APPENDIX I

Waitarere Beach Road Curves Project
Acoustic Assessment Report

Prepared for The New Zealand Transport Agency

November 2015

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Waitarere Beach Road Curves Project

Wellington Northern Corridor RoNS Improvements

Waitarere Beach Road Curves Project

Construction & Road Traffic Noise Assessment

Waitarere Beach Road Curves Project

Construction & Road Traffic Noise Assessment

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Revision Schedule

Rev. No	Date	Description	Prepared by	Reviewed by	Approved by
01	June 2015	Initial draft For comment	M.Hunt	L.Hannah	M.Hunt
02	September 2015	Amended for Designation Boundary adjustment & comments received	M.Hunt	L.Hannah	M.Hunt
03	October 2015	Final check & amendments	M.Hunt	L.Hannah	M.Hunt
04	October 2015	Amended for Further Designation Boundary Adjustment & Final check	M.Hunt	L.Hannah	M.Hunt
05	November 2105	Minor corrections	M.Hunt	L.Hannah	M.Hunt

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Waitarere Beach Road Curves Project
Construction & Road Traffic Noise Assessment

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Executive Summary

Introduction

This report documents the assessment of operational road-traffic noise, and construction noise and vibration effects for the Waitarere Beach Road Curves Project (the Project) involving the realignment of a portion of State Highway 1 near its intersection with Waitarere Beach Road, some 7km from the centre of Levin. This report provides details of the criteria adopted, a description of the existing noise environment and anticipated future conditions, together with an assessment of mitigation requirements, where this is appropriate.

As per established NZ Transport Agency (Transport Agency) practice, assessments of noise effects for designations involving state highways are undertaken based on the methods and procedures recommended within NZS6806:2010 *Acoustics – Traffic Noise – Noise From New & Altered Roads*. This Standard uses the term "protected premises and facilities" (PPFs) to describe noise sensitive buildings and locations where noise from vehicles operating on the new or altered highway may cause an adverse effect. The assessment here is based on 29 dwellings and other buildings (including the Whare Rongopai at 516 SH 1) which are eligible for consideration as a PPF under NZ Standard NZS6806:2010 as they are located within 200 metres of the proposed altered road[1].

Noise emission during the construction of the realigned state highway will principally arise from the earthworks, road base preparation, drainage works, road sealing and landscaping works. These works will be undertaken largely during the daytime except where road safety measures require some tasks to be completed at off peak times. The nature of the roading improvements coupled with local ground conditions indicate construction activities will not be particularly noisy and can be managed to comply with the relevant criteria governing construction noise.

Criteria

As set out below, the Horowhenua District Plan does not identify any criteria for the assessment of noise from new or altered roads *per se*. NZS6806:2010 *Acoustics – Traffic Noise – Noise From New & Altered Roads* is the appropriate New Zealand Standard to adopt for assessing effects of changes in operational traffic noise as a result of the Project. NZS6806:2010 contains an assessment process including guideline levels for road-traffic noise, which is adopted for this project as representing good practice. The methods recommended within NZS6806 were followed for identifying where noise mitigation is to be applied.

While the Horowhenua District Plan does not identify any criteria for the assessment of traffic noise, the Rural Zone provisions (Rule 19.2.15) require noise emitted in the course of any construction work to comply with NZS6803:1984. However that Standard has now been superseded by a 1999 version. This has been picked up within Rule 19.6.7(e) of the Horowhenua District Plan which requires such noise to "be measured, assessed, managed and controlled in accordance with the provisions of NZS 6803:1999 *Acoustics – Construction noise*". While it is well established that construction noise rules in district plans do not apply to designations, NZS6803:1999 is the appropriate Standard and is adopted in this report for assessing construction noise effects.

[1] Note. As noise levels have been assessed for upper and lower levels of two PPFs with habitable rooms on two storey's, the total number of PPFs is 31.

Existing Environment

Site visits to the area, searches of the relevant public records and perusal of aerial photographs has identified the location of sensitive receiver sites (termed PPFs) that may be affected by the proposed works. NZS6806:2010 restricts the consideration of the existing environment to any PPFs located within 200 metres of the alignment.

In terms of the existing acoustic environment, results of a noise survey are presented below for representative locations along the route. The survey measured noise levels over 'long term' periods of 24 hours or more at two residences adjacent to the works, with further short term readings (2 -3 hours) taken at one further PPF location adjacent to the existing highway. The ambient sound environment is dominated by traffic passing through the area on the existing State Highway 1. The existing environment also includes occasional sounds from equipment, animals and people associated with residences and facilities such as two marae located in the area. In addition, bird song was a noticeable feature of the ambient sound environment at some locations.

The noise from the existing state highway was modelled, based on existing traffic flows, vehicle speed, road surface, etc. which agreed ±1.3 dB with the 24 hour L_{Aeq} sound levels measured in the local environment. This confirms the high degree to which sounds from passing vehicles dominate the sound climate at the selected monitoring locations near the state highway.

Modelling

A computer noise modelling exercise has been undertaken using an assessment year of 2025, approximately 5 years after the planned completion of the Project. The modelling includes the scenario without the Project (do-nothing) the scenario with the Project (do-minimum) and various noise mitigation options.

A construction and maintenance noise calculator from the Transport Agency Transport Noise website (www.acoustics.nzta.govt.nz) has been used to estimate the likely scale of noise during construction phase, based upon generic construction equipment and processes. This calculator provides a method for basic assessment of construction and maintenance noise, based on NZS 6803:1999.

Assessment of traffic noise effects

NZS 6806 assesses traffic noise under three categories (A, B and C) to identify where noise mitigation measures should optimally be applied. The assessment requires that the best practicable option (BPO) be adopted when mitigating road-traffic noise. Where NZS67806:2010 signals a sensitive receiver locations should receive mitigation, the category A criterion should be achieved. If this is not practicable, then mitigation should be assessed against category B. However, if it is still not practicable to comply with categories A or B then mitigation should be implemented to ensure the internal criterion in category C is achieved. The following table provides an overview of the Category A, B and C and related criterion.

Category	Criterion	Altered Roads
A	Primary	64 dB $L_{Aeq\ (24\ hr)}$
B	Secondary	67 dB $L_{Aeq\ (24\ hr)}$
C	Internal	40 dB $L_{Aeq\ (24\ hr)}$

Future forecasts of traffic noise levels for the design year (2025) form the basis of the assessment of traffic noise effects. The initial assessment commenced with prediction of future noise levels for the "Do

Minimum" design option which incorporated no specific noise mitigation measures. This was found to result in:

Category	dB Change (LAeq(24H)	No. Of PPFs
Reduction OR Nil effect	< 0 (no Increase)	21
Not Noticeable Effect	+1 to +2.5	5
Minor Effect	+2.5 to +4.5 or greater	5
	Total	**31 PPFs**

The modelling results indicate in the future that most PPFs (i.e. around 70%) will receive reduced noise or a nil change brought about by the project. A second category of around 14% of PPFs will receive (at the design year) very minor noise effects due slight increases in received noise (1 to +2.5 dB) which (over the assessment time frame) would not be a noticeable effect. Around 16% (5 receivers) will likely receive a minor change in noise over the design period, however none of these PPFs will receive an increase sufficient to require mitigation options to be investigated under the recommendations of NZ Standard NZS6806:2010.

Details are provided below of a small number existing dwellings that are located within the boundary of the proposed designation and will be removed. These dwellings are not included within the assessment.

The overall modest degree of noise level change means the numerical trigger values for noise mitigation measures under NZS6806:2010 *Acoustics – Traffic Noise – Noise From New & Altered Roads* are not achieved at any PPF. All PPFs to which this assessment has been applied were found to fall within Category A of this Standard. On this basis operational traffic noise is not considered to be likely to be unreasonable or cause significant adverse effects at any of the identified sensitive receiver sites.

Construction Noise & Vibration

The Project will involve bulk earthworks, transporting fill, grading and levelling, and compaction. Preparing the base course and surface will involve the spreading of fill, distributing the chips / asphalt, and compaction. In addition to the road, kerbing, safety barriers and roadside furniture (such as signage) will be installed, and line marking conducted.

In terms of noise effects during construction, some of the closest dwellings (excluding existing dwellings located within the designation which are to be removed) are expected to receive elevated levels of construction sound at times during daytime periods but the duration of this elevated sound would only be present for a matter of days or possibly 1 to 2 weeks as a worst case. The nature of construction works means noise levels (and therefore effects) will be intermittent and temporary, lasting only as long as the construction phase. This report establishes the construction noise criteria of NZS6803:1999 can be fully complied with.

Conclusions

The Project involves realignment of an existing highway which brings the highway closer to some dwellings or noise sensitive sites. Other sensitive locations will receive lower noise effects owing to the highway being re-located at a greater distance. Potential effects of increased road traffic noise will occur at some receiver sites only. Traffic noise levels for the design year are found to be below the levels

necessary to trigger the NZS6806:2010 values that require traffic noise mitigation measures to be considered for implementation s part of the project.

The effects of noise and vibration effects arising from construction of the alteration are not expected to be significant for any specific receiver sites and are fully expected to comply with the relevant guideline standards for construction noise and vibration set out in ***Section 6.3*** below.

1 Introduction

1.1 Project Overview

The Waitarere Beach Road Curves Project forms a short section of State Highway 1 seven kilometres north of Levin that forms part of the Wellington Northern Corridor RoNS which has been identified as requiring safety improvements due to its record of fatal and serious crashes. The preferred option is to realign the highway to straighten this section of road making it 330m shorter and creating a new and safer Waitarere Beach Road intersection. The works also involve installing a section of median barrier with appropriate local road connections in this area to reduce the risk of crashes.

