APPENDIX D – NOISE ASSESSMENT

Ōtaki to north of Levin Expressway Project

Preliminary Traffic Noise Review Report

For;

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Ōtaki to North of Levin Expressway Project

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Executive Summary

Malcolm Hunt Associates have been engaged by Stantec, as agents to NZ Transport Agency to provide a review of noise and vibration aspects of the O2NL Project, in relation to the current process of identifying the preferred route option(s).

This preliminary assessment includes;

1. A description of the methods used in New Zealand for managing and assessing traffic noise associated with new roading projects under the Resource Management Act and the relevant environmental noise standards and guidelines
2. A summary of the widely understood effects of traffic noise on people's health and welfare and as a social stressor. .
3. An updated 'Tier 1' traffic noise assessment for the O2NL project based on short-listed route options adopted for recent community and stakeholder consultation, locational data on dwellings and sensitive receiver sites located adjacent to each of the route options.
4. A generic description of potential traffic noise mitigation methods that may be effectively adopted within the O2L project.
5. Summary information on the existing noise environment typically found within the wider project area.
6. Commentary on traffic noise-related comments found within submissions received by the Project Team during the community engagement in February/March 2018 from affected landowners and the community.

The information and assessment contained in this review report provide a rational basis to assess potential traffic noise effects associated with each of the main route options short-listed for public consultation. The results of the generic 'Tier 1' assessment of noise levels indicates a ranking for the most preferred to least preferred in general noise effect terms.

The report indicates 'new' noise emissions associated with route options passing through rural areas remote from the current state highway could elevate existing sound levels significantly within limited areas.

The assessment methodology of NZ Standard NZS6806:2010 to be applied during subsequent, more detailed investigation stage, has been identified as a suitable method to ensure cost-effective mitigation noise measures are included within the design of the finally selected preferred route option(s).

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Ōtaki to North of Levin Expressway Project

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Preliminary Traffic Noise Review Report

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1 Background

1.1 The Ōtaki to north of Levin (Ō2NL)expressway project commences at Taylors Road, Ōtaki to tie in to the PekaPeka to Ōtaki expressway. The planned route extends northwards to the northernmost extent of the Ō2NL project immediately south of the Manawatū River at State Highway 1. It is noted the section north of Levin to the Manawatū River is not included within the current expressway investigations.

1.2 We understand the project has the following objectives;

- to reduce deaths and serious injuries on the state highway network
- to reduce travel times on the state highway network
- to enhance the resilience of the state highway network
- to provide appropriate connections that integrate the state highway and local road networks to serve urban areas.

1.3 The project forms part of the Wellington Northern Corridor which aims to promote economic growth and deliver economic benefits for the country. We understand the aims of the O2NL section of the Wellington Northern Corridor is to provide a modern and safe state highway network that will reduce deaths and serious injuries whilst accommodating future traffic volumes and enhancing inter-regional and national economic growth and productivity.

1.4 We further understand the reasons for the project include that in the future the current state highway (a National State highway) will not accord with the function expected of a National State highway which is likely to be exacerbated once the PekaPeka to Ōtaki expressway is open to traffic in 2020.

1.5 We have been provided with the short-listed route options for the O2NL expressway which show a four lane expressway from Taylors Road to north of Levin. All the options commence at Taylors Road north of Ōtaki, linking in with the PekaPeka to Ōtaki Expressway, and end just north of Levin. The route options are made up of a southern option (S6, S7, S7A) and a northern option (N4, N5, N9). The Project team have indicated that the options identified enable each of the southern options to be linked with each of the northern options to form nine potential corridors for the O2NL project.

1.6 We understand the Transport Agency are currently in an options evaluation process to select a preferred route among the short-listed options. Within this context, the Transport Agency has requested Malcolm Hunt Associates (MHA) to prepare this preliminary noise review report (also including comments on noise matters raised within the consultation process, and an update of the earlier 2016 'Tier 1' traffic noise assessment).

1.7 The route options are summarised within Figure 1 as follows:

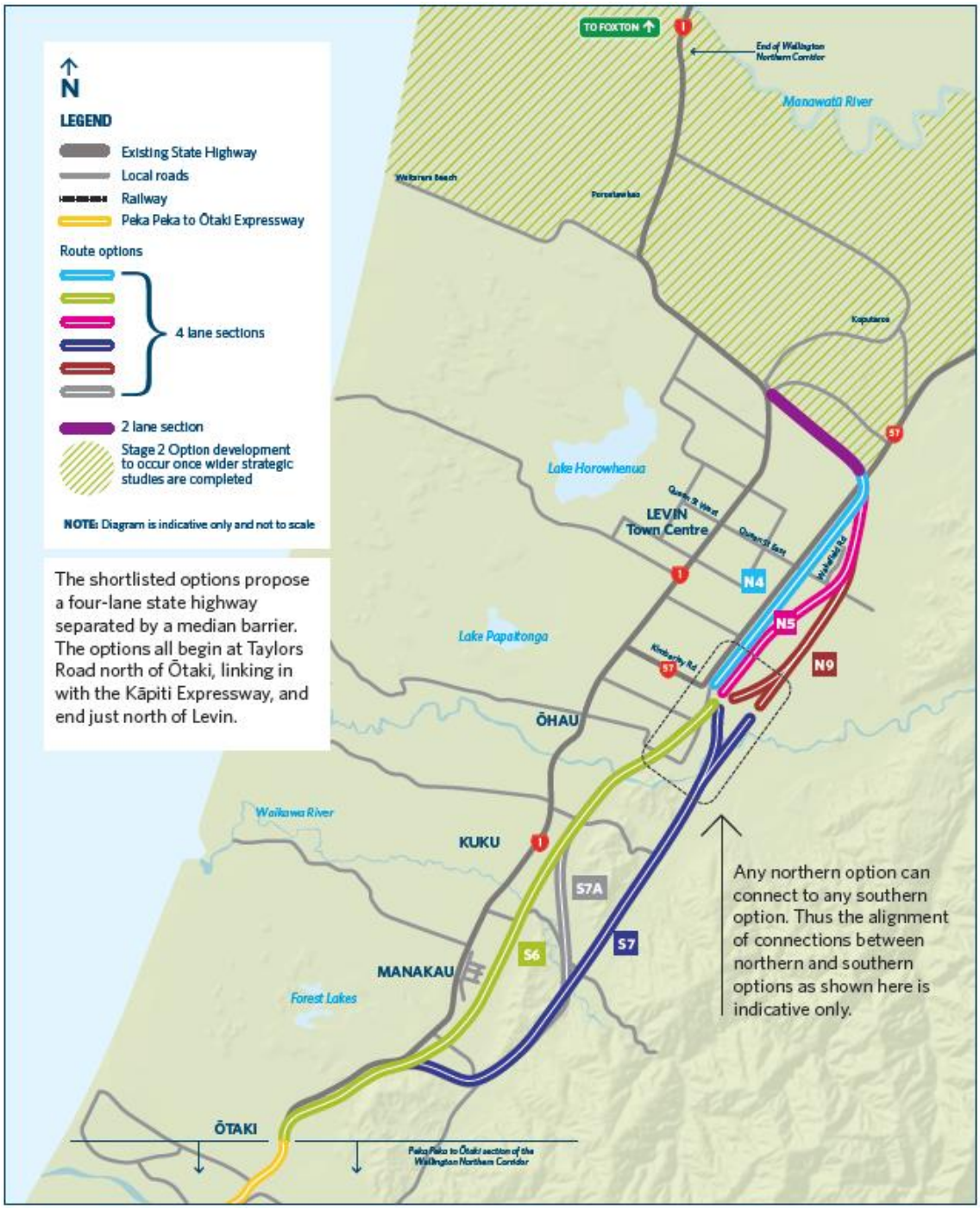

Figure 1 Short-listed route options currently under consideration.

1.8 As shown within Figure 1, all of the corridor options lie to the east of the existing State Highway 1, begin at Taylors Road north of Ōtaki, linking to the PekaPeka to Ōtaki section of the Kāpiti Expressway and re-join the existing SH1 just north of Levin.

1.9 Previous Consultation Reports prepared for the Ō2NL project published in August 2013, April 2014 and February 2016 identify potential noise and vibration effects associated with the proposed expressway.

2 Scope

2.1 Given the above context, this report sets out:

a) Section 3 sets out the methods used for managing and assessing traffic noise as an environmental externality of roading projects in New Zealand, including a summary of the widely understood effects of traffic noise on people's health and welfare and as a social stressor. This section also sets out the over-arching duty to manage the effects of environmental noise under the Resource Management Act and provides a summary of the relevant environmental noise standards and guidelines.

b) Section 4 sets out the methods adopted for traffic noise assessment for new and altered roads in New Zealand.

c) Section 5 contains an updated 'Tier 1' traffic noise assessment for the O2NL project based on short-listed route options adopted for recent community and stakeholder consultation. The assessment utilises spatial data provided by Stantec on the location of dwellings and sensitive receiver sites located in areas potentially affected by noise emitted by each of the route options. This section also comments on the earlier (2015) 'Tier 1' traffic noise and vibration assessment with the above 'updated' 'Tier 1" noise assessment.

d) Section 6 provides a generic description of potential traffic noise mitigation methods. This section identifies the types of noise mitigation methods that may be effective within the O2NL project.

e) Section 7 sets out information describing (in summary fashion) the existing noise environment found within the wider Horowhenua area typical of ambient sound levels currently within the more remote rural parts of the project area. Commentary is provided on the district plan allowable noise limits (applying to permitted activities in rural areas other than road traffic noise) and discusses the extent of change expected in areas with current low ambient sound levels.

f) Section 8 sets out a response to traffic noise-related comments included within submissions received by the Project Team during the community engagement in February/March 2018 from affected landowners and the community.

g) A brief overview of this report is provided within Section 9.

3 Managing Traffic Noise Effects in NZ

3.1 Noise in the environment can cause a range of effects on the health and welfare of people which has been summarised as follows;

- annoyance
- mental health effects (including noise-induced stress-related effects)
- sleep disturbance - in addition to fatigue and mental health effects, disrupted sleep patterns can leave people irritable, change their behaviour, and reduce their ability to work or perform tasks.
- speech interference - high levels of noise in the environment can interfere with verbal communication.
- performance - some noise can make concentration difficult and interfere with tasks such as learning, checking fine details or work where small, precise, movements or intense concentration is required.

3.2 These effects are required to be addressed within NZ Transport Agency's State Highway Environmental and Social Responsibility (ESR) plan[1] which covers the planning, design, and operation of New Zealand's state highway network. The ESR plan, mandated by Section 96(1)(a) of the Land Transport Management Act requires that the NZTA exhibit a sense of social and environmental responsibility. The ESR plan refers to promoting a safe and efficient transport system that avoids "*to the extent reasonable in the circumstances*" adverse environmental and social impacts.

3.3 In addition, the **New Zealand Transport Strategy** sets out Government's vision for a transport system that is affordable, integrated, safe, responsive and sustainable. Objective 4 of the 2008 New Zealand Transport Strategy included *"protecting and promoting public health".* The recent 2018/19 draft transport strategy[2] closely parallels this objective as it seeks to promote "*A land transport system that reduces the adverse effects on the climate, local environment and public health*". The draft wording specifically seeks (paragraph 124) to address areas where transport has an adverse effect on the local environment and public health including addressing "*excessive unreasonable noise and vibration".*

3.4 The **New Zealand Health Strategy** 2016[3] highlights that factors in the environment strongly influence people's health which supports the premise elevated noise in the environment is a serious environmental effect that requires management and mitigation where necessary.

