WAKA KOTAHI
NZ TRANSPORT AGENCY

PAPAKURA TO BOMBAY STAGE 2

ASSESSMENT OF NOISE AND VIBRATION OF EFFECTS

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If you have further queries, call our contact centre on 0800 699 000 or write to us:

NZ Transport Agency
Private Bag 6995
Wellington 6141

This document is available on the NZ Transport Agency's website at http://www.nzta.govt.nz

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A	17/02/2024		S Wilkening	D.Ingoe		

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Abbreviations

Abbreviation	Term
AEE	Assessment of Effects on the Environment
AUPOP	Auckland Unitary Plan (Operative in Part 2016)
BPO	Best Practicable Option as defined in the RMA
CNVMP	Construction Noise and Vibration Management Plan
NoR	Notice of Requirement
NoR 1	Alteration to the SH1 Designation 6706
NoR 2	Alteration to the SH1 Designation 6700
NoR 3	Alteration to the SH1 Designation 6701
NoR 4	Shared User Path between Quarry Road and Bombay Interchange
NoR 5	Drury South Interchange Connections
NZTA	NZ Transport Agency Waka Kotahi
P2B	SH1 Upgrades Project between Papakura to Bombay
PC	Plan Change
RMA	Resource Management Act 1991
SGA	Supporting Growth Alliance
SH1	State Highway 1 Motorway, the Southern Motorway
Southern IIG	Southern Iwi Integration Group
SUP	Shared Use Path

Glossary of Acronyms / Terms

Acronym/Term	Description
Auckland Council	Means the unitary authority that replaced eight councils in the Auckland Region as of 1 November 2010.
the Project	Stages 2 of the P2B Project between Drury to Bombay
Project Area	Area of land that is within the proposed designation boundary.

1 INTRODUCTION

This Assessment of Noise and Vibration Effects Report (Report) has been prepared to inform the Assessment of Effects on the Environment (AEE) for five Notices of Requirement (NoR) being sought by New Zealand Transport Agency Waka Kotahi (referred herein as 'NZTA') under the Resource Management Act 1991 (RMA), for Stage 2 of the Papakura to Bombay Project (P2B) or 'the Project'.

1.1 Purpose and Scope of this Report

This Report considers the actual and potential effects associated with the construction and operation of the Project on the existing and likely future environment as it relates to the Noise and Vibration effects and recommends measured that may be implemented to avoid remedy, and/or mitigate these effects.

This Report should be read alongside the AEE (**Appendix A**), which contains further details on the history and context of the Project. The AEE also contains a detailed description of works to be authorised within each of the five NoRs, and the typical construction methodologies that will be used to implement this work. These have been reviewed by the author of this Report and have been considered as part of this assessment of noise and vibration effects. As such, they are not repeated here. Where a description of an activity is necessary to understand the potential effects, it has been included in this Report for clarity.

1.2 Report Structure

To provide a clear assessment of each NoR, this Report follows the structure set out in the AEE. That is, each notice has been separated out into its own section, and each section contains an assessment of the actual and potential effects for the specific NoR. Where appropriate, measures to avoid, remedy or mitigate effects are recommended.

Table 1-1 below describes the extent of each section, and where the description of effects can be found in this Report.

Table 1-1: Report structure

Sections	Section number
Description of the Project	2
Identification and description of the existing and likely receiving environment	0
Construction noise and vibration: Overview of the methodology used to undertake the assessment, identification of the assessment criteria and any relevant standards or guidelines, and assessment of effects	4
Traffic noise: Overview of the methodology used to undertake the assessment and identification of the assessment criteria and any relevant standards or guidelines, and assessment of effects	5
Overall conclusion of the level of potential adverse noise and vibration effects of the Stage 2 P2B Project.	6

2 PROJECT DESCRIPTION

2.1 Papakura to Bombay Project

The P2B is a NZTA led project to improve the transport capacity and functionality of the State Highway network and provide for long term growth in the South of Auckland. An indicative location plan of the P2B area is illustrated in Figure 2-1 (below).

Further discussion of the different stages of the P2B Project is contained in the AEE (**Appendix A**) and Design Construction Report (**Appendix C**), which support this application.

For clarity and by way of summary we note that:

- The previous stages of the P2B, were approved under the Covid 19 Recovery (Fast Track Consenting) Act 2020 (FTA), as part of the Papakura to Drury South project (P2DS), this includes: Stage 1B1 and Stage 1B2; and,
- Stage 1B1 of the P2DS, was approved by the Expert Consenting Panel (EPA) in November 2022, Stage 1B2 was approved by the EPA in July 2023, both applications altered the existing SH1 Designation 6706 (Takanini to Drury Interchange), which is the subject of NoR 1.

2.2 Stage 2

NZTA is seeking five NoRs for Stage 2 of the P2B, which are summarised in **Error! Reference source not found.** (below).

For clarity and by way of summary we note that:

- The Project area, which was formally known as Stages 2 and 3 under the P2B, is now to be referred to as a single stage for route protection only, this is referred herein as ‘Stage 2’ or ‘the Project’,
- Stage 2 incorporates the remaining portion of the P2B Project area south of Quarry Road to the existing Bombay/Mill Road Interchange,
- Stage 2 will protect land required for the future upgrades of the SH1 corridor.

NZTA is seeking to protect adequate land to authorise the following planned works:

- New interchange constructed at Drury South (one additional lane in both direction of the proposed interchange),
- Upgrades to existing Bombay Interchange (one additional lane in both directions),
- Upgrades to Ramarama Interchange,
- Continuation of a Shared User Path (SUP) from Quarry Road to Bombay Interchange; and,
- Stormwater management devices.

2.3 Statutory context

This assessment has been prepared to support the AEE and NoR process. If confirmed, the designations will authorise the District Plan land use components of the Project. Accordingly, when assessing the actual or potential effects on the environment of allowing the requirement in terms of Section 171 of the RMA, this assessment has been limited to matters that would trigger a District Plan consent requirement.

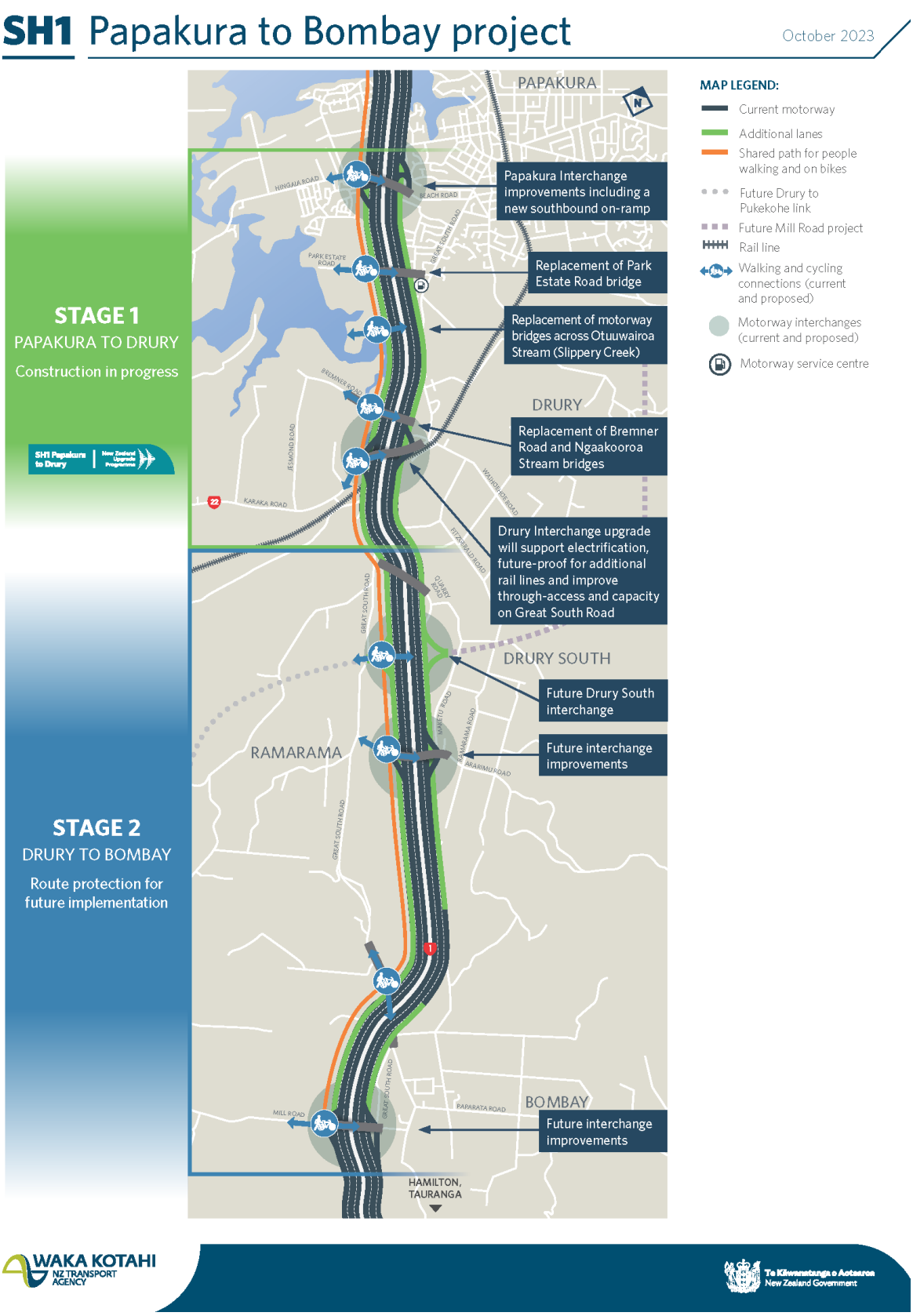


Figure 2-1: Indicative location plan showing Stage 2 of Waka Kotahi's P2B Project

Table 2-1: Stage 2 P2B Notice Package Summary

Notice	Requiring Authority	Project	Purpose	Extent	Lapse Period
NoR 1	Waka Kotahi	Alteration to SH1 Designation 6706	Motorway between Takanini and Hamilton	SH1 CH 15160 to CH 15500 State Highway 1 from north of Takanini Interchange to south of Quarry Road, Drury	Given effect (i.e. no lapse date)
NoR 2		Alteration to SH1 Designation 6700	Motorway	SH1 CH 15500 to CH 22740 State Highway 1 from south of Quarry Road, Drury to Bombay Road, Bombay	
NoR 3		Alteration to SH1 Designation 6701	Motorway	SH1 CH 22740 to CH 24600 State Highway 1 from Bombay Road to Mill Road, Bombay	
NoR 4		Shared User Path	Designation for the construction, operation and maintenance of a shared path and associated infrastructure.	SH1 CH 15160 to CH 24580 State Highway 1 from Quarry Road, Drury to Bombay Interchange/Mill Road.	20 years
NoR 5		Drury South Interchange Connections	Designation for the construction, operation and maintenance of a new link road and associated infrastructure.	CH 300 to CH 1750 Adjacent State Highway 1 at Drury South Interchange, linking to Quarry Road to the east, and Great South Road to the west.	20 years

3 EXISTING AND LIKELY RECEIVING ENVIRONMENT

3.1 Existing Zoning and Potential Future Uses

The existing receiving environment contains a combination of rural and business uses, with some recent developing residential area.

South of the Drury Interchange some limited residential buildings will be removed to enable the construction of the Project. Current land uses are generally rural, however the zoning west of SH1 is Future Urban Zone (FUZ), so significant development is expected in the future. The Structure Plan suggests business and industrial uses next to SH1, which means that no or only limited noise sensitive activities would occur in these areas in the future. Other existing uses in the area include a childcare centre, other businesses, and a small number of dwellings.

Further south, the Project traverses FUZ land (currently rural but to be developed in the future) to the west and undeveloped business zoned land to the east. Around Harrison Road, all land to the west of SH1 is zoned Mixed Rural, while land to the east in the vicinity of Maketu Road is zoned residential. Subdivision development has commenced in this area, with a number of dwellings already constructed.

We understand that Project construction is expected to occur in about 10 to 15 years. Therefore, changes to the surrounding environment are likely in the interim. Any new developments being established adjacent to SH1 should have taken account of the existing elevated noise levels. In fact, some of the proposed residential developments will already have sound insulation requirements relating to truck noise on local roads, which will also provide some benefit in relation to traffic on SH1. In addition to designing houses appropriately, the layout of the subdivision and individual houses will influence the degree of effect from road traffic noise. Where subdivisions include a buffer zone such as an open space area adjacent to SH1, or where non-sensitive uses are facing SH1 (e.g. garages and bathrooms), then the effects from the existing (and future) traffic noise levels is reduced.

South of the subdivision, to the southern extents of the Project, land uses reflect the current zoning of Mixed and General Rural zones. The only interruption in the zoning is the Special Purpose – School zone that accommodates St Stephens School. However, all school buildings are well more than 200 metres from the existing and future road edge.

3.2 Existing Noise Environment

The existing noise environment provides a baseline for assessing noise effects. The existing noise environment at all receivers is controlled by traffic on SH1.

We undertook both long and short duration noise surveys at locations along the Project extent. The survey results are used to determine appropriate construction noise limits, and to verify the computer noise model used to predict traffic noise levels.

Long duration noise logging was undertaken at two locations along the Project extent. Loggers were installed and measured noise levels continuously. The measured data was analysed, and we determined noise levels relative to the construction noise limits and 24-hour noise levels used for the assessment of traffic noise levels. The location of the surveys is shown in Figure 3-1.

Figure 3-1: Noise survey locations

Analysed noise level survey results are shown in Table 3-1. Full survey results are set out in section **Appendix A**.

Table 3-1 Noise level survey results

Survey Location / Period	Location reference	Time	dB $L_{Aeq(T)}$ [1]	dB L_{A90} [2]	dB L_{AFmax} [3]	Measured noise level dB $L_{Aeq(T)}$	Derived noise level dB $L_{Aeq(24h)}$ [1]
Long duration survey results							
1823 Great South Road (12 Oct – 25 Oct 2023)	MP4	0630 – 0730 0730 – 1800 1800 – 2000 2000 – 0630	66 67 64 62	58 60 56 44	82 93 91 90	-	65
199 Hillview Road (16 Oct – 25 Oct 2023)	MP3	0630 – 0730 0730 – 1800 1800 – 2000 2000 – 0630	59 58 56 54	51 52 50 42	84 90 82 84	-	57
Short duration survey results (25 Oct 2023)							
34 Maher Road	MP2	1435 – 1441	53	50	65	53	51
72 Harrison Road	MP1	1502 – 1517	59	57	68	59	57

[1] – logarithmic average
[2] – arithmetic average
[3] – highest level

The measured levels show that ambient noise environment is affected by traffic on SH1, with daytime noise levels for buildings closest to the road around the mid-60 dB L_{Aeq} and background noise levels ranging in the 50 to 60dB L_{A90}. Existing buildings have been exposed to these noise levels for a significant time, as traffic on SH1 has continued to grow.

4 ASSESSMENT OF EFFECTS – CONSTRUCTION NOISE AND VIBRATION

4.1 Performance Standards

This report supports an application for five NORs; three (NoR 1-3) for an alteration of existing Designations 6706, 6700 and 6701, and two (NoR 4 and 5) for the creation of new designations for the SUP and the new link road at Drury South. Many aspects of the Project will be constructed within the existing designation boundaries of existing Designations 6700 and 6701. There are no noise or vibration conditions attached to these Designations. That means that no noise and vibration limits apply to construction works within the existing Designations (although management and mitigation of construction noise will occur as a matter of best practice and with reference to the relevant noise standards, as discussed further below). Designation 6706 contains designation conditions relating to construction noise and vibration as discussed in Sections 4.1.1 and 4.1.2.

As the noise and vibration effects of works inside some of the existing designations are already authorised, the effects of those works have not been assessed. We note, however, that the management of noise and vibration effects within the existing designation will be confirmed through an Outline Plan of Works (OPW) process and will include the preparation and implementation of a CNVMP for the overall works and Schedules to the CNVMP (Schedules) for specific activities and receivers. The criteria against which we have assessed the construction noise and vibration effects from works in the new and altered designation areas, will control the management of effects through the CNVMP and Schedules over all the altered, new and existing designations. The requirements of Sections 16 and 17 of the Resource Management Act 1991 (RMA) also apply, and noise and vibration will be managed accordingly.

Works in areas covered by NoRs 2 and 3, and inside Designation 6706 have been assessed for compliance against relevant standards and guidelines.

4.1.1 Noise

The construction noise conditions of Designation 6706 are those normally applied to State highway projects and are discussed in more detail below. The criteria and approach are appropriate for this entire Project and have been applied.

Construction noise is assessed against NZS 6803:1999 Acoustics – Construction Noise. This standard is referenced in the AUP and the NZTA "State Highway Construction and Maintenance Noise and Vibration Guide", V1.1, August 2019 (the NZTA Guide), as well as Designation condition CNV.2 of Designation 6706.