The existing and proposed road layouts are set out in **Figure 1-1** (section north of Waitarere Beach Road intersection) and **Figure 1-2** (section south of the Waitarere Beach Road intersection).

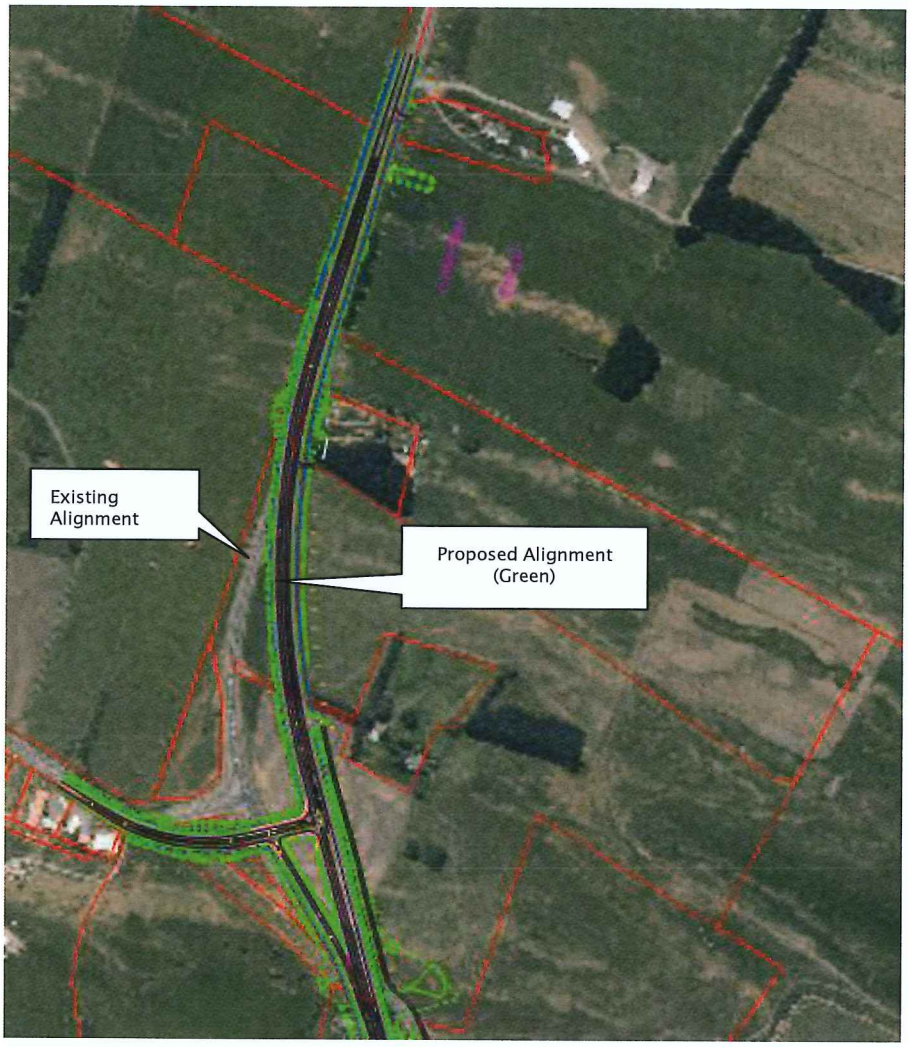

Figure 1-1: Project area north of Waitarere Beach Rd Intersection

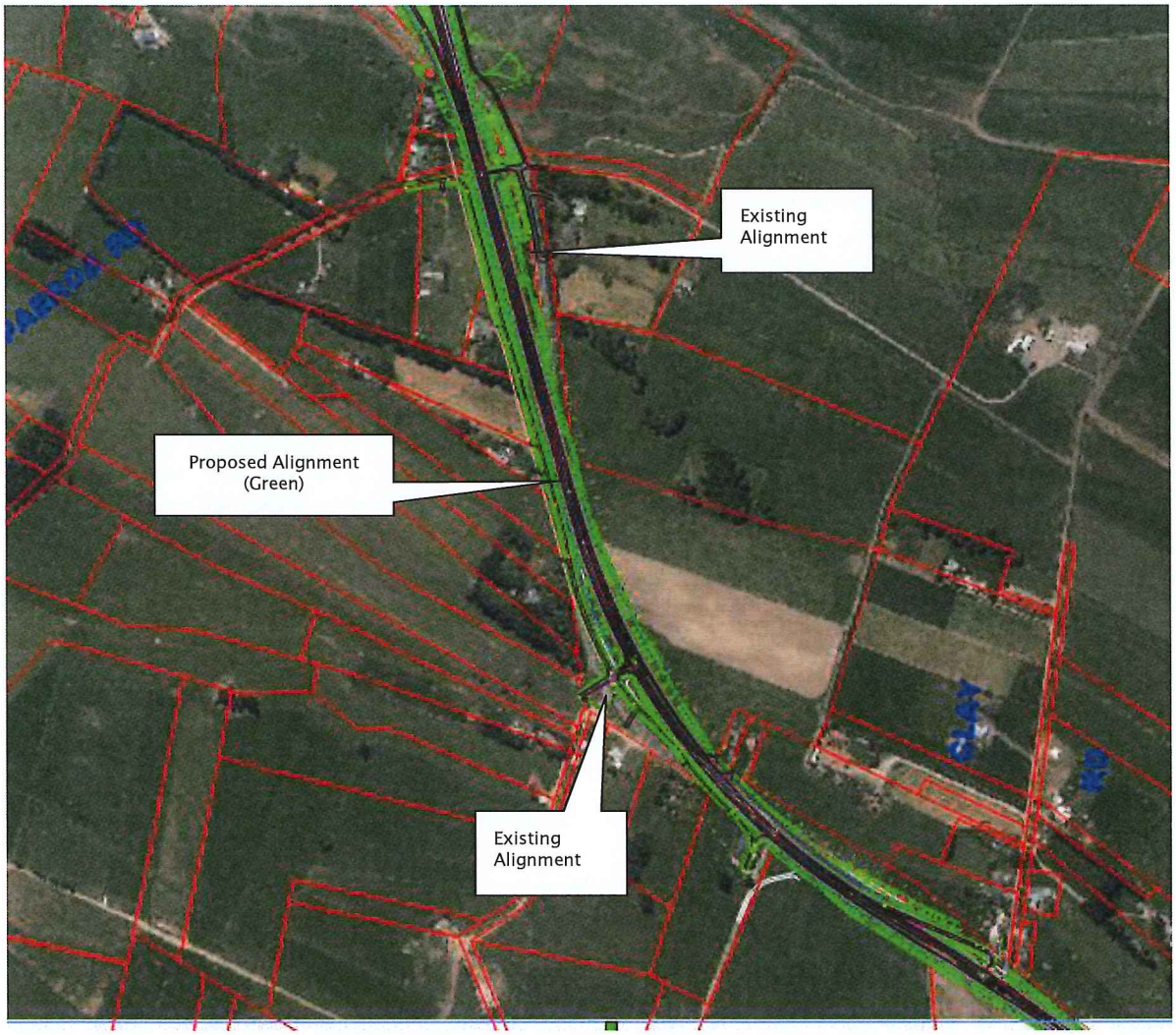

Figure 1-2: Project area south of Waitarere Beach Rd Intersection

This assessment considers noise and vibration effects at marae buildings (19 Clay Road) and the Whare Rongopai (516 SH 1) which fall within the definition for PPF as per NZS6806:2010, and are thus treated as noise-sensitive in a similar fashion to existing dwellings located within 200m of the alignment.

1.2 Project Objectives

The Waitarere Beach Road Curves Safety Improvements Project is part of the Otaki to north of Levin section of the Wellington Northern Corridor Roads of National Significance (RoNS) programme. The project area is approximately 7 km north of the centre of Levin. The objectives of the project in relation to State Highway 1 north of Levin to:

- Enhance inter-regional and national economic growth and productivity;
- Improve journey times on the state highway network;
- Enhance safety of travel on the state highway network.

- Appropriately balance the needs of both interregional traffic and local road users, and
- to achieve the above objectives in a cost effective manner.

The project will require significant earthworks due to the undulating topography. Improvements to the stormwater management will also be made with roadside swales and stormwater retention ponds at key locations and the installation of new culverts for the realigned sections and the upgrade of existing culverts where the existing SH1 alignment will be retained. This report includes assessment of potential noise and vibration effects associated with the construction phase of this project in addition to traffic noise and vibration effects associated with the realigned state highway.

1.3 Noise Assessment

An alteration to designation is required to amend the existing state highway designation in the Horowhenua District Plan. The Notice of Requirement process is therefore a consequence of the need to adjust the designation land boundaries of the state highway to cater for the realignment.

Any change to a designation in a District Plan (Notice of Requirement) is required to be accompanied by an *Assessment of Environmental Effects*. "Noise" is an effect covered by the RMA. Thus, this noise assessment has been prepared in accordance with the requirements for an "Assessment of Environmental Effects" set out in the Fourth Schedule of the RMA. The assessment was undertaken for the Project by Malcolm Hunt Associates during 2015 as part of the environmental assessment of the Project.

The purpose of the noise assessment is to:

- Measure existing noise levels,
- Predict and assess future road-traffic noise levels,
- Identify appropriate measures required to avoid, remedy or mitigate potential operational noise effects.

The results of the study are presented in this report. Potential construction noise and vibration effects are addressed in Section 6.0 of this report.

2 Criteria

2.1 Protected Premises and Facilities

This assessment has considered all noise sensitive locations within a reasonable distance of the Project. In accordance with NZS 6806, the term "Protected Premises and Facilities" (PPFs) is used to define sensitive sites that require protection from the potential adverse effects of traffic noise. In accordance with NZS 6806, PPFs are only considered where the PPF is located within 200 metres of the edge of the nearside traffic lane of the project in rural areas, or 100 metres or less in urban areas.