3.5 Within this context, it is important to ensure that noise (and vibration) effects of highway projects such as the ON2L Project are appropriately assessed and managed. Since 2010 significant state highway projects in New Zealand requiring approval under the Resource Management Act 1991 have had their potential traffic noise effects (of new or altered roads) assessed using NZ *Standard NZS6806:2010 Acoustics – Traffic Noise - New And Altered Roads* which is considered best practice in terms of applicable methods for assessing road traffic noise of the current O2NL project.

4 Traffic Noise Assessment

4.1 The Horowhenua District Plan identifies "reverse sensitivity" noise issues for sensitive uses being established adjacent to existing land transport corridors. However this is not relevant where existing dwellings and other "protected premises and facilities" (PPFs) may be affected by noise from proposed new highways.

4.2 The District Plan controls on noise emitted from 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 Horowhenua 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 are no specific District Plan controls that require 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.

4.3 NZS 6806:2010 sets out recommended methods for assessing road traffic noise effects of new or altered roads in New Zealand. This Standard provides a consistent methodology for the application of resources to mitigate that noise which is exceeding the relevant criteria. The noise criteria contained in the Standard have been developed taking into account health effects associated with noise; the effects of noise levels on people and communities; affordability considerations; and the potential benefits of new and altered roads to people and communities.

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[1] *State Highway Environmental Plan: Improving Environmental Sustainability And Public Health In New Zealand*. NZ Transport Agency June 2008. Ref. https://nzta.govt.nz/assets/resources/environmental-plan/docs/environmental-plan.pdf

[2] Draft Government Policy Statement On Land Transport: 2018/19 – 2027/28

[3] Minister of Health 2016. *New Zealand Health Strategy: Future direction*. Wellington: Ministry of Health. Published in April 2016.

4.4 According to NZS 6806:2010 a new road means any road which is to be constructed where no previous formed legal road existed. As the Project comprises a mix of new and altered roads, the criteria applying under NZS6806:2010 are for both new and altered roads, particularly in the vicinity of linkages to the existing roading network.

4.5 Assessment of traffic noise under NZS6806:2010 is undertaken at locations referred to as Protected Premises & Facilities (PPFs) and has therefore been adopted as the means by which traffic noise effects at noise sensitive locations has been described. The definition of PPFs within NZS6806:2010 includes:

> *(a) Buildings used for residential activities including;*
> *(i) Boarding establishments;*
> *(ii) Homes for elderly persons;*
> *(iii) Retirement villages;*
> *(iv) In-house aged-care facilities;*
> *(v) Buildings used as temporary accommodation facilities in residentially zoned areas, including hotels and motels, but excluding camping grounds.*
> *(b) Marae;*
> *(c) Spaces within buildings used for overnight patient medical care; and*
> *(d) Teaching areas and sleeping rooms in buildings used as educational facilities including tertiary institutions and schools, and premises licensed under the Education (Early Childhood Centres) Regulations, and playgrounds which are part of such facilities and located within 20 m of buildings used for teaching purposes.*

4.6 The Standard uses the LAeq(24h) descriptor for the assessment of road traffic noise based on it being "the preferred metric in New Zealand"[4]. See section 8 for a discussion of units used to assessing traffic noise impact. Section 6 of NZS 6806:2010 describes the noise criteria set out in units LAeq(24 hr) that are applied to road traffic noise from new and altered roads. The basis of the noise criteria set out in NZS6806:2010 is the concept that the best practicable option (BPO) to mitigate road traffic noise effects, as applies to all noise-making activities authorised under the Resource Management Act 1991.

4.7 The noise criteria of NZS6806:2010 are set out under three categories – **Category A**, which provides the best option for reducing noise, and **Categories B and C**, which allow higher levels of noise. Noise criteria apply at the assessment position(s) of PPFs for the design year as detailed below: These categories are applied as follows.

4.8 Noise criteria apply at the assessment position(s) of PPFs for the design year as detailed below:

> a) Where consistent with the best practicable option for the mitigation of road-traffic noise, the criteria of Category A shall apply;
>
> b) Where it is inconsistent with the adoption of the best practicable option to achieve the criteria of Category A , the criteria of Category B shall apply;
>
> c) Where it is inconsistent with the adoption of the best practicable option to achieve the criteria of Category A or Category B and where the indoor noise levels of any habitable space would be greater than 45 dB LAeq(24h), the criteria of Category C shall apply;

4.9 In summary, the above criteria recommend that if it is determined that achieving the external noise criteria of the Standard is not consistent with adopting the BPO to achieve Category A or B noise criteria at the relevant PPFs (or where the internal noise levels of any habitable space would be greater than 45 dB LAeq(24h)), then building modification measures are to be employed to achieve Category C. It is noted that paragraph d) of Clause 6.1.2 applies in such circumstances (i.e. where it is inconsistent with the adoption of the best practicable option to achieve the criteria of Category A,

[4] NZS 6806:2010 page 14.

B or C the internal noise levels of any habitable space shall be mitigated to the extent that is practicable).

4.10 For noise from new roads, the thresholds for implementing noise mitigation measures commence when one or more PPFs are predicted to receive a noise increase of ≥3 dB LAeq(24h) at the design year when compared with the existing noise environment. The Standard provides clarification under C1.2.3 explaining that the predicted comparative increase is found by subtracting the existing sound environment from the predicted do-minimum noise environment. The 'do minimum' noise environment' is a prediction of the noise level at a PPF resulting from the implementation of the road including any incidental noise mitigation from safety barriers and other structures, but does not include any specific noise mitigation measures.

4.11 The 'Tier 1' traffic noise assessment provided below compares potential PPF's affected by the identified route option(s) for the ON2L Project. As explained in Section 5.0, a "Tier 1' noise assessment is an initial overview of potential noise effects of any specific route and is based solely on forecast daily traffic volumes and the number of protected premises affected. As the detailed investigation of noise mitigation has not taken place at this early stage, the assessment below presents results in terms of the potential number of PPF's requiring mitigation under the recommendations of NZS6806:2010 (that is, PPF's forecast to fall within Category B or Category C of NZS6806:2010).

NZS6806:2010 & Best Practicable Option

4.12 Section 16 of the Resource Management Act imposes a duty on all occupiers of land to ensure that noise levels are kept at a "reasonable level" by adopting the **best practicable option** for mitigation, a term defined in s2 of the Act to mean;

"….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 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."

4.13 The BPO concept is adopted within NZS6806:2010 to identify the most efficient and cost-effective noise mitigation option. To achieve this, as recommended within NZS6806:2010, the assessment locations are grouped geographically into "clusters" within natural groupings to facilitate the noise mitigation option assessment recommended by NZS6806:2010.

4.14 Section 8 of NZS6806:2010 sets out the circumstances under which noise mitigation generally is not generally required. This applies where:

- Any PPF falls within Category A;
- Where consent of the landowner or occupier cannot be obtained.

4.15 .The Standard helps to determine the BPO for mitigating noise on the basis of the noise levels meeting or bettering a set of noise criteria that it deems to be reasonable. The process requires acousticians to adopt assessment methods that prepare information about mitigation options and provide analysis of the acoustics benefit-cost ratio (BCR). For significant roading projects such as the O2L, the proposal is segmented into different noise assessment areas or 'sectors', and a number

of noise mitigation options (see NZS 6806 Table 3 – Recommended number of mitigation options to be assessed) are developed for each assessment area.

4.16 Clause 6.3 of the NZS6806 directs the user of the Standard to consider the following factors when determining the BPO for mitigating road traffic noise:

a) the extent to which compliance with the relevant noise criteria is achieved;

b) the extent to which structural mitigation measures (low-noise road surfaces and noise barriers e.g. walls, fences and bunds) will achieve:

i) an average reduction of at least 3 dB LAeq(24h) at the relevant assessment positions of all PPFs that are part of a cluster;

ii) a minimum reduction of 5 dB LAeq(24h) at any assessment position(s) for each PPF that is not part of a cluster[5].

c) the extent to which the use of sound insulation of buildings is needed;

d) plan or policy statement noise management provisions;

e) value for money based on benefit-cost analysis detailed in Appendix D of the Standard;.

f) visual;

g) urban design;

h) views of affected individuals and the known community views;

i) safety standards and guidelines;

j) technical feasibility;

k) land availability and associated cost;

l) ecological, heritage, scientific, cultural or other.

4.17 The identification of the finally preferred noise mitigation measures, identified using the NZS6806:2010 BPO selection process is a procedure undertaken at the detailed noise investigation stage, a future step beyond the current preferred route selection process.

5 Updated 'Tier 1' Traffic Noise Assessment

5.1 A 'Tier 1' assessment is a simple, preliminary assessment based on numbers of affected "sensitive sites" (PPF's - see Section 4) rather than acoustic modelling of noise levels at each affected site as is normally carried out later in the project, during the detailed assessment stage.

5.2 A 'Tier 1' assessment considers geographic information regarding the 'proximity' of PPFs to the proposed alignment(s) together with predicted (generic) LAeq(24 hr) traffic noise level information applicable to the various route options[6]. Although generic in nature, the estimated (unmitigated) noise levels predicted for the various setback distances, coupled with the number of PPFs found within various noise bands enable broad comparisons to be made between the expected noise effects across the route options.

5.3 This 'Tier 1' assessment is based on recently updated spatial data provided by Stantec which indicates the geographic location of each 'indicative' PPFs (such as dwellings, etc) located within the

[5] A "cluster" is defined within NZS6806:2010 as any teaching or medical facility; or a minimum of 3 PPFs that are on the same side of the road being assessed, and are not more than 100m from one another.

[6] NZTA Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects. NZ Transport Agency. Published August 2016 ISBN 978-0-478-44573-2.

study area, its proximity to the route option, and the shortest distance to the existing state highway 1 or 57.

5.4 This Tier 1 noise assessment differs from similar preliminary noise studies conducted under the NZTA guidelines because;

a) The study is based on comparing the number of PPFs affected by forecast levels of traffic noise at year 2041 in the future, a date well after the route has opened for use. This differs from a typical Tier 1 noise assessment which only considers traffic noise levels at the time the new route opens for use. Thus, this Tier 1 assessment is in fact a medium to long term view of potential traffic noise differences between the options.

b) The study area has included all PPFs identified within a 500 metre wide corridor along each route option (that is, all PPFs located within 250 metres each side of the centreline for each option). This exceeds the 400m corridor width usually adopted within a Tier 1 assessment and provides a further measure of conservancy within the assessment (for example, the assessment would remain robust should the centreline of the alignment shift 20 to 30 metres either side of the alignment centreline assumed within the current study)[7].

c) For each PPF identified within this 500m wide 'noise effects' corridor, expected traffic noise levels have not only been provided for the design year (2041) but also the expected 'Do Minimum' traffic noise levels at each PPF based on forecast traffic flows on State Highway 1 or 57 (also at the design year of 2041). The ability to assess changes from a 'Do Minimum' with the PPFs affected by any of the route options is usually included in subsequent detailed noise studies beyond a Tier 1 investigation.