NZS 6803 sets lower noise standards for long duration works of more than 20 weeks, and Stage 2 would fall into this duration. However, the existing ambient noise levels are up around 65 dB L_{Aeq} for the few houses close to SH1. Therefore, we recommend applying the typical duration noise standards to the works of Stage 2. The relevant standards are set out below.

In summary, daytime noise standards are 75 dB L_{Aeq} and 90 dB L_{AFmax}. Night-time noise standards are 45 dB L_{Aeq} and 75 dB L_{AFmax}. The night-time standards are noticeably lower than current ambient noise levels in the area (refer **Table 3-1** of this report), and therefore a relaxation will likely be enabled for any night works through the process of Schedules (refer to section 4.4 of this report).

Noise standards recommended to be applied to the works in the NORs are set out in Table 4-1.

Table 4-1 Noise standards at buildings occupied during the works

Time of week	Time period	Noise criteria	
		dB L_{Aeq}	dB L_{AFmax}
Buildings containing activities sensitive to noise occupied during the works			
Weekdays	0630 – 0730	60	75
	0730 – 1800	75	90
	1800 – 2000	70	85
	2000 – 0630	45	75
Saturdays	0630 – 0730	45	75
	0730 – 1800	75	90
	1800 – 2000	45	75
	2000 – 0630	45	75
Sundays and public holidays	0630 – 0730	45	75
	0730 – 1800	55	85
	1800 – 2000	45	75
	2000 – 0630	45	75
Other buildings occupied during the works			
All days	0730 – 1800	75	n/a
	1800 – 0730	80	n/a

4.1.2 Vibration

Both the AUP and the NZTA Guide reference relevant vibration standards for construction works. Designation 6706 references the vibration standards from the NZTA Guide. These criteria are similar insofar as they address two vibration responses:

- One set has reference criteria for human amenity which act as trigger levels for consultation and communication.
- The other set of standards are designed to avoid cosmetic building damage. This is achieved by ensuring compliance with the provisions of German Standard DIN 4150-3:1999 "Structural Vibration - Part 3: Effects of Vibration on Structures". Waka Kotahi's vibration standards also allow for the application of the British Standard BS 5228-2:2009 "Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration" at unoccupied buildings.

We recommend the application of the standards as referenced in the designation conditions and the NZTA Guide as set out below.

In general terms, the Category A standards for occupied buildings aim to manage annoyance of receivers. Because these criteria are conservative, there is a provision in the NZTA Guide to relax them if they cannot be practicably met, provided a vibration expert is engaged to assess and manage construction vibration to comply with the Category A standards as far as practicable. In addition, affected people should receive communication about the proposed works and anticipated effects, to avoid concern.

If Category A vibration standards are not practicably achievable, the focus then shifts to avoiding building damage by applying the Category B standards. If the Category B standards are complied with, then building damage should not occur, as stated in the relevant standards from which the criteria are taken. If Category B standards are predicted to be exceeded, then monitoring of vibration levels should be undertaken during works and, prior to construction commencing, building condition surveys must occur to allow an assessment of and response to any effects.

The German Standard, that sets the 5mm/s PPV Category B standard for occupied buildings, is a conservative standard designed to avoid all (including cosmetic) damage to buildings, e.g. superficial damage like cracking in plaster. Significantly higher standards would be applied if damage to structural foundations was the only consideration.

Vibration standards recommended to be applied to the works in the NORs are set out in Table 4-2 below.

Table 4-2 Vibration standards at all buildings

Receiver	Location	Details	Category A	Category B
Occupied PPFs	Inside the building	Night-time 2000h-0630h	0.3 mm/s PPV	1mm/s PPV
		Daytime 0630h-2000h	1mm/s PPV	5mm/s PPV
Other occupied buildings	Inside the building	Daytime 0630h-2000h	2mm/s PPV	5mm/s PPV
All other buildings	Building foundation	Vibration – transient	5mm/s PPV	BS 5228-2 Table B.2*
		Vibration – continuous		BS 5228-2 50% of Table B.2 values*

The criteria for Category B for occupied buildings, and Category A for unoccupied buildings are taken from German Standard DIN 4150-3:2016 Vibrations in Buildings – Part 3 Effects on Structures.

The criteria for Category A for occupied buildings, and Category B for unoccupied buildings are taken from British Standard BS 5228-2:2009 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration.

4.2 Assessment methodology of construction noise effects

The following sections discuss the potential construction noise impacts of the Project works on receivers adjacent to the Project.

Assessment of construction noise effects is based on assumptions of construction activities and equipment. However, we have based this assessment on similar construction projects we have worked on, including the Southern Corridor Improvements project and Stages 1A and B of the P2B project.

We have used the following assessment methodology for the construction noise and vibration assessment:

4.2.1 Determine works in the NOR areas

We determined which construction activities would be undertaken in the various NOR areas whose applications are supported by this report.

The works on SH1 are relatively minor and will generally remain within the extents of the existing designations. The SUP will be constructed within the new NoR 4 which in parts overlaps with the existing designations (NoR 1-3). NoR 5 consists of the construction of a new link road at Drury South Interchange which is outside the existing designations.

Table 4-3 shows the indicative construction activities that would occur inside the NoR areas (from north to south) subject to this application.

Table 4-3 Construction activities outside the designation per area

Construction Area	NoR affected	Main construction activities
SH1 widening from Quarry Road to Bombay Interchange	NoR 1-3	▪ Earthworks, including associated swales and integration into surrounding terrain
Mill Road	NoR 3	▪ New bridge crossing SH1 & connecting with SUP
Shared Use Path from Quarry Road to Bombay Interchange	NoR 4 (some parts overlapping with NoR 1-3)	▪ SUP works (mostly earthworks) ▪ Drury South Interchange (SUP works) ▪ Ararimu Road Interchange (SUP works) ▪ Ararimu Road bridge widening ▪ Mill Road (SUP works) ▪ Added lane to Bombay Rd bridge for SUP
Link road at Drury South Interchange	NoR 5	▪ Earthworks and connections with SUP

We also determined which dwelling may be removed as they are inside the designation and would be affected by the works. These are listed in Table 4-4 below.

Table 4-4 Buildings to be removed

Address of buildings to be removed
1233, 1238, 1242, 1254 Great South Road
55 Hillview Road
182, 229 Mill Road
309 Quarry Road

4.2.2 Ambient noise levels

We measured ambient noise levels along the route to determine the existing environment which forms the basis of the effects assessment (refer to section 3.2). These noise levels assist with the assessment of construction noise effects. Where existing ambient noise levels are elevated, construction noise effects may be less pronounced. In addition, where night-time noise levels are elevated and night-time works are required, higher performance standards may be appropriate through the process of Schedules (refer section 4.4).

Since the environment in the Drury area will change significantly over the coming years, ambient noise levels are likely to increase. More residential developments and intensification will lead to more traffic on SH1 and surrounding areas.

4.2.3 Noise emission data

We reviewed noise emission data for each construction task/process based on data previously measured by Marshall Day Acoustics (MDA) for similar activities and used data from appropriate noise standards, where relevant.

We have predicted construction noise levels based on experience with similar projects and in similar circumstances, including Stages 1A and 1B1 of the P2B project. Large scale roading projects normally use similar equipment in New Zealand. The list of equipment and its respective sound power levels used as the basis of our predictions is set out in Table 4-5 below. It is important to keep in mind that this list is a "best estimate" of equipment that is likely to be used. Although the contractor may use different size or type of plant, from experience on other infrastructure construction projects we consider that noise emissions will be similar for each combined activity.

We used the noise levels in Table 4-5 to predict combined "activity sound power levels". The activity sound power level takes account of the fact that not all items of equipment would operate in the same area and at the same time, that some activities are intermittent and therefore have a time component to them, and that some works move along the alignment while others are stationary. It also takes account of the magnitude of works, i.e. that SUP works require lesser sized equipment than road works, and that remarking of lanes to create additional traffic lanes generates lower noise than resurfacing and remarking where widening is required to create additional traffic lanes.

From the activity sound power levels, we then determined the distance at which the 75 dB L_{Aeq} day-time noise criterion can be complied with, without noise barrier mitigation.

Table 4-5 Construction Equipment Noise Levels and Activity Noise Levels

Activity	Plant type	Sound power level (dB L_{WA})	Activity Sound Power Level (dB L_{WA})	Distance at which compliance with day-time limit (75 dB L_{Aeq}) is achieved without noise barriers (m)
Retaining Wall Construction	Vibration piling rig Rotary Piling Rig Concrete trucks Crane On road trucks	120 111 107 106 100	107	25

Activity	Plant type	Sound power level (dB L_{WA})	Activity Sound Power Level (dB L_{WA})	Distance at which compliance with day-time limit (75 dB L_{Aeq}) is achieved without noise barriers (m)
Earthworks	Dump truck Hydraulic excavator Bulldozer Compactor Water truck	106 113 114 112 105	115	50
Bridge foundations (piling)	Rotary piling rig Concrete trucks	111 107	111	35
Concrete foundations and structures	Crane Concrete pump Vibratory pokers Concrete trucks	106 100 114 107	110	30
Pavement construction (road)	Vibratory roller Water trucks Paver Road rollers Asphalt delivery trucks	108 105 113 106 108	110	30
Pavement construction (SUP)	Vibratory roller Water trucks Paver Delivery trucks	113 106 108 108	108	25
Yard activities	Vehicle movements Material handling Administration area Workshop	102 105 50 80	100	10

4.2.4 Envelope of construction noise effects

Using the predicted noise levels, we have determined effects envelopes, i.e. distances at which compliance with the daytime and/or night-time noise standards can be achieved. We have not included shielding of intervening buildings or other structures in the predictions, which means that the distances are conservative.

Where exceedances are indicated, temporary barriers should be installed prior to construction commencing in any one area to achieve the most effective noise mitigation during the construction phase. If that is not practicable, the barriers should be installed as early as practicable during the construction phase.

We recommend that the predictions be updated for the CNVMP (refer Section 4.4) to reflect the proposed scope of works and buildings that exist at the time of construction. Section 16 of the RMA

applies, and the Best Practicable Option (BPO) will need to be implemented to manage noise effects on all areas, irrespective of compliance.

The following activities have been used to determine the envelope of effects. These are the activities we consider having the greatest impact on construction noise.

- Bulk earthworks will generate noise levels of above 75 dB L_{Aeq} within 50m of operations where direct line-of-sight occurs between dwellings and earthworks. With barriers in place, where they are practicable and effective, compliance with the daytime noise limit can be achieved within 20m of the works.
- Piling is limited to areas surrounding any bridges that will be upgraded or replaced. This activity may generate high noise levels nearby. We have recommended that bored piling be utilised instead of impact piling, to reduce noise and vibration levels.
- Bridge construction works, particularly the installation of bridges that require closure of SH1, will likely be undertaken at night-time and therefore may have additional adverse effects on neighbouring residents. These works will need to be addressed through Schedules (refer Section 4.4).
- Construction of structures and pavements is less noisy than bulk earthworks. These activities have the potential to generate noise levels of above 75 dB L_{Aeq} within 25 to 30m, and with acoustic screening within 10m of the works.

We predicted noise levels from construction and determined setback distances where compliance with the Project standards can be achieved.

Staging areas or construction yards should be located away from dwellings. We recommend a buffer distance of about 50m to ensure that comfortable compliance can be achieved with the relevant standards.

Where construction of the Project works is predicted to exceed the noise standards, we recommend management and mitigation. In any event, noise emissions will be managed in accordance with best practice as set out in the NZTA Guide, for all works irrespective of location or compliance with criteria. There is an overriding requirement to apply the best practicable option management and mitigation.

Figures showing the construction noise envelopes are included in **Appendix B**.

4.2.5 Noise effects

Any works subject to this application are generally distant from sensitive receivers. Only a limited number of current dwellings are close to the works outside the designation.

Night-time works would generally be required for bridge works and road surfacing works (which are being undertaken as of right at present) as these works would affect the operation of SH1. Other works related to the construction of the SUP should generally be able to be undertaken during daytime. However, the SH1 bridge across Great South Road may need to be constructed in part during night-time. The closest dwelling (1823 Great South Road) is approximately 85 m from the bridge. This means that consultation and management of noise levels will be required if any piling is to be undertaken at night-time. Effects from night-time works are discussed in section 4.2.5.2 below.

When works occur on the SUP, predicted noise levels at any dwellings on the southbound side of SH1 are predicted to be between 45 and 55 dB L_{Aeq} and noise levels on the northbound side of SH1 would be up to 70 dB L_{Aeq} with a barrier in place. These levels are acceptable and should not cause adverse effects inside houses with windows closed. We expect that works on the SUP can be undertaken during daytime as they are offline.

The following Table 4-6 summarises the number and approximate location of buildings that may receive noise levels exceeding the relevant noise criteria (refer to section 4.1.1 of this report, from earthworks,

without noise barriers in place. Most exceedances will be marginal; nevertheless, noise levels are predicted to be high and therefore will need to be managed appropriately.

Table 4-6 Buildings at which works may exceed the noise standards without noise barriers

Address	Address
88 Ararimu Road	7 McEldownie Road
1 Bombay Road	187, 188, 203, 1-5/216 Mill Road
1121, 1246, 1255, 1279B, 1823, 1875, 1940, 1974, 1998, 2038 Great South Road	17, 19, 21, 23, 25, 27 Pekepeke Lane
65 Harrison Road	11 Piwaiwaka Lane
33, 85, 151, 177, 199, 352 Hillview Road	10, 296 Quarry Road
6, 34, 44 Maher Road	25 Tegal Road

Most SUP works are on the northbound side of SH1. The land use has a mostly rural and lifestyle block character, with intermittent dwellings and business areas. Should any additional buildings be completed and occupied when the Project is constructed, then these additional buildings will also need to be included in the assessment. That would best be done through the CNVMP, which will need to be prepared prior to construction.

Schedules should also be developed prior to any construction activities proposed to occur at night in the vicinity of dwellings. These Schedules should identify the noise and/or vibration risks and establish the management procedures that will be used in each area. These may involve the use of temporary noise barriers, choice of quieter operating equipment or rescheduling activity to occur during the daytime period.

4.2.5.1 Daytime

Noise levels affect people in their place of residence or work. Construction noise is inherently higher than ongoing operational noise, which is reasonable due to its limited duration.

Generally, construction noise is assessed in relation to people inside buildings. It is assumed that people will choose to not spend any extended periods in an outdoor area next to high noise construction activities. It is also assumed that people will keep their windows and doors closed to reduce internal noise levels. Generally, New Zealand dwelling facades reduce noise levels by 20 to 25 decibels. We have assumed conservatively a noise level reduction of 20 decibels, though any new dwellings would achieve 25 to 30 decibels noise level reduction. How people may react to the noise levels predicted is shown in Table 4-7.

Table 4-7 Potential noise effects for varying noise levels

External Façade Noise Level dB L_{Aeq}	Potential Daytime Effects Outdoors	Corresponding Internal Noise Level dB L_{Aeq}	Potential Daytime Effects Indoors
Up to 65	Conversation becomes strained, particularly over longer distances.	Up to 45	Noise levels would be noticeable but unlikely to interfere with residential or office daily activities.
65 to 70	People would not want to spend any length of time outside, except when unavoidable through workplace requirements.	45 to 50	Concentration would start to be affected. TV and telephone conversations would begin to be affected.
70 to 75	Businesses that involve substantial outdoor use (for example garden centres such as Bunnings) would experience considerable disruption.	50 to 55	Face to face and phone conversations and TV watching would continue to be affected. Office work can generally continue.
75 to 80	Some people may choose hearing protection for long periods of exposure. Conversation would be very difficult, even with raised voices.	55 to 60	Phone conversations would become difficult, and Face to face conversations would need slightly raised voices. For residential activities TV and radio sound levels may need to be raised. Continuing office work may become difficult.
80 to 90	Hearing protection would be required for prolonged exposure (8 hours at 85 dB) to prevent hearing loss.	60 to 70	Face to face conversations would require raised voices. In a residential context, people may actively seek respite if these levels are sustained for more than a period of a few hours. Concentration would start to be affected, continuing office work would be difficult and may become unproductive.

In summary, buildings facing the works are predicted to receive façade noise levels up to 75 dB L_{Aeq} for short periods, with noise levels generally between 65 and 70 dB L_{Aeq}.

That means that for buildings facing SH1 there may be some impacts on indoor living or office work environment which can be mitigated by closing doors and windows. In addition, temporary construction noise barriers can be installed where effective, to reduce noise levels by 10 decibels. We also note that existing traffic noise levels are currently already up to 65 dB L_{Aeq} at buildings closest to SH1.

