Warkworth to Wellsford

Operational Noise and Vibration Assessment

July 2019

QUALITY ASSURANCE

Prepared by

Jacobs GHD Joint Venture in association with Chiles Ltd. Prepared subject to the terms of the Professional Services Contract between the Client and Jacobs GHD Joint Venture for the Route Protection and Consenting of the Warkworth to Wellsford Project.

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		Name	Signature	Name	Signature	Date
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Prepared by: Jesse Ngo and Joshua Loh (Jacobs New Zealand Ltd)

Reviewed by: Stephen Chiles (Chiles Ltd)

Approved by: Brad Nobilo (GHD Limited)

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GLOSSARY OF ABBREVIATIONS

The table below sets out the glossary of abbreviations.

Abbreviation/ acronym	Term
AADT	Average Annual Daily Traffic
AEE	Assessment of Effects on the Environment
AUP	Auckland Unitary Plan Operative in Part
BoI	Board of Inquiry
BMM	Building Modification Mitigation
BPO	Best Practicable Option
CNVMP	Construction Noise and Vibration Management Plan
Council	Auckland Council
dB	Decibel
HCV	Heavy Commercial Vehicle
KDC	Kaipara District Council
km	Kilometres
km/h	Kilometres per hour
m	Metres
m^2	Square metres
MCA	Multi Criteria Assessment
NoR	Notice of Requirement
NZS 6801	New Zealand Standard NZS 6801:2008 "*Acoustics – Measurement of environmental sound*"
NZS 6802	New Zealand Standard NZS 6802:2008 *"Acoustics – Environmental Noise"*
NZS 6806	New Zealand Standard NZS 6806:2010 *"Acoustics – Road traffic noise – New and altered roads"*
OGPA	Open Graded Porous Asphalt
P2Wk	Pūhoi to Warkworth project

Abbreviation/ acronym	Term
PPFs	Protected Premises and Facilities
RMA	Resource Management Act 1991
SH(x)	State highway (number)
Transport Agency	NZ Transport Agency
ULDF	Urban and Landscape Design Framework
vpd	Vehicles Per Day

GLOSSARY OF DEFINED TERMS

The table below sets out the defined terms

Term	Definition
Ambient noise/ vibration	The total noise or vibration existing at a specified point and time associated with a given environment, excluding the sound or vibration requiring control. It is a composite of all noise or vibration sources, near and far.
Amenity values	Defined in section 2(1) 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."
Average annual daily traffic	The equivalent to 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 for which traffic volumes were recorded. Measured in vehicles per day.
Best practicable option	Defined in section 2(1) 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 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."
Chainage	A distance measured along a straight line. For this project chainage is measured in metres and starts from the northern extent of the Project.
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).
Construction works	Activities undertaken to construct the Project.
dB $L_{Aeq(24h)}$	Sound pressure level average, A-weighted, sound pressure level over the measurement period of 24 hours.
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 of the RMA."
Designation Boundary	The boundary of the notice of requirement lodged with this application, including as may be amended.

Term	Definition
Earthworks	Defined in section J1 of the AUP(OP), as "disturbance of soil, earth or substrate land surfaces. Includes: blading, boring (greater than 250mm diameter); contouring; cutting; drilling (greater than 250mm diameter); excavation; filling; ripping; moving; placing; removing; replacing; trenching; and thrusting (greater than 250mm diameter). Excludes: ancillary forest earthworks; and ancillary farming earthworks."
Heavy vehicle	A motor vehicle having a gross laden weight exceeding 3500 kg
Indicative Alignment	An indicative road design alignment assessed by the technical experts that may be refined on detailed design within the designation boundary. The Indicative Alignment is a preliminary alignment of a state highway that could be constructed within the proposed designation boundary. The Indicative Alignment has been prepared for assessment purposes, and to indicate what the final design of the Project may look like. The final alignment for the Project will be refined and confirmed at the detailed design stage.
$L_{Aeq(t)}$	The average, A-weighted, sound pressure level over the measurement period, t.
$L_{A90(t)}$	The A-weighted sound pressure level equalled or exceeded for 90% of the measurement period. This is commonly referred to as the background noise level
L_{AFmax}	The maximum fast time weighted, A frequency weighted sound pressure level which occurs during the measurement period.
Project	The Ara Tūhono Pūhoi to Wellsford project: Warkworth to Wellsford section.
Project Works	All proposed activities associated with the Project.
State highway	Means a road, whether or not constructed or vested in the Crown, that is declared to be a State highway under section 11 of the National Roads Act 1953, section 60 of the Government Roading Powers Act 1989 (formerly known as the Transit New Zealand Act 1989), or under section 103 of the LTMA.
The Dome	The highest elevation within the Dome Forest Conservation Area.

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1 INTRODUCTION

1.1 Overview of the Project

The NZ Transport Agency (Transport Agency) is lodging a Notice of Requirement (NoR) and applications for resource consent (collectively referred to as "the Application") for the Warkworth to Wellsford Project (the Project). This report is part of a suite of technical assessments prepared to inform the Assessment of Effects on the Environment (AEE) and to support the Application.

This assessment report addresses the actual and potential Operational Noise and Vibration effects arising from the Project. The assessment considers the effects of an Indicative Alignment and other potential effects that could occur if that alignment shifts within the proposed designation boundary when the design is finalised in the future.

1.2 Project description

The Project involves the construction, operation and maintenance of a new four lane state highway. The route is approximately 26 km long. The Project commences at the interface with the Pūhoi to Warkworth project (P2Wk) near Woodcocks Road. It passes to the west of the existing State Highway 1 (SH1) alignment near The Dome, before crossing SH1 just south of the Hōteo River. North of the Hōteo River the Project passes to the east of Wellsford and Te Hana, bypassing these centres. The Project ties into the existing SH1 to the north of Te Hana near Maeneene Road.

The key components of the Project, based on the Indicative Alignment, are as follows:

a) A new four lane dual carriageway state highway, offline from the existing State Highway 1, with the potential for slow lanes on the steeper grades.

b) Three interchanges as follows:

   i. Warkworth Interchange, to tie-in with the Pūhoi to Warkworth section of the State Highway and provide a connection to the northern outskirts of Warkworth.

   ii. Wellsford Interchange, located at Wayby Valley Road to provide access to Wellsford and eastern communities including Tomarata and Mangawhai.

   iii. Te Hana Interchange, located at Mangawhai Road to provide access to Te Hana, Wellsford and communities including Port Albert, Tomarata and Mangawhai.

c) Twin bore tunnels under Kraack Road, each serving one direction, which are approximately 850 metres long and approximately 180 metres below ground level at the deepest point.

d) A series of steep cut and fills through the forestry area to the west of the existing SH1 within the Dome Valley and other areas of cut and fill along the remainder of the Project.

e) A viaduct (or twin structures) approximately 485 metres long, to span over the existing SH1 and the Hōteo River.

f) A tie in to existing SH1 in the vicinity of Maeneene Road, including a bridge over Maeneene Stream.

g) Changes to local roads:

   i. Maintaining local road connections through grade separation (where one road is over or under the other). The Indicative Alignment passes over Woodcocks Road, Wayby Valley Road, Whangaripo Valley Road, Mangawhai Road and Maeneene Road. The Indicative Alignment passes under Kaipara Flats Road, Rustybrook Road, Farmers Lime Road, and Silver Hill Road.

   ii. Realignment of sections of Wyllie Road, Carran Road, Kaipara Flats Road, Phillips Road, Wayby Valley Road, Mangawhai Road, Vipond Road, Maeneene Road and Waimanu Road.

   iii. Closing sections of Phillips Road, Robertson Road, Vipond Road and unformed roads affected by the Project.

h) Associated works including bridges, culverts, stormwater management systems, soil disposal sites, signage, lighting at interchanges, landscaping, realignment of access points to local roads, and maintenance facilities.

i) Construction activities, including construction yards, lay down areas and establishment of construction access and haul roads.

For description and assessment purposes in this report, the Project has been divided into the following areas (as shown in Figure 1 below):

a) Hōteo South: From the southern extent of the Project at Warkworth to the Hōteo River.

b) Hōteo North: Hōteo River to the northern tie in with existing SH1 near Maeneene Road.

For construction purposes, the Hōteo South section is divided into two subsections being:

- South – from the southern tie in with P2Wk to the northern tunnel portals; and
- Central – from the northern tunnel portals to the Hōteo River.

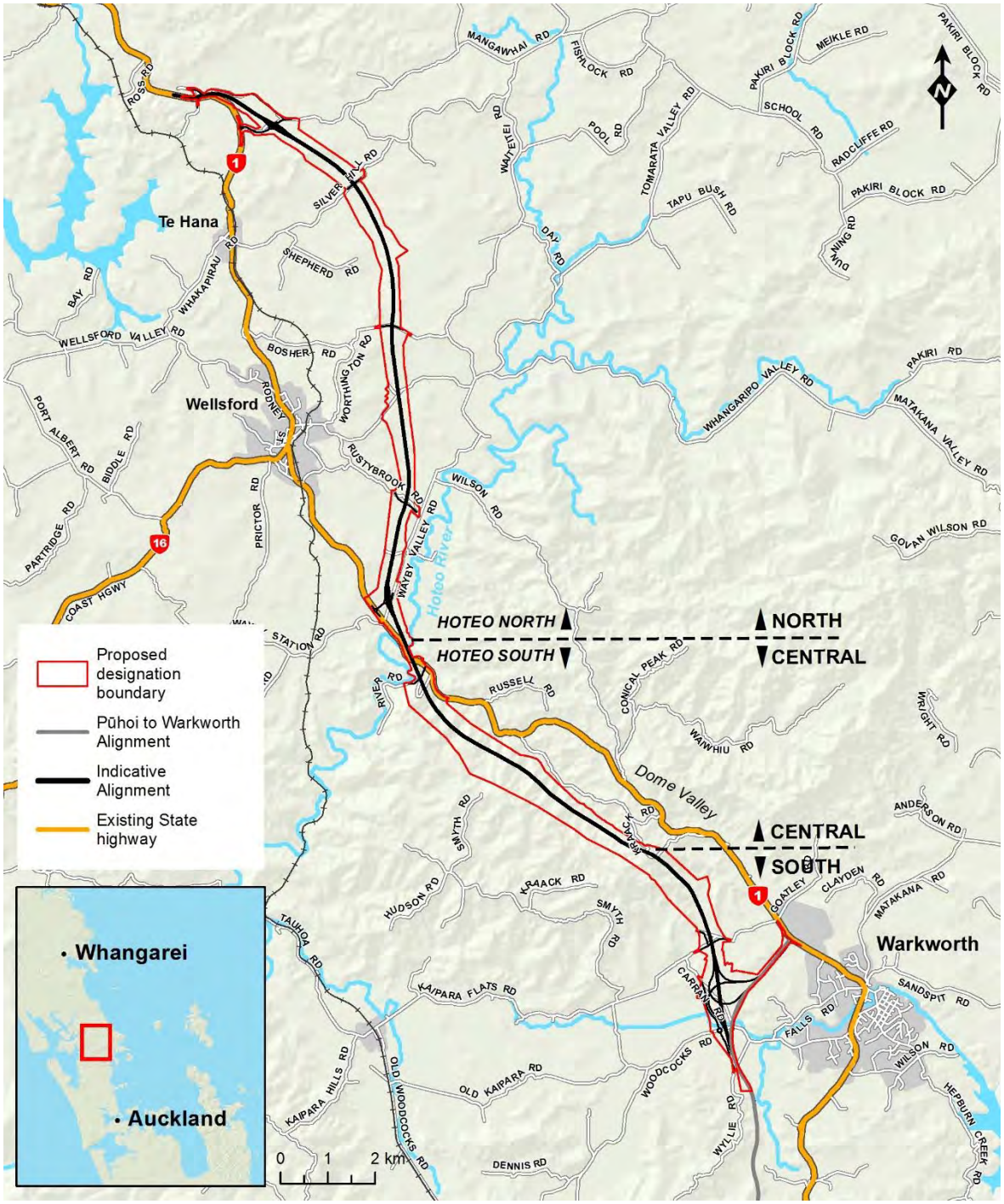


Figure 1 – Project area

The Indicative Alignment shown on the Project drawings is a preliminary alignment for a state highway that could be constructed within the proposed designation boundary. The Indicative Alignment has been prepared for assessment purposes, and to indicate what the final design of the Project may look like. The final alignment for the Project (including the design and location of associated works including bridges, culverts, stormwater management systems, soil disposal sites, signage, lighting at interchanges, landscaping, realignment of access points to local roads, and maintenance facilities), will be refined and confirmed at the detailed design stage.

A full description of the Project including its design, construction and operation is provided in Section 4: Description of the Project and Section 5: Construction and Operation of the AEE contained in Volume 1 and shown on the Drawings in Volume 3.

1.3 Purpose and scope of this report

This report presents our assessment of operational road traffic noise and vibration for the Project. Construction noise and vibration are addressed in a separate report.

Our assessment is based upon New Zealand standards and guidelines with respect to the assessment of the predicted traffic noise level. We also consider the likely response of residents to the predicted change in noise level. This assessment has been made in accordance with the NZ Transport Agency *Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects*, June 2016 v1.1.

Adverse traffic noise effects may include:

- Reduced amenity;
- Annoyance;
- Sleep disturbance; and
- Health impacts.

Our scope of our work has involved the following:

- Determining the existing noise environment in the vicinity of the proposed designation (through measurement and prediction);
- Calculating future traffic noise levels from traffic associated with the Project;
- Determining the areas that may be adversely affected subjectively and objectively by road traffic noise from the Project;
- Identifying and recommending mitigation to reduce these effects to comply with the Project criteria;
- Reviewing the overall effects of the Project with respect to the change in traffic noise levels; and
- Consideration of vibration effects of traffic using the Project.

This report assesses both operational noise and operational vibration. Construction noise and vibration are addressed in a separate report.

The Indicative Alignment shown on the Project drawings has been developed through a series of multi-disciplinary specialist studies. It is anticipated that the final alignment will be refined and confirmed at the detailed design stage. Consequently, this assessment has addressed potential effects arising from the Indicative Alignment, and considers alignment shifts within the proposed designation boundary.

Typically, levels of vibration from cars and trucks travelling on roads are very low. The exception to this may be when a vehicle travels over a discontinuity such as a defect in the road surface, a speed hump or a bridge expansion joint. Expansion joints are used for

bridge structures and allow for the structure to expand and contract during temperature changes. We reviewed the locations of the bridges where expansion joints may be used. As the closest Protected Premises and Facilities (PPFs) are at least 155 m away, vibration is not expected to result in impacts on PPFs and therefore is not discussed further in this report. Tunnel ventilation fans have not been specified in the proposed operational design of the tunnel to date and there are no receivers located near the tunnel portals. Therefore neither operational or emergency extraction fan use has been included in this noise assessment.

The PPFs assessed in this report are shown in Figure 2 to Figure 5. They are numbered between 1 and 77, although not all numbers in this sequence are used and there are a total of 60 PPFs.

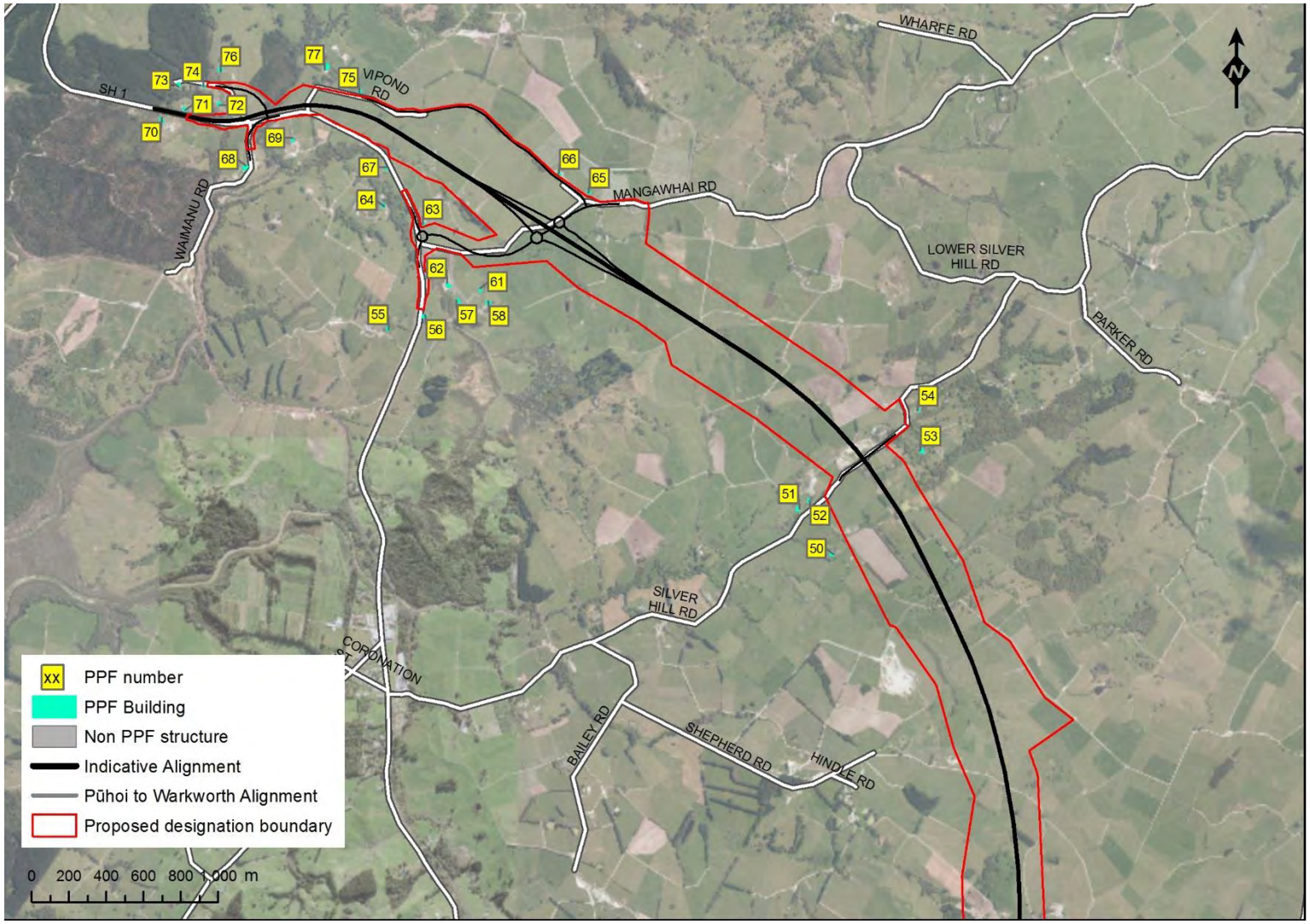


Figure 2 – PPFs assessed – Te Hana Interchange

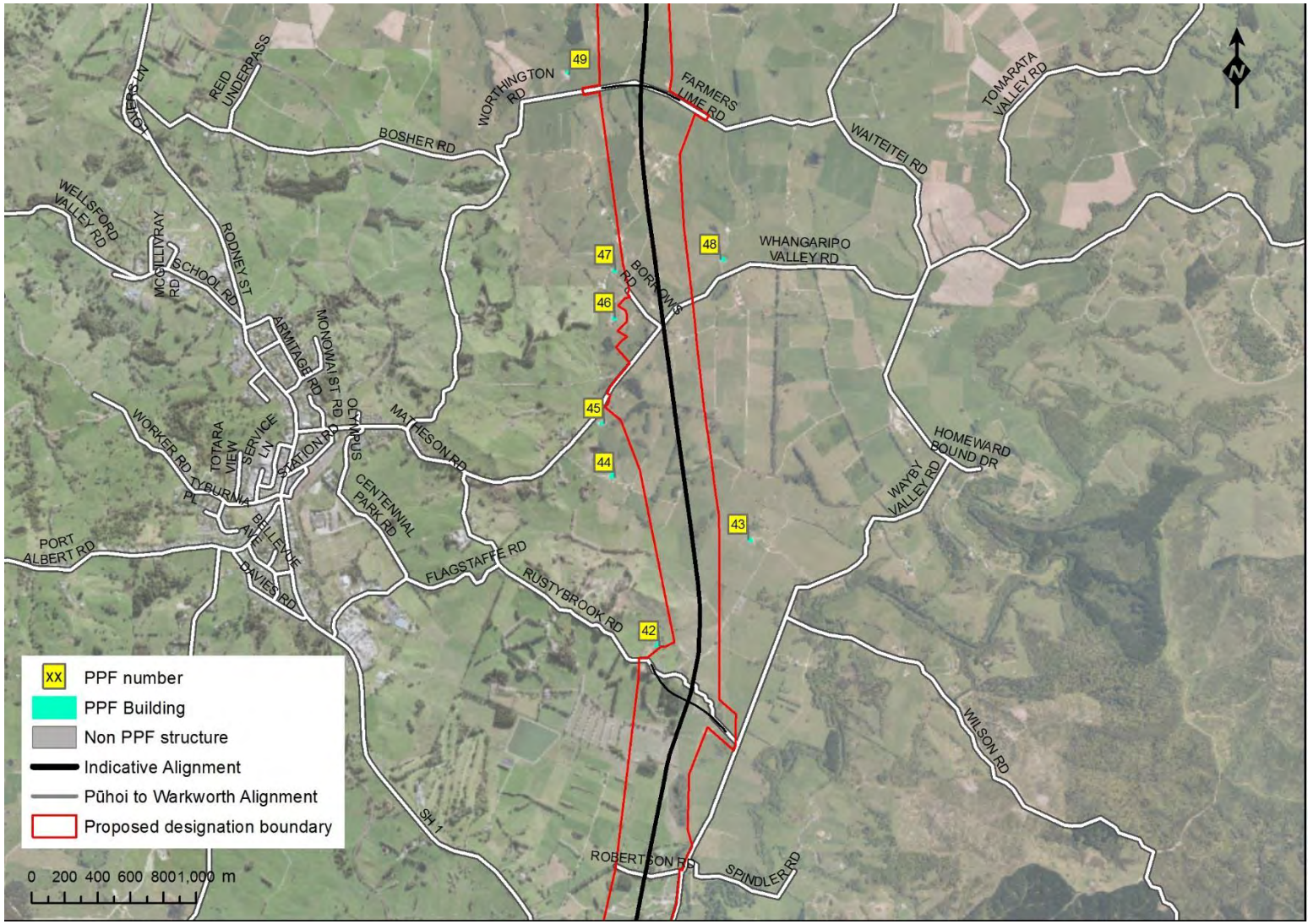


Figure 3 – PPFs assessed – Wellsford

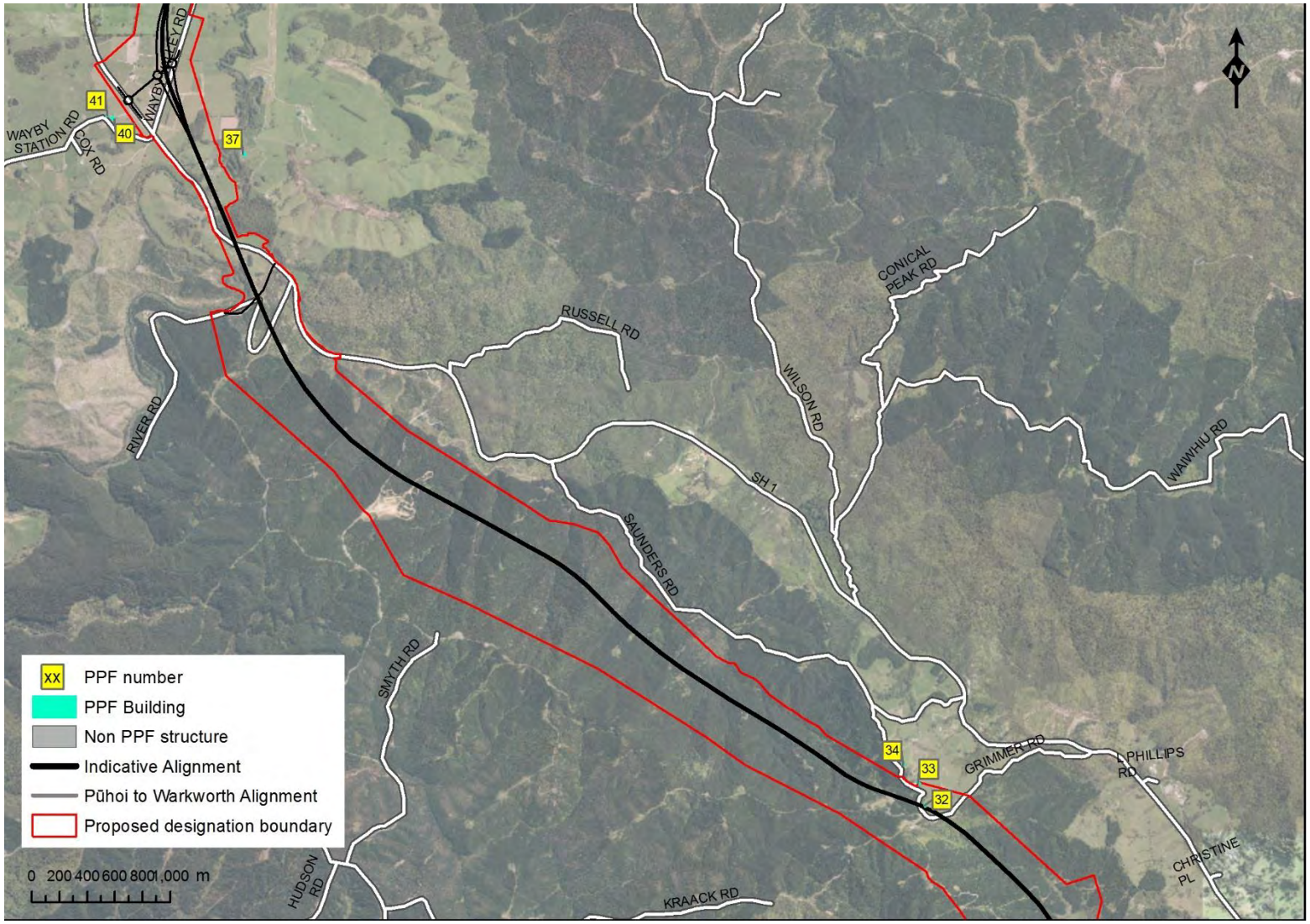


Figure 4 – PPFs assessed – Dome Forest/Wellsford Interchange

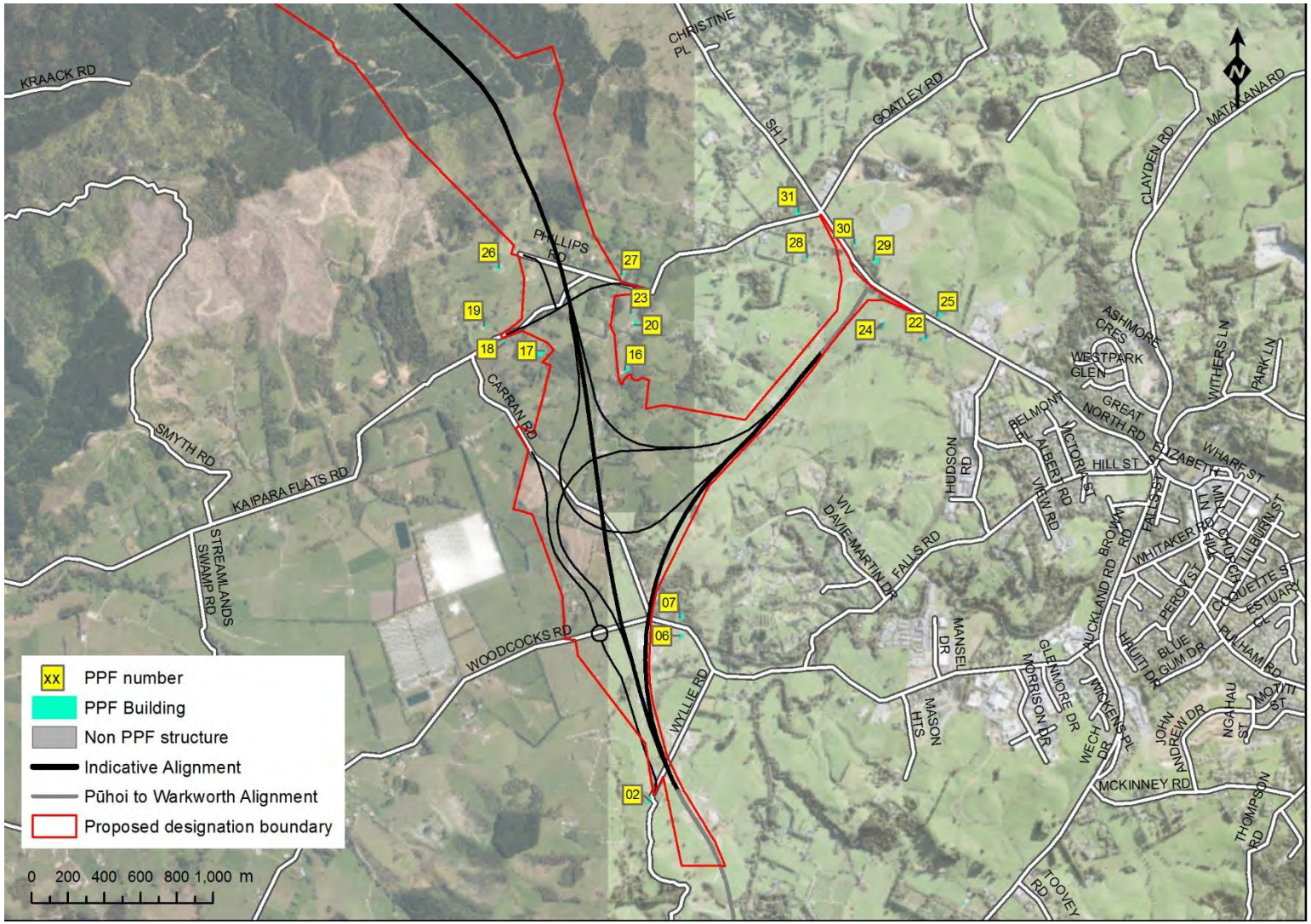


Figure 5 – PPFs assessed – Warkworth Interchange

2 NOISE ASSESSMENT CRITERIA

Noise Assessment Criteria Summary

It is appropriate to assess road traffic noise effects by using standards and guidelines. Our assessment is based upon NZS 6806:2010 (NZS 6806). Conformance with NZS 6806 will achieve reasonable noise levels for affected PPFs in the vicinity of the Project, subject to consideration of broader noise effects as set out in Sections 5 and 6.