5.5 The route options included in the assessment are the currently short-listing options (see Figure 1 above) of;

Northern Section
- N4
- N5
- N9

Southern Section
- S6 to N4
- S6 to N5
- S6 to N9
- S7 to N4
- S7 to N5
- S7 to N9
- S7A to N4
- S7A to N5
- S7A to N9

5.6 Any northern route option can connect to any southern route option. The results below are provided in terms of the result for each individual route option as well as the amalgamated 'whole length' result (this is the northern section result added to the relevant southern section result).

5.7 The number of PPF's identified within 250 metres each side of the specified route option have been investigated as a means of quantifying the initial pool of affected receiver sites. The number of PPFs

[7] Traffic noise levels received at any PPF located > 250m from the centreline of any route option are not considered likely to be unreasonable under the relevant standards and guidelines and have not been included within this Tier 1 assessment on that basis.

identified within the 500 metre wide corridor of each route option have been summarised separately for the northern and southern route options in Figures 2 and 3 below.

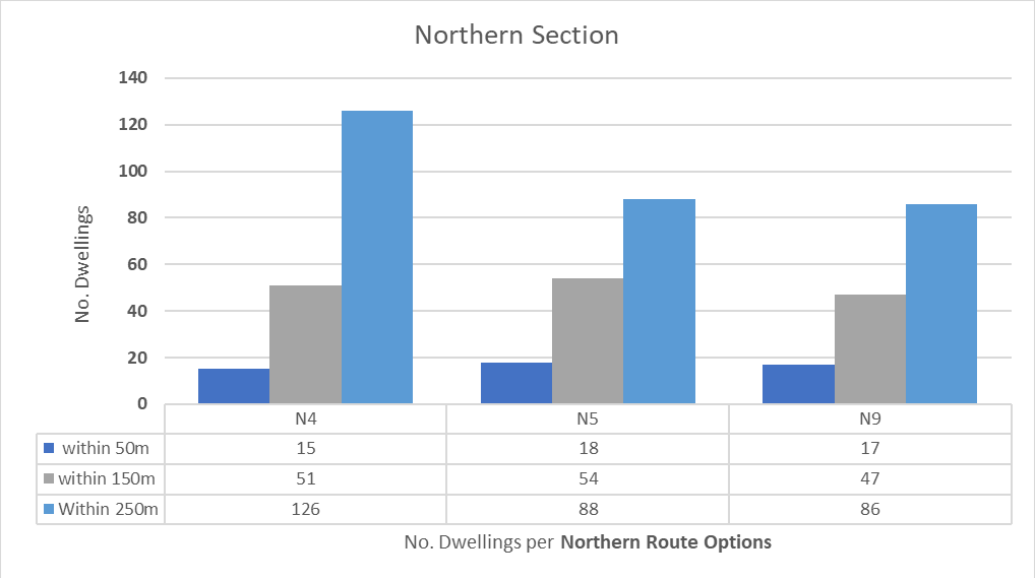

Figure 2 Number of PPFs identified within the given distances to the northern route options.

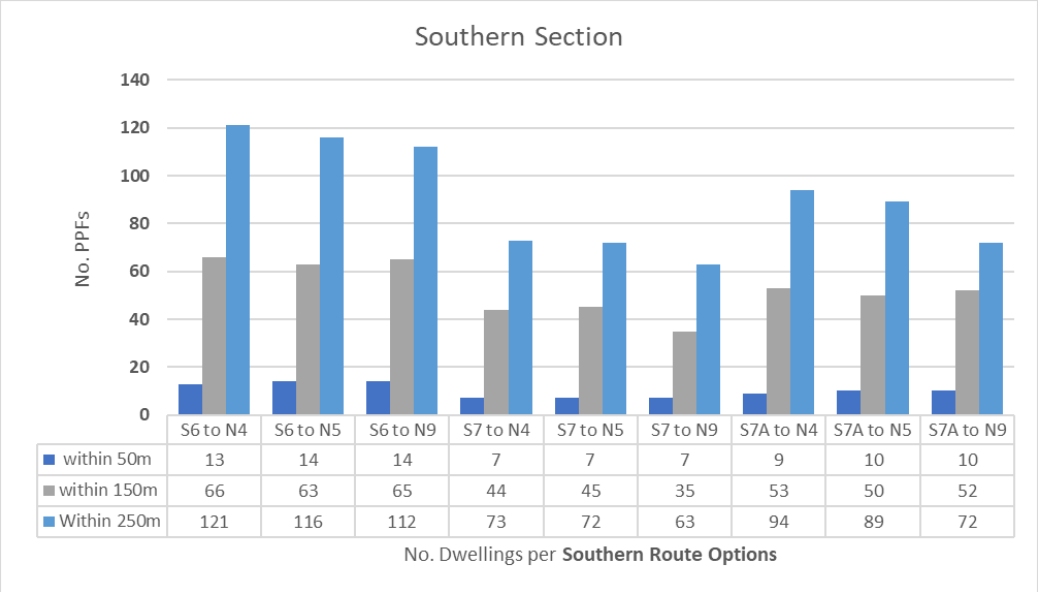

Figure 3 Number of PPFs identified within the given distances to the southern route options.

Traffic Noise Levels

5.8 Generic (unmitigated) $L_{Aeq(24\ hour)}$ traffic noise levels have been predicted for various distances, extending out 250 metres on each side of the route centreline based on NZTA's traffic noise calculator tool[8]. The predictions assume highway speed limits (100 km/hr), 10% heavy vehicles and a smooth asphalt road surface (AC 10) which is a relatively low-noise producing surface[9]. The ground surface is assumed to be 90% 'soft' ground surface (grass), with a flat terrain assumed and no assumed acoustic screening, or other noise mitigation measures in place.

[8] https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/tools/road-traffic-noise-calculator/
[9] https://www.nzta.govt.nz/assets/projects/cambridge/guide-to-assessing-road-traffic-noise.pdf

5.9 The following average daily traffic volumes at the design year of have been provided by the project traffic engineers are for a design year of 2041 based on the Horowhenua District Council (HDC) Long Term Plan (LTP) modelled[10] growth from 2011-2041 applied to 2017 actual traffic volumes.

5.10 The traffic volumes are grouped by as follows:

Groups 1, 2 and 3:

There are three route options south of a potential Tararua Interchange (S6,S7,S7A). The modelling of traffic flows has found traffic volumes will vary depending upon which northern route (N4, N5 or N9) road users using routes S6,S7,S7A are connecting to. This division gives rise to the grouping of traffic volumes shown below in Groups 1, 2 and 3. In order to provide a conservative assessment, traffic volumes adopted for Groups 1 to 3 have been set at the highest forecast traffic volume among options N4, N5 and N9. The highest forecast in all cases was found to be that associated with option N4. This is the traffic volume recorded below in the second column of Table 1.

Group 4:

Group 4 represents the three northern route options (north of a potential Tararua Interchange). As there is no possibility for traffic moving between the options (such as available for the southern options), a single traffic volume can be used to model noise emissions on the northern routes. As above, traffic volumes assumed for noise modelling are based on the option with the highest expected daily flow (N4).

Based on the above, traffic volumes adopted within this Tier 1 traffic noise assessment have been grouped according to route options with similar daily traffic volumes as follows.

	Traffic Volume (AADT)
GROUP 1 S6 to N4 S6 to N5 S6 to N9	13,400 vehicles/day
GROUP 2 S7 to N4 S7 to N5 S7 to N9	11,200 vehicles/day
GROUP 3 S7A to N4 S7Ato N5 S7A to N9	10,500 vehicles/day
GROUP 4 N4 N5 N9	8,700 vehicles/day

Table 1 Indicative 24 hour traffic volumes (AADT) for southern and northern route options adopted within the Tier 1 noise predictions.

5.11 The traffic volumes provided by the project engineers are those expected at the design year (2041). In order to assess changes in road traffic noise for any PPFs located in the vicinity of the existing routes (state highway 1 and state highway 57), the traffic engineers have also provided forecast daily traffic volumes for these routes at year 2041. This data is summarised as follows;

10 *Otaki to Levin SATURN Model*, version 17c, QTP Options Report Feb 2018 v02A

	Traffic Volume (AADT)
Southern Section (SH 1 Ohau Sth/Manukau North)	23,900
Northern Section SH1 Nth of SH57 turnoff SH57 Nth of SH57 turnoff	 19,300 7,400

Table 2 Indicative 24 hour traffic volumes (AADT) for the existing network (southern and northern route Sections) adopted within the Tier 1 noise predictions.

5.12 The 'Do Minimum' traffic noise level at each PPF located within 250m each side of the centreline of each route options has been calculated based on the traffic volumes for state highway 1 and state highway 57 set out in table 2. Traffic noise prediction inputs for the 'Do Min' have been calculated on the same basis as above for the O2L route options, however the road surface was assumed to be a well trafficked chip seal, similar in noise output to a SMA type road surface. Predictions of the 'Do Min' noise levels for PPFs located near to the route options enables the assessment below to consider noise level changes for PPFs affected by any of the route options. As above, these types of 'noise level change' assessments are usually included in subsequent detailed noise studies beyond a Tier 1 investigation.

5.13 Predicted LAeq(24 hour) traffic noise levels for the route options (grouped as above) are set out in Figure 4 below.

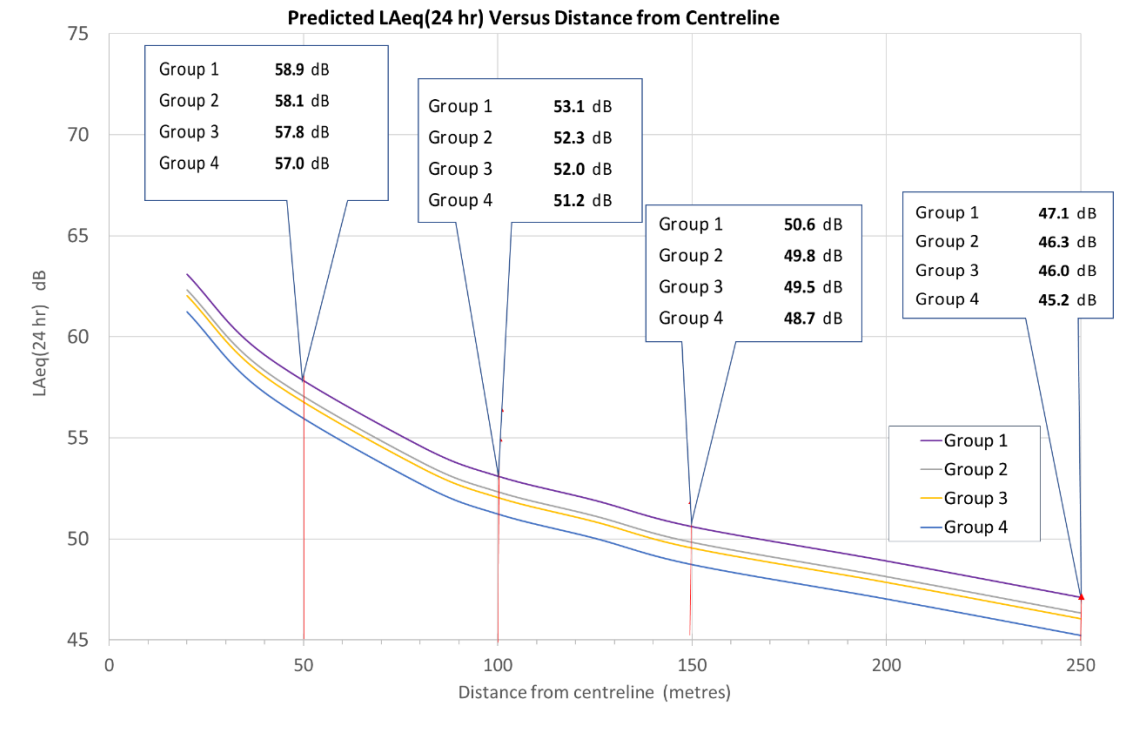

Figure 4 Predicted $L_{Aeq(24\ hour)}$ traffic noise levels versus distance from route centreline, for route options grouped as per Table 1.