The extents of rural and urban areas are defined by Statistics New Zealand[2]. Under this definition, the Project is in a rural area and therefore the 200 metre distance is used. Outside of these areas PPFs do not require assessment under NZS 6806.

29 dwellings and marae buildings are located within 200 metres of the proposed altered road and are eligible for considerations as a PPF under NZ Standard NZS6806:2010. Section 2-4 below identifies the

[2] New Zealand: An urban/rural profile, Statistics New Zealand

specific aspects of NZS6806:2010 that determine in the final analysis whether a potentially sensitive site is actually considered a PPF under NZS6806:2010.

2.2 District Plan

The District Plan identifies "reverse sensitivity" issues for sensitive uses being established adjacent to land transport corridors. However this is not a relevant consideration for existing dwellings and other PPFs that may be affected by the proposed realignment.

The requirements for new roads are set out in a report "*Subdivision and Development Principles and Requirements 2014*" which is listed within "*Documents Incorporated by Reference*" to the District plan. New Zealand Standard NZS 6806:2010 "*Acoustics: Road Traffic Noise - New and Altered Roads*" is identified as a document incorporated by reference into the District Plan. However, there appear to be no specific rules requiring the mandatory application of this Standard to assess noise from new or altered roads in the district. Notwithstanding this situation, NZS6806:2010 is considered the most appropriate and technically appropriate Standard to assess the effects of changes in traffic noise associated with this project.

As above, the operative District Plan refers to measurement and assessment of construction noise using NZS6803. However construction noise rules in district plans do not apply to designations. Consistent with best practice, construction noise is assessed below in accordance with NZS6803:1999 *Acoustics - Construction noise*" as this is the most appropriate Standard available for this purpose.

2.3 Vibration

The District Plan refers to vibration at Rule 19.2.27 as follows;

> 19.2.27 Vibration
>
> No activity shall create any vibration which exceeds the limits in NZS/ISO 2631.2:1989 - *Continuous and Shock-Induced Vibration in Buildings* and NZS 4403:1976 - *Code of Practice for Storage, Handling and Use of Explosives, and any subsequent amendments.*

In April 2005 NZ Standard NZS/ISO 2631-2:1989 was withdrawn as it was superseded by an informative-only version of this Standard ISO 2631-2:2003 that contained no vibration criteria. Consequently, Standards New Zealand withdrew all related vibration standards in the NZS/ISO 2631 series. Since this time, however, the ISO 2631-2:1989 standard has continued to be successfully implemented in some District Plans such as Auckland City and former Waitakere City, as well as the Transport Agency Environmental Plan referencing it, in addition to the German Standard for building damage: DIN 4150-3:1999.

For the purposes of this project, and to ensure the assessment of effects is robust and fit-for-purpose, we recommend alternative standards to the superseded or withdrawn vibration standards (see Section 6.2 and 7.1 below).

2.4 Existing Designation

State Highway 1 is listed as designation D2 in Schedule 1 of the Horowhenua District Plan. There are no conditions attached to this designation.

2.5 NZS 6806

New Zealand Standard 6806 provides criteria and an assessment method for road-traffic noise. The method provides performance targets and requires assessment of different options for noise mitigation (often including barriers and low-noise road surfaces where appropriate). The performance targets in NZS 6806 are set to be reasonable taking into account adverse health effects associated with noise on people and communities, the effects of relative changes in noise levels, and the potential benefits of new and altered roads.

NZS6806:2010 seeks to apply criteria valid into the future, at a "design year" 10 to 20 years after the completion of the new or altered road. In this case the opening year has been taken as 2017. All traffic noise predictions in this report relate to predicted traffic volumes in year 2028.

NZS6806:2010 sets out differing criteria depending on whether the noise being assessed arises from a "new" road or an "altered" road. The definition of *Altered Road* under clause 1.5.2 of NZS6806:2010 is;

> ***Altered Road** means an existing road that is subject to alterations of the horizontal or vertical alignment where at any assessment position at any one or more PPF:*
>
> *(a) The do minimum noise environment is greater than or equal to 64 dB LAeq(24h) and, if no specific noise mitigation was undertaken, the alterations would increase road-traffic noise at that assessment position by 3 dB LAeq (24h) or more at the design year, when compared with the do-nothing noise environment; or*
>
> *(b) The do-minimum noise environment is greater than or equal to 68 dB LAeq(24h) and, if no specific noise mitigation was undertaken, the alterations would increase road-traffic noise at that assessment position by 1 dB LAeq (24h) or more at the design year, when compared with the do-nothing noise environment;*

Throughout this project operational noise associated with the Waitarere Curves Project has been assessed as if the project qualified as an "Altered Road" under NZS6806:2010. However, as indicated within the results set out below for this project, the "do minimum" noise environment at year 2028 for this project is such that:

(a) there are no PPFs with an expected do minimum noise environment reaching 64 dB LAeq(24h) or greater at the design year that will experience a change in noise of +3 dB or more; and

(b) there are no PPF's with a do minimum noise environment above 68 dB LAeq(24h) at the design year.

As the existing formed legal road lies at close proximity to all parts of the proposed new alignment, the project does not qualify as a "new" road under NZS6806:2010.

As above, the noise assessment was carried out as if the project qualified under NZS68062010 definition as an "Altered Road". The following noise criteria in Table 2-1 **Error! Reference source not found.**are usually applied in such circumstances.

Category	Criterion	Altered roads
A	Primary	64 dB $L_{Aeq(24h)}$
B	Secondary	67 dB $L_{Aeq(24h)}$
C	Internal	40 dB $L_{Aeq(24h)}$

Table 2-1: NZS 6806 noise criteria

Under NZS6806:2010 noise mitigation options are to be assessed, and if practicable implemented, for any PPF where the category A criterion cannot be achieved under the "Do Minimum" scenario. Where it is not practicable to meet even Category B, then mitigation should be implemented to ensure the internal criterion in category C is achieved. Depending on the specific building, mitigation in category C could include ventilation and/or noise insulation improvements ranging from upgraded glazing through to new wall and ceiling linings. In category C there is no protection of outdoor amenity.

An over-riding consideration is the RMA requirement to adopt the Best Practicable Option (BPO) to avoid unreasonable noise. NZS 6806 provides a procedure for assessing the benefits and costs of mitigation options to help determine the BPO.

2.6 NZS6803

NZS 6803 provides guideline noise criteria for construction and maintenance works. These criteria set out guidelines as to the noise levels people undertaking construction and maintenance works should try to achieve outside neighbouring buildings (PPFs), The actual compliance assessment location is 1m from the facades and 1.2-1.5m above the relevant floor level. These criteria are applied to manage noise at both residential sites and the marae buildings within 200 metres of the works.

During the day, most people tolerate higher noise levels from temporary activities, compared to permanent activities. Therefore the guideline criteria for temporary work allow for higher noise levels than would be allowed for permanent activities. For typical daytime construction lasting less than 20 weeks, the guideline criteria are 75dB $L_{Aeq(15\ min)}$ and 90dB L_{AFmax} during daytime, as measured at the sensitive receiver location. However, at night the criteria in the standard are set low, at a similar limit to those that apply for permanent activities, to prevent sleep disturbance associated with construction activities.

3 Existing Environment

3.1 Overview

Unlike many other standards, NZS 6806 assesses road-traffic noise independent of levels of existing road noise levels found in the area currently. Measurements of existing levels are therefore not mandatory for assessment under NZS6806:2010. However, an appreciation of the existing environment is required to enable judgements about the sensitivity of the receiving environment and potential effects of any noise increases, regardless of compliance with any particular noise criteria. Therefore, the existing environment has been assessed in detail through both modelling and measurements. Measurements of typical levels of existing traffic noise have been measured in the vicinity of 3 dwellings (PPFs) located as described below. The readings are used to establish the existing $L_{Aeq(24\ hr)}$ levels of traffic noise at known locations adjacent to the existing highway and which will be affected by the proposed realignment.

3.2 Noise Survey

3.2.1 Procedure

Existing levels of traffic noise found in the area have been measured at three PPF locations in the local area, within 20 m to 80m of the existing highway, and generally free from reflection effects of any buildings or fences, at the following locations:

A. North of Waitarere Beach Rd Intersection;

- 648 State Highway 1

B. South of Waitarere Beach Rd Intersection;

- 511 State Highway 1
- 533 State Highway 1

These locations are set out in **Figure 3-1** (section north of Waitarere Beach Road intersection) and **Figures 3-2 and 3-3** (section south of the Waitarere Beach Road intersection);