The methodologies for noise level measurement, prediction and assessment set out in NZS 6806 provide a consistent approach for the management of noise effects for all PPFs. NZS 6806 is based on the best practicable option (BPO) approach, which aligns with Resource Management Act 1991 (RMA) requirements.

We have also assessed traffic noise effects on residents by interpreting the general subjective response to predicted noise level changes at PPFs within 200 m of the proposed designation boundary, in relation to the Indicative Alignment.

2.1 Noise Assessment Criteria

As set out in the NZ Transport Agency *Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects* we consider that NZS 6806 is the most current, and appropriate document with which to assess road traffic noise in New Zealand. The Auckland Unitary Plan Rule E25.6.33 also stipulates that new and altered roads must comply with the requirements of NZS 6806.

Therefore, we have used NZS 6806 criteria to assess the road traffic noise associated with the Project. This approach is consistent with the Pūhoi to Warkworth Operational Noise Assessment among many others[1]. Criteria to assess the potential effects of predicted changes in noise levels have also been considered.

2.1.1 New Zealand Standard NZS 6806:2010

Road traffic noise in New Zealand is generally assessed and managed using NZS 6806. NZS 6806 was issued as a New Zealand Standard in April 2010 and has been applied to many major roading projects in New Zealand since its release, including for Pūhoi to Warkworth.

The intent of NZS 6806 is to present a pragmatic approach to providing noise mitigation which includes the following approach:

(i) a roading project needs to have a noticeable effect before mitigation is considered; and

(ii) any mitigation should only be recommended if it will achieve a noticeable reduction in noise level.

Eligible PPFs

NZS 6806 stipulates that in rural areas, all PPFs within 200 m of a project road alignment shall be assessed. We have undertaken the noise assessment for the Project accordingly. However, as

[1] These include the Kapiti Expressway, Waterview Connection, Transmission Gully, Waikato Expressway Cambridge Section, Christchurch Southern Motorway stage 2, Northern Corridor Improvements

the Indicative Alignment for the Project has not been finalised we have also assessed all PPFs within 200 m of the proposed designation boundary.

Road traffic noise impacts are assessed at the façade (external wall) of the PPFs as specified in NZS 6806.

PPFs include:

- Dwellings (including those not yet built but having obtained building consent);
- Educational facilities and play grounds within 20 metres of educational facilities;
- Boarding houses;
- Homes for the elderly and retirement villages;
- Marae;
- Motels and hotels in residential zones.

All PPFs in this assessment have been identified as dwellings.

NZS 6806 does not include the following and they are excluded from our assessment:

- commercial and business uses (not considered to be noise sensitive);
- future land use (on the basis that land use planning is the preferred tool to manage the location of PPFs rather than pre-empting the location and use of future PPFs); and
- PPFs beyond 200 m of the road alignment (locations outside this area are excluded because at larger distances, noise levels will generally be below the most stringent noise criteria due to the distance attenuation of noise). As mentioned above, to account for possible alignment changes within the proposed designation we have assessed PPFs within 200 m of the proposed designation boundary.

Design Year

NZS 6806 defines the design year as:

- A point in time that is not less than 10 years but not more than 20 years after the opening of a new road, or opening of alterations to an altered road, to the public.

This definition of design year makes an allowance for an increase in traffic volumes over time. The year 2046 has been chosen as the design year for the purposes of our assessment. When the acoustics modelling was undertaken this year was in the specified range of 10 to 20 years after opening. However, the construction assumptions were subsequently refined and now this date is potentially only 9 years after opening so no longer complies with the NZS 6806 requirement. The assumed year for commencement of construction of the Project is 2030, and the constructability assessment described in section 5 of the AEE identifies a construction period of approximately 7 years, which would correspond to the project opening in 2037.

Although the design year (2046) is one year earlier than the range required by NZS 6806 (2047 to 2057) the traffic volumes should not change markedly. Because noise level predictions are relatively insensitive to changes in traffic volume we consider that the chosen design year of 2046 provides appropriate consideration of future traffic noise effects from 2047. (For example a 20%

increase in traffic volume would result in a less than 1 decibel increase in noise level, and a 50% increase in traffic volume would result in less than 2 decibels increase).

Noise Criteria

The noise criteria presented by NZS 6806 are designed to result in reasonable levels, 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.

Within NZS 6806, "*a new road is any road which is to be constructed where no previously formed legal road existed.*" Whilst an altered road means *"an existing road that is subject to alternations of the horizontal or vertical alignment where at any assessment position at one or more PPF."* More lenient criteria apply to altered roads in recognition of the noise environment next to the pre-existing road, whereas more stringent criteria apply to new roads.

The specific noise criteria are dependent on traffic volume and type of road and are presented in Table 1.

Table 1: NZS 6806 Traffic Noise Criteria

Category	Road Type	
	Altered Road dB $L_{Aeq(24h)}$	New Road dB $L_{Aeq(24h)}$
A Primary external noise criterion	64	57
B Secondary external noise criterion	67	64
C Internal noise criterion[1]	40	40

Notes:
1 – This criterion is triggered if habitable rooms would receive internal noise levels greater than 45 dB $L_{Aeq(24h)}$ despite mitigation such as bunds, barriers and road surface materials being used.

We have applied the new road criteria to all PPFs within 200 m of the proposed designation boundary, except for PPFs where the Project is within the area of influence of the existing SH1 (and other existing local roads).

While the categories in NZS 6806 are not dependent on ambient noise levels, NZS 6806 allows for 'Special Cases' where PPFs *are significantly affected by noise from another existing road,*[2] such as the existing SH1. In such areas NZS 6806 states that *it may be more appropriate to apply one of the sets of criteria to some assessment positions affected by the project, and another set of criteria to other assessment positions affected by the same project.* Consequently, we have implemented the approach outlined below to PPFs in the vicinity of existing SH1.

We determined the areas where the existing SH1 contributes significantly to the overall noise level by applying the following methodology:

- We established 200 metre zones around the existing SH1 and around the proposed designation boundary (including parts of the existing P2Wk designation that would contain works);
- Where these two areas intersect, we applied the "Altered Road" criteria to the Project;

[2] NZS 6806 Section 6.2.1 c.

- In these situations, the existing SH1 is close to the Project and will add, or even dominate, the existing and future noise environment; and

- In areas closer to the Project the "New Road" criteria were applied.

The southern tie-in area of the Project is an unusual case in that P2Wk is part of the existing environment and therefore PPFs that were subject to "New Road" criteria for P2Wk could now be subject to increased "Altered Road" criteria for this Project. NZS 6806 does not provide specific guidance for this situation, but we consider a reasonable approach to retain "New Road" criteria for those PPFs to avoid a perverse outcome of increased noise limits simply due to the staging of this Project and P2Wk.

The applicable criterion at any PPF depends on the Best Practicable Option (BPO) assessment as follows:

1) Where noise levels within Category A can be met with the implementation of the BPO for noise mitigation, then Category A applies;

2) Where Category A cannot practicably be achieved, then mitigation to achieve the noise criteria within Category B is subject to the BPO test; and

3) If the noise criteria of Categories A or B are not practicably achievable, then Category C shall be met with the adoption of the BPO.

The preference in NZS 6806 is to use structural mitigation over Building Modification Mitigation (BMM) (i.e. Category C).

Structural mitigation involves the use of structural elements such as bunds, barriers or the choice of road surface material. BMM refers to mitigation that is applied to a building, e.g. improving glazing and providing mechanical ventilation. BMM provides noise level reduction for the indoor environment only and does not protect outdoor living areas.

Assessment Scenarios

NZS 6806 requires the following operational scenarios to be assessed and compared:

- **The existing noise environment**: for altered roads this consists of the current road layout and traffic volume, and for new roads this consists of the current ambient noise level;

- **A future Do-nothing scenario**: consists of the existing SH1 at the design year (2046), with increased traffic volume. Noise levels predicted from the Do-nothing scenario apply for PPFs assessed against the "altered road" criteria only. This scenario (and the following two scenarios) includes P2Wk;

- **A future Do-minimum scenario**: consists of the Project's Indicative Alignment at the design year (2046), but without any specific noise mitigation. This scenario means that the choice of road surface material is independent from its noise generating characteristics. It also means that the only barriers included are solid safety barriers, which are required for reasons other than noise mitigation. Local roads that are not proposed to be altered by the project are not included in the assessment; and

- **Future Project with mitigation**: consists of the Project road alignment at the design year (2046), and includes mitigation that is designed specifically to reduce noise levels.

Mitigation Requirements

NZS 6806 adopts the BPO methodology for noise mitigation. The BPO requires that structural mitigation only be recommended if it will achieve a noticeable noise level reduction.

Consequently, NZS 6806 includes the following criteria for the effectiveness of structural mitigation measures:

1) In areas where mitigation benefits more than one PPF, it should only be implemented if the combination for the structural mitigation measures used would achieve an average reduction of at least 3 dB $L_{Aeq(24h)}$; and

2) Where houses are located sporadically along the alignment, and structural mitigation would benefit only individual dwellings, mitigation should achieve a minimum reduction of 5 dB $L_{Aeq(24h)}$ at any assessment position(s).

2.2 Noise Assessment Areas

The comparison between the **do-nothing** and the **do-minimum** allowed for the identification of the PPFs that fall within the NZS 6806 Category B and C due to the Project. The Project was then split into seven assessment areas labelled A to G shown in Figure 6 to Figure 9.

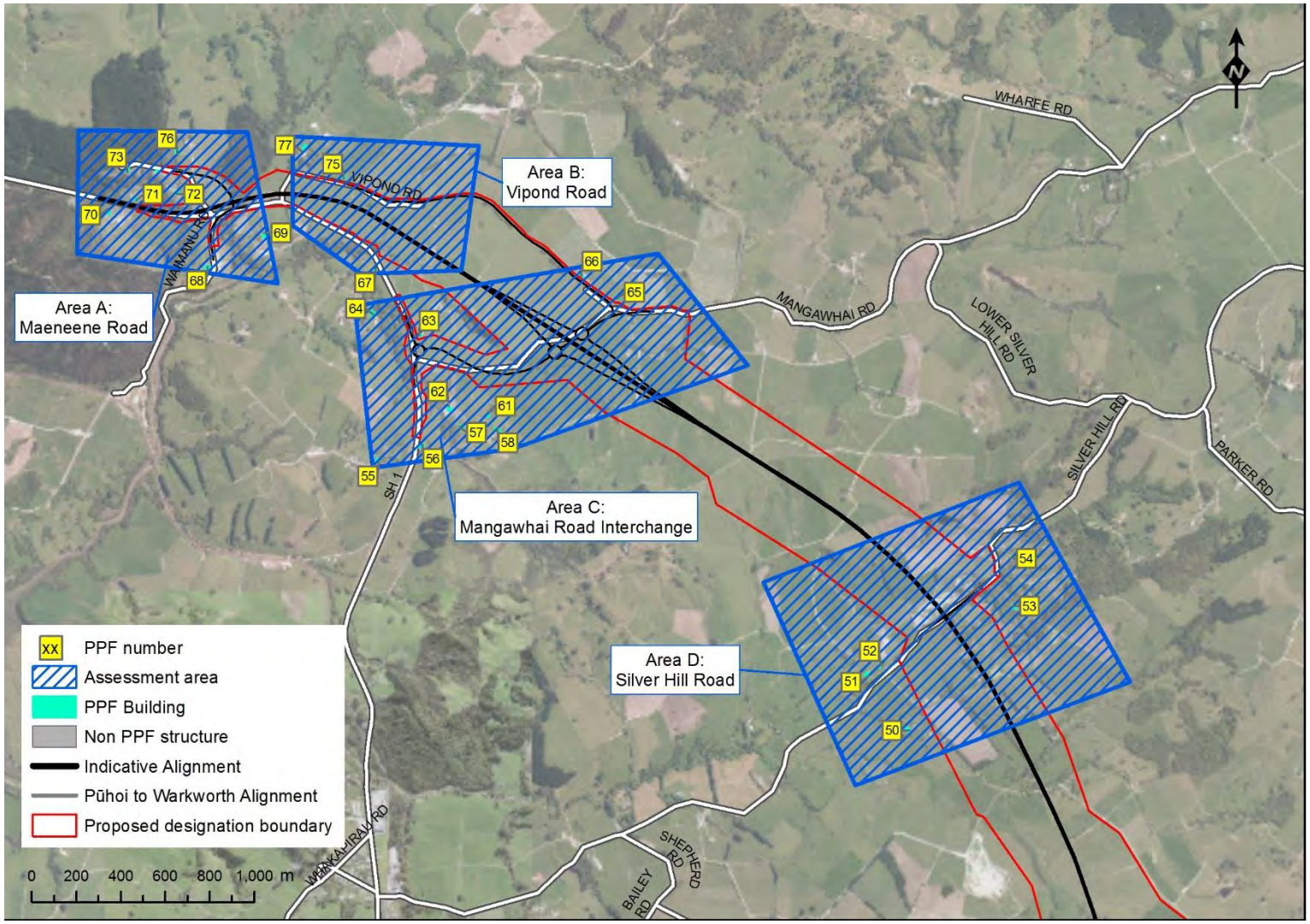


Figure 6 – Assessment areas A – D

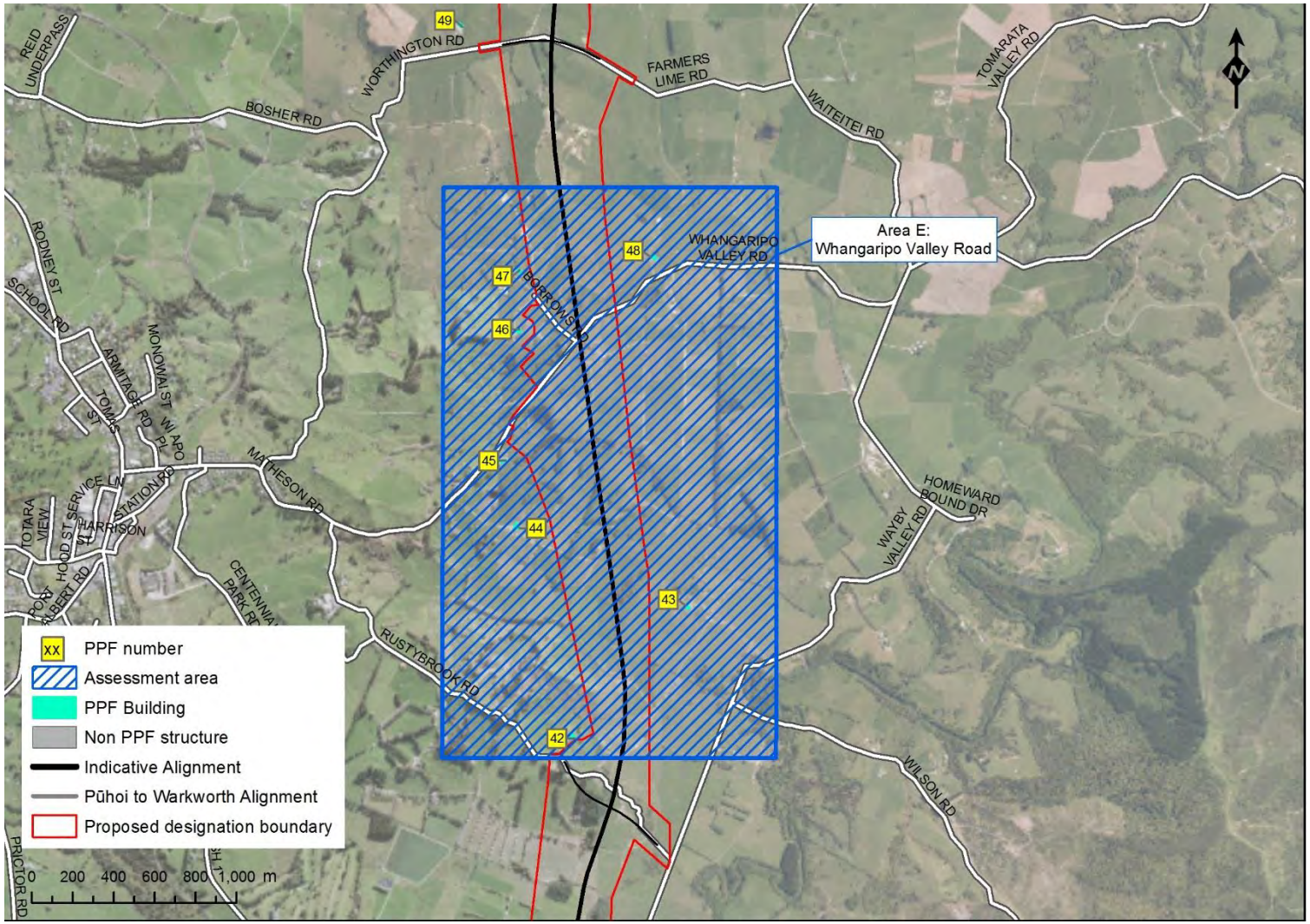


Figure 7 – Assessment area E

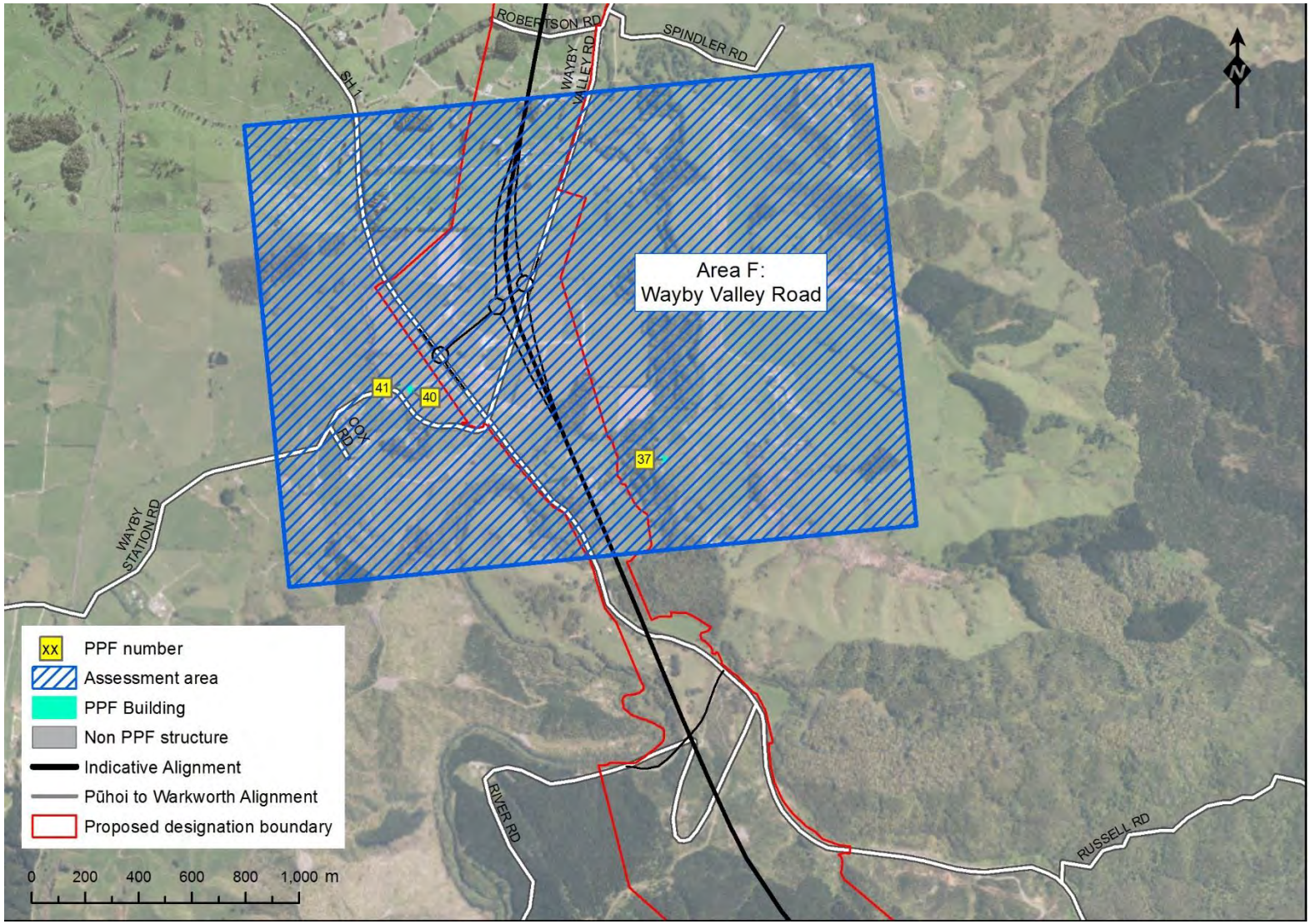


Figure 8 – Assessment area F

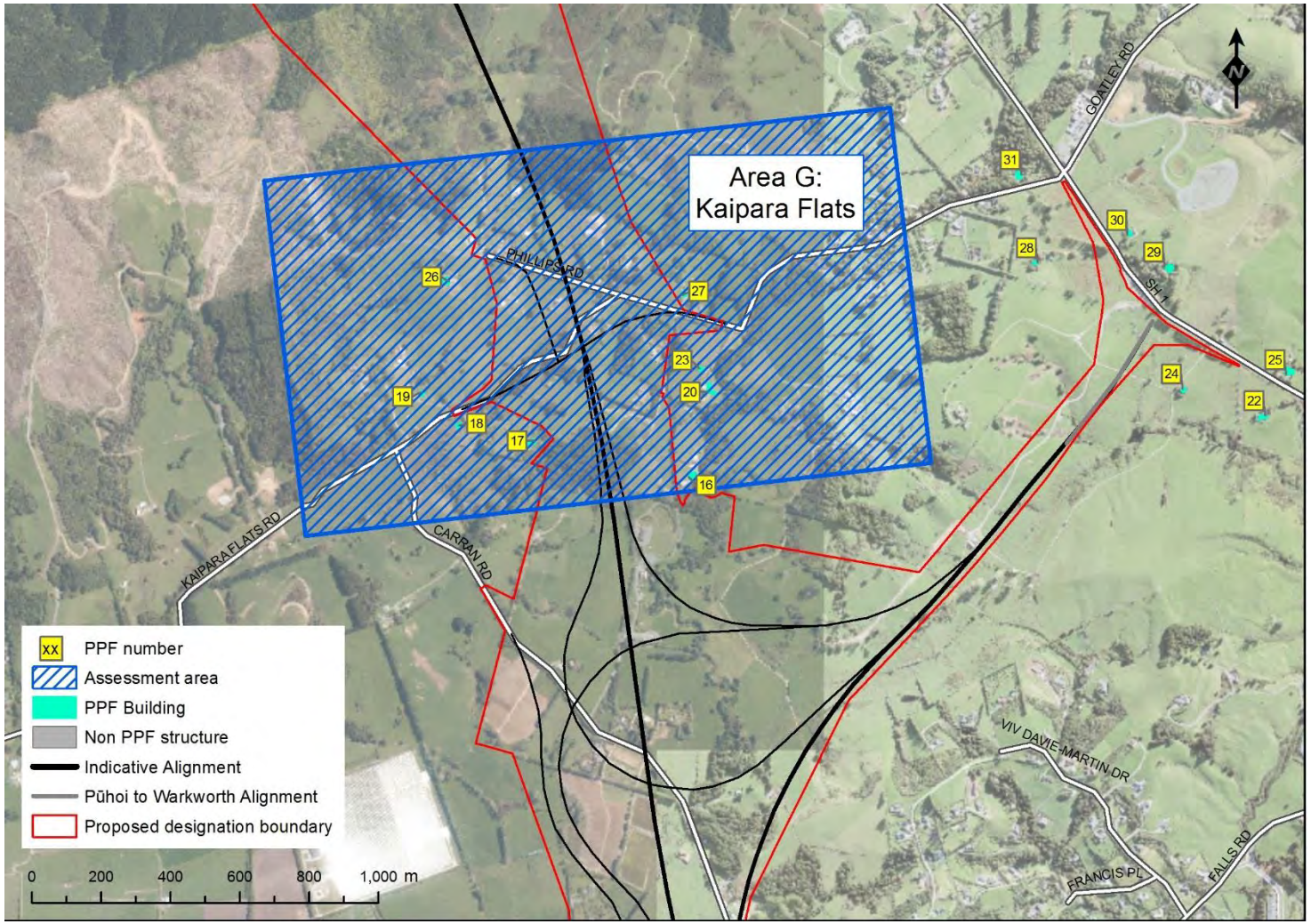


Figure 9 – Assessment area G

2.3 Subjective perception of noise change

An indication of subjective response to noise can be obtained by considering the change in noise level. While people can react differently to noise level changes, research typically shows a general correlation between noise level changes and subjective responses as set out in Table 2. This is based upon information documented in Architectural Acoustics.[3] The changes in noise level are considered along with the corresponding subjective response. The responses relate to two sounds heard consecutively in a controlled environment, and more nuanced responses are likely to occur for longer term changes in residential amenity. People can be more sensitive to changes in their established environment than indicated in this table and non-acoustic factors can significantly influence responses to changes in sound. While the complex subjective responses to changes cannot be accurately represented by single numbers, the table provides an initial indication of possible effects.