5.14 NZS6806:2010 sets out the "Category A" noise category for PPFs expected to receive the least noise effect, where noise levels are expected to not exceed $L_{Aeq(24\ hr)}$ 57 dB. Categories B and C criteria apply to PPFs expected to receive traffic noise at levels greater than $L_{Aeq(24\ hr)}$ 57 dB, a level of noise triggering the investigation of noise mitigation options. As above, a Tier 1 study does not identify any specific mitigation measures to be applied within the project (see Section 7 for a discussion of possible mitigation options). Thus, the number of PPF's considered eligible for mitigation under

Category B / C are assessed without any specific mitigation measures in place (other than the assumed smooth asphalt road surface).

5.15 The overall assessment of noise effects for the short-listed options is based on the location of identified PPFs (specifically their distance to the alignment centreline) together with the above forecast traffic noise levels for the grouped route options (summarised in Figure 4).

5.16 Table 3 summarises the numbers of PPFs expected to be affected by traffic noise greater than $L_{Aeq(24\ hr)}$ 57 dB (i.e. PPFs expected to receive noise classified within NZS6806:2010 as Category B or C) for the above route options (grouped as above);

	Total PPF's Within 250m each side of route	NZS6806 Category A	NZS6806 Category B or C
Group 1			
S6 to N4	121	108	13
S6 to N5	116	102	14
S6 to N9	112	98	14
Group 2			
S7 to N4	73	61	12
S7 to N5	72	59	13
S7 to N9	63	50	13
Group 3			
S7A to N4	94	83	11
S7A to N5	89	76	13
S7A to N9	72	59	13
Group 4			
N4	126	108	18
N5	88	66	22
N9	86	65	21

Table 3 Number of PPFs expected to receive noise compliant with NZS6806:2010 Category A or Category B / C.

5.17 The 'Do Min' analysis of traffic noise enables the change in noise levels to be investigated. The change in traffic noise level is based on a comparison between the PPF and (a) SH1 or SH 57 (whichever is closest to the PPF) and (b) distance to the route option under consideration.

5.18 The number of PPF's expected to receive a +3 dBA or greater increase over 'Do Min' has been calculated for each route option. The results in Table 4 are tabulated alongside the number of PPF's eligible for noise mitigation assessment under Category B / C or NZS6806:2010.

	Total PPF's Within 250m each side of route	NZS6806 Category B or C	No. PPF's Expected to Receive >3 dB increase over 'Do Min"
Group 1			
S6 to N4	121	13	25
S6 to N5	116	14	34
S6 to N9	112	14	34
Group 2			
S7 to N4	73	12	34
S7 to N5	72	13	34
S7 to N9	63	13	37
Group 3			
S7A to N4	94	11	25
S7A to N5	89	13	35
S7A to N9	72	13	34
Group 4			
N4	126	18	23
N5	88	22	43
N9	86	21	40

Table 4 Number of PPFs expected to receive at +3 dBA or greater increase over 'Do Min'. Divided according to whether the PPF will receive noise compliant with NZS6806:2010 Category A or Category B / C.

5.19 Table 4 indicates that while portions of between 20% to 60% of all PPF's will experience some increase in traffic noise as a result of selecting any of the possible options (compared to 'Do Min' traffic noise levels), only between 11% to 25% of PPF's will receive sufficiently elevated levels of traffic noise (at the future design year) to warrant investigating noise mitigation measures under NZS6806:2010.

5.20 The effects of increases in traffic noise at PPF's is discussed below in Section 7.9

5.21 The data presented Tables 3 and 4 has been condensed in order to present the Tier 1 assessment results in 'whole of length' manner allowing for a simple comparison of options. This has involved adding the northern option with the appropriate southern option to provide a 'whole of length' summary of the number of PPF's affected.

5.22 Table 5 below presents data on (a) total PPFs identified within 250 m of each side of the alignment centreline (b) the number of PPF's expected to receive an increase of 3 dB or greater over the 2041 'Do Min' noise level (c) estimated number of PPFs within Category A and within Category B / C without any specific mitigation measures applied (as per Table 3).

Route Option	Total number of PPFs with 250m of Route Option	Category A PPFs	PPFs in Cat B/C	Increase > 3 dB Over 2041 Do Min
N4 and S6 to N4	247	216	31	48
N5 and S6 to N5	204	168	36	77
N9 and S6 to N9	198	163	35	74
N4 and S7 to N4	199	169	30	57
N5 and S7 to N5	160	125	35	77
N9 and S7 to N9	149	115	34	77
N4 and S7A to N4	220	191	29	48
N5 and S7A to N5	177	142	35	78
N9 and S7A to N9	158	124	34	74

Table 5 Number of PPFs estimated within NZS6806:2010 categories of A and "B and C" together with a rating applied based on number of PPFs affected by each route option.

5.23 A ranking method has been used to investigate the Table 5 results to define the option with the least noise effects. This assumes each column of Table 5 has an equal weight within the ranking process which is a reasonable assumption when assessing overall noise effects. The ranking among options for the data presented in each column in Table 5 is presented below in Table 6. This shows the base ranking for each Table 5 column to derive an 'Overall Ranking" - this overall result is indicated in the right hand column of Table 6 below;

	Ranking Among Options Based on least noise effects = 1 , most noise effects = 9				
	Total number of PPFs with 250m of Route Option	Category A PPFs	PPFs in Cat B/C	Increase > 3 dB Over 2041 Do Min	OVERALL Ranking
N9 and S7 to N9	1	1	4	6	1
N9 and S7A to N9	2	2	5	4	2
N4 and S7 to N4	6	6	2	3	3
N4 and S7A to N4	8	8	1	1	4
N5 and S7 to N5	3	3	6	7	5
N4 and S6 to N4	9	9	3	2	6
N9 and S6 to N9	5	5	8	5	7
N5 and S7A to N5	4	4	7	9	8
N5 and S6 to N5	7	7	9	8	9

Table 6 Overall ranking of route options based on the lowest number of PPF's affected (each column of Table 5 has an assumed equal weight within the ranking process).

5.24 This result is based on a modified Tier 1 assessment (as described above) which is a generic assessment of potential noise levels associated with each short-listed option. Potential for mitigation to reduce traffic noise levels at specific PPF locations will be investigated in the future, using a more detailed assessment methodology, due later in the project.

5.25 The earlier 2015 O2NL Tier 1 Noise Assessment[11] was based on an earlier iteration of potential route options that were investigated using generic traffic noise estimates only. That earlier study did not include any spatial data on the location of PPFs. Thus, this earlier Tier 1 assessment is no longer considered a relevant assessment of the 'Tier 1' noise effects suitable for route evaluation purposes.

6 Mitigation Of Traffic Noise

6.1 Noise mitigation measures adopted for expressway projects typically fall into two groups;

a) Structural mitigation (noise barriers and low-noise road surfaces), and
b) Building-modification mitigation (acoustic treatment of buildings).

6.2 The preferred approach to noise mitigation is to implement structural measures within the road reserve or near the road to reduce the noise level outside in the adjacent corridor.

Noise Barriers

6.3 Noise barriers are formed by man-made walls of sufficient mass, an earth bund or a combination of both. The natural terrain can form an effective noise barrier where the road passes through a cut or is located within a depression in the natural or man-made landform.

6.4 NZ Transport Agency has produced a noise barrier design guide[12] which covers the following matters relevant to the design and installation of purpose built noise barriers :

i. Acoustic design precautions,
ii. Urban design issues,
iii. Engineering issues,
iv. Safety issues,
v. Environmental issues,
vi. Maintenance issues, and
vii. Material selection.

6.5 To be effective, traffic noise barriers need to of sufficient height and length and be constructed of materials that have a surface mass of at least 10 kg/m^2, with no (or minimal) gaps or openings. Noise barriers should be designed and constructed to ensure durability, as recommended within clause 8.2.5 of NZS 6806.

6.6 Previous expressway projects in the region have included noise barriers constructed at certain locations to protect PPFs from elevated levels of noise from the passing traffic. These have been assessed as necessary under the assessment methodology recommended within NZS6806:2010. The design of these barriers has included the advice of specialist urban design and landscape experts to ensure the barriers are not only designed to be acoustically effective, but also integrate into the landscape and do not create other adverse effects such as unwelcome shading effects or safety issues.

Low Noise Road Surfaces

6.7 The type and condition of a road surface can affect roadside noise significantly, especially where vehicles are operating at highway speeds. In New Zealand the majority of roads have a chipseal surface. Chipseal consists of a layer of aggregate (of a specific size) embedded into a bitumen

11 Final report in https://www.nzta.govt.nz/assets/projects/otaki-to-north-of-levin/docs/technical-reports/four-laning/O2NL-Taylors-to-Ohau-Four-Laning-Further-Options-Report-Sept-2015-Appendix-11-15.pdf

12 *NZTA State Highway Noise Barrier Design Guide* NZ Transport Agency August 2010 ISBN 978-0-478-36480-4

binder. Many types of chipseal exist and are usually described according to chip size and design (eg single coat or two-coat). Grade 4 is one of the lower noise chipseal type surfaces.

6.8 One type of chipseal which generally results in less noise than traditional chipseals are “slurry seals”. These surfaces comprise a graded aggregate mixed with an emulsion binder, a filler and water. Two common types of slurry seal are standard slurry seal and cape seal.

6.9 Asphalt surfaces are blends of aggregate and bitumen combined and laid whilst hot. The common types include:

- asphaltic concrete (AC), also known as dense graded asphalt (DGA)16, 17
- open graded porous asphalt (OGPA)18
- stone mastic asphalt (SMA)17
- macadam.

6.10 A road surface used on New Zealand highways with well documented low-noise attributes is ‘open graded porous asphalt’ (OGPA).

6.11 OGPA was initially developed to provide paths for water to drain through the road surface, decreasing the amount of spray produced during wet weather. This surface was found to significantly noise caused by the interaction of the road surface and the vehicle tyre. In some circumstances, OGPA is now installed purely for the noise benefit, with an added safety benefit. The reduction of road traffic noise due to OGPA can be improved by including a higher percentage of voids or by using a twin layer surface, however such surfaces require special preparation works and are expensive to implement.

6.12 Other surfaces such as stone mastic asphalt, asphaltic concrete, slurry seal, cape seal and small chipseal (Grade 5 and 6) can also be referred to as being low-noise. Figure 5 below illustrates typical noise reductions road surfaces used on New Zealand highways. These reductions quoted are relative to the “AC-10” surface (smooth asp\halt) which is the surface adopted for this Tier 1 noise study. Note Grade 2 chipseal is included for reference but is not a low-noise surface. Grade 2 chipseal surfaces are commonly found on highway road surfaces in urban areas.