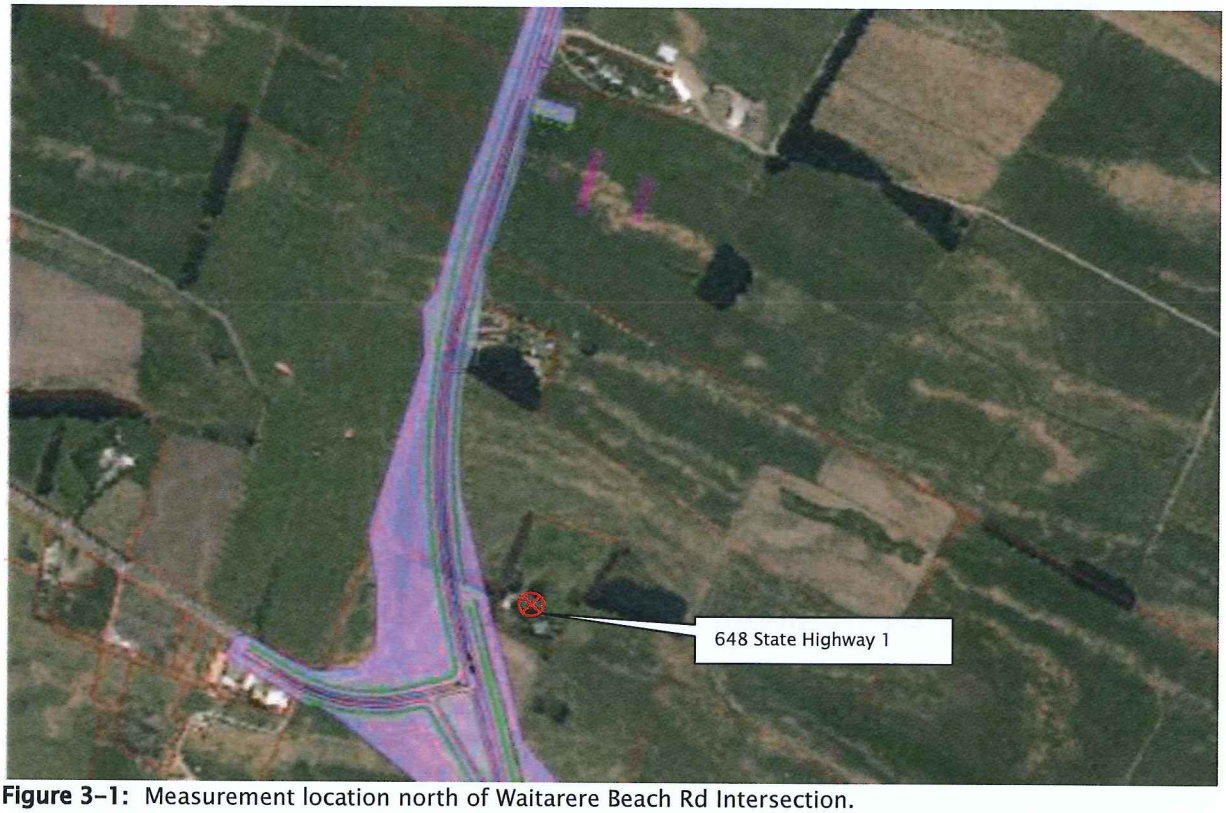

Figure 3-1: Measurement location north of Waitarere Beach Rd Intersection.

Figure 3-2: Measurement locations in mid section.

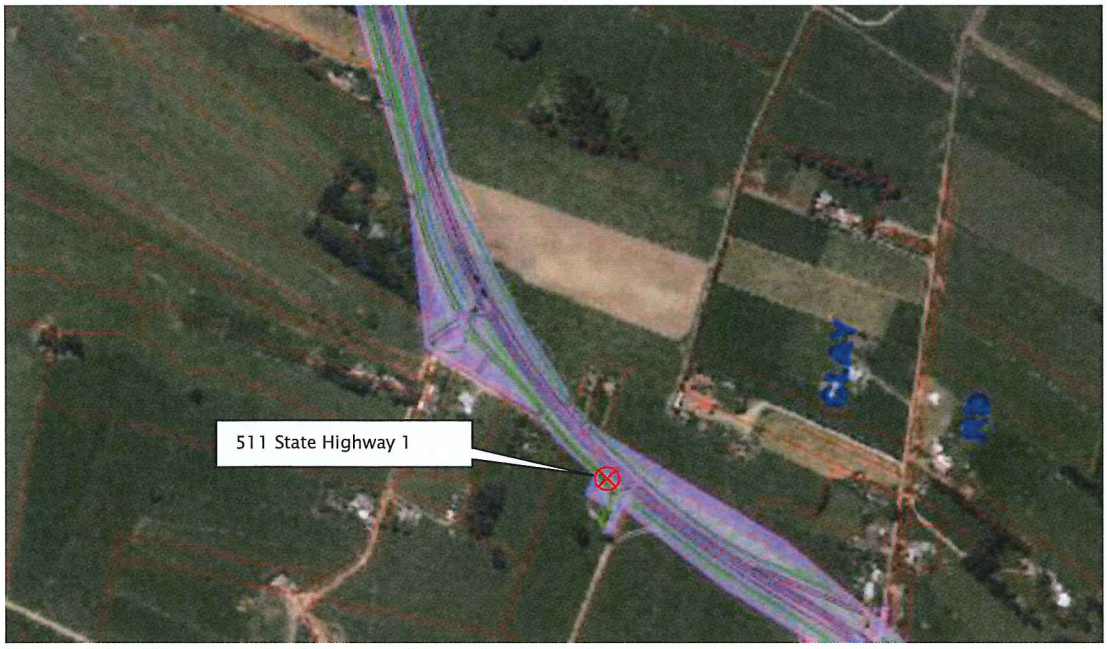

Figure 3-3: Measurement locations in southern section.

The measurements were conducted in general accordance with NZS 6801[3] and assessed in accordance with NZS 6806. The measurements took place during April 2015. Measurement and calibration details required by NZS 6801 are held on file by Malcolm Hunt Associates.

Equipment

The following instrumentation was used for the survey:

Measurement Equipment	Manufacture and Type	Serial Number/Details
Bruel and Kjaer 2260 *Investigator* Sound Level Meter	Bruel and Kjaer 2260 investigator Sound Level Meter	Serial Number: 1933856 Firmware BZ7202 V1.1/BZ7219 V1.0 Sound Level Meter complying with IEC 60651 Type 1, IEC 804 Type 1, and IEC1260 Class 1 specifications for Sound Level Meters
Bruel and Kjaer Calibrator Type 4230	Bruel and Kjaer Calibrator Type 4230. 94 dB @1000 Hz	Serial Number: 622678
Inner and Outer Wind Screens	90 mm Foam Wind Screen type UA237 and 200 m foam wind screen	
Cables	Bruel and Kjaer Cabling and Connections	
Global Positioning Apparatuses		**Manufacture and Type**
Garmin GPS Unit		Garmin GPS 60 Navigator
Garmin GPS Software		Garmin GPS 60 Navigator Software
Additional Apparatuses		**Manufacturer and Type**
Heavy Duty Pelican Cases (weather tight)		Pelican 1510 Cases
Digital Camera [with motion picture functions]		Panasonic Lumix Digital Camera

Table 3-1: Summary of equipment used for noise survey.

Meteorological Conditions

During the survey, meteorological data was obtained from weather stations in the general area, as shown in Table 3-2.

Location	Operator	Data
LEVIN (IHOROWHE2) Lat S 40 ° 37 ' 23 " Long E 175 ° 17 ' 46 "	Private Weather Stn	Wind speed, wind direction, temperature, pressure, humidity, rainfall] http://levinweather.com/index.htm
FOXTON BEACH (IHOROWHE5) Lat S 40° 28' 03" Long E 175° 14' 22"	Private Weather Stn	Wind speed, wind direction, temperature, pressure, humidity, rainfall] http://foxtonbeachweather.host56.com/

Table 3-2: Weather stations

The meteorological data from both these weather stations has been used to identify periods when conditions were likely to have been outside the meteorological restrictions in NZS 6801:2008. Two periods totalling 2.5 hours have been excluded from the ambient noise analysis.

[3] NZS 6801:2008, Acoustics – Measurement of environmental sound

Analysis

Each day's data was analysed and any known abnormal events excluded. The data shows a natural variation in the measured ambient noise environment throughout the day, with low variability in sound levels between days. Areas close to traffic sources generally have a more consistent noise profile than locations dominated by natural sounds. The $L_{Aeq(24h)}$ was calculated for each whole day excluding data affected by bad weather. The energy average $L_{Aeq(24h)}$ was calculated over all valid data using the methods prescribed in NZS6806:2010.

A discussion of the measurement uncertainty is provided in Section 6.2.1.

3.2.2 Results

The results of the noise survey are set out below for the three sites.

511 State Highway 1

Two representative 24 hour readings were obtained as follows;

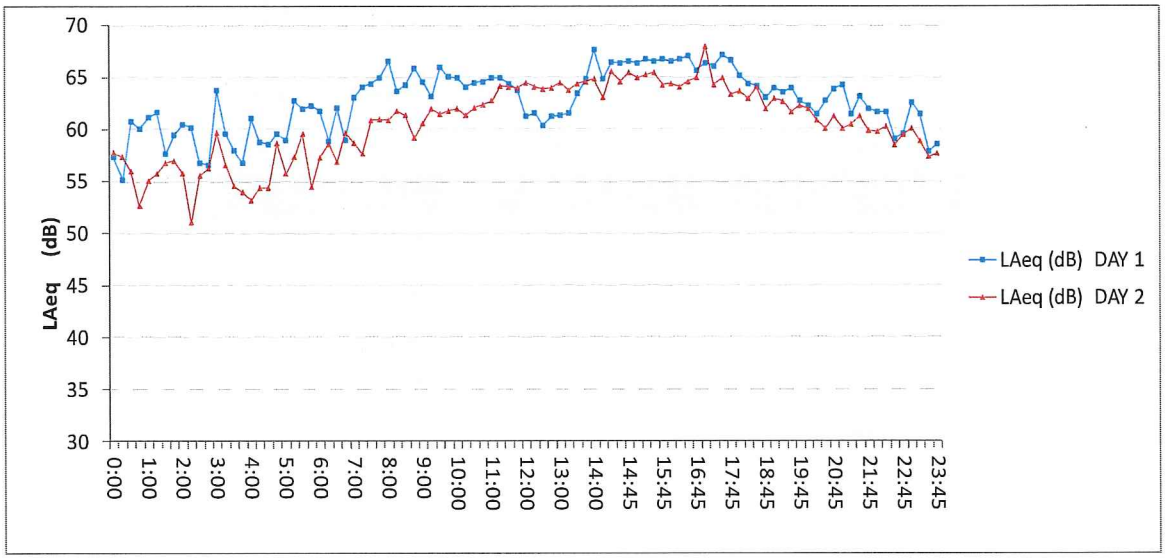

Figure 3-1: Time-varying 15 minute L_{Aeq} ambient sound levels measured at 511 State Highway 1

