ (15\ min)}$ over the daytime period allowing for the above adjustments, except where specific assessment for certain sources are required (helicopters).

No averaging has been allowed for in calculations of night-time noise scenarios.

6.1.2 Selected Receivers

We have selected representative receivers for each aspect of this project and have reported discrete noise levels at each of these in our report (section 11). This is complimented by area wide noise contour calculations that show the spatial noise emission extent.

The selected receivers were chosen because of their likelihood to be most adversely affected by noise generated from different parts of the project. This includes consideration of how close they are to the project, and the presence of, or lack of existing screening. They therefore represent the reasonable worst case locations and thus if noise levels are compliant at these representative receivers, they would be compliant everywhere else.

However, as detailed in section 7.3 with respect to Gladstone, it became clear that noise levels at that particular location were just exceeding the criteria in some localised and specific locations and therefore additional receivers have been reported in that section.

6.1.3 Modelling Parameters

Our modelling is based on the following physical parameters:

Table 8: Summary of significant modelling parameters

Variable	Input
Terrain elevation	Wide terrain from LINZ 8m DEM[9] Base elevation surrounding site from LiDAR scans provided by OGNZL Annual contours for each pit/raise provided by Engineering Geology Ltd
Ground absorption	Generally defined as 'mixed' (G = 0.5) Hard (G = 0.0) areas defined for: • All OGNZL worksite areas, stockpiles etc. • Waihi township urban area • Water areas such as TSF ponds
Source positions	All heights of equipment in Table 9 relative to local terrain elevation.
Receiver positions	All receiver dwellings assumed to be single storey. Calculated at the rural notional boundary line or urban property boundary, at 1.5 metres above ground
General barriers and obstacles	Majority of buildings modelled at 5m height (based on LINZ NZ Building Outlines) No fences, bunds, etc. accounted for outside of OGNZL properties
Spatial definition	All points referenced to LINZ cadastral boundaries (*NZ Primary Parcels*)
Vegetation attenuation	No losses assumed from any plantings or vegetation.

For terrain data, OGNZL also provided working elevation contours for each of the four areas, which broadly all involve creating either pits or embankments/stockpiles. These data have been combined with terrain information noted above.

The input data (in terms of noise sources) used for the GOP, NRS and TSF3 components of the project is similar, given that they all generally make use of standard earthmoving and mining plant. The assumptions on these are given below in Table 9.

Noise data for the WUG, Processing Plant and other minor elements is more specific to those project components. The input data for these are discussed later in the respective sections of this report.

Table 9: Operational noise source data for GOP, TSF3 and NRS models

Plant/Equipment	Level, dB L_{wA}	Height, m	Operating Time*, %		
			GOP	TSF	NRS
Cat 16G 32t Grader	110	3.0	54	41	25
Cat 20t Excavator	103	2.0	-	-	50
Cat 50t Excavator	109	2.5	81	67	25
Cat 777 165t Dump Truck	115	3.5	81	-	-
Cat 785 140t Haul Truck	114	4.0	-	67	75
Cat 825 35t Compactor	110	3.5	-	67	20
Cat 992 100t Loader	116	4.0	-	58	-
Cat 988 51t Loader	110	3.0	81	-	-
Cat D10 70t Dozer	115	4.0	54	58	50
Drilling Rig	115	4.0	81	-	-
Hitachi 180t Excavator	120	4.0	81	-	-
Komatsu D65 23t Dozer	106	2.5	-	67	50
Underground Truck	114	2.0	100	-	-
Volvo 20t Dump Truck	110	3.0	81	67	75
Water Cart	117	3.0	38	41	25
GOP RoM Crusher	119	4.0	100	-	-

** Operating time is the percentage of daytime shift that plant is in use for.*

6.2 Construction Noise

The activities considered as construction noise were identified in Section 5.1. Broadly, this includes the following types of sources:

- Earth moving machinery to prepare land, remove overburden and construct noise control bunds, etc.
- Excavation of tunnel portals using mining techniques such as drilling and blasting.
- Civil engineering plant for internal road and haul route construction, plus realignment and installation of services in the public road corridor.
- Standard construction plant such as cranes and telehandlers to establish site infrastructure and surface facilities.
- Surface connection of the WUG ventilation raise sites.

Examples of typical construction equipment noise source levels used in our assessment are given below in Table 10.

Table 10: Indicative noise levels for typical construction equipment

Noise Source	Noise Level, dB L_{wA}	Height, m
Drill rig (orebody exploration)	111	2.0
Road planer	110	3.0
Vibratory plate	108	1.0
Water pump (orebody exploration)	107	1.0
Hand-held circular saw	107	1.0
Water tanker vacuum pump	107	2.0
Dumper	107	3.0
Vibratory compactor on excavator	106	1.5
Tracked excavator	103	1.5
Asphalt paver & tipper	103	2.0
Vibratory roller	103	1.5
Mini excavator	102	1.0
Compressor	93	1.0
Water pump	93	0.5
Dumper (idling)	91	3.0

Calculations of construction noise were in line with the general environmental noise modelling described above. The main difference in assessment methods is that the construction noise Standard (NZS 6803:1999) applies to noise levels received at the façade of occupied buildings, whereas the general District Plan noise standards apply at either the site or notional boundary.

Most of the activities listed will occur on OGNZL property and generally at the primary worksites. We understand that the main construction works occurring outside of OGNZL land or works areas will be associated with WUG and Willows Road to construct the services trench to the Waihi Processing Plant (via SH25) and Willows Road and likely intersection upgrades required for traffic engineering purposes. These have been consented under a separate RMA process and are not considered in this assessment.

For any construction work, noise levels will typically vary significantly over the course of the project, depending on the nature and location of activities. As such, we have primarily focused more on the calculation of minimum setback distances, rather than the investigation of noise levels at specific receivers.

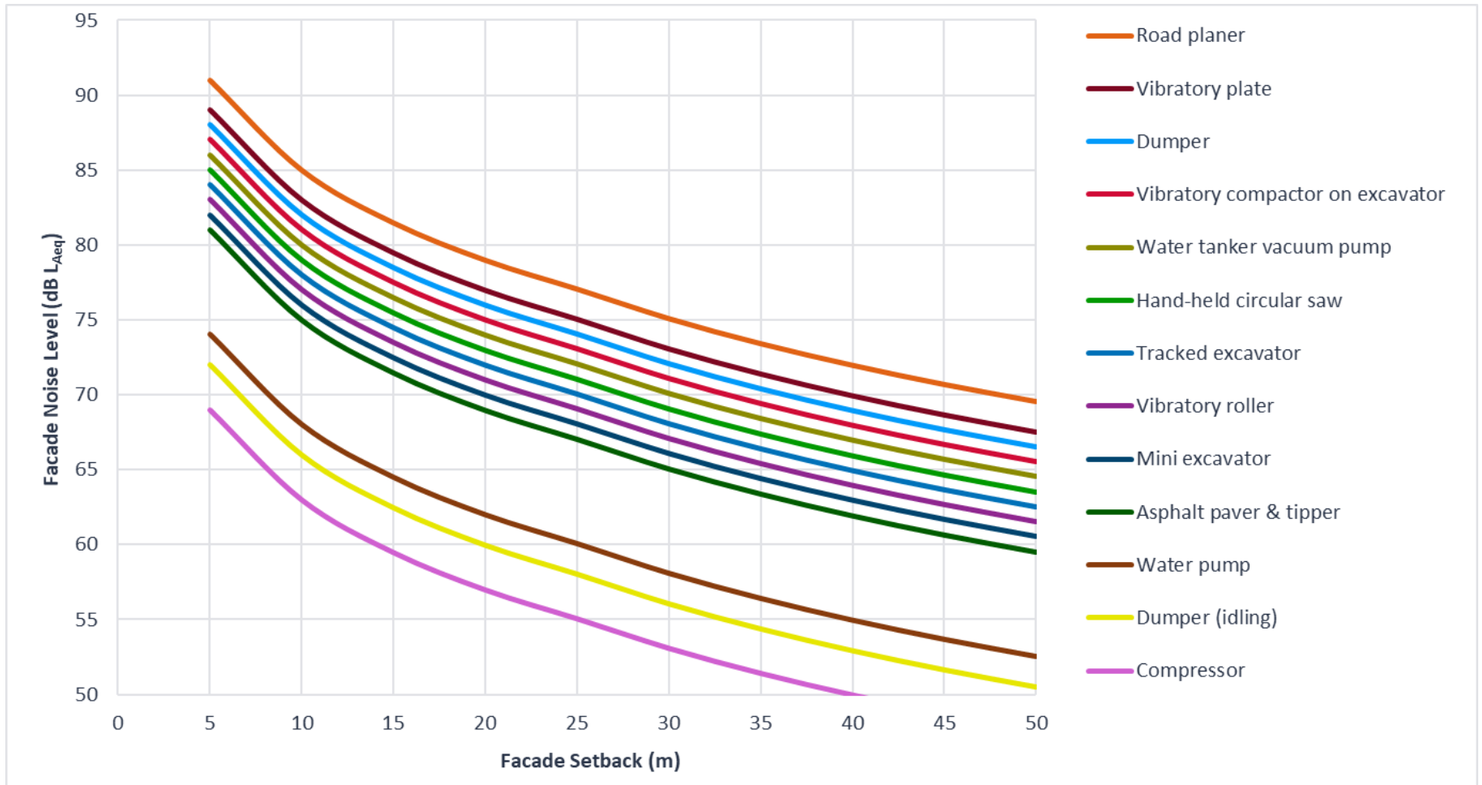
[9] NZ 8m Digital Elevation Model (2012), National Topographic Office (from LINZ)

The setback distances from construction activities indicate the typical area beyond which compliance can be achieved with the construction noise limits. Where receivers fall within a non-compliant area, the distance-based approach can help manage activities by defining trigger levels for mitigation action. Examples of the typical noise propagation for conventional equipment are given in Figure 11 below.

The data indicate that, for noise from individual sources, compliance with the 75 dB L_{Aeq} construction noise limit for typical duration works (see Section 3.2.2) is achieved at distances from below 5 metres up to 30 metres, depending on the type of source.

However, noise levels could be increased where multiple equipment operates simultaneously. Therefore, in addition to this generalised assessment method for construction noise, we have also given further consideration to some specific construction activities that are considered more high risk, factoring the cumulative noise from multiple activities or equipment.

Figure 11: Noise level regression for typical construction equipment



These are addressed in the respective report sections for each component, and in particular relate to:

- Stripping of Gladstone Hill down to 1142 mRL.
- Initial portal construction (adjacent to the Processing Plant).
- Stockpile preparation at the NRS and TSF3 worksites.

While these are not representative of every stage of activities, the examples are provided to demonstrate how different receivers may be affected from any given activity.

6.3 Helicopter Noise

Helicopter noise calculations have also been undertaken in relation to the WUG support flights. Helicopters will be used to transport staff and lift equipment between the vent raises, drill sites, camps and the offsite helipads at the Golden Cross Mine, Baxters Road, and Willows Road Farm.

The helicopter noise calculation procedure has been performed in accordance with DIN 45684-1:2013 “Acoustics – Determination of aircraft noise exposure at airfields – Part 1: Calculation method”. The methodology in this standard allows the acoustic screening of topography and buildings to be calculated.

For our assessment for noise emission in proximity to the residences in Waihi township and in rural areas in the District the L_{dn} noise level has been calculated in accordance with NZS 6807 using this method.

It is proposed to operate standard contractor-type helicopters, such as AS350 or EC130s (i.e. Class H1.1 from DIN 45684) for most flights. A larger helicopter, such as a UH-60 Black Hawk (i.e. Class H2.1) is proposed to lift heavier equipment during the vent shaft construction phase.

We have calculated noise from helicopter arrivals and departures separately to the helicopter construction activities where it would be hovering over a site for a certain period.

Based on data from OGNZL, we have modelled the proposed worst-case scenario of 60 movements in one day (30 flights), between the ‘Southern’ Helipad (forest site) and three helipads with the following distribution:

- 50% Willows Road ↔ Forest Site 30 movements
- 36% Baxters Road ↔ Forest Site 21 movements
- 14% Golden Cross Mine ↔ Forest Site 9 movements

This means that typically in any one 15 minute period there would be just under two flights.

7.0 GLADSTONE AND PROCESSING PLANT NOISE CALCULATIONS

7.1 Gladstone Open Pit (GOP)

A major component of the WNP is the development of a new open pit mine on what is currently Gladstone Hill. The pit will be mined to a depth of 95 metres using conventional open pit mining methods. Development of the GOP will commence around project Year 8 and continue for the following six years.

This part of the project broadly comprises:

- Establishment and mining of a pit that excavates parts of Gladstone Hill and Winner Hill
- Replacement of the Favona portal and infrastructure and reinstatement to the north
- Establishment of Southern stockpile
- Haulage, crushing and conveying of rock to the tailings storage areas and the polishing ponds/Northern Rock Stack
- Operation of existing and new overland conveyor system
- Inclusion of a new crusher adjacent to the relocated Favona portal, used to crush rock from the Gladstone pit
- Construction of noise bunds or screens as described below.

The first few years of mining operations will be the critical phase in terms of noise emissions. Initial construction activities will occur from the top of Gladstone Hill, while initial mining will be at lower hill levels and then in a shallow pit. Noise emissions will be much lower when the GOP is ultimately excavated well below the surrounding ground level. The initial years, when the noise sources are more exposed on top of Gladstone Hill, are therefore our key focus.

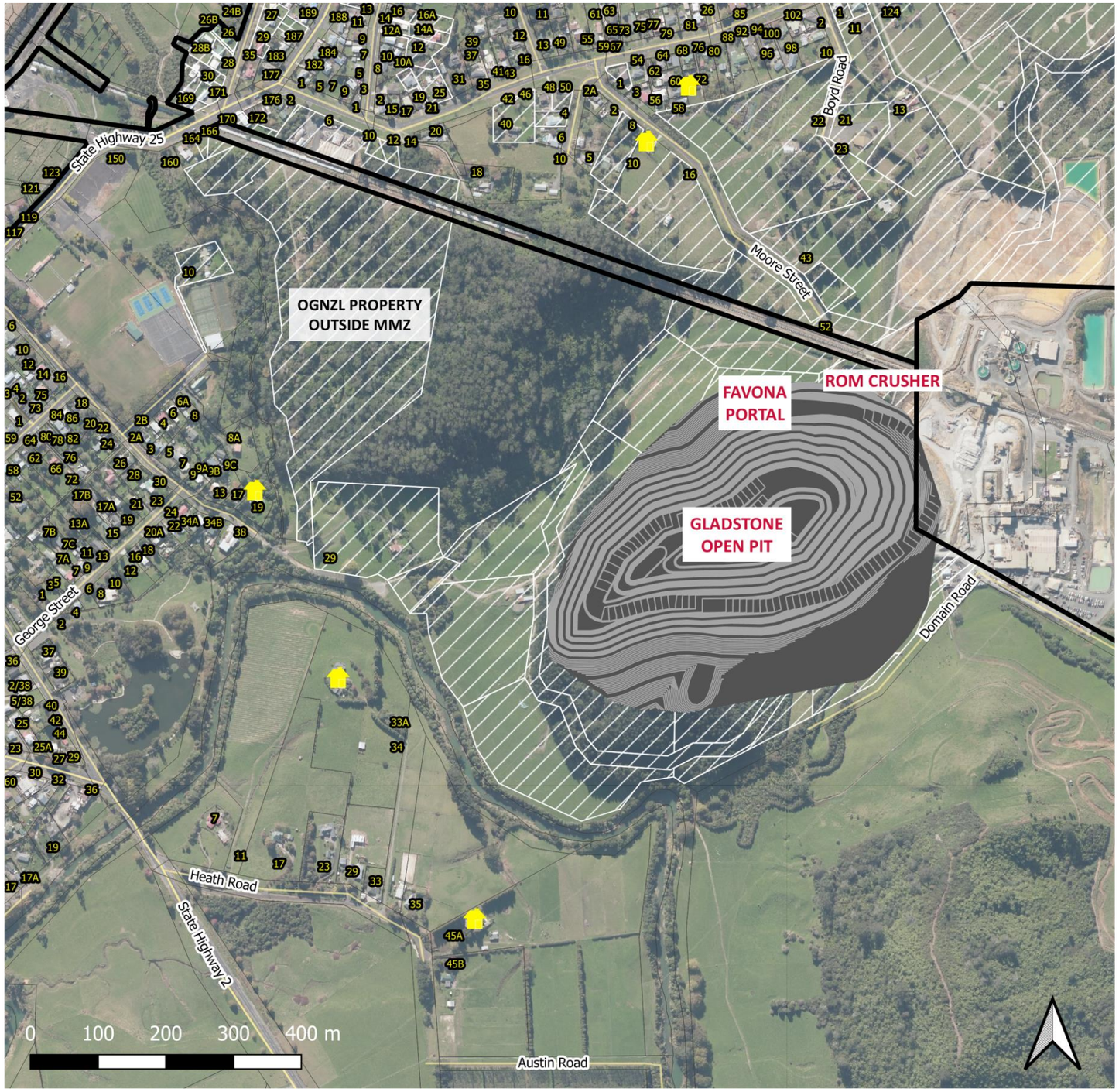
Following completion of the open pit mining works, backfilling and rehabilitation activities will transform the pit into a new tailings storage facility (the Gladstone TSF).

In terms of noise sources and machinery, the plant required for backfilling is likely to be reasonably similar to the mining plant. It is expected that the crusher will no longer be required, while the balance of machinery will shift towards bulk earth-moving plant such as dozers rather than specialist mining equipment like drilling rigs and large dump trucks and excavators and all would be working within the newly mined pit and therefore screened by the pit walls.

As shown in Figure 12, there are dwellings around the site to the north, west and south. The closest to the north are along Barry Road and Moore Street, which follows a valley towards the site, thus forming a 'corridor' between the hills for noise transfer.

To the south and south-west, mining operations are exposed to the closest receivers, with the dwelling at 33A Heath Road just over 300 metres from the western rim of the pit. Noise emissions to the west are effectively screened to residential areas by Union Hill.

Figure 12: Indicative extent of Gladstone pit works and surrounding receivers



7.2 Construction Activities

7.2.1 Gladstone Hill

As described in Table 6, a number of construction activities will be necessary to establish this worksite. The most significant in terms of noise experienced outside the MMZ are expected to be initial works on the hill, including topsoil stripping and removal of overburden, and construction of the MUG Portal with initial sections of the underground drives. The WUG Portal activity is described further in Section 6.2.2.

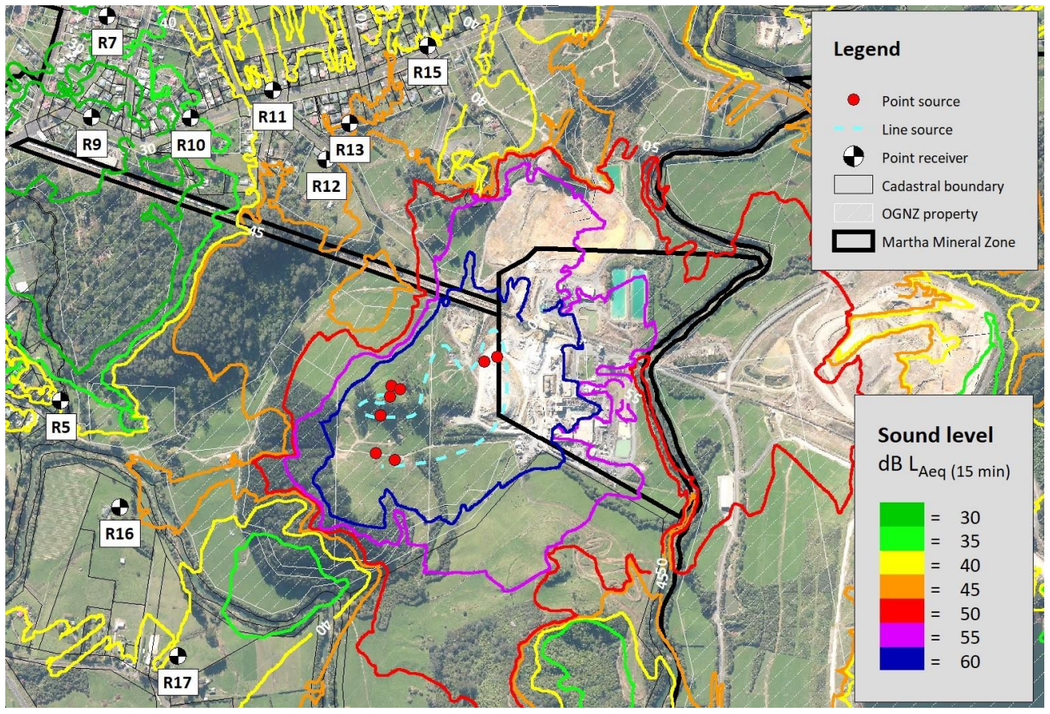
The initial phase of preparation will require earthworks plant to operate on the top of Gladstone Hill, where it will effectively be exposed to receivers on all sides. Noise emissions will, however, be somewhat limited in that only relatively small equipment can be used during this phase of operation, as the available working area is not extensive enough to accommodate the large 180 tonne excavator, for example.

Figure 13 shows noise contours from example construction works occurring on top of the hill. This assumes a scenario with multiple excavators (up to five, 20t - 50t), bulldozers (up to three, 20t - 50t) and articulated dump truck movements. The calculations show that noise levels will be around 45 dB L_{Aeq} at the closest dwellings.

Following these works to establish the site, the initial mining preparation will take place to form the pit and other ancillary features. For receivers of noise outside of the site, this phase will generally be a transition from construction noise to operational noise, and therefore marks a shift from noise being assessed under the construction noise standard (NZS 6803) to being assessed under the project's operational noise limits.

We expect that this transition will occur at the end of project Year 8, when the new GOP crusher becomes operational. Larger mining equipment will also be utilised by this time. Noise-generating activities from then on will be typical of ongoing operations, so it is most appropriate to assess against the operational noise limits.

Figure 13: Noise contours from Gladstone Hill construction activities



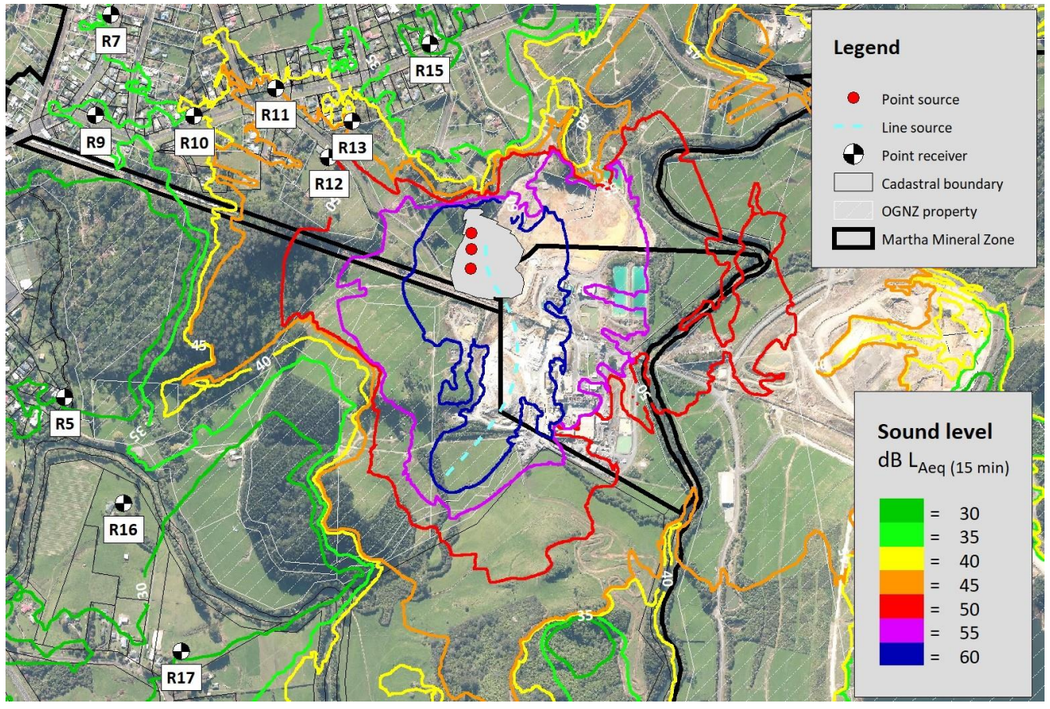
7.2.2 WUG Portal

A new portal will be constructed for the proposed materials handling tunnel to connect the WUG mine with the main site in Waihi. This will allow for transfer of ore to the Processing Plant and if needed, backfill material from the NRS. This portion of the project will also allow for the future development of a new portal to Martha Underground Mine.

We understand that the WUG portal will be achieved through a significant cutback to the Silverton Hill, beneath the company-owned dwelling at 23 Boyd Street. This cut will bring the ground level down to form a plateau around the same elevation as the polishing ponds area.

As previously, the initial earthworks at the top of the existing hill will be the most exposed to northern receivers. We have calculated likely noise levels based on excavators, bulldozers and dump trucks working in this area, with the results shown in Table 11 and Figure 14 below.

Figure 14: Noise contours from WUG Portal construction activities



Calculated noise levels at select receiver locations are given below. Compliance is achieved at all locations.

Table 11: Construction noise levels around Gladstone Hill and the WUG Portal at select receivers

Receiver	Calculated noise level, dB L_{Aeq}	
	Gladstone Hill Construction	WUG Portal Construction
R11 – 55 Barry Road	45	43
R12 – 10 Moore Street	48	44
R13 – 72 Barry Road	45	47
R15 – 107 Barry Road	31	42
R16 – 33A Heath Road	34	44

7.3 Operational Noise Emissions

Noise from the Gladstone operations, in addition to the Processing Plant and WUG Portal, will be one of the primary aspects of WNP in terms of noise effects on receivers. Receivers on both the northern and southern sides of Gladstone Hill will experience noise from these works.

As previously indicated, the early years of GOP development will be most critical for noise emissions, because large mining plant will be used and the machinery will be at a relatively shallow level in the pit.

We have predicted noise levels at the selected representative receivers identified in Section 6.1.2. During the course of our analysis it became clear that additional dwellings would need consideration for Gladstone.

This is because we observed there are a number of localised and discrete areas where noise levels may potentially be above 50 dB, primarily on Barry Road, Knowles Crescent and Moore Street and to a lesser extent George Street.

Figure 15 overleaf shows just the 50 dB L_{Aeq} cumulative noise emission contours for the first three years (assuming no mitigation) and the location of the representative receivers. This Figure shows there are a number of receivers located near the 50 dB L_{Aeq} contour and a couple of receivers just inside the contours. This figure should form the starting point of investigations, prior to works commencing, on what mitigation options shall be considered to ensure noise levels comply with the proposed noise limits.

The discrete noise levels at the representative receivers and the additional receivers, are given in Table 12 below.

Table 12: WNP Noise levels at all receiver locations

Receiver No. (Figure 15)	Address	Calculated Noise Level per Year, dB L_{Aeq}									
		Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y17	Y18
4 (West)	14 George Street	48	51	49	46	44	44	40	41	31	34
11 (North)	55 Barry Road	52	51	50	50	50	50	42	43	34	36
12 (North)	10 Moore Street	54	53	52	51	51	51	44	45	36	38
13 (North)	72 Barry Road	54	53	52	51	51	51	44	45	34	37
16 (West)	33A Heath Road	51	54	53	50	48	47	43	45	33	35
18 (South)	36 Baxter Road	51	49	48	47	46	46	38	42	29	31
Additional Identified Receivers											
	13 Banks Street	52	51	49	48	48	48	42	42	34	36
	16 Banks Street	51	50	49	49	49	48	43	44	36	38
	49 Barry Road	52	51	50	50	49	49	42	43	34	36
	59 Barry Road	52	49	48	46	45	45	41	42	33	36
	56 Barry Road	55	54	53	53	52	52	45	46	35	37
	58 Barry Road	55	54	53	52	52	52	45	46	36	39
	73 Barry Road	51	49	47	47	47	47	42	43	34	37
	76 Barry Road	51	49	48	46	46	46	42	43	33	37
	80 Barry Road	51	49	47	45	45	45	41	42	34	37
	10 George Street	48	51	48	47	45	45	41	41	31	34
	12 George Street	48	51	48	46	44	44	40	41	31	35
	16 George Street	49	51	49	46	45	44	40	41	31	34
	18 George Street	49	51	48	46	44	44	40	42	31	34
	17 Heath Road	48	51	51	49	47	46	40	41	31	33
	23 Heath Road	48	52	51	49	47	46	40	41	32	34
	29 Heath Road	49	51	51	48	45	45	39	45	32	34
	2 Knowles Cres	51	49	48	47	47	47	42	43	35	37
	2A Knowles Cres	52	51	50	49	49	48	43	44	35	37
	3 Knowles Cres	53	52	51	51	51	51	43	44	35	37
	5 Knowles Cres	52	50	50	49	49	49	44	44	36	39
	3 Moore Street	54	53	52	52	51	51	45	45	36	38

Legend: *Potentially reduced by further mitigation.*

It can be seen that unmitigated noise levels are predicted to be above 50 dB L_{Aeq} at 27 receivers (51 to 55 dB L_{Aeq}) in relation to works in the Gladstone area for approximately one to six years.

With respect to the actual noise effects for receivers at 51 to 55 dB L_{Aeq}, the adverse effects of noise are not a 'binary' effect that switch on/off at 50 dB. It is not true to say that there are no adverse effects at 49 dB and there are significant adverse effects at 51 dB. Noise effects gradually increase with noise level on a 'grey scale'. For this project it has been determined that 50 dB is an appropriate objective to keep the noise level below as the adverse effects at this point are reasonable and would be acceptable to most people.

20 of these 27 receivers are predicted to experience 51 to 52 dB L_{Aeq} for one to three years. The other seven dwellings are predicted to experience 53 to 55 dB L_{Aeq} for one to four years with smaller exceedances for a further one to four years. For some years the noise level is only one to two decibels above the criteria.

In terms of the effect when noise is above 50 dB, we note that:

- For noise levels at 51 and 52 dB (20 receivers) the effects are not discernibly different to 50 dB – they are higher than the objective, but not discernibly different.
- For noise levels at 53 dB to 55 dB (seven receivers) the adverse effect becomes more discernible, and warrant mitigation.

Overall, it is our opinion that noise levels in excess of 50 dB L_{Aeq} would have a small adverse impact on the level of amenity these properties experience. This is primarily for those few houses where the exceedance is three to five dB. For those with just a 1 dB exceedance the adverse impact on the level of amenity is very small.

We reach these conclusions based on the existing daytime noise environment (39 dB L_{A90} and 46 dB L_{Aeq}), and the general lack of existing exposure to mining noise in this area. This is as well as the overall noise level received, including the periods during the week when that noise is experienced. Despite there being a barely discernible difference in noise level between 50 dB and 53 dB, it is just sufficiently high to cause an impact.

We acknowledge that the increase above background noise levels would be significant at times, and because of the character of the noise noticeable, but the overall noise level would not exceed what is considered reasonable.

To put into context these small exceedances, the District Plan already contains a rule effectively permitting the nearby process plant to emit noise at 55 dB L_{Aeq} (referenced in Rule 5.17.4.1 of the District Plan). This suggests mining noise is somewhat expected to exist in this local area, and in the wider district.

In addition, and as noted in Section 5.1, these calculations are considered conservative because they are prepared on the assumption that receivers are always downwind of the noise source – a small increase in propagation towards them. This is not always the case in practice and the noise levels will often be less than predicted.

However, the overall conclusion that a small adverse effect is predicted to occur for a small number of houses and mitigation for these receivers is recommended.

This recommendation is fully adopted in the proposed conditions, which set out a mechanism to be followed to ensure noise levels do not exceed the project criteria at any dwelling (not owned by OGNZL or subject to an agreement with OGNZL).

This mechanism is primarily focussed on the use of a management plan approach, this is broadly similar to the nationwide use of such management plans to control construction noise. The key difference in this case is that there is no scope to exceed the noise limits in the proposed conditions. This provides the certainty that the noise effects for all dwellings would be acceptable.

In summary, the proposed conditions require that a noise management plan (NMP) be prepared to outline the methods to be used to ensure noise levels do not exceed 50 dB at any residence. The NMP will prescribe a noise mitigation development process that will occur prior to operations commencing, that will set out the options considered and provide certification that noise levels comply. These options would include (but not be limited to):

- The use of quieter machinery (determined by a noise source characterisation procedure)
- Restrictions on operating hours
- Bespoke screening of individual sources
- Screening of noise sensitive receivers
- Noise monitoring programmes (including noise modelling and measurement regimes, which can be continuous or targeted)
- Investigation of bespoke noise monitoring software to allow proactive management of site noise emissions before non-compliance occurs

Further discussion on mitigation options is given in Section 11, and an example of an initial mitigation analysis process that the NMP may adopt is given in Appendix C. In this case a series of screening options were considered.

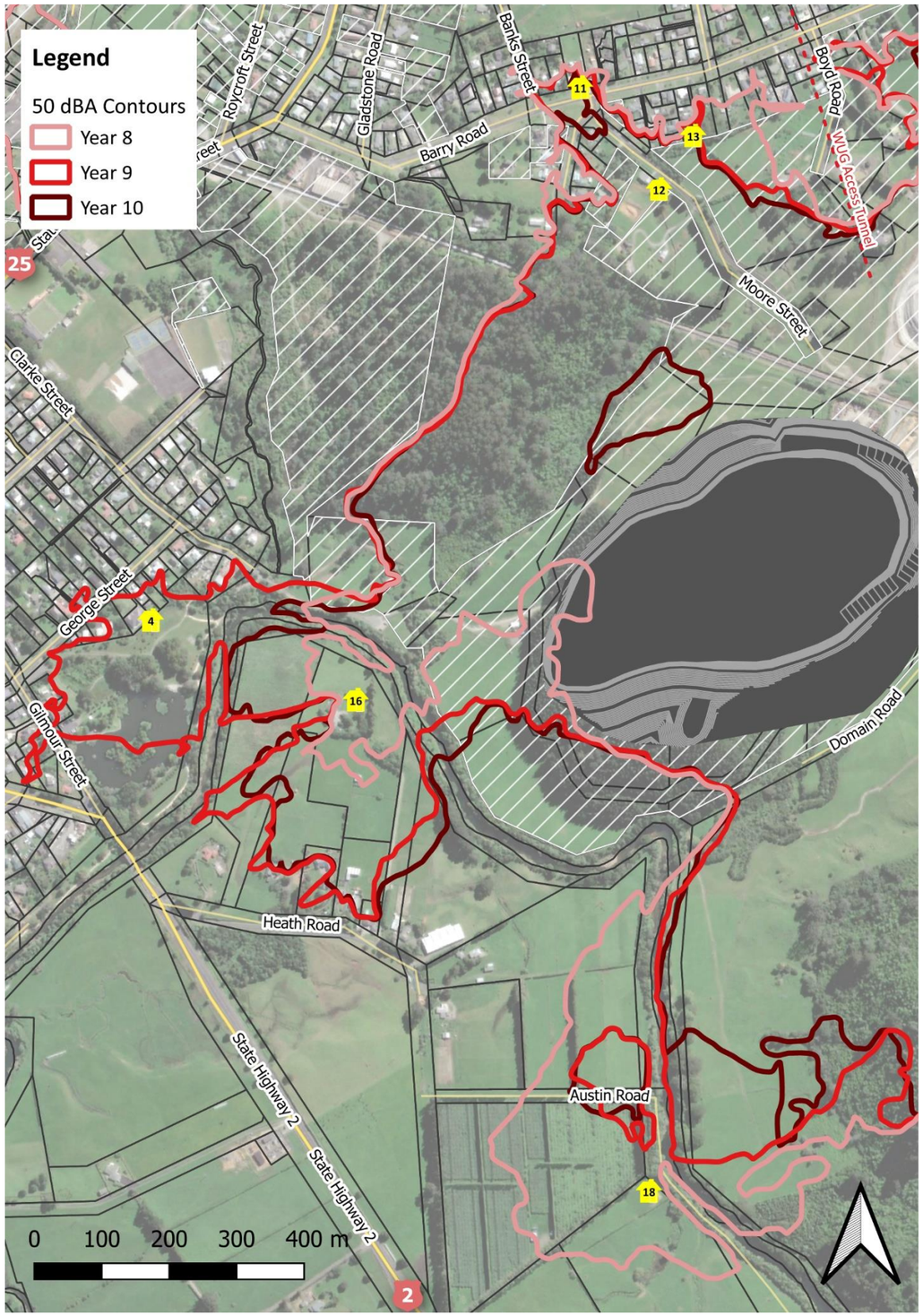
As the proposed conditions require compliance to be achieved through the use of a NMP, then we consider that GOP noise emissions would be adequately managed and that therefore the resultant noise effects would be acceptable.

Regarding night-works, we understand that at most, only minimal low intensity operations may occur at night (or Sundays). This is because the night-time limit of 40 dB L_{Aeq} restricts what is possible, because a level of 40 dB L_{Aeq} inherently does not permit high noise emission activity.

The approach taken in the conditions is that the night-time activities will be managed and/or limited to ensure compliance with the noise limits. The Noise Management Plan required by the conditions will be the mechanism for confirming what night activities are able to meet the night-time noise limit of 40 dB *before* commencing.

Any assessment of night-time operations would also need to consider the periods of the night during which operations are proposed, which could well be the quietest times.

Figure 15: 50 dB L_{Aeq} noise contour for GOP operations Year 8 – Year 10 (cumulative levels, no mitigation) with 'Representative Receiver' locations



7.4 Processing Plant

The Processing Plant will be upgraded to facilitate the additional throughput and extended lifespan resulting from WNP. We have assumed the plant upgrade would occur prior to Gladstone operations commencing and so is in effect a worse-case scenario. As we set out in Section 5.1, all the activity occurring for the Processing Plant upgrades is considered as construction noise. This means that less stringent noise criteria would apply. However, we note that the adoption of the BPO is still required.

The main aspects of this upgrade are:

- Replacing the current pre-feed crusher with primary crushing plant relocated from Reefton
- Replacing the existing SAG mill with that from Reefton
- Replacing the existing pebble crusher
- Installing a new ball mill adjacent to the new SAG mill
- Converting the existing SAG mill into a ball mill
- Additional car parking areas near Martha mine, and Baxter Street
- New substation with associated transformers and switchgear.

While some large new items of plant are proposed, this is expected to only have a relatively small effect on overall operational noise emissions from the Processing Plant.

The modelled major component operational sound power levels are as follows:

Ball mill (open):	113 dB L_{wA}	Jaw crusher:	113 dB L_{wA}
Primary crusher:	119 dB L_{wA}	Mobile crusher:	117 dB L_{wA}
Cyclones:	98 dB L_{wA}	SAG mill:	116 dB L_{wA}

We understand that the existing Water Treatment Plant (WTP) will also be upgraded to around double the current capacity, but that no new major noise sources are anticipated for the operation of this part of the project.

Figure 16 demonstrates the change in noise level after the Processing Plant upgrade. This is based on the existing topography and represents the Processing Plant alone, without inclusion of noise from other mining operations. This allows an assessment of the change in noise emission from the Processing Plant only and is useful because there are some occasions when other proximate mining operations may not actually be occurring.

The calculations show that there is a general increase in noise levels as a result of the Processing Plant upgrades but also a small decrease to the south-west. For the relevant receivers (Barry Road environs), noise levels increase by approximately 3-5 dB.

This is a barely discernible to just noticeable increase. Taking account of the fact that generally, other mining operations often contribute more noise to these receivers, increased Processing Plant noise levels are unlikely to be discernible for much of the time.

For context, the mean noise level increase at all receivers analysed is 3 dB. Of the few that have a calculated increase of up to 5 dB, the Processing Plant contribution is still below 40 dB L_{Aeq}, compared with overall mining noise levels of around 45 dB L_{Aeq}. This means that the Processing Plant will still be an audible source of noise (relative to other mining operations) but will not be dominant – the relative noise levels of most significant mining plant will be broadly similar.

Those that receive the highest levels of Processing Plant noise up to 44 dB L_{Aeq} – are subject to a less notable increase and are generally the most affected by all noise from the Gladstone project area. Again, the Processing Plant will not be an exceptional noise source within the wider WNP.

Overall noise emissions for the Processing Plant are compliant during the day.