Figure 5 Graph comparing noise reduction attributes of various low-noise surfaces used on New Zealand highways. Reductions are relative to AC-10, this being smooth asphaltic concrete. Grade 2 chipseal included for reference purposes only. Ref; Page 28 NZ Transport Agency *Guide to state highway road surface noise.*

6.13 Other road surface features can create noise affecting nearby areas. Joints in road surfaces can cause mechanical noise from vehicles, which can result in disturbance to neighbouring residents. All road surfaces are at least the thickness of the aggregate (eg 10mm), which makes creating a perfect joint difficult. Audio tactile profiles (ATPs), otherwise known as a rumble strips, are designed to generate noise inside a vehicle as a warning to the driver. However, they also cause significant noise outside the vehicle. The noise produced by vehicles travelling on an ATP is dependent on vehicle type, speed, rib height and spacing between ribs. Typically the road noise is increased by 6 dB and has a distinctive low frequency tonal character (rumble).

6.14 Owing to recent experience with the Kapiti Expressway, any decisions by the Transport Agency to install ATPs as a road safety measure will be carefully assessed in terms of expected noise effects for PPFs located in nearby areas.

Building Modification

6.15 Building-modification is usually a mitigation choice of "last resort" as reflected within the recommendations of NZS6806:2010, where it is only to be implemented subsequent to the achievement of the lowest practicable external noise levels of the affected PPF building.

6.16 Building modification can be effective in at least limiting noise received within 'habitable spaces' and thereby ensuring sleep, and indoor rest and relaxation are able to be protected[13]. Habitable space primarily covers living rooms, offices or studies and sleeping rooms in residential dwellings and facilities. It also includes kitchens and dining rooms where these form part of the main living area. Living area can also encompass 'rumpus rooms'.

6.17 A key aspect of acoustic insulation design is to avoid opening windows where windows are provided in a building for the purposes of ventilation. There is little point in improving the sound rating of the building (including window glazing) if the windows need to remain open to ensure adequate comfort

[13] State highway guide to acoustic treatment of buildings NZ Transport Agency Version 1.0, June 2015.

indoors. The Transport Agency's "State highway guide to acoustic treatment of buildings" sets out guidance on PPF ventilation options as well as noise control building options and indicative costs.

7 Existing Ambient Noise Environment

7.1 This section provides information on the existing noise environment found within the wider Horowhenua area. No specific measurements have yet been undertaken for the purposes of O2NL traffic noise assessment purposes, however other sound level readings have been sourced as a means estimating typical of ambient sound levels currently experienced within the more remote parts of the project area.

7.2 Commentary is provided on typical ambient daily sound levels received within rural parts of the district, at sites located well away from the existing state highway. Although not located within the study area, summary noise levels are set out below for ambient rural sound levels measured at three rural sites during 2016 and 2018. Although not measured within areas likely to receive noise from any of the route options investigated, the results provide an insight into typical ambient sound levels found within the district. These sample noise monitoring results are adopted into this report in lieu of detailed ambient sound level monitoring usually undertaken during the Tier 2 or 3 assessment stages.

7.3 Results are presented below for typical 'remote' rural ambient sites located at distances between 2 to 5 kilometres to the existing alignment of State Highway 1;

- Site 1: Rangiruru Road 9 to 15 February 2016
- Site 2: Hokio Sands Road 1 to 6 March 2018
- Site 3: Old Coach Road 7 to 17 June 2017

7.4 The locations of these three rural monitoring locations are shown below within Figure 6. While all three sites are located outside the O2NL study area, the results are considered typical of ambient sound levels received at rural sites remote from the existing highway.

7.5 All monitoring referred to above has been based on a series of 15 minute x 15 minute measurement results automatically logged throughout the measurement periods. The measurement units are described as follows;

LAeq - Energy average sound levels which can be averaged over 24 hours to derive LAeq(24 hr) values.

LA90 – Background sound levels equivalent to the sound level exceeded for 90% of each 15 minute measurement period.

LAMax – Maximum sound levels recorded during each 15 measurement period

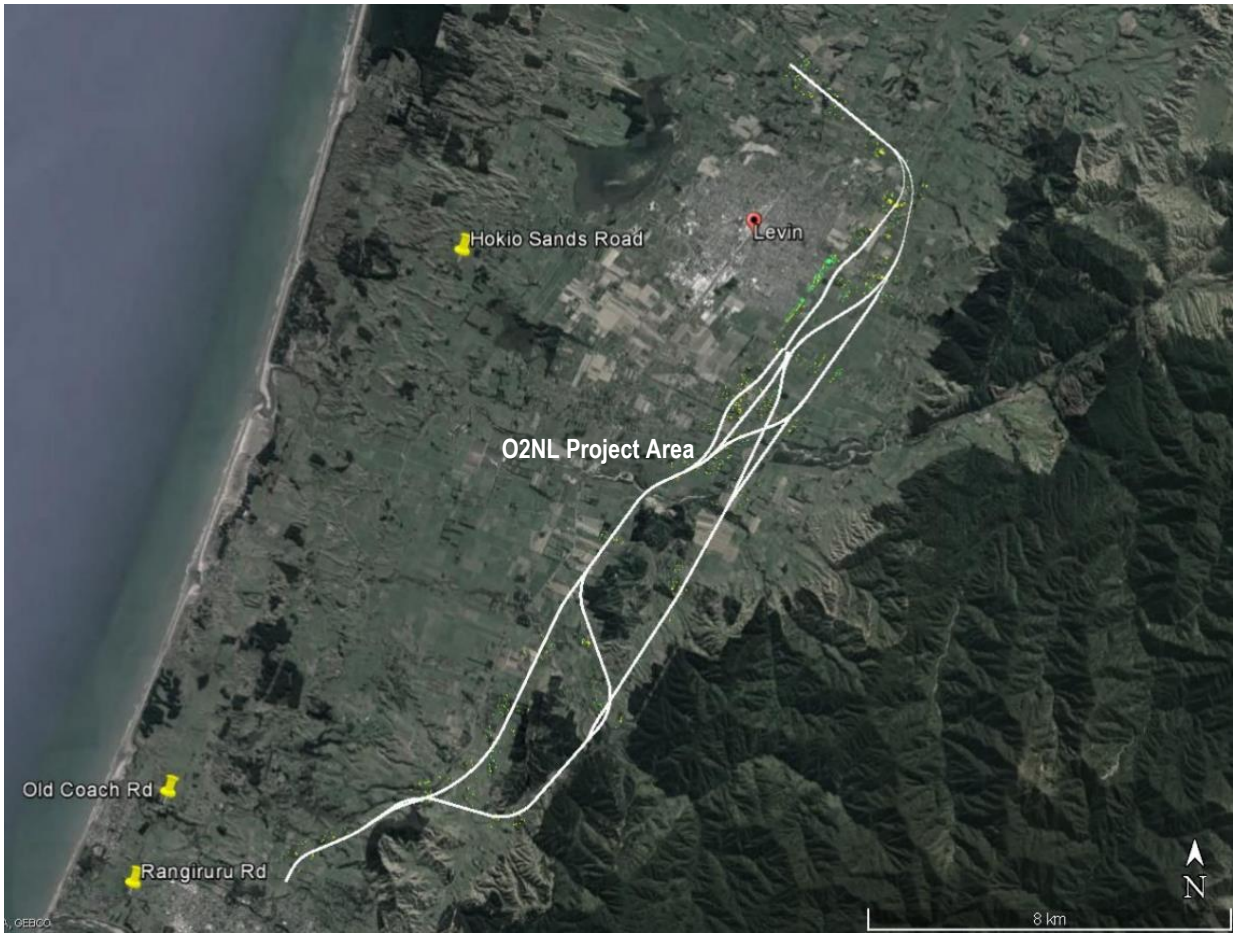

Figure 6 Aerial photograph of Horowhenua district showing three locations at which monitoring of representative ambient sound levels has taken place.

7.6 The results of ambient sound levels measured over periods of 4 to 10 days at remote rural sites in the Horowhenua are summarised in Table 3 with summary graphs of measurement results set out below within Figure 7, 8 and 9.

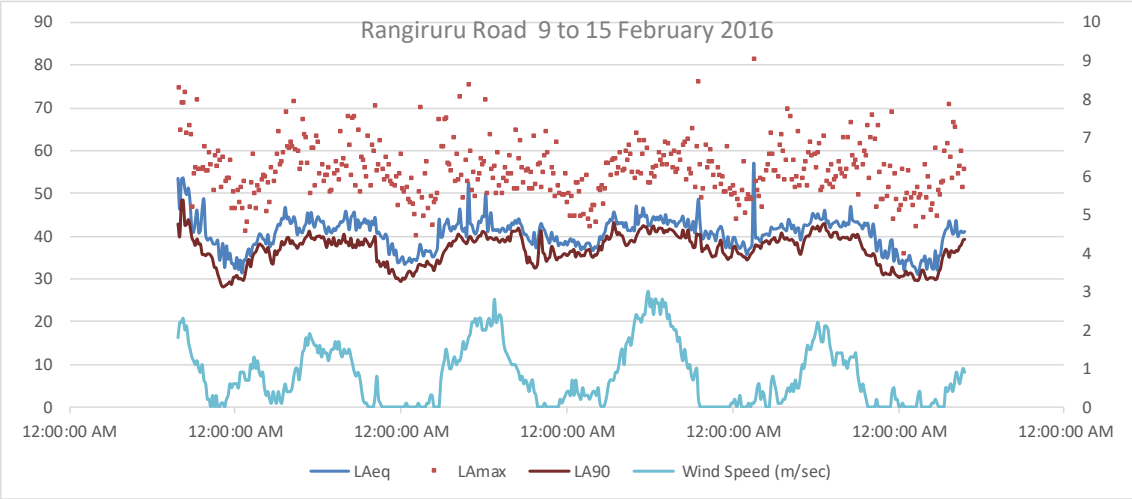

Figure 7 Measured ambient sound levels undertaken at Site 1, Rangiruru Road site between 9 and 15 February 2016.

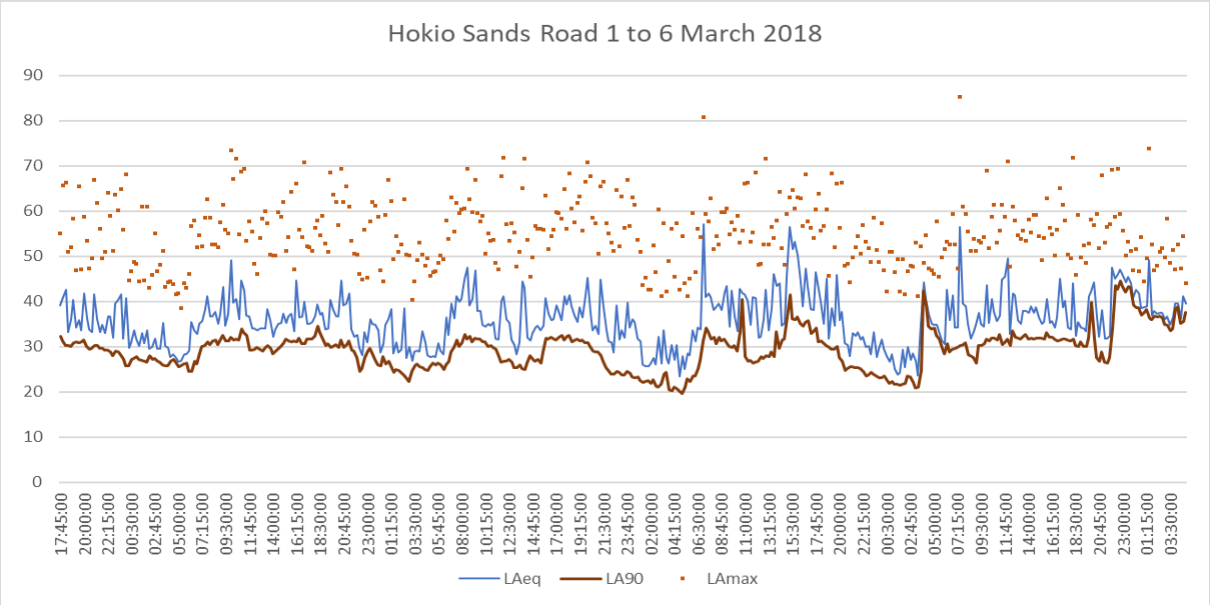

Figure 9 Measured ambient sound levels undertaken at Site 2 Hokio Sands Road 1 to 6 March 2018.