Table 2 - Subjective response to change in noise levels

Change in noise level		Subjective response
Reduction	>10 dB	Major change
	10 dB	About half as loud
	7 to 9	Significant decrease in noise level
	4 to 6 dB	Noticeable reduction in noise level
	3 dB	Just perceptible reduction in noise level
	<2 dB	Negligible
Increase	<2 dB	Negligible
	3 dB	Just perceptible increase in noise level
	4 to 6 dB	Noticeable increase in noise level
	7 to 9	Significant increase in noise level
	10 dB	About twice as loud.
	>10 dB	Major change

The subjective response to changes in noise level as presented in this report is the change between the **future Do-nothing** scenario and the **future Project with mitigation** scenario.

[3] M David Egan, Architectural Acoustics, J Ross Publishing 2007, page 21.

3 NOISE ASSESSMENT METHODOLOGY

Noise Assessment Methodology Summary

We have assessed the existing environment by:

- Undertaking noise monitoring; and
- Computer noise modelling using existing conditions to predict existing noise levels.

The computer noise model results are expressed as individual receiver noise levels at the PPFs and also as noise contours over a larger area. We have used the traffic noise levels predicted at individual PPFs to assess compliance with NZS 6806 and to determine the noise level change at each dwelling.

The noise level contours provide a wider picture of the road traffic noise associated with the Project.

Our assessment is based upon:

- Assessment of compliance with NZS 6806 following the BPO process and focussing on achieving the most stringent Noise Criteria Category A, where practicable; and
- Assessment of the change in noise level at individual properties.

The noise assessment is primarily based upon computer noise modelling which compares future noise levels with baseline conditions partly determined by noise monitoring. Monitoring is also used to provide data for areas where the existing noise environment is not controlled by road-traffic noise. For the modelling, the propagation of road traffic noise is affected by:

- Terrain elevation, including shielding from intervening hills;
- Ground conditions, including absorptive ground such as grassed areas or reflective ground such as water;
- Road parameters, including road surface, traffic speed, vehicle types and road gradient;
- Meteorological conditions; and
- Barriers/bunding.

Computer modelling is able to take all of these parameters into consideration in the prediction of road traffic noise. Appendix B presents details of the computer noise modelling.

The computer noise modelling has been undertaken using SoundPLAN version 7.4. SoundPLAN has implemented the Calculation of Road Traffic Noise methodology.[4]

The noise monitoring allows for the existing noise environment of the Project area to be explored, in areas beyond the influence of existing SH1. The existing environment allows for the

[4] Calculation of Road Traffic Noise, 1988, UK Department of Transport Welsh Office.

determination of the potential effects of a change in noise level due to the Project being in operation, and annoyance for people at PPFs within the Project area can be interpreted.

3.1 Predicted noise levels

Individual Receivers

Traffic noise levels have been predicted for the design year at all eligible PPFs within 200m of the proposed designation boundary. These results are provided in Table 22 in Appendix C. The locations of these dwellings are shown on Figure 2 to Figure 5.

Noise Contours

Noise contour plans show a graphical overview of noise exposure over a project area. The contours are calculated by the computer programme by interpolating a large number of individual points. We have prepared noise contour plans for the Project (included in Volume 3 Drawing Set) of the AEE.

3.2 Assessment

We have used the computer modelling results to assess the operational noise effects on people based on the following:

1) Assessment of compliance with NZS 6806 following the BPO process for noise mitigation and focussing on achieving Noise Criteria Category A, where practicable; and

2) Assessment of noise effects due to the change in noise level (both beneficial and adverse effects).

These assessments have been undertaken to provide a thorough understanding of the impact of the Project as sometimes a noise level increase could have a significant impact even though compliance with the NZS 6806 criteria has been met. It is also important to provide an overarching view of traffic noise effects over the wider area affected by the Project, weighing up benefits and otherwise to people through noise level increases and decreases.

4 EXISTING ENVIRONMENT

Existing Environment Summary

The existing noise environment provides a baseline for assessing subjective noise effects of the Project due to noise level changes. We have both measured and predicted the existing noise levels for PPFs within 200 m of the proposed designation boundary.

Ambient noise measurements show that beside the existing SH1, noise levels are elevated, while in areas away from SH1 the noise levels are low.

Noise levels in the quiet areas are generally in the range 30 to 40 dB $L_{Aeq(24h)}$.

We have undertaken noise monitoring of the existing noise environment in the vicinity of the proposed designation at eight properties. We have also undertaken prediction of the current noise levels due to the existing SH1 (see Section 5). Noise monitoring has been undertaken at selected properties to demonstrate contributions of all existing sound whereas the predictions allow us to estimate the existing noise levels from the existing SH1 at all properties.

The existing noise environment provides a baseline for assessing subjective noise effects associated with a change in noise level due to the Project. In areas close to existing roads, future growth that would occur in the absence of the Project (do-nothing) is also relevant as a benchmark when assessing effects of noise level changes as set out in Section 5.

The current noise environment within the Project area (which for the purposes of this noise assessment extends beyond the proposed designation boundary to the locations and properties potentially influenced by noise and vibration) is relatively quiet as most of the Project area is rural. The main existing noise source is the existing SH1. Local roads may contribute to the overall existing noise environment, however they have relatively low traffic volumes.

4.1 Noise monitoring

Noise monitoring has been undertaken at eight locations as shown on Figure 10 using remote noise logging devices. A summary of the results is shown in Table 3. Details of the long-term noise monitoring are provided in Appendix A.

Noise monitoring locations were selected based upon their proximity to either the Indicative Alignment or the existing SH1. Three of the eight locations are in the vicinity of SH1 while the other locations are in the vicinity of the Indicative Alignment. The locations within proximity of the SH1 are 490 SH1, 1472 SH1 and 761 A SH1. The other locations were chosen due to their proximity to the Indicative Alignment and would provide representative data in relation to the overall change of the noise levels due to the Project.

Table 3 – Summary of noise monitoring results

Measurement Location	Measured Noise Level, dB $L_{Aeq(24h)}$
490 SH1, Wellsford, NZ, 0975	47
1472 SH1, Wellsford, NZ, 0975	54
263 Silver Hill Road, Wellsford, NZ, 0975	35
40 Borrows Road, Wellsford, NZ, 0974	32
294 Wayby Valley Road, Wayby Valley, NZ, 0972	34
761 A SH1, Dome Forest, NZ, 0981	34
39 Philips Road, Dome Forest, NZ, 0981	28
211 Kaipara Flats Road, Warkworth, NZ 0981	24

A wide range of noise levels within the Project area were measured.

Near to the existing SH1, noise levels are elevated, generally above 35 dB $L_{Aeq(24h)}$ and up to 57 dB $L_{Aeq(24h)}$ while in areas away from SH1 in more rural environments, noise levels are as low as 35 dB $L_{Aeq(24h)}$. These noise levels are "energy average" values over 24 hours, and as shown in the graphs in Appendix A the noise levels vary from these average values throughout the day and night. During the day the levels are often close to or above the average values, whereas in the evening and at night they are generally below the average values, typically by 10 dB or more at the quietest times in the middle of the night.

The results of the noise monitoring present baseline information. As the proposed designation is mostly at significant distances from SH1, the noise monitoring has not been used to undertake a validation of the acoustic model in these areas. Furthermore, the three measurement locations that were near the existing SH1 did not have direct line-of-sight to the road so are unsuitable for verification of the model.

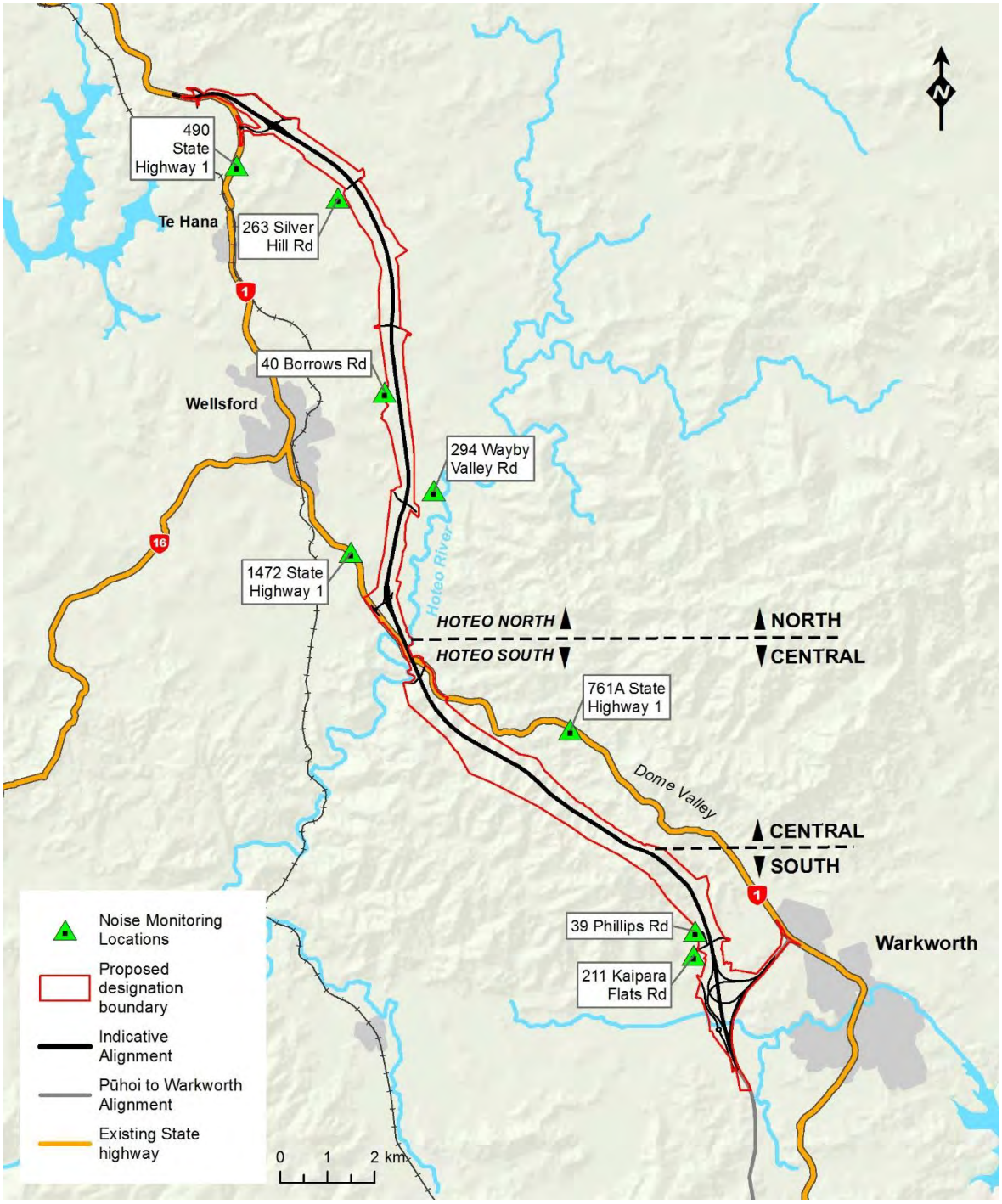


Figure 10: Noise monitoring locations

5 ASSESSMENT OF EFFECTS

Assessment of Effects Summary

We have assessed the operational noise effects from the proposed new road on PPFs within 200 metres of the proposed designation boundary. The assessment looks at the Project with and without the influence of the existing SH1 in terms of the **Do-minimum** scenario. Furthermore, we have considered the potential noise level changes should the Indicative Alignment be moved within the proposed designation boundary during detailed design.

The **Do-nothing** scenario (where the Project is not built, but inclusive of the P2Wk project showed that noise levels would increase up to 11 dB, with the larger increases being due to P2Wk . General increases along SH1 of up to 4 dB at the design year are expected. These increases in noise without the Project generally occur gradually over time, other than the changes due to P2Wk which will result in a step change to the local noise environment.

The **Do-minimum** scenario (where the Project is built with no noise mitigation) allowed for a chip seal road surface for the Hōteo North section of the Indicative Alignment, stone mastic asphalt (SMA) for 400 m either side of the tunnel portals and the tunnel itself and finally Open Grade Porous Asphalt (OGPA) (or similar) for the Hōteo South section south of Kaipara Flats Road along the Indicative Alignment.

For the do-minimum scenario, noise levels would increase by up to 26 decibels. PPFs in close vicinity of existing SH1 have a reduction in noise levels varying substantially between locations. Up to 17 PPFs would fall into Categories B and C. This is typical of new state highway projects.

Noise effects from the Project with the selected mitigation, i.e. the **future Project with mitigation** scenario, (described in Section 6 of this report) generally comply with Category A. Whilst the PPFs are predicted to have increases of greater than 10 dB, at most PPFs the predicted noise level complies with the Category A noise for a 'new' road of 57 dB $L_{Aeq(24h)}$.

The overall noise effects of the Project were assessed by comparing predicted **future Do-nothing** scenario noise levels with the predicted noise levels of the **future Project with mitigation** scenario. In areas remote from the existing SH1, although mitigation results in reasonable absolute noise levels being achieved within recommended criteria, there will be a major change experienced at some houses, representing a significant adverse noise effect. In other areas closer to the existing SH1 noise effects are to a minor extent with some being positive and others adverse depending on whether traffic is moved slightly further from or closer to individual houses.

We have also taken into account possible alignment shifts within the proposed Designation Boundary. The possible effects of Indicative Alignment adjustments in relation to specific areas within the proposed designation boundary, are detailed in Sections 5.4 to 5.10 below. The assessment details the indicative distances the alignment can shift west and east within the proposed designation boundary and the approximate distances at which re-assessment of mitigation would be required for specific PPFs.

Overall, provided that the mitigation recommended in Section 6 of this report is adopted, we conclude that the Project overall can be operated to achieve reasonable noise levels at affected dwellings, accepting there will be a significant adverse change in acoustics amenity in some areas.

5.1 NZS 6806 evaluation process

Do Nothing Scenario

For this scenario, the Project is not implemented and traffic on SH1 increases over time up to the Design Year (2046). In addition to these assumptions, P2Wk has also been built.

For this scenario, the following is assumed:

- The existing SH1 and local roads of Mangawhai, Whangaripo Valley, Wayby Valley, Kaipara Flats, Carran and Woodcocks Roads all have a road surface finish of chip seal: and
- Generally, traffic noise would increase by up to approximately 4 decibels due to traffic increase on the existing SH1. PPFs in close proximity to P2Wk were predicted to have traffic noise increases of approximately 11 decibels when compared to the existing scenario.

Do Minimum Scenario

For this scenario the Project is implemented without any specific noise mitigation.

Road surface finishes for the Indicative Alignment are provided in Table 4. Surface corrections for existing and altered roads are detailed further in Appendix B Table 20. The road surface finishes are calculated using the *NZTA: Guide to state highway surface noise – Version 1.0 (2014)*, which utilises surface type, speed and heavy vehicle percentage in the calculation.

Table 4 – Road surface finishes

Main Alignment	Location	Road Surface Finish	Correction Note 1 dB
CH23800 to 44000	Northern sector and the forest zone	Two coat chip seal	-0.8
CH 44000 to 45600 Southbound	The tunnel including 400 m either side	SMA	-4.6
CH 44000 to 46700 Northbound	Start of the north bound crawler lane to 400 m north of the tunnel	SMA	-4.6
CH 45600 to 50900 Northbound	Wk interchange towards the tunnel	OGPA	-5.8
CH 46700 to 47400 Southbound	From tunnel to Kaipara Flats Road	Two coat chip seal	-0.8
CH 46700 to 50900 Southbound	From Kaipara Flats Road to Wk interchange	OGPA	-5.8
Note: 1 – These corrections include a conversion from $L_{A10\ (18h)}$ to $L_{Aeq\ (24h)}$			

The median and shoulder traffic barriers that have been assumed along the Indicative Alignment are wire rope barriers. These barriers provide no acoustic benefit and are not modelled. The bridges and viaducts utilise concrete safety barriers of approximately 0.8 m in height and may provide noise attenuation. These have been included in the computer model assuming the barriers extend along the full length of the structure.

Houses which are within the proposed designation boundary or owned by the Transport Agency have not been considered as PPFs and have been excluded from the assessment. These are listed in Appendix B.8.

Predicted noise levels for the Do Minimum Scenario (No mitigation)

The predicted noise levels at the PPFs assessed for the Design Year ranged from 35 to 71 dB $L_{Aeq(24h)}$ due to traffic on the Project only.

Out of the 60 PPFs assessed along the alignment, 60 PPFs were in Category A, 14 PPFs were in Category B and 3 PPFs were Category C. The definitions for Category A to C properties are provided in Table 1.

Selected mitigation options

Noise mitigation options have been assessed in accordance with NZS 6806 as set out in Section 6.2. The selection of mitigation has occurred as an integral part of the indicative road design, and therefore the following assessment is made including the benefits of the selected mitigation. Details of the mitigation evaluation and the rationale for options selected and not selected is set out in Section 6.

5.2 Summary of noise levels

As a basis for this assessment of effects, a summary of the predicted traffic noise levels is provided in Table 5 Further details are contained in Appendix C.

It is important to note that the change in noise level compared to the **do-nothing** for PPFs with BMM will have an assessment based on internal levels. The values for these PPFs have been placed in brackets.

Table 5 – Summary of assessment

No.	PPF	Fl	Existing (2016) dB $L_{Aeq(24h)}$	New / Altered Road	Do Nothing (2046 No Project) dB $L_{Aeq(24h)}$	Do Minimum (2046 Project) dB $L_{Aeq(24h)}$	Selected Mitigation		
							Project Only	Project + SH1	Change in noise level from do nothing
The coloured cells denote the NZS 6806 Category; Green is Category A, Yellow is Category B and Red is Category C.									
2	74 Wyllie Rd, Streamlands	GF	41	new	52	54	54	54	2
6	371 Woodcocks Rd, Warkworth	GF	56	new	59	56	56	57	-2
7	372 Woodcocks Rd	GF	60	new	62	61	61	61	-1
7	372 Woodcocks Rd	F 1	62	new	64	63	63	63	-1
16	131 Kaipara Flats Rd	GF	36	new	45	57	56	56	12
17	211 Kaipara Flats Rd	GF	41	new	47	57	55	55	8
18	215 Kaipara Flats Rd	GF	50	new	56	59	58	58	3
19	214 Kaipara Flats Rd	GF	44	new	49	45	42	42	-7
20	115 Kaipara Flats Rd	GF	38	new	45	53	53	53	8
22	27 SH-1, Warkworth	GF	61	altered	63	35	33	63	1
23	115 - 2 Kaipara Flats Rd	GF	46	new	51	54	54	54	3
24	63 SH-1, Warkworth	GF	56	altered	58	46	46	58	0
25	42 SH-1, Warkworth	GF	69	altered	71	42	42	71	1
26	39 Phillips Rd, Streamlands	GF	42	new	47	58	53	53	7
27	130 Kaipara Flats Rd	GF	50	new	55	58	58	58	3
28	105 SH1, Warkworth	GF	57	altered	59	38	36	59	0
29	102 SH-1, Warkworth	GF	61	altered	63	46	45	62	0
30	104 SH1, Warkworth	GF	65	altered	66	41	40	67	0
31	6 Kaipara Flats Road, Dome Valley	GF	60	altered	63	36	34	59	-4
32	161 Kraack Rd, Dome Forest	GF	36	new	39	53	51	51	12
33	145 Kraack Rd, Dome Forest	GF	40	new	43	40	38	40	-2
34	127 Kraack Rd, Dome Forest	GF	35	new	38	51	48	49	10

No.	PPF	Fl	Existing (2016) dB $L_{Aeq(24h)}$	New / Altered Road	Do Nothing (2046 No Project) dB $L_{Aeq(24h)}$	Do Minimum (2046 Project) dB $L_{Aeq(24h)}$	Selected Mitigation		
							Project Only	Project + SH1	Change in noise level from do nothing
The coloured cells denote the NZS 6806 Category; Green is Category A, Yellow is Category B and Red is Category C.									
37	1232A SH-1, Wayby Valley	GF	50	altered	53	59	55	55	2
37	1232A SH-1, Wayby Valley	F 1	51	altered	53	60	55	55	2
40	4 Wayby Station Rd, Wellsford	GF	57	altered	60	60	57	58	-3
41	44 Wayby Station Rd, Wellsford	GF	57	altered	60	59	57	57	-3
42	177 Rustybrook Rd, Wellsford	GF	36	new	38	58	53	53	15
43	351 Wayby Valley Rd, Wellsford	GF	39	new	40	60	54	54	14
44	64 Whangaripo Valley Rd, Wellsford	GF	35	new	37	58	53	53	16
45	96 Whangaripo Valley Rd, Wellsford	GF	48	new	46	56	52	52	6
46	40 Borrows Rd, Wellsford	GF	47	new	45	62	57	57	12
47	47 Borrows Rd, Wellsford	GF	33	new	34	57	52	52	18
48	213 Whangaripo Valley Rd, Wellsford	GF	51	new	49	56	53	53	4
49	263 Worthington Rd, Wellsford	GF	35	new	37	56	51	51	14
50	250 Silver Hill Rd, Wellsford	GF	30	new	32	58	53	53	21
51	263 Silver Hill Rd, Wellsford	GF	29	new	32	58	52	52	21
52	273 Silver Hill Rd, Wellsford	GF	29	new	31	57	52	52	21
53	332 Silver Hill Rd, Wellsford	GF	35	new	37	61	56	56	19
54	344 Silver Hill Rd, Wellsford	GF	34	new	36	59	54	54	18
55	469 SH-1, Te Hana	GF	58	altered	61	55	53	54	-7
56	490 SH-1, Wellsford	GF	63	altered	66	62	61	61	-6
57	10 Charis Lane, Wellsford	GF	55	altered	58	55	52	52	-6
58	13 Charis Lane, Wellsford	GF	49	altered	52	59	55	55	4
59	8 Charis Lane, Wellsford	GF	54	altered	57	57	54	54	-3

No.	PPF	Fl	Existing (2016) dB $L_{Aeq(24h)}$	New / Altered Road	Do Nothing (2046 No Project) dB $L_{Aeq(24h)}$	Do Minimum (2046 Project) dB $L_{Aeq(24h)}$	Selected Mitigation		
							Project Only	Project + SH1	Change in noise level from do nothing
The coloured cells denote the NZS 6806 Category; Green is Category A, Yellow is Category B and Red is Category C.									
60	7 Charis Lane, Wellsford	GF	52	altered	54	59	55	55	1
61	9 Charis Lane, Wellsford	GF	52	altered	54	60	56	56	3
62	6 Charis Lane, Wellsford	GF	56	altered	59	58	55	55	-4
63	542 SH-1, Topuni	GF	68	altered	72	60	59	59	-12
64	557 SH1, Wellsford	GF	58	altered	62	59	55	55	-7
65	139 Vipond Road, Wellsford	GF	54	altered	54	61	57	57	3
66	129 Vipond Rd, Wellsford	GF	45	altered	47	59	54	54	7
67	575 SH-1, Topuni	GF	66	altered	70	64	59	59	-11
68	28 Waimanu Rd, Topuni	GF	53	altered	57	60	55	55	-2
69	641 SH-1, Wellsford	GF	57	altered	61	64	60	60	-2
70	705 SH-1, Wellsford	GF	66	altered	70	70	68	68	(-2)
70	705 SH-1, Wellsford	F 1	67	altered	71	71	70	70	(-2)
71	704 SH-1, Wellsford	GF	67	altered	71	70	69	69	(-2)
72	17 Maeneene Rd, Wellsford	GF	60	altered	64	66	62	62	-2
73	45 Maeneene Rd, Wellsford	GF	57	altered	61	61	59	59	-2
74	33 Maeneene Rd, Wellsford	GF	57	altered	61	63	59	59	-2
75	35 Vipond Road, Wellsford	GF	54	new	58	67	62	62	4
76	18 Maeneene Rd, Wellsford	GF	55	altered	59	61	57	57	-2
77	17 Vipond Rd, Wellsford	GF	53	new	56	62	57	57	1

5.3 Assessment of noise effects within Project Areas

Generally, the PPFs affected by the Project are scattered, predominantly being located around local roads or intersection crossroads.

Most PPFs exposed to road traffic noise from existing SH1 in the do-nothing scenario would benefit from the Project due to the reduction of traffic flow along SH1. Improvements up to -6 dB for these PPFs in the do-minimum scenario represents a positive effect of the Project. These PPFs are primarily at the northern tie-in.

The areas with dwellings most affected by the Project include Maeneene Road, Vipond Road, Mangawhai Road, Silver Hill Road, Whangaripo Valley Road, Wayby Valley Road and Kaipara Flats Road. The following sections discuss the effect of the Project on the PPFs within each area. We also take into account possible alignment adjustment within the proposed designation boundary at each area as a sensitivity test for the noise effects we have assessed.

For the purposes of this assessment, we have split the affected PPFs into 6 general areas. We summarise the effects of the Project, including the effects of any shift in the Indicative Alignment, below.