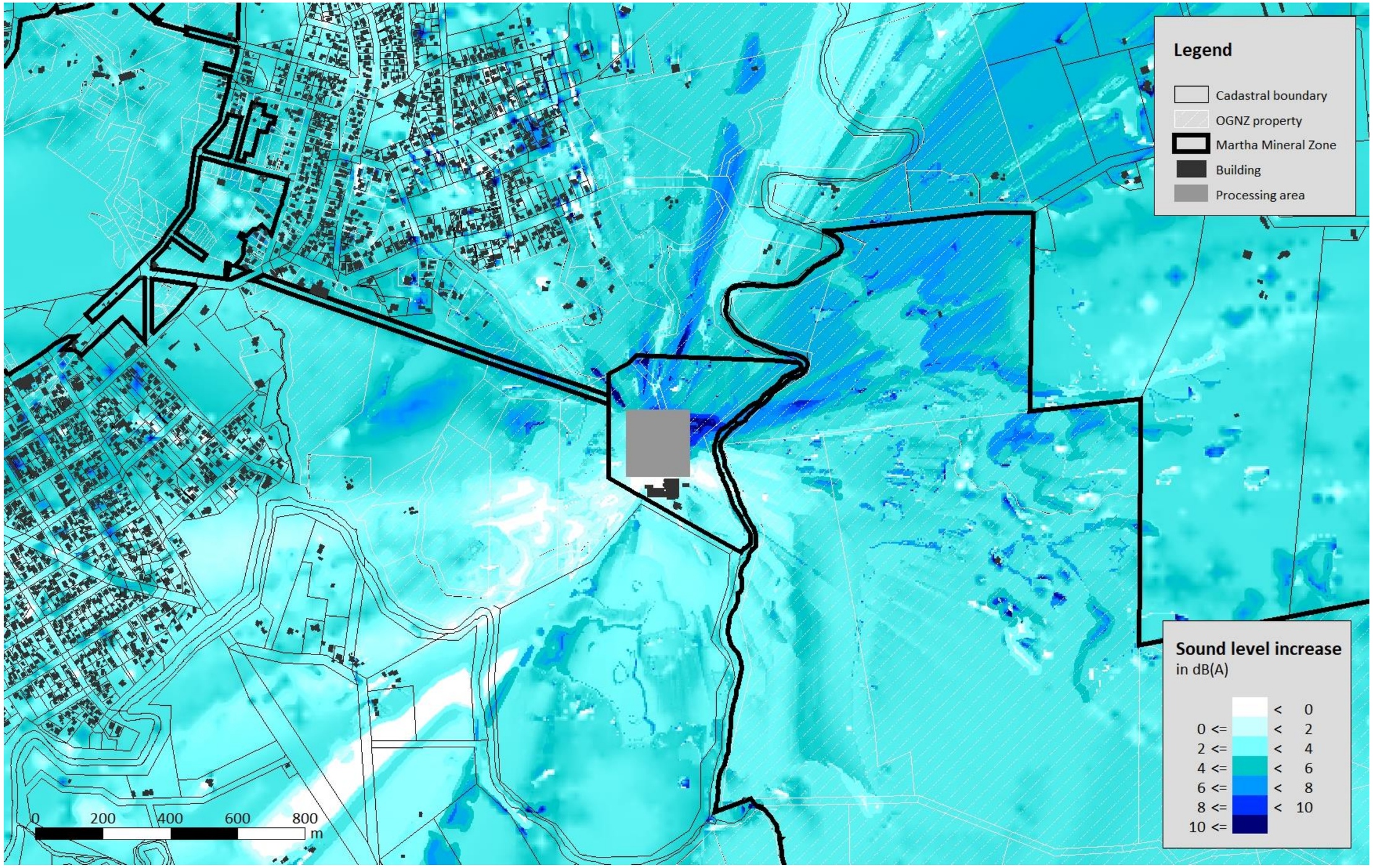
However, as shown above for the worst affected receivers, it is possible that noise levels at night may just exceed the night-time noise limit of 40 dB by a small margin. As the Processing Plant design is not possible to accurately model at this stage because the equipment is relatively unique, being sourced from other OGNZL sites around the country, and is currently not operational so we cannot measure the noise emissions, we have necessarily included some conservatism in the calculations. This means it is possible that once established on site, there is likely to be lower noise levels in practice.

In any event, and as for Gladstone, the proposed conditions require that a noise management plan (NMP) be prepared to outline the methods to be used to ensure noise levels do not exceed 40 dB at any residence not owned by OGNZL or subject to or with an agreement with OGNZL. The mitigation methods would include (but not be limited to);

- Restrictions on operating hours
- Bespoke screening of individual sources (primarily by the use of full enclosures)
- Screening of noise sensitive receivers
- Noise monitoring programmes (including detailed noise modelling of the new plant when installed and measurement regimes)

On this basis and with the above measures in place, we consider the processing plant noise emissions would be able to comply with the noise limits in the proposed conditions, and therefore would be reasonable from a noise effects perspective.

Figure 16: Comparison of future and existing Processing Plant noise

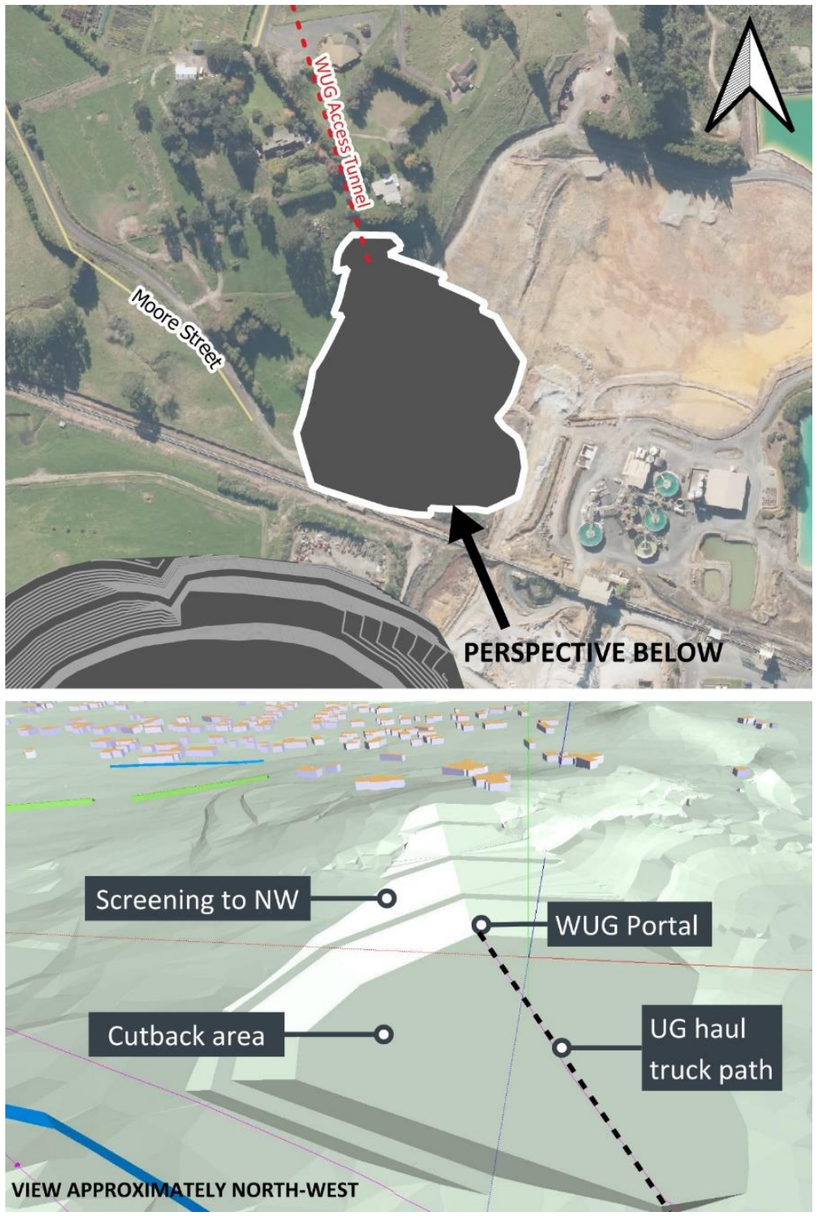


7.5 WUG Portal

We have considered the potential need to form bunds along the north-western shoulder of the WUG Portal cutback. While these may provide some small benefit to overall noise emissions from WNP (e.g. the Processing Plant), we do not think it is necessary to control noise from the WUG Portal alone.

Daytime noise emissions from portal use will be masked by other activities, while night-time movement of underground vehicles will be screened by the cutback edge, meaning that noise from the vehicles alone will be minimal.

Figure 17: Indicative WUG Portal layout



7.6 Ngati Koi Domain and Other Recreation Areas

We have also considered noise impacts on users of the recreation areas in close proximity to Gladstone, particularly Ngati Koi domain and the areas of Union Hill with public access.

Generally speaking, noise levels would be 50-55 dB L_{Aeq} from typical Gladstone operations, with some small areas of the existing motocross track exposed to noise levels of 60 dB L_{Aeq} at times.

By virtue of the nature of that recreational activity, users of the motocross track and to a lesser extent the mountain bike track on Winner Hill would not be particularly noise sensitive. Because of this, adverse noise impacts are unlikely to eventuate.

For any proximate walking tracks, we expect that for users of these, operational noise would be clearly audible. However recreational users inherently choose to come to these areas, would only be in the area for short periods and would in our opinion not be subject to unreasonable noise levels while in the vicinity. This is because noise levels would be only just above what would occur without the project in place and in addition, these areas are already subject to mining noise to a degree. This suggests that a user of these recreational areas would currently appreciate it would be subject to mining noise.

To provide some additional context, the predicted noise levels presented above would ensure a similar level of amenity protection as provided for by some District Plans that contain noise limits of 55 dB for residential activity. That is because in our opinion residential activity is inherently more noise sensitive than recreational activity. In other words, if the noise levels presented above would be acceptable in a residential context, they are entirely acceptable in this recreational context.

We also consider that based on the urban location of the tracks it is unlikely to cause annoyance.

8.0 NORTHERN ROCK STACK NOISE CALCULATIONS

The NRS is required to accommodate the significant amount of surplus rock created by mining for future re-use as backfill material and constructing TSFs or that is unable to be stored or utilised elsewhere. It will also accommodate non-ore-bearing rock from part of the WUG Access Tunnel. Non-ore-bearing rock from the remainder of the WUG development will be stored at the Willows Rock Stack.

The NRS will be located to the north-east of the Processing Plant. Smaller stockpiles will be created around the NRS to accommodate the topsoil that is necessarily stripped during its construction. These smaller stockpiles will be sited and formed to provide additional noise screening for the nearest neighbours wherever practical and would be around 10m in height.

The layout is shown in Figure 18. The equipment used in this process will again be typical of mining plant, though with more focus on heavy earthmoving machinery.

Development of the NRS will have the effect of bringing the project's activities closer to existing properties on Golden Valley Road to the north. The closest dwelling not owned by OGNZL is located at 669 Golden Valley Road, approximately 10 metres from the OGNZL site boundary. All other adjacent properties are owned by OGNZL.

This dwelling is reasonably distant from the main NRS – approximately 400 metres – and is partially shielded by the intervening terrain.

Figure 19 overleaf shows on the lefthand side the NRS construction phase (stockpiling), which will commence prior to the majority of WNP works and features heavy activity in the northern stockpile area. Figure 18 also shows on the righthand side the subsequent operational phase (main NRS activity). We note that the proposed stockpile then also provides screening of operational noise for the dwelling at 669 Golden Valley Road.

As can be seen overleaf, construction noise emissions are just above 50 dB L_{Aeq}, which indicates ready compliance with the day-time construction noise criterion given in Section 4. For operational activity, calculated noise levels are below 50 dB L_{Aeq} at all relevant receivers and are thus compliant with the operational criterion.

While this discussion focusses on the initial construction scenario in Year 8, we note that rehabilitation of the land and removal of the stockpiles after Year 15 will also generate similar levels of noise.

We note that any activity that occurs at night has to meet the much more stringent night-time noise limit of 40 dB L_{Aeq}. Whilst this noise limit does allow for some activity to be undertaken, it does mean night-time activity will necessarily be at a much lower intensity in order to comply. Any proposed night-time activity needs to be carefully considered in the NMP, required by the conditions, to ensure compliance.

Figure 18: Indicative plan of NRS location and layout

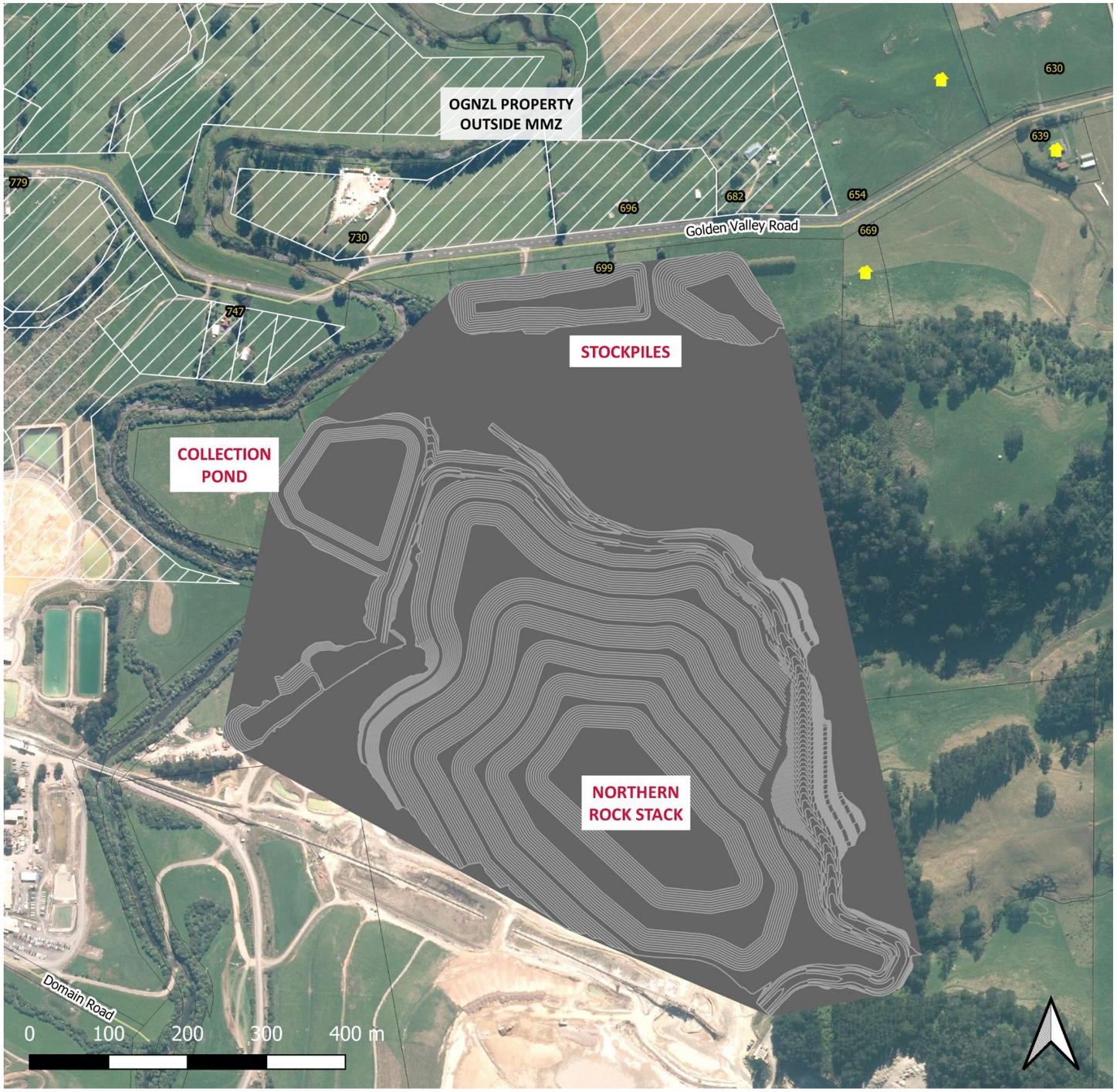
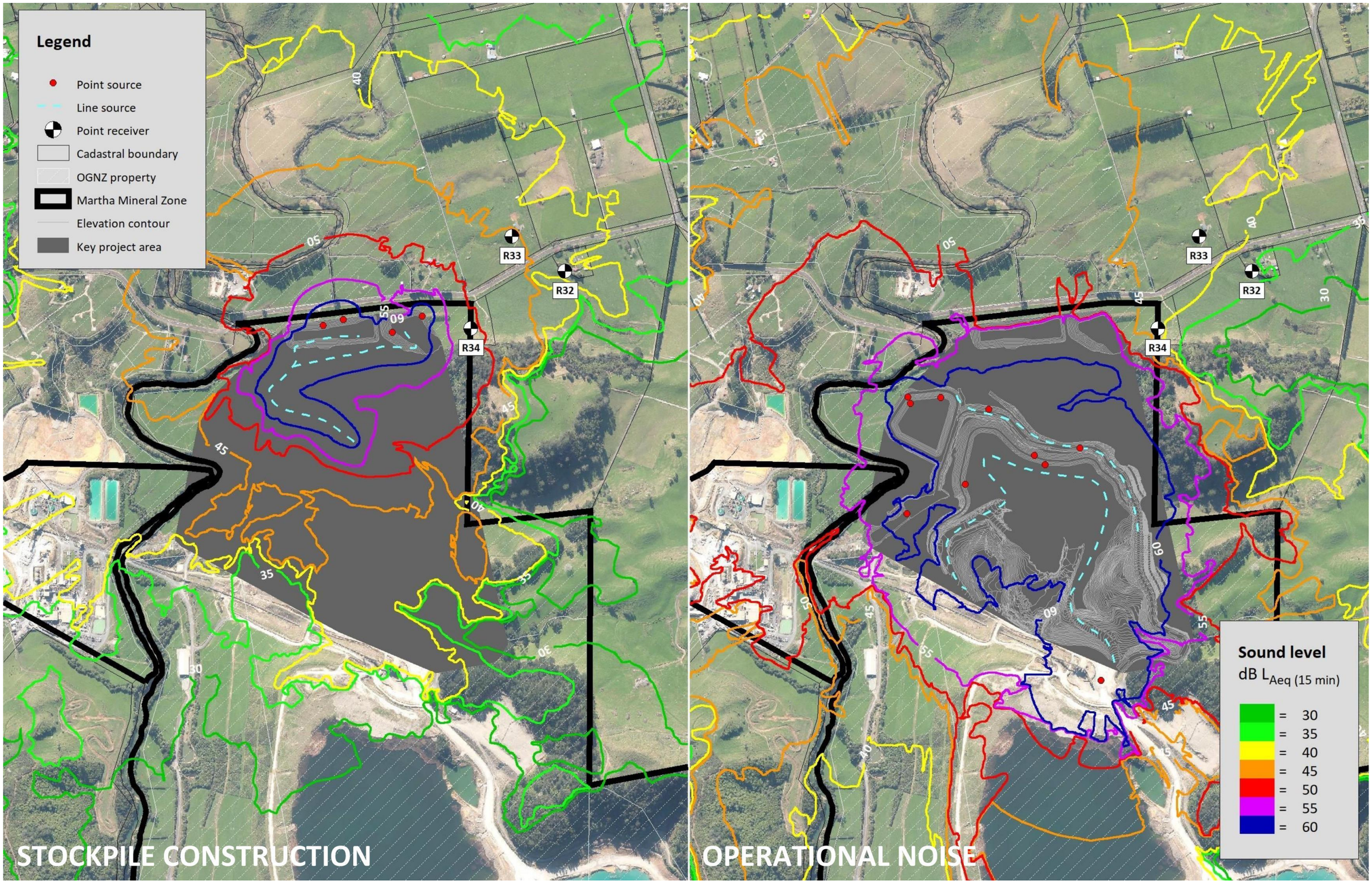


Figure 19: Noise contours for initial NRS works in Year 8



9.0 TAILINGS STORAGE FACILITY 3 NOISE CALCULATIONS

Another consequence of the expanded mining operation is the need to create additional capacity for tailings storage and associated borrow pits.

Expansion is already planned to the capacity of facilities TSF1A and TSF2 to meet existing operational requirements. The new TSF3 facility will be constructed for WNP. The Gladstone TSF will also provide some capacity in future years.

Figure 20 shows the key TSF activity areas. Details around the new Gladstone storage facility were previously discussed in Section 7.0.

The new facility will be approximately 53 m in height and have a target crest height of 1155 mRL and a 50 m wide crest. It's construction will bring OGNZL's activities closer to existing rural dwellings on Trig Road North. The closest dwellings (e.g. 131 Trig Road North) will be around 250 metres from the outer extent of TSF3 and associated stockpiles.

There will be little operational noise associated with any of the facilities, once constructed. Construction activity will, however, result in periods of elevated noise levels in the vicinity of the TSFs.

With the exception of the initial foundation earthworks and specific other works (Table 1) the overall TSF3 construction activity is sufficiently long and similar in character to normal mining activities that we consider it as an 'operational' activity, rather than 'construction'. Noise emissions from these activities should therefore be considered against the operational noise limits outlined in Section 5.0, rather than the less stringent construction noise limits.

However, initial excavation, backfilling of the embankment cut, topsoil stockpiles, the clean water diversion drains and haul road construction is treated and assessed as construction noise.

Because TSF3 construction will precede other parts of WNP, initial material for will be borrowed from pits in the TSF3 project area. This will comprise material being quarried from elevated areas and transported downhill to form the TSF3 embankments.

Material will first be sourced from the eastern borrow pit and then central pit. A final borrow pit is also ultimately likely to be created at the NRS, with material transported overland to TSF3.

Figure 21 shows that noise levels are generally higher to the southern side, with lower levels to the west and to the east, partially because of more effective screening by terrain and TSF 1A. Overall, noise levels from worst case TSF3 construction are below 50 dB L_{Aeq}.

We note that any activity that occurs at night has to meet the much more stringent night-time noise limit of 40 dB L_{Aeq}. Whilst this noise limit does allow for some activity to be undertaken, it does mean night-time activity will necessarily be at a much lower intensity in order to comply. Any proposed night-time activity needs to be carefully considered in the NMP, required by the conditions, to ensure compliance.

Figure 20: Designation of main tailings storage facilities (TSF1, 2 & 3)

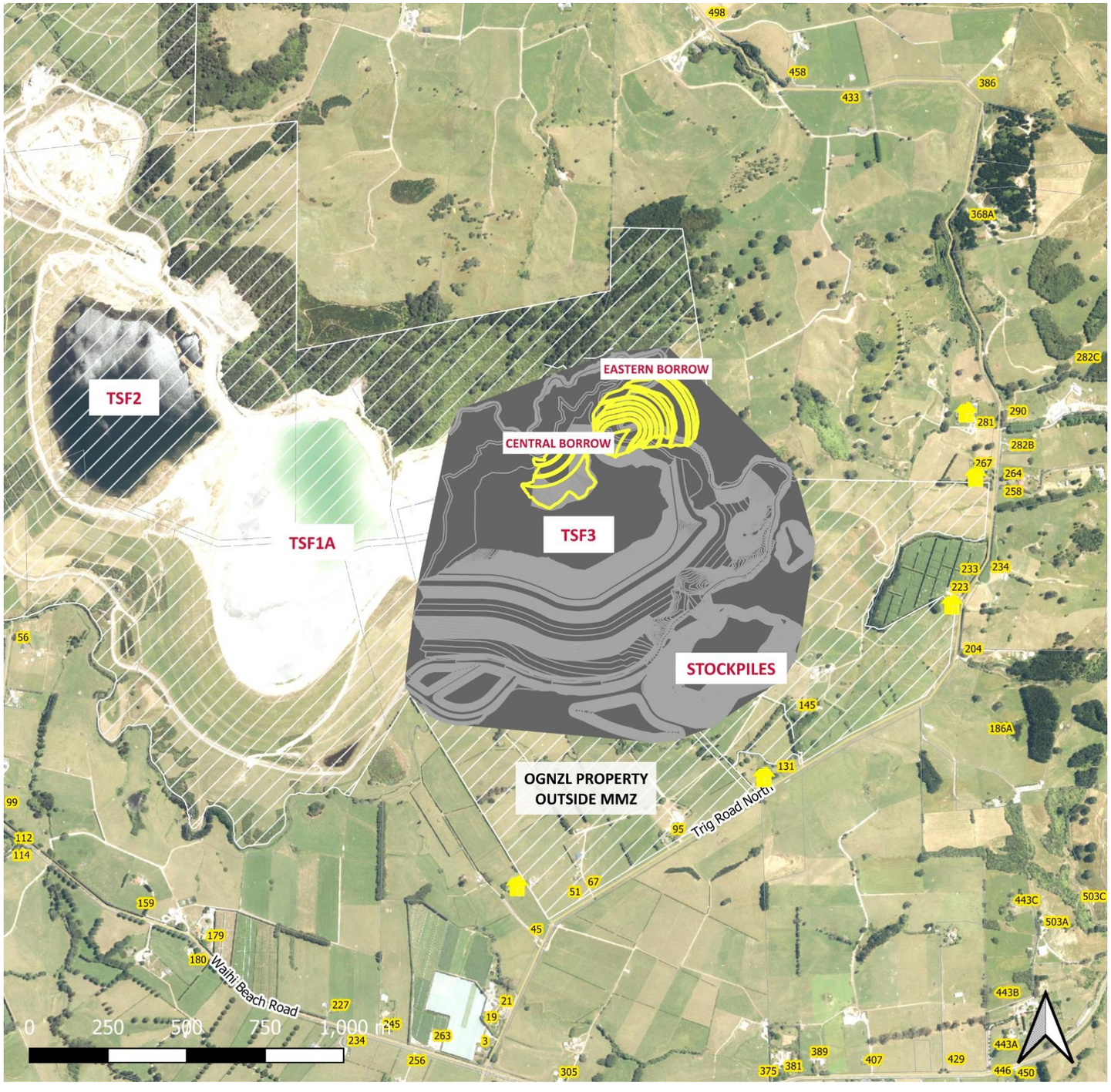
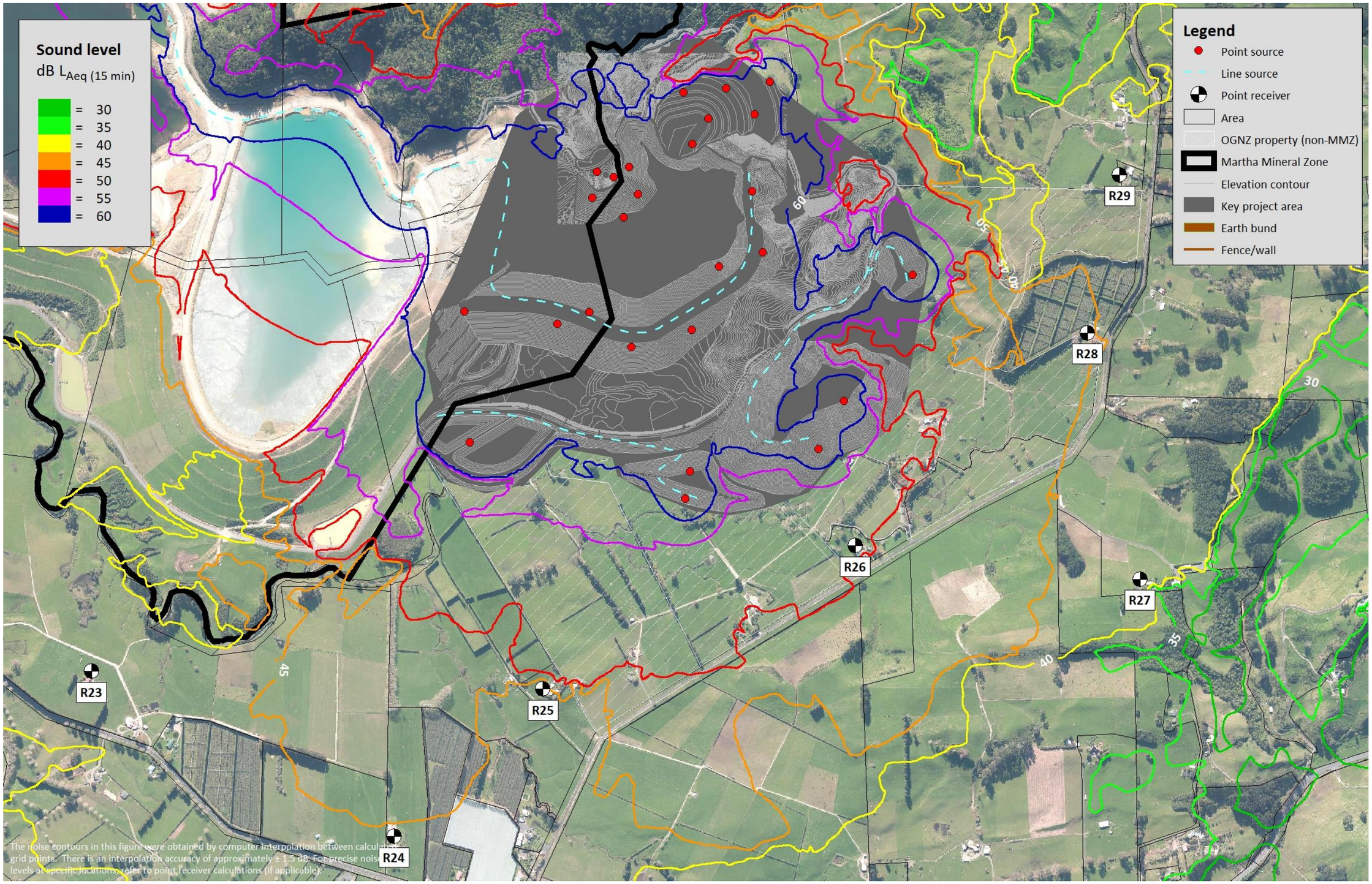


Figure 21: Highest noise emission contours from TSF3 works (Year 10 scenario)



10.0 WUG NOISE CALCULATIONS

The WUG aspect of the project involves a new underground mine and associated mine infrastructure to the north of Waihi Township. It involves the following main activities with the potential to create noise effects:

- Construction and operation of the Willows Portal, primarily from the portal to the first vent raise – where underground plant is nearer the portal
- Underground blasting and the transport of rock to stockpile (the Willows Rock Stack)
- Construction of the Surface Facilities Area (SFA) site and associated roadworks and earthworks
- Construction and operation of a vent raise within the Rural Zoned landholding (the 'farm raise')
- Construction of four vent raises in the Forest Park, including helicopter movements and surface works
- Additional exploratory drilling activity in the Forest Park, including helicopter use
- Ongoing operation of underground ventilation fans.

Activities like construction and stockpiling will only occur during the day. This is both to control noise and for operational reasons. Underground operations will progress on a 24/7 basis.

While activity will mainly be confined to within the tunnel at night, there will be some need for service vehicles to enter and exit the portal.

Drilling and raise boring/surface connection activities at the vent raise sites are also anticipated to be on a 24/7 basis, albeit for only a few weeks at any location.

10.1 Calculation Details

Noise-generating aspects of each of the key phases are given in Table 13. The discrete scenarios below are referenced later in this report with respect to our noise modelling.

Activities 1a, 1b, 3a and 3b are considered construction activities. Work to develop the tunnels and supporting facilities is expected to take around four years. This is broadly one year of site establishment and construction and three years of tunnel driving.

We note that a plant access tunnel of approximately 5 km will also be constructed to connect the Dual Tunnels with the Processing Plant at Waihi. While this is a major engineering operation, it will have limited surface noise effects. Our calculations therefore do not consider this as a standalone element, as the main short-term effects from establishment of the tunnel portal is captured in activities shown in Table 13.

The Willow Access Tunnel will initially be ventilated through use of an external, sound attenuated, containerised fan outside the portal entrance until the first raise is established on the farm site, which will permit conventional ventilation fans located in the tunnel itself. These are discussed further in Sections 10.3.2 and 10.3.3 respectively.

Table 13: Modelled scenarios for WUG

Project Phase	Scenario	Description
Site Establishment	1a	Site earthworks and foundations
	1b	Infrastructure, road and portal works
Tunnelling	2a	Initial tunnel drive and initial vent raise
	2b	Later stages (after farm vent)
	2c	Night works
Vent Raises	3a	Vent raises and exploratory drilling
	3b	Helicopter activity to support 3a above
	3c	Vent shaft operational fan noise

For night works, (Scenario 2c) we have assessed a range of different activities that could occur during the night. This includes noise from vehicles (e.g. personnel shift change or deliveries), tool usage in the SFA and the temporary generators required in the initial phase.

The noise from the temporary generators has been based on manufacturer data provided by OGNZL. We note that the predicted overall night-time noise levels would exceed the relevant criteria without attenuation being included for these units. Therefore, mitigation is required. The night-time noise level calculations include this attenuated noise source in the cumulative noise emissions to the nearby receivers.

The exact noise control necessary will depend on the final engineering requirements. As well as detailed attenuation design for the generators, typical noise control measures would be only one generator will operate at night, a barrier close to the generator and it being placed at the northern end of the site.

None of the operational scenarios allow for noise from any tonal reversing alarms.

10.1.1 Receivers

The nearest dwellings to the main worksite are shown overleaf in Figure 22. This excludes the dwelling at 132 Willows Road, which will remain under the ownership of OGNZL during the project.

Earth bunds of various heights have been included in the topographical model provided by OGNZL. These provide a degree of screening from vehicle noise on the access road and activity within the overflow car park.

10.1.2 WUG Noise Source Assumptions

The following plant in Table 14 has been included in the model.

Table 14: Noise source data used in WUG calculations

Item	Noise Level, dB L_{WA}	Source Height*, m	Operating Time†
50t Excavator	109	2.5	75%
20t Excavator	103	2.0	50%
Concrete Truck & Pump	103	2.0	50%
Mobile Crane	102	2.5	75%
Vibratory Poker	104	1.0	50%
Telehandler/Forklift	104	1.5	75%
General Light Tools	98	1.0	90%
Grader	110	2.0	50%
Vibratory Roller	109	2.0	50%
Dump Trucks	110	3.0	90%
3t Mini Excavator	99	1.5	80%
12t Trenching Excavator	101	2.0	50%
Trench Compactor/Roller	106	2.0	20%
Large Truck Movement	108	1.5	100%
Medium Truck	104	1.5	100%
Small Truck	100	1.5	100%
Light Vehicle/Ute	95	1.0	100%
Underground Truck	114	2.0	100%
Dozer	106	2.0	75%
Water Cart	119	3.0	75%
Temporary Ventilation Fan‡	108	3.0	100%
Transformer	66	2.0	100%
Compressor	103	1.0	100%
Shaft Collar Installation	115	2.5	75%
Large Generator‡	97	2.5	100%
Water Pump (Orebody Exploration)	107	1.0	100%
Drill Rig (Orebody Exploration)	111	2.0	100%
Small Generator	82	1.0	100%

** Modelled source emission height relative to the source's local terrain elevation.*
† As percentage of shift duration for daytime activities for averaging.
‡ Level includes significant noise control applied to source (refer section 10.1).

10.2 Willows SFA

10.2.1 Willows Road SFA Noise Calculation Results

SoundPLAN modelling has been used to calculate the noise levels from the various noise sources associated with the Willows SFA. The results for five scenarios are shown as noise contours in Appendix E and in Table 15 for individual receiver locations (R33 to R39 shown in Figure 22). The contours for the highest noise level scenario, 1b, are shown in Figure 23 overleaf.

Figure 22: Location of Willows SFA and nearby receivers

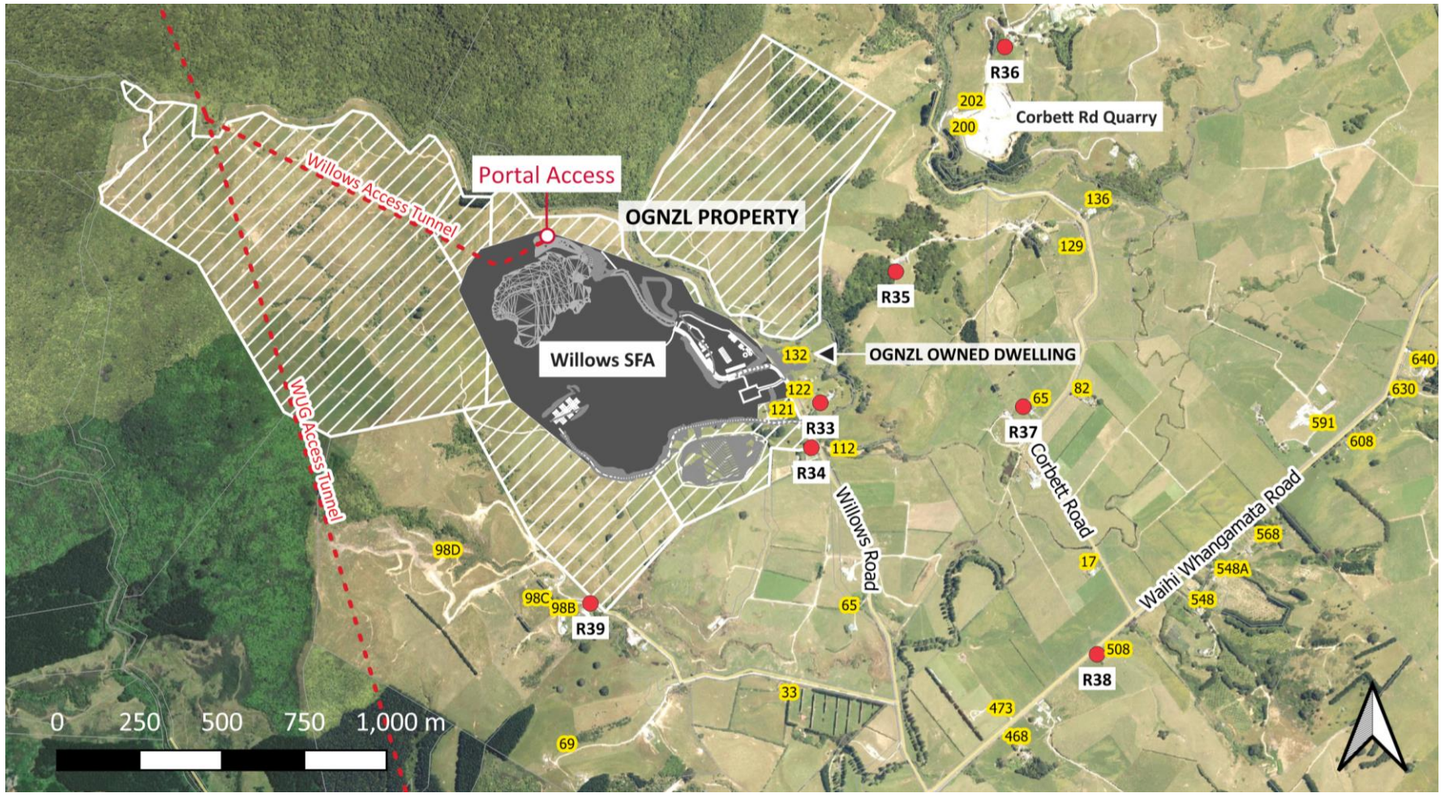


Table 15: Calculated noise levels at select dwellings for each model scenario

Receiver	Receiver Address*	Calculated Noise Level for Model Scenarios, dB L_{Aeq}				
		1a Site Earthworks and Foundations	1b Infrastructure, road and portal works	2a Initial Tunnelling	2b Later Tunnelling	2c Night Operations
33	122 Willows Rd	47	52	45	45	39
34	111 Willows Rd	46	46	40	40	35
35	129A Corbett Rd	42	45	41	40	35
36	202 Corbett Rd	26	27	28	28	23
37	65 Corbett Rd	36	37	34	34	29
38	508 Waihi-Whangamata Rd	35	34	30	31	25
39	98A Highland Rd	27	31	26	27	<20

** Dwelling at 132 Willows Road excluded as this is occupied by OGNZL.*

10.2.2 Willows SFA Noise Effects

The calculated noise levels in Table 15 (without extra mitigation beyond that already included) show that noise levels comply with the relevant construction/ operational noise limits at all locations.

We note that for 122 Willows Road during one construction phase for surface facilities construction (daytime only), noise levels are above 50 dB L_{Aeq}. However, this Scenario 1b activity is considered construction noise so readily complies with the construction criteria.

At most receivers, noise levels readily comply by some margin, due to the distance between the site and the dwellings.

A number of the receiver locations comply with the 50 dB L_{Aeq} operational noise limit by a considerable margin, with a number of scenarios below 40 dB L_{Aeq}. We consider this would ensure the existing amenity would remain largely unaffected.