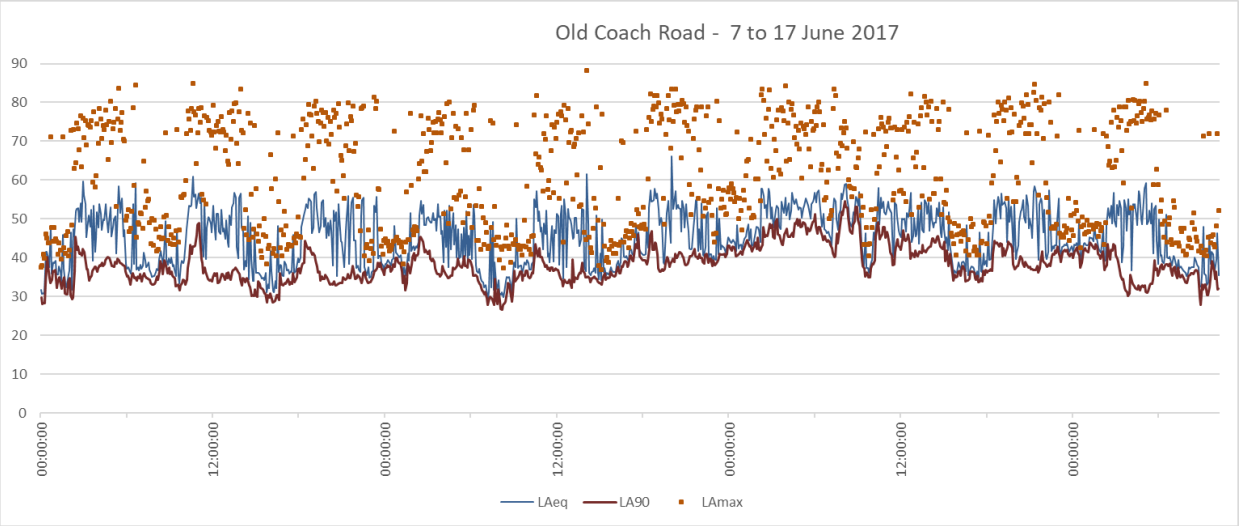

Figure 9 Measured ambient sound levels undertaken at Site 3 Old Coach Road 7 to 17 June 2017.

The following table summarises the above results for all three monitoring sites;

	Site 1: Rangiruru Road	**Site 2: Hokio Sands Road**	**Site 3: Old Coach Road**
Range: LAeq(24 hr)	42 to 46 dB	36 to 39 dB	37 to 44 dB
Average: Daytime LAeq	46 dB	38 dB	48 dB
Average: Night time LAeq	37 dB	33 dB	35 dB
Average: Daytime LA90	40 dB	32 dB	41 dB
Average: Night time LA90	33 dB	28 dB	39 dB
Average: Daytime LAmax	79 dB	67 dB	78 dB
Average: Night time LAmax	64 dB	58 dB	52 dB

Table 7 Summarises monitoring results for all three monitoring sites.

7.7 The above monitoring results show a range of ambient sound levels are typically measured within remote rural areas. Most likely the sound sources are due to rural activities taking place in the area,

distant vehicle noise from local roads, sounds from natural sources such as birds and insects as well as occasional distant aircraft sounds and sounds from animals and stock.

7.8 Comparing the measured LAeq sound levels with the following chart signals typical rural sound levels measured at remote receiving sites are reasonably low in level.

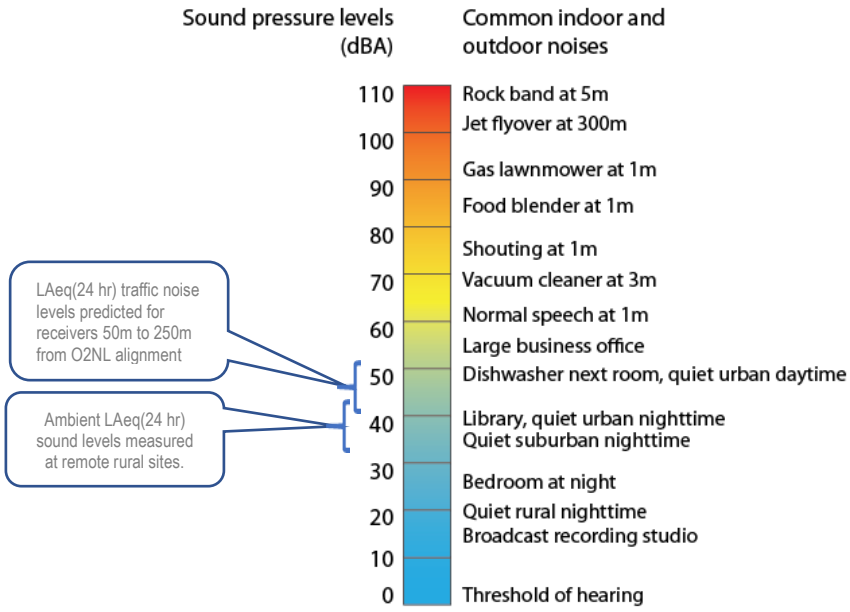

Figure 10 Typical examples of everyday dBA sound levels, also showing range of ambient LAeq(24 hr) sound levels measured at remote rural sites, and the range of LAeq(24 hr) traffic noise levels predicted to be received at 50m to 250m from O2NL alignment centreline.

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7.9 The expected increase in ambient sound levels for remote rural sites due to noise from unmitigated O2NL route options[14] has been investigated. The expected 'worse case' decibel increase in LAeq(24 hr) for receiver sites located at various distances from a generic O2NL alignment are shown in Table 6.

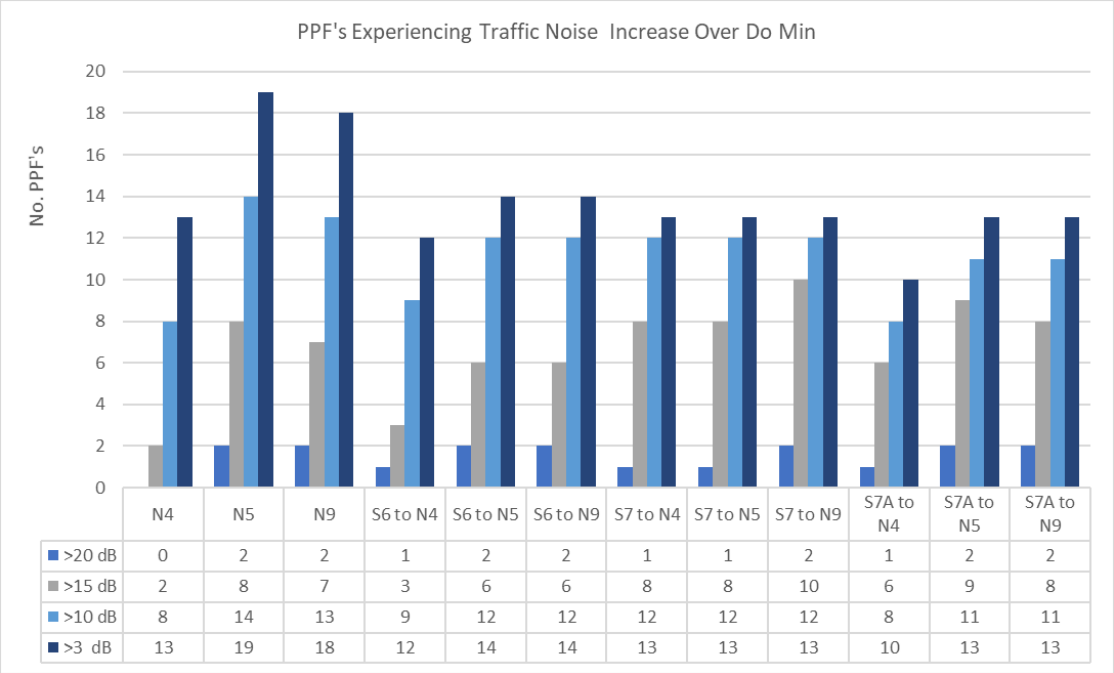
Distances from O2NL route	Expected increase in LAeq(24 hr) For Remote Rural Sites (dB)
50m	+21 dB
100m	+15 dB
150m	+12 dB
200m	+10 dB
250m	+9 dB

Table 6 Predicted unmitigated increase in daily LAeq(24 hr) sound levels for receiver sites located within the distances from the centreline of the O2NL alignment.

7.10 As above, predictions of the 'Do Min' 2041 traffic noise level (due to traffic on SH1 and SH 57) has been analysed for each PPF located within 250m of the centreline of each route option. The degree of change (increase in 'Option' traffic noise over 'Do Min' traffic noise) is an indicator of the change

[14] The comparison is based on noise emissions associated with the higher traffic volumes predicted for 'Group1' route options (see Table1).

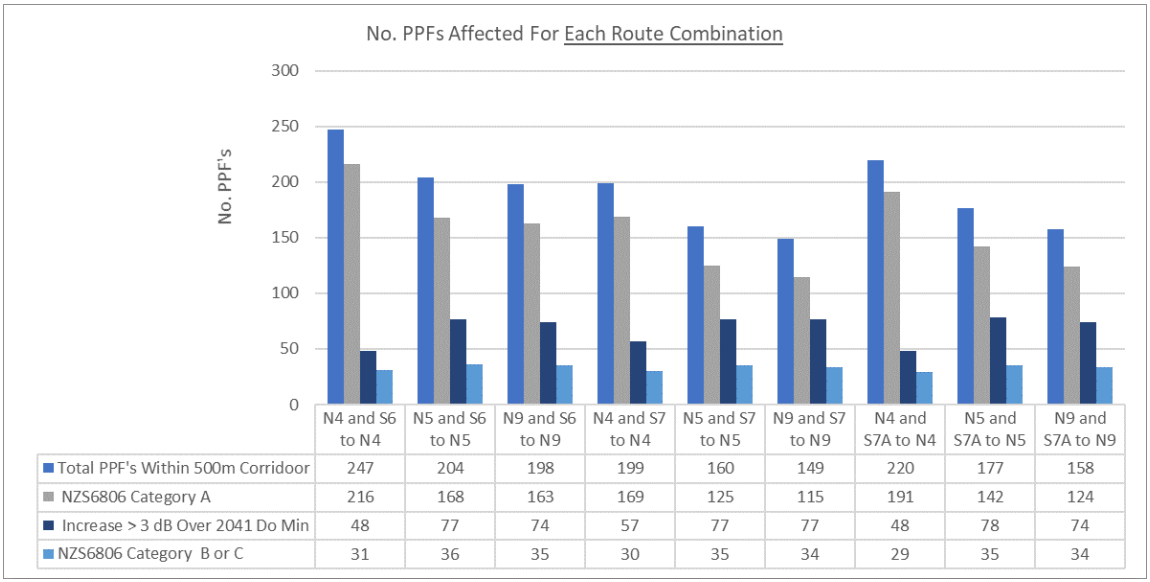
in noise effects and has been investigated, as reported below in Figure 11. This figure breaks down the expected increase into categories of >3 dB, >10 dB, >15 dB and >20 dB over the 'Do Min' noise level. Data presented in this way is cumulative in nature. Therefore, the number of PPF's reported in each category cannot be added together to derive a total.