4.2.5.2 Night-time

The noise level received inside a noise sensitive space (e.g. bedroom) will depend on the external noise level, sound insulation performance of the façade (particularly the glazing) and room constants (such as the room dimensions and surface finishes). These factors can vary widely.

The Construction Noise Standard (NZS 6803) recommends noise limits assessed at 1m from the external façade of a building, assuming a façade sound level difference of 20 decibels. However, a 20-decibel reduction is particularly conservative for modern buildings. The sound insulation performance can be measured, or generally be estimated with knowledge of the façade glazing type as follows:

- Sealed glazing: 30 decibels façade sound level difference.
- Closed windows (openable): 20 – 25 decibels façade sound level difference.

- Open windows: 15 decibels façade sound level difference.

Table 4-8 provides guidance on the potential night-time effects inside sensitive spaces, depending on the external noise level and façade glazing type. The potential effects are colour coded as follows:

- Typically acceptable
- Sleep disturbance for some occupants
- Sleep disturbance for most occupants

Table 4-8 Night-time noise levels in bedrooms of dwellings

External Noise Level (dB L_{Aeq})	Estimated Internal Noise Level (dB LAeq)			
	Sealed glazing	Openable windows (modern building)	Openable windows (older style building)	Open windows
70 – 75	40 – 45	45 – 50	50 – 55	55 – 60
65 – 70	35 – 40	40 – 45	45 – 50	50 – 55
60 – 65	30 – 35	35 – 40	40 – 45	45 – 50
55 – 60	25 – 30	30 – 35	35 – 40	40 – 45
50 – 55	20 – 25	25 – 30	30 – 35	35 – 40
45 – 50	15 – 20	20 – 25	25 – 30	30 – 35

That consultation will likely be required if night-time works are proposed in the vicinity of dwellings, where internal noise levels would affect sleep (likely limited to dwellings close to the night-time bridge works).

4.3 Assessment of construction vibration effects

4.3.1 Vibration data of construction equipment

Like the construction noise assessment, we have determined the likely construction equipment to be used for works in the three NoR areas. We then assessed which of the construction methodologies and plant would cause the highest vibration levels.

For that equipment, we have determined relevant vibration level data from previous measurements carried out by MDA, the British Standard BS 5228-2:2009 and the Transport Research Laboratory Report referenced by that standard.

Our predictions are based on regression curves of vibration level at various distances for vibratory rollers and vibropiling rigs. We then applied a 100% safety margin to the regression curve derived from the measured data, to make allowance for ground condition uncertainty, making the predictions conservative. The regression curves (including safety margin) for vibratory rollers and vibropiling are shown in Figure 4-1. Vibropiling may only be used for retaining walls and bridge structures, both of which are localised and at distances of more than 10m from dwellings and more than 5m from industrial buildings.

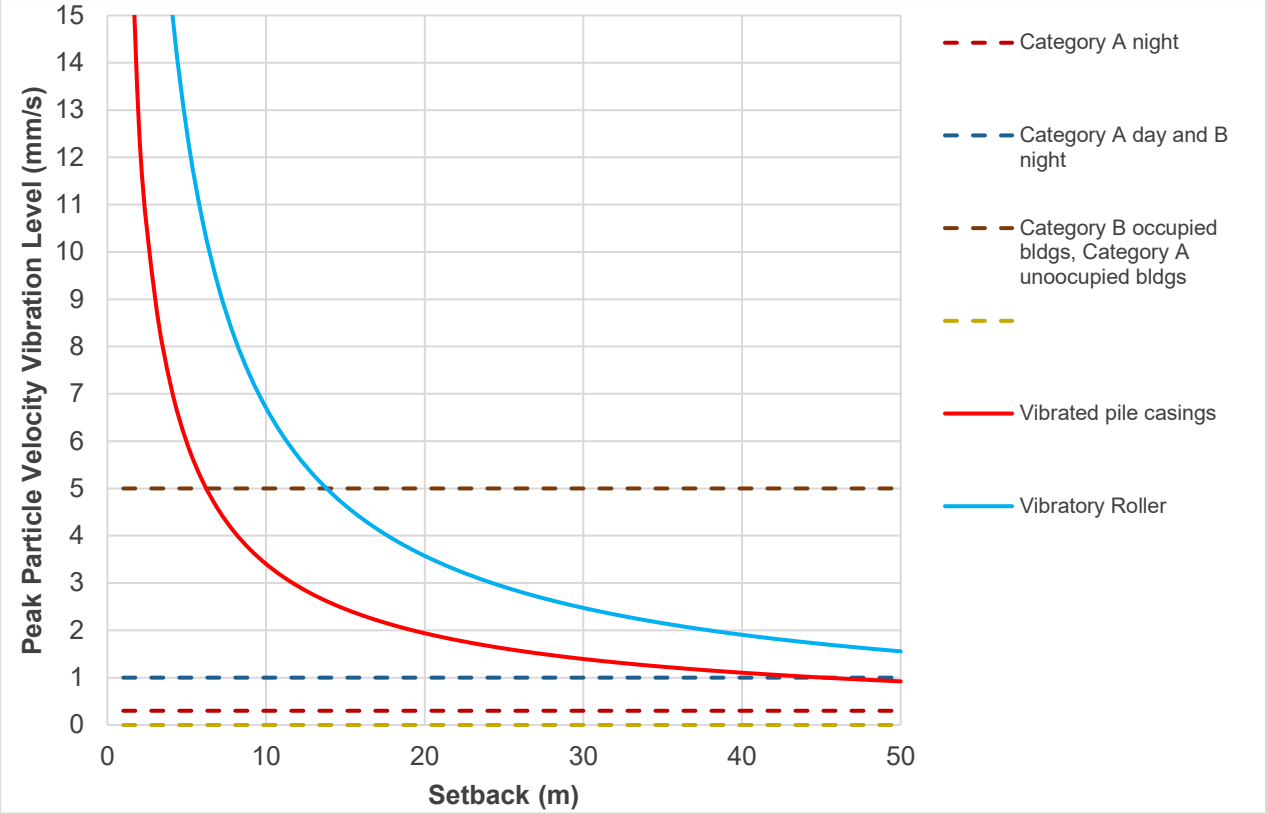


Figure 4-1 Vibration Regression Curves

4.3.2 Envelope of vibration effects

The activities that pose the greatest risk of exceeding the vibration criteria (human annoyance and building damage as set out in the NZTA guidelines) are vibratory rolling and vibropiling. Therefore, our erassessment has focused on these activities. Other construction activities, while also generating vibration, would do so at a much lower level and are predicted to comply with the relevant criteria.

Only very few buildings are in close proximity to the works. This is reflected in the low number of dwellings where (with the conservative safety margin applied) there may be a risk of the daytime Category A criteria being exceeded.

There is a risk that the amenity criteria may be exceeded at dwellings where vibratory rollers are used for the compaction of new or widened traffic lanes and the SUP.

The risk categories in Table 4-9 relate to the risk of exceeding the Project criteria set out in Table 4-2, at various distances from the vibration inducing works. The "all other buildings" zone has been calculated under the worst-case assumption that all these buildings are light weight structures. The risk categories are defined as follows:

- High Risk — Predicted to exceed Category B criteria as well as Category A criteria.
- Medium Risk — Predicted to exceed Category A criteria, but comply with the Category B criteria.
- Low Risk — Predicted to comply with Category A and B criteria.

Table 4-9 Activity and risk zones

Equipment	Risk Zones		
	Occupied Dwellings (Residential)	Other Occupied Buildings (Commercial)	All Other Buildings
Vibratory Roller	High: < 15 m Med: 15 – 55 m Low: > 55 m	High: < 15 m Med: 15 – 40 m Low: > 40 m	High: < 5 m Med: 5 – 15 m Low: > 15 m
Vibropiling	High: < 7 m Med: 7 – 45 m Low: > 45 m	High: < 7 m Med: 7 – 20 m Low: > 20 m	High: < 5 m Med: 5 – 10 m Low: > 10 m

The approximate number of buildings where there is a risk of exceeding Category A or B, is summarised in Table 4-10 below. Due to the small number of dwellings (and other buildings) in the vicinity of the NOR areas, only a few receivers are predicted to receive vibration levels exceeding the amenity criteria, and no buildings are predicted to receive vibration levels exceeding the building damage criteria.

Table 4-10 Number of buildings in each vibration risk category for daytime works

Approx. number of buildings potentially receiving vibration levels exceeding	
Category A (excluding Cat. B)	Category B
19	5

The Project standards are significantly more stringent at dwellings during the night and have the potential to be exceeded at distances greater than 200m from the night-time works. On this basis, vibration intensive activities adjacent residential areas should be generally scheduled for the daytime wherever practicable.

Figures showing the location of the construction vibration envelope are shown in **Appendix C**.

4.3.3 Vibration effects

Vibration levels can be perceived well below a level at which cosmetic building damage may occur. For structural damage to occur, vibration levels would need to be magnitudes higher than the levels at which vibration can be perceived. People tend to react to low vibration levels, and it is important to inform residents in the vicinity of the works of the potential for construction vibration to be felt.

How people may experience vibration inside residences or offices, is described in Table 4-11 below. That table does not take account of non-sensitive activities such as factories, storage spaces and similar uses.

Table 4-11 Vibration effects

Vibration level (mm/s PPV)	Potential effects indoors
0.14	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.

0.3	Vibration might be just perceptible in residential environments This is the AUP limit for construction vibration generated at night-time for sensitive receivers.
1	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents. What people feel would be subject to the source/activity (i.e., continuous motion or a one off event) and associated frequency (i.e., fast or slow vibration), but could include a steady vibration from sources such as vibratory compaction, or a small jolt such as from the movement of a large digger. Vibration at this level could rattle crockery and glassware. Sleep disturbance would be almost certain for most people.
2	Vibration would clearly be felt in all situations. Can be tolerated in indoor environments such as offices, houses and retail, where it occurs intermittently during the day and where there is effective prior engagement. This is the AUP limit for occupied buildings for construction projects generating vibration.
5	Unlikely to be tolerable in a workplace or residential environment without prior warning and explanation. If exposure was prolonged, some people could want to leave the building affected. Computer screens would shake, and light items could fall off shelves. This is the AUP limit for construction activities generating vibration for three days or less between the hours of 7:00 am – 6:00 pm
10	Likely to be intolerable for anything more than a very brief exposure.

For dwellings where the category A (amenity) criteria are predicted to be exceeded, residents may be disturbed by vibration if no prior notification is given. We recommend timely engagement to avoid such situations. It is noted, however, that vibration inducing equipment generally moves along the alignment, i.e. vibration levels will not remain high for any length of time.

Overall, with appropriate management and mitigation (refer to section 4.4 of this report), we consider that the effects from construction noise and vibration are within a reasonable range and would not generally cause significant adverse effects.

4.4 Construction Noise and Vibration Mitigation and Management

Good noise and vibration management is essential in reducing adverse effects as far as practicable, irrespective of the low number of dwellings potentially affected.

4.4.1 Construction Noise and Vibration Management Plan

The most effective way to control construction noise and vibration is through good on-site management and communication between managers and other staff. Management and mitigation measures are most appropriately set out in a CNVMP, which would be used to manage works on site and sets out how the construction contractor interacts with the neighbouring affected parties. The CNVMP should also follow the approach outlined in the NZTA Guide. This includes a requirement for high noise and vibration risk construction projects to have an independently peer reviewed CNVMP and include a comprehensive risk-based quality assurance programme to ensure risks are appropriately managed.

The CNVMP should also include information set out in NZS6803:1999 such as:

- Summary of the Project noise standards contained within this assessment.
- Summary of assessments/predictions contained within this assessment.

- General construction practices, management and mitigation that will be used for the Project.
- Noise management and mitigation measures specific to activities and/or receiving environments, particularly for high noise and/or vibration activities, and all night-time works.
- Monitoring and reporting requirements.
- Procedures for handling complaints.
- Procedures for review of the CNVMP throughout the period of Project works.

The CNVMP will be implemented on site for each specific area of work. The CNVMP should be prepared when more detail is available. In addition to the CNVMP, NZTA standard procedures for the management of noise and vibration should be implemented for all noise and vibration emissions from construction activities, irrespective of the construction occurring inside or outside the designation. These will be relied on to avoid, remedy and mitigate adverse effects where appropriate.

4.4.2 Schedules

In addition, Site Specific Noise and/or Vibration Management Schedules (Schedules) are a useful tool in determining how the noise and vibration effects from specific activities or in specific areas will be managed and potentially affected parties communicated with. Schedules would generally be prepared where there is a high risk of exceeding the noise and/or vibration standards.

The Schedules are specific to the activity or receiver they relate to, and would therefore contain detailed information on communication, management and mitigation specific to a certain task or area.

The following information would normally be included in a Schedule:

- The activity start and finish dates;
- The nearest neighbours to the activity;
- A location plan;
- The activity equipment and methodology;
- Predicted noise/vibration levels
- Recommended BPO mitigation;
- Documented communication and consultation with affected persons;
- Monitoring details; and
- Any pre-activity building condition survey for any buildings predicted to receive vibration levels exceeding the Category A criteria and receiving noise levels towards the Category B criteria.

They would be attached to the CNVMP, providing additional information that would sit alongside the general management and mitigation options within the CNVMP.

5 ASSESSMENT OF EFFECTS – TRAFFIC NOISE

The following sections discuss the traffic noise effects of the Project works.

5.1 Performance Standards

Most of the traffic lanes of Stage 2 will be located inside the existing designation boundary of Designations 6706, 6700 and 6701. There are no traffic noise conditions attached to these Designations. That means that no noise limits apply to traffic within the three Designations. We understand that traffic noise effects of any changes inside the existing designation are already authorised and have not in detail assessed the effects of those changes.

For any roads outside the designation (in this instance NoR 5), the provisions of the AUP would apply, which references NZS 6806:2010 *Acoustics – Road-traffic noise – New and altered roads*. Once the designation is confirmed, the relevant designation conditions would apply. Therefore, the AUP requirements have been used as a guide for this assessment.

Traffic noise generation inside NoR 5 areas cannot be assessed separately from traffic noise generation inside the existing Designations. Therefore, we have applied the provisions of NZS 6806 to all traffic noise generation in the vicinity of the NORs and make separate comment about what the inclusion of the NOR areas would mean for the traffic noise generation overall.

The SUP does not generate traffic noise levels, and where noise is generated from passing bikes or pedestrians, this will be magnitudes below the SH1 traffic noise, and of a passing nature. Therefore, the SUP is not discussed in relation to operational noise.

5.1.1 Noise

The New Zealand Road Noise Standard NZS 6806:2010 "*Acoustics – Road-traffic noise – New and altered roads*" (NZS6806) has been adopted by NZTA and is also the applicable standard for roads in the AUP.

In addition to this standard, NZTA has released its *"Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects (Version 1.1, August 2016)"* (NZTA Guide 2016). The NZTA Guide 2016 describes how NZS 6806 can be implemented. In addition, some NZTA specific processes are described. Overall, the NZTA Guide 2016 provides background on how to implement NZS 6806 and is therefore a useful complimentary document to the Standard itself.

We consider the intent of NZS 6806 is to provide a pragmatic approach to the use of noise mitigation. This approach includes the requirement that a roading project needs to have a noticeable noise effect before mitigation is considered, and that any mitigation should seek to achieve a noticeable reduction in noise level.

NZS 6806 applies to traffic noise assessments where a project falls within its thresholds, which are briefly explained below.

- **Altered Roads** are those roads where the horizonal or vertical realignment of a road result in noise level changes of at least 3 dB (for noise levels 64 dB $L_{Aeq(24h)}$ or above), or 1 dB (for noise levels of 68 dB $L_{Aeq(24h)}$ or above). The Project does not qualify as an altered road as such changes do not occur for any PPF within the Project extent.
- **Assessment Positions** are described as "Protected Premises and Facilities" (PPFs). PPFs include dwellings (including those that have building consent but are not built yet), educational facilities and their playgrounds within 20m of any school building, boarding houses, retirement villages, Marae, hospitals with in-patient facilities and motels/hotels in residential zones. Businesses are not PPFs as they are not considered noise sensitive and are often noise generators in their own right.

- **Assessment Extent** is 100m from the edge of the new carriageway for urban areas. Urban areas are defined by Statistics NZ, and the Project area falls within the Urban area.[1]
- **Assessment Areas** are areas which combine PPFs in a cluster that would benefit from the same mitigation (e.g. barrier). For the Project, we have identified 16 assessment areas, 8 on the southbound side and 8 on the northbound side of SH1. Some of these assessment areas may only contain one PPF if these are not part of a cluster of PPFs that are within 100m of one another.
- **Design Year** in accordance with NZS 6806 is a year 10 to 20 years after opening of the Project. Given the changing environment surrounding the Project (e.g. the Future Urban Zone that is to be developed in the future, and its associated roading projects), we decided that 2038 is an appropriate design year. For this year, the traffic data was available and is relatively reliable. While this year is at the low end of (or even within) the design year period, it would allow all of the P2B project stages and other projects in the area to be implemented. Even if the Project is delayed by a few years, a significant change in traffic volume would be required to result in a meaningful change in noise level (refer Section 5.1.2 below). Therefore, we consider that the design year chosen is reasonable under the circumstances.
- **Noise Criteria Categories** are set out in the Standard for 'new' and 'altered' roads. The Project consists of an altered road (i.e. an upgrade to an existing road). The relevant Noise Criteria Categories are set out in **Table 5-1** below. The Category A and B criteria apply at the façade of any PPF, and the Category C criterion applies inside any habitable room of a PPF (and should be achieved with the provision of appropriate ventilation).