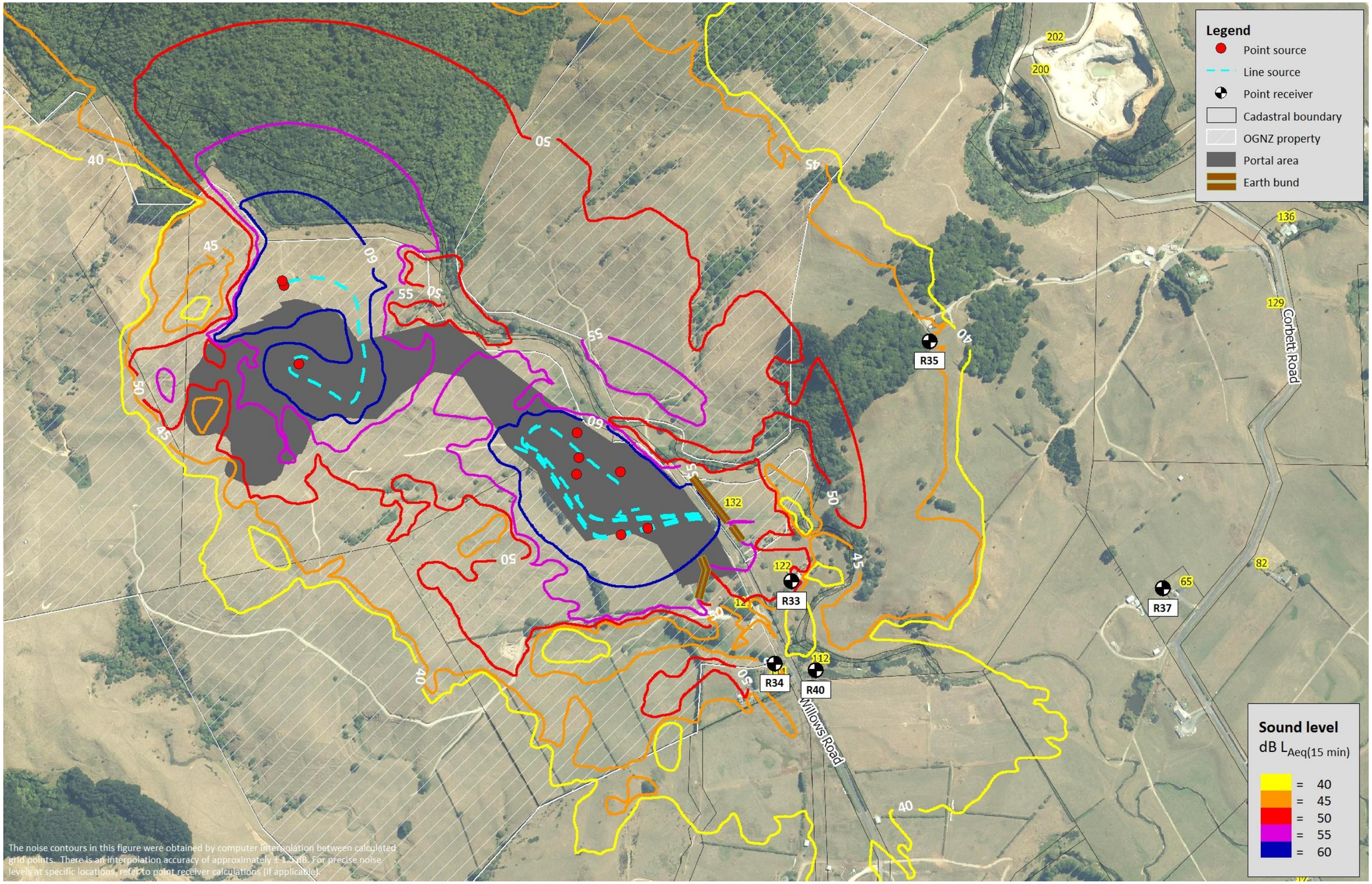
Night-time operations would comply with the 40 dB L_{Aeq} noise limit in all cases. Aside from Receivers 33-35, night-time noise levels will be below 30 dB L_{Aeq} at all other dwellings and thus below the existing background noise level at night (31 dB L_{A90} as per Table 5). In these cases, noise from SFA activity will essentially be inaudible over other existing sounds.

For the closest three receivers, noise levels may be slightly higher than the background levels at times, although the average existing night-time noise level of 38 dB L_{Aeq} is notably the same as the highest predicted value in Table 15. This indicates that, while noise from the activity may be audible at times, it is unlikely to be significantly beyond the existing ambient noise levels and therefore will not be a major change to the noise environment.

We note that the noise levels discussed here are external levels – noise received inside dwellings where occupants are sleeping will be much lower.

Beyond the night-time activity that we have explicitly assessed, any further proposed night-time activity needs to be carefully considered in the NMP, required by the conditions, to ensure compliance.

Figure 23: Willows Portal, Scenario 1b – Infrastructure development



10.3 Ventilation Raise Noise Emissions

10.3.1 Construction Noise

Construction noise contours are shown in Figures 25-27 later in this section for a representative vent raise site (located closest to the walking tracks in the forest area), but the general conclusions apply to all vent raises.

These show noise level emissions from the following construction phases as they affect users of the conservation area:

- Pad construction (excavator, chainsaws, hovering helicopter)
- Drilling (generator, raisebore drill)
- Vent shaft construction (generator, excavator, compressor, air leg, blasting, hovering helicopter)

Figure 28 also shows the worst-case construction noise (vent shaft construction scenario, above), but with the additional impact of a helicopter hover operation to support construction activity.

The closest walking tracks to any of the ventilation raises are the Wharekirauponga Walk and the lesser used unofficial Wharekirauponga to Golden Cross Track (that traverses the Coromandel Range). These are shown in Figure 24.

The calculated contours indicate that construction activity would be audible to recreational uses where noise from the proposed project operations is higher than the background noise levels (L_{A90}).

From our measurements in a remote forest location ,we have determined the quietest background noise levels to be 29 dB $L_{A90\,(15\,min)}$[10]. Therefore, our figures show predicted construction noise contours from 30 dB L_{Aeq} and above. We note this is a very low noise level to present, particularly for construction noise.

Noise levels drop off relatively quickly due to the local topography however the area of land exposed to noise levels above background noise (around 30 – 35 dB) is quite extensive, particularly when the helicopter is operating.

We understand from the Greenaway and Associates recreation report that the Wharekirauponga Walk has a daily average of approximately 10 walkers each way and a maximum number in Summer of typically 60 walkers each way. Because the track counters used to record these visits is at the start of the track, it is likely that not all walkers would complete the entire track, so these numbers may be considered conservative.

Further we understand that the track is closed at present because of kauri dieback concerns but could, in theory, open at any time.

For recreational users on the Wharekirauponga Walk, worst case noise levels from construction activity at the vent raises would be clearly audible at the loop part of the track, rising to high noise levels of 75 dB close to the swing bridge (when construction occurs in this location). However, this would only be for a small period of time, and likely only for this part of the track.

The Greenaway report refers to the sparsely used Wharekirauponga to Golden Cross track, that traverses close to a potential ventilation raise location. The users of this track are likely only hunters and tramping groups because it is not widely known about and primarily used by experienced trampers. For this limited exposure group, the noise levels may be audible. Nevertheless, the absolute noise exposure level is less important than the general ability to hear this noise source in the conservation area in the first place.

That is, whether the noise level is 35 dB or 75 dB is less important than the fact it is audible at all. The transient nature of exposure means the noise impacts are similar regardless of the level.

The exception to this is when construction works may occur in close proximity to the track and therefore users are exposed to higher noise levels. At these locations, users of the track would experience significant disruption and people may actively avoid the area.

We understand that there are no other walking tracks where construction noise would be audible in these areas and therefore noise effects on recreational users within this part of the conservation area are limited. This means that despite construction activity being potentially audible at some distance, and therefore over broad swathes of the park, in our opinion it does not mean construction activity is unacceptable.

Whilst our predictions show that technically, construction activity is likely audible over a large area, particularly the associated helicopters, there will be extensive areas within our contours where the background noise level is significantly higher than 30 decibels. This would be due to a variety of reasons, including topographical screening, noise from wind in trees, watercourses or at times rainfall. This has the potential to reduce the extent to which construction noise would be audible in practice. As we also discuss in Section 3.3, we consider that construction noise doesn't necessarily need to meet the policy criteria of the Waikato CMS as it is temporary in nature.

Nevertheless, we consider that warnings should be displayed at the track entrances/accessways detailing the construction programme and the likelihood of elevated noise levels being experienced in the backcountry as a method to manage ventilation raise construction activity. It is also preferable if construction close to the tracks is restricted to winter, when there is likely to be fewer users of the track. Further, where possible, the same methods as outlined in Section 13.3 should be implemented for construction equipment to reduce construction noise as far as practicable at the ventilation raise sites.

Overall, we conclude that based on the small extent of likely exposure and the short duration of the noise, that despite being audible and at times elevated, we consider the construction noise effects to be reasonable.

[10] Based on our ambient noise survey in the conservation area in August 2024 (refer Appendix F for further information).

Figure 24: Proximity of walking tracks and recreational areas to WUG sites

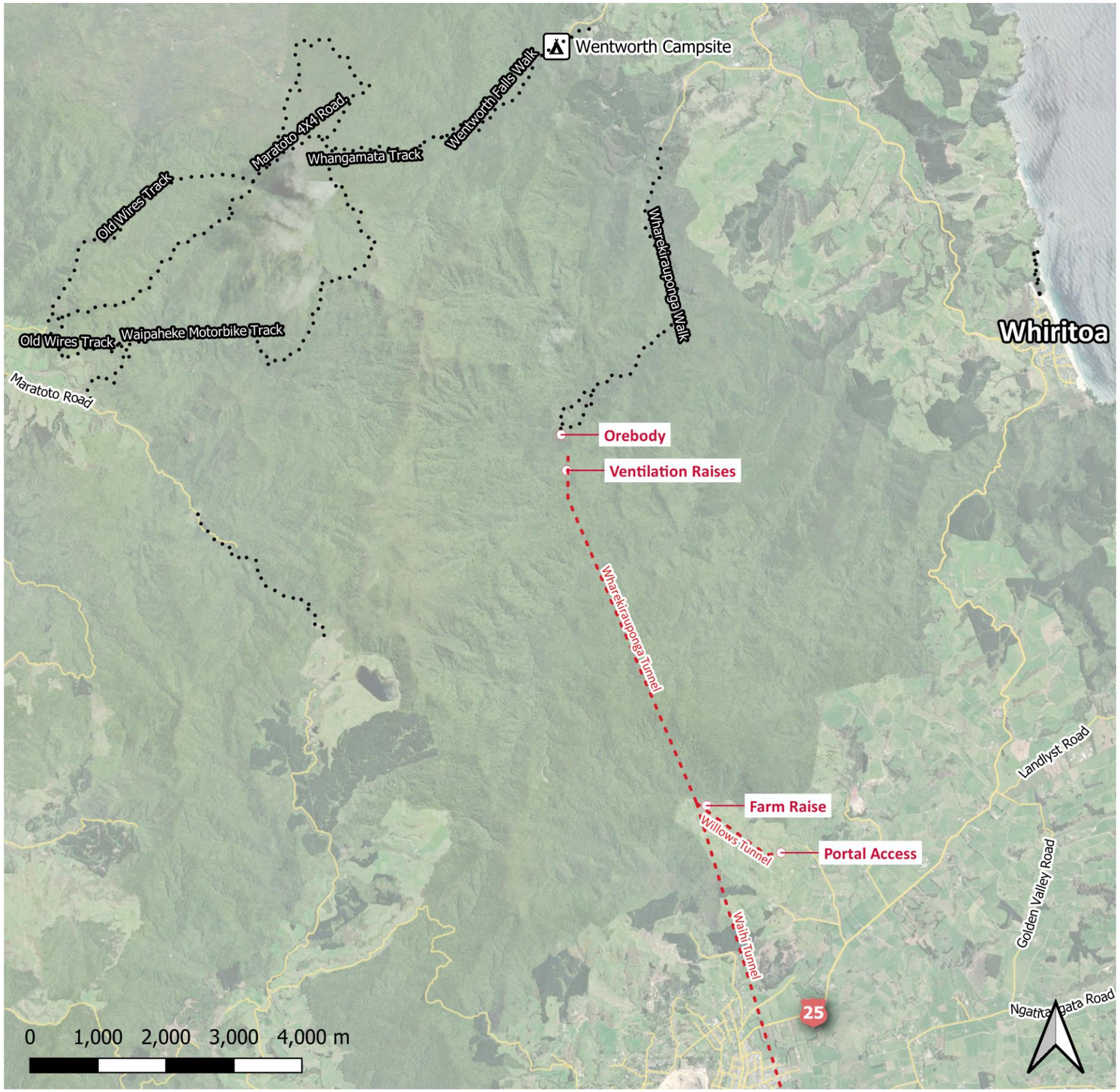


Figure 25: Pad construction phase for a pumping test / vent shaft site

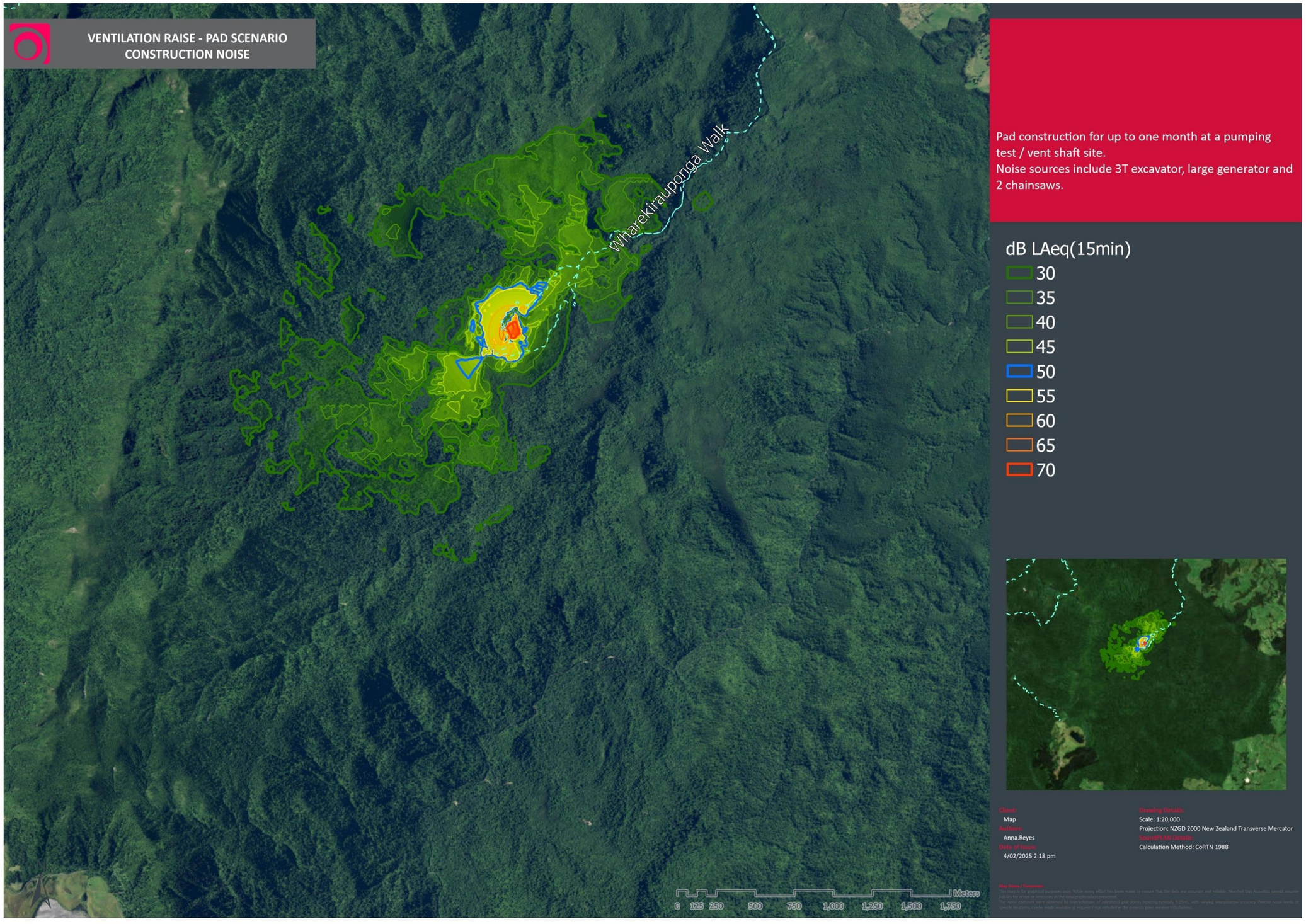


Figure 26: Drilling construction phase

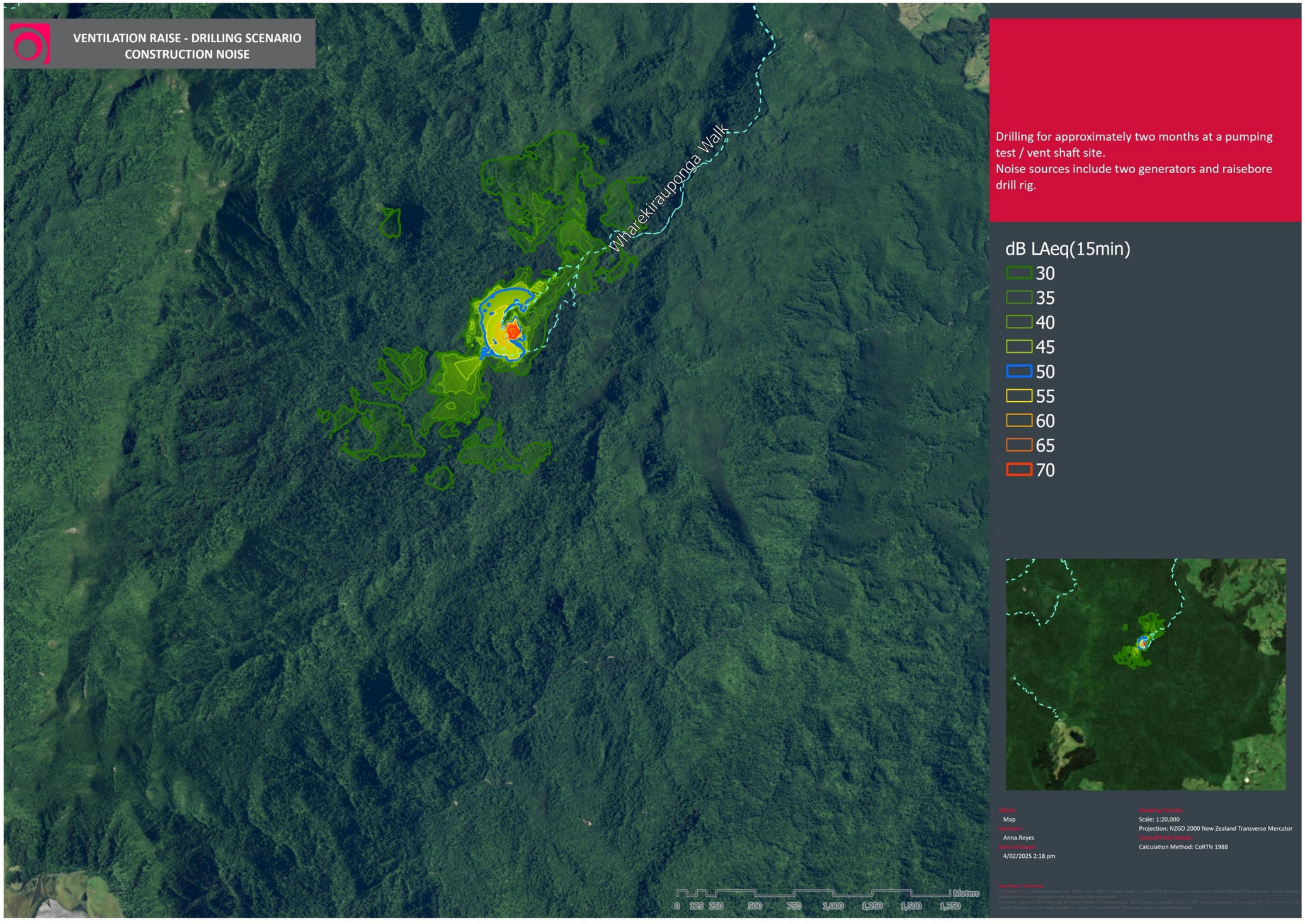


Figure 27: Shaft construction phase

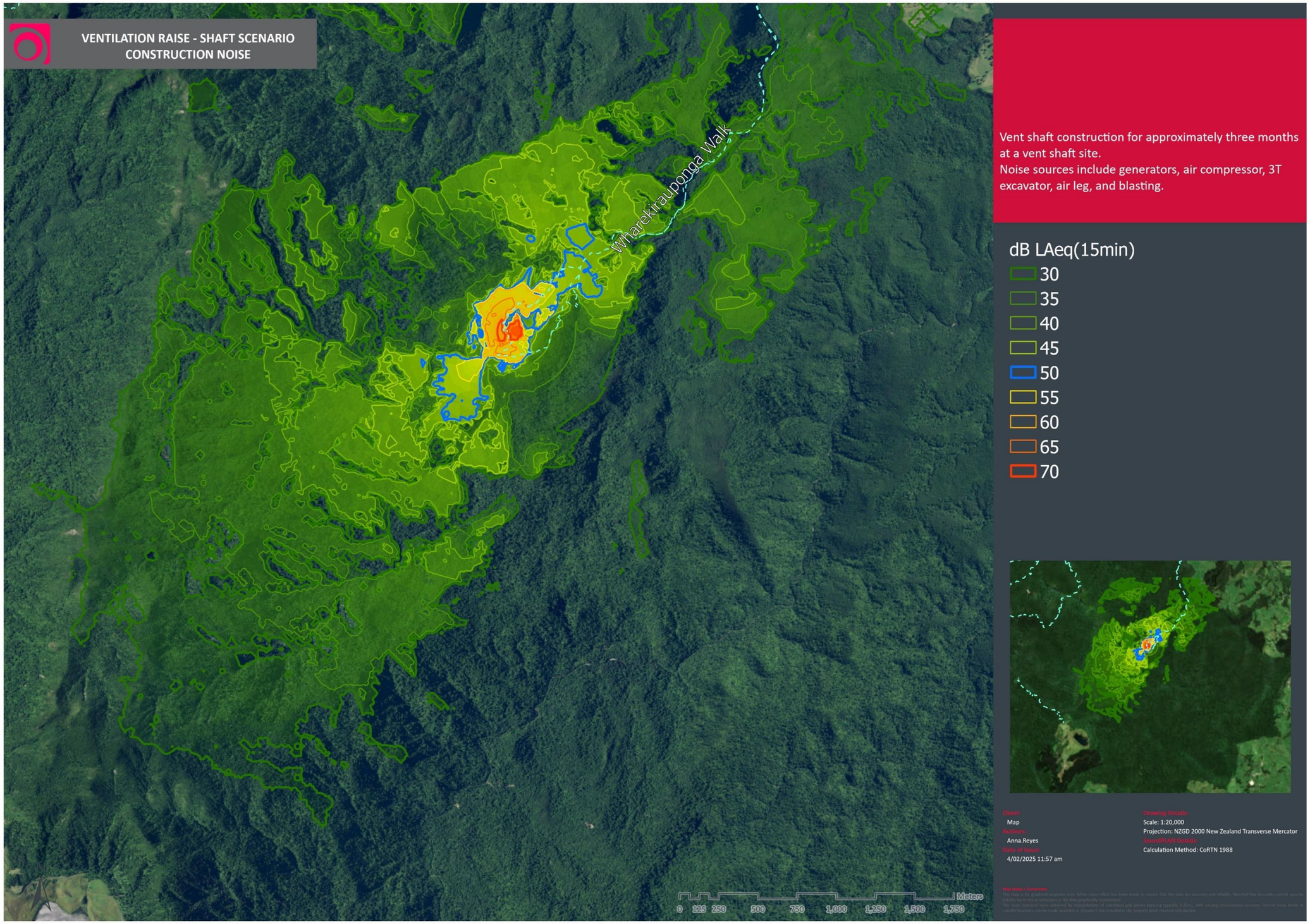
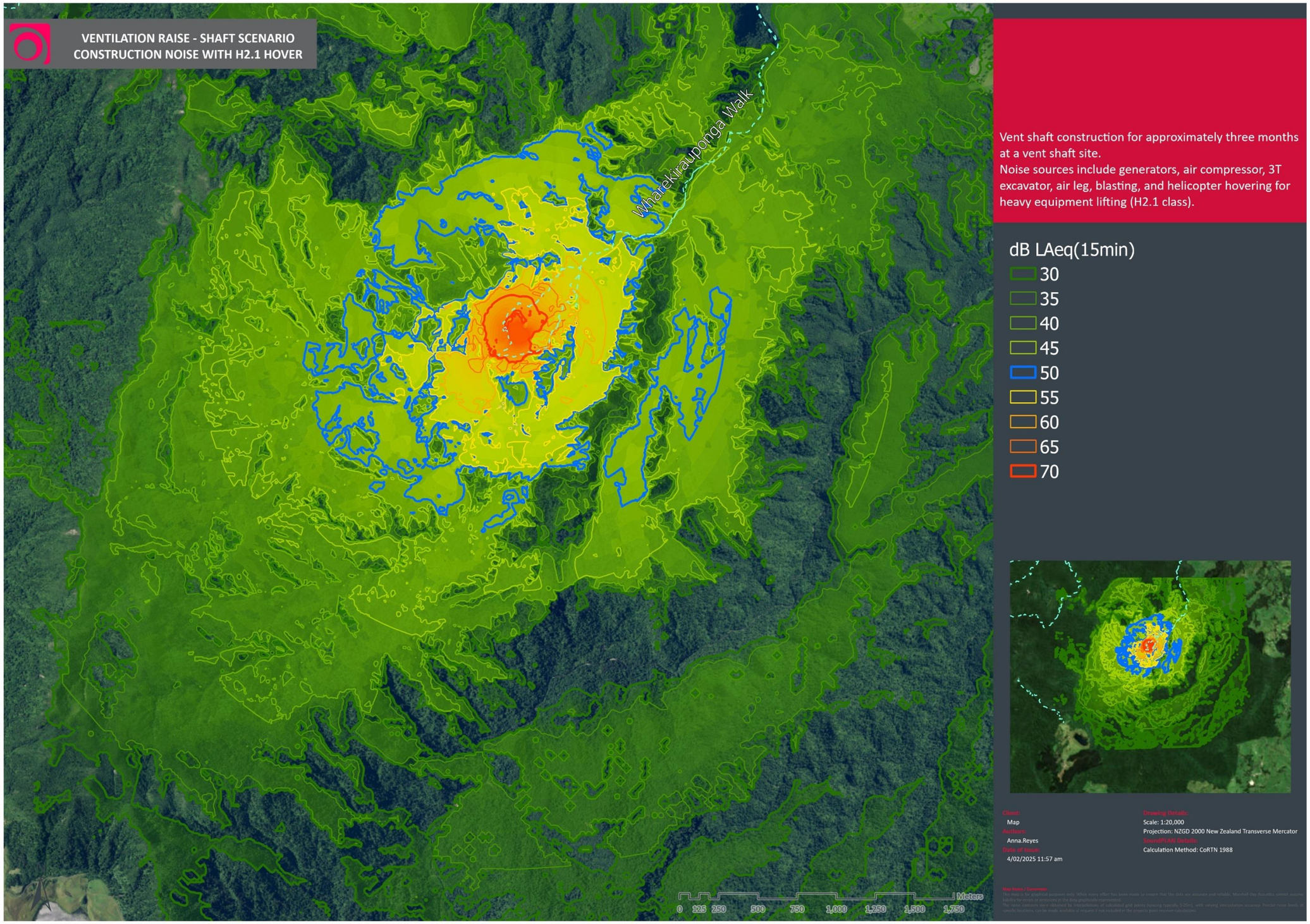


Figure 28: Shaft construction phase with helicopter hovering



10.3.2 Vent Raise Fan Noise Emissions

Surface ventilation raise sound power levels have been calculated from fan noise from the fans located at the base of the vent raise (i.e. underground). The calculated sound power levels are based on measurements of sound pressure levels at 5, 10 and 15 m from the existing Union Hill vent located close to Martha mine in Waihi. This is of equivalent duty, but the calculations of sound power levels have been adjusted where necessary to account for slight changes in duty, and vent raise geometry. Due to the topography, the raises closer to the orebody are shallower than those further south and therefore produce higher noise levels at the surface.

Predictions of operational fan noise in the conservation area from the proposed vent raises are shown in Figure 29 opposite.

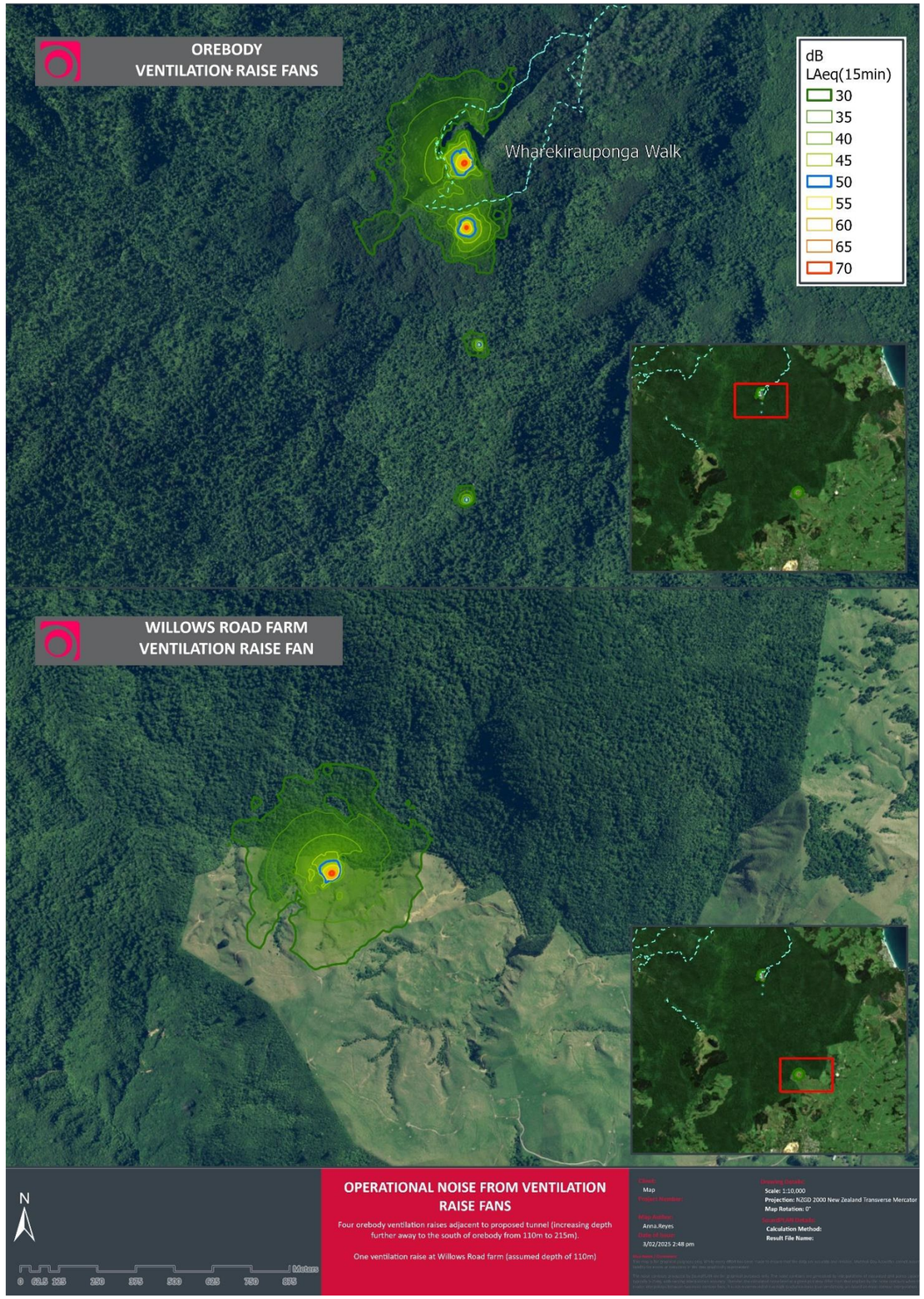
This shows that noise levels are generally only above background noise levels within 200 m of the ventilation raise at the orebody, and would be barely audible at the other raises, and likely only if receivers are at the raise site itself.

For the users of the Wharekirauponga Walk track, noise levels may approach 50-55 dB in a few limited locations close to the raise. For the same reasons outlined in section 10.3.1, the general audibility is more important than the absolute noise level. Overall, these noise levels are still at a level low enough to be considered not significant.

With respect to the Waikato CMS, we consider that the operation of the ventilation fans would not cause anything beyond 'occasional intrusion' when backcountry visitors are traversing the loop part of the track and therefore noise levels would in our opinion be acceptable in terms of the intent of the Waikato CMS.

We consider operational noise from the fans to be acceptable because recreational users inherently choose to come to these areas, would only be in the area for short periods, and noise exposure is fleeting and of a short duration and there is an accepted expectation of some occasional and minimal noise disturbance.

Figure 29: Operational noise from ventilation fans



10.3.3 Willows Road Portal Ventilation Fans

The noise from the containerized ventilation platform has been based on fan sound power levels calculated from measurements within the tunnel at Martha for fans of a similar duty. The predicted overall noise levels would exceed the relevant night-time criteria without attenuation being included in the design of the container system.

The temporary containerised fan therefore requires mitigation whilst it is in use during the initial phases of tunnelling to achieve acceptable noise levels. The operational noise level calculations for early phases of tunnelling include this attenuated noise source in the cumulative noise emissions to the nearby receivers.

The exact noise control necessary will depend on the final engineering requirements and detailed designs for the ventilation fans. From our initial estimates, an example of the typical noise control measures would be a 1500 mm long 50% open area attenuator at each side of the fan in addition to the standard 2D cylindrical attenuators.

Construction details for any fan enclosures are also of key importance, with the following aspects likely to be required:

- Transitions between the cylindrical attenuators and the attenuator being solid sheet metal construction a minimum of 1 mm thick
- Flexible connectors constructed from mass loaded vinyl minimum 4 kg/m2, no greater than 100 mm wide.
- Fans mounted on vibration isolation mounts
- The ends of the container housing the fans being sealed with a solid material (i.e. a surface weight of at least 8 kg/m^2, such as 15 mm plywood, 9 mm fibre cement or 8 kg/m^2 mass loaded vinyl).

10.4 Exploratory drilling noise emissions

As for the ventilation raise construction assessment in Section 10.3.1, we have assumed that the exploratory drilling operations would be audible to recreational uses where noise from the proposed project operations is higher than the background noise levels (29 dB $L_{A90\,(15\,min)}$[11]).

Future exploration operations are expected to consist of up to six drill rigs operating simultaneously and two helicopters. OGNZL have provided three scenarios for the future operations (drill rigs spread out, clustered in the north and clustered in the south). We have modelled the drill rigs spread out, with and without associated helicopter operations as being representative of exploratory drilling operations.

The predicted $L_{Aeq\,(15\,min)}$ exploratory drilling operational noise emissions are shown below; Figure 30 shows the predicted noise levels from just the drill rigs and ground-based activity, and Figure 31 includes associated helicopter servicing activity,

For recreational users on the Wharekirauponga Walk, worst case noise levels from exploratory drilling activity would be likely audible in proximity to the loop part of the track (figure 30), potentially rising to high noise levels of 55 - 60 dB (if drilling occurs in this location) when helicopters are operating (Figure 31). However, for most parts of the track, noise levels are significantly lower, and despite being audible for some of the time, would also be inaudible for periods of time as well, particularly if well screened or in locations alongside streams etc.

As for ventilation raise construction noise emissions, whether the noise level is 35 dB or 55 dB is less important than the fact it is audible at all. However, the transient nature of exposure means the noise impacts are similar regardless of the level.

This means that despite exploratory drilling activity being potentially audible some of the time at some distance, in our opinion it does not mean it is unacceptable.

Further, current exploratory drilling operations consist of two drill rigs operating simultaneously and one helicopter servicing the site from time to time. Predicted noise levels of current operations are shown in Figure 32. This shows that current operations produce noise levels that are similar in extent and magnitude in the immediate locale of the activity to that proposed, but over a smaller total area.

Overall, we conclude that based on the small extent of likely exposure and the short duration of the noise, we consider the noise effects to remain reasonable. We also note that the intensity of exploratory drilling activity does not cause noise levels significantly different to that already being received at present. Rather, exploratory drilling noise would occur at more locations meaning the potential for noise exposure would increase, but the absolute received noise level for any given receiver would remain similar to what it is now.

At present exploratory drilling is carried out under an existing DoC concession, which contains conditions relating to noise. These conditions effectively require OGNZL to quantify aircraft and drilling noise in the Forest and if required take measures to minimise the noise effects on conservation values. There are also specific restrictions imposed in relation to setback distances and operating hours and days where activity is allowed.

We expect that a concession from DoC for this aspect of the project would be similar in scope and extent in terms of the concession conditions imposed, and would therefore provide adequate management of exploratory drilling noise in this case.

[11] Based on our ambient noise survey in the conservation area in August 2024 (refer Appendix F for further information).