	N4	N5	N9	S6 to N4	S6 to N5	S6 to N9	S7 to N4	S7 to N5	S7 to N9	S7A to N4	S7A to N5	S7A to N9
>20 dB	0	2	2	1	2	2	1	1	2	1	2	2
>15 dB	2	8	7	3	6	6	8	8	10	6	9	8
>10 dB	8	14	13	9	12	12	12	12	12	8	11	11
>3 dB	13	19	18	12	14	14	13	13	13	10	13	13

Figure 11 Number of PPF's predicted to experience predicted increases over the 'Do Min' $L_{Aeq(24\ hour)}$ traffic noise level, for each route option under consideration.

7.11 Figure 12 presents the same information as Figure 11, except the number of PPF's have been added together to give a 'whole route length' assessment of changes due to increase over the 2041 'Do Min' traffic noise levels due to the existing highway(s);



	N4 and S6 to N4	N5 and S6 to N5	N9 and S6 to N9	N4 and S7 to N4	N5 and S7 to N5	N9 and S7 to N9	N4 and S7A to N4	N5 and S7A to N5	N9 and S7A to N9
Total PPF's Within 500m Corridoor	247	204	198	199	160	149	220	177	158
NZS6806 Category A	216	168	163	169	125	115	191	142	124
Increase > 3 dB Over 2041 Do Min	48	77	74	57	77	77	48	78	74
NZS6806 Category B or C	31	36	35	30	35	34	29	35	34

Figure 12 Number of PPF's predicted to experience predicted increases over the 'Do Min' $L_{Aeq(24\ hour)}$ traffic noise level, amalgamated to provide a 'whole route length' summary of expected noise level changes.

7.12 The increase in daily average sound levels due to the selected route option may increase noise by up to 24 dB for unmitigated traffic noise received as close as 50m from the alignment centreline. These increases may be considered reasonably significant in terms of the following rules of thumb regarding changes in subjective loudness measured in units dB:

Three decibel increase = humans perceive only a slight change in noise level.

Five decibel increase = clearly noticeable change

Ten decibel increase = perceive the sound to be twice as loud.

Twenty decibel increase = perceive the sound to be four times as loud.

7.13 On the basis of the foregoing analysis, the scale of changes in daily LAeq(24 hr) sound levels experienced by receivers located near to the O2NL alignment but away from existing highways is expected to be reasonably significant. Predicted (unmitigated) future traffic noise levels received at these sites will be perceived as a sound adjudged to be between two to four times as loud as existing rural ambient sound levels. However adopting the BPO mitigation approach of NZS6806:2010 within the final design of O2NL will likely mean the final approved design will include noise mitigation measures that have the effect of lowering LAeq(24 hr) levels received within the highest noise areas.

7.14 It is beyond the scope of a Tier 1 assessment to quantify reductions in noise levels expected for PPF's located along the existing state highways 1 and 57.

8 Traffic Noise Matters Raised Within Submissions

8.1 Section 7 sets out a table of comments and observations regarding traffic noise-related submission points raised by affected landowners and the community during O2NL community engagement undertaken during February/March 2018. The considered response to each of the traffic noise matters raised is set out below in table format, with the matter described within the left hand column, and the response provided in the right hand column.

Noise Matters Raised By Submitter	Response
The submitters are directly affected by the proposed routes and are deeply concerned about the ill health effects caused by the noise of the proposed expressway, as well as the impact the noise will have to the enjoyment of inside and outside amenities and the associated loss of capital on properties.	As set out above in Section 3, the project is being developed within a policy framework which places priority on protecting public health. NZ Standard NZS6806:2010 sets performance targets generally considered reasonable taking into account adverse health effects associated with noise on people and communities, the effects of relative changes in highway noise levels due to projects, and the potential benefits of new and altered roads.
We do not believe that NZTA has put the correct weight on the impact to protected premises and facilities (PPF) and associated ill health for the community as should be required under the international standards. Noise should be included as an important SEPARATE criteria in the MCA. NZS 6806:2010 and the NZTA guide for State Highway Asset Improvement Projects both require that all PPF be assessed within 200m from the closest traffic lane. Simply put, a Tier 1 assessment can be based solely on the volume of traffic at the design year and the number of PPFs within 200m of the proposed alignment providing an initial indication of potential noise exposure. This submission believes that this investigation must be ongoing given the requirement in the RMA that actual and potential noise effects must be assessed and this is done from the NZTA's Environmental and Social Responsibility Screen using the NZS 6806 5 Assessment-Matrix-0.5 Generally investigate the failings of the NZS 6806:2010 standard and, with Standards New Zealand, update NZS 6806:2010 to take into account the Night Noise Guidelines.	As multi-criteria analysis is considered a reliable and well recognised method for systematic identification of a preferred option, often involving a diverse range of aspects (or criteria) are to be included within the evaluation - including intangible values which cannot readily be translated into monetary terms. We therefore support, in principle, traffic noise being considered within the MCA. The above Tier 1 noise assessment has considered PPFs within 250m of the centreline of each route option which ensures distant PPFs are included within the noise assessment. As the Tier 1 stage does not involve detailed use of the NZS6806:2010 methodology, no failings have been identified to date in applying the concepts of this Standard to the O2NL Project. As the project progresses it is recommended the Transport Agency, via investigation, confirm the detailed methodology and criteria of NZS6806:2010 are entirely suitable for application within a Tier 2 or 3 "preferred option' noise study. This "Pre-Tier 2/3" investigation should identify what aspects of NZS6806:2010 might appear inappropriate and require amendment, if any, to best address the project's social and environmental impacts. See below for comment regarding the "Night Noise Guidelines".

Noise Matters Raised By Submitter	Response
Recess the expressway into the ground and build Queen Street over it to reduce light and noise pollution and visual effects.	Section 6 above identifies noise from highways can be reduced by barriers and by including designing the highway to operate within a man-made depression in the normal land surface. The assessment of the viability of such noise mitigation measures is a key aspect of the detailed traffic noise assessment undertaken with Tier 2 and 3 investigations yet to be carried out for the O2NL Project, and also need to be considered in terms of other aspects of the project's design (such as ground conditions).
Regarding the issue of noise and bearing in mind that there have been a few complaints about excessive noise on M2PP I would ask that **everything learned from M2PP and being currently applied there (e.g. Removal of rumble strips and use of low road noise asphalt) be applied** to the more densely populated area between Tararua Road and Roslyn Road.	As above, the use of low noise road surfaces and the placement of ATPs (rumble strips) will form part of future detailed traffic noise mitigation investigations to take place at the subsequent stages of the project. Learnings from earlier projects will be incorporated.
A number of concerns have been expressed about NZTA decisions made up to this point, including: •The sudden removal of previously viable routes on the Western side without robust justification or the opportunity to receive community feedback •The lack of a robust Social Impact Assessments •The **lack of a Noise Mitigation Report** •NZTA's intention to proceed to develop its recommendation paper to the NZTA Board prior to gathering detailed information on social impact and noise mitigation, as well as the extent and costs of other mitigations that may be necessary for each corridor	This Tier 1 noise assessment has primarily been produced to assist Transport Agency decision-makers in identifying a preferred O2NL route. This report also includes a generic discussion of traffic noise mitigation measures available to apply to the project (as have been applied elsewhere). As above, it is recommended traffic noise be taken into account in the preferred route selection process, to ensure information on the numbers of sensitive sites affected is available, with broad information also provided regarding the degree of noise effects anticipated for these identified receiver sites. Detailed assessment of cost-effective noise mitigation measures is usually undertaken once the preferred route has been selected. This is considered the more appropriate point in time to conduct detailed evaluations leading to a Noise Mitigation Report.

Noise Matters Raised By Submitter	**Response**
NZS 6806:2010 requires all protected premises and facilities (PPF) to be assessed within 200m from the closest traffic lane. With a carriage way width of 27m and an assessment area of 200m either side of the carriage way a minimum corridor of 427m with the centreline in the centre of the corridor is required to perform a Tier1 assessment. The 300m corridor with the road to be placed somewhere within that corridor makes it simply impossible to assess the PPF's and certainly compare the different road options.	The above Tier 1 noise assessment has considered PPFs within 250m of the centreline of each route option. This provides some measure of conservatism as the 200m wide assessment corridor (from the edge of the carriageway) recommended within NZS6806:2010 can be adopted should the actual centreline of the route need to be shifted up to 40 metres to either side. The approach of the Tier 1 assessment also ensures more distant PPFs are included within the noise assessment.
The 300m corridor should be 500m as homes within the 300m corridor that only require some land to be taken but not all will badly affected by noise, vibration, dust etc. during construction, & ongoing road noise once the expressway is built. If extend to 500m these affects would be reduced.	As above, a 500m wide corridor has been adopted within the Tier 1 assessment set out above.
Noise and vibration may reverberate more within a confined valley.	The acoustic effects arising when traffic noise is generated and received in the vicinity of steep, undulating landforms such valleys do not usually include any known reverberation effect. Although some impulsive sounds (such as a rifle shot) in such environments will usually result in reflected sound that is audible (an echo), this is not a phenomenon affecting traffic noise. The effects of traffic noise in valleys can be summarised as follows: a) Valleys enable elevated receiver sites to receive sound that has travelled from the source at a considerable distance above the ground surface (which avoids or largely reduces the sound absorbing effect the land surface has on the propagation of sound over significant distances). This effect can be accurately modelled within the detailed assessment stages of the project. b) Under calm air conditions, valleys can form complex temperature profiles that arise temporary under certain conditions. Studies have shown that such effects can

	account for level changes between -3 dBA and +10 dBA relative to a homogeneous atmosphere, however this is for receiver sites over 1 kilometre from the road (where received noise from a distant highway would not normally be considered a significant noise effect). The guidance on sound modelling set out within NZS6801:2008 Acoustics – Measurement of Environmental Sound ensures an adequate range of meteorological effects, including temperature gradients) are accounted for within the modelling results. Vibration caused by vehicles travelling along the highway is to be investigated in detail at subsequent stages of a project.
Suggest the NZTA adopt the W.H.O. "NIGHT NOISE GUIDELINES" for Europe. These are 40dB in our situation. The NZTA proposes 57-64 dB which is unacceptable. This level is dangerous for public health and the ongoing costs will be high.	See discussion of the Night Noise Guidelines set out below.
NZS6806 Concerns	
Category A or B in NZS 6806:2010 could be exposed to indoor noise levels that exceed 40 dB LAeq(24hr) or are higher than Category C;	The Standard does allow for indoor noise levels higher than 40dB in cases where the best practicable option does not favour application of sufficient mitigation to lower this level. These would be in especially unique circumstances and are not likely to arise within the O2NL project. The Standard aims for achieving Category A if at all possible.
Perception that NZS 6806:2010 requires a rigid development of noise mitigation	The method for assessing noise and applying noise mitigation in high noise areas is able to be applied in a range of situations (both new roads and altered existing roads). The extensive worked examples included within the Standard indicate the wide range of typical circumstances to which this Standard can be successfully applied.
Perceived imbalance between the importance of economic and social well-being of the community, and the health and social well-being of directly affected persons.	Unless the detailed analyses of noise effects planned to occur within future stages of the O2NL investigations throw up unexpected or unusual findings, the health and well-being of people affected by noise from the new highway are considered to be adequately protected via application of the application of NZS6806:2010. Ultimately the RMA approvals processes will establish the appropriate balance between the factors mentioned.
NZS 6806:2010 does not provide a set test or methodology but offers guidance and recommendations	The methodology Is reasonably 'set' in the Standard but it is a flexible approach whereby higher than normal noise levels may occur but only where the cost-benefit analysis of applying noise mitigation measures does not stack up.
Night-time criteria should be different from day- time criteria and NZS 6806:2010 does not differentiate between the two. In fact, the Board	As set out below in the discussion around the Night Time Noise Guidelines For Europe.