5.4 Area A: Maeneene Road (8 PPFs)

Assessment of noise affects

The 8 PPFs within the vicinity of Maeneene Road are already exposed to road traffic noise from existing SH1. PPFs in the southern part of Area A benefit from the Project under the do-minimum scenario because the Project takes some traffic away from the existing SH1. Toward the northern part of Area A this benefit is not apparent because the Project ties in with existing SH1. The design speed of the Project is 110 km/h, and this also influences the noise levels for PPFs within the area. For the do-minimum scenario, 3 PPFs would fall within Category C and 1 PPF within Category B. This noise exposure also occurs in the do-nothing scenario.

With the selected mitigation of OGPA road surface, the overall change in noise level is an improvement on the do-minimum and do-nothing scenarios, moving 1 Category C and 1 Category B PPF to Category B and Category A respectively. With the selected mitigation, the overall noise effect on the PPFs is a negligible reduction in noise level for 8 PPFs, with 2 PPFs, 705 and 704 SH1 receiving significant reductions due to the BMM required on those Category C PPFs (Table 6). This represents a minor positive effect in this area.

Table 6 – Change in noise level – Maeneene Road

Change in noise level (selected mitigation)		Number of ppfs	Subjective response
Reduction	>10 dB	0	Major change
	10 dB	0	About half as loud
	7 to 9	0	Significant decrease in noise level
	4 to 6 dB	0	Noticeable reduction in noise level
	3 dB	0	Just perceptible reduction in noise level
	<2 dB	8	Negligible
Increase	<2 dB	0	Negligible
	3 dB	0	Just perceptible increase in noise level
	4 to 6 dB	0	Noticeable increase in noise level
	7 to 9	0	Significant increase in noise level
	10 dB	0	About twice as loud.
	>10 dB	0	Major change

Potential Alignment Adjustment

The potential for additional effects relating to changes to the Indicative Alignment within Area A of the Project is minimal, because the proposed designation boundary is within 5 m of the Indicative Alignment where the Project ties in with existing SH1.

5.5 Area B: Vipond Road (2 PPFs)

Assessment of noise affects

The do-minimum scenario for the Project resulted in 35 Vipond Road and 17 Vipond Road being within Categories C and B respectively. Because there are only 2 PPFs affected in Area B, the most effective mitigation measure was deemed to be OGPA instead of inefficient noise barriers.

The overall change in noise level for 35 Vipond Road with the selected mitigation is 4 dB compared to the do-nothing scenario. This represents a noticeable change in noise level.

The overall change in noise level for 17 Vipond Road with the selected mitigation is 1 dB compared to the do-nothing scenario. This represents a negligible increase.

Overall there is a minor adverse noise effect in this area with mitigation in place.

Potential Alignment Adjustment

The Project alignment could be adjusted considerably in Area B. The Indicative Alignment could possibly move up to 70 m north, before it interacts with Vipond Road itself. If the alignment were to move 30 m or more northwards, 35 Vipond Road might move into Category C and potentially 17 Vipond Road might become Category B. To avoid such changes in category occuring, the alignment should only be moved to this extent if further design showed that enhanced mitigation were practicable to maintain the categories currently achieved.

5.6 Area C: Mangawhai Road (13 PPFs)

Assessment of noise affects

The 13 PPFs within proximity of the Mangawhai interchange are generally pre-exposed to the road traffic noise occurring on SH1 for the existing and do-nothing scenarios. The do-minimum and selected mitigation scenarios improve the overall noise levels within Area C as traffic is moved away from existing SH1 onto the Project alignment. As shown in Table 7, eight of the 13 PPFs show an improved overall noise level, including significant reductions of greater than 10 dB at PPFs along SH1 (542 SH1 and 575 SH1). The scale of effects varies in this area and could not reliably be portrayed by a single rating. Effects range from a significant positive effect to a moderate adverse effect.

Table 7 – Change in noise level – Mangawhai Road

Change in noise level (selected mitigation)		Number of PPFs	Subjective response
Reduction	>10 dB	2	Major change
	10 dB	0	About half as loud
	7 to 9	2	Significant decrease in noise level
	4 to 6 dB	3	Noticeable reduction in noise level
	3 dB	1	Just perceptible reduction in noise level
	<2 dB	0	Negligible
Increase	<2 dB	1	Negligible
	3 dB	2	Just perceptible increase in noise level
	4 to 6 dB	1	Noticeable increase in noise level
	7 to 9	1	Significant increase in noise level
	10 dB	0	About twice as loud.
	>10 dB	0	Major change

Potential Alignment Adjustment

The potential for adjustments to the Indicative Alignment in Area C is relatively broad due to the width of the proposed designation. The proposed designation boundary borders existing SH1 and incorporates part of Mangawhai Road. The Indicative Alignment could possibly move up to 100m closer to the properties at Charis Lane. However, the Charis Lane properties are currently more than 400m away from the Project alignment. If changes to the Project alignment occur in this area, additional mitigation would not be required as the properties within Charis Lane are well below the Category B noise level for an Altered Road. The scale of noise effects should remain as discussed above.

5.7 Area D: Silver Hill Road (5 PPFs)

Assessment of noise affects

The Silver Hill Road area of the Project (Area D), has low noise levels for the existing and do-nothing scenarios. Area D is generally quiet due to the low levels of traffic along Silver Hill Road. Under the do-minimum scenario the noise levels for PPFs located on Silver Hill

Road would increase by more than 25 dB compared to the do-nothing scenario, with 4 of the 5 PPFs falling in Category B for a new road.

As the PPFs are quite sparse and located on variable topography, the selected mitigation for Area D focused on the use of OGPA on the alignment through the area of Silver Hill Road. The mitigation achieves Category A for all 5 of the PPFs located within the area. Nevertheless, the increase in noise level for all of the PPFs still remains in excess of 10 dB which is a significant change. There would be a significant adverse noise effect in Area D.

Table 8 – Change in noise level – Silver Hill Road

Change in noise level (selected mitigation)		Number of PPFs	Subjective response
Reduction	>10 dB	0	Major change
	10 dB	0	About half as loud
	7 to 9	0	Significant decrease in noise level
	4 to 6 dB	0	Noticeable reduction in noise level
	3 dB	0	Just perceptible reduction in noise level
	<2 dB	0	Negligible
Increase	<2 dB	0	Negligible
	3 dB	0	Just perceptible increase in noise level
	4 to 6 dB	0	Noticeable increase in noise level
	7 to 9	0	Significant increase in noise level
	10 dB	0	About twice as loud.
	>10 dB	5	Major change

Potential Alignment Adjustment

The proposed designation boundary within Area D allows for potential shifts of the Project alignment up to approximately 170 m west and approximately 130 m east. A 170 m shift west could potentially change 273 Silver Hill Road into Category B. A shift east of 130 m would potentially change 332 Silver Hill Road from Category A to Category B. Smaller magnitude shifts of the alignment of less than 50 m west or east would be unlikely to change PPF Categories. To avoid such changes in category occuring, the alignment should only be moved more than 50 metres if further design showed that enhanced mitigation were practicable to maintain the categories currently achieved.

5.8 Area E: Whangaripo Valley Road (8 PPFs)

Assessment of noise affects

The Whangaripo Valley Road intersection has relatively low noise levels for the existing and do-nothing scenarios as Whangaripo Valley Road does not have considerable traffic flow and the area is more than 2 km away from existing SH1. With the do-minimum scenario, the noise level increase for all PPFs would be significant (seven PPFs would experience increases of more than 10dB, and 4 of the 8 PPFs would change to Category B).

As the PPFs are quite sparse and located on quite variable topography, the selected mitigation for Area E focused on the use of OGPA on the alignment. The mitigation achieves

Category A for all 8 PPFs. Nevertheless, the increase in noise level for 6 of the PPFs remains in excess of 10 dB which is a significant change. These include 263 Worthington Road, 177 Rustybrook Road, 351 Wayby Valley Road, 64 Whangaripo Valley Road, 40 and 47 Borrows Road (Table 9). There would be a significant adverse noise effect in Area E.

Table 9 – Change in noise level – Whangaripo Valley Road

Change in noise level (selected mitigation)		Number of PPFs	Subjective response
Reduction	>10 dB	0	Major change
	10 dB	0	About half as loud
	7 to 9	0	Significant decrease in noise level
	4 to 6 dB	0	Noticeable reduction in noise level
	3 dB	0	Just perceptible reduction in noise level
	<2 dB	0	Negligible
Increase	<2 dB	0	Negligible
	3 dB	0	Just perceptible increase in noise level
	4 to 6 dB	2	Noticeable increase in noise level
	7 to 9	0	Significant increase in noise level
	10 dB	0	About twice as loud.
	>10 dB	6	Major change

Potential Alignment Adjustment

The Project alignment within Area E has potential to shift approximately 180 m west or east from the current Indicative Alignment.

A shift of 180 m to the east may potentially change 213 Whangaripo Valley Road from a Category A to a Category B property. A shift within 50 m to the east should not alter PPF Categories.

Any shift to the west would result in a change for 40 Borrows Road from Category A to B. Any shift of more than about 80 m to the west may result in a change from Category A to category B for 2 PPFs on the western side of the alignment.

To avoid such changes in category occuring, the alignment should only be moved to this extent if further design showed that enhanced mitigation were practicable to maintain the categories currently achieved.

5.9 Area F: Wayby Valley Road (3 PPFs)

Assessment of noise affects

The noise levels in the area of the Wayby Valley Road interchange are affected by existing SH1. The Project shifts the majority of the traffic away from existing SH1. However, with the Project the PPFs in this area would remain exposed to noise from existing SH1, the Project or a combination of both road corridors.

Compared to the do-nothing scenario, the noise levels at the three PPFs in this area are predicted to increase up to 7 dB with the do-minimum scenario (ie the Project and no mitigation).

The sparse nature of the PPFs has led to the selected mitigation to be OGPA throughout the interchange. This has reduced the change in noise level to an overall reduction in noise level for 2 PPFs and a negligible increase at one PPF (Table 10). Overall the Project has a minor positive noise effect in Area F.

Table 10 – Change in noise level – Wayby Valley Road

Change in noise level (selected mitigation)		Number of PPFs	Subjective response
Reduction	>10 dB	0	Major change
	10 dB	0	About half as loud
	7 to 9	0	Significant decrease in noise level
	4 to 6 dB	0	Noticeable reduction in noise level
	3 dB	2	Just perceptible reduction in noise level
	<2 dB	0	Negligible
Increase	<2 dB	1	Negligible
	3 dB	0	Just perceptible increase in noise level
	4 to 6 dB	0	Noticeable increase in noise level
	7 to 9	0	Significant increase in noise level
	10 dB	0	About twice as loud.
	>10 dB	0	Major change

Potential Alignment Adjustment

Theoretically, the Project alignment in the area of the Wayby Valley Road intersection could potentially move within the proposed designation 120 m east or 140 m west. In practice, it is understood from the project team that the extent to which the Project alignment could shift is limited due to road geometry standards such as minimum sight lines for the interchange.

The PPFs were assessed with the altered road criteria. Even a highly unlikely shift of 120 m east or 140 m west would not affect the overall selected mitigation.

5.10 Area G: Kaipara Flats Road (8 PPFs)

Assessment of noise affects

In the Kaipara Flats Road area we assessed 8 PPFs with noise levels under the existing and do-nothing scenarios that are dictated by traffic flow along Kaipara Flats Road.

The addition of the Project in the do-minimum scenario would significantly change the noise levels at 2 PPFs, with changes in excess of 10 dB. Furthermore, in the do-minimum scenario 3 PPFs would change from Category A to Category B.

The selected mitigation for Kaipara Flats was the use of OGPA along the Indicative Alignment, north of Kaipara Flats Road. As a result, one of the "do-minimum" Category B PPFs would improve to Category A. As shown in Table 5.8, the overall change in noise level would exceed 10 dB at one PPF, 131 Kaipara Flats Road. Other PPFs would experience either a just perceptible increase in noise level or a significant increase in noise level. Overall the Project would have a significant adverse noise effect in Area F.

Table 11 – Change in noise level – Kaipara Flats Road

Change in noise level (selected mitigation)		Number of PPFs	Subjective response
Reduction	>10 dB	0	Major change
	10 dB	0	About half as loud
	7 to 9	1	Significant decrease in noise level
	4 to 6 dB	0	Noticeable reduction in noise level
	3 dB	0	Just perceptible reduction in noise level
	<2 dB	0	Negligible
Increase	<2 dB	0	Negligible
	3 dB	3	Just perceptible increase in noise level
	4 to 6 dB	0	Noticeable increase in noise level
	7 to 9	3	Significant increase in noise level
	10 dB	0	About twice as loud.
	>10 dB	1	Major change

Potential Alignment Adjustment

The Kaipara Flats Road area is the most sensitive to alignment shifts. The Indicative Alignment has the potential to shift west by approximately 120 m or east by 180 m.

Due to the sensitivity of the area, a shift west of more than 50 m would result in 2 PPFs changing from Category A to B. A shift of more than 70 m east would result in 1 PPF changing from Category A to B. Contemporaneously, lateral shifts of the alignment would benefit PPFs on the opposing side of the alignment, such that their noise Category may improve.

To avoid changes in category occuring, the alignment should only be moved to these extents if further design showed that enhanced mitigation were practicable to maintain the categories currently achieved.

5.11 Township of Wellsford

Comparing future traffic forecasts:

- Future traffic volumes on the existing SH1 from South of the Mangawhai interchange, through the Dome Forrest would be considerably less with the Project than without the Project.

- Along the existing SH1 up until south of Goatley Road future traffic volumes would be less with the Project. South of Goatley Road, the Project does not alter future traffic volumes along the existing SH1.

- South of Mangawhai Road along the existing SH1, future traffic volumes with the Project would be almost 10 time less than without the Project. Through the township of Wellsford and further south, future traffic volumes with the Project are approximately 5 times less than future traffic volumes without the Project.

If these reductions in future traffic were experienced by people as one scenario occuring immediately after another, it would equate to noise level reductions of 4 dB to 9 dB, which subjectively is a noticeable to significant decrease in noise levels. However, these reductions will not be experienced in this manner as they relate to future scenarios, and at least one of them will not occur. What will be experienced relative to the existing situation

is that rather than traffic volumes on the existing SH1 and corresponding noise substantially increasing over time without the Project, such increases will be avoided with the Project. This is considered to be a minor positive noise effect.

6 RECOMMENDED MITIGATION

Recommended Mitigation Summary

Road traffic noise from the Project can be avoided, or mitigated by the following means:

- Mitigation of noise effects through choice of low noise road surface material;
- Mitigation of noise effects through use of noise barriers or mounds.

Mitigation of traffic noise is most effective at source. Therefore, from an acoustics standpoint choosing low noise road surface material is the preferred mitigation method as it protects the widest possible area. Following this preferred mitigation, barriers can be used to break acoustic line-of-sight from the noise source (the road) to the PPFs. Barriers should be as close as possible to the road or the PPF.

According to NZS 6806, only if these measures are not practicable to achieve suitable noise levels at the PPFs, should BMM be considered. Building modification involves treatment such as the installation of insulation, improved glazing, sealing or other upgrades to the façade, and alternative ventilation. Such building improvements would lead to improving internal noise levels only and would not protect the outdoor environment around the houses.

We have assessed mitigation based on structural mitigation being employed first, before considering building improvements as required in NZS 6806.

The selected mitigation involves the use of OGPA road surfacing in Hōteo North and for a small section north of Kaipara Flats Road. Two PPFs that remain in NZS 6806 Category C even with this low noise road surfacing have been recommended for BMM. One further PPF in Category B is recommended for BMM due to the increase in noise caused by the Project.

We have considered other mitigation options, such as noise barriers or acoustic bunds. However, due to the terrain, the distance of PPFs from the road and the low population density, barriers are not considered practicable for this Project. Barriers would need to be of considerable height to meet the noise attenuation targets outlined in NZS 6806 and these barriers would create visual and urban design issues with only marginal acoustic benefit achieved.

6.1 Noise mitigation options

The general methods that can be used to control traffic noise generation or propagation are:

- Selecting noise reducing road surface material;
- Installing noise barriers (or bunds);
- Combination of noise reducing road surface material and noise barriers (or mounds); and
- Upgrading building envelopes, e.g. upgrading glazing, insulation or seals around doors and windows, and installing alternative ventilation options so that windows can remain closed.

6.1.1 Road surface

Mitigating traffic noise through the road surface material reduces noise at the source. Smooth porous materials such as OGPA reduce noise generation while rough non-porous materials such as chip seal increase noise generation.

Chip seal is the most common road surface used on the state highway network covering approximately 89% (as at 2010). While it is one of the noisiest road surface materials it provides good adhesion and is durable and cost effective.

OGPA, on the other hand is the most common low-noise road surface used in New Zealand, used on approximately 6% of the state highway network (as at 2010). It is generally used in densely populated areas and on high capacity and high speed roads. While it provides good drainage due to its porosity it can require frequent maintenance and replacement to maintain its noise reducing characteristics.

OGPA can reduce noise levels by around five decibels when compared with chip seal.

The **Do-minimum** scenario is based upon the use of two coat chip seal in the northern section of the Indicative Alignment, stone mastic asphalt through the tunnel, two coat chip seal from the tunnel to Kaipara Flats Road and OGPA through the south of the Indicative Alignment from Kaipara Flats Road to the P2Wk Intersection. The P2Wk designation conditions require OGPA surfacing from south of Wyllie Road to the roundabout connection with existing SH1.

For some areas where increased shear resistance for the pavement is required, e.g. for areas where vehicles brake, accelerate or turn, a more substantial structural road surface material is required. This includes the on and off ramps to and from the interchanges. In these instances, SMA or similar may be utilised. This material, while also smooth and therefore generating less noise than chip seal, is non-porous. Therefore, noise levels for SMA are marginally higher than those for OGPA.

6.1.2 Barriers and bunds

Noise barriers (fences/walls or bunds) work by breaking acoustic line-of-sight between the noise source and the receiver. An acoustic barrier must be of solid contiguous material (i.e. have no holes or gaps) and have a minimum surface weight of 10 kg/m^2.

Traffic noise barriers can take a variety of forms such as:

- Earth bunds – soil or fill material;
- Barriers – concrete fibre cement or similar; or
- Transparent barriers – acrylic; polycarbonate; glass.

The process for mitigation of traffic noise by a noise barrier is shown in Figure 11.

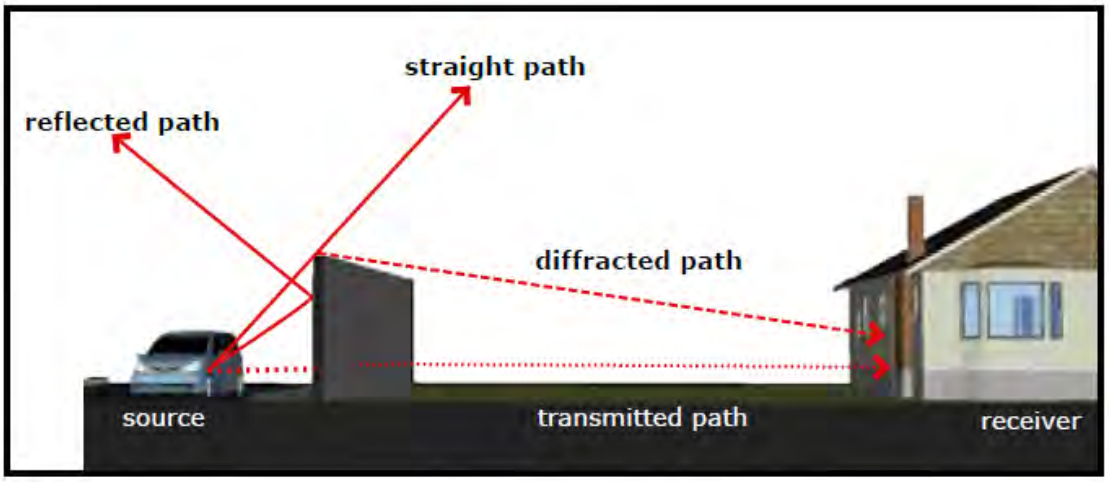


Figure 11: Acoustic barriers (Source: NZTA State Highway Noise Barrier Design Guide Version 1.0/August 2010)

Barriers can be installed immediately beside the road, which means that the widest surrounding area can be protected. Alternatively, barriers are installed along property boundaries close to dwellings providing noise level reductions for those properties only.

There are several bridge and viaduct structures along the Project route. Bridges and viaducts are elevated above the ground and often do not benefit from screening provided by topography, cuttings or ground absorption. However, bridges and viaducts are generally required to include crash barriers, which typically consist of 810 mm high solid concrete barriers. These barriers can provide noticeable noise attenuation.

To maintain the effectiveness of barriers over time, the following need to be considered:

- Barriers should not develop gaps or other openings;
- Bunds should not reduce in height through settlement; and
- Any damage, vandalism, or material failure would need to be repaired or remedied.

6.1.3 Building Modification Mitigation

Where the relevant external noise criteria at PPFs cannot be achieved with "external" structural mitigation in the road corridor, further mitigation may be required if they are within Category C. Such mitigation to buildings can only be undertaken with the agreement of the owners, giving them the choice over whether they require an offered noise benefit.

The Category C assessment is triggered if the noise level inside habitable rooms would be 45 dB $L_{Aeq(24h)}$ or more, with the implementation of the selected structural mitigation measures. In that instance, at least a five decibel noise level reduction is required to achieve an internal noise level of no more than 40 dB $L_{Aeq(24h)}$.

The improvements required vary from building to building. Some buildings are designed to achieve suitable internal noise environments, with the choice of heavy building materials, improved glazing and insulation, and well-fitting doors and windows, other building structures may not provide sufficient attenuation. Therefore, a case-by-case assessment is required for those buildings identified to fall within Category C.

Often, improvements to glazing and joinery may be sufficient to achieve the required internal noise levels. Mechanical ventilation may also be necessary so windows can remain closed.

Any insulation or other building envelope improvements have to be implemented concurrently with the achievement of the requirements of Clause G4 of the New Zealand Building Code, which governs the ventilation requirements for buildings, and also with the provision of reasonable thermal comfort.

In addition to building modification required under NZS 6806 for Category C PPFs as discussed above, we consider that it is also appropriate to investigate building treatment for Category B PPFs if there is a material increase in noise of more than 3 dB due to the Project and the resulting noise level is such that internal levels might exceed 40 dB $L_{Aeq(24h)}$.

6.2 Selected mitigation recommended for the Project

In accordance with NZS 6806, for each group/area of PPFs exceeding relevant noise criteria, a number of noise mitigation options have been developed. Relevant specialists working on the Project have assessed the options to collectively select mitigation indicative of the BPO for noise mitigation.

The selection process was in accordance with NZS 6806 and is described in detail in the NZ Transport Agency *Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects*. In summary, the process started with the generation of options by the acoustics specialist, followed by desk-top evaluation of those options by the relevant team members (a multidisciplinary team including design engineers and techncial specialists such as landscape and visual). The evaluations were recorded in the matrices shown in Appendix D forming a basis for multi-criteria analysis. These matrices were developed and reviewed through several workshops. The potential noise reduction of each option was fundamental to this evaluation process and from an acoustics standpoint we recommend the selected options as providing appropriate mitigation. There are some minor discrepancies between numbers of PPFs in the matrices in Appendix D and those discussed in this report, which has arisen from slight changes to the extent of the designation since mitigation options were evaluated. These changes are not material to the selection of mitigation.

The mitigation options evaluated for each specific area are detailed in Table 12 and with the modelled scenarios detailed in Table 13.

Table 12 – Mitigation options

Area	Project Section	Noise Mitigation Options
A	Maeneene Road	Option 1: Porous asphalt on main alignment Option 2: 3m high noise wall by main alignment
B	Vipond Road	Option 1: Porous asphalt on main alignment Option 2: 3m high noise bund Option 3: 3m high noise wall by Vipond Road
C	Mangawhai Road	Option 1: Porous asphalt on main alignment Option 2: 0.8 high concrete safety barriers
D	Silver Hill Road	Option 1: Porous asphalt on main alignment Option 2: 3m high noise wall at top of cuts Option 3: 0.8m high concrete safety barriers
E	Whangaripo Valley Road	Option 1: Porous asphalt on main alignment Option 2: 3m high noise walls at top of cuts Option 3: 0.8 high concrete safety barrier
F	Wayby Valley Road	Option 1: Porous asphalt on main alignment
G	Kaipara Flats Road	Option 1: Porous asphalt on main alignment Option 2: Porous asphalt on Kaipara Flats Road Option 3: 0.8m concrete safety barriers

Table 13 – Modelled scenarios

Scenario	Year	Assessment Area						
		A	B	C	D	E	F	G
Existing	2017	X	X	X	X	X	X	X
Do-nothing	2046	X	X	X	X	X	X	X
Do-minimum	2046	X	X	X	X	X	X	X
Mitigation Option 1	2046	X	X	X	X	X	X	X
Mitigation Option 2	2046	X	X	X	X	X		X
Mitigation Option 3	2046		X		X	X		X
Key X = assessed Blank = not assessed								

As a result of this process, we have selected the mitigation for the Project to be a combination of low noise generating road surface, Open Graded Porous Asphalt (OGPA), and Building Modification Mitigation (BMM). Specifically, the selected mitigation for the Project is the combination of:

- OGPA for 15 km through the Hōteo North section of the Project;
- OGPA for 800 m on the main alignment in the south of the Project from Kaipara Flats Road northwards;
- BMM for two PPFs that would otherwise change to noise Category C, at 704 and 705 SH1. While these two PPFs could have slightly greater noise exposure without the Project (do-nothing), NZS 6806 and Transport Agency guidance requires such legacy problems to be addressed as part of the Project.

- BMM for one PPF (35 Vipond Road) that has an increase of more than 3 dB due to the Project and is in Category B even with OGPA.

OGPA has been selected based on consideration of wider amenity effects, in addition to the direct benefits modelled at the nearest PPFs. We note that to assess the effectiveness of mitigation we have modelled the noise from an OGPA surface. However, other noise surfaces such as Stone Mastic Asphalt (SMA) could also produce a similar level of noise reduction. Therefore, our references to OGPA in the text throughout should be taken to mean "asphaltic surface with low noise generating characteristics." This acknowledgement reflects the potential for technological developments over time, and engineering requirements for more durable surfaces than OGPA in areas such as intersections.

Noise barriers such as walls and bunds were considered in the process of determining the selected mitigation. Mitigation scenarios for different noise walls and bunds were modelled and inputs from specialists detailed in Appendix D were considered and discussed by the project team. In consideration of these inputs from other specialists and due to the poor acoustics efficiency of noise walls and bunds they were not chosen as part of the selected noise mitigation. Noise barriers are inefficient due to the topography and sparse nature of the PPFs. For example, noise barriers of 2.5 m in height and 400 m in length were assessed and only 1–2 dB of noise reduction was predicted. We have found that mitigation of more than 5 dB is not achievable using noise barriers or bunds unless they are considerable in height and length.