Figure 30: Proposed exploratory drilling noise (six sites)

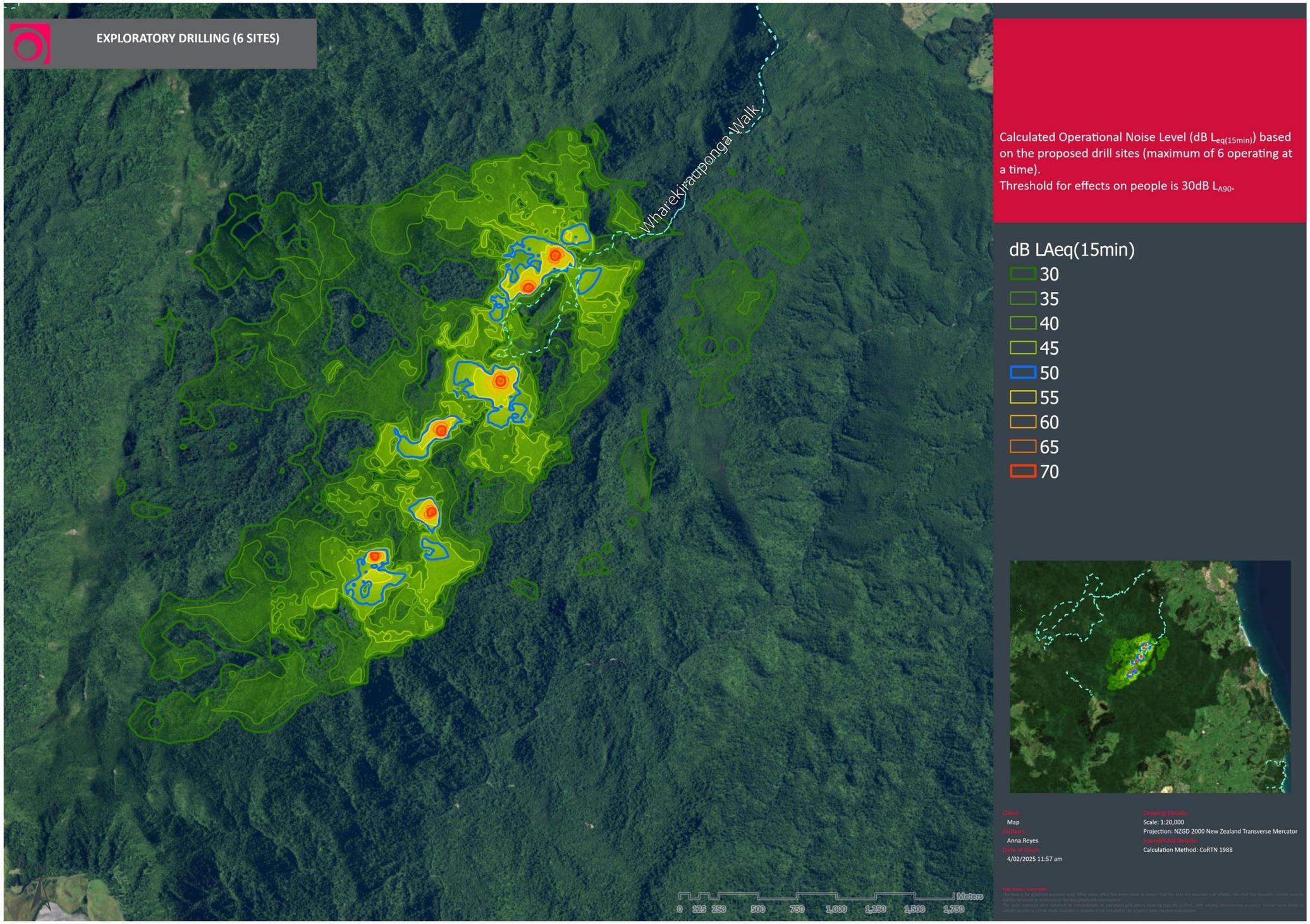


Figure 31: Proposed exploratory drilling noise with two helicopters hovering

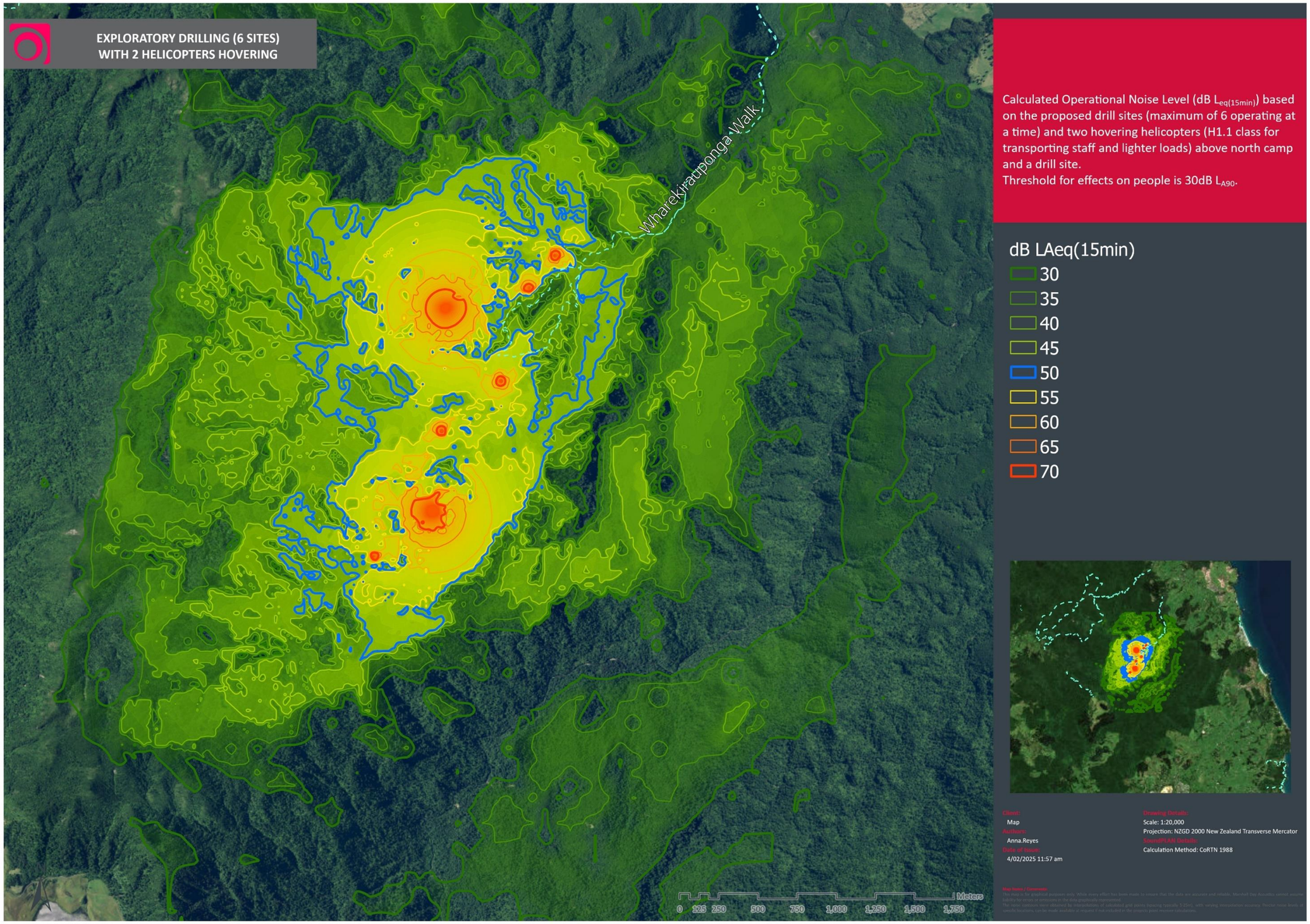
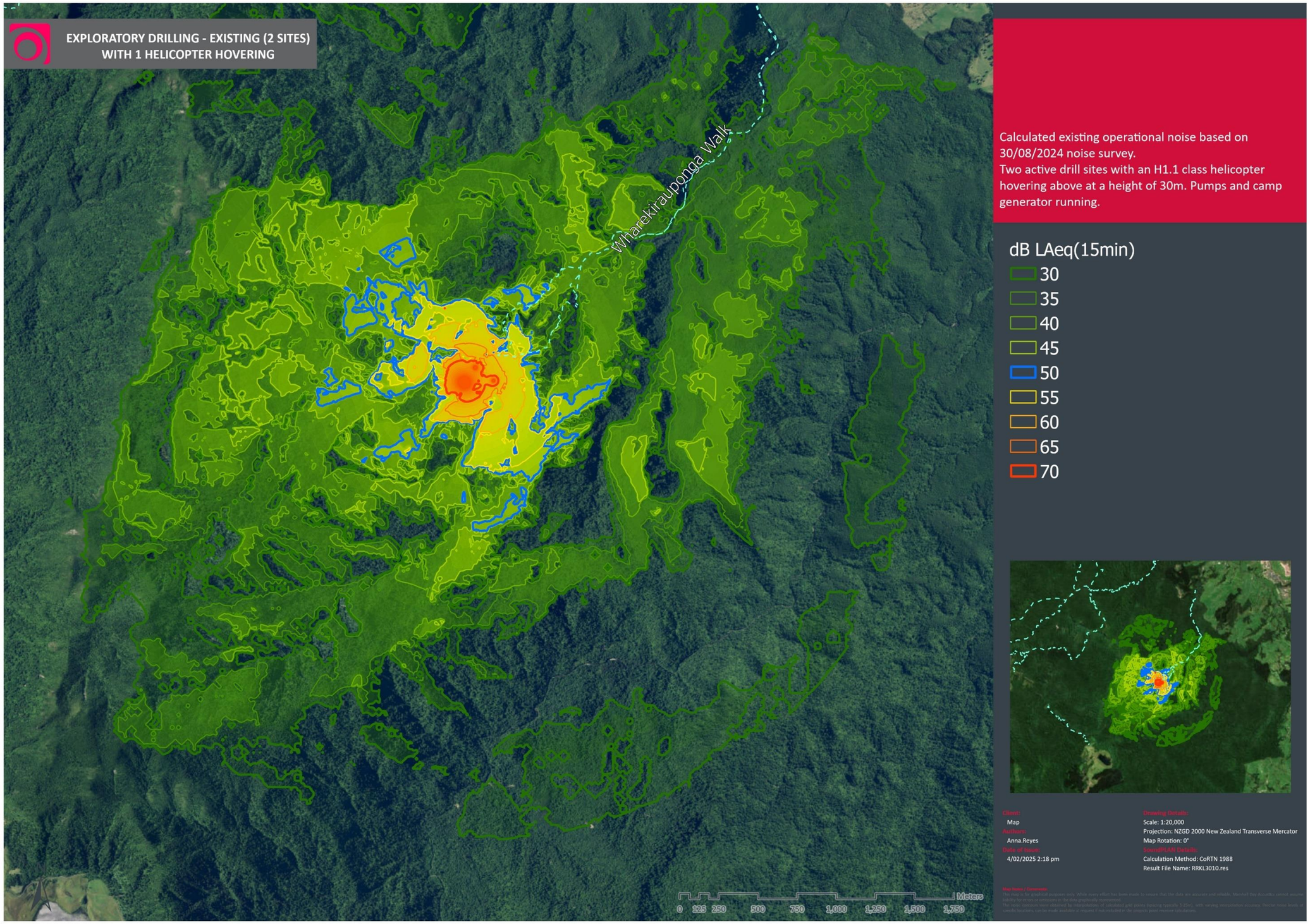


Figure 32: Exploratory drilling – existing with 1 helicopter hovering



10.5 Predicted Helicopter Noise Levels

Predicted operational helicopter noise levels are shown in Figure 33 and Figure 34, which give the calculated L_{dn} noise levels near where residential occupation occurs, and L_{Aeq} 15 mins for recreational users in the Forest Park. We have only presented noise levels from helicopters accessing the existing 'Southern Helipad' in the Forest Park from the three offsite helipads at Willows Road, Baxters Road, and Golden Cross Mine, but the assessment and conclusions would be valid for any remote sites associated with the project. We have calculated the full flight paths which include the departure and arrival vectors at the different sites.

10.5.1 Populated Area - Construction Noise

Because the helicopters operate to and from the ventilation raise and exploratory drilling construction sites, they only pass houses for a short period of time in transit. The maximum noise levels received at these dwellings are comfortably below 70 dB L_{AFmax} at the notional boundary of all dwellings. This means they are significantly lower than the construction criteria of 90 dB L_{AFmax}. The $L_{Aeq\ (15\ min)}$ noise level is also well below the construction criteria of 75 dB L_{Aeq}. An indication of this noise level can be seen in the L_{Aeq} noise levels shown in Figure 34.

10.5.2 Populated Area - Operational Noise

Noise exposure levels predicted in accordance with NZ6807 are shown in Figure 33 and Figure 34. These show that noise emissions from Helicopter operations do not exceed a noise level of 50 dB L_{dn} at any noise sensitive receiver. Broadly speaking, this means that noise levels from general helicopter operations as a result of the project are acceptable.

Individual helicopter operations would be clearly audible for some receivers in proximity to the helicopter bases and the overflying tracks and would be noticeable above the existing ambient noise environment. However, taking into account the large periods of respite between events and the ambient noise environment in the vicinity of nearby receivers, as well as the other noise sources present, we consider that helicopter noise effects on people as a result of the Project are reasonable.

10.5.3 Conservation Area

As we discuss in Section 10.3 and 10.4, we consider that helicopter noise levels are likely to be at elevated levels only in close proximity to the vent raise and exploratory drilling sites during construction, and audible to track users/back country visitors during a flyover across the conservation area as a whole. Noise would be regular in nature during each helicopter campaign.

As shown on Figures 28 and by way of comparison, the construction noise level of 70 dB $L_{Aeq\ (15\ min)}$ (red contour) is emitted only relatively close to helicopter construction activity.

With any helicopter use, we expect that for users of the Wharekirauponga Walk track, helicopter noise would be clearly audible for most parts of the track closest to either the vent raise or exploratory drilling sites, but based on the number of users it is likely only for a very small number of people.

We note from Figure 34 that individual helicopter operations would still likely be distantly audible across much of the Forest Park. However, these events would be at relatively low noise levels at the walking tracks, for only a brief duration and for only a relatively small number of events per campaign. In our opinion this means that helicopter noise impacts on users of the conservation area are not significant.

With respect to the Waikato CMS, we note that Policy 16.3.5.3 a) suggests that limits of 2 landings (which includes hovering ops) per operator per day (or 20 landings per year) at any one site should be applied. This is unlikely to be achieved in practice. However, we consider that the operation of helicopters would not cause anything beyond 'occasional intrusion' when backcountry visitors are traversing the loop part of the track and therefore noise levels would in our opinion be acceptable, and consistent with the overall intent of the policies of the Waikato CMS.

Overall, we consider that helicopter operations would not result in unacceptable noise effects for recreational users of the conservation area.

To adopt BPO, some methods to reduce helicopter noise effects on users of the Forest Park would be to limit the number of flights in a given period or to time flights when recreational use is lower (during the weekdays, or winter) however we consider specific mitigation beyond this or overall restrictions on the number of movements, is not necessary in this case.

Figure 33: Calculated helicopter noise levels associated with staff transport and equipment lifting

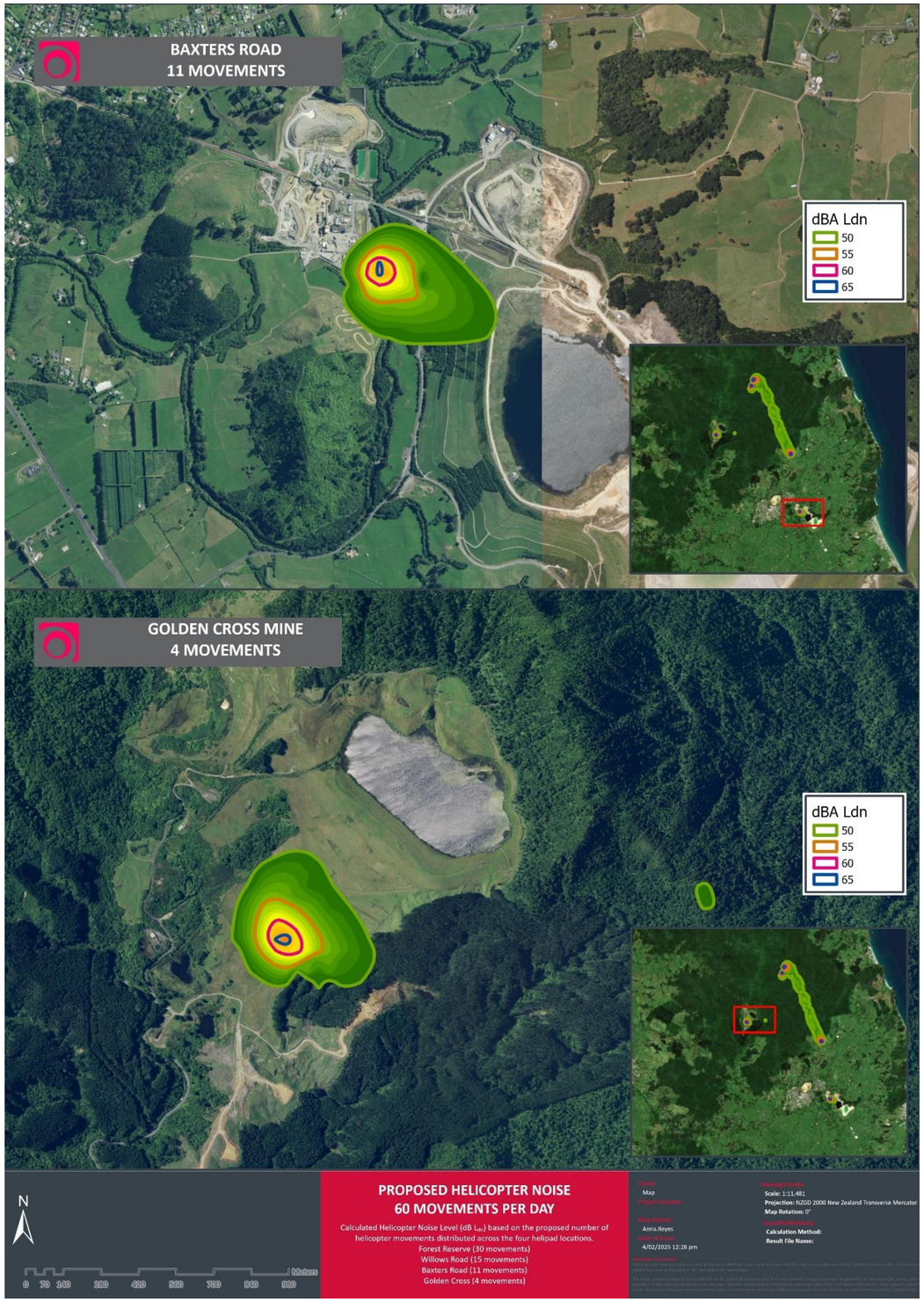
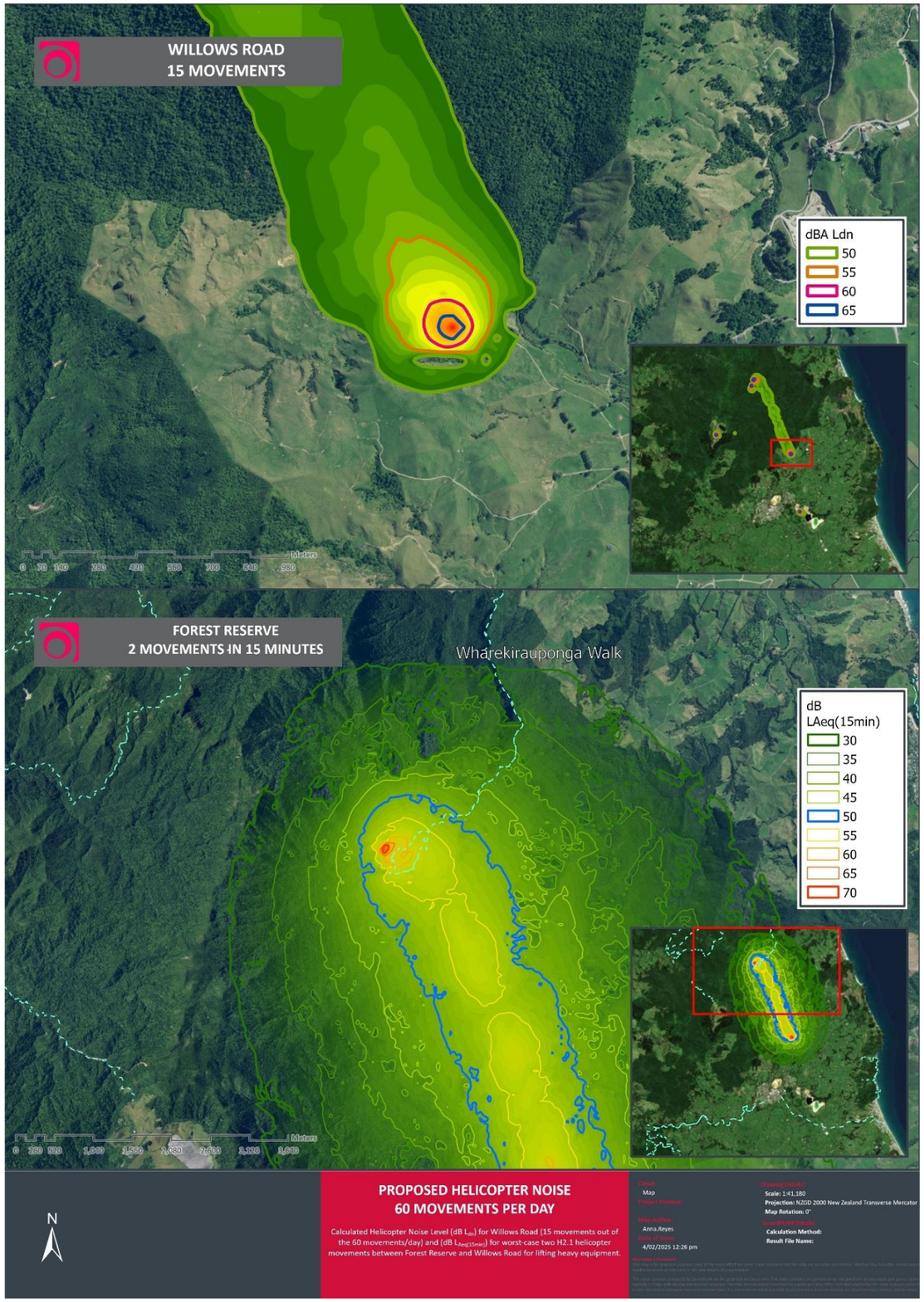


Figure 34: Calculated operational helicopter noise levels associated with staff transport and equipment lifting



11.0 WNP NOISE LEVELS OVER TIME AND ASSESSMENT

11.1 Calculated Noise Levels

Based on the methodology described above, the cumulative noise level from all the various WNP operations (including the WUG) has been calculated for each year of the project.

The calculated noise levels for each year are shown in the noise contour plots in Appendix D. Results for the Year 8 are shown in Figure 35 overleaf, which also shows the receiver locations referenced below. The calculated noise levels at selected representative receiver locations are shown in Table , for each year over the project's duration.

Seven receiver locations are located closer to the WUG activity and are thus reported separately in Table 15.

11.2 Cumulative Effects with Martha operations

We have also considered the cumulative noise impacts of WNP in conjunction with currently consented, typical Martha operations. Whilst we note that there is a significant physical separation between WNP sites and Martha, it is still pertinent to understand what cumulative noise impacts may arise.

We have prepared a cumulative noise contour plot of this scenario and this is presented below. This shows that there is no material cumulative noise impact. This is primarily due to the distances between WNP and Martha, and the presence of Union Hill. We conclude that generally, residents impacted by Martha would not receive elevated noise levels from WNP, and vice versa. Therefore cumulative noise impacts are considered reasonable.

11.3 Assessment of Effects

As discussed in Section 4.0 the proposed daytime operational noise limit is 50 dB L_{Aeq}. This is typical of most District Plan noise limits around New Zealand for residential and rural residential receivers. (We note that there are some districts that do use 55 dB L_{Aeq} as well.)

The ambient noise levels measured at sites around Waihi show the noise levels are typically 36 to 44 dB L_{A90} and 43 to 49 dB L_{Aeq}. In our opinion, taking these ambient noise levels into consideration, the 50 dB L_{Aeq} noise limit represents providing protection to an appropriate level of amenity and the noise effects from the proposed operations would be reasonable.

Noise levels at almost all receiver locations not owned by OGNZL would comply with the 50 dB L_{Aeq} limit, with a number below 40 dB L_{Aeq}. Further, in our opinion because of the existing noise environment in the vicinity of these properties, impacts on amenity would not occur and the existing level of amenity would be maintained.

For those receivers where the noise levels without mitigation are above 50 dB L_{Aeq}, we reach a slightly different conclusion. Generally though we note that noise levels are only just above 50 dB L_{Aeq}. The ambient noise levels in the vicinity of these receivers are at the upper range of those measured in Waihi which goes some way to reduce the impact.

Overall, we consider that noise levels received at these properties would have an adverse impact on the level of amenity these properties experience when non-compliant. This is despite exceeding the proposed noise standards by only a few decibels. However, because of the background noise levels that currently exist, and the relatively short-term nature of the noise effects over only a few years this impact on amenity is only slight, and on balance marginal.

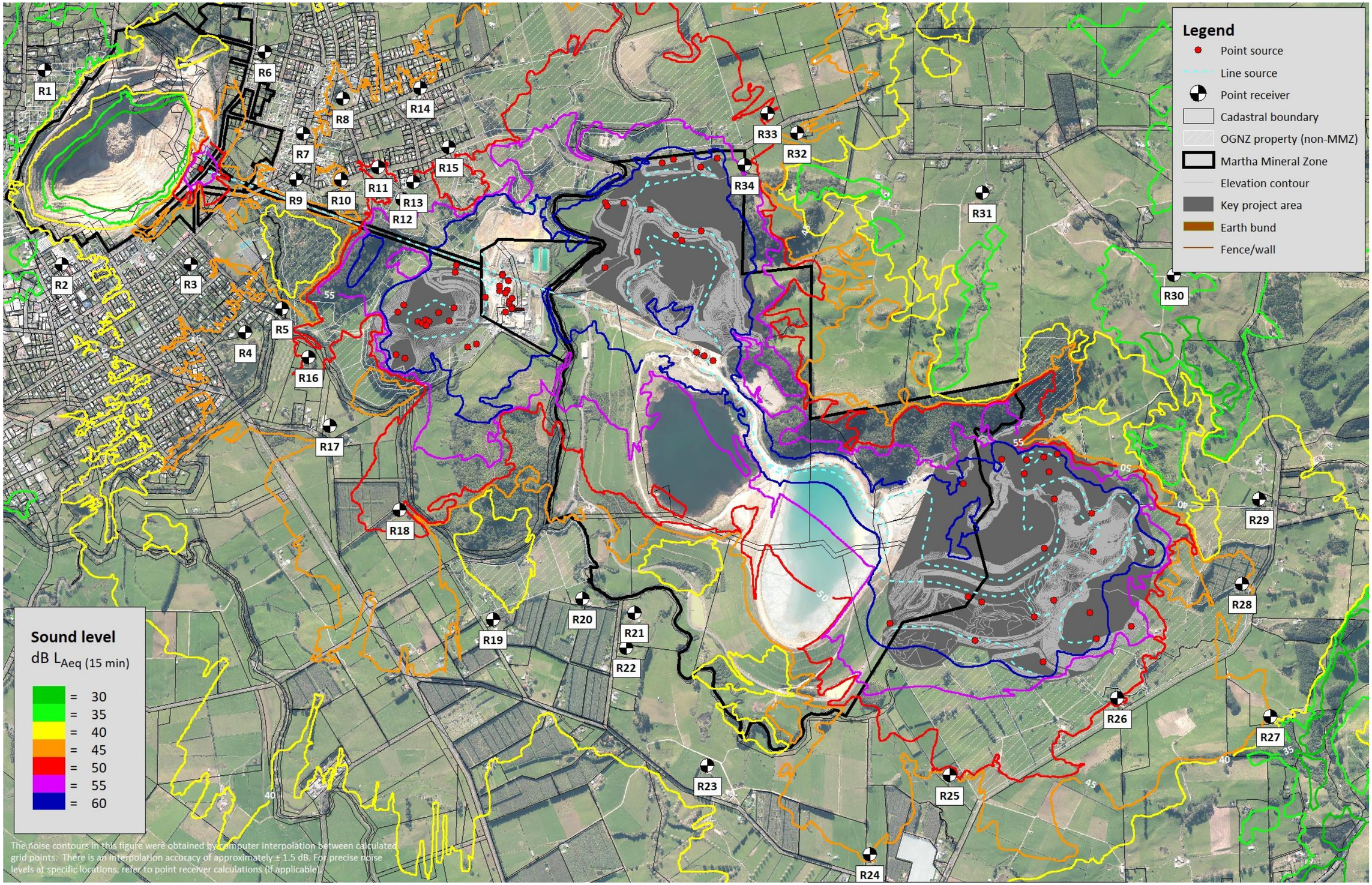
Nevertheless, to ensure that noise levels would comply with the proposed consent condition noise limits, the required NMP would stipulate the methods to develop appropriate mitigation options prior to operations commencing, that ensure noise limits are complied with.

Without this mechanism in place, we consider external noise levels from the project may have had a small adverse impact on amenity (for when the mine is operational), but that once mitigation is implemented through the NMP process to ensure noise levels are compliant with the proposed noise limits, then the noise effects from WNP would be reasonable.

Table 17: WNP Noise levels at each representative receiver location (excluding WUG and additional Gladstone receivers)

Receiver (Figure 35)	Receiver Address	Calculated Noise Level per Project Year, dB L_{Aeq}									
		Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y17	Y18
1	4 Cambridge Road	33	32	31	30	30	30	29	29	24	26
2	41 Seddon Street	37	35	37	33	32	32	30	32	25	26
3	120 Kenny Street	41	39	38	35	34	34	32	35	28	29
4	14 George Street	48	51	49	46	44	44	40	41	31	34
5	19 Clarke Street	39	39	38	35	35	33	31	34	25	26
6	15 Grey Street	42	41	40	39	39	39	36	37	30	32
7	201 Kenny Street	45	42	42	41	41	41	39	39	32	35
8	Waihi East School	47	45	44	44	44	44	39	40	32	35
9	5 Barry Road	44	42	42	42	42	42	40	40	38	39
10	31 Barry Road	46	43	42	41	41	41	38	39	33	35
11	55 Barry Road	52	51	50	50	50	50	42	43	34	36
12	10 Moore Street	54	53	52	51	51	51	44	45	36	38
13	72 Barry Road	54	53	52	51	51	51	44	45	34	37
14	43 Mataura Road	46	44	43	42	42	42	40	40	33	36
15	107 Barry Road	48	46	45	44	44	44	42	42	34	38
16	33A Heath Road	51	54	53	50	48	47	43	45	33	35
17	35 Heath Road	49	47	49	47	46	46	39	42	32	35
18	36 Baxter Road	51	49	48	47	46	46	38	42	29	31
19	38 Kingsley Road	42	41	41	39	39	39	39	39	34	36
20	57 Fisher Road	42	42	43	43	43	43	39	39	35	36
21	56 Fisher Road	43	42	43	42	42	42	38	38	35	35
22	36 Fisher Road	42	42	43	42	42	42	39	38	36	36
23	159 Waihi Beach Road	41	41	42	41	41	40	39	38	37	37
24	245 Waihi Beach Road	45	44	45	45	45	42	42	42	43	43
25	45 Trig Road North	44	44	45	44	44	43	43	42	43	43
26	131 Trig Road North	50	50	51	51	51	41	41	45	49	49
27	186 Trig Road North	45	43	43	43	43	39	39	39	43	43
28	223 Trig Road North	46	44	45	45	45	38	38	39	40	40
29	267 Trig Road North	43	42	43	42	42	36	36	36	39	38
30	433 Trig Road North	36	36	37	36	36	35	34	34	30	31
31	549 Trig Road North	39	38	39	39	39	39	37	37	29	33
32	639 Golden Valley Road	49	46	43	43	42	42	46	46	30	45
33	654 Golden Valley Road	51	49	47	48	48	47	48	48	28	47
34	669 Golden Valley Road	54	49	45	44	44	44	53	53	32	53
Legend:	*Unmitigated levels, to be reduced by further GOP mitigation requirements enshrined in the NMP.*										
	Noise level influenced by NRS area construction/rehabilitation activities so is considered compliant with construction noise limits.										

Figure 35: Cumulative noise contour plot – Year 8



12.0 SUPPORTING NOISE INFORMATION FOR ECOLGICAL ASSESSMENT

12.1 Overview

Consideration needs to be given to effects on fauna in addition to noise effects on users of conservation areas and wilderness areas.

The effect of noise on fauna can be difficult to assess because it depends on many factors:

- Acoustic factors such as noise level, frequency content, character and duration
- Bioacoustics factors such as the hearing sensitivity, audible frequency range and vocalisation of the species of interest
- Ecological factors such as the importance of the receiving environment to the species of interest, time of year, species behaviour and abundance.

We understand that the species group that is most sensitive to noise is likely to be forest birds. This is because forest bird vocalisations serve a number of important ecological functions which can be interrupted by anthropogenic (manmade) noise. This can have the following effects[12]:

> *"a decrease in hearing sensitivity; an increase in stress and steroid hormone levels; changes in foraging location and behaviour; interference with acoustic communication between conspecifics; and failure to recognize other important biological signals such as the sounds of predators and/or prey."*

We are not aware of any established guidelines or criteria for assessing behavioural noise effects on New Zealand forest birds. We have instead determined potential effects zones by predicting where anthropogenic noise would be above the ambient noise levels in the frequency range of the forest bird vocalisations. These zones estimate where there is the potential for masking effects. Our findings are included in the memo attached in Appendix F.

Our predicted zones have been provided to the project ecologist, who has assessed the potential effects on the forest bird species. Their findings are presented in Section 6 of the ecological assessment prepared for the WNP by Boffa Miskell.

12.2 2024 Survey near Orebody

This section summarises our noise survey in August 2024 near the orebody. The full results are included in our memo in Appendix F.

The purpose of these measurements was to quantify ambient noise levels and exploratory operations. We carried out short term measurements (1 – 5 mins) in 14 locations and long term measurements (1 – 2 weeks) in 4 locations across the ore body site. Our dataset includes remote/pristine forest areas, forest areas with varying levels of anthropogenic noise, and areas next to existing helicopter movements, drills, pumps and generators.

Our survey was designed to collect the base data for an assessment of potential masking noise effects on forest birds. The processed results are weighted according to the vocalisation frequency range of the forest bird species of interest (e.g. tui, fantail, morepork, bellbird, silvereye). We have also conducted bird vocalisation counts of the long term data using machine learning, which enables us to compare the number of detections from the remote forest area to areas nearby the drill sites.

In summary:

- The drilling operations generate continuous broadband noise:
  - The noise overlaps the same frequency range as forest bird vocalisations in areas close to active sites.
  - At distance (e.g. 500 m away), the drill/pump noise becomes a low frequency hum because the high frequency content is absorbed by the atmosphere, vegetation and soft ground. This low frequency hum has less overlap with the bird vocalisations, and therefore less potential masking.
- The masking is greatest for tui, morepork and the New Zealand bellbird which vocalise at a relatively wide frequency range (500 Hz – 10 kHz) that overlaps with the anthropogenic noise. There is less masking for forest bird species with higher frequency vocalisations such as the New Zealand fantail, silvereye, tomtit and similar (vocalisations at 2 kHz – 10 kHz).
- There were significantly less bird vocalisation detections in forest areas near the active sites as compared with quieter locations. The greatest reduction in detections was for the morepork, which is expected because its 'hoot' can be easily masked by anthropogenic noise.
- The helicopters generated high levels of broadband noise when travelling overhead, masking all other forest sounds. Helicopter noise reduced to a low frequency rumble at distance, which had less overlap with the forest bird vocalisations and therefore less potential masking. We note the helicopters are intermittent, so the duration of masking is limited.

We also note noise levels in the forest can vary significantly with weather and proximity to rivers/streams. Wind in trees, rainfall and water flowing can generate broadband noise in the same frequency range as forest bird vocalisations and can therefore cause masking. While these ambient noise sources are not as loud at source as the drilling operations, they raise the noise level in large areas of the forest.

12.3 Predicted effect zones

Our memoranda in Appendix F have focussed on exploration operations (existing and proposed) in the orebody area. This includes helicopters, drill rigs, pumps and generators.

We note that the construction and operation of the ventilation shafts will also generate noise in the orebody area which may result in masking noise effects on forest birds. We consider that our predicted noise contours for the exploration operations (refer figures at end of Appendix F) are generally representative of the ventilation shaft activities.

12.4 Mitigation and Management

General good practice for minimising noise should be implemented from the planning stage for any new activity or change in operation. Using the best practicable option to minimise noise will limit the area of forest affected and duration of the effect.

[12] https://acousticstoday.org/wp-content/uploads/2019/09/The-Impact-of-Urban-and-Traffic-Noise-on-Birds-Robert-J.-Dooling.pdf

13.0 GENERAL NOISE MITIGATION AND MANAGEMENT MEASURES

The specific mitigation recommendations that may be implemented for each component of WNP is discussed in detail in Sections 6 to 9, and to some extent in Appendix C. This section discusses in general terms mitigation and management best practice, which is focussed on construction activity, but is also generally applicable to management of general longer-term operations as well.

13.1 Noise Barriers

Noise barriers are required in some locations to ensure noise levels meet the performance criteria.

In general terms, noise barriers are required to be constructed with no gaps and have a minimum surface density of 10 kg/m^2.

The required heights will vary depending on the source and receiver locations (and the intervening ground), but around 3 metres is a common starting point for analysis. Earth bunds or a combination of bunds and screening walls or fences are also acceptable provided they are constructed to the same specified height.

We note that the extent of required noise barriers is highly dependent on the noise sources in each scenario and where they are located. Because of this, noise barriers are not necessary in all scenarios. The ones that we have specified are not needed for the duration of the project and can be removed when not required. Mechanisms to ensure noise barriers are performing as expected should be put in place through the use of an Operational Noise Management Plan.

13.2 Receiver Building Mitigation

Because of the mechanisms enshrined in the proposed conditions, noise levels will not be allowed to exceed the noise limits, therefore no building modification mitigation is required or proposed. This section merely describes what options are theoretically available and is therefore for information purposes only.

Building mitigation for receivers aims to achieve appropriate internal noise levels if external levels cannot be practicably mitigated at (or near) the source. We consider an appropriate internal daytime noise criterion to be 40 dB L_{Aeq}.

At high external noise levels (for example 65 dB and above), this criterion generally requires upgrades to the building envelope, such as improved glazing, joinery or internal wall and ceiling linings. New houses often do not need additional upgrades as standard building code compliant designs are often good enough. In all cases, these upgrades only work if windows and doors remain closed. This therefore also triggers a requirement to provide alternative forms of ventilation and comfort cooling (through mechanical systems).

At moderately high external noise levels (for example 55 – 65 dB), existing buildings perform adequately (can achieve 40 dB L_{Aeq}) with windows closed. Therefore, the only additional requirement would be a mechanical ventilation system for all habitable rooms.

At moderate external noise levels (for example 50 – 55 dB), existing buildings normally perform adequately with windows open. A typical New Zealand weatherboard house will achieve a noise reduction (from outside to inside) of approximately 15dB with the windows slightly open. However, if a dwelling has seriously degraded joinery or other construction defects, or unusually large areas of glazing the noise reduction performance may be lower.

In the case of Gladstone (Section 6.3.1), a hypothetical exceedance where noise levels are only just above the criteria, many houses would not require any specific building treatment. If they did, by simply ensuring windows and doors can remain closed is going to be sufficient from a noise reduction perspective. Therefore, the only additional requirement would be a mechanical ventilation system for all habitable rooms.

Because there are also no significant night-time noise emissions of concern for the affected dwellings there would be no additional night-time requirements for bedrooms (however they are still considered as a habitable room).

The provision of a suitable ventilation system could take the form of a heat pump (with a fresh air supplement) or ducted ceiling fan system. These systems are not cost prohibitive, nor generally invasive in terms of installation. The provision of such a system may also enable written approval to be sought.

13.3 Management of Plant and Equipment

When selecting construction equipment:

- Use quieter construction methodologies where practicable
- Use electric motors rather than diesel engines where practicable
- Use rubber tracked equipment rather than steel tracked equipment where practicable
- Use equipment that is suitably sized for the task
- Maintain equipment well to minimise rattles, squeaks etc.
- Fit engines with exhaust silencers and engine covers where practicable
- Ensure pumps, compressors and generators are adequately enclosed where practicable
- Avoid tonal reversing or warning alarms (beepers). Alternatives include broadband alarms (squawkers/quackers), flashing lights, proximity sensors, reversing cameras and spotters
- Apply appropriate setback distances for certain high noise equipment
- Limiting high noise equipment to a particular year/height of excavation.

13.4 Helicopter Noise

All helicopter operations should be flown to avoid residential areas of Waihi township and where possible, rural dwellings as far as is practicable.

Wherever practicable, we recommend that the helicopter operates in a manner in accordance with the "Fly Neighbourly" guide published by Helicopter Association International and recommend by the New Zealand Helicopter Association.

13.5 Noise Management

13.5.1 Community liaison

Consideration of written communication (e.g. newsletter) provided to nearby building occupants prior to starting construction operations. This could include:

- Details of the overall works, its timing and duration
- Contact details and names of personnel whose job is to receive complaints and enquiries;
- Acknowledge that some activities could potentially generate elevated noise levels and may result in small disturbance for short periods.

13.5.2 Complaint handling

Complaints should be acknowledged immediately where practicable and responded to within a short timeframe. If a more detailed response is needed, it should be provided within a set timeframe.

All construction noise complaints should be recorded in a complaints file that could be made available to the Council on request.

14.0 CONCLUSION

We have investigated and assessed proposed noise emissions from the Waihi North Project (WNP) under the provisions of the FTA. WNP is broadly made up of Gladstone Open Pit (and other ancillary operations) (GOP), the Northern Rock Stack (NRS), Tailings Storage Facility 3 (TSF3) and the Wharekirauponga Underground Mine (WUG).

Our assessment is based on the activities proposed to be undertaken, the existing noise environment, the currently consented operations and the mitigation that can be implemented. Overall, our assessment indicates that noise levels generally would be compliant with the recommended criteria.

An important aspect in our considerations relates to what we consider is construction activity and what is operational. Following discussions with OGNZL, we defined the construction activities to which less stringent noise criteria would apply.

Construction noise levels remain compliant in almost all circumstances. There may be some limited localised exceedances, but these would be managed through appropriate management plans, as enshrined in the proposed conditions.

There are some 27 receivers where the operational noise levels without mitigation are slightly above 50 dB L_{Aeq}. For these, there would be an adverse impact on the level of amenity these properties experience. However, the proposed conditions OGNZL are committing to would not allow that to occur so remedial action prior to operations commencing is necessary.

Our overarching conclusion is that if the noise limits enshrined in the proposed conditions are met, then noise effects as a result of the WNP project are acceptable.

The assessment at each location is summarised below.

14.1 Gladstone

For identified construction activities, predicted noise levels will be around 45 dB L_{Aeq} at the closest dwellings. This is well below the construction noise limits proposed in the conditions.