A single value for the 24 hour ambient sound level at this location was calculated as follows;

Day	Measured Ambient Sound Level $L_{Aeq(24hr)}$
Day 1	63.7 dB
Day 2	62.0dB
Average $L_{Aeq\ (24\ hours)}$	**62.8 dB**

648 State Highway 1

Four representative 24 hour readings were obtained as follows;

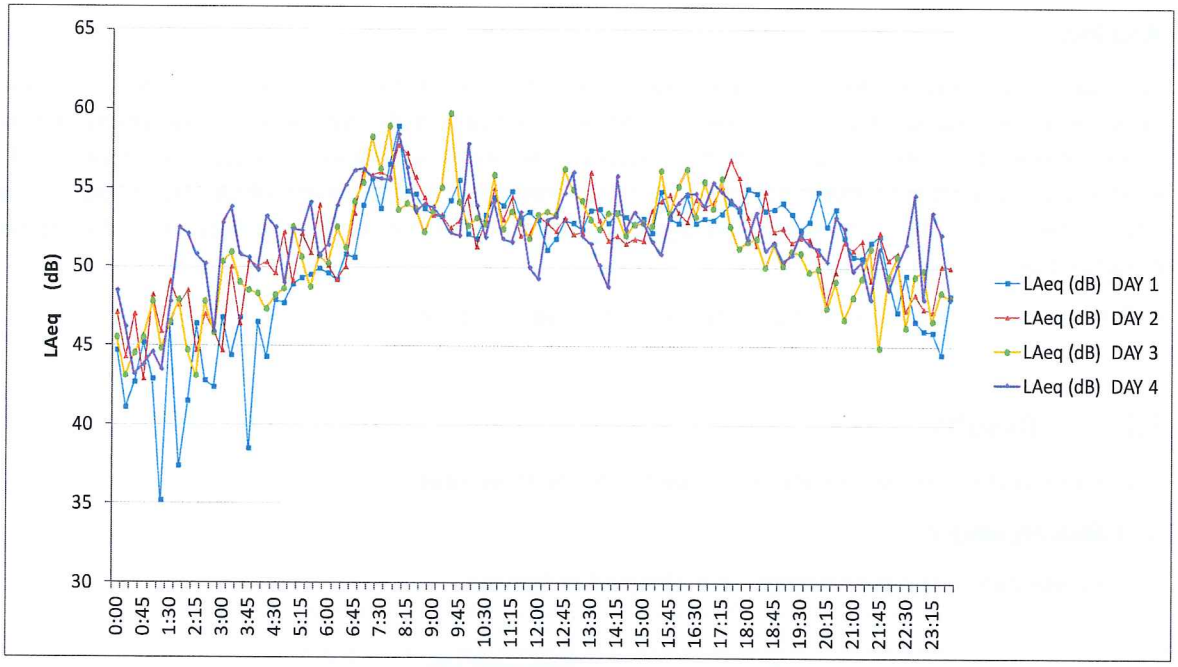

Figure 3-2: Time-varying 15 minute L_{Aeq} ambient sound levels measured at 648 State Highway 1.

A single value for the 24 hour ambient sound level at this location was calculated as follows;

Day	Measured Ambient Sound Level $L_{Aeq(24\ hr)}$
Day 1	52.2 dB
Day 2	52.5 dB
Day 3	52.2 dB
Day 4	52.6 dB
Average $L_{Aeq\ (24\ hours)}$	**52.4 dB**

533 State Highway 1

Three handheld readings totalling 180 minutes were taken within the road reserve, at a location similar to a nearby dwelling at 533 State Highway. Measurement was taken over 184 minutes between 1pm and 4.30pm under fine, calm conditions (dry road). These short term readings were combined to form an estimate of the likely 24 hour L_{Aeq} sound level based on the CRTN "shortened measurement procedure". A single value for the 24 hour ambient sound level at this location was estimated as follows;

Reading	Measured Ambient Sound Level $L_{Aeq(24\ hr)}$
Reading 1	58.1 dB
Reading 2	56.5 dB
Reading 3	56.2 dB
Average $L_{Aeq\ (24\ hours)}$	**57.9 dB**

Summary

Listed in **Table 3-1**, with a description of the observed environment. In the case of unattended loggers, the notes about the noise environment should only be taken as a guide, as observations were only made at the start and end of the measurement cycle.

Dates	Address	$L_{Aeq(24h)}$	Notes
17th to 19th April 2015	511 State Highway 1	62.8 dB	Logged sound levels. Adjacent to dwelling, approx 25 m to road. Partial screening by front fence.
19th to 23 April 2015	648 State highway 1	52.9 dB	Logged sound levels. Adjacent to dwelling, approx 125 m to road. Restricted angle of view of highway.
23 April	Adj. 533 State Highway 1	57.9 dB	Shortened measurement procedure. Handheld measurements. Taken at representative dwelling location

Table 3-1: Noise survey results

The survey of ambient sound levels revealed the existing environment is dominated by sounds from traffic passing through the area on the existing State Highway 1. The existing environment also includes occasional sounds from equipment, animals and people associated with residences and facilities such as two marae located in the area. In addition, bird song was a noticeable feature of the ambient sound environment at some locations.

3.3 Existing road-traffic noise

3.3.1 Modelling

As above, measurements of existing noise levels have been performed at 3 PPF locations. The results of measurements have been used as a check on the accuracy of predictions of current noise levels predicted across all PPFs. The results of this comparison are set out below.

A key aspect of the NZS6806:2010 assessment process is the 'do-nothing' scenario which comprises the existing road with traffic flows predicted for year 2028. For the 3 PPFs near the existing state highway where measurements have been conducted, the do-nothing scenario can be calculated based on adjusting traffic volumes to give noise levels relating to the future 2028 AADT. The adjustment made is $10\times\log_{10}(^{\text{current year AADT}}/_{\text{do-nothing AADT}})$. This future "do-nothing" value derived from measurements is used below to compare with to the "do-nothing" value provided by computer modelling. Section 4 of this report describes the computer modelling undertaken for road-traffic noise.

3.3.2 Results

A comparison of the measured noise levels discussed in Section 3.2.2 with the results of the computer modelling using 2014 parameters is provided in Table 3-2. The measured values and predicted values agree reasonably closely. This meets the NZS6806 recommendation that modelling results be within ±2

dB of measurements. The CRTN[4] method used in these predictions has previously been shown to provide the required accuracy under controlled conditions close to state highways.

PPF No.	Measurement location	Project Area	Measured $L_{Aeq(24h)}$	Predicted $L_{Aeq(24h)}$	Difference dB	Comment
5	648 State Highway 1	North	52.9	53.1	0.4	Prediction results within ±1 dB of measured value.
14	533 State Highway 1	Central	57.9	58.4	0.5	
21	511 State Highway 1	Southern	63	62.4	-0.6	

Table 3-2: Comparison of measured and predicted noise levels

The results of the comparison shown in Table 3-2 indicates noise predictions based current day AADT and 2014 traffic parameters agree well with the results of free-field measurements at three selected PPF locations.

4 Modelling

4.1 Procedures

The cornerstone of this assessment is modelling of road-traffic noise, which provides an objective basis to assess potential future traffic noise effects. The modelling techniques used are well established in New Zealand. The method adopted has been to utilise the NZ-modified version of a UK procedure referred to as *Calculation of Road traffic Noise*[5]

Parameter	Setting/source
Software	Predict based on ISO9613-Part 2
Algorithm	e.g. CRTN
Order of reflections	Zero
Parameter	$L_{Aeq(24h)}$
Ground absorption	Soft
Receiver height	1.5 m (4.5 m upper floors) - most exposed façade
Noise contour grid	1.5 m height, 10 m resolution
Receivers and grid position	free-field

Table 4-1 lists the key model settings.

Parameter	Setting/source
Software	Predict based on ISO9613-Part 2
Algorithm	e.g. CRTN
Order of reflections	Zero
Parameter	$L_{Aeq(24h)}$
Ground absorption	Soft
Receiver height	1.5 m (4.5 m upper floors) - most exposed façade
Noise contour grid	1.5 m height, 10 m resolution
Receivers and grid position	free-field

Table 4-1: Model settings

[4] Calculation of Road Traffic Noise (CRTN). UK Department of Transport and the Welsh Office. ISBN 0115508473. 1988

[5] Department of Transport (1988) *Calculation of road traffic noise*. UK: Department of Transport, Welsh Office.

The NZ-modified CRTN algorithm gives results in terms of the $L_{A10(18h)}$. To convert this to $L_{Aeq(24h)}$ a -3 dB adjustment has been made.

In addition to the existing scenario ("Do Nothing") scenarios modelled were:

- Do-nothing – the Project not constructed; the existing roads with 2028 traffic; and
- Do-minimum – the Project constructed; 2028 traffic; no specific noise mitigation.

Comparison of do-nothing and do-minimum noise levels confirmed that the Project does not meet the threshold criteria to be considered as an "altered road" owing to the low levels of noise increases expected out to the deign year 2028. This assessment excludes effects on PPFs located within the designation boundary which NZTA plan to remove. For all PPFs located beyond the designation boundary the relevant trigger levels for implementing mitigation set out within NZS6806:2010 are not reached, and thus no specific mitigation options have been assessed as none are required according to NZS6806:2010.

4.2 Input Data

Most data used in the noise model has been obtained directly from the project GIS system. However, in some instances additional data such as traffic flow and barriers have required manual entry direct into the noise model.

Terrain

Terrain information has been imported into the noise model as spot heights across a 20m x 20m grid of the project area. Road gradients and screening have been determined from the terrain information with the available terrain information adopted within modelling for the Do-nothing contours which use the existing landform without Project modifications.

