NZ TRANSPORT AGENCY
WAKA KOTAHI

Roads of national significance

Ara Tūhono – Pūhoi to Wellsford

FURTHER NORTH

Pūhoi to Warkworth

Construction Noise Assessment Report

August 2013

MARSHALL DAY Acoustics

Pūhoi to Warkworth

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Glossary of abbreviations

Abbreviation	Definition
AEE	Assessment of Environmental Effects
BPO	Best Practicable Option
CMA	Coastal marine area
CNVMP	Construction Noise and Vibration Management Plan
NZS 6801:2008	New Zealand Standard NZS 6801:2008 "*Acoustics – Measurement of environmental sound*"
NZS 6802:2008	New Zealand Standard NZS 6802:2008 "*Acoustics – Environmental noise*"
NZS 6803:1999	New Zealand Standard NZS 6803:1999 *"Acoustics – Construction Noise"*
NZS 6803P:1984	Provisional New Zealand Standard NZS 6803P:1984 *"The Measurement and Assessment of Noise from Construction, Maintenance and Demolition Work"*
NZTA	NZ Transport Agency
OPW	Outline Plan of Works
RMA	Resource Management Act 1991
SHx	State Highway (number)
vpd	Vehicles per day

Glossary of defined terms

Abbreviation	Definition
Ambient (or total) sound / vibration	The total sound 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.
Auckland Council	The unitary authority that replaced eight councils in the Auckland Region as of 1 November 2010.
dB	A decibel is a unit of sound level.
dBC	A unit of sound level which has its frequency characteristics modified by a filter (C-weighted) so as to account for the non-linear frequency response of the human ear at high noise levels (typically greater than 100 decibels).
Earthworks	The disturbance of land surfaces by blading, contouring, ripping, moving, removing, placing or replacing soil or earth, or by excavation, or by cutting or filling operations.
$L_{Aeq(t)}$	The time averaged noise level (on a log/energy basis). This is commonly referred to as the average noise level. The "A" represents A – weighting whereby the value has had its frequency characteristics modified by a filter so as to more closely approximate the frequency bias of the human ear. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent the period between 10 pm and 7 am.
L_{Amax}	The maximum sound pressure level measured during the sampling period. The "A" represents A – weighting as described for $L_{Aeq(t)}$ above.
Noise mitigation	An activity or structure which reduces/mitigates the impact or effect of noise.
Peak sound level	The peak instantaneous C-weighted pressure level recorded during the measurement period. Typically measured or estimated at a person's ear during any noisy event, e.g. blasting.
Project	Ara Tūhono Pūhoi to Wellsford Road of National Significance (RoNS), Pūhoi to Warkworth Section.
Project area	From the Johnstone's Hill tunnels portals in the south to Kaipara Flats Road in the north.

Contents

1. Introduction

This report provides an assessment of the construction noise effects of the Pūhoi to Warkworth Project (the Project).

The purpose of this assessment is to ensure that the Project can be constructed in such a way that any adverse construction noise effects will be managed or mitigated.

Our assessment involved the review and determination of appropriate construction noise criteria, calculation of construction noise levels from potential activities and equipment, determination of potentially affected dwellings and recommendation of noise management and mitigation measures where these are required to achieve appropriate outcomes.

1.1 Purpose and scope of this report

This report describes our assessment of construction noise effects of the Pūhoi to Warkworth Project (the Project). We have based our assessment on the current New Zealand standard which is widely used and accepted. The Standard has been applied to all recent large scale roading construction projects.

The purpose of this construction noise assessment is to ensure that the Project can be constructed in such a way that any adverse construction noise effects will be managed or mitigated. We have recommended construction noise criteria that should be met whenever practicable.

The Project area is sparsely populated, and only a small number of dwellings will be affected by the construction of this Project. As a result, the contractor will be able to give particular attention to each affected dwelling.