We have considered whether improvements such as extended concrete safety barriers or noise walls should be part of the selected mitigation in addition to OGPA. However, as for barriers alone, when in combination with OGPA the barriers still have limited acoustic benefit so we have therefore discounted their inclusion.

Furthermore, due to the desired urban design and landscape outcome of retaining the current rural landscape, noise barriers and acoustic bunds were deemed undesirable by the Project Landscape Architect as shown in the matrices in Appendix D.

The extent of OGPA required for the Project is illustrated in Figure 12 to Figure 16. Table 14 details the addresses of the PPFs requiring building modification mitigation.

Table 14 – PPFs requiring building modification mitigation

No.	PPF
70	705 SH–1, Wellsford
71	704 SH–1, Wellsford
75	35 Vipond Road

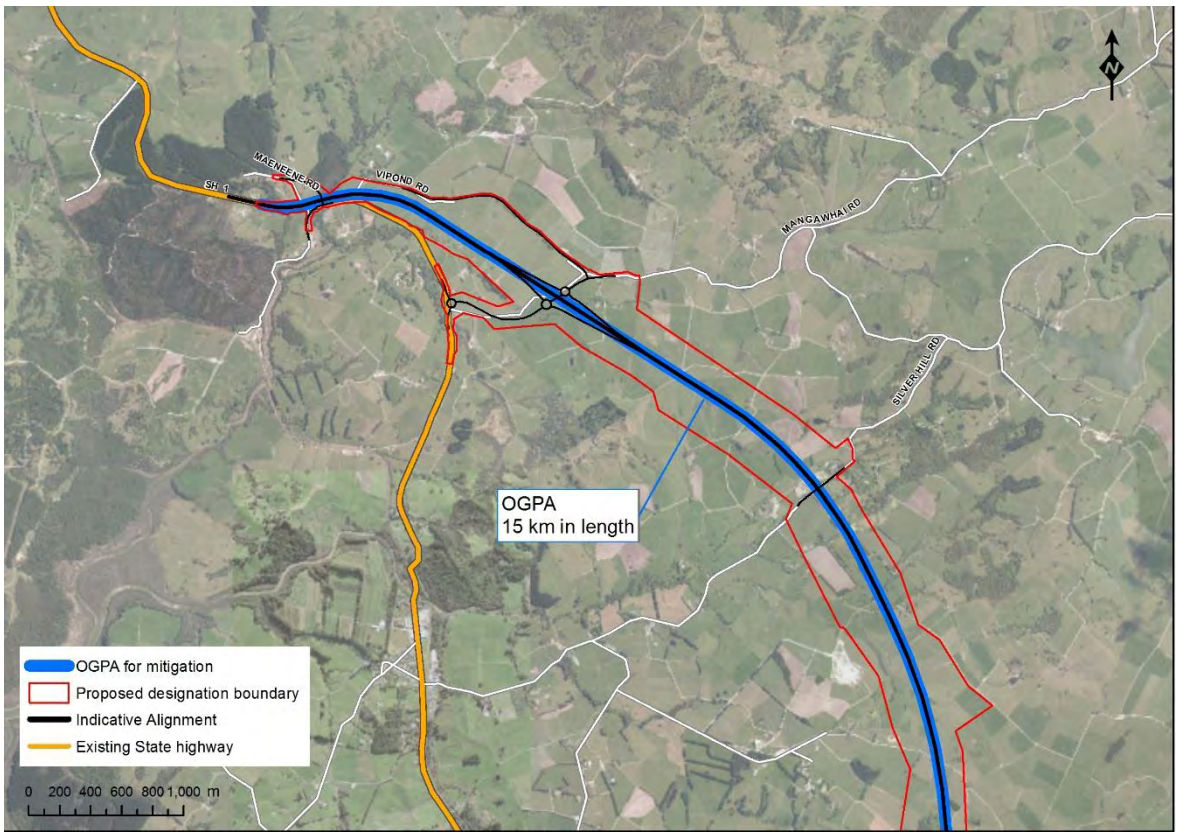


Figure 12: OGPA mitigation specification – Hōteo North Areas A–D

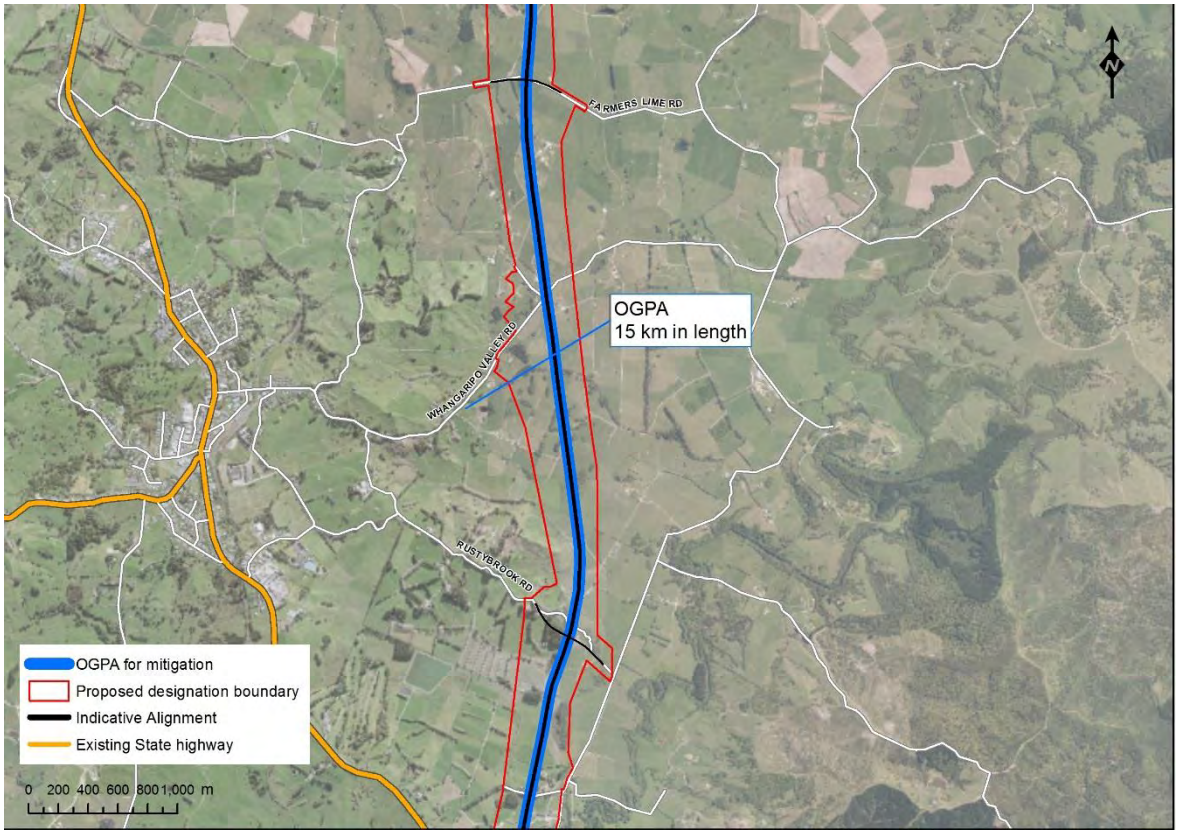


Figure 13: OGPA mitigation specification – Hōteo North Area E

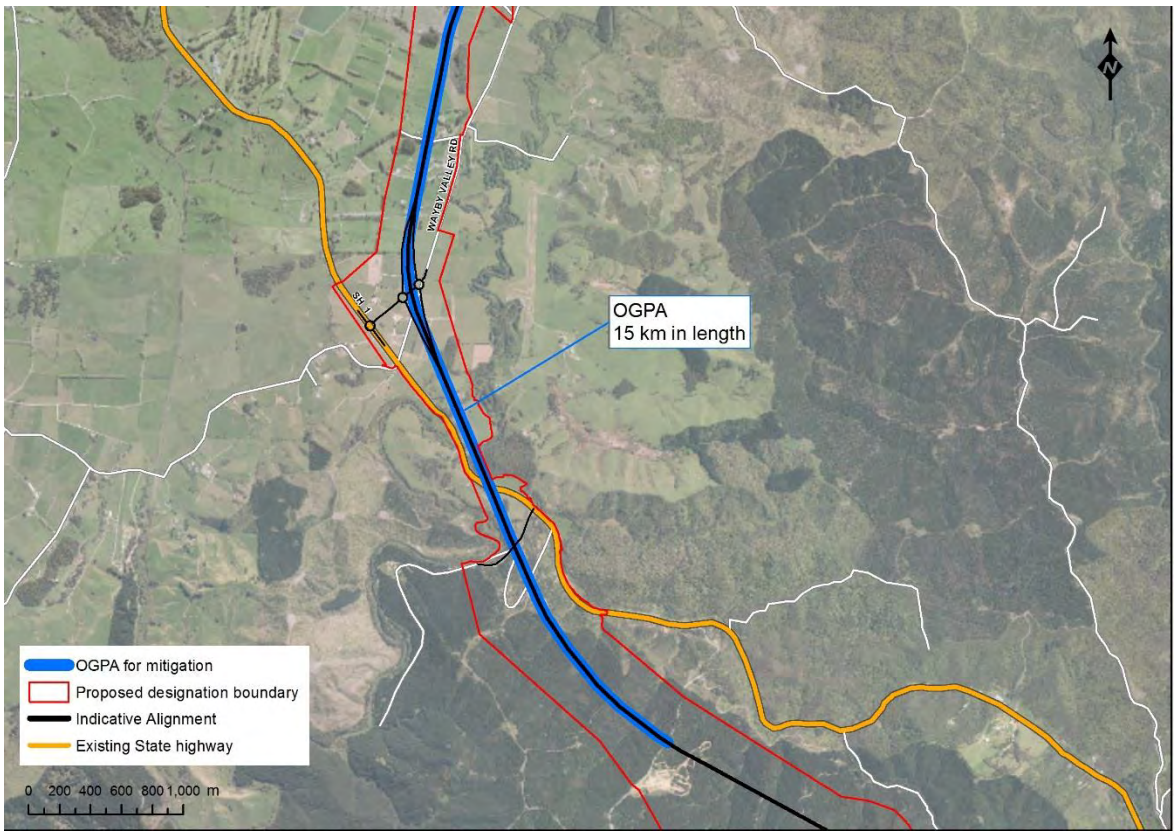


Figure 14: OGPA mitigation specification – Hōteo North Area F

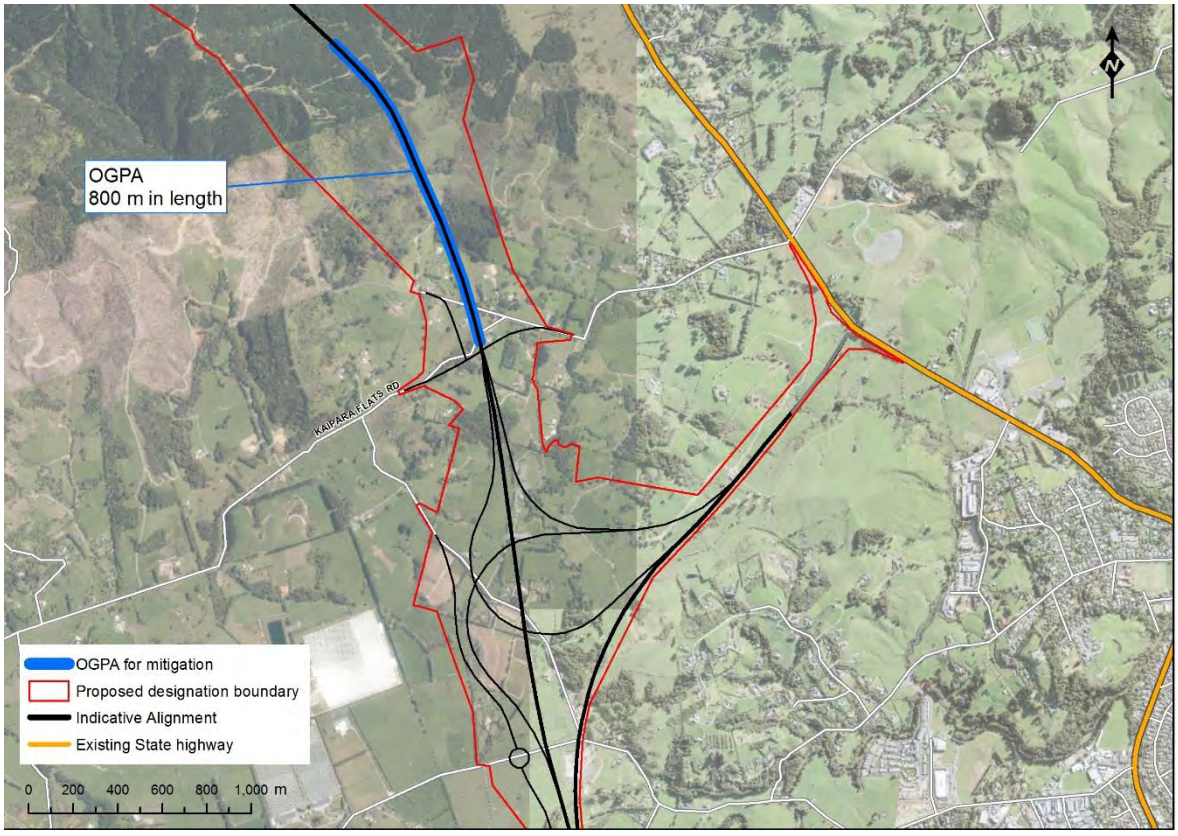


Figure 15: OGPA mitigation specification – Hōteo South Area G

6.3 Noise Mitigation Plan

In addition to noise effects related to the level of noise, subjective responses can depend on the character of noise. In most respects the Project should result in noise characteristics that are not unduly disturbing as traffic on the new road will be free flowing, with smooth and gradual changes in horizontal and vertical alignment. Vehicles should generally be travelling at a steady speed and should not need to undertake hard acceleration or braking. The new pavement will be evenly formed resulting in a smooth road surface that should be free of discontinuities to a much greater extent than the existing SH1.

Despite the positive attributes of a new road in terms of noise characteristics, there are a number of potential issues that are recommended to be addressed in the detailed design and construction. Under the Transport Agency specification for noise mitigation (NZTA P40:2014) a Noise Mitigation Plan is required. It is recommended that the NMP for the Project should explicitly address the following matters to minimise adverse noise characteristics:

- Bridge joints within 200 metres of houses should be selected to reduce noise and should be installed to minimise discontinuities between the road surface and the mechanical joints (including the concrete thresholds holding the joints).

- Audio Tactile Profile, ATP (rumble strip), and raised lane markers should not be located near houses where compatible with safety requirements. Any ATP should be offset outside lane markings.

- The road environment should encourage gradual deceleration on approach to roundabouts and other intersections through lighting, landscaping, signage and road markings. In particular, treatment is needed for the proposed roundabout at the existing SH1 and Mangawhai Road, which is likely to introduce significant braking and acceleration sounds. While these could be largely avoided if a T-intersection were used (with free flow for the priority movements between Te Hana and Mangawhai Road) it is understood that due to property and safety constraints a roundabout is required. Likewise, the eastern roundabout of the new Mangawhai interchange has a relatively steep downhill approach from the east that is likely to exacerbate braking sounds, and therefore requires mitigation through the design of the road environment.

6.4 Alignment changes

As discussed in Section 5, if the main alignment moved closer to houses in certain areas mitigation may need to be re-assessed. Based on our assessment, in some cases it might not be practicable to provide adequate mitigation in which case changes to the alignment may in practice be constrained. It is recommended that noise effects predicted and mitigation are reconsidered and confirmed to meet the noise categories set out in Table 15 if the main alignment moves closer to affected PPFs within the following areas:

- Vipond Road: Closer than 40 metres to the east of the propsed designation boundary.

- Silver Hill Road: Further than 50 metres east or west of the indicative alignment

- Whangaripo Valley Road: Further west of the indicative alignment or further than 50 metres east of the indicative alignment.

- Kaipara Flats Road: Further than 50 metres east or west of the indicative alignment.

Table 15 – Noise category limit

No.	PPF	Noise category limit	NZ 6806 Category Type
16	131 Kaipara Flats Rd	A	new
17	211 Kairpara Flats Rd	A	new
18	215 Kaipara Flats Rd	B	new
19	214 Kaipara Flats Rd	A	new
20	115 Kaipara Flats Rd	A	new
26	39 Phillips Rd, Streamlands	A	new
27	130 Kaipara Flats Rd	B	new
42	177 Rustybrook Rd, Wellsford	A	new
43	351 Wayby Valley Rd, Wellsford	A	new
44	64 Whangaripo Valley Rd, Wellsford	A	new
45	96 Whangaripo Valley Rd, Wellsford	A	new
46	40 Borrows Rd, Wellsford	A	new
47	47 Borrows Rd, Wellsford	A	new
48	213 Whangaripo Valley Rd, Wellsford	A	new
49	263 Worthington Rd, Wellsford	A	new
50	250 Silver Hill Rd, Wellsford	A	new
51	263 Silver Hill Rd, Wellsford	A	new
52	273 Silver Hill Rd, Wellsford	A	new
53	332 Silver Hill Rd	A	new
54	344 Silver Hill Rd, Wellsford	A	new
65	139 Vipond Road	A	altered
66	129 Vipond Rd	A	altered
75	35 Vipond Road, Wellsford	B	new
77	17 Vipond Rd, Wellsford	A	new

7 CONCLUSIONS

We have assessed the operational noise effects from the Project on PPFs within 200 metres of the proposed designation boundary.

Our assessment is based on:

- the relevant Standard, NZS 6806; and
- the potential subjective response of people to the change in noise level.

We recommend the following mitigation for the Project:

- OGPA in the Hōteo North section of the Indicative Alignment, for approximately 15 km;
- OGPA in the Hōteo South section of the Indicative Alignment, for 800 m north of Kaipara Flats Road;
- Building Modification Mitigation for 2 PPFs along the Indicative Alignment, to address high exposure that exists regardless of the Project (and is in fact marginally reduced by the Project):
  - 705 SH1, Wellsford; and
  - 704 SH1, Wellsford.
- Building Modification Mitigation for one PPF that has an increase greater than 3 dB due to the Project and is in Category B even with OGPA:
  - 35 Vipond Road, Wellsford

From our assessment, we conclude that with the recommended mitigation the Project can be operated to achieve reasonable noise levels at affected dwellings even with the increase of noise levels around the Project area. The overall noise level for a number of dwellings along the existing SH1 has reduced because of the Project. In areas remote from the existing SH1 the change in noise due to the new road will cause a significant adverse effect at nearby PPFs.

Noise contour plans for the full Project with mitigation are provided in the Drawing Set Operational Noise series. These plans show interpolated noise level bands at 5 decibel intervals from 35 dB to 75 dB $L_{Aeq(24h)}$. The contour plans also show the noise categories for PPFs after the selected mitigation.

In order to ensure that appropriate traffic noise outcomes are achieved, we recommend that designation conditions should cover the following issues:

- Confirmation of predicted sound levels for the construction design and re-assessment of the selected mitigation so that noise exposure categories of PPFs do not increase; and

- A requirement to install, where appropriate, noise mitigation measures prior to opening of the Project to the public (with OGPA road surfaces laid within 12 months of the road opening).

APPENDIX A: NOISE MONITORING

Unattended external baseline noise monitoring has been conducted at eight locations across the Project area.

A.1.1 Noise monitoring locations

Noise monitoring has been conducted at 8 locations across the Project area. The specific locations are detailed in Table 16 and shown in Figure 16.

Table 16 – Noise monitoring locations

Location No	Address	Measurement Dates
1	761 A SH1, Dome Forest, NZ, 0981	29/06/17 – 06/07/17
2	1472 SH1, Wellsford, NZ, 0975	29/06/17 – 06/07/17
3	263 Silver Hill Road, Wellsford, NZ, 0975	29/06/17 – 06/07/17
4	490 SH1, Wellsford, NZ, 0975	06/07/17 –13/07/17
5	40 Borrows Road, Wellsford, NZ, 0974	06/07/17 – 13/07/17
6	211 Kaipara Flats Road, Warkworth, NZ 0981	13/07/17 – 20/07/17
7	39 Philips Road, Dome Forest, NZ, 0981	13/07/17 – 20/07/17
8	294 Wayby Valley Road, Wayby Valley, NZ, 0972	13/07/17 – 20/07/17

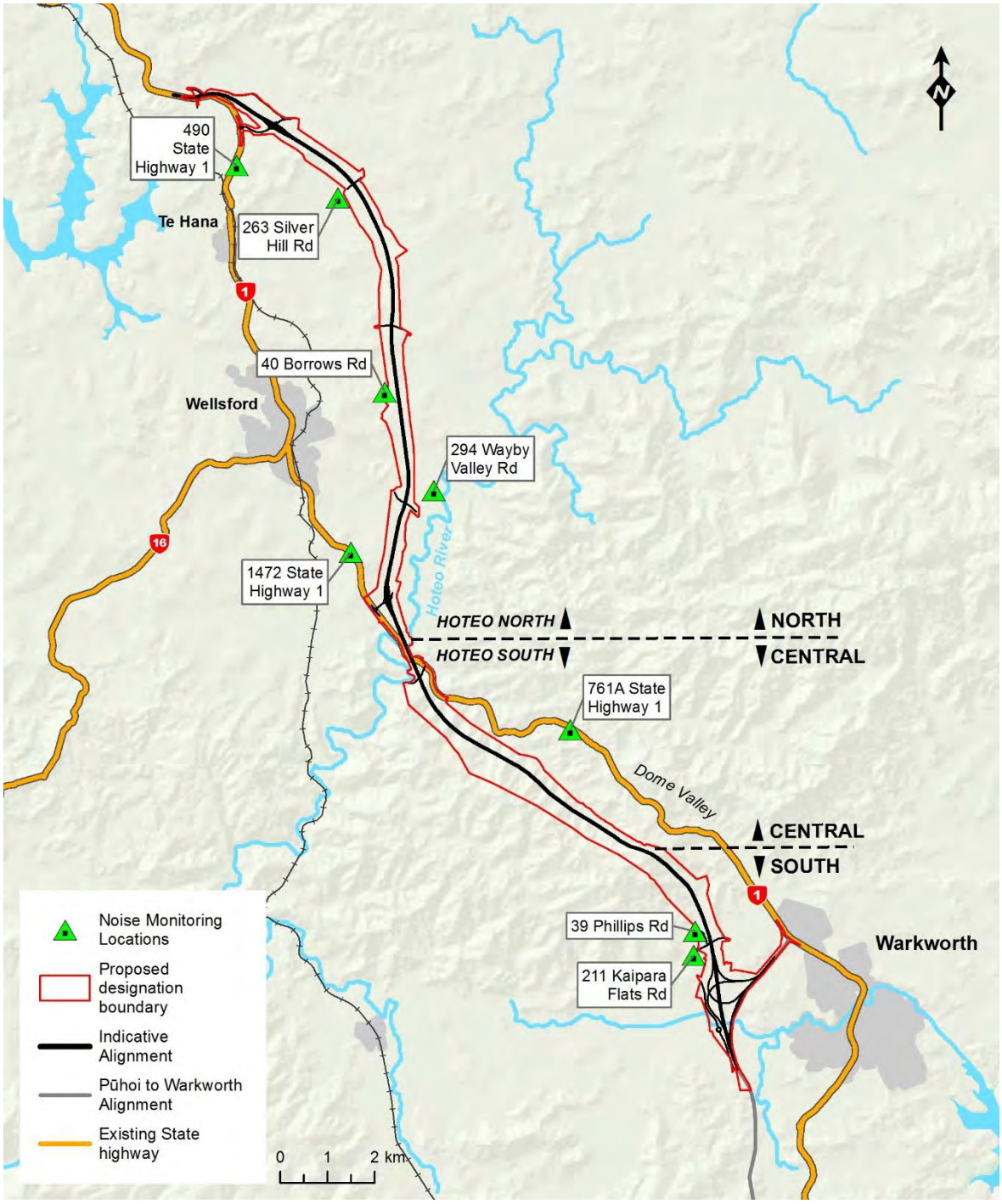


Figure 16 – Noise monitoring locations

A.1.1 Relevant Standards

Noise monitoring has been conducted in general compliance with New Zealand Standard NZS 6801:2008 Acoustics – Measurement of environmental Sound (NZS 6801) and NZS 6806.

A.1.2 Acoustic equipment

Details of the acoustic equipment used to conduct these measurements are provided in Table 17. All acoustic equipment had current calibration certificates.

Table 17 – Acoustic equipment

Manufacturer	Type	Serial No	Last calibration date
Acoustic Research Labs	NGARA Noise Logger	87813F	17/05/2017
Acoustic Research Labs	NGARA Noise Logger	87805E	03/12/2015
Acoustic Research Labs	NGARA Noise Logger	8780B6	11/01/2016
Acoustic Research Labs	Logger Calibrator	C17208	18/05/2017

The noise loggers were checked for calibration before and after each set of measurements. A windshield was fitted to the microphone for all measurements.

A.1.3 Meteorology / anomalous data

Meteorological conditions during the measurement period have been recorded by Cliflo weather stations in Warkworth and Leigh Auckland. This information, in addition to subjective observations, audio recordings, and review of the noise monitoring results, has been used to assess the impact of weather at all properties. It is likely that the wind speed will be higher at the weather stations than at the monitoring locations which are generally more shielded. As such, the measurements have been assessed and judgement used to determine if it is affected by a weather event.

Where anomalous or weather effected data is identified it has been excluded in the determination of acoustic parameters.

A.1.4 Results

The $L_{Aeq(24hr)}$ results have been presented on Figure 17 to Figure 24 .

The calculated parameter presented has been calculated from the measured weekday data, excluding periods of inclement weather and anomalous data.