For the future, terrain heights have been manually adjusted in the Do-Minimum model to reflect the proposed road height and any cut faces located close to the road (exceeding 0.5 metres above road level) where these faces may have some acoustic screening effect. All of the mitigation options and final BPO scenario are based on the do-minimum terrain.

Buildings

The footprints for all buildings and all other structures within 200 metres of the road have been located for all buildings exceeding 5 metres in height. All PPFs are single storey buildings except for 9 Paeroa Road and 7 Clay Road. Predictions were made at all façades of individual buildings; with the noise levels stated being the highest of any facade.

	Existing road (2014)				Do nothing (2028)				Do minimum (2028)			
Road section	Surface	Speed (km/h)	AADT (vpd)	HV (%)	Surface	Speed (km/h)	AADT (vpd)	HV (%)	Surface	Speed (km/h)	AADT (vpd)	HV (%)
North of Waitarere Beach Road Intersection	Two Coat Grade 3/5	100	9,031	11.1	Two Coat Grade 3/5	100	10,278	12.6	Two Coat Grade 3/5	100	10,278	12.6
Central section	Two Coat Grade 3/5	100	7,810	12.8	Two Coat Grade 3/5	100	8,888	14.5	Two Coat Grade 3/5	100	8,888	14.5
Southern section	Two Coat Grade 3/5	100	7,810	12.8	Two Coat Grade 3/5	100	8,888	14.5	Two Coat Grade 3/5	100	8,888	14.5

Table 4-2: Road surface and traffic details used in noise modelling.

Road surfaces

A chip seal road surface has been assumed within both the current and future noise modelling. As per Transport Agency standard practice, the road surface is assumed to be a two-coat chip seal Grade 3/5 medium chip seal. This is a +4.3 "combined surface adjustment" of 4.3 dB according to NZTA's *Guide to State Highway Road Surface Noise*, January 2014.

Safety barriers

No solid (e.g. concrete) safety barriers have been assumed to be located at the edge of the carriageway.

Traffic data

Traffic data has been provided by the traffic engineer as Annual Average Daily Traffic (AADT) separately for the sections north and south of the Waitarere Beach Intersection. In addition the engineers provided information on percentage of heavy vehicles and the posted speed limit. This has been provided separately for each carriageway and separately for crawler lanes. All traffic data has been provided for the design year of 2028 which is less than 10 years after the assumed opening of the project. Details are set out in **Table 4-2** below.

PPFs Included

The analysis has included all PPFs located within 200 metres of the alignment, except those existing residences which lie within the designation boundaries. As these PPF's are likely to be removed or demolished (or will be otherwise under the control of the requiring authority), these PPFs have been excluded from assessment. A list of PPFs included in the assessment is provided in **Table 4-3** below.

4.3 Results

Predicted road-traffic noise levels at all relevant PPFs are set out below in Table 4-3 **for the "Existing", "Do Nothing" and "Do Minimum" options.** The cells are colour coded according to the NZS 6806 category: Category A – green, Category B – orange, and Category C - red. All PPF's are marked as green as all PPFs fall within the Category A criteria.

Noise contour plots for the "do Minimum" are presented in ***Appendix A***. Specific noise level values should not be taken directly from the contours as they are interpolated from a grid resulting in some localised inaccuracies.

Area	Address	Existing	Do-nothing	Do-minimum
1	719 State Highway 1	56.9	57.7	57.7
2	717 State Highway 1	55.8	56.6	56.6
3	708 State Highway 1	58.9	59.8	59.8
4	670 State Highway 1	58.1	58.9	59.4
5	648 State Highway 1	52.9	56.2	62.6
6	15 Waitarere Beach Road	55.4	56.9	54.6
8	12 Paeroa Road	56.2	57.7	62
9	9 Paeroa R (Upper level)	56.9	57.8	61.2
9a	9 Paeroa R (Lower level)	56.9	57.8	61.0
10	563 State Highway 1	52.5	53.4	54.1
11	594 State Highway 1	64.7	65.6	61.0
12	559 State Highway 1	58.9	59.7	61.6
13	549 State Highway 1	61.6	62.4	63.2
14	533 State Highway 1	57.9	60.5	57.4
15	535 State Highway 1	64.0	64.9	60.5
16	537 State Highway 1	56.2	57.1	55.9
17	541 State Highway 1	57.9	58.8	56.7
18	537A State Highway 1	52.9	53.8	52.7
19	527 State Highway 1	54.0	54.9	53.6
20	519 State Highway 1	65.8	66.7	62.1
22	516 State Highway 1	60.6	61.5	63.8
23	514 State Highway 1	58.7	59.6	61.7
24	19 Clay Road	58.0	58.9	58.7
25	13 Clay Road	59.9	60.7	59.9
26	7 Clay RD (Upper level)	64.3	65.2	60.8
26a	7 Clay RD (Lower level)	63.9	64.8	60.4
27	6 Clay Road	65.3	66.2	61.9
28	9 Clay Road	59.6	60.4	59.5
29	10 Clay Road	59.5	60.3	59.6
30	16 Clay Road	56.1	57.0	56.5
31	22 Clay Road	54.4	55.3	54.9

Table 4-5: Predicted noise levels (all values $L_{Aeq(24\ hour)}$ dB).

Figure 4-1 provides a description of the traffic noise increase for the Do-Minimum at year 2028 compared to the Do Nothing for the same design year.

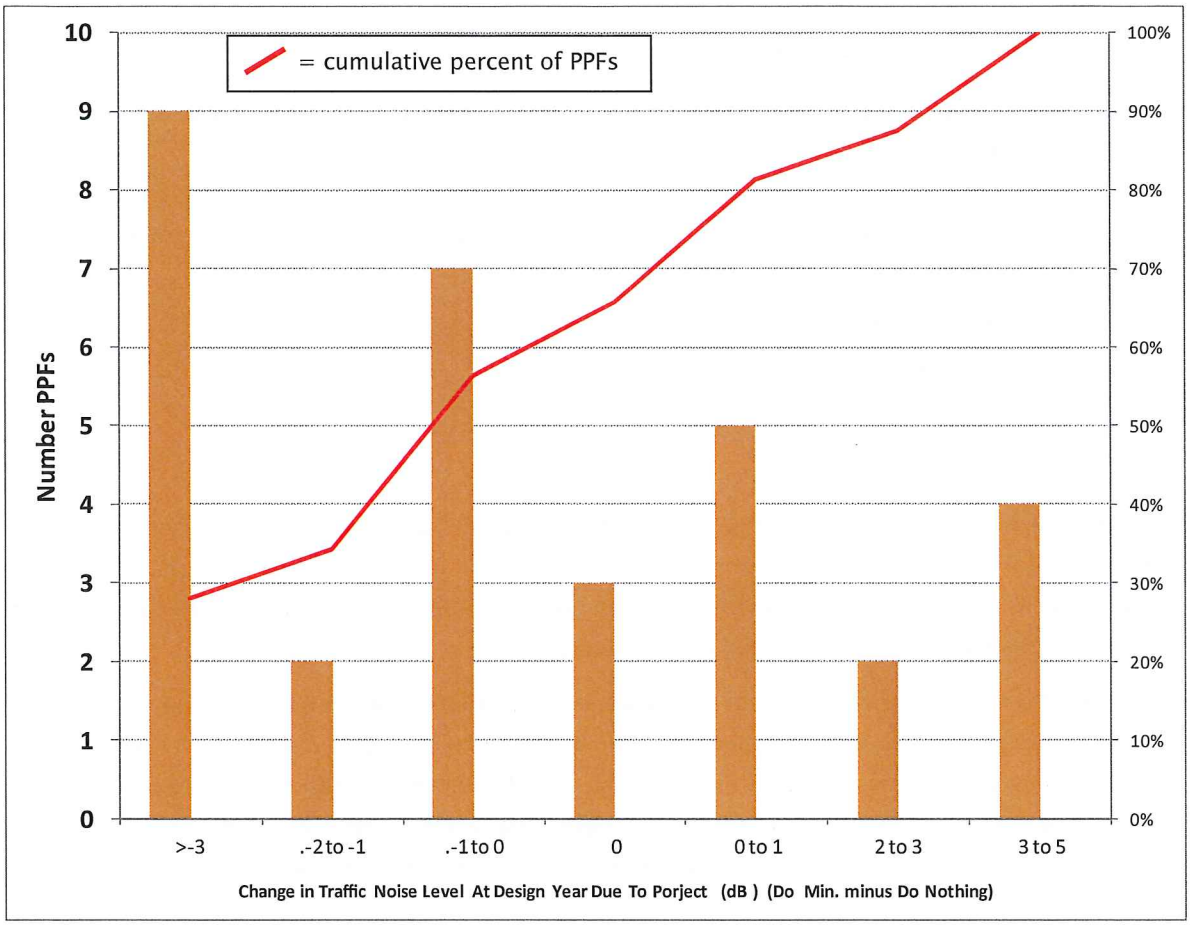

Figure 4-1 Number of PPFs (frequency and cumulative percent) versus dB change in LAeq(24 hr) noise level at the design year, with the project in place (Do- Minimum) compared to the Do Nothing option (Do Nothing option = as if the project did not exist, but noise from "normal" traffic growth included).

Overall, at the future design year operational noise from the re-aligned State Highway will remain the same or decrease for around two thirds of affected PPF's. Of those PPF's where an increase in traffic noise at the design year is expected, the average increase is 2.3 dB with a maximum increase of 6.2 dB for a single PPF (648 State Highway 1). The average noise level change for those PPFs expected to receive >60 dB LAeq(24hr) was found to be close to zero owing to expected increases at some PPFs being matched by comparable reductions at other PPFs.