Operational noise levels from the Gladstone Pit are predicted to be below 50 dB L_{Aeq} at all receivers except for 27 dwellings located on Moore Street, Barry Road and George Street. For these residents, there is a small adverse impact on the level of amenity these properties experience.

However, the proposed conditions require that a noise management plan (NMP) be prepared to outline the methods to be used to ensure noise levels do not exceed 50 dB at any residence. The NMP will prescribe a noise mitigation development process that will occur prior to operations commencing, that will set out the options considered and provide certification that noise levels comply. These options would include (but not limited to);

- The use of quieter machinery (determined by a noise source characterisation procedure)
- Restrictions on operating hours
- Bespoke screening of individual sources
- Screening of noise sensitive receivers
- Noise monitoring programmes (including noise modelling and measurement regimes)

On this basis and with the above measures in place, we consider that the Gladstone noise emissions would be reasonable from a noise effects perspective.

14.2 Process Plant

The Processing Plant will be upgraded to facilitate the WNP's additional throughput and extended lifespan.

The calculations show that there is a general increase in noise levels from the Processing Plant only (3-5 dB) as a result of the upgrades but also a small decrease to the south-west. This is a barely discernible to just noticeable increase. During the day, taking account of the fact that generally, other mining operations often contribute more noise to these receivers, increased Processing Plant noise levels are unlikely to be discernible for much of the time. Overall, noise emissions for the processing plant are also compliant during the day.

However, it is possible that noise levels at night may just exceed the night-time noise limit of 40 dB by a small margin. As the processing plant design is not possible to accurately model at this stage because the equipment is relatively unique, being sourced from other OGNZL sites around the country, and is currently not operational so we cannot measure the noise emissions, we have necessarily included some conservatism in the calculations. This means it is possible that once established on site, there is likely to be lower noise levels in practice.

In any event, and as for Gladstone, the proposed conditions require that a noise management plan (NMP) be prepared to outline the methods to be used to ensure noise levels do not exceed 40 dB at any residence not owned by OGNZL or subject to or with an agreement with OGNZL. The mitigation methods would include (but not be limited to);

- Restrictions on operating hours
- Bespoke screening of individual sources (primarily by the use of full enclosures)
- Screening of noise sensitive receivers
- Noise monitoring programmes (including detailed noise modelling of the new plant when installed and measurement regimes)

On this basis and with the above measures in place, we consider the processing plant noise emissions would be able to comply with the noise limits in the proposed conditions, and therefore would be reasonable from a noise effects perspective.

14.3 NRS

For identified construction activities, calculated noise levels associated with the construction of topsoil stockpiles will be compliant at the closest dwellings.

Operational noise is also compliant with the recommended criteria.

14.4 TSF3

The overall TSF3 construction activity is sufficiently long and similar in character to normal mining activities that we consider it as an 'operational' activity, rather than 'construction'. However, the construction of topsoil stockpiles, initial excavation, construction of clean water diversion drains, foundations, borrow pits and haul roads is assessed as construction noise.

The predicted noise levels are all below 50 dB L_{Aeq} and are therefore below the proposed compliance limit.

14.5 WUG

We assessed the potential noise effects from the construction, and establishment phase of the project, including the Willows Access Tunnel. Our assessment included consideration of noise effects on rural receivers, and receivers in the DOC conservation area. We have also provided extensive noise level data to help inform the ecological assessment.

For the ventilation raise and exploratory drilling sites, noise levels from the construction of the raises, both on ground and from helicopter operations would have potentially some small effects on recreational users of the DOC land, but would be of no appreciable significance due to the relatively short duration and the infrequent use by recreational users.

Noise emissions from helicopter operations associated with the operation of the WUG do not exceed a noise level of 50 dB L_{dn} at any noise sensitive receiver. We conclude that noise levels from general helicopter operations as a result of the project are acceptable.

For the Willows Road SFA site, construction and operational noise levels received at the nearest rural receivers would comply with the recommended noise limits and we therefore consider to be acceptable overall.

APPENDIX A GLOSSARY OF TERMINOLOGY

Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
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)
$L_{A10\,(t)}$	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. 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.
$L_{A90\,(t)}$	The A-weighted noise level equalled or exceeded for 90% of the measurement period. This is commonly referred to as the background 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.
$L_{Aeq\,(t)}$	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.
L_{dn}	The day night noise level which is calculated from the 24 hour L_{Aeq} with a 10 dB penalty applied to the night-time (2200-0700 hours) L_{Aeq}.
Masking Noise	Intentional background noise that is not disturbing, but due to its presence causes other unwanted noises to be less intelligible, noticeable and distracting.
Noise	A sound that is unwanted by, or distracting to, the receiver.
NZS 6801:2008	New Zealand Standard NZS 6801:2008 *"Acoustics – Measurement 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"*
NZS 6806:2010	New Zealand Standard NZS 6806:2010 "*Acoustics - Road-traffic noise - New and altered roads*"
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.
Special Audible Characteristics	Distinctive characteristics of a sound which are likely to subjectively cause adverse community response at lower levels than a sound without such characteristics. Examples are tonality (e.g. a hum or a whine) and impulsiveness (e.g. bangs or thumps).
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 AMBIENT NOISE SURVEYS

B1 Waihi Township Area Survey Details

The key details of the noise monitoring programme are as follows:

Personnel: Lodewyk Jansen, Marshall Day Acoustics (deployment and retrieval).

Instrumentation: See Table below. Example photographs are also provided below.

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

Weather History: Recorded public data for "*Five Oaks Kingsley Rd - IWAIHI15*" station opposite in Figure 37.

Table 18: Survey details for each Measurement Position

		MP1	MP2	MP3	MP4	MP5	MP6
Details	Address	26 Islington Tce	14 Roycroft St	126 Kenny St	28 Russell St	34 Heath Rd	131 Trig
	Coordinates	37° 23' 12 S 175° 50' 15 E	37° 23' 3 S 175° 51' 7 E	37° 23' 23 S 175° 50' 51 E	37° 23' 19 S 175° 50' 7 E	37° 23' 43 S 175° 51' 17 E	37° 24' 2 175° 53'
	Recording Start	30/07/20 10:40	30/07/20 14:55	30/07/20 11:20	30/07/20 11:45	30/07/20 12:55	30/07/2(
	Recording Stop	02/08/20 23:50	14/08/20 12:35	20/08/20 10:15	20/08/20 09:45	14/08/20 12:50	20/08/2(
Equipment	Model	01dB CUBE	01dB DUO	01dB DUO	B&K Type 2250	01dB CUBE	01dB CU
	Serial No.	11186	10863	10862	3025096	10702	10420
	Calibration Due	19/12/21	25/09/22	06/06/21	27/11/21	15/08/21	17/06/2

Figure 36: Example photographs of loggers installed at MP1 (right) and MP3 (left)

Figure 37: Weather history for August 2020 (which covers most survey days)

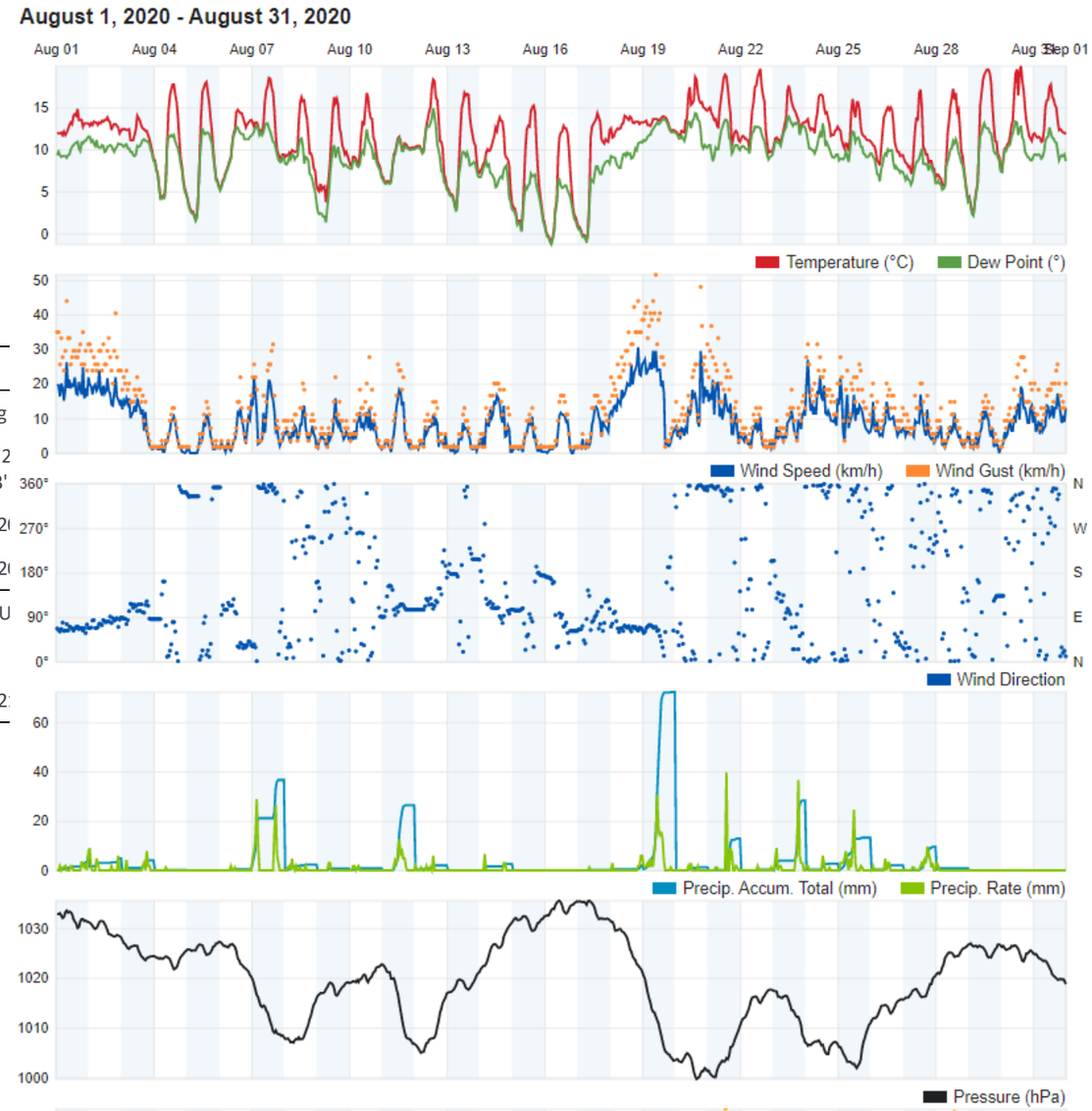
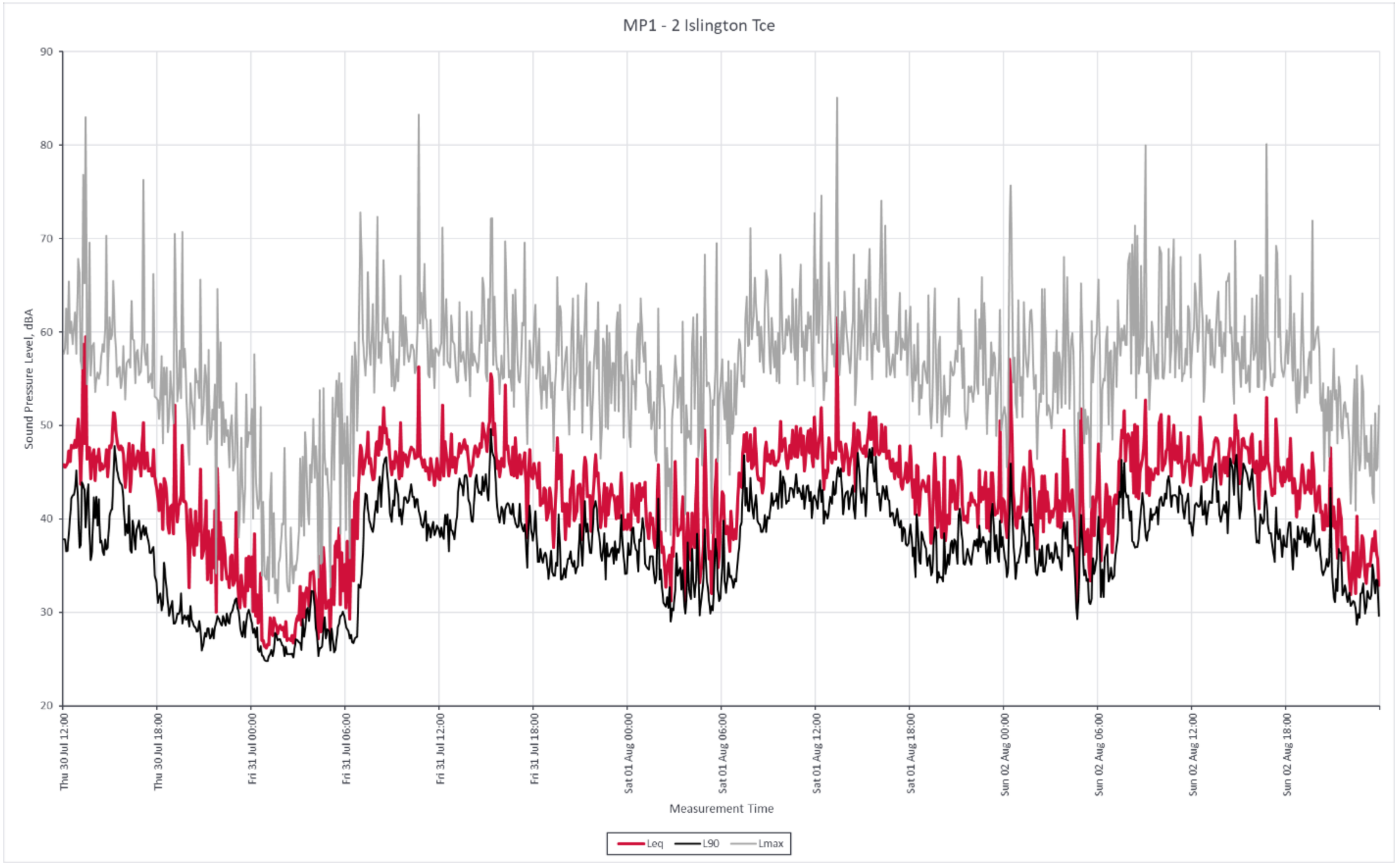
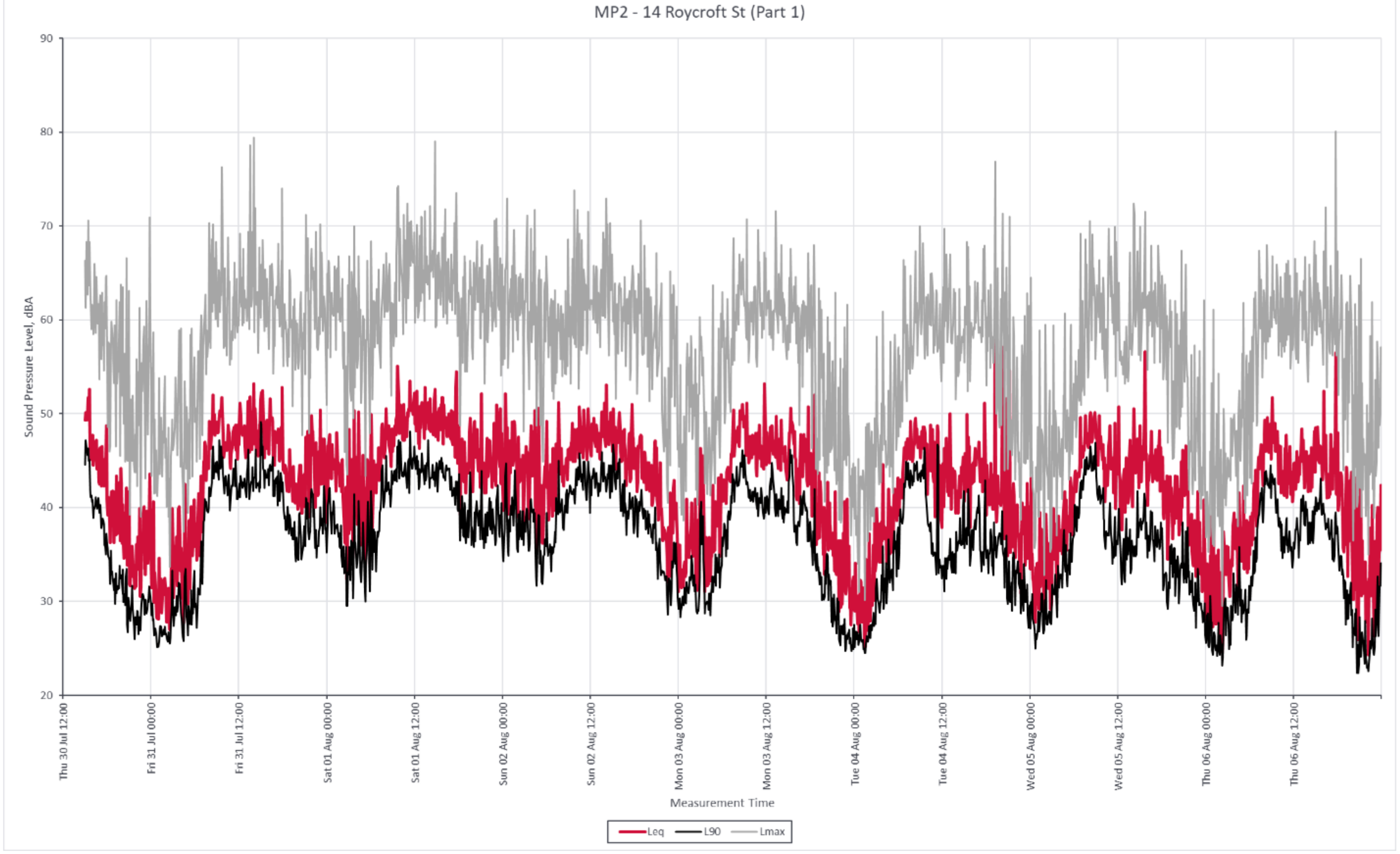


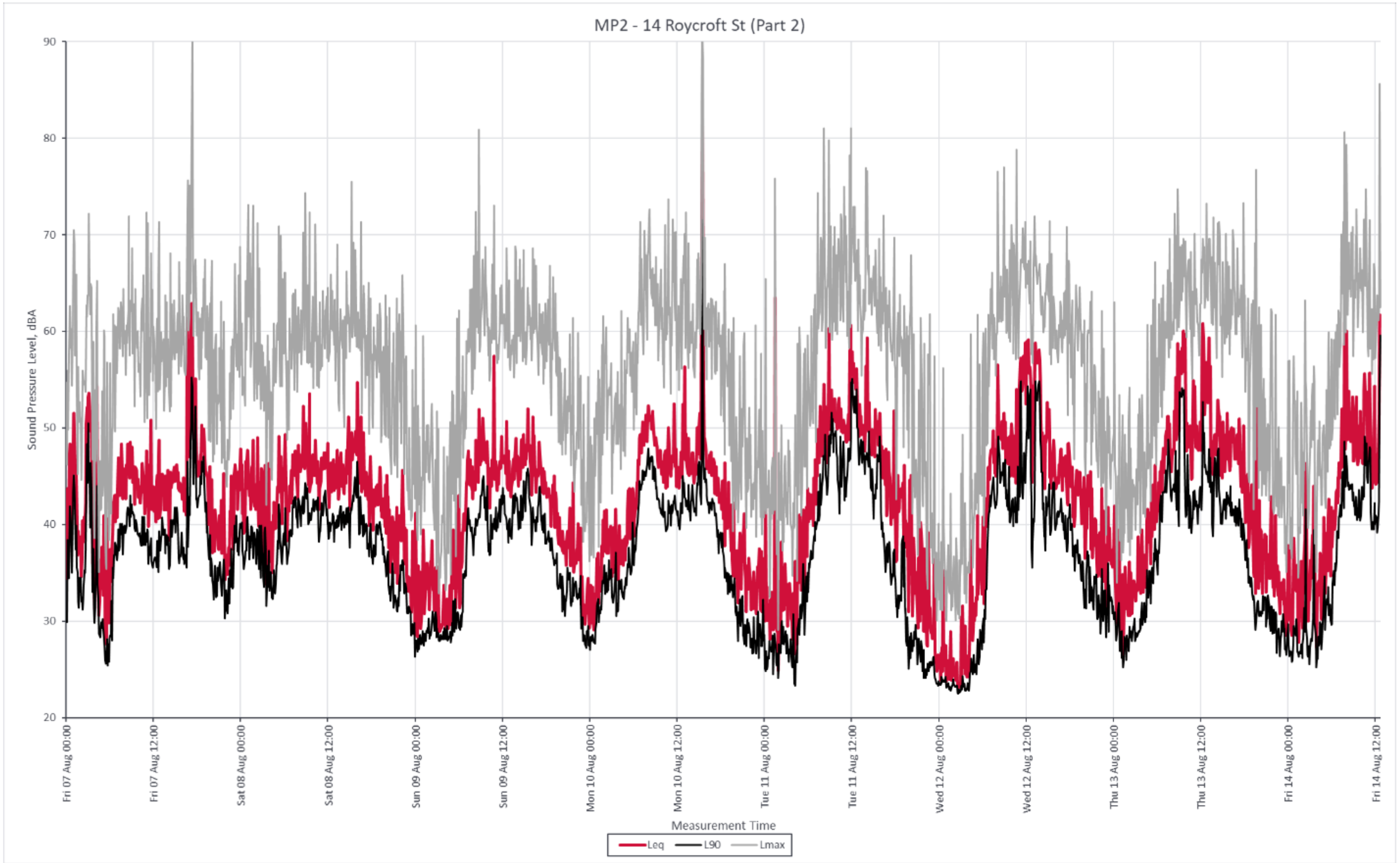
Figure obtained from: https://www.wunderground.com/dashboard/pws/IWAIHI15/graph/2020-08-2/2020-08-2/monthly

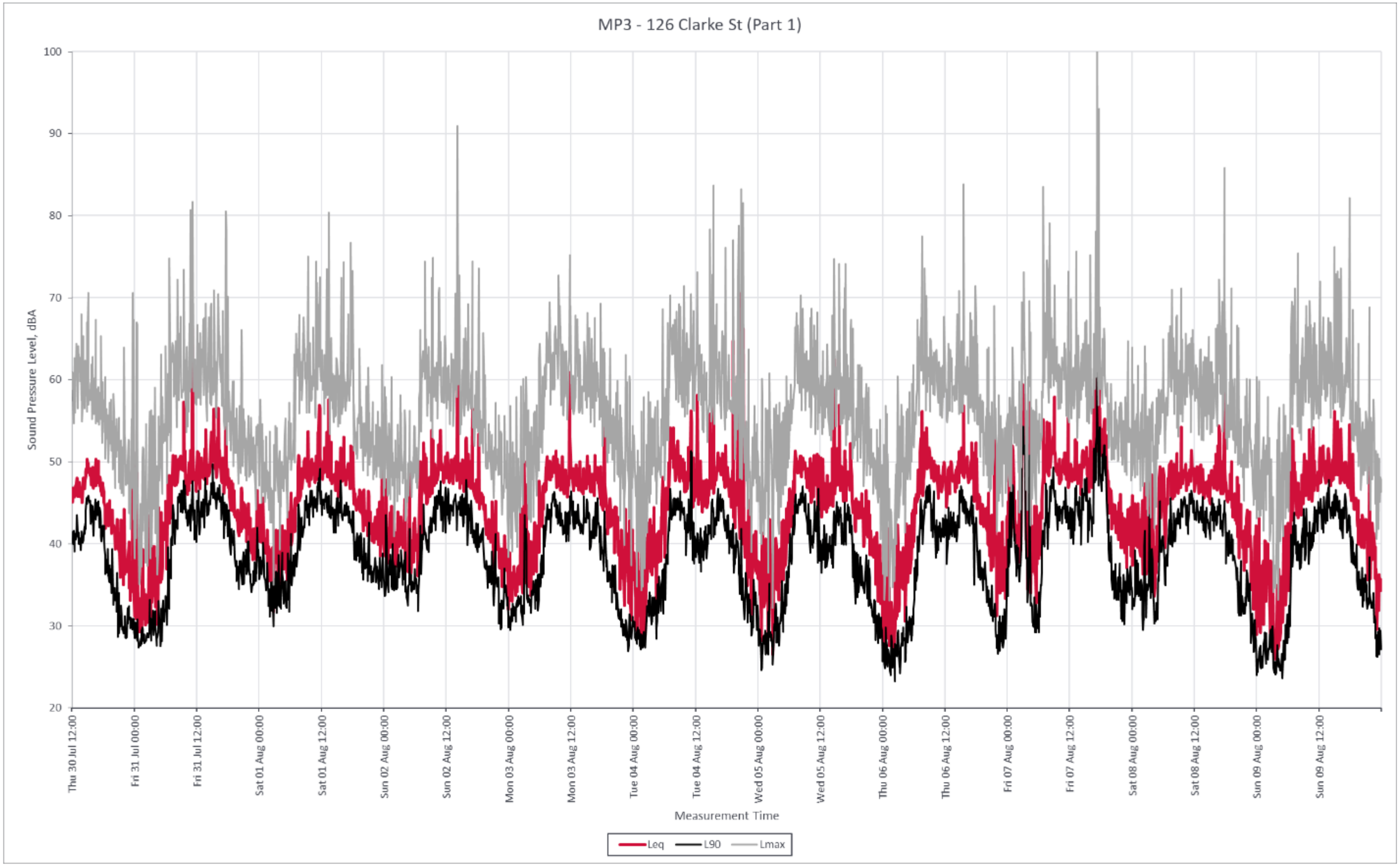
B2 Waihi Township Area Measured Ambient Noise Levels

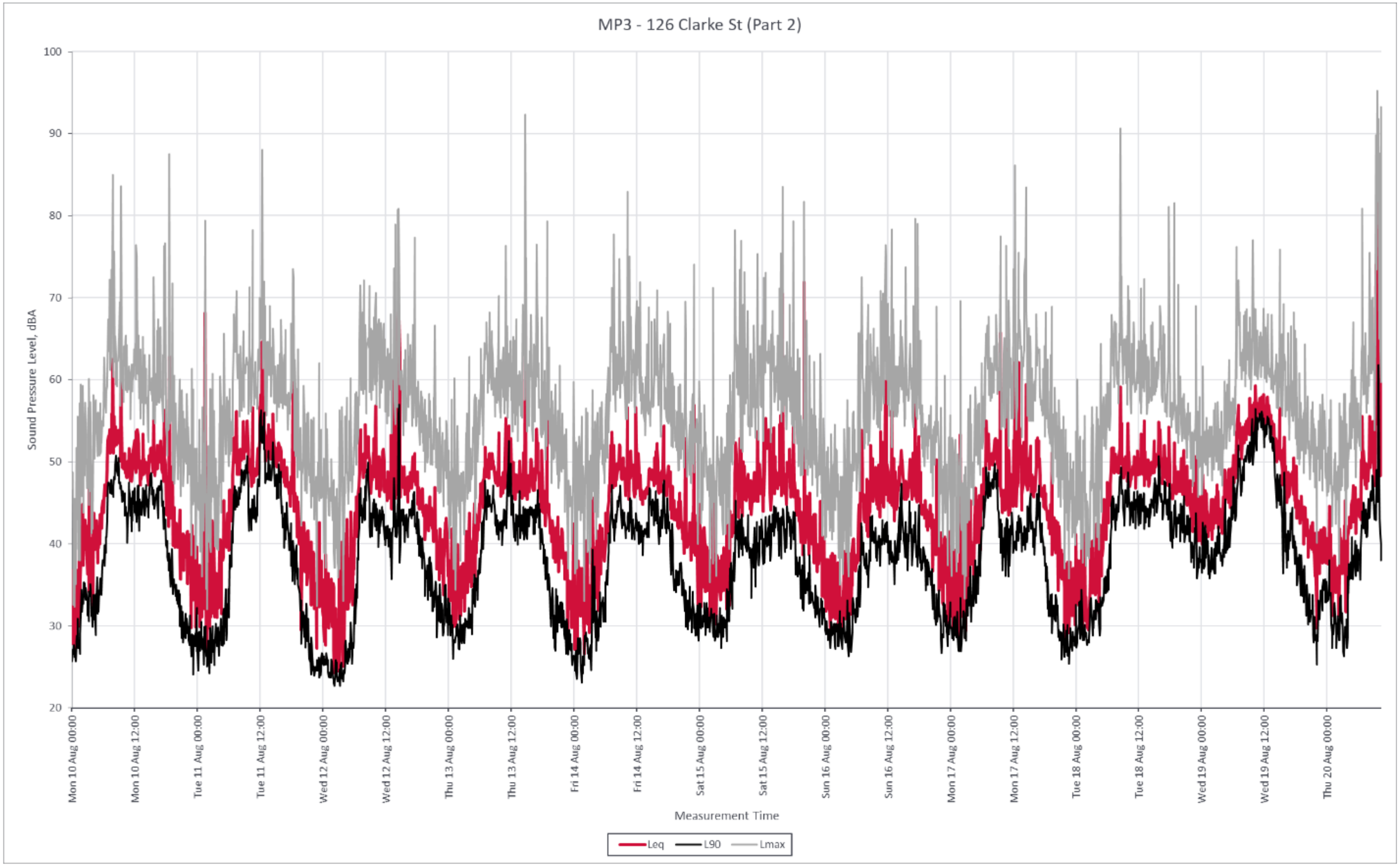
Presented on following pages.

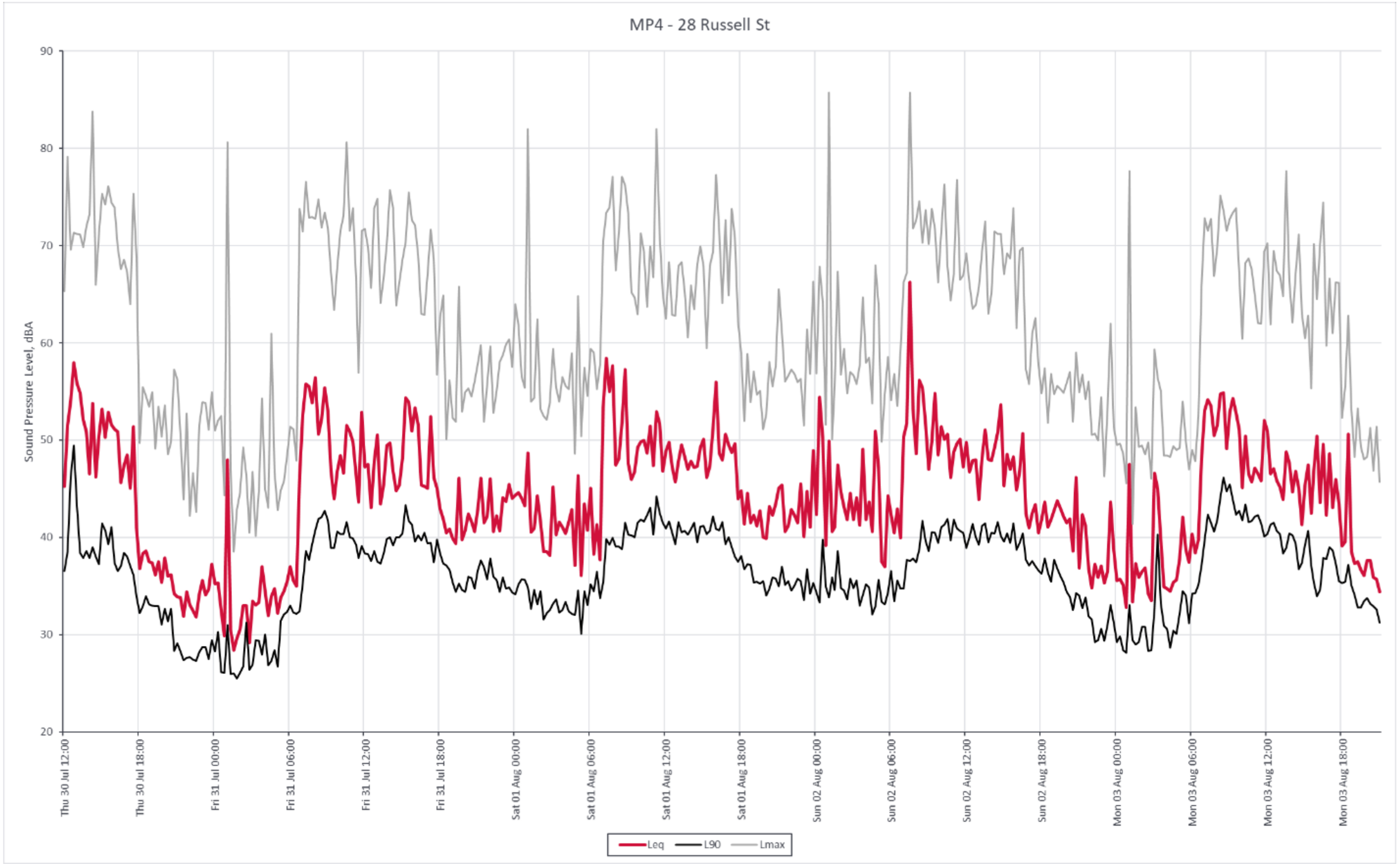


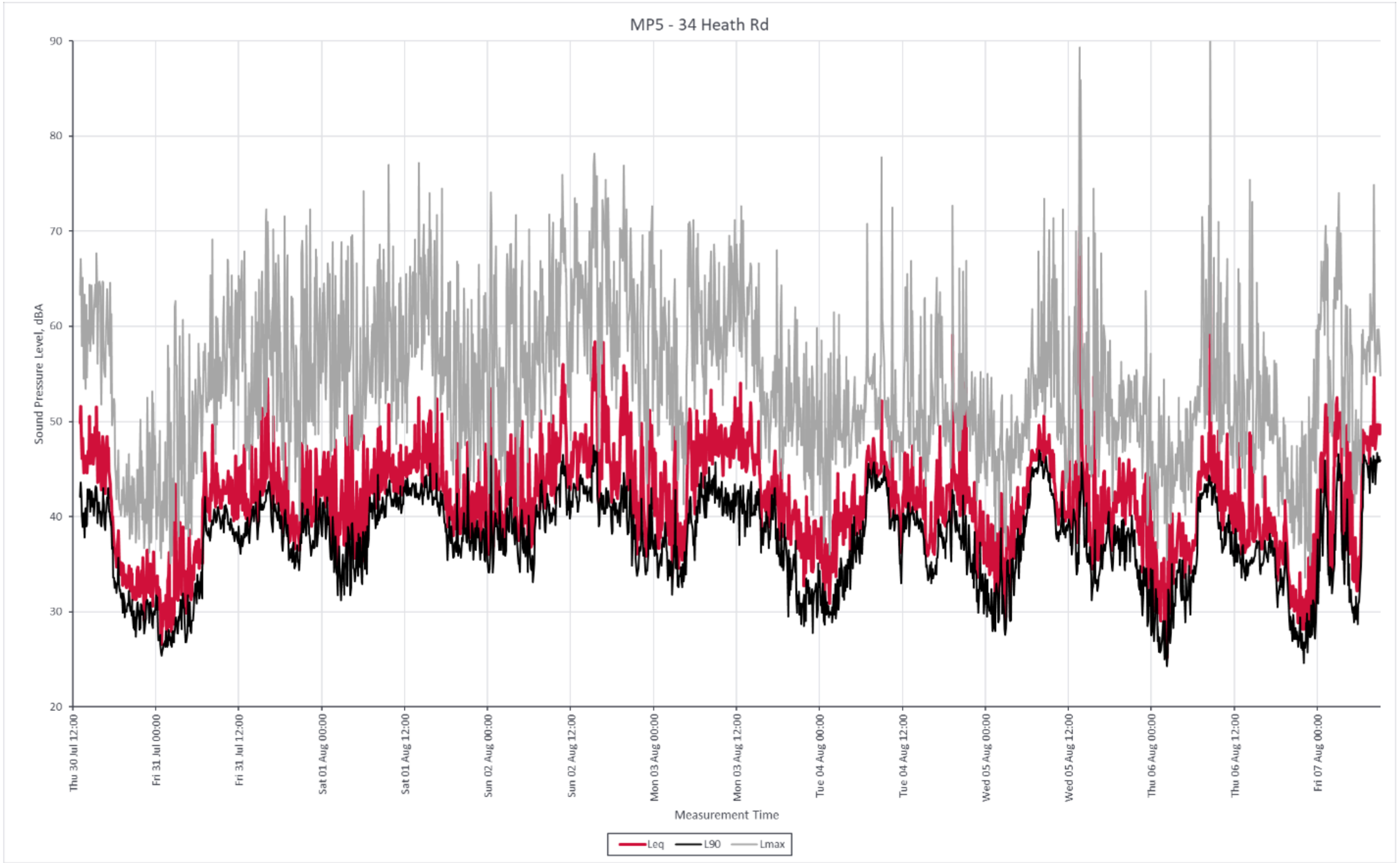


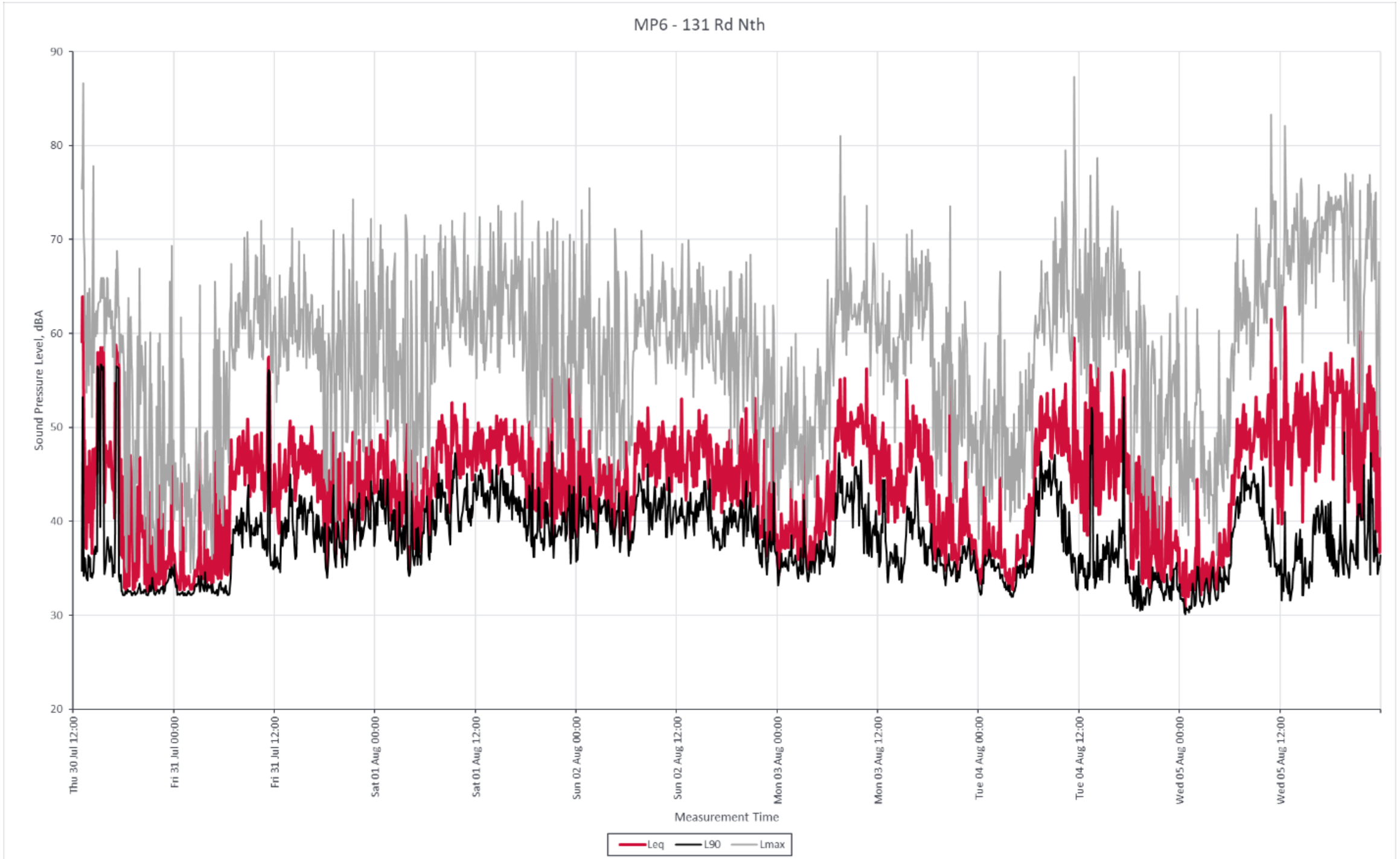












B3 WUG Area Survey Details

The key details of the noise survey are as follows:

Date: 0920 hrs 15 July 2020 to 0930 hrs 30 July 2020

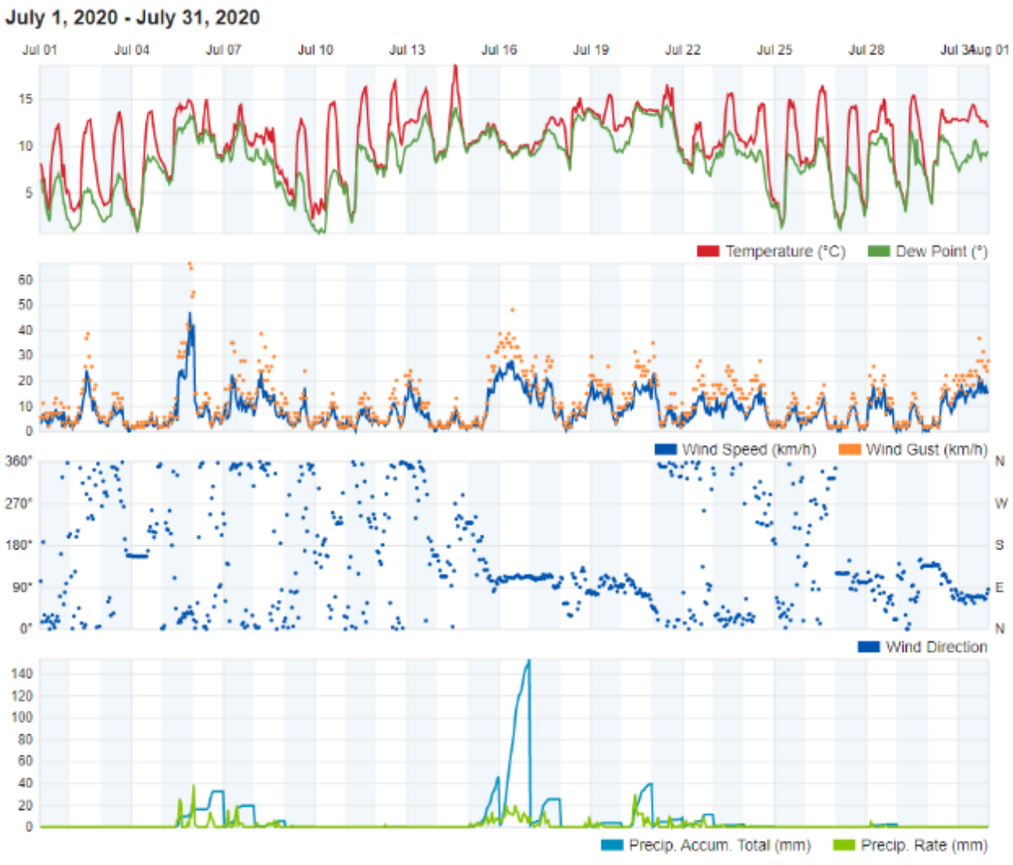
Personnel: Lodewyk Jansen, Marshall Day Acoustics (deployment and retrieval)

Weather: Recorded public data for "*Five Oaks Kingsley Rd - IWAIHI15*" station below

Instrumentation: MP1 – DOC Reserve Land:
01dB CUBE Noise Monitoring Terminal, serial 10420, calibration due 17/06/2021
MP2 – 121 Willows Road:
01dB CUBE Noise Monitoring Terminal, serial 10702, calibration due 15/08/2021

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

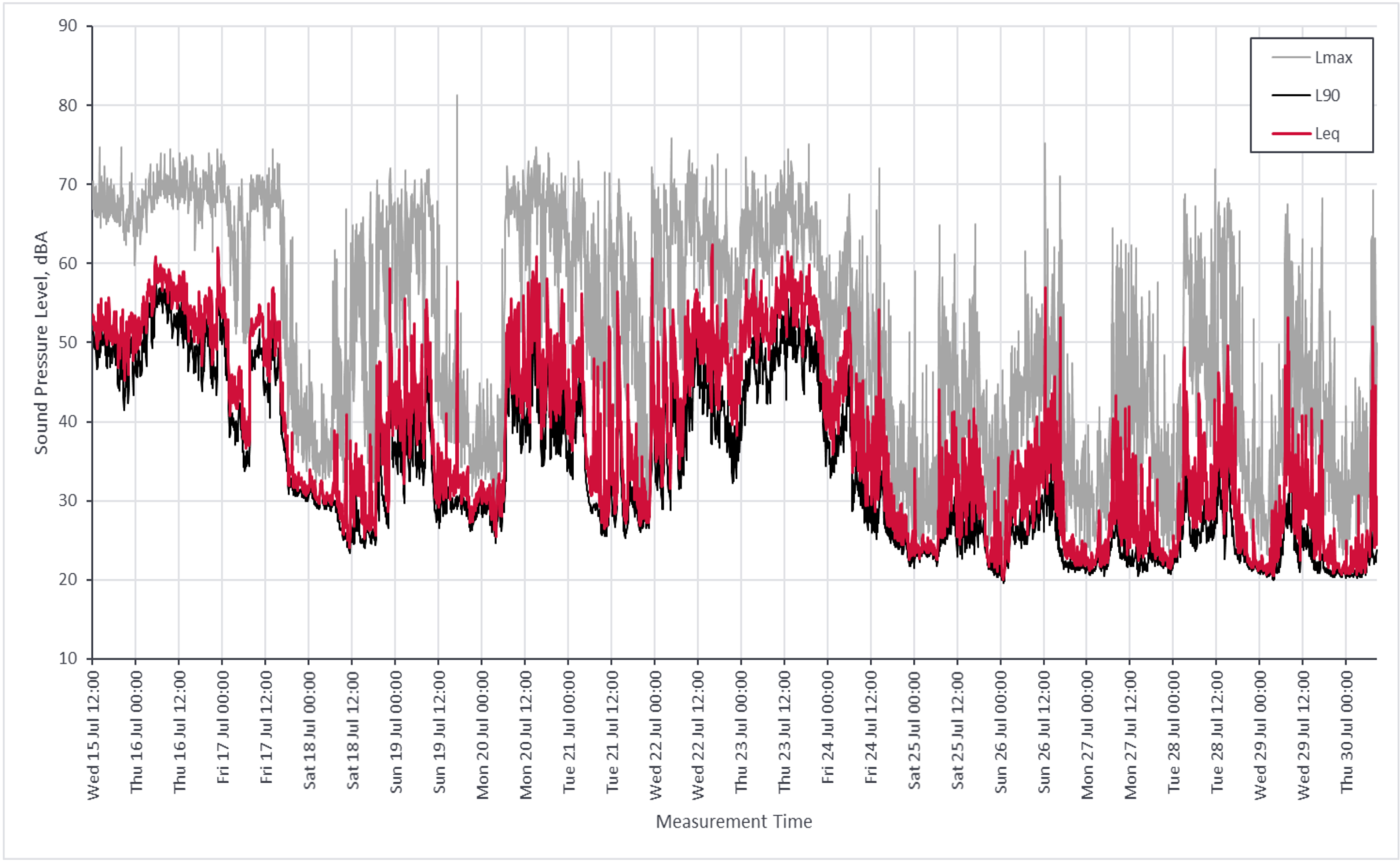
Weather History:



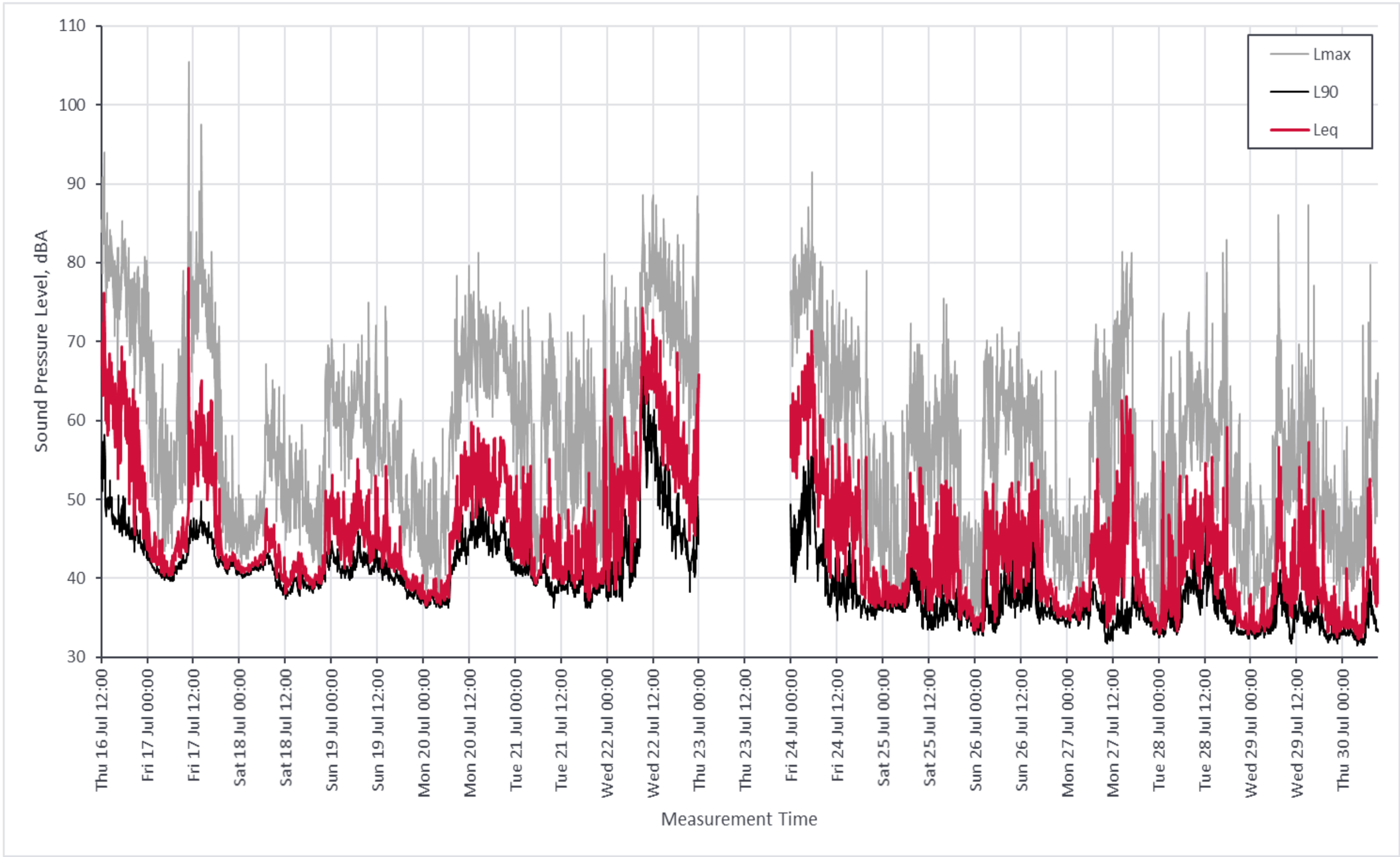
B4 WUG Area Measured Ambient Noise Levels

Presented on following pages.

Measurement Position 1 – DOC Land



Measurement Position 2 – 121 Willows Road



APPENDIX C GLADSTONE STRUCTURAL NOISE MITIGATION ANALYSIS

This section describes the noise mitigation packages we have investigated and analysed in a noise mitigation design workshop with OGNZL staff and representatives. Most of the mitigation is focussed on reducing noise towards Barry Road to the north, an aim that is made difficult by the surrounding topography.

Our intent with this analysis was to establish, at least at a concept level, what mitigation would be required to achieve a firm limit of 50 dB L_{Aeq} at all properties. Once we had a suite of mitigation options, these were presented to and discussed with the Project team. At this time several issues were raised that render some of the options undesirable for practical or logistical reasons.

C1 Intention

Develop noise mitigation to ensure a reasonable level of amenity is maintained at all properties not owned by OGNZL or subject to an agreement with OGNZL

C2 Reasons

This was initially required because our preliminary modelling indicated that noise levels up to 57 dB L_{Aeq} were predicted at some dwellings.

The elevated levels were significantly influenced by noise from the new GOP crusher and associated loading activity, with this cluster of sources alone contributing over 50 dB L_{Aeq} at the closest dwellings.

C3 Structural Mitigation Options

We investigated a combination of structural mitigation (i.e. barriers and bunds) and source noise management (e.g. the selection of quieter equipment or similar restrictions).

The following noise barrier concepts were developed through this process:

- A standard timber fence on OGNZL land along the boundary with 56-88 Barry Road ('Barrier A');
- A bund along Moore Street, halfway between the pit and Barry Road ('Barrier B');
- A wall north of the GOP crusher slot and loading area ('Barrier C');
- A wall along the south-western rim of the Gladstone pit, to block noise to the south ('Barrier D').

These options are labelled accordingly in Figure 38.

C4 Discussion and Workshop

We discussed the potential effectiveness and practicalities of such measures with the project team.

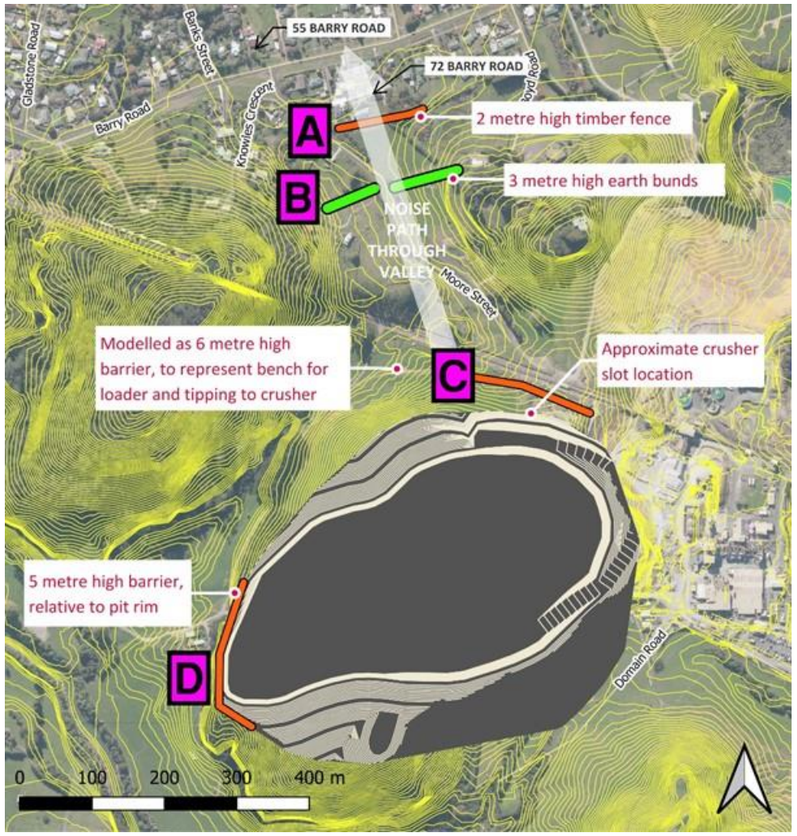
Northern Crusher Loading

Initially, a main focus was on the northern crusher slot wall (Barrier C). This was required in part to control noise from a large 100t wheeled loader that was modelled at the new GOP crusher load point. Because this large piece of machinery would sit outside of the pit (effectively at normal ground level), noise from this area, combined with that from the CAT777 haul trucks, could relatively easily propagate up the valley to the north-west.

To address this, the northern wall was initially modelled as 6 metres high. While such a structure is unlikely to be feasible from an engineering perspective, it was investigated to ascertain its noise reduction effectiveness. In practice, we expected that an equivalent degree of noise control could be achieved by dropping the ROM crusher tipping point and vehicle paths so that they are on a bench between the crusher slot and surrounding ground. A more conventionally sized noise barrier or bund could be formed on the top edge of this in order to create a significant 'path difference', i.e. a long noise path for noise to escape the pit.

Barriers A and B had a further influence in reducing noise from these sources.

Figure 38: Indicative noise barrier options in mitigation workshop



Additional Mitigation

A barrier has also been considered on the south-western edge of the pit to reduce noise emissions towards receivers in the Heath Road and Clarke Street areas. This is intended to reduce the noise from large mining equipment operating on the western portion of the pit before it is established to a reasonable depth, as described in Section 7.3.

Further mitigation is considered in the form of equipment management, particularly during the early years of the project when the pit is not sufficiently deep. During this time – approximately years 8 to 10, inclusive – we investigated the impact of reducing the use of extra-large mining equipment such as the Hitachi 180t excavator and replacing them with multiple smaller plant items used instead (e.g. 2x 50t CAT excavators). Similarly, we proposed that use of the selected CAT 992 front end loader at the ROM processing plant could be limited to a smaller model such as a CAT 960 whenever possible.

Subsequent Refinement

Following discussion with OGNZL, the proposal and mitigation options have been refined to achieve a more practical balance. The CAT 992 loader was over specified for the task and has been scaled down to a maximum size of 51 tonnes, e.g. a CAT 988k. With noise suppression fitted, we have based our calculations on a sound power level of 110 dB L_{wA}, which is a notable reduction over that used for the initial modelling.

As a result, the barriers have also been refined, with a maximum proposed height of 3 metres for the northern wall now proposed.

C5 Noise Level Analysis

The table below shows the noise levels at the north-western receivers for year 8. Overall noise levels are similar in years 9 and 10. These calculations assume use of the smaller 51 tonne loader as discussed above for the baseline (i.e. non-mitigated) scenario, and a 3 metre wall at Barrier C.

Table 16: Year 8 noise emissions to north-west, with Barriers A-C and source management options

Receiver	Noise level with no mitigation, dB L_{Aeq}	Dominant noise sources	Noise level with mitigation, dB L_{Aeq}						
			Quieter plant	A only (Fence)	B only (Bund)	C only (N wall)	A+B	A+B+C	All
55 Barry Rd	51.4	Processing (45 dBA) GOP FEL (44 dBA) 180t Excv. (43 dBA) 777 Haul (42 dBA) GOP Crush (40 dBA)	50.8	51.4	51.3	50.6	51.3	50.6	50.0
72 Barry Rd	53.9	180t Excv. (47 dBA) GOP FEL (47 dBA) 777 Haul (44 dBA) Processing (43 dBA) GOP Crush (43 dBA)	52.6	51.9	52.6	53.1	51.9	51.8	50.3
10 Moore St	53.0	180t Excv. (46 dBA), Processing (46 dBA) GOP FEL (44 dBA) 777 Haul (41 dBA) GOP Crush (42 dBA)	51.7	53.0	51.2	52.4	51.2	51.1	49.5

Table 17: Noise levels at 33A Heath Road for years 8-10, with Barrier D and source management options

Year	Noise level with no mitigation, dB L_{Aeq}	Dominant noise sources	Noise level with mitigation, dB L_{Aeq}		
			Quieter plant	SW Pit Wall	Both
8	51	180t Excv. (44 dBA) 777 Haul (43 dBA) 50t Excv. (43 dBA) 65t Dozer (40 dBA)	50	N/A	50
9	54	777 Haul (50 dBA) 40t ADT's (48 dBA) Drills (45 dBA) Water cart (41 dBA)	54	49	49
10	53	180t Excv.'s (49 dBA) GOP crusher (44 dBA) 777 Haul (43 dBA) 40t ADT's (40 dBA)	53	51	51

C6 Outcomes

Northern Barriers

The results opposite indicate that the range of mitigation options available generally all achieve the same result when used in isolation. Barriers A and B only provide any benefit to the houses immediately behind them.

In general, Barrier A benefits 72 Barry Road, Barrier B benefits 10 Moore Street and Barrier C benefits 55 Barry Road. In all cases the benefits are small to the extent of being imperceptible.

From the discussions we have held, we understand the use of quieter plant may render the project unfeasible, and would almost certainly extend the duration of mining, meaning it is not considered further. With this in mind, the best acoustical outcome would be the construction of barriers A, B and C.

Notwithstanding this, we note that these barriers still do not ensure noise levels are below 50 dB, only offer an imperceptible improvement and may have other adverse effects (such as visual). Therefore, alternative mitigation in the form of building mitigation has been considered.

Southern Barrier

With respect to Barrier D in the south-west, we understand from discussions with OGNZL that in practice this would be a difficult barrier to construct. On top of this, the construction of the barrier itself would give rise to construction noise emissions. While it would not be impossible to construct, we note also it is only effective for year 8 with insignificant benefits in later years. For these reasons, this barrier is discounted. The implications of this however are that noise levels at this dwelling are in excess of the criteria for some operational scenarios.

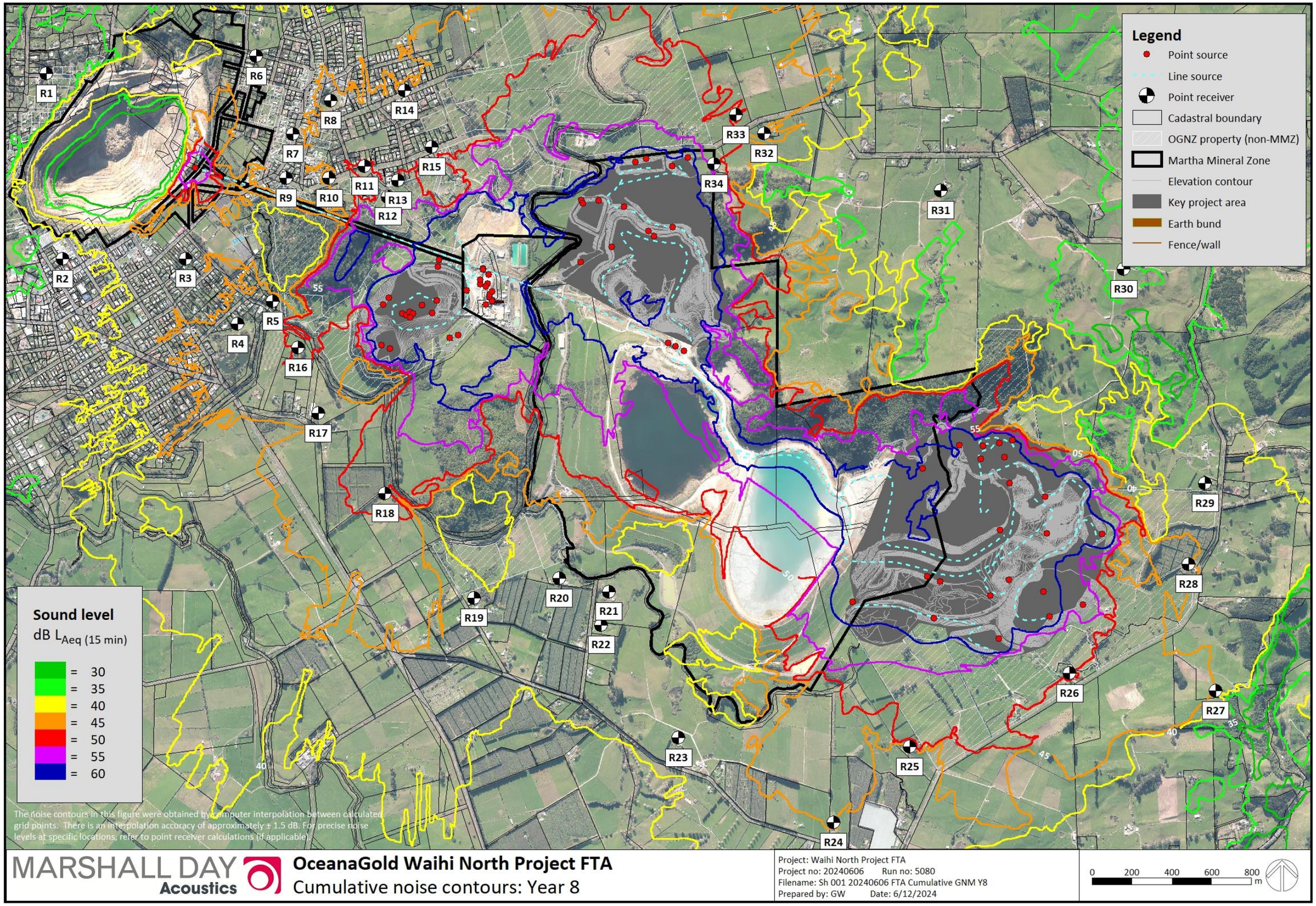
In addition, we have also investigated localised screening around 33A Heath Street, such as a double-height container barrier on the property boundary. As well as being intrusive visually for that property, it also does not achieve any appreciable noise reduction. This is therefore discounted as being an option. Therefore alternative mitigation in the form of building mitigation has been considered.

C7 Building Mitigation

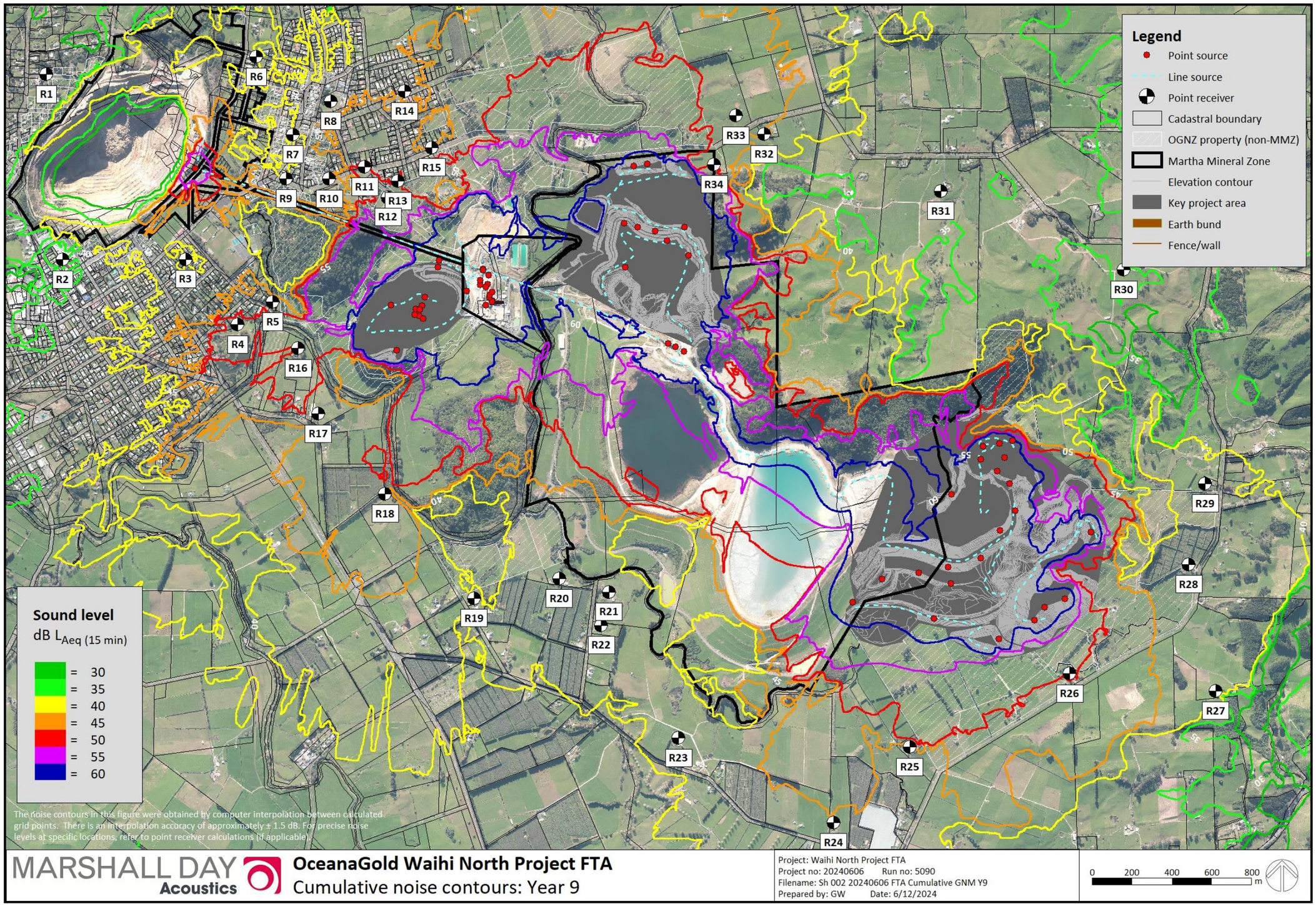
Consideration can also be given to offering building mitigation to these dwellings to enable acceptable indoor noise levels. We expect this would consist of provision of a mechanical ventilation system so that windows and doors can remain closed. Whilst not ideal, it goes some way to mitigating noise effects and would in our opinion maintain the existing amenity for these residents. This is broadly consistent with the approach adopted for large infrastructure projects, such as roads, ports and airports.

APPENDIX D WNP NOISE CONTOUR PLOTS (EXCLUDING WUG)

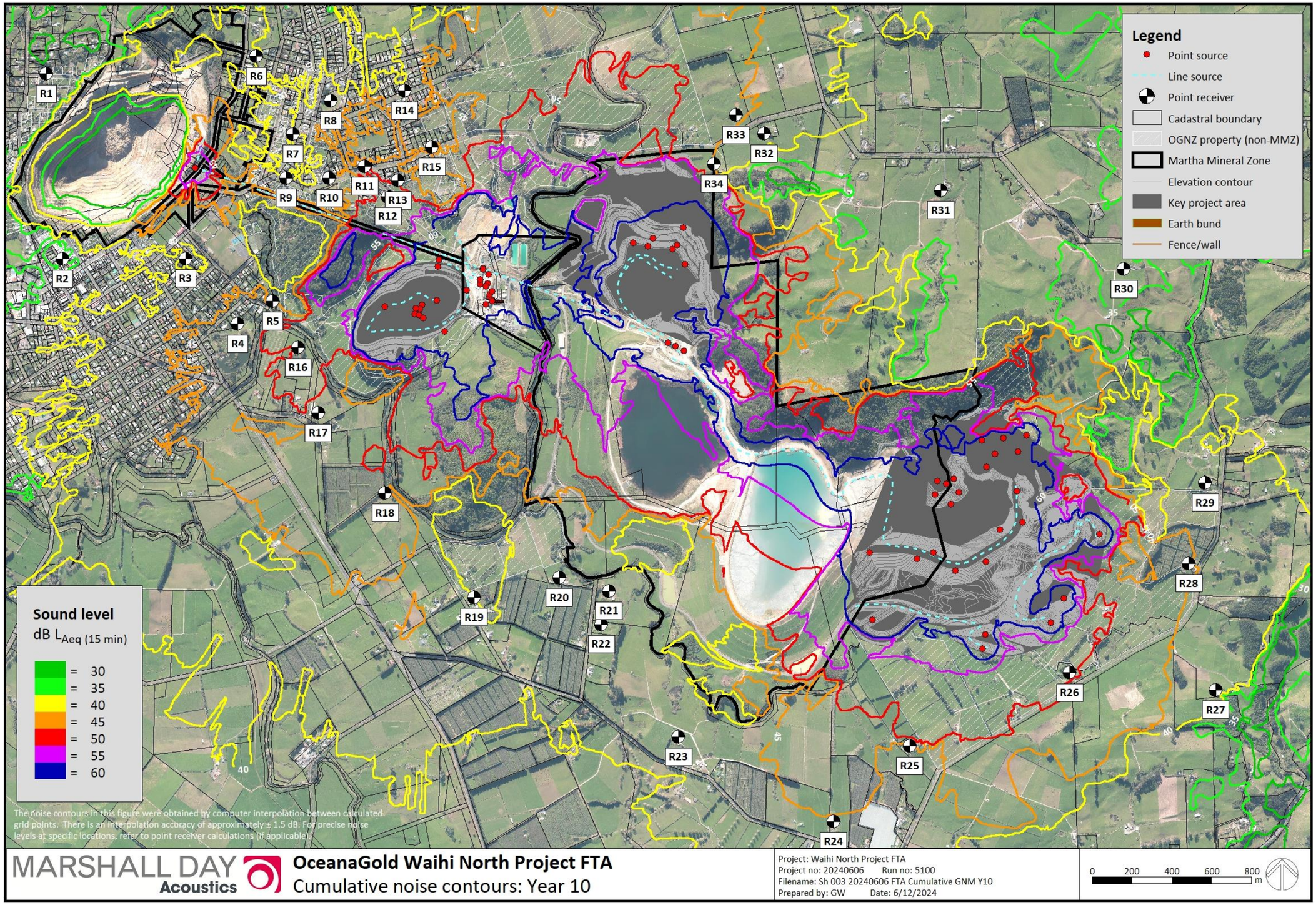
Noise contour plot 1: Cumulative noise contours for Waihi North area, Year 8



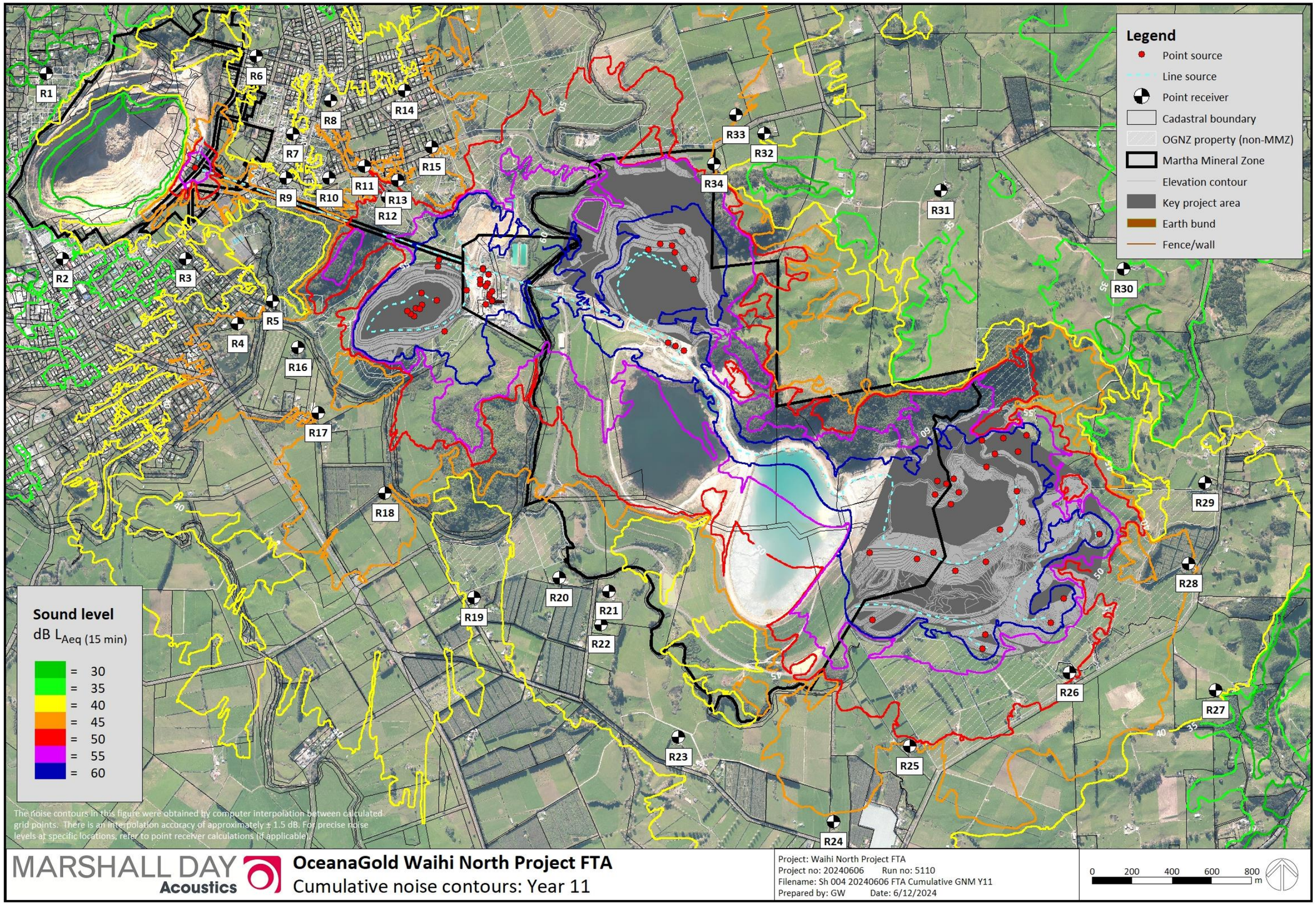
Noise contour plot 2: Cumulative noise contours for Waihi North area, Year 9



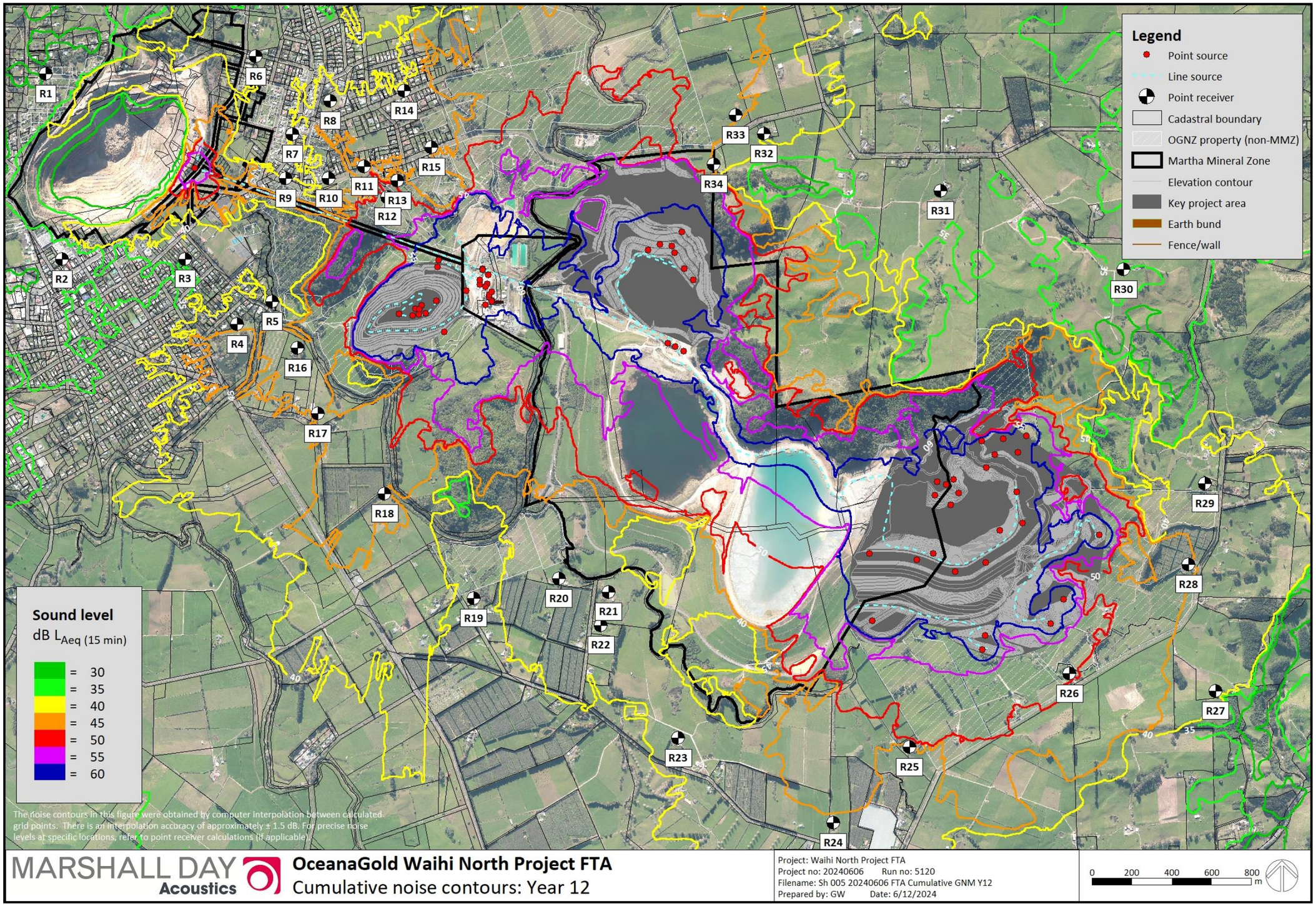
Noise contour plot 3: Cumulative noise contours for Waihi North area, Year 10