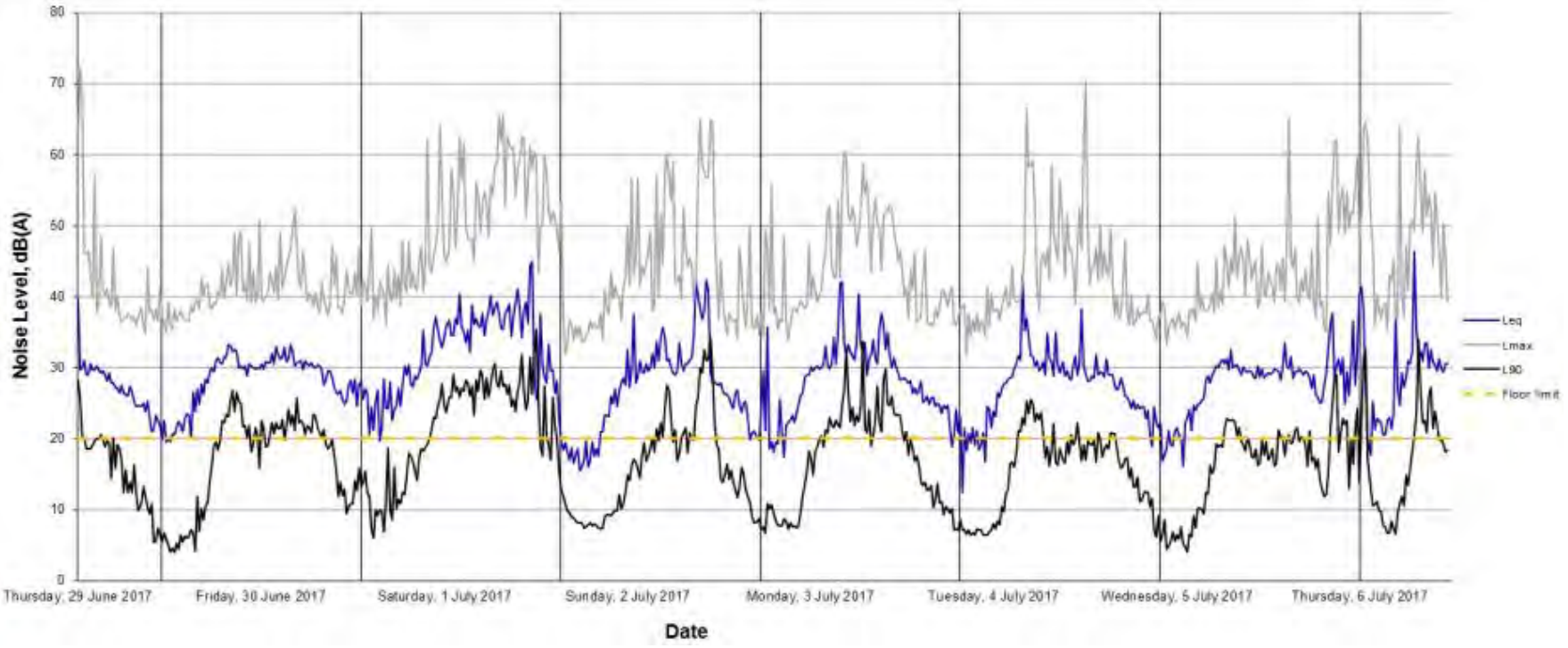


Image 1: In the direction of Alignment

Image 2: In the direction of SH1

Image 3: Measurement location

$L_{Aeq(24h)}$: 35 dB

Comments: Farm chickens present at the property. Logger is located approximately 143 m south of SH1.

Measurement location: Next to a retaining wall approximately 3.5 m away from the south facade of the property.

Meteorology: 15°C Sunny, RH: 70%, Wind: 7 km/h, W, Rain: 0 mm.

Figure 17 – Noise monitoring results at 761A SH1, Dome Forest

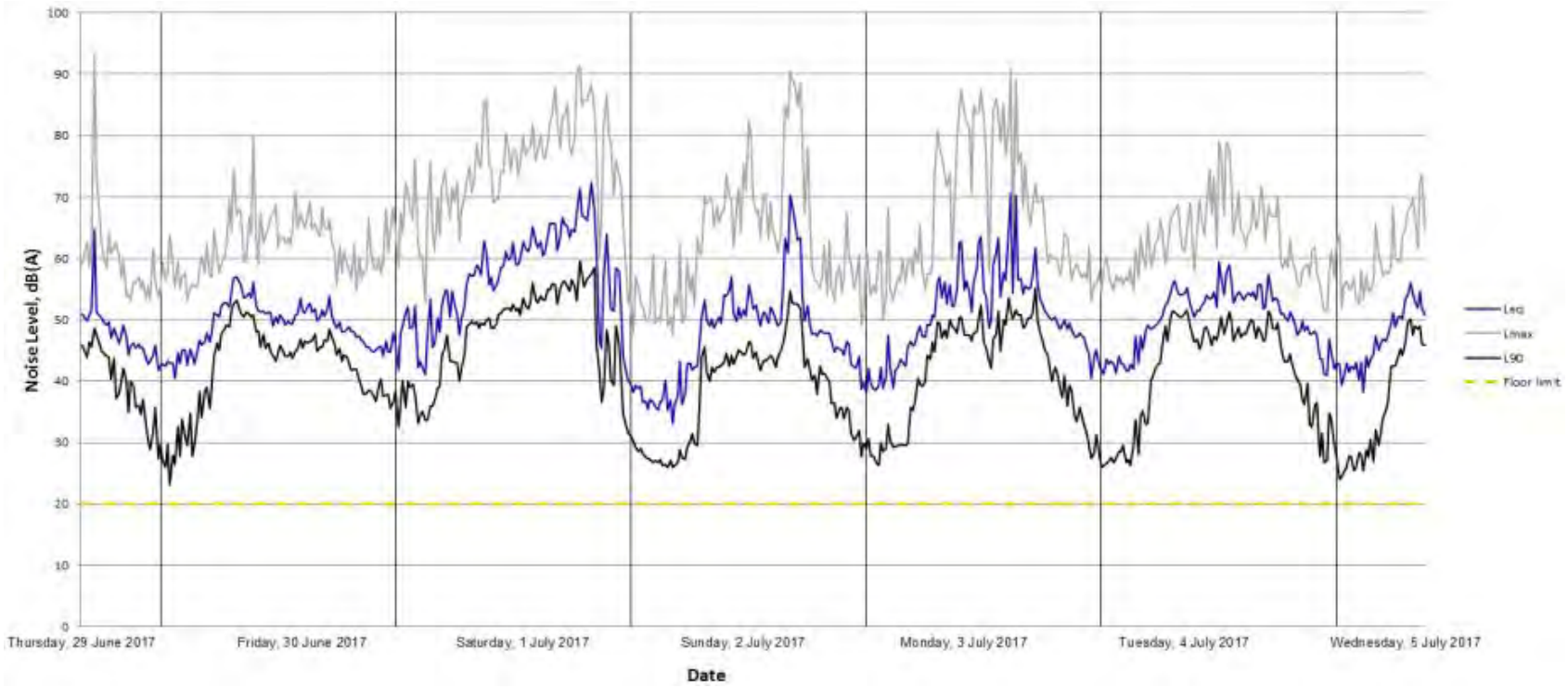


Image 1: In the direction of SH1

Image 2: In the direction of alignment

Image 3: Measurement location

$L_{Aeq(24h)}$: 57 dB

Comments: Farm animals present at the property (dogs, chickens, horses and cows). Logger located approximately 140 m north of SH1.

Measurement location: Approximately 30 m from the northern facade along the north boundary of the property to minimise impact of animal noise.

Meteorology: 14°C Cloudy, RH: 69%, Wind: 9 km/h, NE, Rain: 0 mm.

Figure 18 – Noise monitoring results at 1472 SH1, Wellsford

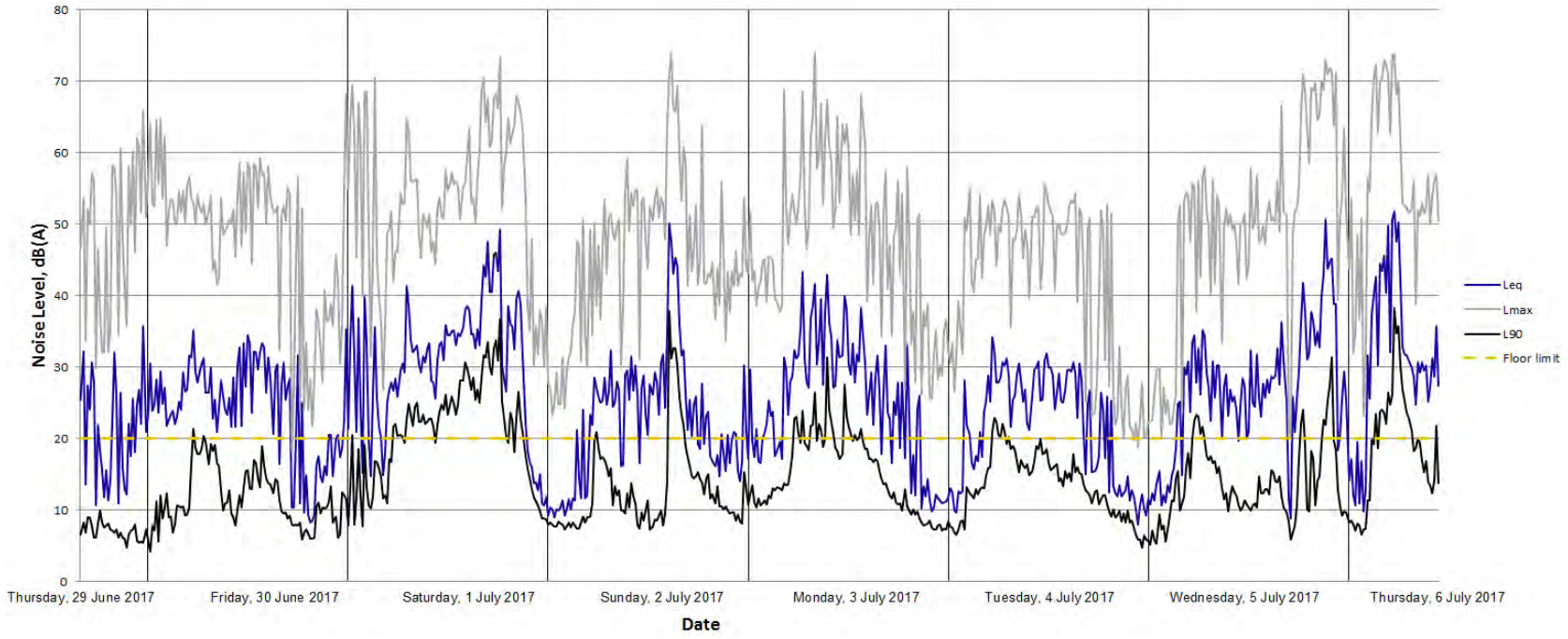


Image 1: View towards property

Image 2: In the direction of SH1 and alignment

Image 3: Measurement location

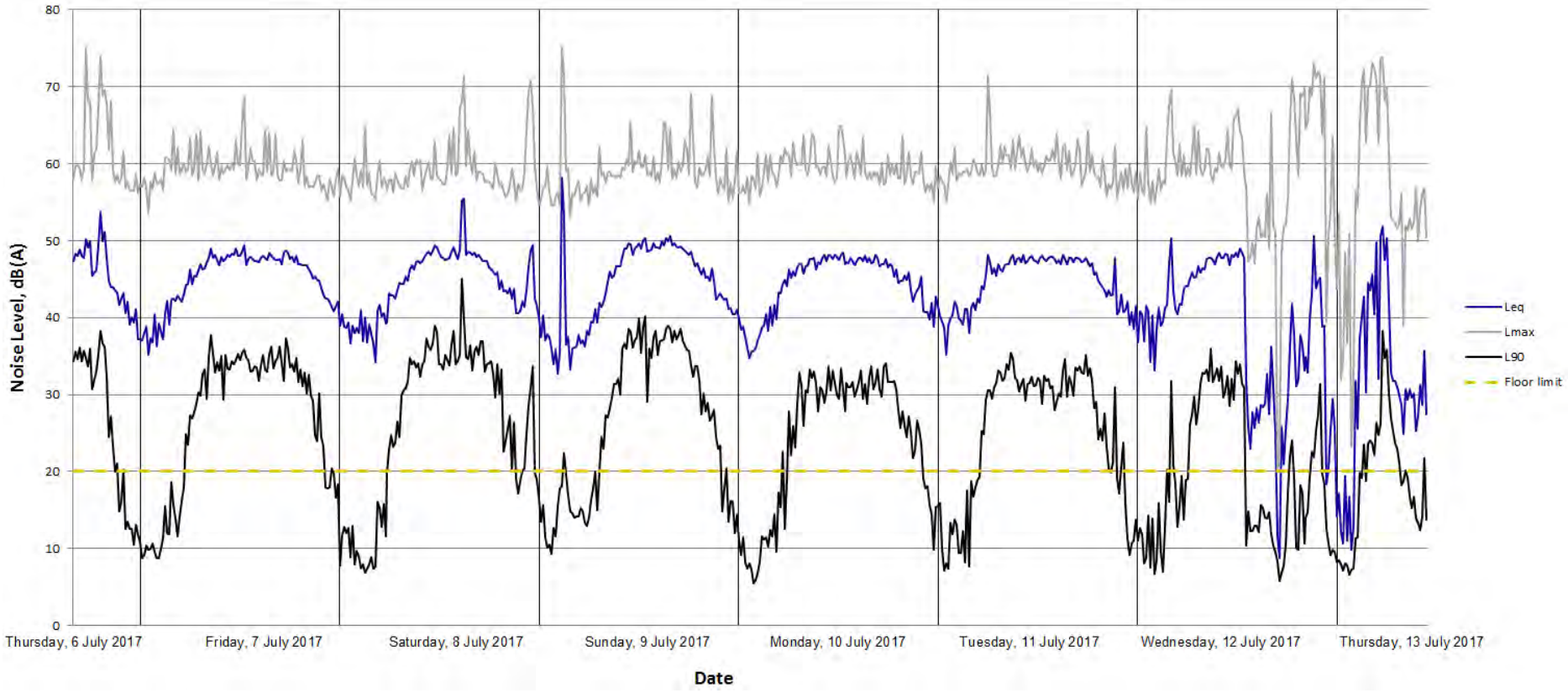
$L_{Aeq(24h)}$: 37 dB

Comments: Loud music played from neighbour at the time of setup. Nearby farm animals are also present. A milk tanker operates daily.

Measurement location: Approximately 37 m from the facade of the property near the edge of Silver Hill Road, Wellsford.

Meteorology: 14°C, Drizzle, RH: 68%, Wind: 7 km/h, N, Rain: 0 mm.

Figure 19 – Noise monitoring results at 263 Silver Hill Road



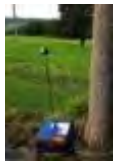


Image 1: In direction of alignment

Image 2: In direction of SH1

Image 3: Measurement location

$L_{Aeq(24h)}$: 47 dB

Comments: Audible water system nearby logger and approximately 21 m east of SH1. The logger is located in open land with the property being 10 m south.

Measurement location: Approximately 14 m from the northern facade of the property.

Meteorology: 11°C Drizzle, RH: 83%, Wind: 5 km/h, W, Rain: 0 mm.

Figure 20 – Noise monitoring results at 490 SH1, Wellsford

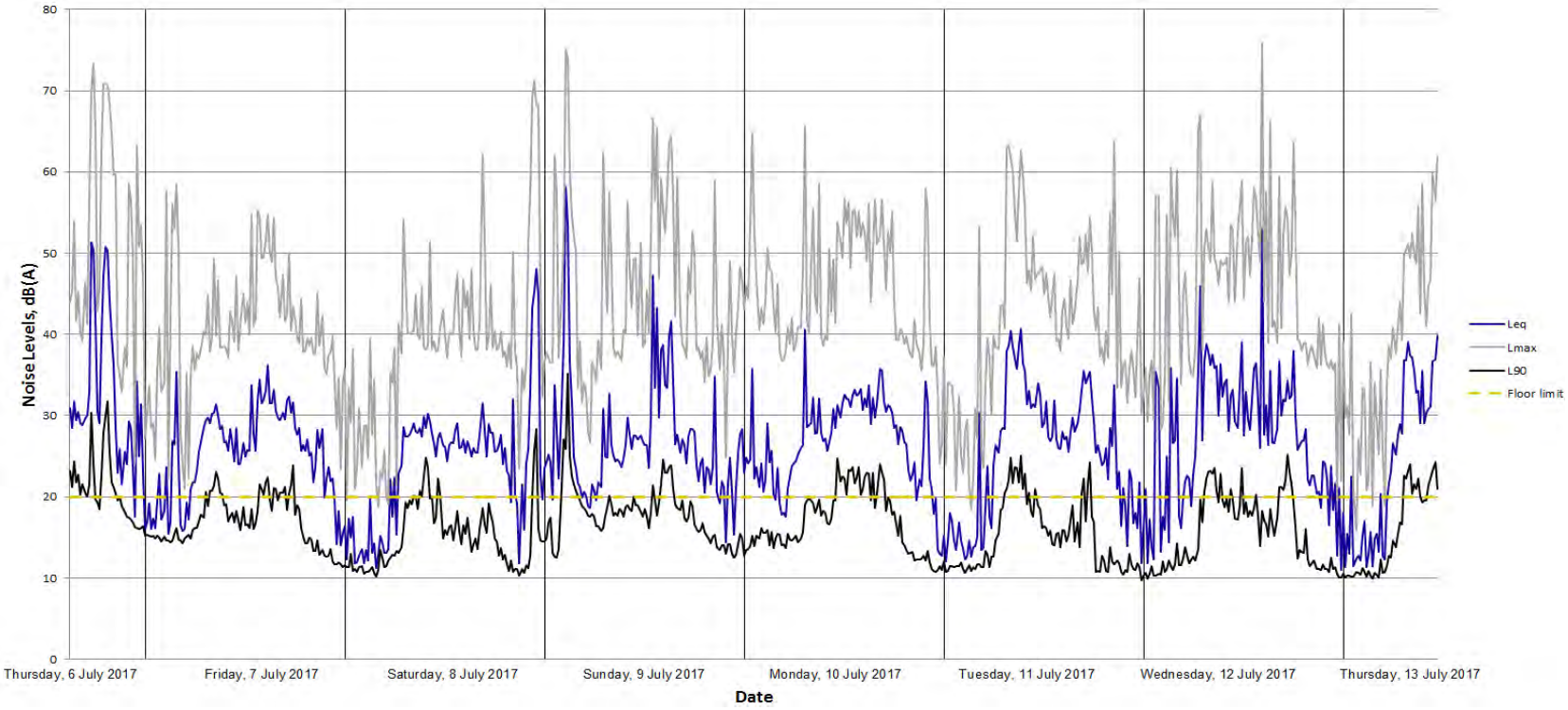


Image 1: In direction of alignment

Image 2: view towards property

Image 3: Measurement location

$L_{Aeq(24h)}$: 40 dB

Comments: Located north of vegetation surrounding the swimming pool and west of a paddock containing a herd of cows.

Measurement location: Approximately 5 m away from the northeast facade of the property.

Meteorology: 15°C Cloudy, RH: 81%, Wind: 17 km/h, SW, Rain: 0 mm.

Figure 21 – Noise monitoring results at 40 Borrows Road

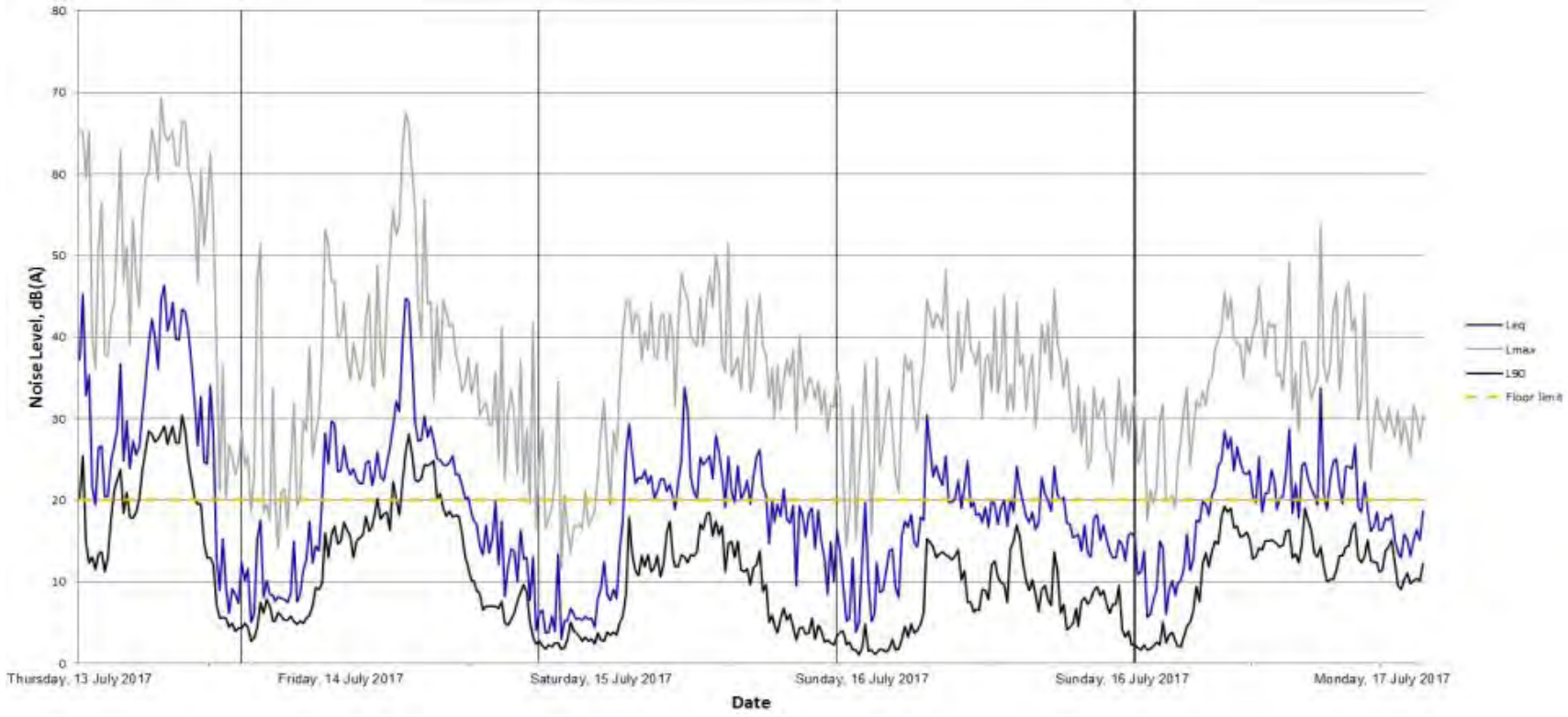


Image 1: In direction of alignment

Image 2: view towards property

Image 3: Measurement location

$L_{Aeq(24h)}$: 30 dB (Max)

Comments: Logger failure occurred on Monday the 17th. Located along north east boundary of property.

Measurement location: Approximately 22 m front the northeast facade of the property facing the alignment.

Meteorology: 9°C Sunny, RH: 66%, Wind: 14 km/h, NW, Rain: 0 mm.

Figure 22 – Noise monitoring results at 211 Kaipara Flats Road

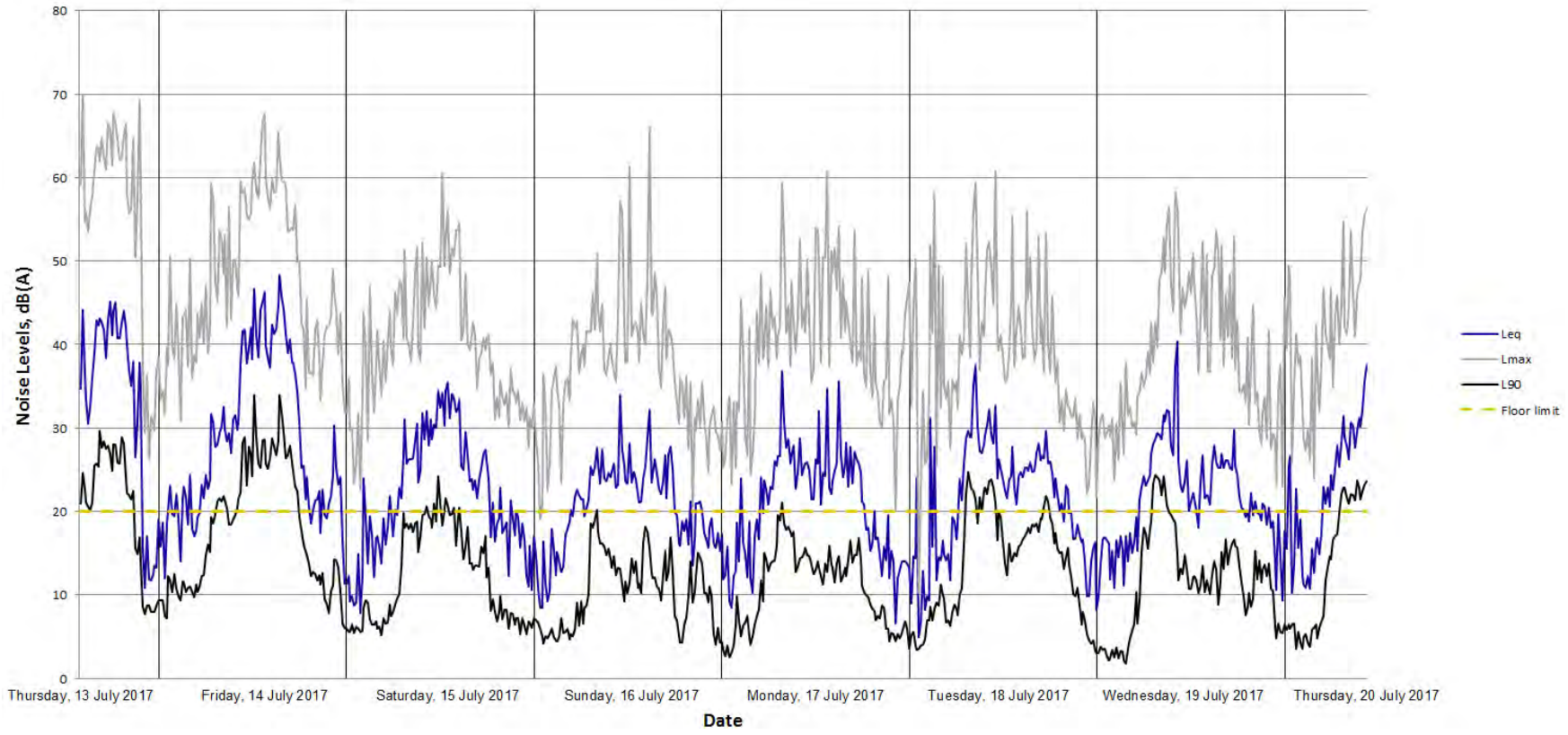


Image 1: In direction of alignment and SH1

Image 2: In direction of property

Image 3: Measurement location

$L_{Aeq(24h)}$: 38 dB

Comments: Logger location was moved further along the entrance driveway to avoid noise from animals (chickens. sheep, cows) within the property boundary.

Measurement location: Approximately 43 m from the northeast facade of the property.

Meteorology: 9°C Cloudy, RH: 76%, Wind: 13 km/h, SW, Rain: 0.6 mm.