  Table 5-1 Noise criteria categories for PPFs

Category	Altered Road dB $L_{Aeq(24h)}$
A (primary external noise category)	≤ 64
B (secondary external noise category)	64 – 67
C (internal noise category)	40

  Under the Standard, the applicable criterion at any PPF depends on the BPO test, by progressively applying the noise criteria categories to determine which can practicably be achieved. NZS 6806 is clear that preference is to be given to structural mitigation (e.g. barriers and road surface options) over building modification mitigation. NZS 6806 also requires achievement of the lowest external noise level with practicable structural mitigation, before considering building modification to mitigate internal noise levels.
- **Assessment Scenarios** are the various operational scenarios that we assess and compare. The Standard includes the following scenarios:

  Existing noise environment: this consists of the current road layout and traffic volume (for this Project for the year 2018).

  Future Do-nothing scenario: consists of the existing SH1 at the design year, with (increased) Design Year (2038) traffic volume.

  Future Do-minimum scenario: consists of the widened and rearranged SH1 at the Design Year (2038), but without any specific noise mitigation. This scenario means that the only barriers included are solid safety barriers, which are required for reasons other than noise mitigation. Local roads that are not proposed to be altered by the Project are not included in the assessment.

[1] http://archive.stats.govt.nz/~/media/Statistics/browse-categories/maps-and-geography/geographic-areas/urban-rural-profile/maps/auckland.pdf

Future Project with mitigation: consists of the widened and rearranged SH1 road at the Design Year, and includes mitigation that is designed specifically to reduce noise levels.

- **Mitigation Requirements** are set out in the Standard based on the BPO. Mitigation is split into structural (road surface, barriers, bunds etc) and building modification mitigation (improvement of building façades and ventilation, subsequent to the implementation of the structural mitigation). Any mitigation should achieve a noticeable noise level reduction of an average of 3 decibels within each assessment area, or 5 decibels if only one PPF benefits from the mitigation.

In summary, the works associated with the Project do not trigger the provisions of NZS 6806 as Stage 2 does not result in a noise level increase of more than 3 dB for noise levels above 63 dB $L_{Aeq(24h)}$, or 1 dB for noise levels above 67 dB $L_{Aeq(24h)}$. This means that the Project is likely to have no noticeable adverse effect on the receiving environment for the majority of people in the vicinity.

5.1.2 Change in noise level

In addition to assessing the Project in accordance with NZS 6806, we have also undertaken an assessment of effects based on the subjective impression of changes in noise levels.

These subjective impression of changes in noise can generally be correlated with the numerical change in noise level. While every person reacts differently to noise level changes, research shows a general correlation between noise level changes and subjective responses. In summary, the smallest change that can be heard is around 3 decibels, while a 10 decibel change in noise level would sound as double (or half) as loud.

Table 5-2 shows indicative subjective responses to explain the noise level changes discussed in this report. This effect is based on people's annoyance reaction to noise level changes.

Table 5-2 Noise level change compared with general subjective perception

Noise level change	General subjective perception[2]
1–2 decibels	Insignificant/imperceptible change
3–4 decibels	Just perceptible change
5–8 decibels	Appreciable to clearly noticeable change
9–11 decibels	Halving/doubling of loudness
>11 decibels	More than halving/doubling of loudness

Noise is measured on a logarithmic scale, meaning that a doubling in traffic volume (e.g. from 10,000 vehicles per day (vpd) to 20,000 vpd) results in a noise level increase of 3 decibels, a just-perceptible change. A tenfold increase in traffic volume (e.g. from 10,000 to 100,000 vpd) would result in a noise level increase of 10 decibels, which would sound twice as loud.

The perception of these noise level changes generally applies to immediate changes in noise level, as would be the case for a new road, unlike for the Project where an existing road is modified in a minor way. Nevertheless, people may subjectively have an annoyance reaction to a greater or lesser degree, depending on their perception of the Project.

[2] Based on research by Zwicker & Scharf (1965); and Stevens (1957, 1972).

5.2 Assessment methodology

We have identified all PPFs within 100 to 200m of the NoR areas relating to traffic lanes (i.e. excluding the SUP) and assigned each PPF to an assessment area.

Given the sporadic location of PPFs, we have not clustered them together by location or NoR but have assessed them individually. Given the long lead in time for this Project, that is for route protection, the environment is likely to change in the future prior to implementation of the Project.

We have modelled the traffic noise levels for various scenarios (existing, future without and future with the Project). We then used the predicted noise levels at each of the PPFs to assess the traffic noise effects on people (both beneficial and adverse) based on:

- The noise criteria categories of NZS6806 and
- Determination of noise level changes due to Stage 2.

The reason for the two-pronged approach is that in some circumstances, compliance with NZS 6806 does not necessarily mean that the effects of a project would be minor, and vice versa.

Potentially, the effects of a noise level increase can be small (e.g. a noise level increase of less than 3 decibels). At the same time, the resulting noise environment can be very high, particularly adjacent to SH1, and cause adverse effects for residential use.

The proposed extensive urban development of land south of Auckland (the Future Urban Zones) is predicted to result in traffic volumes approximately doubling, thus resulting in a noise level increase of 2 to 3 decibels when comparing current and design year traffic volumes. These changes in noise level are not due to the Project but result from the natural traffic growth predicted to occur because of the development in the area.

All PPFs have been assessed against the altered road criteria of NZS 6806 and in relation to the noise level change that would be caused by the Project.

5.3 Assessment methodology of traffic noise effects

The Project provides for route protection of the future widening of SH1. As the implementation of the Project will be some undetermined time in the future, the modelling provides an overview of likely effects and changes. Since the alignment location is fixed (i.e. the existing SH1 and associated connections), the modelling is considered to closely reflect what will be implemented in the future.

5.3.1 Computer noise modelling

The propagation of road traffic noise is affected by multiple factors, amongst them:

- Terrain elevations, including shielding from intervening terrain and exposure due to elevation
- Ground condition, including absorptive ground such as meadows or reflective ground such as water
- Atmospheric conditions, including wind or temperature inversions; and
- Road parameters, including road surface, traffic speed, vehicle types and gradient

Because of the multiple factors and their interaction, computer noise modelling is a vital tool in predicting traffic noise levels in the vicinity of roads and for the development of mitigation measures. Modelling enables a comprehensive and overall picture of noise impacts to be produced, taking into consideration all factors potentially affecting noise propagation.

We used the software SoundPLAN (V9), which is an internationally recognised computer noise modelling programme. In summary, SoundPLAN uses a three-dimensional digital topographical terrain map of the area as its base. In addition, we entered data into the model for existing buildings and structures (including auxiliary buildings

and existing NZTA noise barriers) within the assessment area. We digitised road traffic noise sources, with road lanes located on the terrain file.

The SoundPLAN model uses the calculation algorithms of the "Calculation of Road Traffic Noise" methodology which is referenced in NZS 6806 in Section 5.3.2. The calculation algorithms take account all the factors set out above, including relevant atmospheric and ground conditions within appropriate parameters. The adjustments for New Zealand road conditions, specifically road surface types, are also included in the model. Therefore, modelling results can be compared with the relevant criteria without further adjustment.

5.3.2 Model verification

The accuracy of the computer model needs to be verified. We used the measurement results set out in section 3.2 to verify that the computer model operates within satisfactory tolerances, as shown in Table 5-3.

Table 5-3 Computer noise model verification

Location	Measured/Derived Noise Level	Predicted Level	Difference
	dB $L_{Aeq(24h)}$	dB $L_{Aeq(24h)}$	decibels
1823 Great South Road (logger)	65	68	3
199 Hillview Road (logger)	57	60	3
34 Maher Road (short duration survey)	51	58	7
72 Harrison Road (short duration survey)	57	58	1

A comparison of the measured and predicted levels shows that for most of the location, the accuracy is reasonable. Only for one location (34 Maher Road) was the measured noise level significantly lower than the modelled one. This may occur if the terrain is not entered into the computer noise model at sufficient accuracy (e.g. if there is a small mound that shields SH1 which isn't shown in the model). In any event, short duration surveys are not as accurate as those over many days (i.e. the logger surveys) and should not be given too much weight.

Overall, we consider that the model performs appropriately.

5.3.3 Model input

The road parameters entered into the model are set out in Table 5-4.

Table 5-4 Road parameters

	Existing 2018					Do-Nothing 2038					Project 2038				
Road	AADT[1]	%HCV[2]	Surface	Correction[3]	Speed	AADT	% HCV	Surface	Correction	Speed	AADT	% HCV	Surface	Correction	Speed
SH1 Southbound															
Sth of Drury to New Drury Sth Interchange	28070	13	PA10	-5.8	100	50,700	11	PA10	-5.7	100	62,800	10	PA10	-5.7	100
New Drury Sth Interchange offramp	-	-	-	-	-	-	-	-	-	-	9,000	9	SMA	-4.6	70
New Drury Sth Interchange onramp	-	-	-	-	-	-	-	-	-	-	5,600	5	SMA	-4.2	70
New Drury Interchange to Ramarama Interchange	28,070	13	PA10	-5.8	100	50,700	11	PA10	-5.7	100	59,300	10	PA10	-5.7	100
Ramarama Interchange offramp	2,569	6	AC	-5	70	5,200	8	AC	-5	70	5,700	5	SMA	-4.2	70
Ramarama Interchange onramp	793	13	AC	-5	70	6,800	9	AC	-5	70	3,900	10	SMA	-4.7	70
Ramarama to Bombay Interchange	26,294	12	PA10	-5.8	100	52,100	11	PA10	-5.7	100	57,500	11	PA10	-5.7	100
Bombay interchange offramp	6,731	8	AC	-5	70	9,300	8	AC	-5	70	12,600	6	SMA	-4.3	70
Bombay interchange onramp	1,629	15	AC	-5	50	3,900	8	AC	-5	50	2,800	7	SMA	-4.4	50
South of Bombay Interchange	19,563	12	PA10	-5.8	100	46,700	12	PA10	-5.8	100	47,700	11	PA10	-5.7	100
SH1 Northbound															

Sth of Drury to New Drury Sth Interchange	28,106	13	PA10	-5.8	100	50,000	13	PA10	-5.8	100	58,700	13	PA10	-5.8	100
New Drury Sth Interchange onramp	-	-	-	-	-	-	-	-	-	-	6,900	7	SMA	-4.4	70
New Drury Sth Interchange offramp	-	-	-	-	-	-	-	-	-	-	6,900	9	SMA	-4.6	70
New Drury Interchange to Ramarama Interchange	28,106	13	PA10	-5.8	100	50,000	13	PA10	-5.8	100	58,700	13	PA10	-5.8	100
Ramarama Interchange onramp	2,682	7	SMA	-4.4	70	4,400	5	SMA	-4.2	70	4,700	4	SMA	-4.1	70
Ramarama Interchange offramp	986	18	SMA	-5.2	70	6,500	12	SMA	-4.8	70	3,200	13	SMA	-4.9	70
Ramarama to Bombay Interchange	26,409	12	PA10	-5.8	100	52,100	14	PA10	-5.9	100	57,200	13	PA10	-5.8	100
Bombay interchange on ramp	6,760	7	AC	-5	70	9,200	8	AC	-5	70	12,100	7	SMA	-4.4	70
Bombay interchange offramp	5,190	8	AC	-5	70	3,900	10	AC	-5	70	4,000	10	PA10	-5	70
South of Bombay Interchange	19,649	12	PA10	-5.8	100	46,800	15	PA10	-5.9	100	49,000	14	PA10	-5.9	100

[1] Annual average daily traffic
[2] Percentage heavy commercial vehicles
[3] Road surface correction in accordance with page 36 of Waka Kotahi Guide, adjusted by -3dB to account for the conversion of $L_{A10(18h)}$ to $L_{Aeq(24h)}$

5.4 NZS 6806 Assessment

In accordance with NZS 6806, we have assessed different scenarios of the road:

- Existing – existing road, with current traffic volumes
- Do-nothing – existing road, with design year traffic volumes
- Do-minimum – future road, with design year traffic volumes

The **Existing scenario** is used to verify the computer noise model against measured noise levels and determine the existing noise level at all PPFs. Measurement can only be undertaken at a small number of PPFs, with the model filling in the other PPFs.

The **Do-nothing scenario** showed that noise levels would increase by approximately 2 to 4 decibels along SH1 until the design year 2038 compared with the existing scenario. This is due to the significant increase in traffic volume over time because of the extensive development of the area that is anticipated.

The **Do-minimum scenario** shows that only minor, generally unnoticeable, changes in traffic noise level would be caused by the Project. We note that the Do-minimum scenario already allows for PA-10 (Open graded porous asphalt) road surface on the entire alignment (except loop ramps, where SMA surface was assumed). This road surface is a low-noise road surface material that is commonly used as a mitigation measure but is already part of the "base option" for the Project.

The number of PPFs in each NZS 6806 noise criteria category for the assessment areas affected by the Project works have been summarised in Table 5-5.

Table 5-5 Number of PPFs in each NZS 6806 noise criteria category

Situation	Category A	Category B	Category C
Existing (2018)	177	7	0
Do-nothing (2038)	148	29	7
Do-minimum (2038)	140	29	15

A small number of PPFs is predicted to receive noise levels in Category C in the future, without and with the Project in place. This is mostly due to the increase in traffic volume, but also where the connecting roads may move closer to existing dwellings.

Some of these PPFs may be able to receive a barrier to reduce noise levels, while others may be more effectively mitigated by applying building modification mitigation (e.g. improved glazing, joinery or additional façade improvements as well as alternative ventilation). This mitigation will be determined at the time of detailed design. Some of these existing PPFs may not exist anymore when the Project is implemented and would therefore not require such specific mitigation. The use of low noise road surface is the main mitigation measure to be applied to the Project and will benefit existing and future dwellings equally.

Noise level contours showing the various assessment scenarios for each NoR are included in **Appendix D**. The contours represent all NoRs rather than individual NoRs only.

Individual predicted noise levels for all identified PPFs, sorted by NoR, are shown in **Appendix E**. The predicted levels include all NoRs of the Project. PPFs receiving noise levels in Category A are coloured green, those in Category B orange and in Category C red. The colour code is reflected in both the contour maps and noise level

tables in the appendices. NoR 4 represents the SUP only. Since the SUP does not generate traffic noise levels, there are no traffic noise predictions for NoR 4.

5.5 Assessment of change in noise level

Noise effects can be described based on the change in noise level with and without the Project. To remove the "time factor" that affects that traffic volume, from the existing situation to the design year, the comparison is made between scenarios in the Design Year only. These assessment scenarios are Do-nothing (existing road with future traffic) and Do-minimum (the Project implemented without additional noise mitigation). For the Project, both future scenarios include PA10 road surface.

The future traffic volumes set out in Table 5-4 may change slightly as more detail is known over time. However, traffic noise level changes require at least a 30% change to result in a 1 decibel change. Therefore, we consider that any minor changes would have no impact on the outcome of this assessment.

The character of the noise will remain unchanged as the Project provides for the alteration of an existing state highway. Nevertheless, people may subjectively have an annoyance reaction to a greater or lesser degree, depending on their perception of the Project. The Project is predicted to change the overall noise level in the vicinity only marginally and to an unnoticeable and negligible degree, ranging from -1 to +2 dB.

5.6 Assessment of Shared Use Path noise

The SUP (NoR 4) will be used predominantly by cyclists, and potentially walkers. Given the location of the path adjacent to SH 1, and the existing, and predicted future, traffic noise levels from vehicles on the road, any use of the SUP will be inaudible for most of the time.

We consider that the use of the SUP will have no effect on the overall noise environment.

6 CONCLUSION

We have assessed the construction noise and vibration, and traffic noise effects from the proposal to alter the existing SH1 designation in small parts to allow for minor realignments and widening of SH1, the establishment of a SUP via a new NoR, and a new link road in another new NoR.

Construction noise and vibration can be managed appropriately with the use of a CNVMP and Schedules, should these be required. Generally, noise and vibration levels will be able to comply with the relevant standards as most buildings are at a sufficient distance from the works. Where night-time works will be required (e.g. for the construction of bridges that would disrupt traffic on SH1), noise standards are likely to be infringed for the closest dwellings. This should be managed with Schedules to the CNVMP and with additional consultation with affected parties.