for Transmission Gully specified that the windows needed to be open when determining the compliance with the internal noise criterion, as required for ventilation. There was also concern about the use of LAeq(24hr) measurement in NZS 6806:2010 whereas other international standards often utilise an average that imposes a penalty on night-time noise.	
NZS 6806:2010 does not address all matters relevant to a decision under the RMA which seems to be a vast oversight	The Standard cannot hope to cover all matters relevant to assessing traffic noise within an RMA application. The Standard is considered a tool to assist in the reporting of traffic noise effects, and on methods adopted to assess the degree of noise mitigation applied within any particular project. The Standard is an effective means of fulfilling the minimum requirements for an "Assessment of Environmental Effects", the requirements for which are set out in the fourth schedule to the Act.
Concerns were raised as to how NZS 6806:2010 ensures that health and amenity of directly affected persons are balanced fairly against the social benefits of the project and it was conceded that the potential impacts of the project need to be considered in a wider context	The Standard seeks to manage noise to avoid adverse effects on people and their well-being. The Standard does not profess to specially address amenity effects, other than the reduction of such effects that occur when mitigation is applied to address the more significant effects of traffic noise on people's health and well-being.

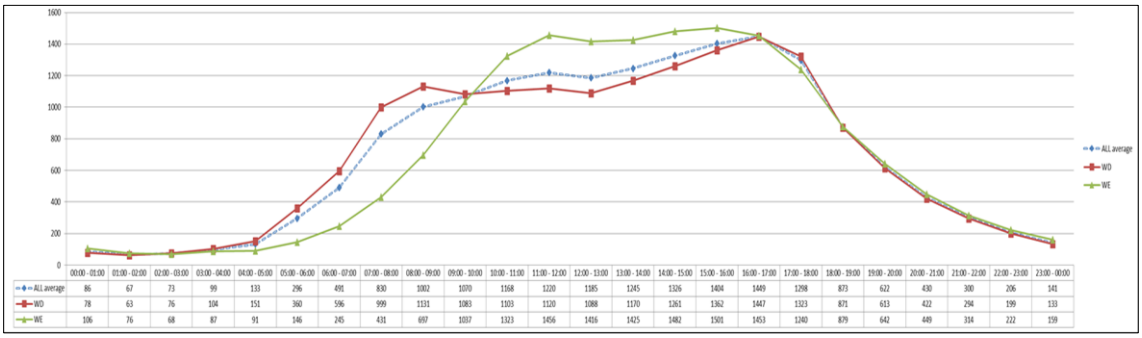
WHO Night Noise Guidelines

8.2 In October 2009, the World Health Organization (WHO) Regional Office for Europe published *Night Noise Guidelines For Europe*[15] (NNGL) to provide evidence-based policy advice to EU Member States in the development of future legislation and policy. The NNGL expanded on the earlier 1999 WHO Community guidelines on the issue of sleep disturbance, and concluded recommending an 'interim target' of 55 Lnight for protection of sleep and well-being.

8.3 The NNGL for Europe provide aspirational goals for policy makers to consider when aiming to minimise the impact of environmental noise on the population during night time. As defined in EU-directive 2002/49, these guidelines adopt the "Lnight" noise unit as the night-time noise indicator. The guidelines adopt a definition of night as being by default 23.00 - 07.00 - however Member States may adapt this to the sleep pattern of the population.

8.4 The NNGL indicate Lnight levels of 40 dB, being the lowest observed adverse effect level for night noise as the recommended target. However, most Member States adopt higher Lnight values for traffic noise. The Lnight noise limits for traffic noise quoted in Table 1.1 of the guidelines indicate Lnight limits applying in different EU countries which range from 40 dB (Latvia and Netherlands) to 62 dB (France).

8.5 There are important differences to consider when comparing the above Lnight noise limits with traffic noise levels quantified using LAeq(24 hr). Whilst both units are based on A-weighted Leq sound levels, the time averaging period adopted within these two units differ considerably. The important differences between these two units are related to the varying amount of road traffic found on our highways at various times of the day and night. The following graphs have been provided by the project traffic engineers setting out 2017 daily traffic flow patterns (all vehicles, both directions) recorded on State Highway 1 at Ohau which lies within the project area. Hourly traffic flow data from other state highway sites confirm this is a typical pattern of traffic flows on main roads in rural New Zealand.



	00:00 - 01:00	01:00 - 02:00	02:00 - 03:00	03:00 - 04:00	04:00 - 05:00	05:00 - 06:00	06:00 - 07:00	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00	19:00 - 20:00	20:00 - 21:00	21:00 - 22:00	22:00 - 23:00	23:00 - 00:00
ALL average	86	67	73	99	133	296	491	830	1002	1070	1168	1220	1185	1245	1326	1404	1449	1298	873	622	430	300	206	141
WD	78	63	76	104	151	360	596	999	1131	1083	1103	1120	1088	1170	1261	1362	1447	1323	871	613	422	294	199	133
WE	106	76	68	87	91	146	245	431	697	1037	1323	1456	1416	1425	1482	1501	1453	1240	879	642	449	314	222	159

Figure 9 Typical hourly traffic flow patterns during 2017 at Ohau, State Highway 1. All vehicle types, both directions counted.

8.6 These traffic count records indicate 7% of vehicle movements typically occur during the period 11pm to7am. Essentially this means 93% of the sound energy is spread over the remaining 16 hours. ON typical NZ highways the relationship between LAeq(24 hr) values and Lnight values (assessed over the same 24 hour periods) indicate:

LAeq(24 hr) = Lnight + 5 dB.

[15] WHO Regional Office for Europe, Night noise guidelines for Europe, Copenhagen. http://www.euro.who.int/document/e92845.pdf.

8.7 A study of traffic flows versus roadside noise levels in EU[16] shows;

LAeq(24 h) = Lnight + 4.7 dB

8.8 Thus, the Lnight guidance of the NNGL needs to be compared correctly with the recommended thresholds for traffic noise mitigation set out within NZS6806:2010. Additionally, once the numerical differences are accounted for, there is no evidence to suppose regulating traffic noise using a night time metric such as Lnight in New Zealand would represent any improvement in environmental regulation. The NNGL document itself states (at chapter 4, page 80):

"Therefore, in epidemiological studies in which the relative effects of road traffic noise is studied, the sound emission during the daytime can as well be viewed as an approximate relative measure of the overall sound emission including the night. This seems to be further justified because existing noise regulations usually consider a 10 dB(A) difference between the day and the night. The NOAEL of 60 dB(A) for Lday night corresponds, in this respect, with 50 dB(A) for Lnight".

8.9 Adopting the above 5 dB conversion factor, it is evident the NZS6806:2010 recommended threshold for investigating noise mitigation at a level of LAeq(24 hr) 57 dB is a threshold which lies;

- ✓ 3 dB below the EU 'interim target' of 55 Lnight for protection of sleep and well-being.
- ✓ 2 dB above the NOAEL for night time traffic noise of 50 dB Lnight, and
- ✓ 1 dB above the median Lnight traffic noise performance standard adopted within 12 EU countries (Table 1.1 of NNGL).

8.10 The NZ Transport Agency is charged with managing the effects of new highway developments and has elected to adopt the criteria of NZS68-06:2010 as reasonable under the circumstances and not inconsistent with any of its policy objectives. The difficulties for project feasibility associated with application of more protective noise performance standards are briefly discussed within Appendix 6 to the NZTA Planning Policy Manual (page A6:16) where it is stated:

"Achieving less than LAeq(24 hr) 55 dB would be "…very difficult and likely to have significant cost implications for projects."

8.11 The European NNGL document sets out useful aspirational goals for policy makers, including those within other jurisdictions. The recommended NNGL noise guidelines are not considered applicable to the O2NL project which is based on the assessment of noise effects and application of suitable mitigation under NZS6806:2010.

[16] *Conversion between noise exposure indicators Leq24h, LDay, LEvening, LNight, Ldn and Lden: Principles and practical guidance*. Brink M1, Schäffer B, Pieren R, Wunderli JM. Int J Hyg Environ Health. 2018 Jan;221(1):54-63

9 Summary

9.1 This report sets out a discussion on methods used for managing and assessing traffic noise from roading projects in New Zealand, including methods adopted for traffic noise assessment for new and altered roads within NZS6806:2010 *Acoustics – Traffic Noise - New And Altered Roads.*

9.2 A summary description is provided of the known effects of traffic noise on people's health and welfare and as a social stressor.

9.3 A complete revision of an earlier 2015 'Tier 1' traffic noise assessment for the O2L project is provided. The expected number of sensitive sites (PPFs) affected by various levels of traffic noise have been quantified based on achieving the methodology of NZS6806:2010. The assessment has included estimates of the number of PPF's likely to experience an increase in traffic noise compared to the 2041 'Do Min' scenario.

9.4 The results of noise projections for each short-listed route option have been ranked according to the number of PPFs affected under each option. The assessment utilised spatial data on the location of dwellings with the expected noise levels in each area being predicted based on the expected traffic flows and stated assumptions around the road surface and traffic speed and composition. Section 6 provides a generic description of potential traffic noise mitigation methods that can be applied within later stages of the O2NL project to, where practicable, apply mitigation measures to reduce the number of affected PPFs.

9.5 Section 7 sets out information on ambient noise levels found within the wider Horowhenua area which are considered typical of ambient sound levels found within the more remote rural parts of the O2NL project area. Commentary is provided on expected changes in ambient noise within areas affected by noise from the proposed O2NL expressway, especially were currently only low ambient sound levels are experienced.

9.6 Section 8 sets out a response to traffic noise-related comments included within submissions received following recent community and stakeholder consultation. The response to the issues is based on New Zealand Standards and overseas noise guidelines, including the EU Night Time Noise Guidelines.

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