The scope of our work involved the following:

- Reviewing relevant construction noise standards and determining of appropriate noise criteria;
- Determining potential construction activities and equipment, and associated noise levels;
- Calculating construction noise levels and determining potentially affected dwellings;
- Recommending mitigation where required to achieve appropriate outcomes.

This report deals with construction noise only. Vibration and operational noise are addressed in separate reports.

This report forms part of a suite of technical reports prepared for the NZ Transport Agency's (NZTA's) Ara Tūhono Pūhoi to Wellsford Road of National Significance (RoNS) Pūhoi to Warkworth Section (the Project). Its purpose is to inform the Assessment of Environmental Effects (AEE) and to support the resource consent applications and Notices of Requirement for the Project.

The indicative alignment shown on the Project drawings has been developed through a series of multi-disciplinary specialist studies and refinement. A NZTA scheme assessment phase was

completed in 2011, and further design changes have been adopted throughout the AEE assessment process for the Project in response to a range of construction and environmental considerations.

It is anticipated that the final alignment will be refined and confirmed at the detailed design stage through conditions and outline plans of works (OPW). For that reason, this assessment has addressed the actual and potential effects arising from the indicative alignment, and covers the proposed designation boundary area.

Except as noted in this report:

- We consider that the sites we have selected for surveys and testing are generally representative of all areas within the proposed designation boundary; and
- The recommendations we propose to mitigate adverse effects are likely to be applicable to other similar areas within the proposed designation boundary, subject to confirmation of their suitability at the detailed design stage.

1.2 Project description

This Project description provides the context for this assessment. Sections 5 and 6 of the Assessment of Environment Effects (Volume 2) further describe the construction and operational aspects of the Project and should be relied upon as a full description of the Project.

The Project realigns the existing SH1 between the Northern Gateway Toll Road (NGTR) at the Johnstone's Hill tunnels and just north of Warkworth. The alignment will bypass Warkworth on the western side and tie into the existing SH1 north of Warkworth. It will be a total of 18.5km in length. The upgrade will be a new four-lane dual carriageway road, designed and constructed to motorway standards and the NZTA RoNS standards.

1.3 Project features

Subject to further refinements at the detailed design stage, key features of the Project are:

- A four-lane dual carriageway (two lanes in each direction with a median and barrier dividing oncoming lanes);
- A connection with the existing NGTR at the Project's southern extent;
- A half diamond interchange providing a northbound off-ramp at Pūhoi Road and a southbound on-ramp from existing SH1 just south of Pūhoi;
- A western bypass of Warkworth;
- A roundabout at the Project's northern extent, just south of Kaipara Flats Road to tie-in to the existing SH1 north of Warkworth and provide connections north to Wellsford and Whangarei;
- Construction of seven large viaducts, five bridges (largely underpasses or overpasses and one flood bridge), and 40 culverts in two drainage catchments: the Pūhoi River catchment and the Mahurangi River catchment; and
- A predicted volume of earthworks being approximately 8Mm^3 cut and 6.2Mm^3 fill within a proposed designation area of approximately 189ha earthworks.

The existing single northbound lane from Waiwera Viaduct and through the tunnel at Johnstone's Hill will be remarked to be two lanes. This design fully realises the design potential of the Johnstone's Hill tunnels.

The current southbound tie-in from the existing SH1 to the Hibiscus Coast Highway will be remarked to provide two way traffic (northbound and southbound), maintaining an alternative route to the NGTR. The existing northbound tie-in will be closed to public traffic as it will no longer be necessary.

1.4 Interchanges and tie-in points

The Project includes one main interchange and two tie-in points to the existing SH1, namely:

- The Pūhoi Interchange;
- Southern tie-in where the alignment will connect with the existing NGTR; and
- Northern tie-in where the alignment will terminate at a roundabout providing a connection with the existing SH1, just south of Kaipara Flats Road north of Warkworth.