The Project does not have a significant impact on the traffic noise levels. NZS 6806 does not apply as noise level changes are negligible to insignificant. Low noise road surface is proposed to be used on the alignment which will benefit existing and future dwellings in the vicinity. A small number of dwellings are predicted to receive noise levels in Category C even with the low noise road surface in place. Any additional mitigation for these houses will be determined during the detailed design, should the houses still exist at that time. The mitigation may consist of barriers or building modification mitigation, whichever is determined to be the best practicable option at the time.

Overall, the Project can be constructed and operated so that noise and vibration levels are reasonable.

APPENDICES

APPENDIX A – AMBIENT NOISE SURVEY DETAILS

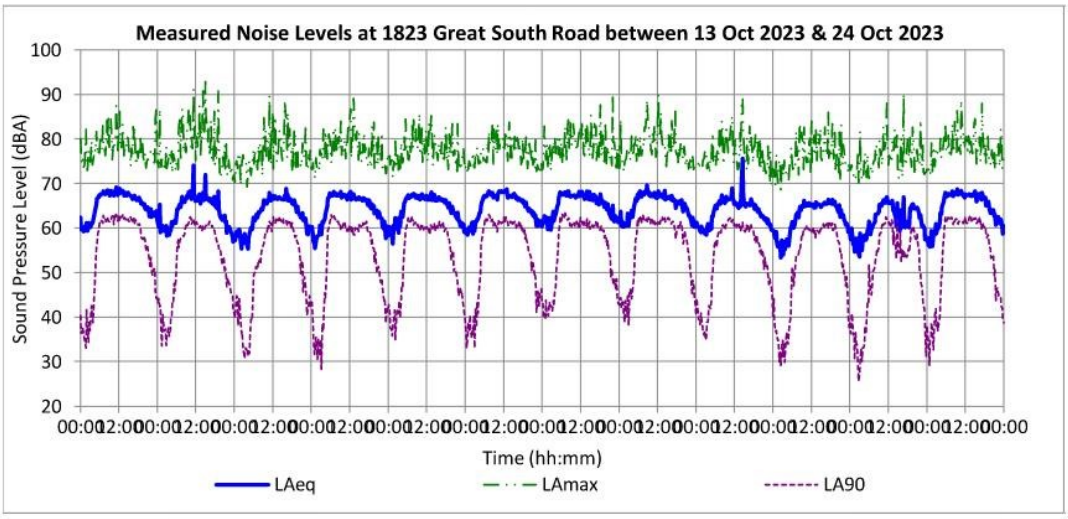
Logger Measurements

Date:	Monday, 30 October 2023
File name:	I:\JOBS\2019\20190430\03 Survey Data & Measurements\20190430 OL 2023 Oct Stage 2 and 3\1823 Great South Rd\[Summary Sheet.xlsx]Logger_Summary
Job number:	20190430
Job name:	Papakura to Bombay Stage 2
Initials:	OL
Measurement Dates:	Friday, 13 October 2023 to Tuesday, 24 October 2023
Weather during Measurement:	No adjustments for adverse weather were required
Notes:	1823 Great South Road

OVERVIEW SUMMARY SHEET

Noise Level, dB		L_{Aeq}	L_{A10}	L_{A90}	L_{Amax}
Day (0700-1800)	Lowest	59	61	48	71
	Average	67	69	60	79
	Highest	76	80	63	93
Evening (1800-2200)	Lowest	59	62	44	71
	Average	64	67	56	77
	Highest	68	70	61	91
Night (2200-0700)	Lowest	53	57	26	68
	Average	62	66	44	76
	Highest	68	71	63	90

$L_{Aeq\ 24\text{-}hr}$ 65 dB



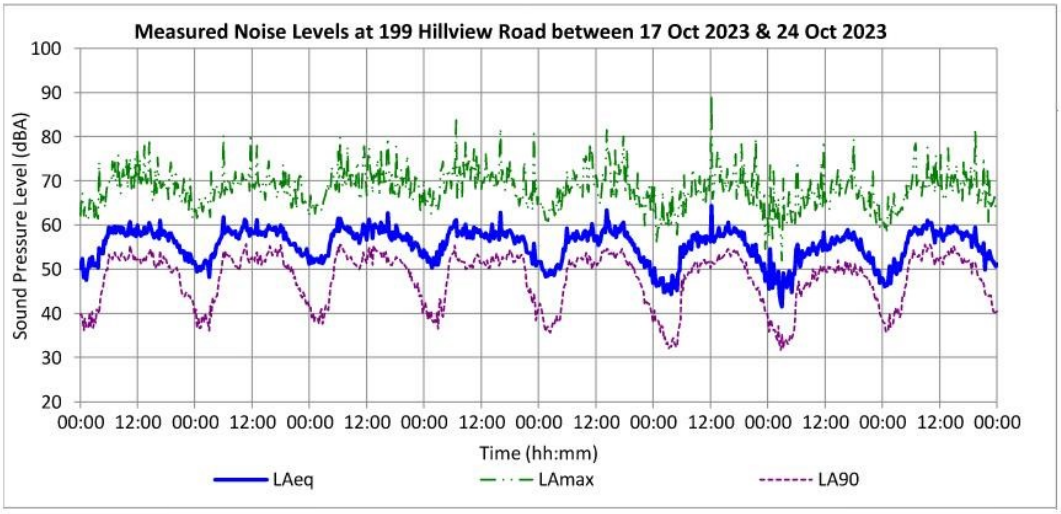
Logger Measurements

Date:	Monday, 30 October 2023
File name:	I:\JOBS\2019\20190430\03 Survey Data & Measurements\20190430 OL 2023 Oct Stage 2 and 3\199 Hillview Rd\[Summary sheet.xlsx]Logger_Summary
Job number:	20190430
Job name:	Papakura to Bombay Stage 2
Initials:	OL
Measurement Dates:	Tuesday, 17 October 2023 to Tuesday, 24 October 2023
Weather during Measurement:	No adjustement for adverse weather required
Notes:	199 Hillview Road

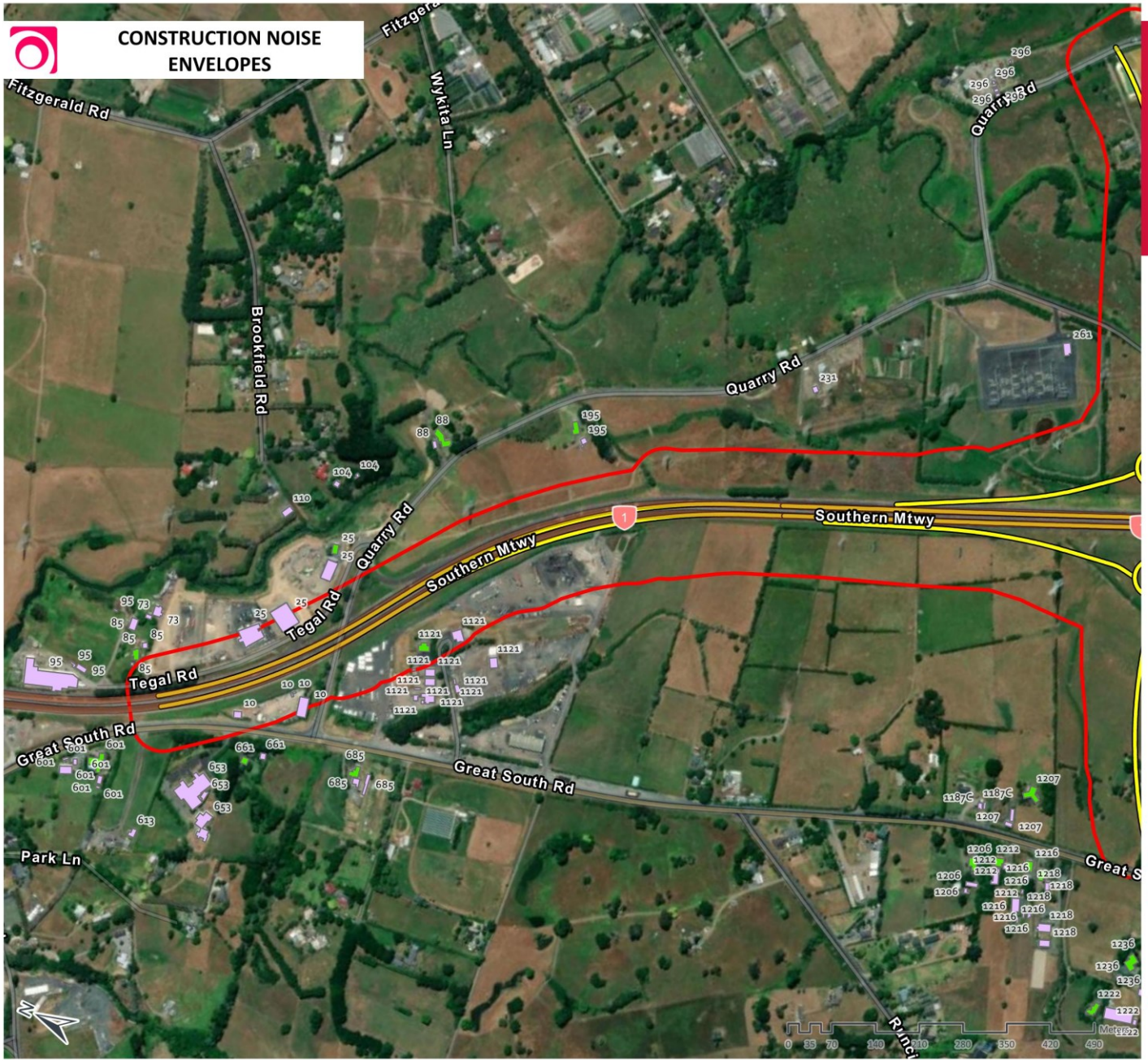
OVERVIEW SUMMARY SHEET

	Noise Level, dB	L_{Aeq}	L_{A10}	L_{A90}	L_{Amax}
Day	Lowest	52	54	44	63
(0700-1800)	Average	58	61	52	70
	Highest	64	65	56	90
Evening	Lowest	50	52	44	61
(1800-2200)	Average	56	59	50	69
	Highest	60	63	55	82
Night	Lowest	42	45	32	52
(2200-0700)	Average	54	57	42	66
	Highest	62	64	56	84

$L_{Aeq\ 24\text{-}hr}$ 57 dB



APPENDIX B – CONSTRUCTION NOISE ENVELOPE FIGURES



SH1 PAPAKURA TO BOMBAY (SECTION PART 1)

ProjectRoad

Construction Noise Envelops

Buildings

PPF

Non PPF

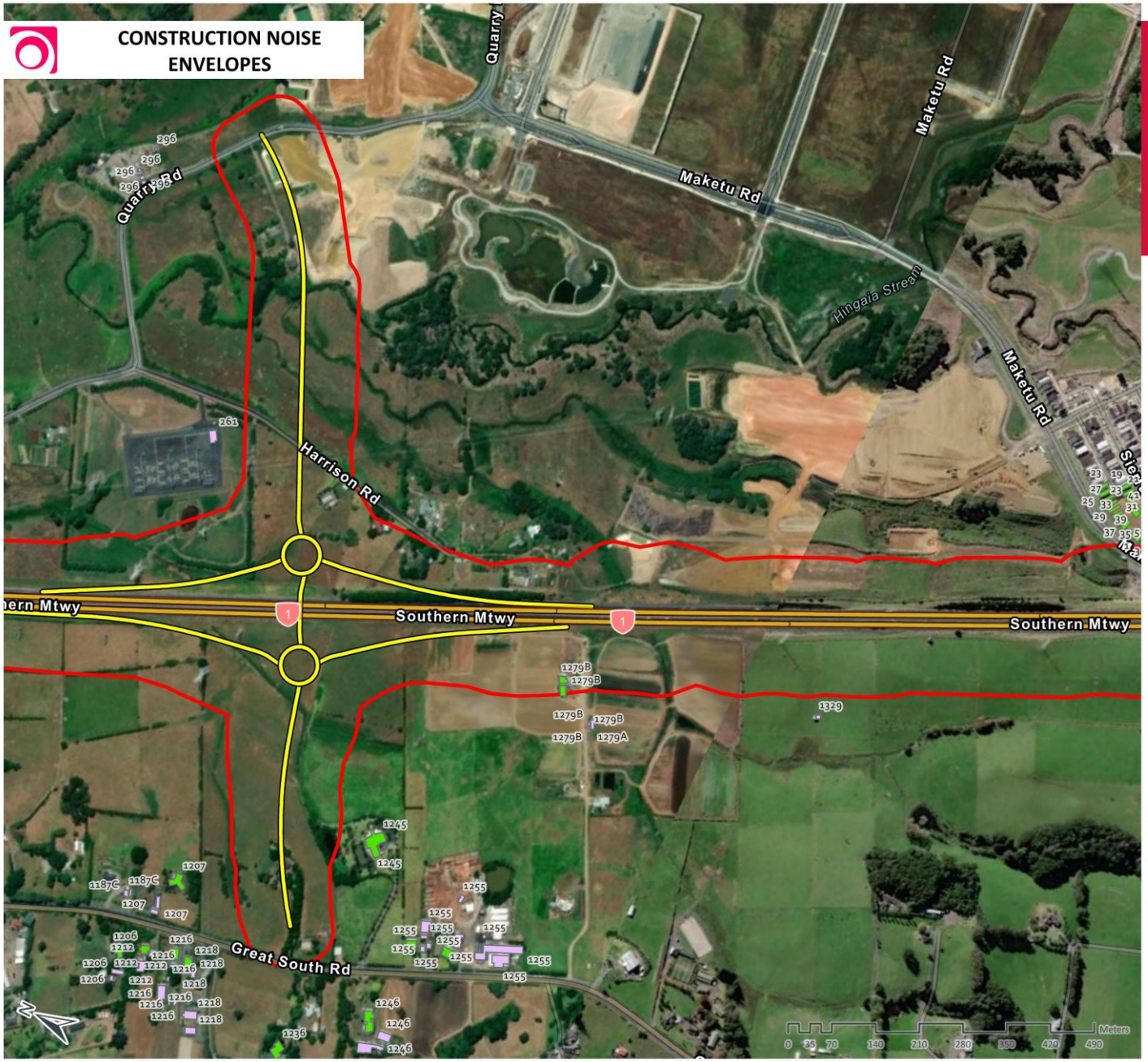
Client:
Waka Kotahi

Authors:
Owen.Li

Date of Issue:
3/11/2023 3:39 pm

Drawing Details:
Scale: 1:8,158
Projection: NZGD 2000 Mount Eden Circuit
Map Rotation: 63.946505°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.