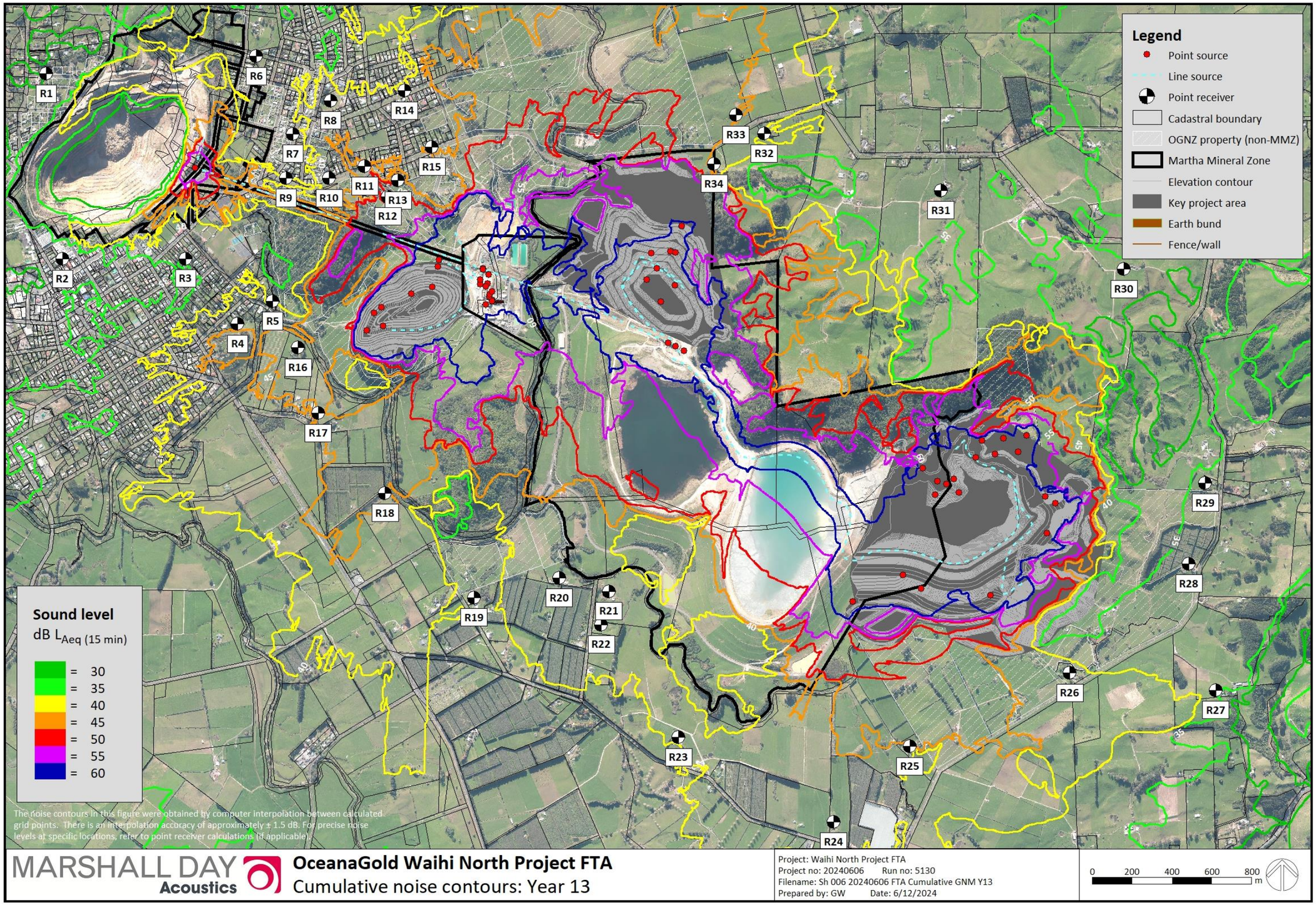
Noise contour plot 4: Cumulative noise contours for Waihi North area, Year 11



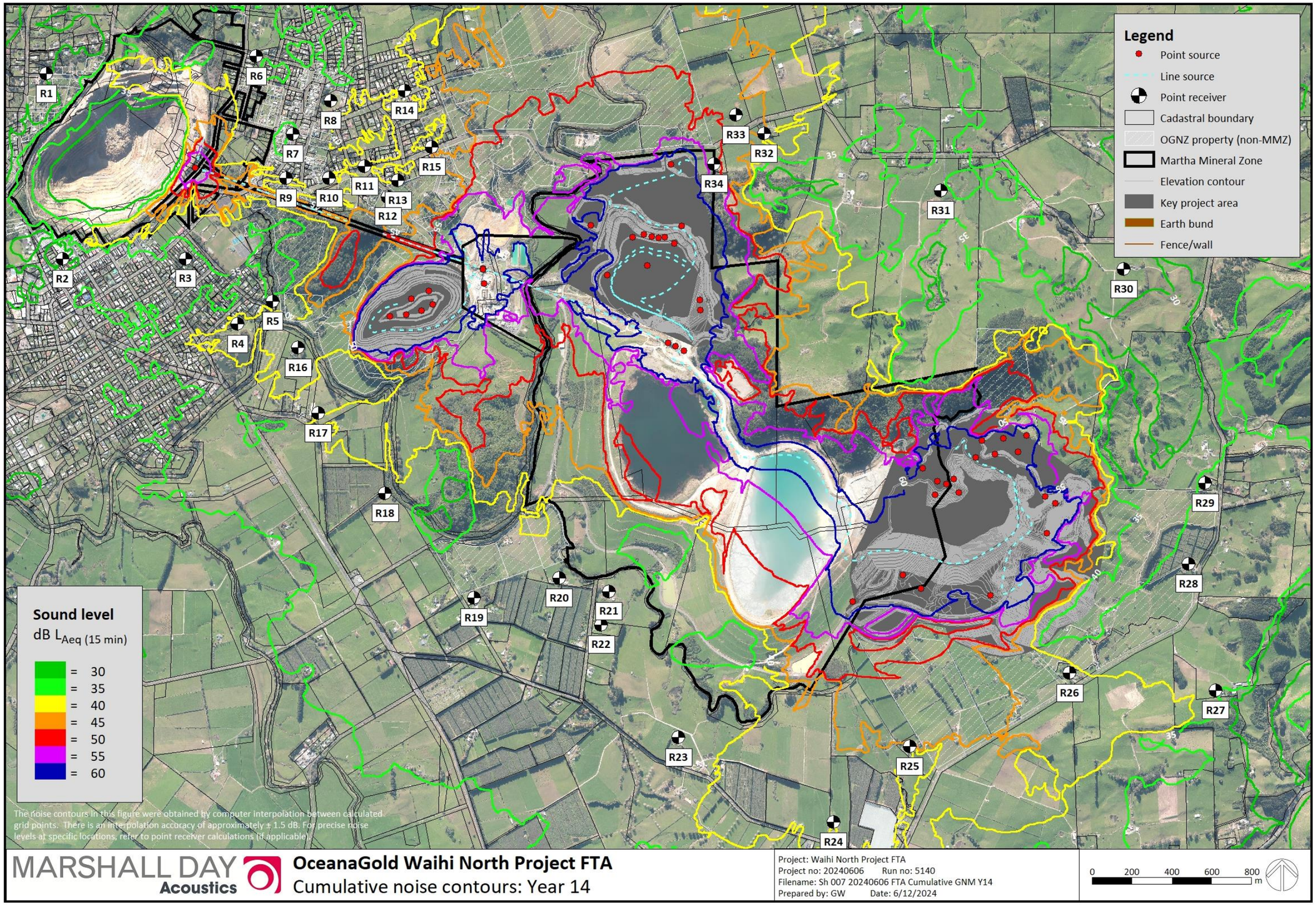
Noise contour plot 5: Cumulative noise contours for Waihi North area, Year 12



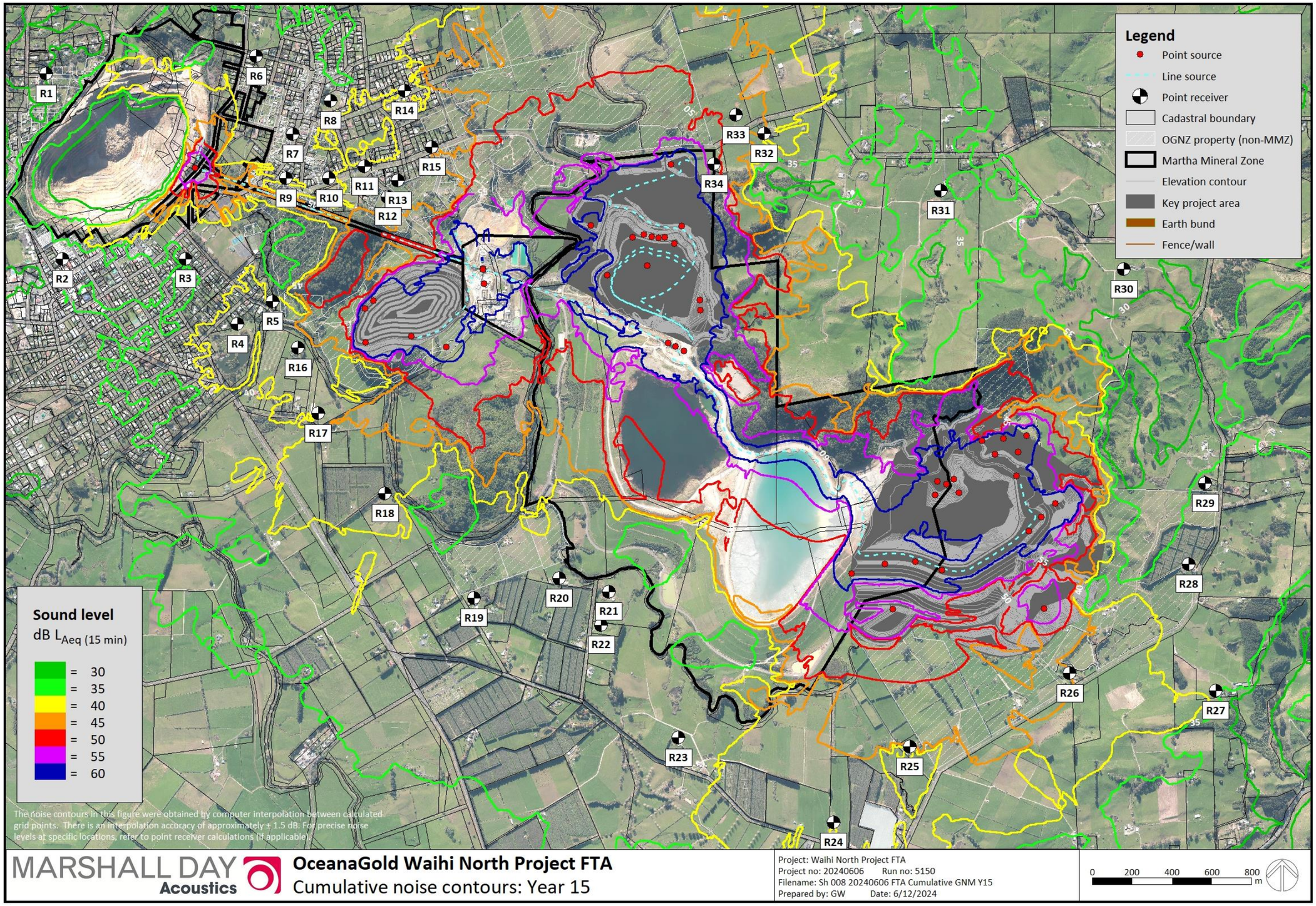
Noise contour plot 6: Cumulative noise contours for Waihi North area, Year 13



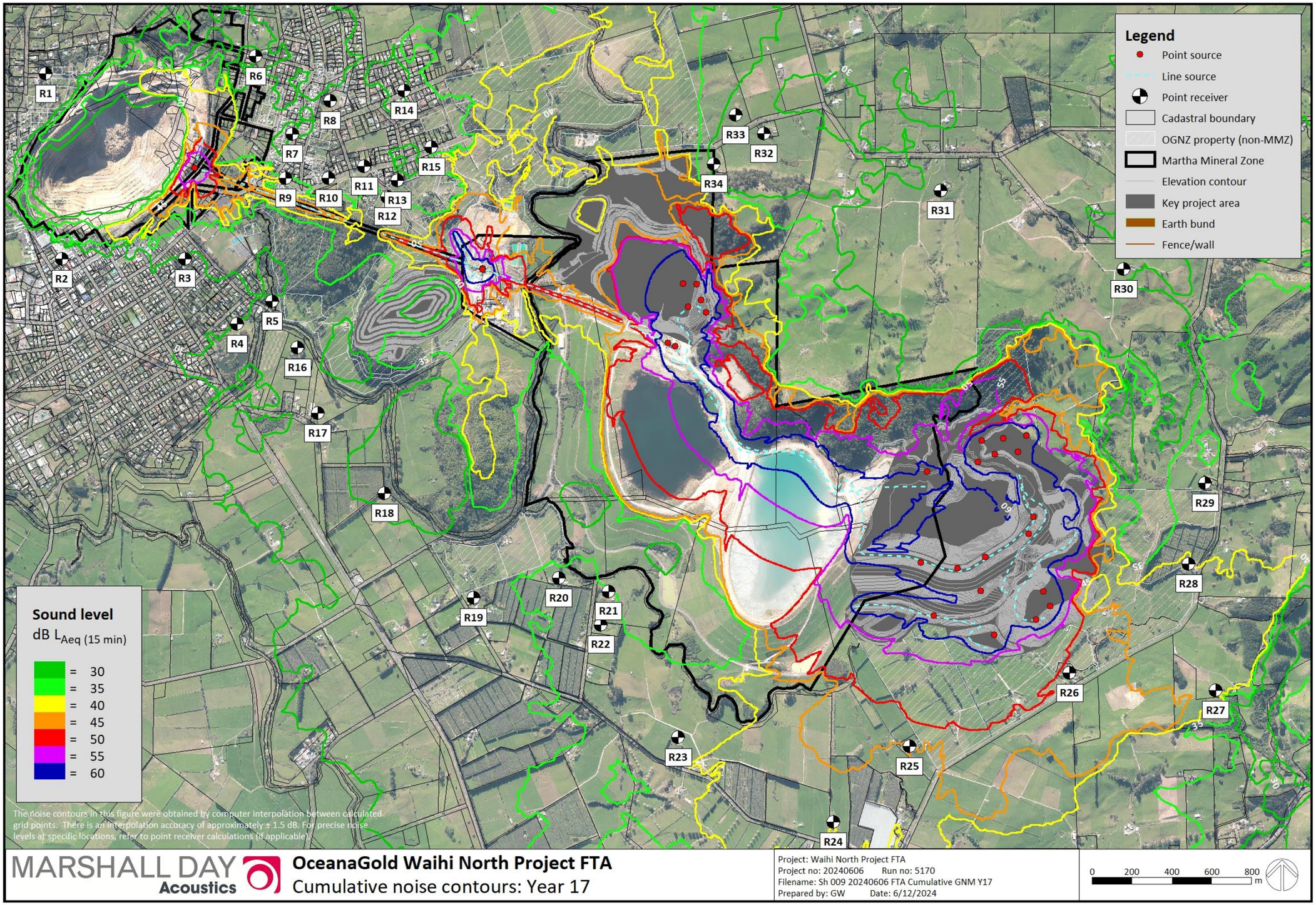
Noise contour plot 7: Cumulative noise contours for Waihi North area, Year 14



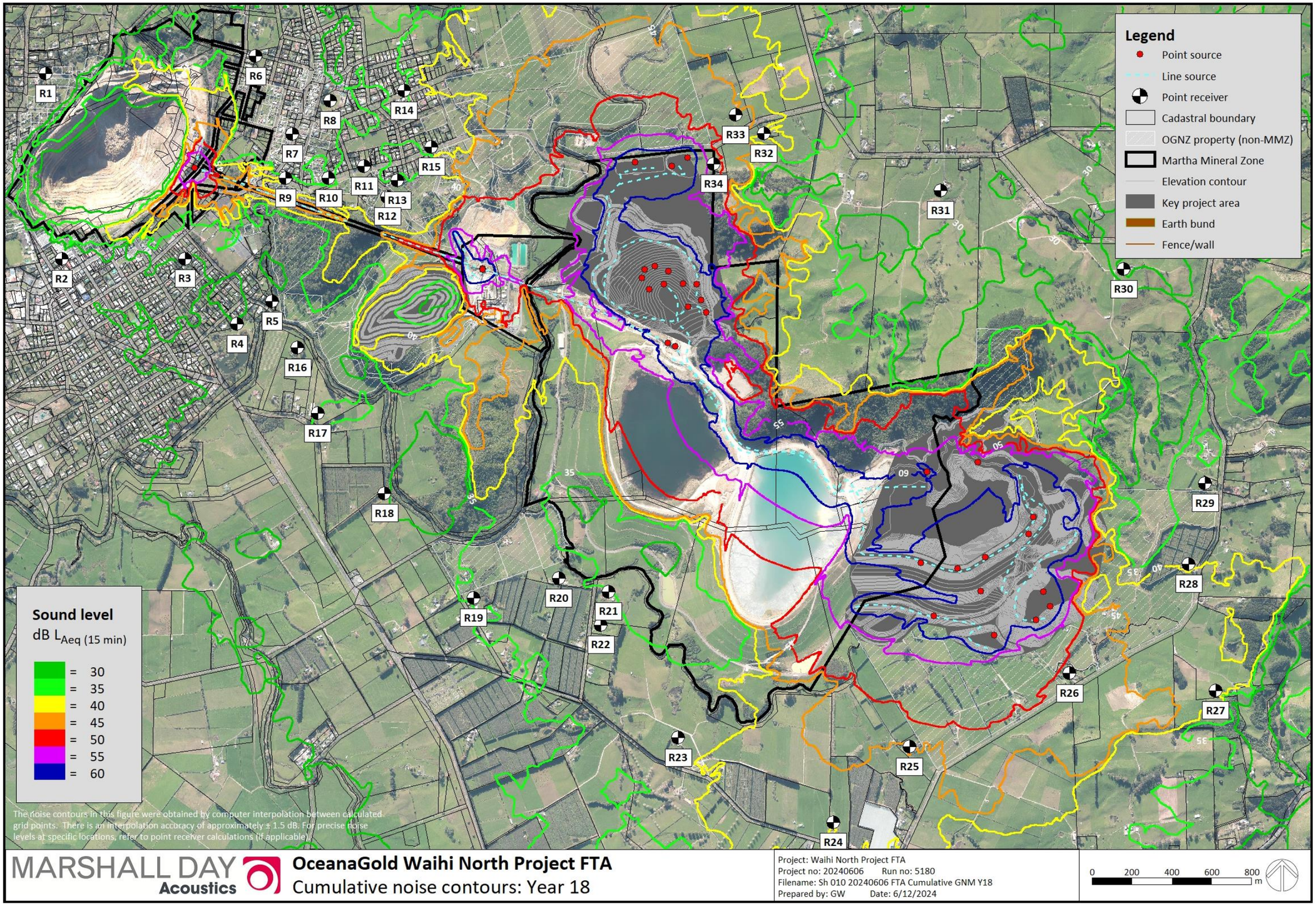
Noise contour plot 8: Cumulative noise contours for Waihi North area, Year 15



Noise contour plot 9: Cumulative noise contours for Waihi North area, Year 17

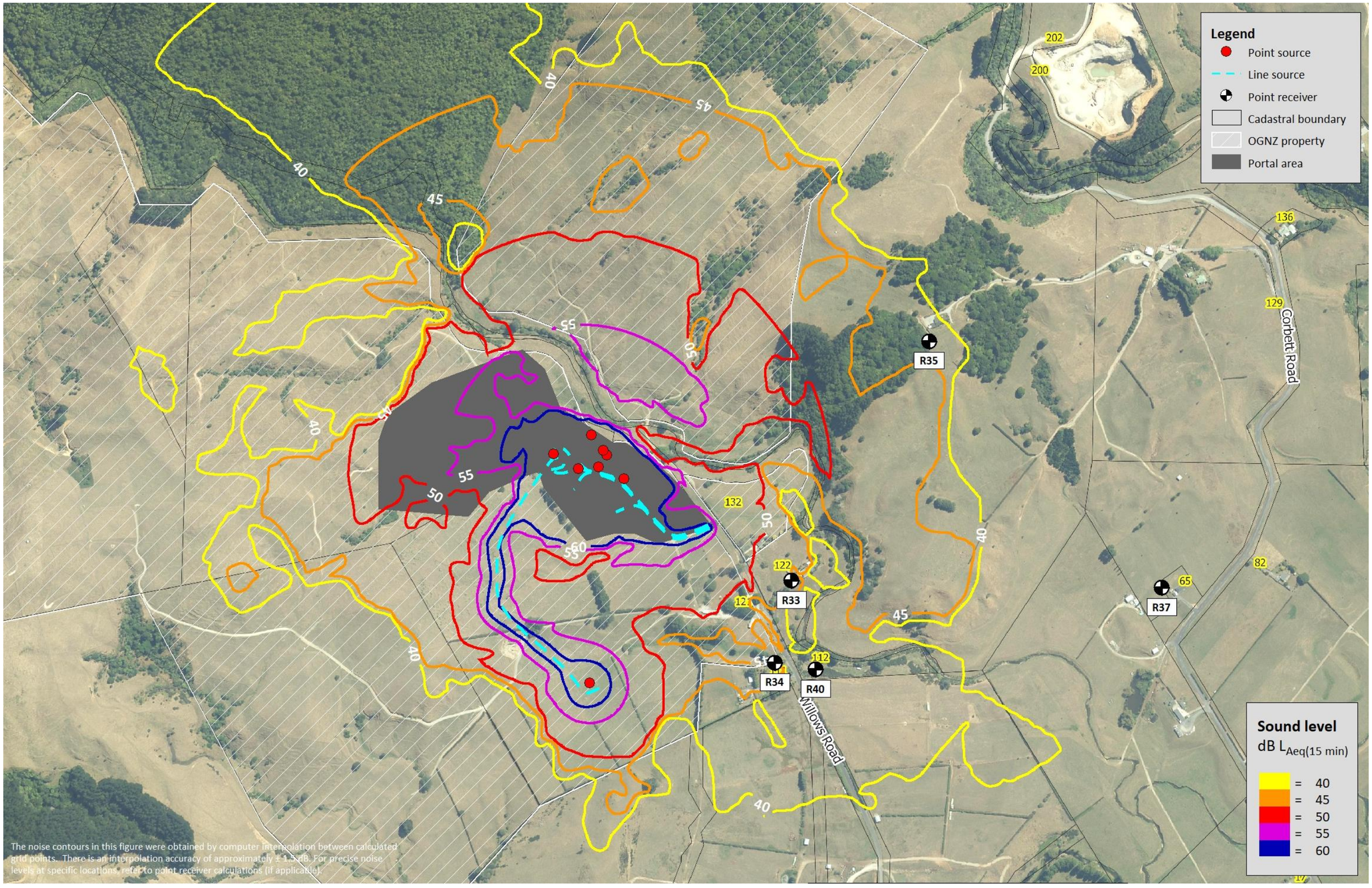


Noise contour plot 10: Cumulative noise contours for Waihi North area, Year 18

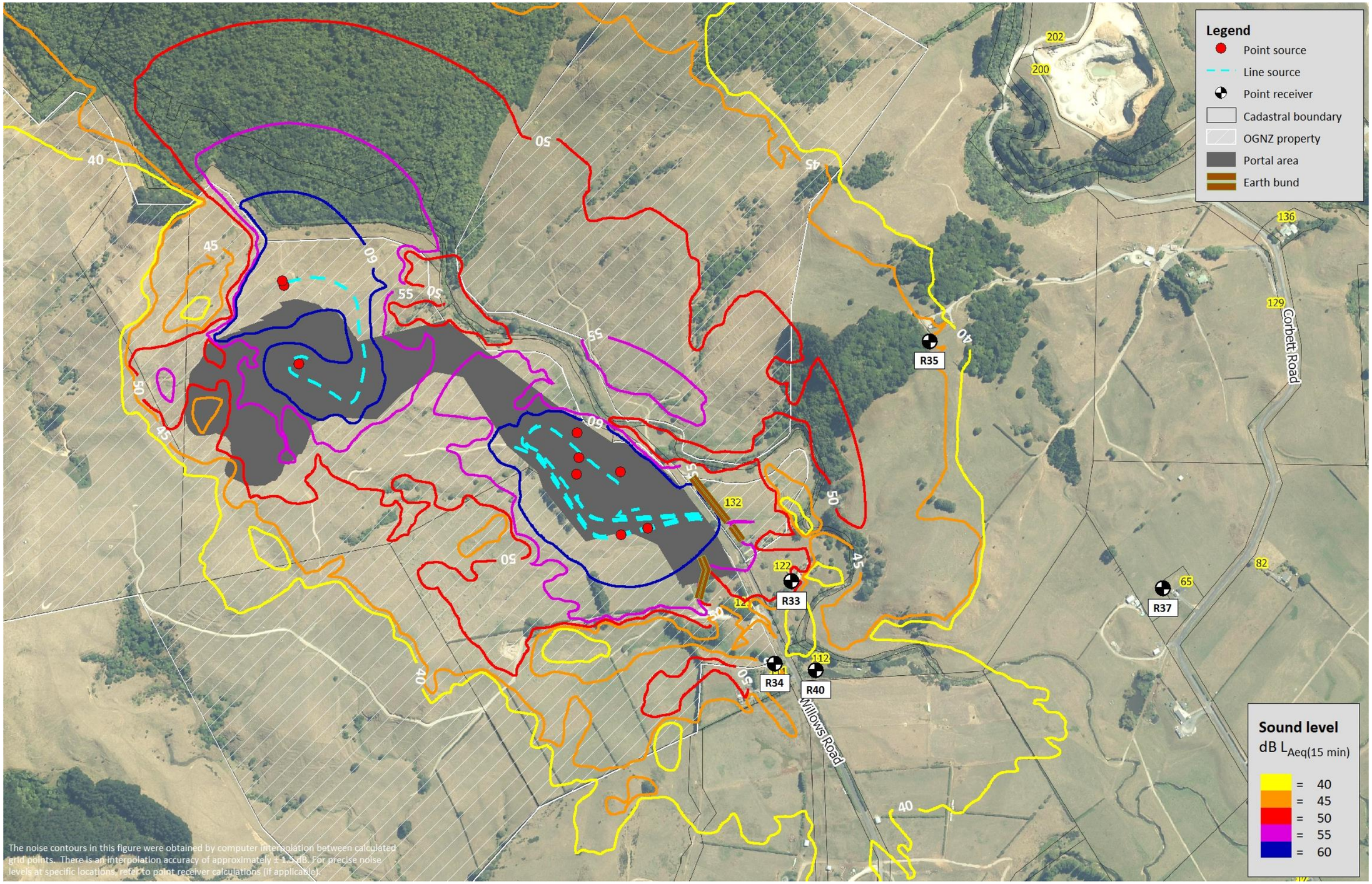


APPENDIX E WUG NOISE CONTOUR PLOTS

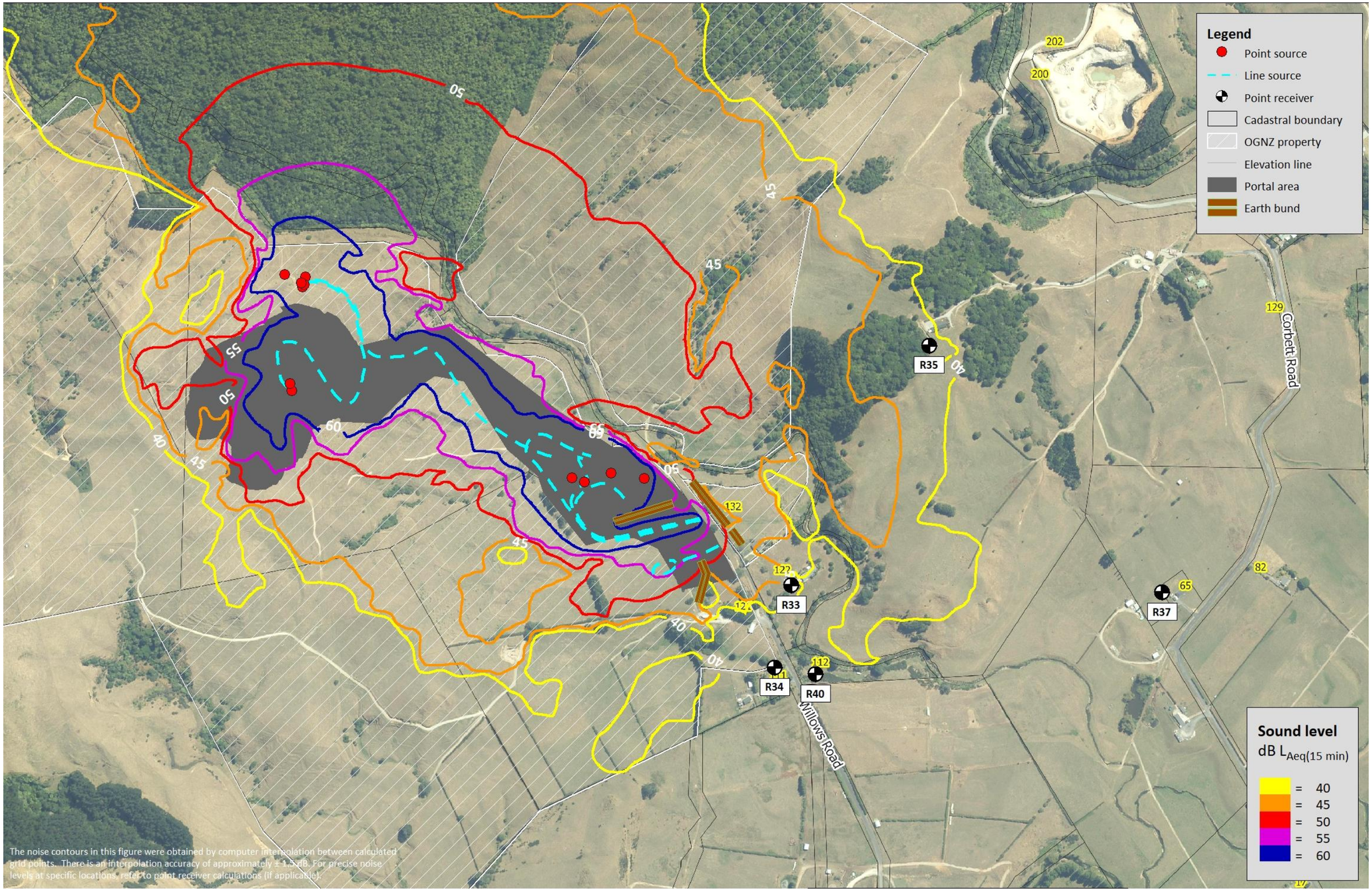
Noise contour plot 11: WUG Willows Portal, Scenario 1a – Site Establishment



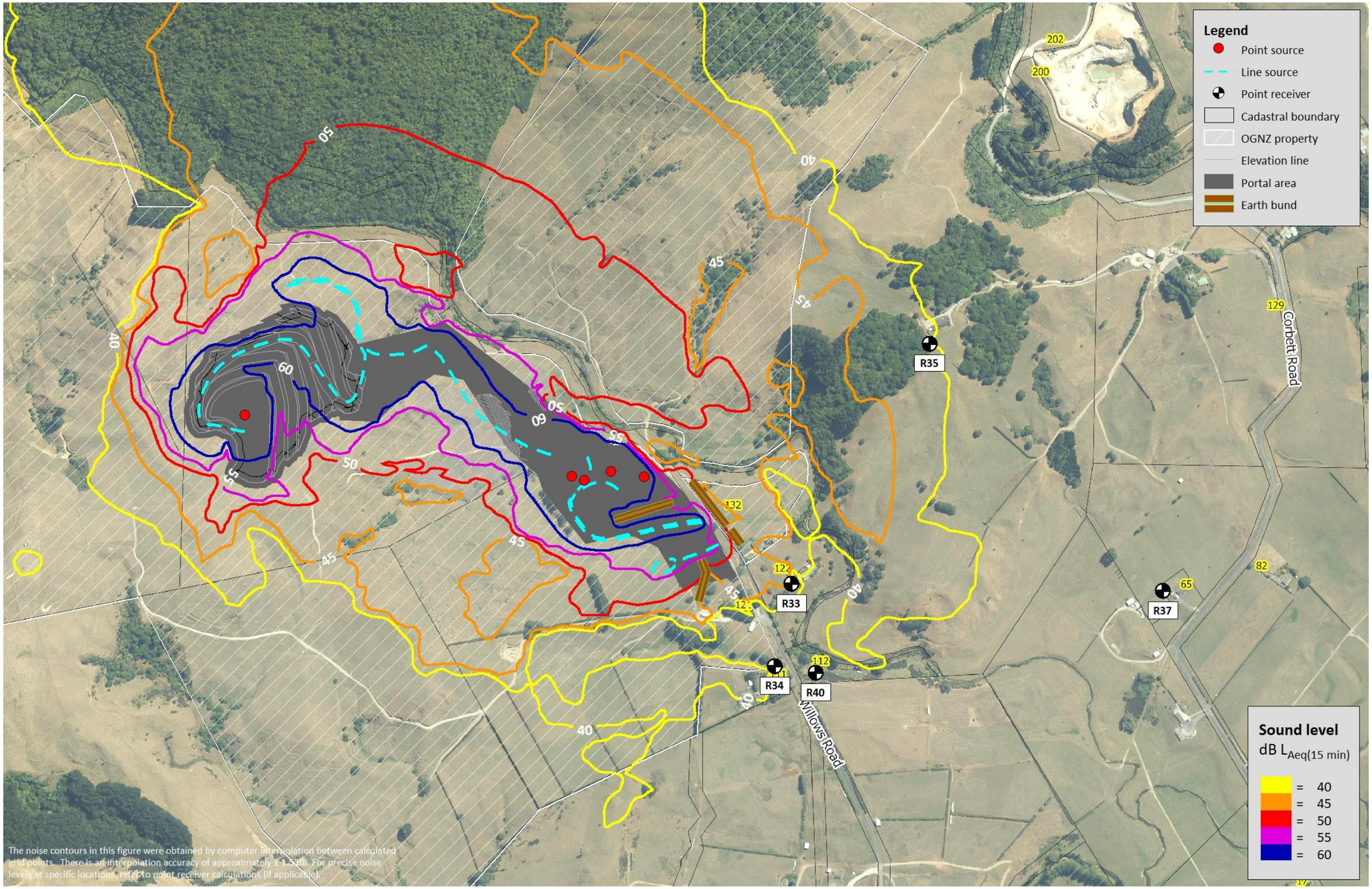
Noise contour plot 12: WUG Willows Portal, Scenario 1b – Infrastructure Development



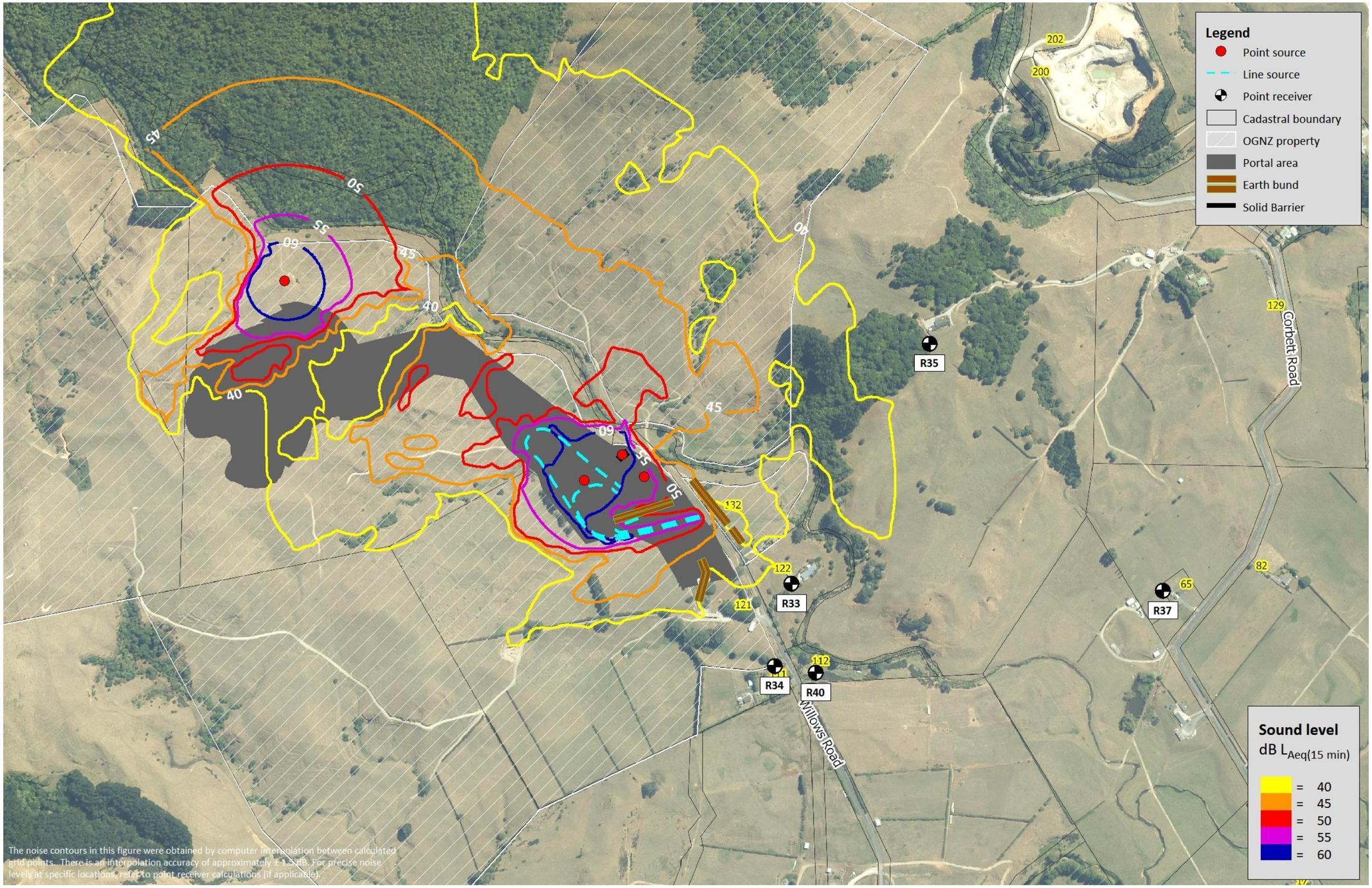
Noise contour plot 13: WUG Willows Portal, Scenario 2a – Initial Tunnel Drive



Noise contour plot 14: WUG Willows Portal, Scenario 2b – Later Tunnelling



Noise contour plot 15: WUG Willows Portal, Scenario 2c – Tunnelling Night Operations



APPENDIX F SUPPORTING MEMOS FOR ECOLOGICAL ASSESSMENTS

MEMO

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Project:	Waihi North FTA	**Document No.:**	Mm 001 R01		
To:	Oceana Gold	**Date:**	15 November 2024		
Attention:	Cassie McArthur	**Cross Reference:**	Mm 002		
Delivery:	Email	**Project No.:**	20240606		
From:	Ben Lawrence	**No. Pages:**	14	**Attachments:**	No
Subject:	Forest Noise Survey and Bird Count Results				

Overview

We visited the site on 30 September 2024 to measure ambient and equipment noise levels. The purpose of our survey is to inform Tonkin & Taylor's ecological effects assessment on forest birds.

We have focussed our survey on collecting acoustic data to support an assessment of masking noise effects. The output will be a predicted 'masking effects envelope' where anthropogenic noise from the proposed operations would be above the ambient noise levels in the forest bird's vocalisation frequency range. The envelopes are provided in our supplementary memo[1].

In summary:

- We carried out short term measurements (1 – 5 mins) in 14 locations, and long term measurements (1 – 2 weeks) in 4 locations across the site. Our dataset includes quiet forest areas, forest areas with varying levels of anthropogenic noise, and areas near existing helicopter movements, drills and pumps.
- We have run a machine learning algorithm called BirdNET on the datasets to count the number of vocalisation detections for the species of interest[2]. As expected, there were a greater number of detections in the quiet forest areas compared to those with anthropogenic noise.
- Our results show that:
  - The existing anthropogenic operations generate noise in the same frequency range as forest bird vocalisations in areas nearby the active sites. The high frequency anthropogenic noise is absorbed by the atmosphere and vegetation more than the low frequency, so there is less overlap with the bird vocalisations further afield.
  - The masking is greatest for tui, morepork and the New Zealand bellbird which vocalise at a relatively wide frequency range (500 Hz – 10 kHz) that overlaps with the anthropogenic noise. There is less masking for forest bird species with higher frequency vocalisations such as the New Zealand fantail, silvereye, tomtit and similar (vocalisations at 2 kHz – 10 kHz).
  - There were significantly less bird vocalisation detections in forest areas near the active sites as compared with quieter locations. The greatest reduction in detections was for the morepork, which is expected because its hoot can be easily masked by anthropogenic noise.