5 Design and Mitigation

5.1 Alignment

The proposed works will ultimately result in the highway being re-built slightly closer or further away from PPFs compared to the current alignment. The designation boundary includes land on which the following existing PPF's are located;

- 577 State Highway 1
- 511 State Highway 1
- 607 State Highway 1

The new alignment will adversely affect these dwelling locations, either through direct land take necessary for the new alignment, or because the new alignment will lie in very close proximity to the PPF resulting in unacceptable safety or living conditions for the occupants. Potential noise and vibration effects on these PPF's have therefore not been assessed within this report.

For some PPFs the preferred alignment does not alter the available buffer distance. There will be potential noise reductions for those PPFs where the future alignment increases the available buffer distance. Consequently the noise assessment process does not identify these locations as warranting additional noise mitigation. It has been found that the straightening of the curves will result in noise increases at those PPFs located near to the road, and within the broad arc of the existing curves which are proposed to be straightened.

5.2 Mitigation Options

Owing to the expected low levels of noise effects of the project, and the inclusion of a limited number of dwellings within the land to be designated for use in the project, no specific noise mitigation options were required to be assessed under the NZS 6806 criteria. Either the future noise levels did not achieve a significantly high noise level at each dwelling location, or where increases are experienced, the degree of increase is quite moderate being less than the minimum required to trigger implementing noise mitigation measures under NZWS6806:2010.

6 Assessment

The proposed route closely follows the existing State highway, with most PPFs currently exposed to road-traffic noise from the State highway. The correct noise assessment criteria to apply to the project are those of NZS6806:2010.

6.1 Traffic Noise Effects Assessment

Taking into account the expected "Do Minimum" traffic noise levels for each PPF in the future (2028) operational noise effects of the Waitarere Curves Project are not likely to be significant or detract from the area as a place to live.

No extra noise mitigation measures are needed to ensure a satisfactory living environment according to the NZS6806:2010 assessment methodology[6].

On this basis, adopting traffic noise levels predicted for year 2028 (and excluding all dwellings currently located within the designation boundary) traffic noise effects are considered to be low without any sites receiving any significant adverse noise effect.

The PPF assessed exclude a number of PPFs that were considered in the assessment areas but are beyond the 200 m distance from the road specified by NZS 6806. There are no PPFs located beyond 200 metres from the alignment that are considered likely to be affected by noise associated with the project works, except in a less than minor way.

6.2 Operational Vibration Effects

The potential vibration effects from the operation of the Project relate to vehicles using the new realigned road and is therefore, related to the quality of the road surface and the speed of traffic.

Vibration effects of the proposed realignment have been investigated. Vehicles on new and altered state highways generally cause negligible adverse vibration effects. The Transport Agency does not routinely assess vibration for specific new and altered state highway projects, unless, for example, there are PPFs immediately adjacent to a new traffic lane[7].

The Transport Agency assesses road-traffic vibration from altered state highways around compliance with "Class C levels" set out in Norwegian Standard NS 8176E:2005 *Vibration and shock - Measurement of vibration in buildings from landbased transport and guidance to evaluation of its effects on human beings*[8]. Such standards are almost always met for new or altered roads that have a road surface free from irregularities. No vibration effects are predicted to be negligible at any of the PPFs located in the area, including those to which the re-aligned highway will pass closer too, but excluding those PPFs that are to be removed as they are located within the designated site for the project .

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[6] See NZTA's *Guide To Assessing Road-Traffic Noise Using NZS6806 For State Highway Asset Improvement Projects.* Oct 2011

[7] See https://acoustics.nzta.govt.nz/sites/default/files/Tech-memo-NV3-State-highway-noise-and-vibration-management-v1.0.pdf

[8] See www.standard.no/en/

6.3 Construction Noise & Vibration Assessment

Construction noise has the potential to generate significant levels of noise at dwellings during daytime. The following construction noise guidelines (based on NZ Standard NZS6803:1999 *Acoustics – Construction Noise*) have been adopted by the Transport Agency:

Noise criteria at residential sites

		Duration of works					
		Less than 14 days		Less than 20 weeks		More than 20 weeks	
	Time period	$L_{Aeq(15\ min)}$	L_{AFmax}	$L_{Aeq(15\ min)}$	L_{AFmax}	$L_{Aeq(15\ min)}$	L_{AFmax}
Weekdays	0630–0730	65dB	75dB	60dB	75dB	55dB	75dB
	0730–1800	80dB	95dB	75dB	90dB	70dB	85dB
	1800–2000	75dB	90dB	70dB	85dB	65dB	80dB
	2000–0630	45dB	75dB	45dB	75dB	45dB	75dB
Saturdays	0630–0730	45dB	75dB	45dB	75dB	45dB	75dB
	0730–1800	80dB	95dB	75dB	90dB	70dB	85dB
	1800–2000	45dB	75dB	45dB	75dB	45dB	75dB
	2000–0630	45dB	75dB	45dB	75dB	45dB	75dB
Sundays and public holidays							
	0630–0730	45dB	75dB	45dB	75dB	45dB	75dB
	0730–1800	55dB	85dB	55dB	85dB	55dB	85dB
	1800–2000	45dB	75dB	45dB	75dB	45dB	75dB
	2000–0630	45dB	75dB	45dB	75dB	45dB	75dB

Noise criteria at commercial/industrial neighbours

Any day	0730–1800	80dB	–	75dB	–	70dB	–
	1800–0730	85dB	–	80dB	–	75dB	–

Compliance with the above construction noise limits adopted from NZS 6803 has been based on assessment of noise expected for typical road construction activities involving significant earthworks and checked using the construction sound calculator on the Transport Agency Transport Noise website (www.acoustics.nzta.govt.nz). From these calculations, buffer distances required from construction activities to comply with guideline noise limits can be calculated for various sectors of the project. It has been determined construction activities will be able to comply at all times with the daytime LAeq and LAFmax limits for "long term" projects.

Methods such as implementing "Construction Noise & Vibration Management Plans" help ensure construction management responsibilities are properly implemented by contractors and subcontractors will ensure construction noise effects are adequately mitigated.

Regarding construction vibration effects, the works will fully comply with the Transport Agency's guideline criteria developed for road construction projects as follows;

Vibration level (component ppv)	effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for vibration frequencies associated with construction and maintenance. At lower frequencies, people are less sensitive to vibration.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	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.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

Table 6-1: Vibration levels from vibratory compactor

In addition, owing to the nature of the proposed construction works and available buffer distances, compliance will also be able to be achieved with ISO 4866:2010 '*Mechanical vibration and shock - Vibration of fixed structures- Guidelines for the measurement of vibrations and evaluation of their effects on structures'* and BS5228-2:2009 '*Code of Practice for Noise and Vibration Control on Construction and Open Sites - Part 2: Vibration'.*

6.4 Uncertainty

By performing a measurement, the true value of a parameter is only known to within a measurement uncertainty. Best practice is to provide within acoustic reports an "Uncertainty Budget" that considers each separate contribution to the uncertainty chain, evaluates its contribution, and then combines them according to set statistical procedures. The methodology followed is that proposed by Craven and Kerry[9]. Uncertainty can arise with sound measurements where contributions from other noise sources affect the representativeness and repeatability of the ambient measurement. The possibility of errors of this type have been minimised by taking measurements at PPFs located close to the existing highway and avoiding times of high wind or rain.

An uncertainty budget has been drawn up and potential sources identified under the headings, source, transmission path and receiver. One of the most significant sources of possible error is the change in the source noise (assuming there is no resurfacing scheduled) which will most likely be due to variations in the traffic flow and its make-up (% heavy vehicles and average speed). The uncertainty budget developed for this project includes possible errors in estimating vehicle speed and % heavy vehicles as well as factors affecting sound propagation and receiver factors.

[9] N.J. Craven and G. Kerry. *A good practice guide on the sources and magnitude of uncertainty arising in the practical measurement of environmental noise.* University of Salford. 2001.

Source of uncertainty	Value (half width)	Conversion	Distribution	Standard uncertainty
Source				
Traffic flow		0.2 dB	Rectangular	0.11 dB
% HGV and	5% at 90km/hr	3.1 dB	Rectangular	1.8 dB
Mean speed	to 15% at 110km/hr			
Transmission path				
Weather	3 dB	3.0 dB	Rectangular	1.7 dB
Ground	min inc in weather			
Topography	No change	0.0 dB	Rectangular	0.0 dB
Receiver				
Position	1 m in 100 m	0.9 dB	Rectangular	0.50 dB
Instrumentation	1.9 dB	1.9 dB	Rectangular	1.1 dB
Background	Minimal			
Reflective surfaces	1.25 dB	1.25 dB	Rectangular	0.72 dB
Combined uncertainty				**2.9 dB**
Expanded uncertainty (95% confidence)				**5.7 dB**

Table 6-2: Measurement uncertainty budget

The above uncertainty summary indicates the predictions are reasonably reliable. Although a wide margin of potential error must be accepted if the results are assumed to be accurate within 95% of the true value, however that is a high standard of certainty. The fact that the errors tend to have a neutral bias, this means the error would spread evenly about a mean, such that the overall effect is that the results are sufficiently reliable for assessment and design purposes.

7 Summary

Road traffic noise and vibration effects have been assessed for all dwellings and sensitive sites (PPFs) within 200 metres of the alignment. Field readings indicate there are significant levels of traffic noise currently present in the area. The future predictions take into account traffic growth and traffic composition for a design year of 2028.

The assessment of operational noise is guided by NZS6806:2010, a New Zealand Standard specifically developed to be applied to assess mitigation requirements for noise from new or altered roads.