SH1 PAPAKURA TO BOMBAY (SECTION PART 2)

ProjectRoad

Construction Noise Envelops

Buildings

PPF

Non PPF

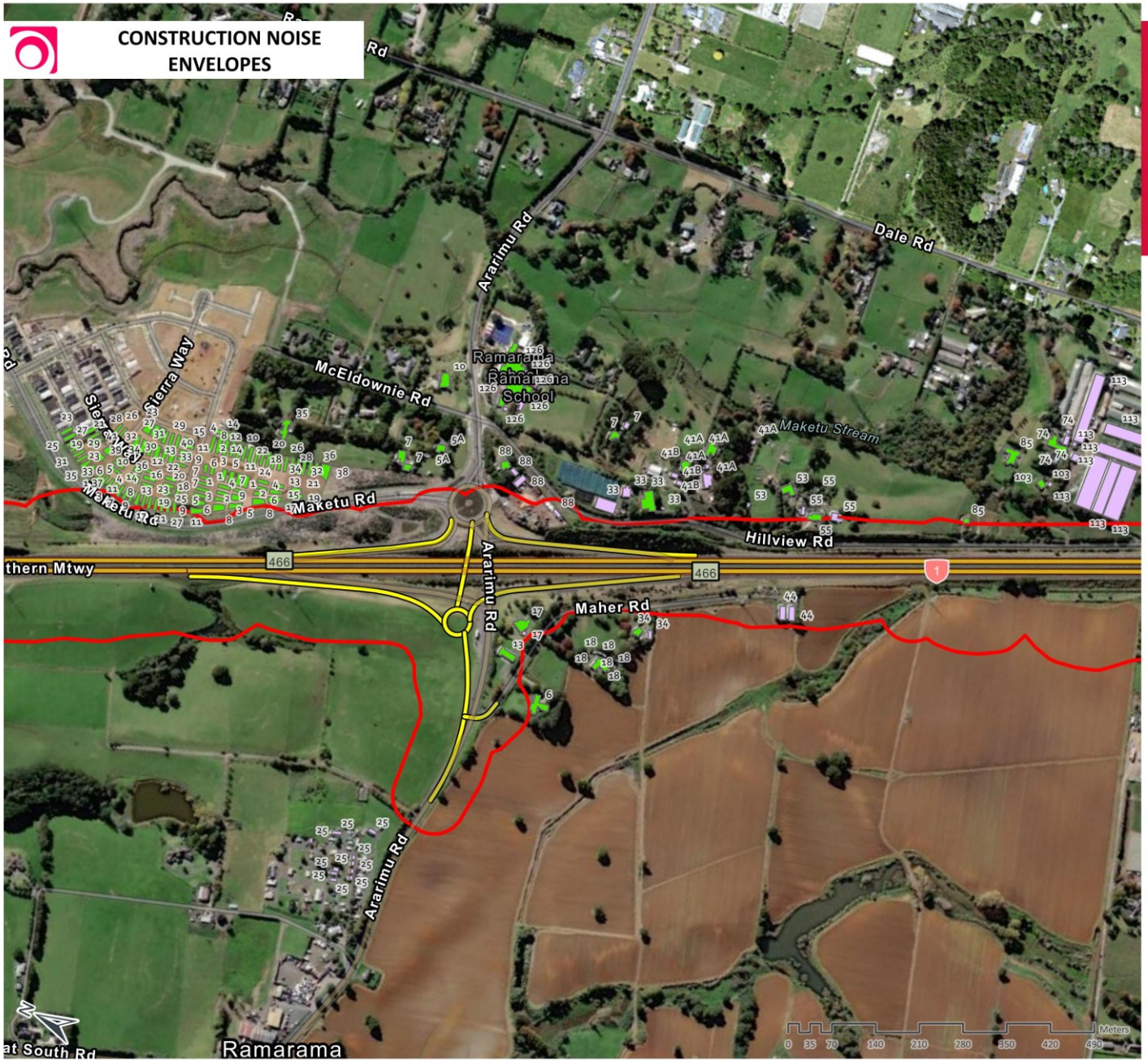
Client:
Waka Kotahi

Authors:
Owen.Li

Date of Issue:
3/11/2023 3:39 pm

Drawing Details:
Scale: 1:8,158
Projection: NZGD 2000 Mount Eden Circuit
Map Rotation: 63.946505°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.



SH1 PAPAKURA TO BOMBAY (SECTION PART 3)

ProjectRoad

Construction Noise Envelops

Buildings

PPF

Non PPF

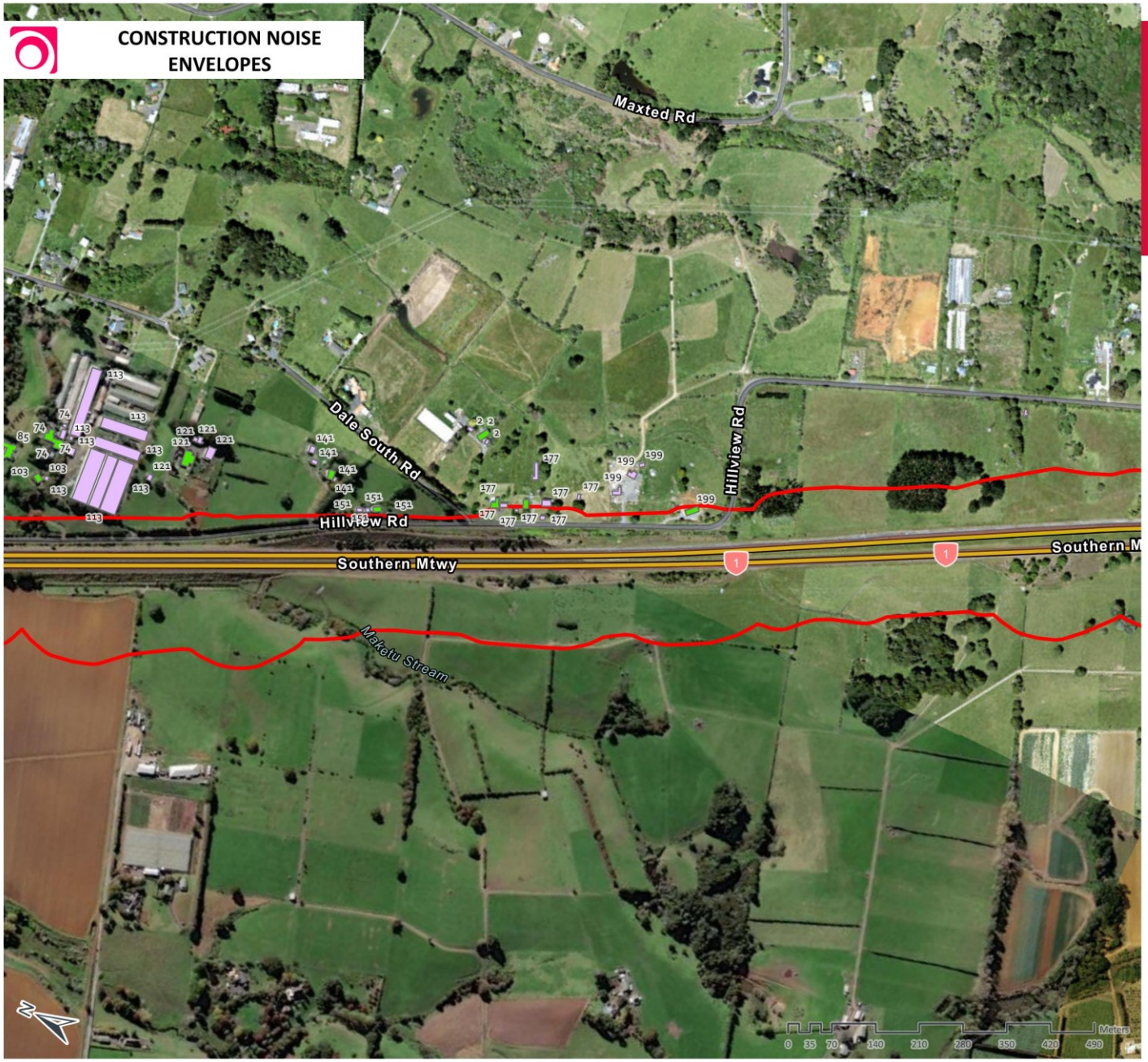
Client:
Waka Kotahi

Authors:
Owen.Li

Date of Issue:
3/11/2023 3:39 pm

Drawing Details:
Scale: 1:8,158
Projection: NZGD 2000 Mount Eden Circuit
Map Rotation: 63.946505°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.



SH1 PAPAKURA TO BOMBAY (SECTION PART 4)

ProjectRoad

Construction Noise Envelops

Buildings

PPF

Non PPF

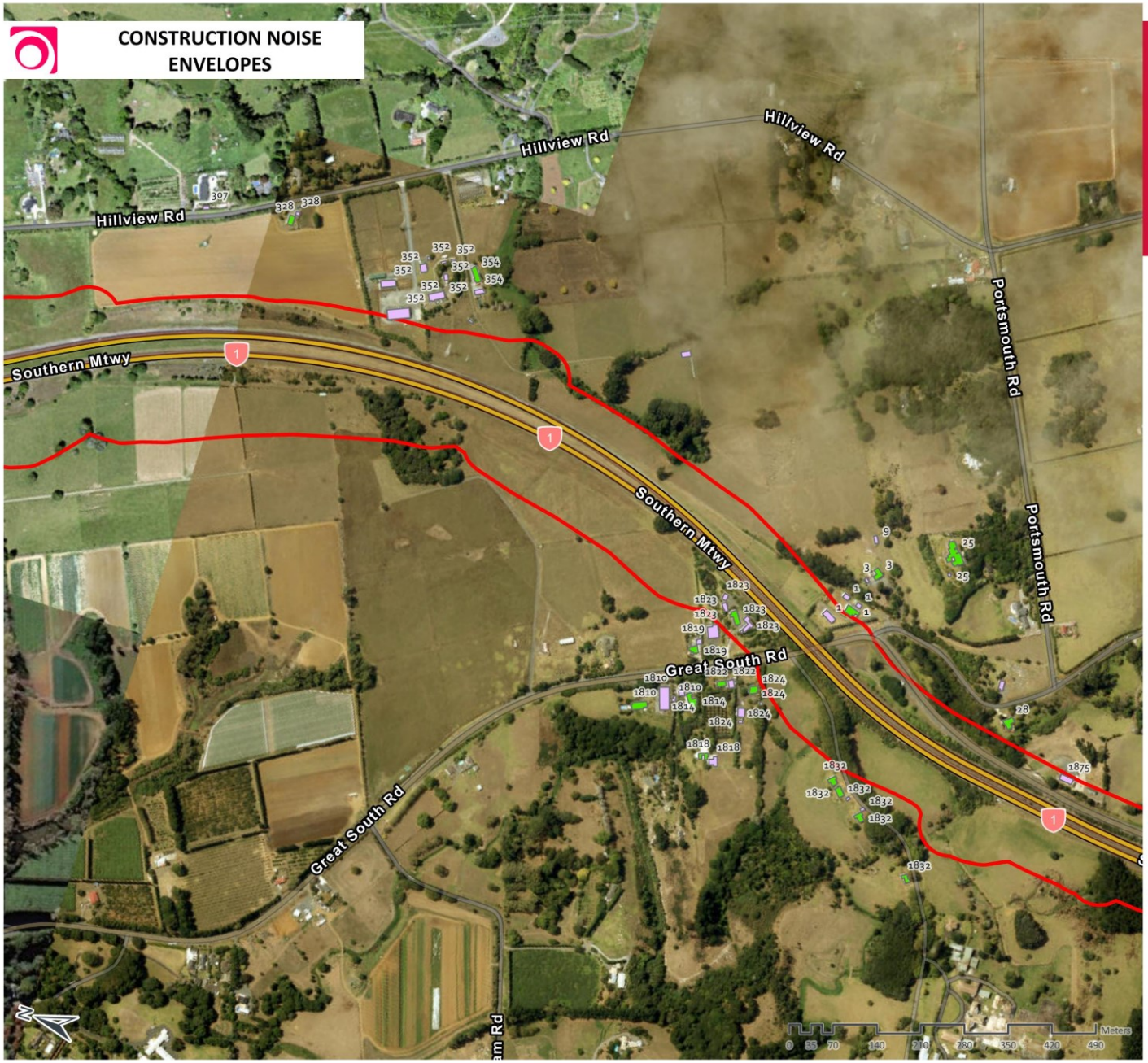
Client:
Waka Kotahi

Authors:
Owen.Li

Date of Issue:
3/11/2023 3:39 pm

Drawing Details:
Scale: 1:8,159
Projection: NZGD 2000 Mount Eden Circuit
Map Rotation: 63.946505°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.



SH1 PAPAKURA TO BOMBAY (SECTION PART 5)

ProjectRoad

Construction Noise Envelops

Buildings

PPF

Non PPF

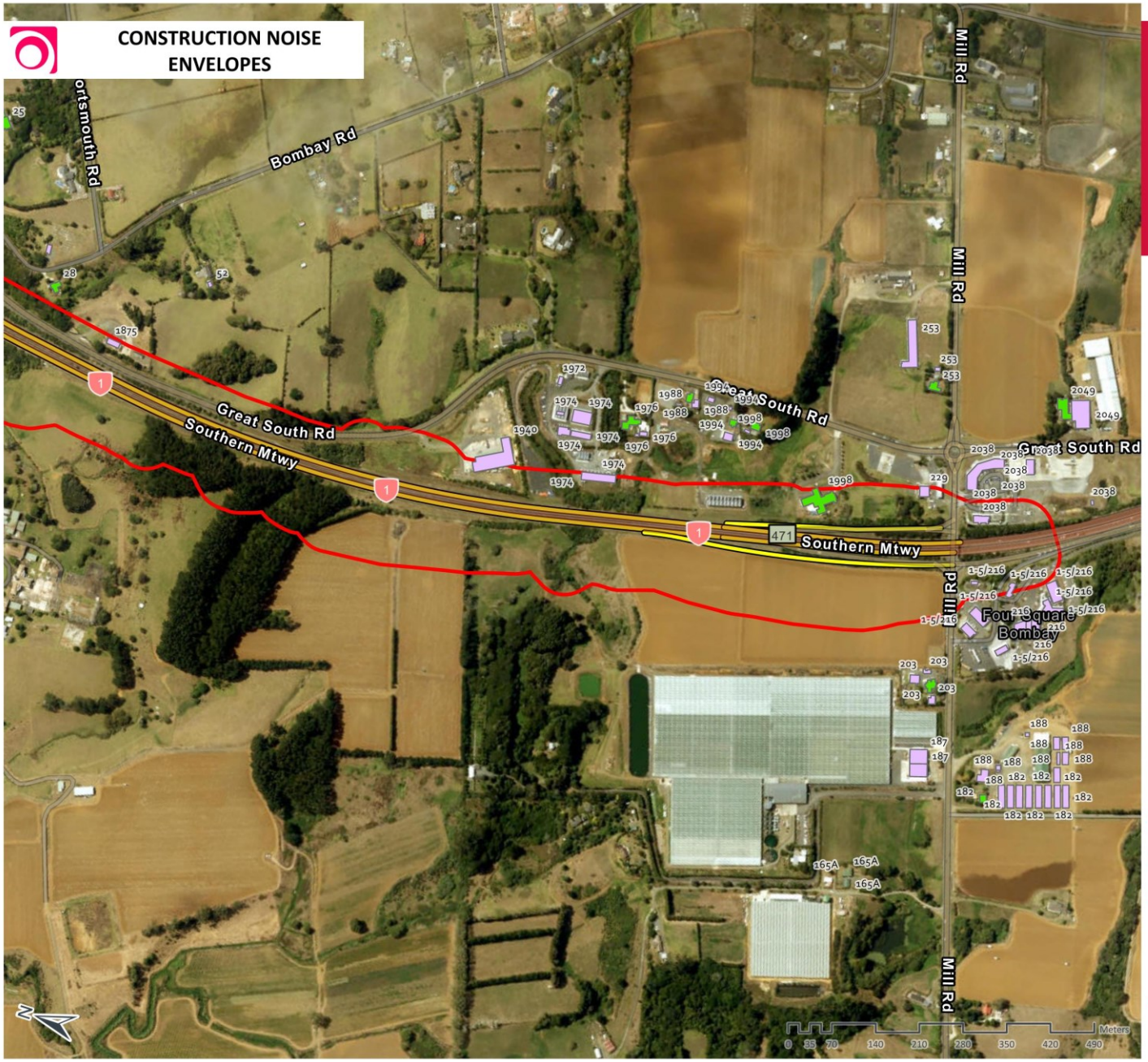
Client:
Waka Kotahi

Authors:
Owen.Li

Date of Issue:
3/11/2023 3:39 pm

Drawing Details:
Scale: 1:8,159
Projection: NZGD 2000 Mount Eden Circuit
Map Rotation: 72.03086°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.