1.5 Route description by Sector

For assessment and communication purposes, the Project has been split into six sectors, as shown in Figure 1. Section 5.3 of the AEE describes these sectors.

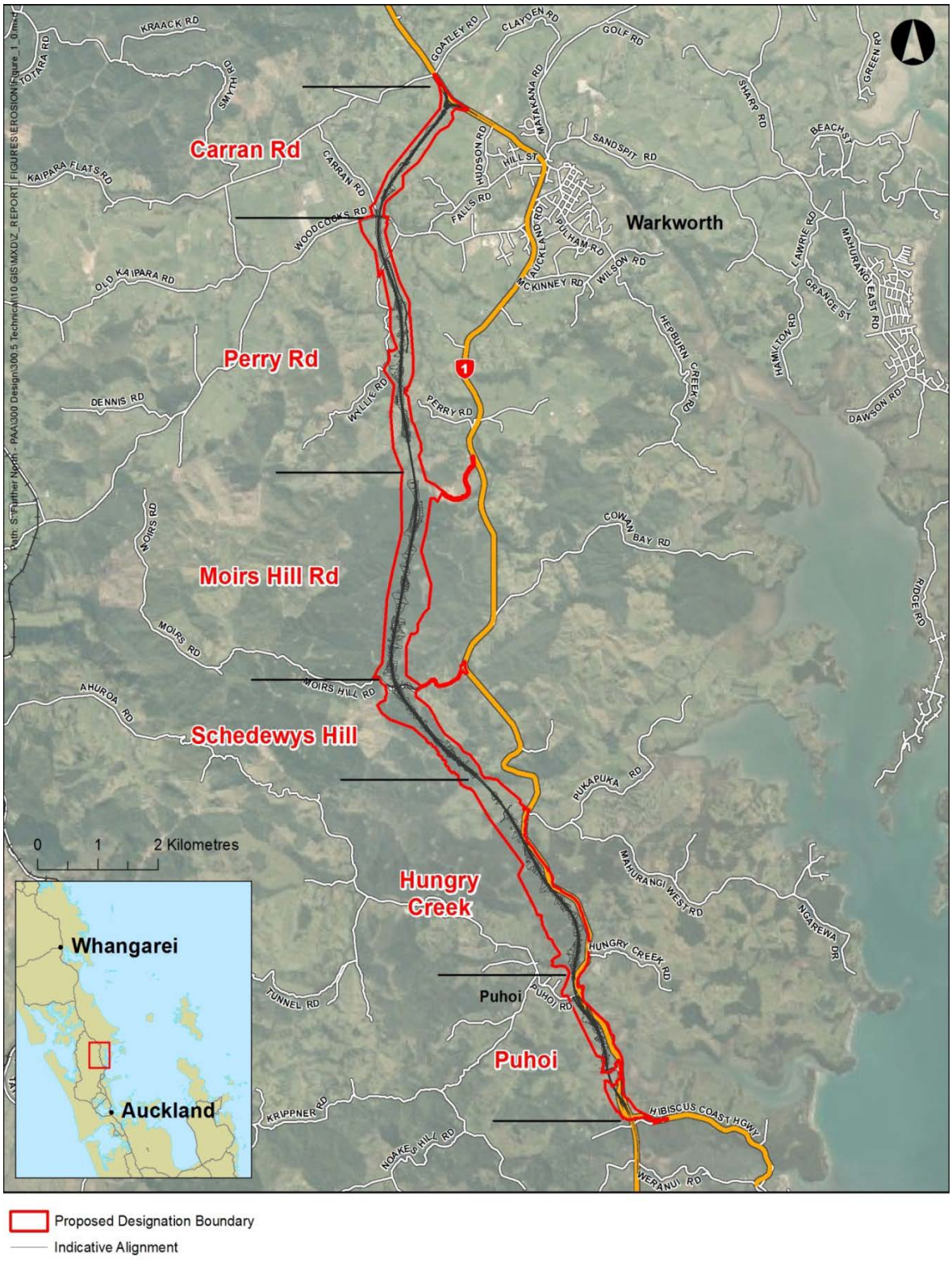


Figure 1: Project sectors

2. Existing noise environment

Ambient noise levels adjacent to the Project are generally low, particularly for those areas away from the existing SH1. The Operational Noise Report describes the surveys undertaken and shows in more detail the existing ambient noise levels in the area.