Noise modelling has been carried out adopting the standardised methods and site-specific data outlined. The results show that traffic noise levels for the "do minimum" noise environment at year 2028 for this project are such that:

(a) there are no PPFs with an expected do minimum noise environment reaching 64 dB LAeq(24h) or greater at the design year that will experience a change in noise of +3 dB or more; and

(b) there are no PPF's with a do minimum noise environment above 68 dB LAeq(24h) at the design year.

As the existing formed legal road lies at close proximity to all parts of the proposed new alignment, the Project does not qualify as a "new" road under NZS6806:2010.

Thus, the noise effects due to operation of the proposed realigned state highway are insufficient to trigger the standardised mitigation assessment methodology developed specifically for this type of purpose (and is in fact, the only relevant criteria available for this purpose in New Zealand).

The mitigation assessment methodology (involving an analysis of costs and benefits of implementing certain noise mitigation measures) have not needed to be implemented because;

a) At the future design year operational noise from the re-aligned State Highway will remain the same or decrease for around two thirds of affected PPF's.

b) Where an increase in traffic noise at the design year is expected at a PPF:
   - The average increase is 2.1 dB with a maximum increase of 6.2 dB for a single PPF (648 State Highway 1).
   - The average noise level change for those PPFs expected to receive >60 dB LAeq(24hr) was found to be 0.3 dB. This reflects the fact that noise increases at PPF's were mostly experienced by PPF's located at significant distance from the highway.

Overall, the noise effects are expected to be minor or less than minor. Adopting the usually applied assessment methodology which has been adopted within other new or altered roading projects, no specific operational noise mitigation measures are recommended.

Expected noise effects during earth works and construction activities have also been investigated. Noise from earthworks and preparing the new road surface will, at times, exceed current ambient noise levels found in the area. The shifting of significant quantities of earth and fill will mean the frequent use of diggers, transport trucks, rollers and compaction equipment, sometimes in close proximity to dwellings.

Limiting adverse noise and vibration effects during the construction phase can be addressed within conditions such as conditions requiring the Requiring Authority to prepare a Construction Noise & Vibration Management Plan to be certified by Council setting out the methods to be adopted to ensure the levels of construction noise comply with the relevant noise Standard (NZS6803:1999) and standards for protecting people and dwellings from excessive ground vibration due to construction works.

8 Conclusions

The Project has been assessed in accordance with NZS 6806 regarding potential traffic noise effects of the Project. For each Protected Premises and Facilities (PPFs) within 20 metres of the alignment future road traffic noise levels are insufficient to require any specific noise mitigation measures be adopted under NZS6806:2010.

Vibration effects of the proposed realignment have been investigated. Based on experience and observations in the area, the proposed realignment will not be likely result in an PPF receiving any traffic-inducted vibrations perceptible beyond the designation boundary.

The potential adverse effects of noise and vibration associated with the temporary construction works associated with the Project have also been investigated. Potential adverse effects are considered to be able to be adequately managed and controlled through conditions, including via the implementation of a Construction Noise & Vibration Management Plan.

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November 2015

Glossary

Abbreviation	Meaning	Abbreviation	Meaning
AADT	Annual average daily traffic	NoR	Notice of requirement
AC	Asphaltic concrete	NZS	New Zealand Standard
AEE	Assessment of effects on the environment	Transport Agency	New Zealand Transport Agency
BCR	Benefit-cost ratio	OGPA	Open graded porous asphalt
BoI	Board of Inquiry	PPF	Protected premises and facilities
BPO	Best practicable option	PPM	Planning policy manual NZTA
BS	British Standard	RoNS	Road of national significance
CRTN	Calculation of road traffic noise	RP	Route position
dB	Decibels	RMA	Resource Management Act 1991
EPA	Environmental Protection Authority	SAR	Scheme assessment report
GIS	Geographic information system	SH1	State Highway 1
HV	Heavy vehicle	SMA	Stone mastic asphalt
Hz	Hertz	TRRL	Transport and Road Research Laboratory (UK)
km	Kilometre	WHO	World Health Organisation
km/h	Kilometres per hour	vpd	Vehicles per day

Term	Definition
Alignment	The horizontal or vertical geometric form of the centre line of the carriageway.
Amenity values	Defined in section 2 of the RMA as: "those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes."
Annual average daily traffic	The total volume of traffic passing a roadside observation point over the period of a calendar year, divided by the number of days in that year (365 or 366 days). Measured in vehicles per day.
Benefit-cost ratio	The ratio that compares the benefits accruing to land transport users and the wider community from implementing a project or providing a service, with that project's or service's costs.
Best practicable option	Defined in section 2 of the RMA as: "in relation to a discharge of a contaminant or an emission of noise, means the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to - (a) the nature of the discharge or emission and the sensitivity of the receiving

Term	Definition
	environment to adverse effects; and (b) the financial implications, and the effects on the environment, of that option when compared with other options; and (c) the current state of technical knowledge and the likelihood that the option can be successfully applied."
Bridge	A structure designed to carry a road or path over an obstacle by spanning it. This includes culverts with a cross-sectional area greater than or equal to 3.4 square metres.
Carriageway	That portion of the road devoted particularly to the use of travelling vehicles, including shoulders.
Centreline	The basic line, at or near the centre or axis of a road or other work, from which measurements for setting out or constructing the work can conveniently be made.
Chip seal	A wearing course consisting of a layer or layers of chips originally spread onto the pavement over a film of freshly sprayed binder and subsequently rolled into place.
Clear zone	An area adjacent to a road carriageway that is clear of fixed objects and other hazards, providing a recovery zone for vehicles that have left the carriageway.
Conditions	Conditions placed on a resource consent (pursuant to section 108 of the RMA) or conditions of a designation (pursuant to subsection 171(2)(c) of the RMA).
Cross-section	A vertical section, generally at right-angles to the centreline showing the ground. On drawings it commonly shows the road to be constructed, or as constructed.
Deceleration lane	A speed-change lane provided to allow vehicles to decrease speed.
Designation	Defined in section 166 of the RMA as: "a provision made in a district plan to give effect to a requirement made by a requiring authority under section 168 or section 168A or clause 4 of schedule 1."
Design life	The period during which the performance of a pavement is expected to remain acceptable.
Design speed	A speed fixed for the design of minimum geometric features of a road.
Design year	The predicted year in which the design traffic volume would be reached.
Effect	Defined in section 3 of the RMA as: "(a) Any positive or adverse effect; (b) Any temporary or permanent effect; (c) Any past, present, or future effect; (d) Any cumulative effect which arises over time or in combination with other effects – Regardless of the scale, intensity, duration, or frequency of the effect and also includes – (e) Any potential effect of high probability; and (f) Any potential effect of low probability, which has a high potential impact."
Embankment	A construction work (usually of earth or stone) that raises the ground (or formation) level above the natural surface.
Environment	Defined in section 2 of the RMA and includes: "(a) Ecosystems and their constituent parts, including people and communities;

Term	Definition
	(b) All natural and physical resources; (c) Amenity values; and (d) The social, economic, aesthetic and cultural conditions which affect the matters stated in paragraphs (a) to (c) of this definition or which are affected by those matters."
Expressway	A road mainly for through traffic, usually dual carriageway, with full or partial control of access. Intersections are generally grade separated.
Footpath	That portion of the road reserve set aside for the use of pedestrians only.
Free-field (Noise)	Description of a location which is at least 3.5 metres from any significant sound reflecting surface other than the ground.
Guard rail	A rail erected to restrain vehicles from physically leaving the road, including wire-rope barriers.
Hertz	Unit of frequency, used for sound and vibration.
Interchange ramp	A carriageway within an interchange providing for travel between two arms (legs) of the intersecting roads.
Interchange	A grade separation of two or more roads with one or more interconnecting carriageways.
Intersection	A place at which two or more roads cross at grade or with grade separation.
$L_{Aeq(24h)}$	Time-average sound level over a twenty-four hour period, measured in dB.
Local road	A road (other than a State highway) in the district, and under the control, of a territorial authority, as defined in Section 5 of the Land Transport Management Act 2003.
Median barrier	A device used on multi-lane roads to keep opposing traffic within their prescribed carriageways.
Noise	Noise may be considered as sound that serves little or no purpose for the exposed persons and is commonly described as 'unwanted sound'.
Notice of requirement	A notice given to a territorial authority (under section 168 of the RMA) or by a territorial authority (under section 168A of the RMA) of a requirement for land, water, subsoil or airspace to be designated.
Outline plan	A plan of the public work, project, or work to be constructed on designated land provided to a territorial authority, pursuant to section 176A of the RMA, prior to the work being undertaken.
Ramp	Carriageway within an interchange providing for travel between two arms (legs) of the intersecting roads.
Retaining wall	A wall constructed to resist lateral pressure from the adjoining ground or to maintain in position a mass of earth.
Reverse sensitivity	The vulnerability of an established activity to objection from a new sensitive land use.
Road	An area formed for vehicular traffic to travel on. The term 'road' describes the area between kerbs or surface water channels and includes medians, shoulders and parking areas.
Road reserve	A legally described area within which facilities such as roads, footpaths and associated features may be constructed and maintained for public travel.

Term	Definition
Roundabout	An intersection where all traffic travels in one direction around a central island.
Sound	Sound (pressure) levels are an objective measure of changes in pressure levels that may be heard by humans. Unwanted sound can be considered as noise.
Traffic flow	The number of vehicles passing a given point during a specified period of time.
Traffic lane	A portion of the carriageway allotted for the use of a single line of vehicles.
Traffic volume	The number of vehicles flowing in both directions past a particular point in a given time (e.g. vehicles per hour, vehicles per day).
Vehicles per day	The number of vehicles observed passing a point on a road in both directions for 24 hours.

Appendix A "Do Minimum" Noise Contour Plot

Predicted contours of equal sound pressure ($L_{Aeq(24\ hour)}$ dB, for the "Do Minimum" option.