SH1 PAPAKURA TO BOMBAY (SECTION PART 6)

ProjectRoad

Construction Noise Envelops

Buildings

PPF

Non PPF

Client:
Waka Kotahi

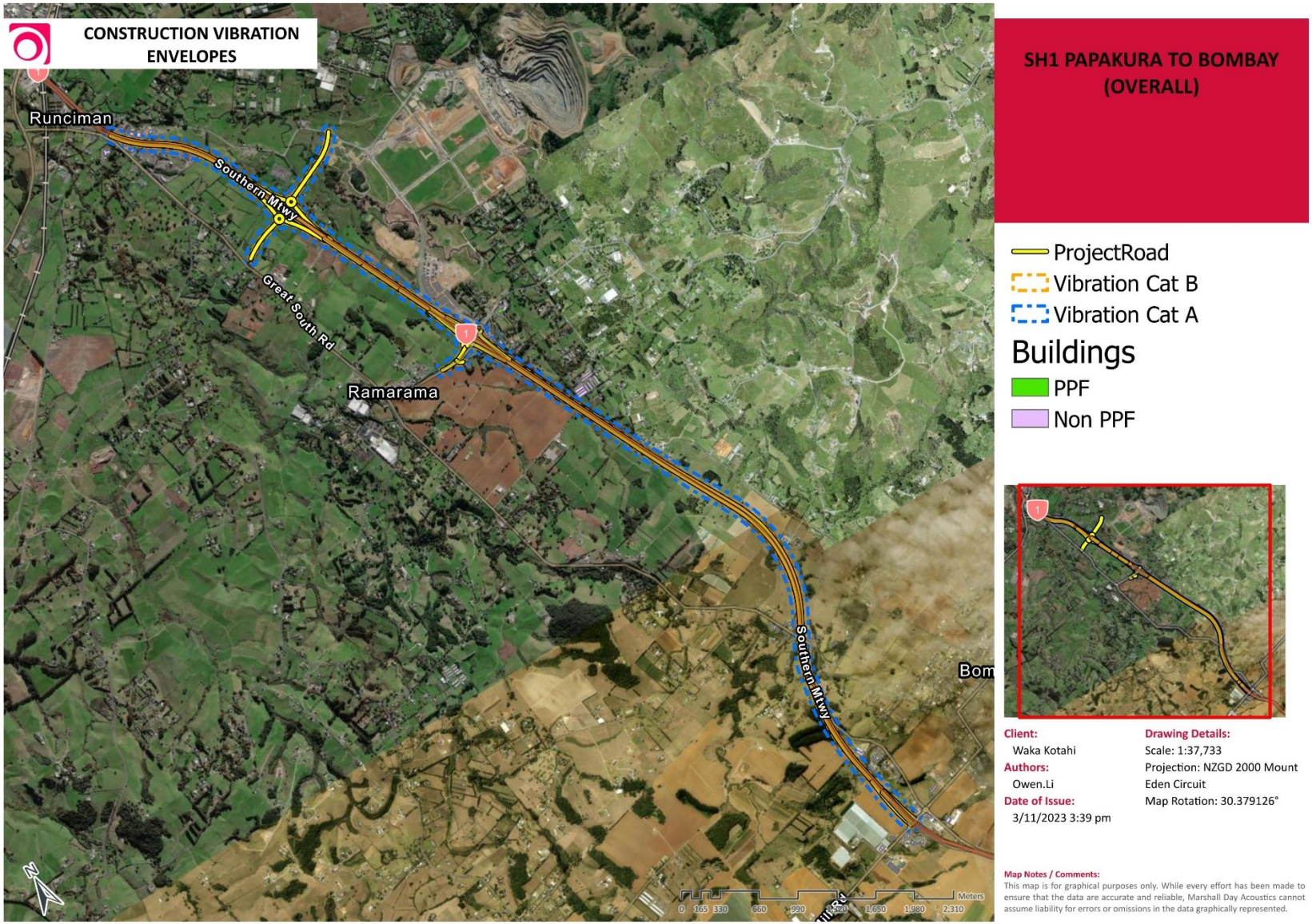
Authors:
Owen.Li

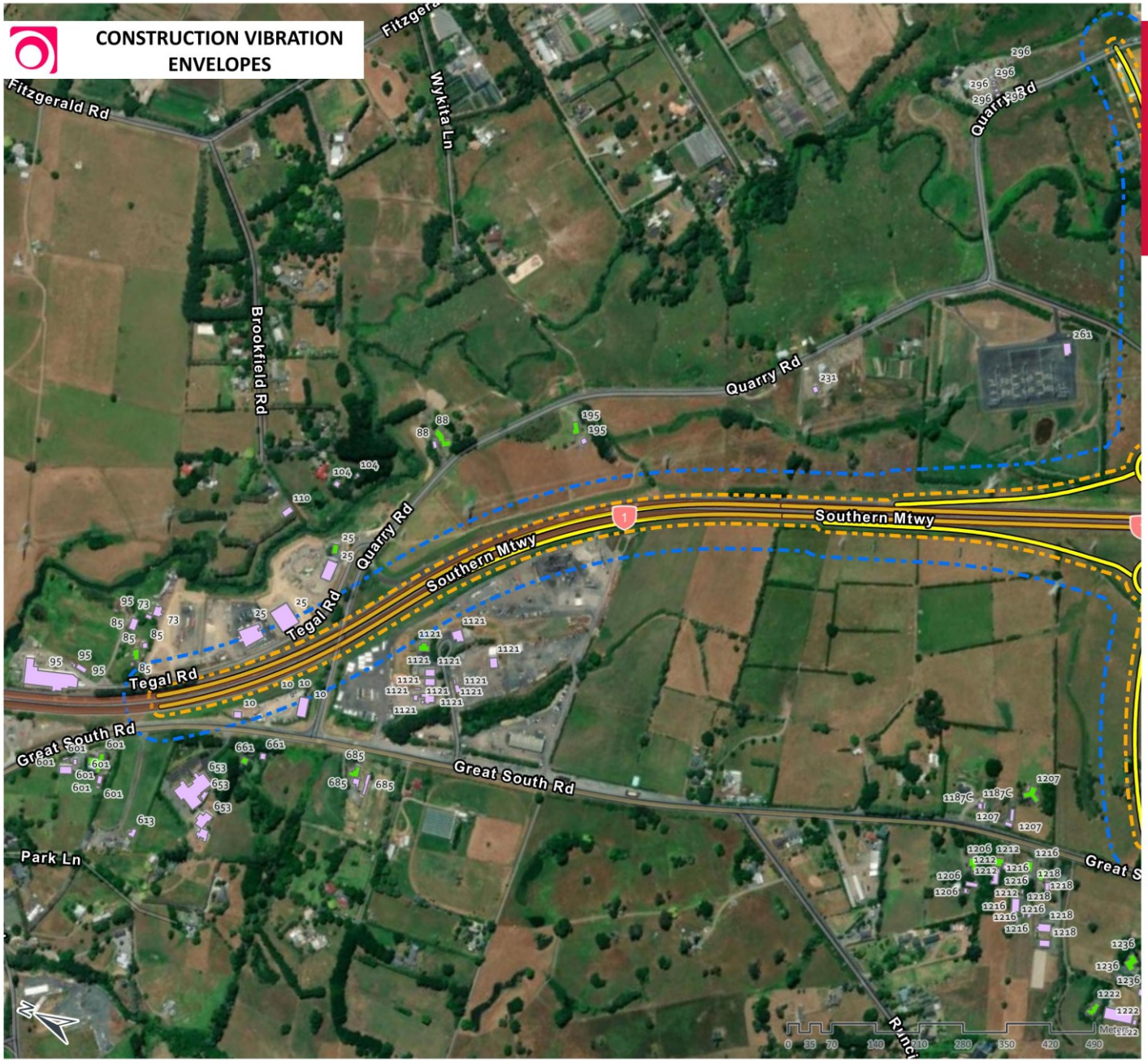
Date of Issue:
3/11/2023 3:39 pm

Drawing Details:
Scale: 1:8,159
Projection: NZGD 2000 Mount Eden Circuit
Map Rotation: 72.03086°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

APPENDIX C – CONSTRUCTION VIBRATION ENVELOPE FIGURES





SH1 PAPAKURA TO BOMBAY (SECTION PART 1)

ProjectRoad
Vibration Cat B
Vibration Cat A

Buildings

PPF
Non PPF

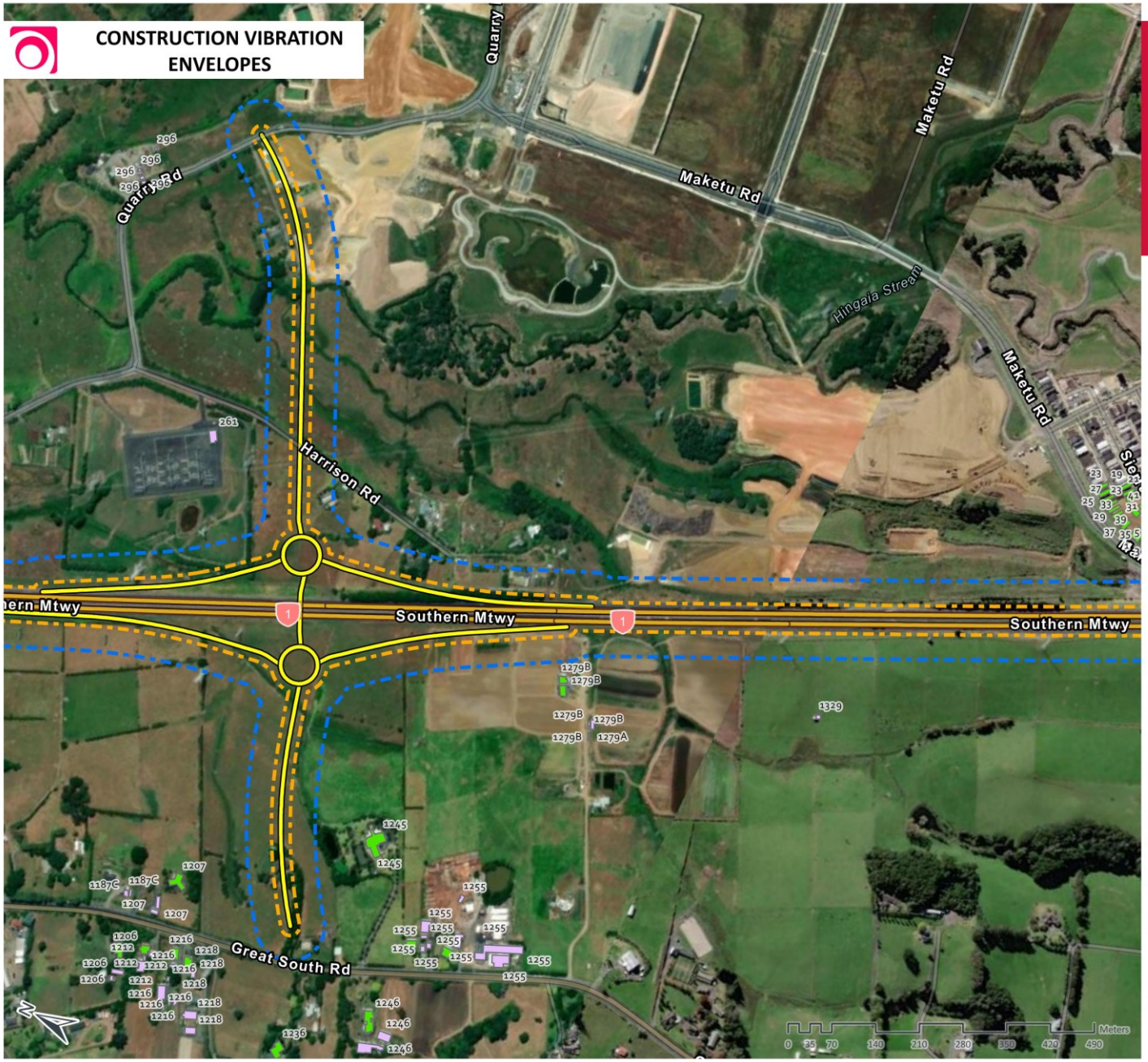
Client:
Waka Kotahi

Authors:
Owen.Li

Date of Issue:
3/11/2023 3:39 pm

Drawing Details:
Scale: 1:8,158
Projection: NZGD 2000 Mount Eden Circuit
Map Rotation: 63.946505°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.



SH1 PAPAKURA TO BOMBAY (SECTION PART 2)

ProjectRoad
Vibration Cat B
Vibration Cat A

Buildings

PPF
Non PPF

Client:
Waka Kotahi

Authors:
Owen.Li

Date of Issue:
3/11/2023 3:39 pm

Drawing Details:
Scale: 1:8,158
Projection: NZGD 2000 Mount Eden Circuit
Map Rotation: 63.946505°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

SH1 PAPAKURA TO BOMBAY (SECTION PART 3)

ProjectRoad
Vibration Cat B
Vibration Cat A

Buildings

PPF
Non PPF

Client:
Waka Kotahi

Authors:
Owen.Li

Date of Issue:
3/11/2023 3:39 pm

Drawing Details:
Scale: 1:8,158
Projection: NZGD 2000 Mount Eden Circuit
Map Rotation: 63.946505°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

SH1 PAPAKURA TO BOMBAY (SECTION PART 4)

ProjectRoad
Vibration Cat B
Vibration Cat A

Buildings

PPF
Non PPF

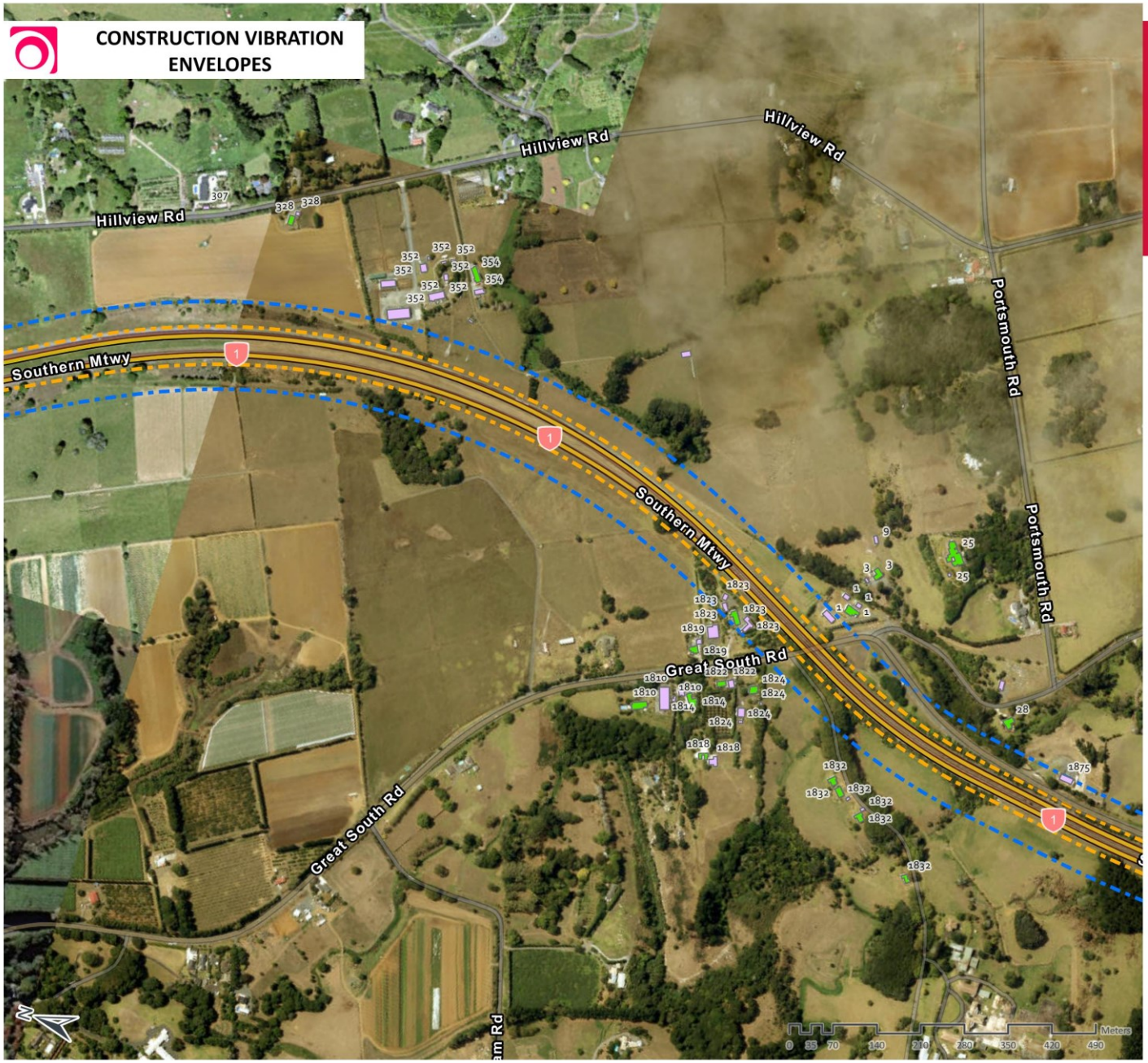
Client:
Waka Kotahi

Authors:
Owen.Li

Date of Issue:
3/11/2023 3:39 pm

Drawing Details:
Scale: 1:8,159
Projection: NZGD 2000 Mount Eden Circuit
Map Rotation: 63.946505°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.