Masking of biological sounds is our key consideration

The following section is based on the 2019 paper *'The Impact of Urban and Traffic Noise on Birds'* by Dooling et al. This paper is essentially an updated version of the widely referenced 2007 Dooling et al. publication *'The Effects of Highway Noise on Birds'*.

The 2019 Dooling et al. paper has a general description of the potential effects from anthropogenic noise on birds as follows:

[1] 'Mm 002 20240606 BL (Forest Bird Effect Zones)', dated 15 November 2024

[2] List provided by Tonkin & Taylor on 3 October 2024

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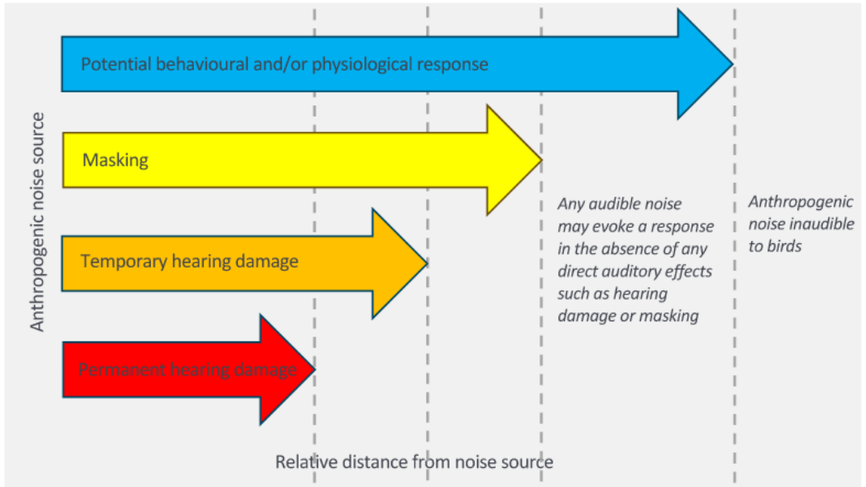
> *"The effects of urban, construction, or traffic noise are probably of little consequence when the noise adds very little to existing ambient-noise levels. By contrast, when traffic noise does add significantly to background noise levels, such as heavy traffic in quieter suburban and rural areas, this extra noise has the potential to produce a suite of significant short- and long-term sensory, behavioural, and physiological changes in birds. These may include kinds of physiological effects, stress effects, and distraction that we experience from a TV constantly on in the background. All four of these categories of effects could occur simultaneously if the noise exposure was sufficiently intense."*

Noise effects on birds can be separated into four categories as shown on Figure 1.

Figure 1: Overlapping categories of noise effects (reproduced from Figure 1 of the Dooling et al. paper)



The Dooling et al. paper states that *"extensive laboratory data shows that birds are much more resistant to hearing loss, auditory damage, and decline in vocal quality from acoustic overexposure than humans and other mammals"*. It goes on to explain that hearing damage in birds is unlikely even "*for extremely long durations (i.e., 72 hours) at extreme levels (i.e., over a 100 dB sound pressure level)*". Therefore, the proposed activities in our assessment (drills, pumps, vent shafts and helicopter flights) would not generate noise levels that could cause hearing damage in birds.

Masking effects can occur at significantly lower noise levels than hearing damage. The Dooling et al. paper states that introducing noise that masks critical biological sounds *"could seriously interfere with a bird's ability to detect prey, assess its acoustic environment (i.e., auditory scene), and communicate with other birds"*. The proposed activities have the potential to cause masking noise effects on birds depending on:

- The loudness of the noise source
- The distance of the bird from the noise source
- The frequency range and loudness of the biological sounds which could be masked.
- The ambient noise levels

We have carried out a simplified masking assessment by comparing the predicted noise levels for the proposed activities to our measured ambient noise levels. Our assumption is that a noise source may cause masking if it is above the ambient noise levels at the same frequencies as a birds vocalisation. The likelihood of masking increases as distance to the noise source decreases (i.e. the closer the bird gets to the noise source, the higher the masking effect, and vice versa).

This approach only accounts for communication between birds. It does not consider their ability to detect prey or assess its environment. Nonetheless, we consider our approach to be a pragmatic estimate of the zone of potential masking noise effects, which we have referred to as the 'masking effects envelope'.

We note that audible anthropogenic noise can cause behavioural and/or physiological response at lower levels than the threshold for masking. Therefore, there is the potential for noise effects beyond the masking effects envelope.

The masking effects envelope is an input for the Tonkin & Taylor overall ecological effects assessment, which considers the sensitivity of the species and importance of the environment in the affected area.

We have grouped the relevant forest bird species into two groups

Table 1 shows the vocalisation frequency range for each of the key forest bird species. These frequency ranges are based on our analysis of recorded bird vocalisations from the Department of Conservation[3].

These results align with the Dooling et al. paper, which states *"noise in the spectral region of a bird's vocalizations (generally 2 – 4 kHz) has a much greater masking effect on detection of communication signals than do noises outside this range."*

Table 1: Summary of key forest bird species

Species	Vocalisation type	Frequency range of vocalisation
Wide frequency range vocalisations (500 Hz – 10 kHz)		
Kōkō/tūī	Song	1 – 10 kHz
	Alarm	1 – 10 kHz
Ruru/morepork	Hoot	600 Hz – 1.25 kHz
Korimako/New Zealand bellbird	Territorial	1.25 – 5 kHz
	Repetitive	1 – 5 kHz
	Alarm	1.25 – 7 kHz
Kākā (North Island)	Song	1.25 – 4 kHz
High frequency vocalisations (2 – 10 kHz)		
Pīwakawaka/New Zealand fantail	Song	2 – 8 kHz
	Contact	3 – 10 kHz
Tauhou/silvereye	Contact/cree	3 – 5 kHz
	Song	3 – 5 kHz
Miromiro/tomtit	Song	3 – 5 kHz
	Contact	6 – 8 kHz
Riroriro/grey warbler	Song	3 – 5 kHz
Whitehead / pōpokatea	Song	3 – 7 kHz
	Territorial	3 – 7 kHz
Yellow-crowned kākāriki	Song	2 – 6 kHz
	Territorial	2 – 5 kHz

[3] https://www.doc.govt.nz/globalassets/system/training-courses/bird-id/index.html#/ and https://www.doc.govt.nz/nature/native-animals/birds/bird-songs-and-calls/

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We have based our assessment on these two species groups:

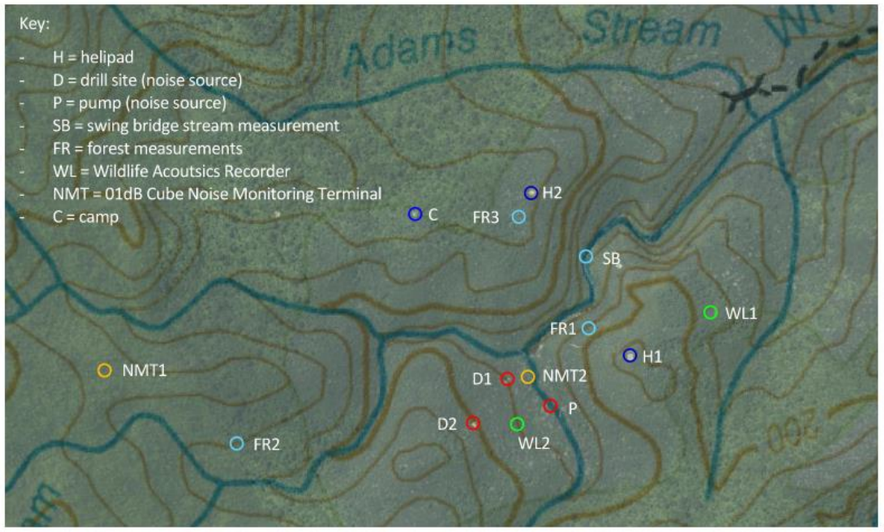
- **Wide frequency range vocalisations**: 600 Hz – 10 kHz
- **High frequency vocalisations**: 2 – 10 kHz

We measured noise levels at a range of locations across the site

Figure 2 shows a map of the measurement locations.

We carried out short term measurements at all locations identified on the map, and deployed long-term recorders at the WL and NMT locations.

Figure 2: Map of noise source and measurement locations



We used a B&K 2250, two 01dB Cubes and two Wildlife Acoustics Song Meter Mini units

We used two types of devices for the survey:

- 01dB Cube sound level meters: these are Type-1 sound level meters that measure in accordance with all relevant acoustic standards, and have a high dynamic range (able to measure loud sounds such as helicopter flyovers and quiet environments such as the nighttime forest with accuracy).
- Wildlife Acoustics Song Meter Mini: these units are intended for ecological monitoring and suitable for general analysis of the noise environment as well as bird detections.
- Brüel and Kjær 2250 handheld sound level meter: this as a Type-1 sound level meter that measures in accordance with all relevant acoustic standards, comparable to the 01dB Cubes.

Table 2 summarises the equipment we used.

All devices were calibrated with a Norsonic Nor1256 calibrator.

Table 2: Summary of equipment

Device	Location name	Details/settings	Recording period
Cube 14318	NMT1	Type-1 sound level meter, recording continuous audio with 24 bits at 51.2 kHz	31 Sep – 14 Oct
Cube 14319	NMT2	Type-1 sound level meter, recording continuous audio with 24 bits at 51.2 kHz	31 Sep – 13 Oct
Song Meter Mini SMA05673	WL1	Standard microphone, recording audio for 30 minutes on 30 minutes off with 16 bits at 48 kHz. Gain set to default (12 dB)	31 Sep – 9 Oct
Song Meter Mini SMA05482	WL2	Standard microphone, recording audio for 30 minutes on 30 minutes off with 16 bits at 48 kHz. Gain set to default (12 dB)	31 Sep – 9 Oct
B&K 2250	All locations	Short term measurements at all locations while	30 Sep

We carried out short term measurements at all locations to understand the noise environment

The purpose of our short term measurements was to identify the noise sources across the site that informed our analysis of the long term measurements. Table 3 summarises our short term measurement results. The measurement locations are shown on Figure 2.

The measurements we carried out in general accordance with New Zealand Standard NZS 6801:2008 *Acoustics – Measurement of environmental sound* aside from the measurement duration. We limited our measurements to 1 – 5 mins to allow time to get to all of the sites. We consider the average level (L_{Aeq}) to be generally representative of the daytime noise environment in each location, but the background (L_{A90}) levels would be lower with a longer measurement.

Our results in Table 3 are A-weighted with a reference sound pressure level of 20 uPa. These parameters are specific to human hearing, which is understood to be more sensitive in threshold and frequency range than bird hearing. These results are provided for context only as they aren't directly applicable to this assessment. We have used the long-term monitor at the frequency ranges of the bird vocalisations as the basis of our masking assessment.

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Table 3: Summary of short term measurements

Location	Time	Duration	Measured levels: Average	Measured levels: Background	Description
Forest measurements					
H1	9:16 am	5 mins	51 dB L_{Aeq}	50 dB L_{A90}	Exposed location with some wind noise. Drill rig/pump and stream audible
WL1	9:38 am	1 min	30 dB L_{Aeq}	29 dB L_{A90}	Quiet area on bush track, no audible anthropogenic noise or birdsong
ST	9:56 am	5 mins	64 dB L_{Aeq}	61 dB L_{A90}	Stream noise dominant (10 m from measurement), includes a helicopter flyover
ST	10:02 am	5 mins	61 dB L_{Aeq}	61 dB L_{A90}	Stream noise dominant (10 m from measurement), no anthropogenic noise
FR1	10:15 am	1 min	51 dB L_{Aeq}	50 dB L_{A90}	Stream noise dominant (50 m from measurement), drill rig/pump just audible
FR2	11:06 am	1 min	34 dB L_{Aeq}	31 dB L_{A90}	Quiet punga grove with some tui vocalisations, no anthropogenic noise
NMT1	11:50 am	3 min	40 dB L_{Aeq}	30 dB L_{A90}	Wind in trees dominant, no anthropogenic noise
WL2	12:48 pm	1 min	55 dB L_{Aeq}	54 dB L_{A90}	Drill/pump noise dominant, some audible tui vocalisations
NMT2	1:22 pm	1 min	55 dB L_{Aeq}	54 dB L_{A90}	Drill rig and pumps dominant
FR3	1:47 pm	1 min	40 dB L_{Aeq}	38 dB L_{A90}	Drill rig/pump dominant
H2	2:09 pm	5 mins	37 dB L_{Aeq}	34 dB L_{A90}	Exposed location but minimal wind noise, drill rig faintly audible
Equipment measurements					
Waihi helipad	8:41 am	12 sec	87 dB L_{Aeq}	-	Squirrel helicopter on pad during take-off (25 m from measurement). Sound power level of 123 dB L_{WA}
P	12:54 pm	30 sec	76 dB L_{Aeq}	-	Pump noise dominant (15 m from measurement). Sound power level of 107 dB L_{WA}
D1	1:28 pm	30 sec	82 dB L_{Aeq}	-	Drill rig dominant (10 m from measurement). Sound power level of 110 dB L_{WA}
C	1:56 pm	30 sec	74 dB L_{Aeq}	-	Small camp site generator (1 m from measurement). Sound power level of 82 dB L_{WA}

Figure 3 shows our calculated sound power level spectra from the equipment measurements in Table 3. This shows:

- The hovering helicopter is the loudest by a significant margin, the drill rig and pumps are comparable, and the camp generator is relatively quiet
- The helicopter, pumps and drill rig are generally broadband (similar noise levels across the frequency range), whereas the camp generator is primarily low frequency noise.

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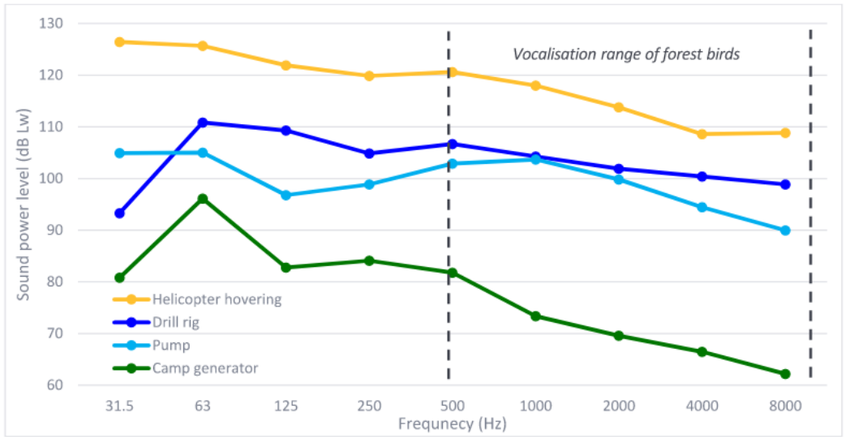
Figure 3: Calculated sound power level spectra from equipment measurements



We carried out long term noise monitoring at four locations

Our selected locations are as follows:

- **Noise monitoring terminal 1 (NMT1):** remote site, large separation from active drill rigs and pumps. The results from this location are representative of typical forest noise levels with some intermittent helicopter noise. Noise levels were monitored from 31 August – 13 September at this location.
- **Noise monitoring terminal 1 (NMT2):** centre of existing operations. The levels are controlled by drill rigs, pumps and helicopters. These results are representative of worst-case noise levels in the forest. Noise levels were monitored from 31 August – 13 September at this location.
- **Forest 1 (WL1)**: quiet area that is screened from the active drill rigs and pumps, but close to the southern helipad. Noise levels were monitored from 31 August – 8 September at this location.
- **Forest 2 (WL2)**: nearby existing operations. The levels are controlled by drill rigs, pumps and helicopters. These results are representative of noise levels in the forest area surrounding the site (e.g. within a 500 m radius)[4]. Noise levels were monitored from 31 August – 8 September at this location.

The weather was generally fine over the survey period, although there were some periods of rain on the morning of 31 August, morning of 1 September, evening of 3 September and before dawn on 8 September. We have included this data in our analysis.

Table 4 presents our overall measured levels at each location. We have presented the following parameters:

- L_{eq} (the energy average level): This includes anthropogenic noise
- L_{50} (the 50th percentile): We consider this to be representative of the ambient levels in the absence of intermittent anthropogenic noise such as helicopter flights
- L_{90} (the 90th percentile): This is typically used as the background noise level
- L_{01} (the 1st percentile): This is controlled by intermittent high noise sources like helicopter flyovers

[4] The active drill rigs and pumps were 300 – 500 m from this measurement location.

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Table 4: Summary of long term noise monitoring data

	Measured levels (dB)			
	Wide frequency range vocalisations (500 Hz – 10 kHz)		High frequency vocalisations (2 kHz – 10 kHz)	
Location	Daytime	Night-time	Daytime	Night-time
NMT1 (remote forest location)	L_{eq}: 45 L_{50}: 35 L_{90}: 29 L_{01}: 57	L_{eq}: 46 L_{50}: 35 L_{90}: 28 L_{01}: 57	L_{eq}: 41 L_{50}: 31 L_{90}: 23 L_{01}: 53	L_{eq}: 42 L_{50}: 30 L_{90}: 21 L_{01}: 55
NMT2 (noisiest forest area)	L_{eq}: 56 L_{50}: 54 L_{90}: 51 L_{01}: 60	L_{eq}: 63 L_{50}: 53 L_{90}: 50 L_{01}: 72	L_{eq}: 49 L_{50}: 48 L_{90}: 46 L_{01}: 53	L_{eq}: 53 L_{50}: 47 L_{90}: 45 L_{01}: 62
WL1 (quiet location next to southern helipad)	L_{eq}: 60 L_{50}: 39 L_{90}: 31 L_{01}: 73	L_{eq}: 51 L_{50}: 39 L_{90}: 31 L_{01}: 63	L_{eq}: 52 L_{50}: 34 L_{90}: 27 L_{01}: 64	L_{eq}: 48 L_{50}: 31 L_{90}: 26 L_{01}: 61
WL2 (moderate noise area)	L_{eq}: 57 L_{50}: 51 L_{90}: 34 L_{01}: 70	L_{eq}: 50 L_{50}: 48 L_{90}: 31 L_{01}: 56	L_{eq}: 48 L_{50}: 39 L_{90}: 28 L_{01}: 60	L_{eq}: 40 L_{50}: 37 L_{90}: 24 L_{01}: 53

Our measurements show the activities can mask bird vocalisations

The following Figure 4 - Figure 15 show the variation in overall noise level over time and spectrograms for a representative night-time, dawn chorus and day period at all locations (5 September 2024).

The spectrograms show the variation in noise level (colour scale) and frequency (y-axis) over time (x-axis). This illustrates where the anthropogenic noise overlaps with the bird vocalisations, which can result in masking. We have annotated the spectrograms where relevant.

The results shown are the average unweighted levels in 0.1 second time slices.

Figure 4: NMT1 (remote forest location) – night-time

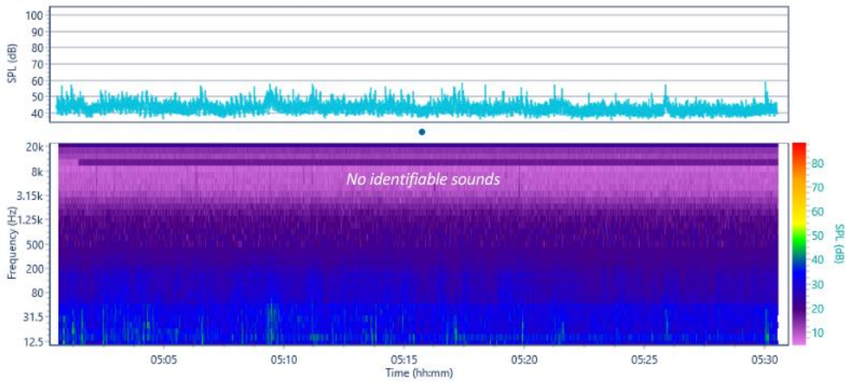

Figure 5: NMT1 (remote forest location) – dawn chorus

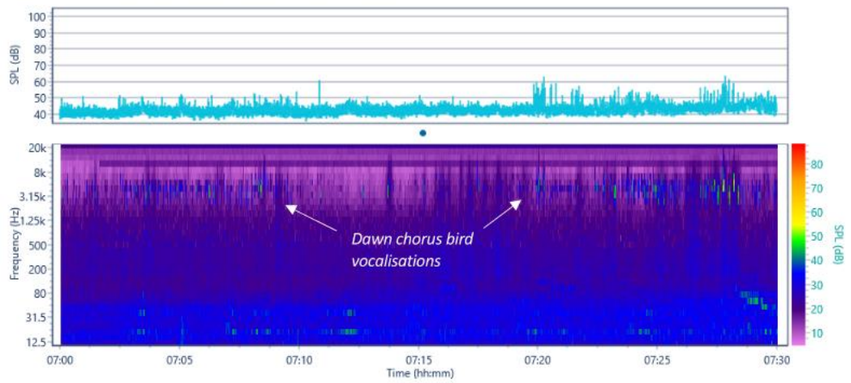

Figure 6: NMT1 (remote forest location) – daytime

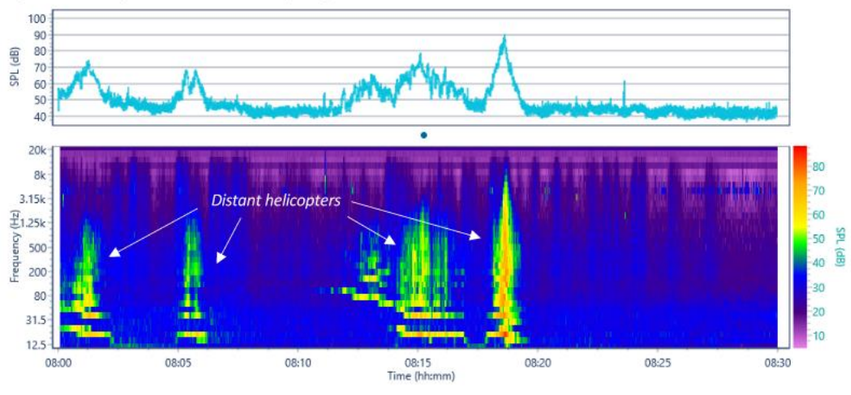

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Figure 7: NMT2 (noisiest forest area) – night-time

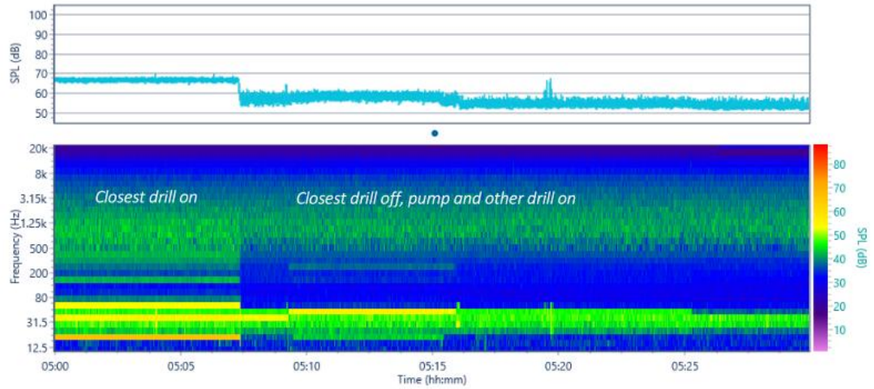

Figure 8: NMT2 (noisiest forest area) – dawn chorus

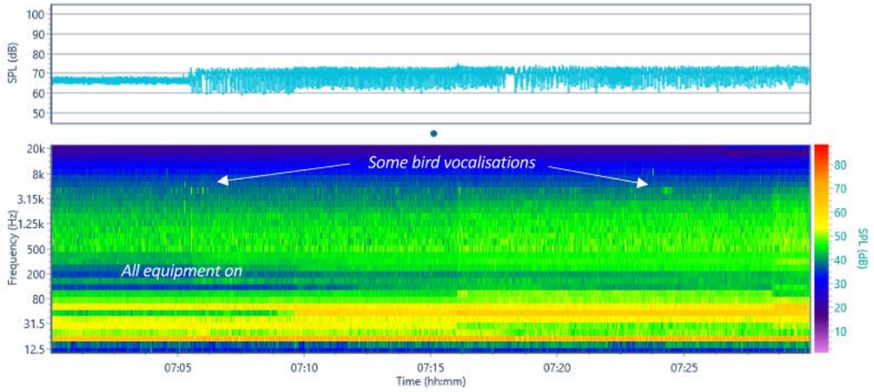

Figure 9: NMT2 (noisiest forest area) – dawn chorus

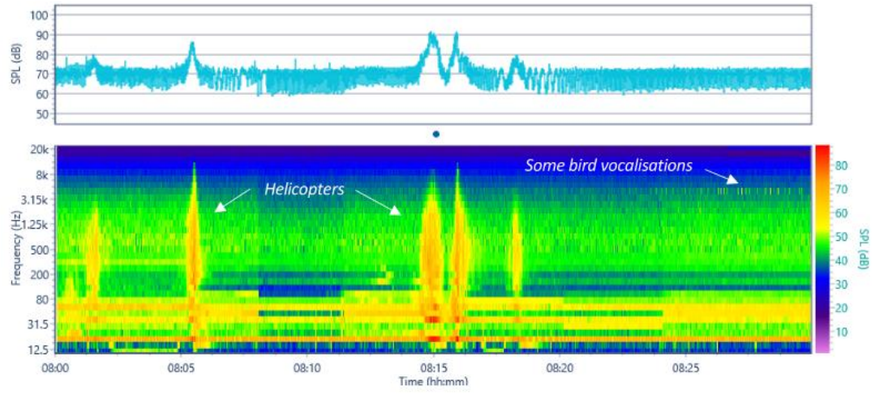

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Figure 10: WL1 (quiet location next to southern helipad) – night-time

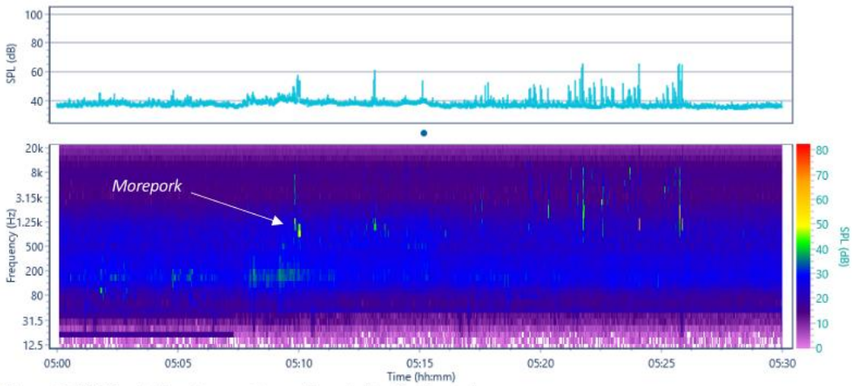

Figure 11: WL1 (quiet location next to southern helipad) – dawn chorus

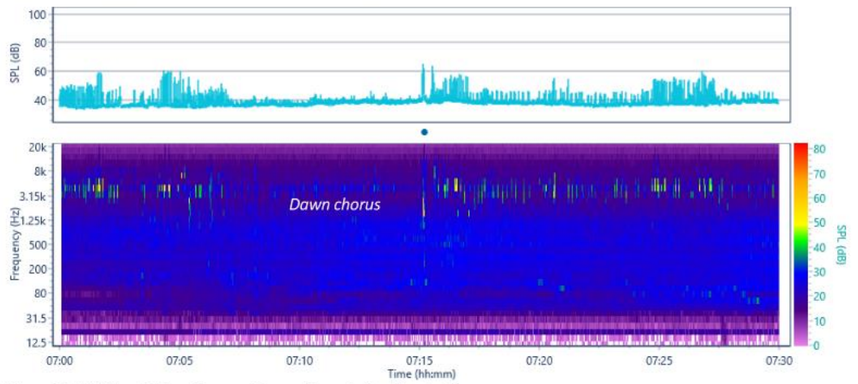

Figure 12: WL1 (quiet location next to southern helipad) – daytime

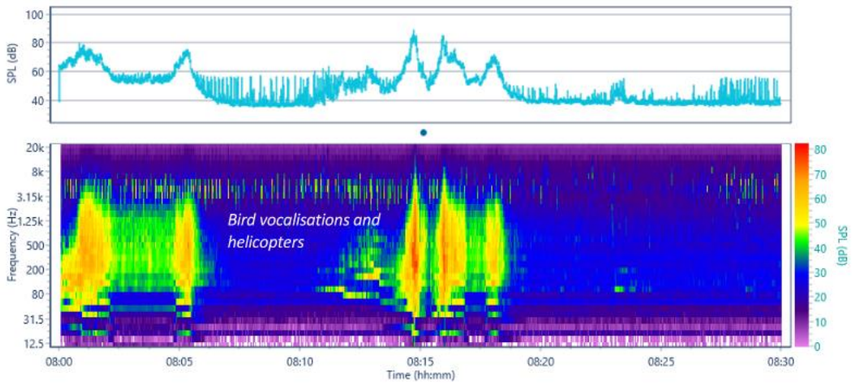

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Figure 13: WL2 (moderate noise area) – night-time

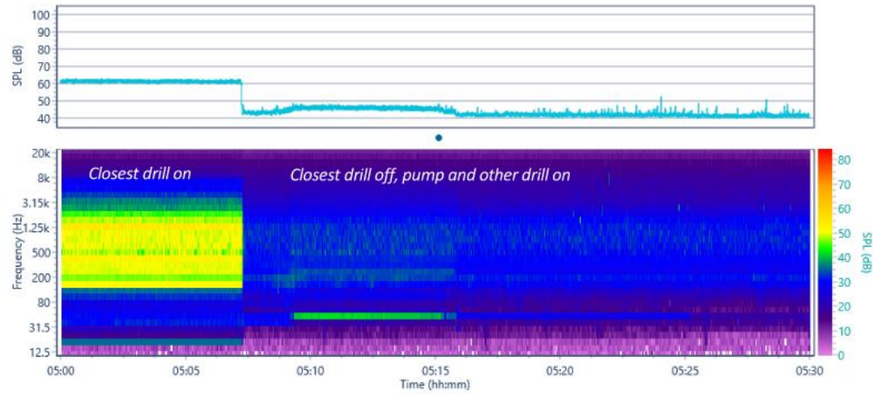


Figure 14: WL2 (moderate noise area) – dawn chorus

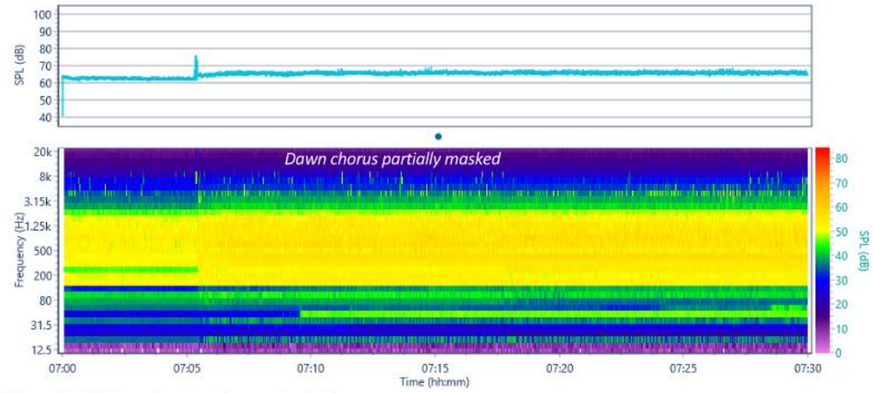
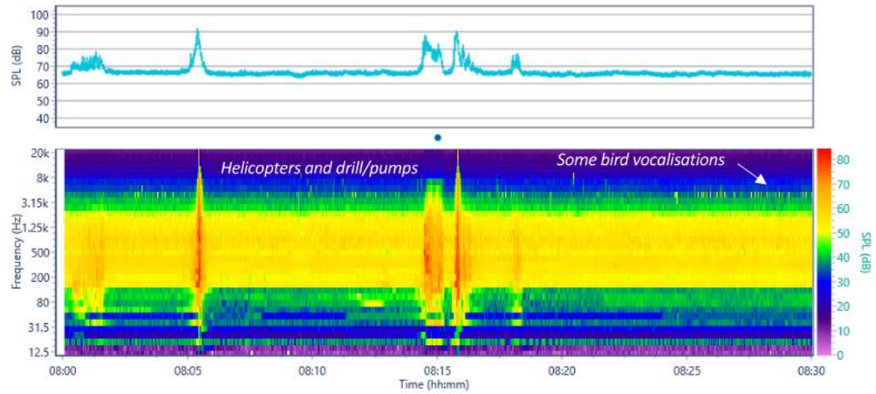


Figure 15: WL2 (moderate noise area) – daytime



The machine learning analysis results may indicate the presence of bird species

Table 5 presents a comparison of the NMT locations, and Table 6 of the FR locations. We have separated these categories because the monitoring equipment had different settings and durations.

Table 5: Comparison of bird vocalisations at the NMT locations (31 August – 13 September)

	Number of detections	
Species	**NMT1 (remote forest location)**	**NMT2 (noisiest forest area)**
Wide frequency range vocalisations (500 Hz – 10 kHz)		
Tui	1,880	317
Morepork	3,410	4
New Zealand Bellbird	5,922	201
High frequency vocalisations (2 – 10 kHz)		
New Zealand Fantail	11,865	215
Silvereye	6,911	40
Tomtit	175	1,437
Gray Gerygone (Grey Warbler)	4,264	144
Common Chaffinch	1,516	109
All other detections (other species)	*3,800 (10% of total)*	*555 (18% of total)*

Table 6: Comparison of bird vocalisations at the WL locations (31 August – 8 September)

	Number of detections	
Species	**WL1 (quiet location next to southern helipad)**	**WL2 (moderate noise area)**
Wide frequency range vocalisations (500 Hz – 10 kHz)		
Tui	852	740
Morepork	823	12
New Zealand Bellbird	1,005	395
High frequency vocalisations (2 – 10 kHz)		
New Zealand Fantail	3,667	1,066
Silvereye	1,304	809
Tomtit	413	1,539
Gray Gerygone (Grey Warbler)	1,246	816
Common Chaffinch	769	23
All other detections (other species)	*1,208 (12% of total)*	*776 (14% of total)*

These results show that there were generally less bird vocalisation detections at the locations with higher anthropogenic noise. As expected, there was a significant reduction in detections at the high noise site (comparing NMT1 to NMT2), and a moderate reduction at the moderate noise site (comparing WL1 to WL2).

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The greatest reduction in detections is the morepork, which is expected because its 'hoot' is the lowest frequency localisation of vocalisation of the list of forest birds.

Tomtits were the only species where there were higher numbers of detections in areas affected by anthropogenic noise.

It is important to note the following in regard to the detection results:

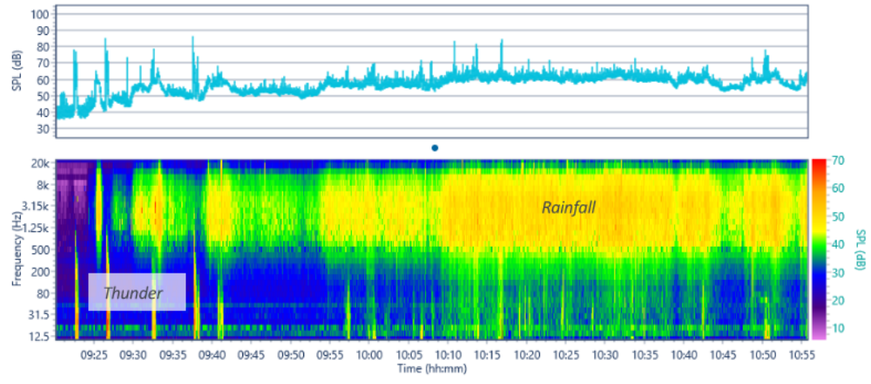
- The detections may be an indication of forest bird presence in these areas (i.e. less detections means less birds). However, the detectors may also be affected by anthropogenic noise masking the vocalisations at the monitoring locations.
- The detectors have varying levels of accuracy, which is a known and unavoidable limitation of automatic detection algorithms. However, our review of a sample of the detection audio files indicates that the vast majority appeared to be correct.

Other ambient sources can also mask birdsong

Ambient noise levels in the forest can vary significantly due to variations in wind and rain, as well as proximity to rivers/waterfalls. The ambient sources produce noise in generally the same frequency range as the proposed activities, and therefore can also mask birdsong.

We note that the Coromandel Forest is an area of very high rainfall (over 2,000 mm per annum)[5]. Moderate to heavy rainfall can produce relatively high noise levels as shown on Figure 16. This time trace and spectrogram shows a period of thunderstorms from the morning of 31 August at the remote forest location. The noise from the rainfall is in the same frequency range as the bird vocalisations (500 Hz – 10 kHz).

Figure 16: Period of heavy rainfall on morning of 31 August 2024 (remote forest location NMT1)



[5] https://webstatic.niwa.co.nz/static/Waikato%20ClimateWEB.pdf

MEMO

Project:	Waihi North FTA	**Document No.:**	Mm 002		
To:	Oceana Gold	**Date:**	15 November 2024		
Attention:	Cassie McArthur	**Cross Reference:**	Mm 001 R01		
Delivery:	Email	**Project No.:**	20240606		
From:	Ben Lawrence	**No. Pages:**	2	**Attachments:**	No
Subject:	Forest Bird Effect Zones				

This memo presents our predicted zones where there is the potential for masking of forest bird vocalisations. It should be read in conjunction with our memo on our ambient noise survey[1] which explains the basis of our masking noise assessment.

The results only include the frequency range where the forest birds vocalise. We have separated the species into two distinct groups:

- Wide frequency range vocalisations (500 Hz – 8 kHz) such as tui, NZ bellbird, ruru
- High frequency range vocalisations (2 kHz – 8 kHz) such as fantail, silvereye, tomtit, grey warbler, whitehead

We have assumed that there is the potential for masking where noise from the proposed project operations is higher than the ambient noise levels. We have determined the ambient noise levels from our measurements in a remote forest location to be 35 dB $L_{50\,(500\,Hz-8\,kHz)}$ and 31 dB $L_{50\,(2-8\,kHz)}$. The L_{50} levels represent the sound that is in the forest for more than 50% of the time, which excludes intermittent sources such as helicopter pass-bys, birdsong and most wind/rain.

Drill rig and helicopter noise emissions have been calculated using SoundPLAN. It is an internationally recognised computer-based 3D digital sound modelling package. The program allows detailed terrain to be imported and modelled, and noise levels to be calculated for slight downwind conditions in all directions.

We have calculated noise levels using the algorithms of ISO 9613-2: 1996 *'Acoustics – Attenuation of noise during propagation outdoors – Part 2: General method of calculation'*.

Table 1 presents the coverage areas for each of the scenarios to enable comparison between the different scenarios.

Figures for each scenario are attached. The extent of the potential masking effects zone is shown by the light green border and the noise sources are in the red areas. The colour gradient Illustrates that the vocalisation masking increases closer to the noise source.

[1] *'Mm 001 R01 20240606 BL (Forest Noise Survey and Bird Count Results)'*, dated 15 November 2024

Table 1: Summary of masking areas from each scenario

Scenario	Operation Description	Vocalisation group	Potential masking area
S1	Continuous noise from 6 drill rigs spread out arrangement	Wide frequency range	4 km^2
S2	Continuous noise from 6 drill rigs spread out arrangement	High frequency range	1.4 km^2
S3	Continuous noise from 6 drill rigs compact arrangement (north sites)	Wide frequency range	3.4 km^2
S4	Continuous noise from 6 drill rigs compact arrangement (north sites)	High frequency range	1.3 km^2
S5	Continuous noise from 6 drill rigs compact arrangement (south sites)	Wide frequency range	3.3 km^2
S6	Continuous noise from 6 drill rigs compact arrangement (south sites)	High frequency range	1.3 km^2
S7	Short term noise from 2 helicopters hovering with drill rigs	Wide frequency range	14.4 km^2
S8	Short term noise from 2 helicopters hovering with drill rigs	High frequency range	4.6 km^2