Figure 23 – Noise monitoring results at 39 Phillips Road

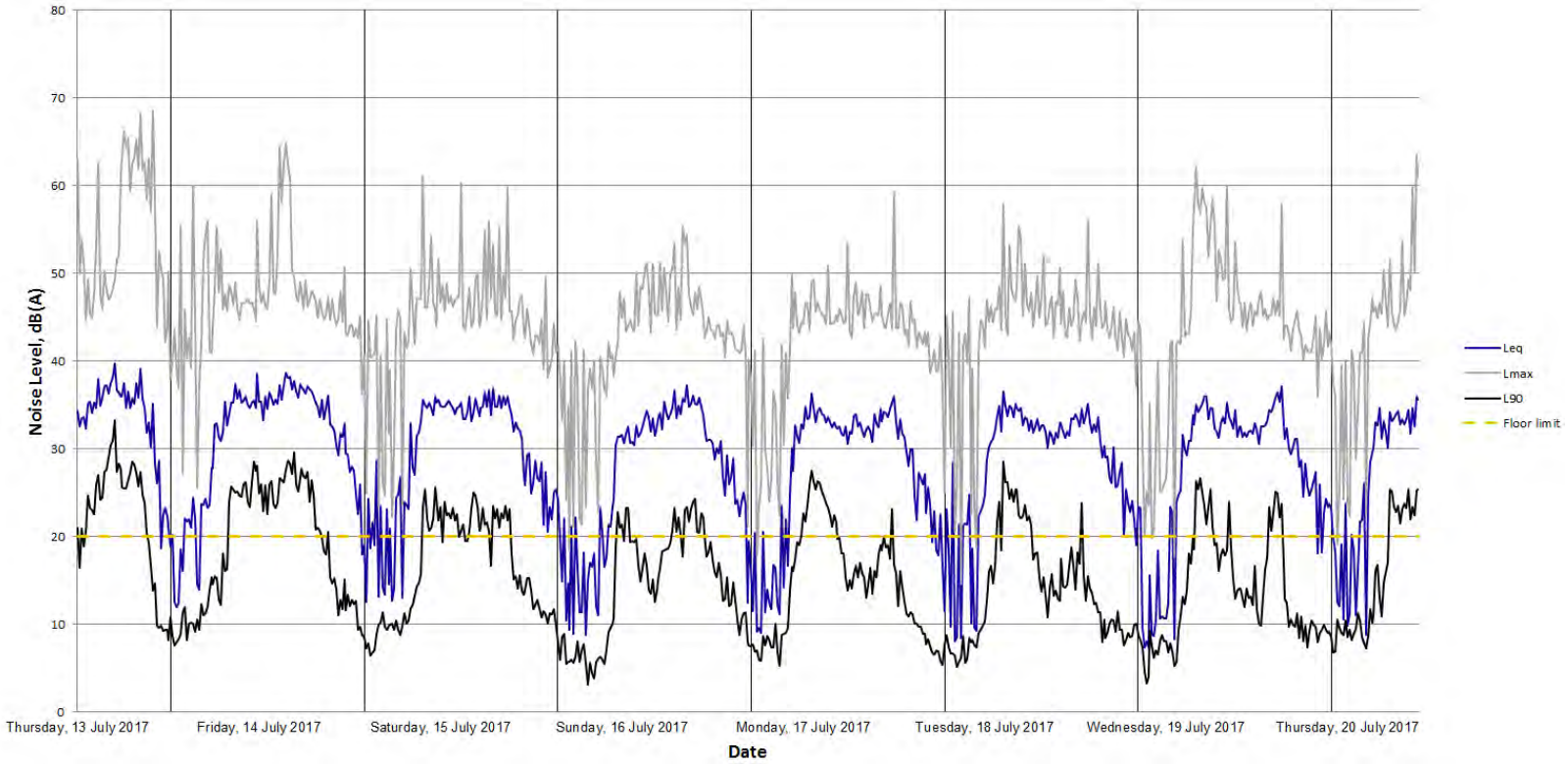


Image 1: In direction of alignment

Image 2: in direction of property

Image 3: Measurement location

$L_{Aeq(24h)}$: 34 dB

Comments: Located adjacent to the driveway with SH1 directly south and Wayby Valley Road to the west of the logger location.

Measurement location: Approximately 28 m from the west facade of the property.

Meteorology: 9°C Cloudy, RH: 75%, Wind: 18 km/h, SW, Rain: 0.3 mm.

Figure 24 – Noise monitoring results at 294 Wayby Valley Road

APPENDIX B: NOISE MODELLING

The traffic noise modelling that has been undertaken is based on the following:

B.1 Noise model

We have used the software SoundPLAN version 7.4 to undertake the traffic noise modelling of the Project.

The SoundPLAN model has implemented the calculation algorithms of the *Calculation of Road Traffic Noise*[5] methodology. This methodology is referenced in NZS 6806.

The adjustments for New Zealand road conditions, specifically road surface types, are also included in the model. Therefore, modelling results can be compared with the relevant criteria without further adjustment.

B.2 Modelling input data

Elevation Contours – Contour_5m_UTM60s.shp

Alignment – Plan_JG15_noise_Polyline_UTM60S_2.dxf

Indicative Footprint – Indicative_Footprint_20170630_300mBuffer_UTM60S.dxf

B.3 Design year

The design year is 2046 which is based on the road opening to the public in 2035.

B.4 Traffic speeds

The traffic speeds used in the model are provided in Table 18.

[5] Calculation of Road Traffic Noise, Department of Transport, Welsh Office, HMSO, 1988.

Table 18 – Traffic speeds

Road	Speed km/hr	Comment
Future		
Project main alignment	110	Design speed
On-ramps	70	
Off-ramps	60	
Existing		
SH1	100	This is the posted speed unless posted otherwise
SH1	80	Within the Dome Valley
SH1	70	Within Te Hana
SH1	60	Within Warkworth
SH1	50	Within Wellsford
Whakapirau Rd	100	This is the posted speed
School Rd	50	This is the posted speed
Matheson Rd	50	This is the posted speed
Kaipara Coast Hwy	70	This is the posted speed
Wayby Valley Rd	80	This is the posted speed
Kaipara Flats Rd	50	This is the posted speed
Woodcocks Rd	50	This is the posted speed at SH1 intersection
Woodcocks Rd	80	This is the posted speed at the proposed Warkworth Interchange.

B.5 Traffic volumes

Traffic flows generally increase with time. For the Project, the operation of the new road will also result in decreased traffic flows on the existing SH1.

Traffic volumes were provided by the team's traffic modelling specialist and are provided in Table 19.

Table 19 – Traffic volumes

Location		AADT											
	Year	2016				2046							
	Scenario	Existing				No Project				Project			
	Direction	UC1	UC3	Total	HCV%	UC1	UC3	Total	HCV%	UC1	UC3	Total	HCV%
SH1 South of Woodcocks Road (South of McKinney Rd)	NB	10916	613	11529	5%	8331	641	8972	7%	8353	640	8993	7%
	SB	10839	667	11506	6%	7678	735	8413	9%	7728	744	8472	9%
Woodcocks Road	WB	1514	169	1682	10%	3195	604	3799	16%	3157	589	3746	16%
	EB	2779	459	3237	14%	4875	586	5462	11%	4818	501	5319	9%
SH1 south of Hill Street	NB	13126	1336	14461	9%	10245	1630	11875	14%	10087	1653	11741	14%
	SB	10413	1209	11623	10%	10858	2141	12999	16%	10584	2224	12808	17%
Sandspit Road (East of Park Ln)	WB	3973	475	4448	11%	7712	842	8554	10%	7685	841	8526	10%
	EB	4528	324	4852	7%	7582	817	8400	10%	7598	822	8420	10%
Matakana Road (North of Matakana Link Rd)	NB	3584	354	3938	9%	5464	527	5991	9%	5468	528	5996	9%
	SB	3223	477	3700	13%	5013	772	5785	13%	5013	772	5785	13%
SH1 South of Goatley Road	NB	6680	988	7668	13%	6615	1277	7892	16%	6439	1278	7717	17%
	SB	7136	1010	8145	12%	7792	1868	9660	19%	7461	1846	9307	20%
Goatley Road	WB	290	154	444	35%	500	636	1136	56%	500	636	1136	56%
	EB	343	170	513	33%	535	663	1198	55%	534	662	1196	55%
Kaipara Flats Road	WB	414	205	619	33%	1158	785	1942	40%	849	801	1649	49%
	EB	383	152	535	28%	556	658	1214	54%	550	764	1315	58%
SH1 South of Wayby Valley Road	NB	5963	740	6703	11%	12629	1418	14047	10%	2764	343	3107	11%
	SB	6524	838	7362	11%	12958	1586	14544	11%	770	258	1028	25%
Wayby Valley Road	WB	244	57	300	19%	293	72	364	20%	294	71	365	20%
	EB	242	84	326	26%	300	114	414	28%	295	115	410	28%
SH1 South of Centennial Park Rd	NB	5720	656	6376	10%	12330	1303	13633	10%	3701	255	3956	6%
	SB	6281	781	7062	11%	12665	1514	14180	11%	3823	268	4091	7%
Kaipara Coast Hwy	WB	1120	120	1240	10%	1658	54	1712	3%	1711	104	1814	6%

Location		AADT											
	Year	2016				2046							
	Scenario	Existing				No Project				Project			
	Direction	UC1	UC3	Total	HCV%	UC1	UC3	Total	HCV%	UC1	UC3	Total	HCV%
	EB	1309	136	1445	9%	1568	67	1635	4%	1535	65	1600	4%
Whangaripo Valley Rd (Matheson Road extension)	WB	957	139	1096	13%	741	71	811	9%	775	70	845	8%
	EB	961	136	1097	12%	751	101	852	12%	799	69	867	8%
SH1 South of School Road	NB	7235	859	8094	11%	12653	1341	13994	10%	4378	272	4650	6%
	SB	7484	922	8407	11%	12526	1492	14018	11%	4624	257	4880	5%
School Road	WB	507	128	634	20%	582	134	716	19%	551	85	636	13%
	EB	507	90	597	15%	996	148	1144	13%	551	87	638	14%
SH1 South of Silver Hill Road	NB	6146	866	7012	12%	11499	1465	12964	11%	2567	367	2934	13%
	SB	6376	975	7351	13%	11465	1624	13089	12%	2788	364	3152	12%
Silver Hill Road	WB	0	0	0		0	0	0		0	0	0	
	EB	0	0	0		0	0	0		0	0	0	
Whakapirau Road	WB	389	204	593	34%	814	237	1051	23%	396	237	633	37%
	EB	403	199	602	33%	330	165	494	33%	403	228	631	36%
SH1 South of Mangawhai Road	NB	4848	725	5574	13%	9529	1320	10848	12%	932	301	1233	24%
	SB	5055	847	5902	14%	10109	1591	11700	14%	1145	328	1474	22%
Mangawhai Road	WB	351	222	573	39%	269	285	555	51%	281	286	567	50%
	EB	419	209	629	33%	303	228	531	43%	356	260	616	42%
SH1 South of Ross Road	NB	4485	518	5004	10%	9274	1096	10370	11%	9267	1095	10362	11%
	SB	4761	627	5388	12%	9888	1310	11198	12%	9888	1310	11198	12%
P2W North of Pūhoi Road	NB	0	0	0		18066	218	18284	1%	17775	205	17981	1%
	SB	0	0	0		17444	203	17647	1%	17177	195	17372	1%
P2W South of SH1	NB	0	0	0		18066	218	18284	1%	0	0	0	
	SB	0	0	0		17444	203	17648	1%	0	0	0	
P2W South of SH1	NB	0	0	0		0	0	0		16446	1527	17973	8%
	SB	0	0	0		0	0	0		13411	1242	14654	8%

Location		AADT											
	Year	2016				2046							
	Scenario	Existing				No Project				Project			
	Direction	UC1	UC3	Total	HCV%	UC1	UC3	Total	HCV%	UC1	UC3	Total	HCV%
Carran Road Re-Alignment	NB	276	124	400	31%	508	484	992	49%	469	467	935	50%
	SB	200	144	344	42%	1048	559	1607	35%	706	454	1159	39%
W2W Warkworth Interchange Through	NB	0	0	0		0	0	0		6677	11	6688	0%
	SB	0	0	0		0	0	0		6975	12	6987	0%
W2W Warkworth Interchange on ramp	NB	0	0	0		0	0	0		3208	1060	4268	25%
	SB	0	0	0		0	0	0		10203	182	10385	2%
W2W Warkworth Interchange off ramp	NB	0	0	0		0	0	0		11098	195	11293	2%
	SB	0	0	0		0	0	0		5348	1332	6680	20%
Kaipara Flats Road East of W2W	WB	414	205	619	33%	1158	785	1942	40%	849	801	1649	49%
	EB	383	152	535	28%	556	658	1214	54%	550	764	1315	58%
Kaipara Flats Road West of W2W	WB	414	205	619	33%	1158	785	1942	40%	849	801	1650	49%
	EB	383	152	535	28%	556	658	1214	54%	550	764	1315	58%
W2W South of Wayby Valley Road	NB	0	0	0		0	0	0		9876	1075	10951	10%
	SB	0	0	0		0	0	0		12323	1344	13667	10%
W2W Wayby Valley Interchange Through	NB	0	0	0		0	0	0		8634	974	9608	10%
	SB	0	0	0		0	0	0		8968	1263	10230	12%
W2W Wayby Valley Road on ramp	NB	0	0	0		0	0	0		10	76	86	88%
	SB	0	0	0		0	0	0		3356	81	3436	2%
W2W Wayby Valley Road off ramp	NB	0	0	0		0	0	0		1242	102	1343	8%
	SB	0	0	0		0	0	0		10	0	10	0%
Wayby Valley Road West of W2W	WB	0	0	0		0	0	0		1033	8	1041	1%
	EB	0	0	0		0	0	0		3149	106	3255	3%
Wayby Valley Road East of W2W	WB	0	0	0		0	0	0		294	71	365	20%
	EB	0	0	0		0	0	0		295	115	410	28%
	NB	0	0	0		0	0	0		8645	1050	9695	11%

Location		AADT											
	Year	2016				2046							
	Scenario	Existing				No Project				Project			
	Direction	UC1	UC3	Total	HCV%	UC1	UC3	Total	HCV%	UC1	UC3	Total	HCV%
W2W South of Mangawhai (South of Silver Hill Rd)	SB	0	0	0		0	0	0		8978	1263	10241	12%
W2W Mangawhai Interchange Through	NB	0	0	0		0	0	0		8645	1050	9695	11%
	SB	0	0	0		0	0	0		8978	1263	10241	12%
W2W Mangawhai Interchange on ramp	NB	0	0	0		0	0	0		622	45	668	7%
	SB	0	0	0		0	0	0		0	0	0	
W2W Mangawhai Interchange off ramp	NB	0	0	0		0	0	0		0	0	0	
	SB	0	0	0		0	0	0		910	47	957	5%
W2W North of Mangawhai Road	NB	0	0	0		0	0	0		9267	1095	10362	11%
	SB	0	0	0		0	0	0		9888	1310	11198	12%

Note:

- A correction factor of 0.95 has been multiplied into the AADT for conversion from 24 hour to 18 hour indicative traffic volumes
- For roads that are singular two-lane Northbound (NB) and Southbound (SB) arterials, the NS and SB AADT are summated.

B.6 Road surface finishes

Table 20 presents the road surface finishes which apply to all scenarios which are dependent on posted speed, HCV percentage and pavement requirements.

Table 20 – Road surface finishes

Vehicle speed	Correction Note 1 dB								
	Chip Seal (grade2/4)			SMA			OGPA		
Heavy vehicle %	5	10	20	5	10	20	5	10	20
50 km/h	-0.5	-1.3	-2.3	-4.5	-5.0	-5.6	-5.8	-6.1	-6.4
60 km/h	-0.2	-1.1	-2.1	-4.4	-4.9	-5.5	-5.7	-6.0	-6.3
70 km/h	0.0	-0.9	-1.9	-4.4	-4.8	-5.4	-5.6	-5.9	-6.3
80 km/h	0.1	-0.8	-1.8	-4.3	-4.7	-5.3	-5.6	-5.9	-6.2
100 km/h	0.3	-0.6	-1.5	-4.2	-4.6	-5.1	-5.5	-5.8	-6.1
110 km/h	0.4	-0.5	-1.4	-4.2	-4.5	-5.1	-5.5	-5.7	-6.0
Note: These corrections include a conversion from $L_{A10\ (18\ Hour)}$ to $L_{Aeq\ (24\ Hour)}$									

The major source of traffic noise is road tyre interaction for traffic speeds above 40 km/h. Therefore, the choice of road paving material has a significant effect on traffic noise generation.

B.7 Safety barriers

Based on current state highway bridge standards, all bridge and viaduct structures along the Indicative Alignment will include solid concrete safety barriers of 810 mm in height on both sides of the road. As such, these barriers were included in our modelling for the linear extent of each structure.

The safety barriers proposed for the median strip and the ramps are wire rope barriers. These barriers offer no acoustic attenuation and have not been modelled.

B.8 Houses not assessed

Table 21 – Houses not assessed

Sensitive Re ceivers Not Assessed (Within designation boundary, or Crown Land)
70 Wyllie Rd, Warkworth
4 Wyliie Rd, Warkworth
434 Woodcocks Rd, Streamlands
438 Woodcocks Rd, Streamlands
152 Carran Rd, Warkworth
151 Carran Rd, Warkworth
141 Carran Rd, Warkworth
108 Carran Rd, Warkworth
113 Carran Rd, Warkworth
119 Carran Rd, Streamlands
83 Carran Rd, Warkworth
63 Carran Rd, Warkworth
171 Kaipara Flats Rd
157 Kaipara Flats Rd
141 Kaipara Flats Rd

Sensitive Re ceivers Not Assessed (Within designation boundary, or Crown Land)
157A Kaipara Flats Rd, Warkworth
27 Philips Rd, Dome Forrest
11 Phillips Rd, Streamlands
6 Phillips Rd, Dome Valley
154 Kaipara Flats Rd, Dome Valley
30 Phillips Rd, Dome Valley
156 Kaipara Flats Rd, Dome Valley
18 Phillips Rd, Warkworth
161 Kraack Rd, Dome Forest
1207 SH1, Wayby Valley
1282 SH1, Wayby Valley
133 Wayby Valley Rd, Wellsford
30 Robertson Rd, Wellsford
20 Robertson Rd, Wayby Valley
230 Rustybrook Rd, Wellsford
16 Robertson Rd, Wayby Valley
199 Rustybrook Rd, Wayby Valley
118 Whangaripo Valley Rd, Wellsford
17 Borrows Rd, Wellsford
170 Whangaripo Valley Rd, Wellsford
12 Borrows Rd, Wellsford
37 Borrows Rd, Wellsford
35 Borrows Rd, Wellsford
50 Farmers Lime Rd, Wellsford
29 Farmers Lime Rd, Wellsford
15 Farmers Lime Rd, Wellsford
312 Silver Hill Rd, Wellsford
122 Mangawhai Rd, Wellsford
173 Carran Rd
99 Carran Rd
135 Kaipara Flats Rd
1282 SH1, Wayby Valley
200 Rustybrook Rd, Wellsford
159 Whangaripo Valley Rd, Wellsford
12 Borrows Rd, Wellsford
314 Silver Hill Road
558 SH-1 Warkworth
106 Rustybrook Rd
75 A Wyllie Rd
75 B Wyllie Rd

APPENDIX C: PREDICTED NOISE LEVELS

Table 22 – Predicted noise levels for assessed Project PPFs

No.	PPF	Floor	Existing dB $L_{Aeq(24h)}$	NZS 6806 Criteria dB $L_{Aeq(24h)}$			Do Nothing dB $L_{Aeq(24h)}$		Do Minimum dB $L_{Aeq(24h)}$			Selected Mitigation dB $L_{Aeq(24h)}$		
				Type	Cat A	Cat B	No project	Change from existing	Project only	Project + SH1	Change from do nothing	Project only	Project + SH1	Change from do nothing
2	74 Wyllie Rd, Streamlands	GF	41	new	57	64	52	11	54	54	2	54	54	2
6	371 Woodcocks, Warkworth	GF	56	new	57	64	59	3	56	57	-3	56	57	-3
7	372 Woodcocks Rd	GF	60	new	57	64	62	2	61	61	-2	61	61	-2
7	372 Woodcocks Rd	F 1	62	new	57	64	64	2	63	63	-1	63	63	-1
16	131 Kaipara Flats Rd	GF	36	new	57	64	45	8	57	57	12	56	56	12
17	211 Kairpara Flats Rd	GF	41	new	57	64	47	5	57	58	11	55	55	8
18	215 Kaipara Flats Rd	GF	50	new	57	64	56	5	59	59	4	58	58	3
19	214 Kaipara Flats Rd	GF	44	new	57	64	49	5	45	46	-4	42	42	-7
20	115 Kaipara Flats Rd	GF	38	new	57	64	45	7	53	53	8	53	53	8
22	27 SH-1, Warkworth	GF	61	altered	64	67	63	1	35	63	1	33	63	1
23	115 - 2 Kaipara Flats Rd	GF	46	new	57	64	51	5	54	54	3	54	54	3
24	63 SH-1, Warkworth	GF	56	altered	64	67	58	2	46	58	0	46	58	0
25	42 SH-1, Warkworth	GF	69	altered	64	67	71	1	42	71	1	42	71	1
26	39 Phillips Rd, Streamlands	GF	42	new	57	64	47	5	58	58	11	53	53	7
27	130 Kaipara Flats Rd	GF	50	new	57	64	55	5	58	58	3	58	58	3
28	105 SH1, Warkworth	GF	57	altered	64	67	59	1	38	59	0	36	59	0
29	102 SH-1, Warkworth	GF	61	altered	64	67	63	2	46	62	0	45	62	0
30	104 SH1, Warkworth	GF	65	altered	64	67	66	1	41	67	0	40	67	0
31	6 Kaipara Flats Road, Dome Valley	GF	60	altered	64	67	63	3	36	59	-4	34	59	-4
32	161 Kraack Rd, Dome Forest	GF	36	new	57	64	39	3	53	53	14	51	51	12
33	145 Kraack Rd, Dome Forest	GF	40	new	57	64	43	3	40	42	-1	38	40	-2
34	127 Kraack Rd, Dome Forest	GF	35	new	57	64	38	3	51	51	12	48	49	10
37	1232A SH-1, Wayby Valley	GF	50	altered	64	67	53	3	59	59	7	55	55	2
37	1232A SH-1, Wayby Valley	F 1	51	altered	64	67	53	3	60	60	7	55	55	2

No.	PPF	Floor	Existing dB $L_{Aeq(24h)}$	NZS 6806 Criteria dB $L_{Aeq(24h)}$			Do Nothing dB $L_{Aeq(24h)}$		Do Minimum dB $L_{Aeq(24h)}$			Selected Mitigation dB $L_{Aeq(24h)}$		
				Type	Cat A	Cat B	No project	Change from existing	Project only	Project + SH1	Change from do nothing	Project only	Project + SH1	Change from do nothing
40	4 Wayby Station Rd, Wellsford	GF	57	altered	64	67	60	3	60	60	0	57	58	-3
41	44 Wayby Station Rd, Wellsford	GF	57	altered	64	67	60	3	59	59	-1	57	57	-3
42	177 Rustybrook Rd, Wellsford	GF	36	new	57	64	38	2	58	58	20	53	53	15
43	351 Wayby Valley Rd, Wellsford	GF	39	new	57	64	40	2	60	60	19	54	54	14
44	64 Whangaripo Valley Rd, Wellsford	GF	35	new	57	64	37	2	58	58	22	53	53	16
45	96 Whangaripo Valley Rd, Wellsford	GF	48	new	57	64	46	-2	56	56	10	52	52	6
46	40 Borrows Rd, Wellsford	GF	47	new	57	64	45	-2	62	62	17	57	57	12
47	47 Borrows Rd, Wellsford	GF	33	new	57	64	34	0	57	57	23	52	52	18
48	213 Whangaripo Valley Rd, Wellsford	GF	51	new	57	64	49	-2	56	56	7	53	53	4
49	263 Worthington Rd, Wellsford	GF	35	new	57	64	37	2	56	56	19	51	51	14
50	250 Silver Hill Rd, Wellsford	GF	30	new	57	64	32	2	58	58	26	53	53	21
51	263 Silver Hill Rd, Wellsford	GF	29	new	57	64	32	2	58	58	26	52	52	21
52	273 Silver Hill Rd, Wellsford	GF	29	new	57	64	31	2	57	57	26	52	52	21
53	332 Silver Hill Rd	GF	35	new	57	64	37	2	61	61	24	56	56	19
54	344 Silver Hill Rd, Wellsford	GF	34	new	57	64	36	2	59	59	23	54	54	18
55	469 SH-1, Te Hana	GF	58	altered	64	67	61	3	55	55	-5	53	54	-7
56	490 SH-1, Wellsford	GF	63	altered	64	67	66	3	62	62	-5	61	61	-6
57	10 Charis Lane, Wellsford	GF	55	altered	64	67	58	3	55	55	-3	52	52	-6
58	13 Charis Lane, Wellsford	GF	49	altered	64	67	52	2	59	59	8	55	55	4
59	8 Charis Lane, Wellsford	GF	54	altered	64	67	57	3	57	57	0	54	54	-3
60	7 Charis Lane, Wellsford	GF	52	altered	64	67	54	2	59	59	5	55	55	1
61	9 Charis Lane, Wellsford	GF	52	altered	64	67	54	2	60	60	6	56	56	3
62	6 Charis Lane, Wellsford	GF	56	altered	64	67	59	3	58	58	-1	55	55	-4
63	542 SH-1, Topuni	GF	68	altered	64	67	72	4	60	60	-11	59	59	-12

No.	PPF	Floor	Existing dB $L_{Aeq(24h)}$	NZS 6806 Criteria dB $L_{Aeq(24h)}$			Do Nothing dB $L_{Aeq(24h)}$		Do Minimum dB $L_{Aeq(24h)}$			Selected Mitigation dB $L_{Aeq(24h)}$		
				Type	Cat A	Cat B	No project	Change from existing	Project only	Project + SH1	Change from do nothing	Project only	Project + SH1	Change from do nothing
64	557 SH1, Wellsford	GF	58	altered	64	67	62	4	59	59	-3	55	55	-7
65	139 Vipond Road	GF	54	altered	64	67	54	0	61	61	7	57	57	3
66	129 Vipond Rd	GF	45	altered	64	67	47	2	59	59	11	54	54	7
67	575 SH-1, Topuni	GF	66	altered	64	67	70	4	64	64	-6	59	59	-11
68	28 Waimanu Rd, Topuni	GF	53	altered	64	67	57	4	60	60	3	55	55	-2
69	641 SH-1, Wellsford	GF	57	altered	64	67	61	4	64	64	3	60	60	-2
70	705 SH-1, Wellsford	GF	66	altered	64	67	70	4	70	70	0	68	68	-2
70	705 SH-1, Wellsford	F 1	67	altered	64	67	71	4	71	71	0	70	70	-2
71	704 SH-1, Wellsford	GF	67	altered	64	67	71	4	70	70	-1	69	69	-2
72	17 Maeneene Rd	GF	60	altered	64	67	64	4	66	66	2	62	62	-2
73	45 Maeneene Rd, Wellsford	GF	57	altered	64	67	61	4	61	61	0	59	59	-2
74	33 Maeneene Rd	GF	57	altered	64	67	61	4	63	63	2	59	59	-2
75	35 Vipond Road, Wellsford	GF	54	new	57	64	58	4	67	67	9	62	62	4
76	18 Maeneene Rd	GF	55	altered	64	67	59	4	61	61	3	57	57	-2
77	17 Vipond Rd, Wellsford	GF	53	new	57	64	56	4	62	62	6	57	57	1

APPENDIX D: NOISE MITIGATION OPTIONS ASSESSMENT MATRICES

D.1 Assessment area A – Maeneene Road

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2
Achievement of NZS 6806 categories A or B	Acoustics	There is existing high exposure at some PPFs near SH1 and while the project does not cause a significant increase it provides an opportunity to address the current issues.	- - -	- - -
			One PPF remains in Cat C and one in Cat B	One PPF remains in Cat C and one in Cat B
Reduction in noise provided	Acoustics		+	o
			4.4 dB reduction	2.7 dB reduction, although this may be reduced with breaks for driveway access
Efficiency in terms of BCR	Acoustics	Increased pavement costs have not been included.	- -	- - -
			BCR 0.47. This improves to 0.67 if also used for areas B & C, which would increase the rating to –	BCR 0.09. Benefits from substantial barriers are primarily for two PPFs
Effects of changes to existing noise environment	Acoustics		+	+
			The mitigation largely offsets the natural increase that would occur with increasing traffic on SH1	At the most affected PPFs the mitigation largely offsets the natural increase that would occur with increasing traffic on SH1
Maintenance (including access)	Engineering		+ +	-
			OGPA provides superior design life in comparison to chipseal, reducing maintenace requirements. No requirement for offline access.	Further infrastructure over and above existing, requiring increased maintenance obligations. Susceptibility to vandalism. Requirements for offline access.
Constructability/technical feasibility (including structural, geotech and stormwater considerations)	Engineering	Detailed information of ground conditions unknown. Tie-in with existing SH1 will trigger traffic management requirements.	o	- -
			No more or less constructable than status quo	Additional space requirements to construct walls outside of carriageway (in tight corridor) and longer construction timeframe due to increased quanitity of infrastructure. Partial length of wall can be constructed in parallel with pavement construction offline of existing SH1.