SH1 PAPAKURA TO BOMBAY (SECTION PART 5)

ProjectRoad
Vibration Cat B
Vibration Cat A

Buildings

PPF
Non PPF

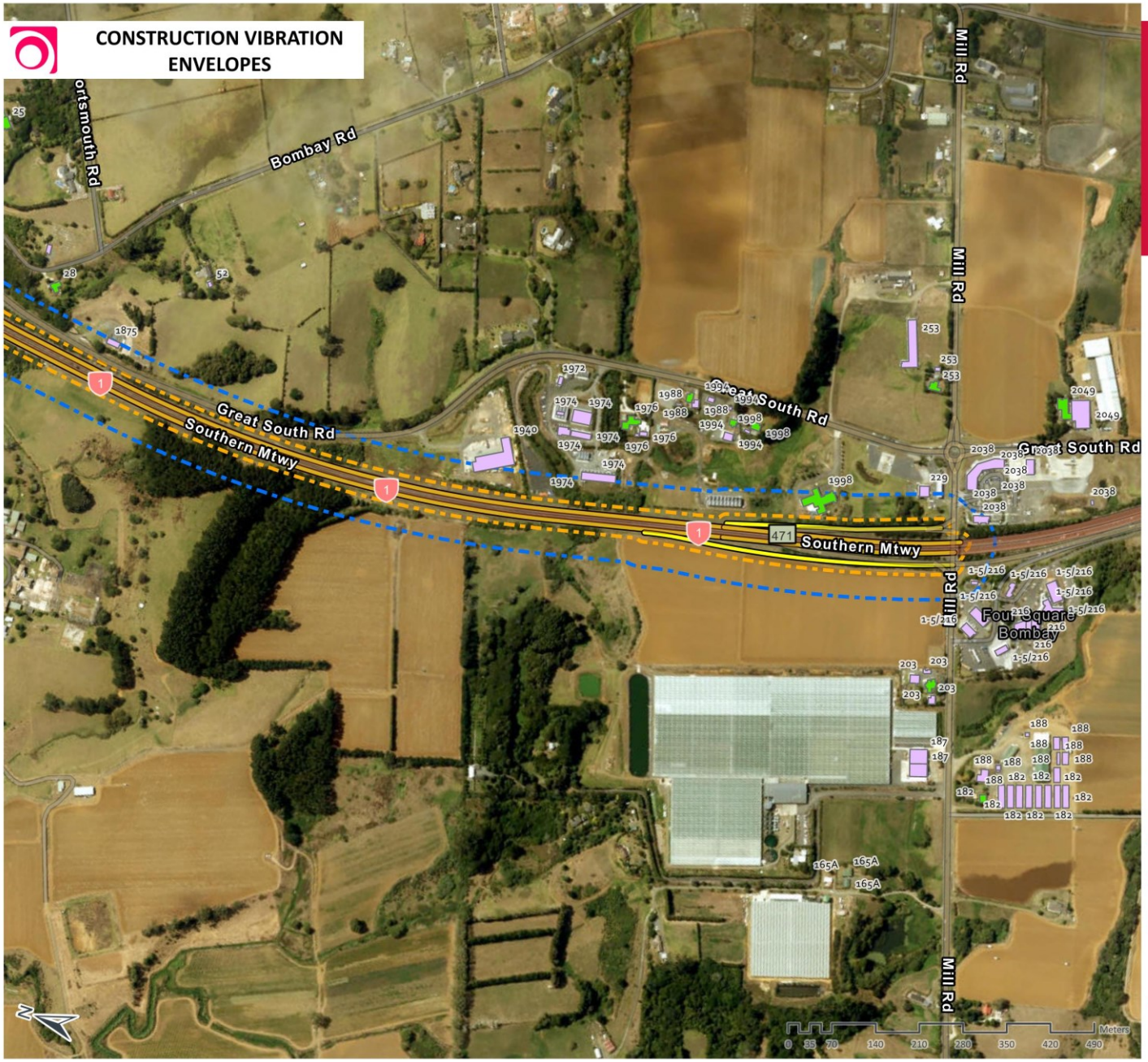
Client:
Waka Kotahi

Authors:
Owen.Li

Date of Issue:
3/11/2023 3:39 pm

Drawing Details:
Scale: 1:8,159
Projection: NZGD 2000 Mount Eden Circuit
Map Rotation: 72.03086°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.



SH1 PAPAKURA TO BOMBAY (SECTION PART 6)

ProjectRoad
Vibration Cat B
Vibration Cat A

Buildings

PPF
Non PPF

Client:
Waka Kotahi

Authors:
Owen.Li

Date of Issue:
3/11/2023 3:39 pm

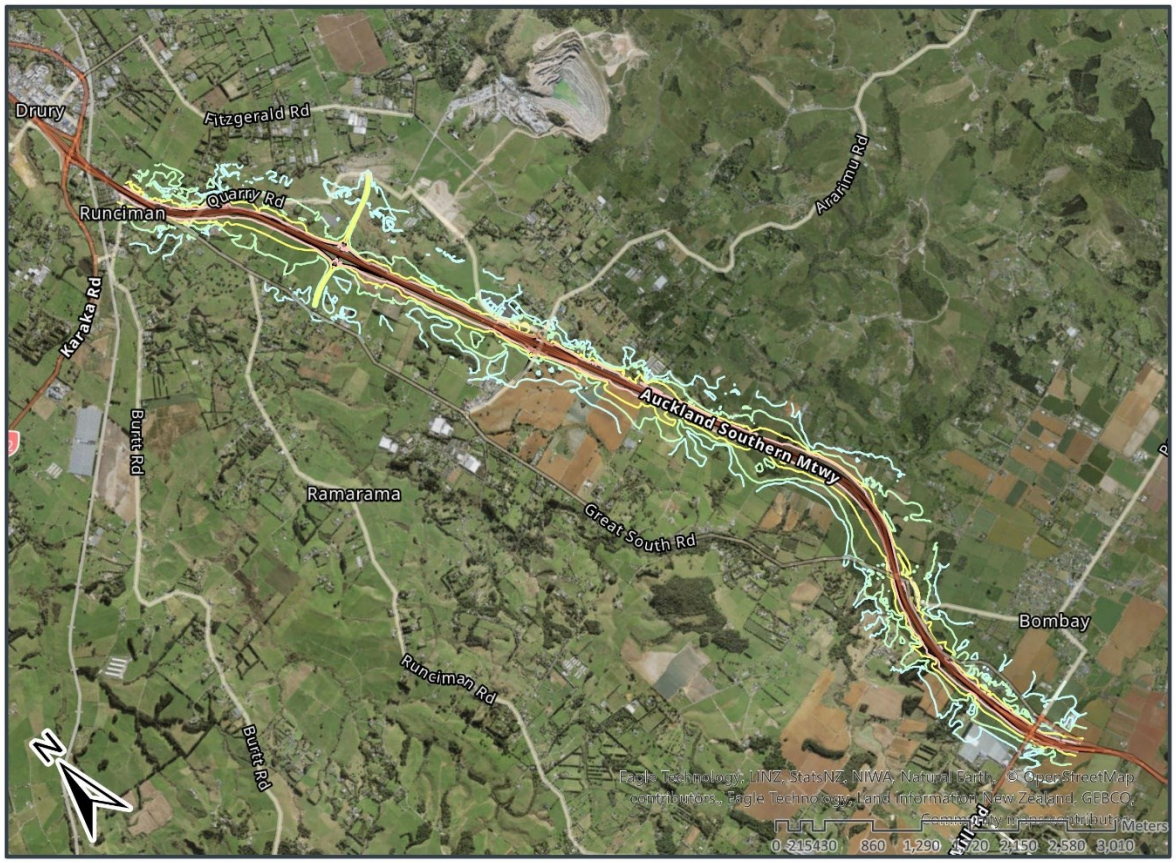
Drawing Details:
Scale: 1:8,159
Projection: NZGD 2000 Mount Eden Circuit
Map Rotation: 72.03086°

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

APPENDIX D – NOISE LEVEL CONTOURS AND NZS6806 CATEGORIES

PAPAKURA TO BOMBAY STAGE 2

Overview Map



Map Legend

Dwellings (dB $L_{Aeq(24h)}$)		Contours dB $L_{Aeq(24h)}$
< 64	Category A	55
64 - 67	Category B	60
> 67	Category C	65
		70
		Project Roads


88
195
25
85
1121
601
661
685
Existing


Do-Nothing


Do-Minimum


195
1279B
1279B
Existing


Do-Nothing


Do-Minimum


Existing


Do-Nothing


Do-Minimum


85
74
103
85
121
141
151
2
177
177
0
199
Existing


Do-Nothing


Do-Minimum


328
354
3
1
1823
1819
1822
1824
1814
1810
1818
1832
Existing


Do-Nothing


N
Do-Minimum


25
3
1
1823
1819
1822
1814
1824
1818
28
1832
1832
1832
1832
1988
1976
1994
1998
1998
253
2049
203
182
Existing


Do-Nothing


N
Do-Minimum


1206
1212
1216
1207
1218
1222
1236
1246
1245
1255
1255
Existing


Do-Nothing


N
Do-Minimum

APPENDIX E – PREDICTED NOISE LEVELS

NoR 1

PPF Address	Predicted noise levels (dB $L_{Aeq(24h)}$)		
	Existing scenario	Do Nothing scenario	Do Minimum scenario
601 Great South Road	64	66	67
661 Great South Road	60	62	63
685 Great South Road	60	63	63
1121 Great South Road	66	69	69
88 Quarry Road	60	63	63
195 Quarry Road	59	62	62
25 Tegal Road	59	62	62
85 Tegal Road	67	69	70

NoR 2

PPF Address	Predicted noise levels (dB $L_{Aeq(24h)}$)		
	Existing scenario	Do Nothing scenario	Do Minimum scenario
88 Ararimu Road	59	63	64
126 Ararimu Road	51	54	55
126 Ararimu Road	53	56	56
126 Ararimu Road	54	57	58
126 Ararimu Road	52	55	55
1 Bombay Road	65	68	68
3 Bombay Road	63	66	66
74 Dale Road	60	63	63
2 Dale South Road	55	58	58
1810 Great South Road	57	60	60
1814 Great South Road	60	63	64
1818 Great South Road	59	62	63
1819 Great South Road	61	64	64
1822 Great South Road	59	62	62
1823 Great South Road	66	69	70
1824 Great South Road	63	66	66
1832 Great South Road	60	63	65
1279B Great South Road	64	66	68
1279B Great South Road	62	64	65
1 Hillock Rise	57	59	60
2 Hillock Rise	57	59	60
3 Hillock Rise	56	58	59
4 Hillock Rise	56	59	60
5 Hillock Rise	57	59	60

PPF Address	Predicted noise levels (dB $L_{Aeq(24h)}$)		
	Existing scenario	Do Nothing scenario	Do Minimum scenario
6 Hillock Rise	57	59	60
7 Hillock Rise	54	57	58
8 Hillock Rise	56	59	59
9 Hillock Rise	55	58	58
10 Hillock Rise	56	59	59
11 Hillock Rise	55	57	58
12 Hillock Rise	56	58	59
13 Hillock Rise	58	61	62
14 Hillock Rise	56	58	59
15 Hillock Rise	60	63	64
16 Hillock Rise	56	58	59
17 Hillock Rise	62	65	65
18 Hillock Rise	56	59	59
19 Hillock Rise	62	65	66
20 Hillock Rise	56	59	60
21 Hillock Rise	59	62	63
22 Hillock Rise	56	59	60
24 Hillock Rise	57	59	60
26 Hillock Rise	58	61	62
28 Hillock Rise	58	61	62
30 Hillock Rise	59	62	62
32 Hillock Rise	61	64	64
34 Hillock Rise	61	64	65
36 Hillock Rise	62	65	65
38 Hillock Rise	63	66	66
7 Hillview Road	47	50	50
33 Hillview Road	60	63	64
53 Hillview Road	61	64	64
55 Hillview Road	63	67	67
85 Hillview Road	66	69	70
85 Hillview Road	60	63	64
103 Hillview Road	63	66	66
121 Hillview Road	61	64	65
141 Hillview Road	58	61	62
151 Hillview Road	60	63	64
177 Hillview Road	58	61	61
177 Hillview Road	59	62	62
199 Hillview Road	65	68	68
328 Hillview Road	58	61	61
354 Hillview Road	59	62	63
41A Hillview Road	58	61	62
41B Hillview Road	58	61	61
7 John Main Drive	59	61	62

PPF Address	Predicted noise levels (dB $L_{Aeq(24h)}$)		
	Existing scenario	Do Nothing scenario	Do Minimum scenario
9 John Main Drive	57	59	60
11 John Main Drive	56	59	60
13 John Main Drive	56	59	59
14 John Main Drive	55	57	58
15 John Main Drive	54	57	57
6 Maher Road	55	58	59
13 Maher Road	57	60	63
17 Maher Road	62	65	67
18 Maher Road	55	58	59
34 Maher Road	59	62	63
7 Mceldownie Road	59	62	63
7 Mceldownie Road	61	64	65
10 Mceldownie Road	51	54	54
35 Mceldownie Road	59	62	63
5A Mceldownie Road	57	60	61
1 Pekeketua Lane	56	58	59
2 Pekeketua Lane	55	58	58
3 Pekeketua Lane	56	59	60
4 Pekeketua Lane	56	59	60
5 Pekeketua Lane	61	63	64
6 Pekeketua Lane	57	60	60
8 Pekeketua Lane	60	63	64
1 Pekepeke Lane	62	65	65
2 Pekepeke Lane	58	60	61
3 Pekepeke Lane	63	65	65
4 Pekepeke Lane	58	61	61
5 Pekepeke Lane	63	66	66
6 Pekepeke Lane	59	61	62
7 Pekepeke Lane	63	65	66
8 Pekepeke Lane	59	62	62
9 Pekepeke Lane	63	65	67
10 Pekepeke Lane	56	59	60
11 Pekepeke Lane	63	66	67
12 Pekepeke Lane	57	60	61
13 Pekepeke Lane	63	66	67
14 Pekepeke Lane	58	60	61
15 Pekepeke Lane	64	66	67
16 Pekepeke Lane	59	62	63
17 Pekepeke Lane	64	66	67
18 Pekepeke Lane	59	62	62
19 Pekepeke Lane	64	66	68
20 Pekepeke Lane	57	60	60
21 Pekepeke Lane	64	66	68

PPF Address	Predicted noise levels (dB $L_{Aeq(24h)}$)		
	Existing scenario	Do Nothing scenario	Do Minimum scenario
22 Pekepeke Lane	56	58	59
23 Pekepeke Lane	64	66	68
25 Pekepeke Lane	64	66	68
27 Pekepeke Lane	64	66	68
1 Piwaiwaka Lane	58	60	61
2 Piwaiwaka Lane	57	60	61
3 Piwaiwaka Lane	58	61	61
4 Piwaiwaka Lane	58	60	61
5 Piwaiwaka Lane	59	61	62
6 Piwaiwaka Lane	59	61	62
7 Piwaiwaka Lane	59	61	62
8 Piwaiwaka Lane	62	65	66
9 Piwaiwaka Lane	60	62	64
11 Piwaiwaka Lane	64	67	68
195 Quarry Road	59	62	62
23 Roslyn Farm Street	56	58	59
25 Roslyn Farm Street	56	58	59
27 Roslyn Farm Street	56	58	59
29 Roslyn Farm Street	55	58	59
31 Roslyn Farm Street	56	58	59
33 Roslyn Farm Street	55	57	58
19 Sierra Way	56	58	59
21 Sierra Way	56	58	59
23 Sierra Way	57	59	60
26 Sierra Way	57	59	60
28 Sierra Way	57	60	60
30 Sierra Way	58	60	61
32 Sierra Way	58	61	61
34 Sierra Way	58	60	61
36 Sierra Way	58	60	61
38 Sierra Way	58	61	62
40 Sierra Way	58	61	61
23 Waharau Lane	58	60	61
25 Waharau Lane	58	61	62
27 Waharau Lane	59	61	62
29 Waharau Lane	59	62	62
31 Waharau Lane	59	62	63
33 Waharau Lane	60	63	63
35 Waharau Lane	61	63	64
37 Waharau Lane	61	64	65
39 Waharau Lane	58	61	61
41 Waharau Lane	57	60	61

NoR 3

PPF Address	Predicted noise levels (dB $L_{Aeq(24h)}$)		
	Existing scenario	Do Nothing scenario	Do Minimum scenario
1 Bombay Road	65	68	68
3 Bombay Road	63	66	66
28 Bombay Road	66	69	69
1814 Great South Road	60	63	64
1818 Great South Road	59	62	63
1819 Great South Road	61	64	64
1822 Great South Road	59	62	62
1823 Great South Road	66	69	70
1824 Great South Road	63	66	66
1832 Great South Road	59	62	63
1832 Great South Road	60	63	65
1832 Great South Road	60	63	65
1832 Great South Road	59	62	63
1976 Great South Road	61	64	65
1988 Great South Road	60	63	64
1994 Great South Road	58	61	61
1998 Great South Road	64	67	68
1998 Great South Road	59	62	63
2049 Great South Road	58	62	62
182 Mill Road	51	54	55
203 Mill Road	53	56	57
253 Mill Road	56	59	60
25 Portsmouth Road	62	65	66

NoR 5

PPF Address	Predicted noise levels (dB $L_{Aeq(24h)}$)		
	Existing scenario	Do Nothing scenario	Do Minimum scenario
1206 Great South Road	56	59	59
1207 Great South Road	58	61	61
1212 Great South Road	56	58	59
1216 Great South Road	52	55	56
1218 Great South Road	50	53	54
1222 Great South Road	47	50	50
1236 Great South Road	51	54	55
1245 Great South Road	59	61	60
1246 Great South Road	51	54	55
1255 Great South Road	53	56	56
1255 Great South Road	56	58	59

Papakura to Bombay Project Office

Aurecon New Zealand Limited

Level 3, Te Tihi

110 Carlton Gore Road,

Newmarket, Auckland 1023

PO Box 9762, Newmarket, Auckland 1149, New Zealand

New Zealand