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2
Compliance with relevant safety standards and guidelines	Engineering	All activity will be completed in compliance with standards and guidelines. Have therefore assumed assessment relates to the assessed level of safety for each option.	+	-
			Well established safety standards and guidelines Asphalt deemed safer than chipseal due to elimination of chip spray.	Assumption that wall sits as close to road as possible. Introduces further roadside hazard into road corridor, with risk of being within deflection zone of WRB.
Availability of sufficient land, and impacts on adjoining properties	Planning	Additonal land take required for mitigation	o	o
			Sufficient land available	The noise walls do not appear to require any additional land take (within the existing SH1 road corridor)
Consenting issues	Planning	Visual issues associated with noise walls resulting in implications with consenting/ additional mitigation requirements	o	-
			Unlikely to be any consenting issues given it involves use of road surface material	May introduce additional visual effects associated with 3 m high noise walls. Project designation does not extend to the full distance however existing road corridor is designated.
Cultural/heritage effects	Planning	Sites of cultural/ heritage significance affected by construction of bunds/ noise walls	o	-
			No heritage sites located in the vicinity. Unknown if any cultural sites of significance but the option follows existing road (does not affect any new area)	No recorded heritage sites located in the vicinity, although potential for unrecorded sites in vicinity of Maeneene Road. Unknown if any cultural sites of significance but the option is located within existing road corridor
Ecological effects – Potential effects on areas of significant indigenous vegetation and significant habitats of indigenous fauna	Planning	Sites of ecological significance affected by bunds/ noise walls	o	o
			Use of OGPA will not affect sites of ecological significance (over and above the road itself)	No sites of ecological significance identified in the AUP(OP) here. Unknown if the ecology specialist has identified anything significant here (the walls are currently outside the Project area).
Visual/landscape effects from road including longer corridor compatibility	Urban design	Visual clutter, look form and scale of noise walls.	o	- - -
			No visible change	Will be very noticable for road users.
	Urban design		o	- -

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2
Visual/landscape, urban design, CPTED effects from local roads, reserves, walkways, etc		Walls eliminate passive observation from adjacent properties.	No effect	Removes any opportunity for passive surveillance
Visual/shading/landscape effects for adjoining residents	Urban design	3m high walls will have adverse visual effects on adjacent properties.	o	- - -
			No effect	Close to adjacent houses.

D.2 Assessment area B – Vipond Road

Assessment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Achievement of NZS 6806 categories A or B	Acoustics		+	- - -	- - -
			Two PPFs remain in Cat B	One PPF remains in Cat C and one in Cat B	One PPF remains in Cat C and one in Cat B
Reduction in noise provided	Acoustics		+	-	- -
			4.4 dB reduction	1.1 dB reduction	1.8 dB reduction (2.5 dB for 35 Vipond Road)
Efficiency in terms of BCR	Acoustics	Increased pavement costs have not been included.	- - -	- - -	- - -
			BCR 0.18. This improves to 0.67 if also used for areas A & C, which would increase the rating to –	BCR 0.10. This may improve if placement of material comes at no additional cost due to need for soil disposal.	BCR 0.04. This would improve if barrier were optimised just for 35 Vipond Road.
Effects of changes to existing noise environment	Acoustics	Sound from the existing SH1 is audible at these PPFs but it is at a distance and existing levels are modest.	-	-	-
			Even with mitigation there is a noticeable increase to the existing noise environment	Even with mitigation there is a noticeable increase to the existing noise environment	Even with mitigation there is a noticeable increase to the existing noise environment
Maintenance (including access)	Engineering	Option 2 – slope stability risk	+ +	-	-

Assessment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
			OGPA provides superior design life in comparison to chipseal, reducing maintenace requirements. No requirement for offline access.	Possible maintenance requirements to address settlement and slope stability issues. Potential mowing difficulties (if grassed) or maintenance obligations if planted.	Further infrastructure over and above existing, requiring increased maintenance obligations. Susceptiblity to vandalism. Ease of access from Vipond Rd
Constructability/technical feasibility (including structural, geotech and stormwater considerations)	Engineering	Detailed information of ground conditions unknown.	o	-	-
			No more or less constructable than status quo	Construction over and above pavement construction. Potential for difficulties with material sourcing and usability	Construction over and above pavement construction, though length of wall can be constructed in parallel with pavement construction.
Compliance with relevant safety standards and guidelines	Engineering	All activity will be completed in compliance with standards and guidelines. Have therefore assumed assessment relates to the assessed level of safety for each option.	+	o	-
			Well established safety standards and guidelines Asphalt deemed safer than chipseal due to elimination of chip spray.	Proposed mainline edge barrier provides protection to bund	Further roadside hazard introduced onto Vipond Rd.
Availability of sufficient land, and impacts on adjoining properties	Planning	Additonal land take required for mitigation	o	o	o
			Sufficient land available	Sufficient land available	Sufficient land available
Consenting issues	Planning	Visual issues associated with noise walls resulting in implications with consenting/ additional mitigation requirements	o	o	-
			Unlikely to be any consenting issues given it involves use of road surface material	Unlikely to be any consenting issues as the area is identified as a soil disposal area on current plans and is more in keeping with rural nature than noise wall (refer urban design assessment)	May introduce additional visual effects associated with 3 m high noise wall.
Cultural/heritage effects	Planning		o	o	o

Assessment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
		Sites of cultural/ heritage significance affected by bunds/ noise walls	No heritage sites located in the vicinity. Unknown if any cultural sites of significance but the option follows existing road (does not affect any new area)	No recorded heritage sites located in the vicinity. Unknown if any cultural sites of significance	No recorded heritage sites located in the vicinity. Unknown if any cultural sites of significance
Ecological effects – Potential effects on areas of significant indigenous vegetation and significant habitats of indigenous fauna	Planning	Sites of ecological significance affected by bunds/ noise walls	o	o	o
			Use of OGPA will not affect sites of ecological significance (over and above the road itself)	No sites of ecological significance identified in the AUP(OP) here. Unknown if the ecology specialist has identified anything significant here.	No sites of ecological significance identified in the AUP(OP) here. Unknown if the ecology specialist has identified anything significant here.
Visual/landscape effects from road including longer corridor compatibility	Urban design	Visual clutter, walls being out of context in rural landscape. Option 2 can be screened with planting.	o	o	- - -
			No effect	No effect	Out of context with the rural landscape.
Visual/landscape, urban design, CPTED effects from local roads, reserves, walkways, etc	Urban design	Adjacent houses distant from alignment and structures are set back so CPTED issues not relevant. Visual effects result from Option 3 wall out of context in rural landscape.	o	-	- -
			No effect	Potential to block views from adjacent properties. Will need planting to integrate it into the landscape.	Potential adverse visual effects on Vipond Road
Visual/shading/landscape effects for adjoining residents	Urban design	Adjacent houses distant from alignment so not relevant	o	o	- - -
			No effect	No effect	Potential to block views from adjacent properties. Design and scale of walls have potential adverse amenity effects.

D.3 Assessment area C – Mangawhai Road

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2
Achievement of NZS 6806 categories A or B	Acoustics		+ + +	+ + +
			All PPFs in Cat A	All PPFs in Cat A
Reduction in noise provided	Acoustics		+	- -
			4.0 dB reduction	0.8 dB reduction (2.5 dB for 575 SH!)
Efficiency in terms of BCR	Acoustics	Increased pavement costs have not been included. Offset costs for wire-rope barriers have not been included.	-	- - -
			BCR 0.52. This improves to 0.67 if also used for areas A & B, which would increase the rating to -	BCR 0.05. This would improve slightly if extents of barriers limited to section benefitting houses by existing SH1
Effects of changes to existing noise environment	Acoustics		-	-
			Even with mitigation there is a noticeable increase to the existing noise environment	Even with mitigation there is a noticeable increase to the existing noise environment
Maintenance (including access)	Engineering	Note: SMA is the likely surfacing to be used on ramps.	+ +	+
			OGPA provides superior design life in comparison to chipseal, reducing maintenace requirements. No requirement for offline access.	Replacement of WRB with concrete barrier. Concrete barrier is less susceptible to damage when struck resulting in improved maintenance obligations.
Constructability/technical feasibility (including structural, geotech and stormwater considerations)	Engineering	Detailed information of ground conditions unknown. Note: SMA is the likely surfacing to be used on ramps.	o	-
			No more or less constructable than status quo	Construction is more extensive for concrete barrier in comparison to proprietry WRB system. May affect Stormwater flow paths and introduce requirement for a reticulation system.
Compliance with relevant safety standards and guidelines	Engineering	All activity will be completed in compliance with standards and	+	-

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2
		guidelines. Have therefore assumed assessment relates to the assessed level of safety for each option. Note: SMA is the likely surfacing to be used on ramps.	Well established safety standards and guidelines Asphalt deemed safer than chipseal due to elimination of chip spray.	Well established safety standards and guidelines WRB deemed safer than concrete barrier due to being more forgiving to the motorist.
Availability of sufficient land, and impacts on adjoining properties	Planning	Additonal land take required for mitigation	o	o
			Sufficient land available	Sufficient land available
Consenting issues	Planning	Visual issues associated with noise walls	o	o
			Unlikely to be any consenting issues given it involves use of road surface material	Unlikely to be any consenting issues given it involves use of road safety barriers
Cultural/heritage effects	Planning	Sites of cultural/ heritage significance affected by bunds/ noise walls	o	o
			No heritage sites located in the vicinity. Unknown if any cultural sites of significance but the option follows existing road (does not affect any new area)	No heritage sites located in the vicinity. Unknown if any cultural sites of significance but the option follows existing road (does not affect any new area)
Ecological effects - Potential effects on areas of significant indigenous vegetation and significant habitats of indigenous fauna	Planning	Sites of ecological significance affected by bunds/ noise walls	o	o
			Use of OGPA will not affect sites of ecological significance (over and above the road itself)	Use of road safety barriers will not affect sites of ecological significance (over and above the road itself)
Visual/landscape effects from road including longer corridor compatibility	Urban design	Visual effects from barriers being out off context with rural landscape. Traffic noise results in sensory effects on rural character	o	- -
			No effect	Concrete barriers create an urban aesthetic urban unless assocaited with a bridge. Out of context with rural character.
Visual/landscape, urban design, CPTED effects from local roads, reserves, walkways, etc	Urban design	Not applicable	o	o
			No effect	No effect
Visual/shading/landscape effects for adjoining residents	Urban design	Not applicable	o	o
			No effect	No effect

D.4 Assessment area D – Silver Hill Road

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Achievement of NZS 6806 categories A or B	Acoustics		+	+	+
			One PPF remains in Cat B	Four PPFs remain in Cat B	Three PPFs remain in Cat B
Reduction in noise provided	Acoustics	Other barrier placements have been tried, but the terrain does not allow for effective screening without high barriers.	o	- - -	- - -
			2.8 dB	0 dB	0.4 dB
Efficiency in terms of BCR	Acoustics	Increased pavement costs have not been included. Offset costs for wire-rope barriers have not been included.	- - -	- - -	- - -
			BCR 0.23	BCR 0	BCR 0
Effects of changes to existing noise environment	Acoustics	The existing environment is not affected by state highway traffic. The new road therefore changes the current amenity.	- - -	- - -	- - -
			Even with mitigation there is a significant increase to the existing noise environment	Even with mitigation there is a significant increase to the existing noise environment	Even with mitigation there is a significant increase to the existing noise environment
Maintenance (including access)	Engineering		+ +	-	+
			OGPA provides superior design life in comparison to chipseal, reducing maintenace requirements. No requirement for offline access.	Further infrastructure over and above existing, requiring increased maintenance obligations. Susceptiblity to vandalism. Requirements for offline access.	Replacement of WRB with concrete barrier. Concrete barrier is less susceptible to damage when struck resulting in improved maintenance obligations.
Constructability/technical feasibility (including structural, geotech and stormwater considerations)	Engineering	Detailed information of ground conditions unknown.	o	-	-
			No more or less constructable than status quo	Construction over and above pavement construction, though length of wall can be constructed in parallel with pavement construction.	Construction is more extensive for concrete barrier in comparison to proprietry WRB system. May affect Stormwater flow paths and introduce requirement for a reticulation system.

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Compliance with relevant safety standards and guidelines	Engineering	All activity will be completed in compliance with standards and guidelines. Have therefore assumed assessment relates to the assessed level of safety for each option.	+ Well established safety standards and guidelines Asphalt deemed safer than chipseal due to elimination of chip spray.	o Well established safety standards and guidelines Wall offset away from roadside	- Well established safety standards and guidelines WRB deemed safer than concrete barrier due to being more forgiving to the motorist.
Availability of sufficient land, and impacts on adjoining properties	Planning	Additonal land take required for mitigation	o Sufficient land available	o Sufficient land available	o Sufficient land available
Consenting issues	Planning	Visual issues associated with noise walls	o Unlikely to be any consenting issues given it involves use of road surface material	- May lead to additional visual effects	o Unlikely to be any consenting issues given it involves use of road safety barriers
Cultural/heritage effects	Planning	Sites of cultural/ heritage significance affected by bunds/ noise walls	o No heritage sites located in the vicinity. Unknown if any cultural sites of significance but the option follows existing road (does not affect any new area)	o No heritage sites located in the vicinity. Unknown if any cultural sites of significance but the option follows existing disturbed areas for the road (does not affect any new area)	o No heritage sites located in the vicinity. Unknown if any cultural sites of significance but the option follows existing disturbed areas for the road (does not affect any new area)
Ecological effects – Potential effects on areas of significant indigenous vegetation and significant habitats of indigenous fauna	Planning	Sites of ecological significance affected by bunds/ noise walls	o Use of OGPA will not affect sites of ecological significance (over and above the road itself)	o No sites of ecological significance identified in the AUP(OP) here. Unknown if the ecology specialist has identified anything significant here.	o No sites of ecological significance identified in the AUP(OP) here. Unknown if the ecology specialist has identified anything significant here.
Visual/landscape effects from road including longer corridor compatibility	Urban design	Context with rural landscape character	o No effect	- - Potentially visible from the road.	- - - Concrete barriers create an urban aesthetic unless assocaited with a bridge.

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
					Out of context with rural character.
Visual/landscape, urban design, CPTED effects from local roads, reserves, walkways, etc	Urban design	Not applicable	o	o	o
			No effect	No effect	No effect
Visual/shading/landscape effects for adjoining residents	Urban design	Not applicable	o	- - -	o
			No effect	Visible from local road and adjacent properties.	No effect

D.5 Assessment area E – Whangaripo Valley Road

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Achievement of NZS 6806 categories A or B	Acoustics		+ + +	+	+
			All PPFs in Cat A	Three PPFs remain in Cat B	One PPF remains in Cat B
Reduction in noise provided	Acoustics	Other barrier placements have been tried, but the terrain does not allow for effective screening without high barriers.	+	- - -	- -
			4.3 dB reduction	0 dB	1 dB
Efficiency in terms of BCR	Acoustics	Increased pavement costs have not been included. Offset costs for wire-rope barriers have not been included.	- - -	- - -	- - -
			BCR 0.18	BCR 0	BCR 0.04
Effects of changes to existing noise environment	Acoustics	The existing environment is not affected by state highway traffic. The new road therefore changes the current amenity.	- - -	- - -	- - -
			Even with mitigation there is a significant increase to the existing environment	Even with mitigation there is a significant increase to the existing environment	Even with mitigation there is a significant increase to the existing environment
Maintenance (including access)	Engineering		+ +	-	+
			OGPA provides superior design life in comparison to chipseal, reducing maintenace requirements. No requirement for offline access.	Further infrastructure over and above existing, requiring increased maintenance obligations. Susceptiblity to vandalism. Requires for offline access.	Replacement of WRB with concrete barrier. Concrete barrier is less susceptible to damage when struck resulting in improved maintenance obligations.
Constructability/technical feasibility (including structural, geotech and stormwater considerations)	Engineering	Detailed information of ground conditions unknown.	o	-	-
			No more or less constructable than status quo	Construction over and above pavement construction, though length of wall can be constructed in parallel with pavement construction.	Construction is more extensive for concrete barrier in comparison to proprietry WRB system. May affect Stormwater flow paths and introduce requirement for a reticulation system.
	Engineering		+	o	-

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Compliance with relevant safety standards and guidelines		All activity will be completed in compliance with standards and guidelines. Have therefore assumed assessment relates to the assessed level of safety for each option.	Well established safety standards and guidelines Asphalt deemed safer than chipseal due to elimination of chip spray.	Well established safety standards and guidelines Wall offset away from roadside	Well established safety standards and guidelines WRB deemed safer than concrete barrier due to being more forgiving to the motorist.
Availability of sufficient land, and impacts on adjoining properties	Planning	Additonal land take required for mitigation	o	o	o
			Sufficient land available	Sufficient land available	Sufficient land available
Consenting issues	Planning	Visual issues associated with noise walls	o	-	o
			Unlikely to be any consenting issues given it involves use of road surface material	May lead to additional visual effects	Unlikely to be any consenting issues given it involves use of road safety barriers
Cultural/heritage effects	Planning	Sites of cultural/ heritage significance affected by bunds/ noise walls	o	o	o
			No heritage sites located in the vicinity. Unknown if any cultural sites of significance but the option follows existing road (does not affect any new area)	No heritage sites located in the vicinity. Unknown if any cultural sites of significance but the option follows existing disturbed areas for the road (does not affect any new area)	No heritage sites located in the vicinity. Unknown if any cultural sites of significance but the option follows existing disturbed areas for the road (does not affect any new area)
Ecological effects - Potential effects on areas of significant indigenous vegetation and significant habitats of indigenous fauna	Planning	Sites of ecological significance affected by bunds/ noise walls	o	o	o
			Use of OGPA will not affect sites of ecological significance (over and above the road itself)	No sites of ecological significance identified in the AUP(OP) here. Unknown if the ecology specialist has identified anything significant here.	No sites of ecological significance identified in the AUP(OP) here. Unknown if the ecology specialist has identified anything significant here.
Visual/landscape effects from road including longer corridor compatibility	Urban design	Visual clutter, walls being out of context in rural landscape. Option 2 can be screened with planting.	o	- -	- -
			No effect	Potentially visible from the road.	Concrete barrier extending beyound the bridge will out of context with the rural character.
	Urban design		o	o	o

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Visual/landscape, urban design, CPTED effects from local roads, reserves, walkways, etc			No effect	No effect	No effect
Visual/shading/landscape effects for adjoining residents	Urban design		o	- - -	- -
			No effect	Visible from local roads, out of character with rural context.	Will increase visibility of road from adjacent properties.

D.6 Assessment area F – Wayby Valley Road

Assesment criteria	Discipline	Issues / Risks	Option 1
Achievement of NZS 6806 categories A or B	Acoustics		+ + +
			All PPFs in Cat A
Reduction in noise provided	Acoustics		o
			3 dB reduction
Efficiency in terms of BCR	Acoustics	Increased pavement costs have not been included.	- - -
			BCR 0.13
Effects of changes to existing noise environment	Acoustics	The existing environment is already subject to state highway noise.	+ +
			With mitigation levels are less than would occur without the project
Maintenance (including access)	Engineering		+ +
			OGPA provides superior design life in comparison to chipseal, reducing maintenance requirements. No requirement for offline access.
Constructability/technical feasibility (including structural, geotech and stormwater considerations)	Engineering	Detailed information of ground conditions unknown.	o
			No more or less constructable than status quo
	Engineering		+

Assesment criteria	Discipline	Issues / Risks	Option 1
Compliance with relevant safety standards and guidelines		All activity will be completed in compliance with standards and guidelines. Have therefore assumed assessment relates to the assessed level of safety for each option.	Well established safety standards and guidelines Asphalt deemed safer than chipseal due to elimination of chip spray.
Availability of sufficient land, and impacts on adjoining properties	Planning	Additonal land take required for mitigation	o Sufficient land available
Consenting issues	Planning	No effect	o Unlikely to be any consenting issues given it involves use of road surface material
Cultural/heritage effects	Planning	Sites of cultural/ heritage significance affected by bunds/ noise walls	o Recorded heritage sites are located in the vicinity, but would already be affected by road. Unknown if any cultural sites of significance but the option follows existing road (does not affect any new area)
Ecological effects – Potential effects on areas of significant indigenous vegetation and significant habitats of indigenous fauna	Planning	Sites of ecological significance affected by bunds/ noise walls	o Use of OGPA will not affect sites of ecological significance (over and above the road itself)
Visual/landscape effects from road including longer corridor compatibility	Urban design		o No effect
Visual/landscape, urban design, CPTED effects from local roads, reserves, walkways, etc	Urban design		o No effect
Visual/shading/landscape effects for adjoining residents	Urban design	OGPA will assist with reducing noise and therefore reduce the sensory aspects of rural character.	o No effect

D.7 Assessment area G – Kaipara Flats Road

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Achievement of NZS 6806 categories A or B	Acoustics		+	+	+
			Two PPFs remain in Cat B	Two PPFs remain in Cat B	Two PPFs remain in Cat B
Reduction in noise provided	Acoustics	Other barrier placements have been tried, but the terrain does not allow for effective screening without high barriers.	-	- -	- - -
			1.7 dB	1.2 dB. Up to 2.3dB at individual PPFs	0.5 dB
Efficiency in terms of BCR	Acoustics	Increased pavement costs have not been included. Offset costs for wire-rope barriers have not been included.	- - -	- - -	- - -
			BCR 0.23	BCR 0.16	BCR 0
Effects of changes to existing noise environment	Acoustics	The existing environment is not affected by state highway traffic. The new road therefore changes the current amenity.	- - -	- - -	- - -
			Even with mitigation there is a significant increase to the existing environment	Even with mitigation there is a significant increase to the existing environment	Even with mitigation there is a significant increase to the existing environment
Maintenance (including access)	Engineering		+ +	+ +	+
			OGPA provides superior design life in comparison to chipseal, reducing maintenace requirements. No requirement for offline access.	OGPA provides superior design life in comparison to chipseal, reducing maintenace requirements. No requirement for offline access.	Replacement of WRB with concrete barrier. Concrete barrier is less susceptible to damage when struck resulting in improved maintenance obligations.
Constructability/technical feasibility (including structural, geotech and stormwater considerations)	Engineering	Detailed information of ground conditions unknown.	o	o	-
			No more or less constructable than status quo	No more or less constructable than status quo	Construction is more extensive for concrete barrier in comparison to proprietry WRB system. May affect Stormwater flow paths and introduce requirement for a reticulation system.
	Engineering		+	+	-

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Compliance with relevant safety standards and guidelines		All activity will be completed in compliance with standards and guidelines. Have therefore assumed assessment relates to the assessed level of safety for each option.	Well established safety standards and guidelines Asphalt deemed safer than chip seal due to elimination of chip spray.	Well established safety standards and guidelines Asphalt deemed safer than chip seal due to elimination of chip spray.	Well established safety standards and guidelines WRB deemed safer than concrete barrier due to being more forgiving to the motorist.
Availability of sufficient land, and impacts on adjoining properties	Planning	Additional land take required for mitigation	o Sufficient land available	o Sufficient land available	o Sufficient land available
Consenting issues	Planning	No effect	o Unlikely to be any consenting issues given it involves use of road surface material	o Unlikely to be any consenting issues given it involves use of road surface material	o Unlikely to be any consenting issues given it involves use of road safety barriers
Cultural/heritage effects	Planning	No effect	o Recorded heritage sites are located in the vicinity, but would already be affected by road. Unknown if any cultural sites of significance but the option follows existing road (does not affect any new area)	o Recorded heritage sites are located in the vicinity, but would already be affected by road. Unknown if any cultural sites of significance but the option follows existing road (does not affect any new area)	o Recorded heritage sites are located in the vicinity, but would already be affected by road. Unknown if any cultural sites of significance but the option follows existing disturbed areas for the road (does not affect any new area)
Ecological effects – Potential effects on areas of significant indigenous vegetation and significant habitats of indigenous fauna	Planning	No effect	o Use of OGPA will not affect sites of ecological significance (over and above the road itself)	o Use of OGPA will not affect sites of ecological significance (over and above the road itself)	o Use of road safety barriers will not affect sites of ecological significance (over and above the road itself)
Visual/landscape effects from road including longer corridor compatibility	Urban design		o No effect	o No effect	- - Concrete barriers create an urban aesthetic unless associated with a bridge. Out of context with rural character.

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Visual/landscape, urban design, CPTED effects from local roads, reserves, walkways, etc	Urban design		o	o	o
			No effect	No effect	No effect
Visual/shading/landscape effects for adjoining residents	Urban design		o	o	- -
			No effect	No effect	Concrete barriers create an urban aesthetic unless associated with a bridge. Out of context with rural character.