Noise levels ranged from 40 dB L_{Aeq} in rural areas to 73 dB L_{Aeq} adjacent to SH1.

The ambient noise environment in the vicinity of the Project is relatively low due to the absence of major local roads and industry. Exceptions are the northern and southern connections of the Project with the existing SH1, where traffic on SH1 affects ambient noise levels at Pūhoi and Warkworth.

Measurements of ambient (or total) sound show a range of noise levels from 40 dB to 73 dB L_{Aeq}. Noise levels at the lower end represent positions away from the existing roading network and at the higher end represent positions close to the existing SH1.

We have measured ambient noise levels at various dwellings adjacent to the indicative alignment. The full survey results are contained in the Operational Noise Assessment Report. Results from the long duration surveys are shown in Table 1 below.

Table 1: Measured ambient average ($L_{Aeq(24h)}$) noise levels

Survey position	Measured average noise level dB $L_{Aeq(24h)}$
8 Pūhoi Close	51
815 SH1	52
87 Perry Road	49
4 Wyllie Road	51

The existing ambient noise levels for most of the alignment are dominated by natural environmental sounds and not by road traffic noise.

3. Noise performance criteria

New Zealand Standard NZS 6803:1999 "Acoustics – Construction Noise" (NZS 6803:1999 or the Standard) is the most commonly used and, in our opinion, the most appropriate Standard on which to base an assessment of construction noise effects. We have reviewed relevant documentation, including the Standard, the District Plan and Regional Coastal Plan provisions. Both the District and Regional Plans reference a version of the Standard.

We consider application of NZS 6803:1999 will achieve equitable treatment of all affected parties and reasonable noise levels from Project construction activities. The Standard sets appropriate noise criteria that should be complied with if practicable. Where full compliance with the criteria is not practicable, then alternative measures should be employed to deal with the potential exceedance.

Based on the Standard, we have recommended appropriate criteria for general construction noise and noise from blasting.

We have reviewed the following relevant standards and plans in relation to this construction noise assessment:

- New Zealand Construction Noise Standard NZS 6803:1999;
- NZTA Environmental Plan (June 2008) – references NZS 6803:1999;
- Auckland Council District Plan (Rodney Section) 2011 – references NZS 6803:1999;
- Auckland Regional Plan: Coastal – references NZS 6803P:1984; and
- Resource Management Act 1991 – requires that unreasonable noise be avoided and that the best practicable option (BPO) be implemented to avoid, remedy or mitigate noise.

Based on this review, we recommend that NZS 6803:1999 be used for the assessment of construction noise from this Project.

The NZS 6803:1999 contains recommended noise criteria that are specifically intended for the control of noise from construction activities.

This Standard is the most up-to-date New Zealand Standard, which integrates with the newest versions of associated Standards such as NZS 6801:2008[1] and NZS 6802:2008[2], and includes technical refinements such as the use of the $L_{Aeq(T)}$ parameter. The NZS 6803:1999 Standard is widely acknowledged by regional authorities, the Environment Court and the acoustic profession in New Zealand as being the appropriate standard for construction noise control.

We recommend that NZS 6803:1999 be used for all parts of this Project, including those within the Coastal Marine Area (CMA). We also recommend that a condition setting out the relevant criteria (refer Sections 3.1 and 3.2 below) be included in the designation.

[1] NZS6801:2008 Acoustics – Measurement of Environmental Sound.

[2] NZS6802:2008 Acoustics – Environmental Noise.

3.1 Construction noise criteria

The recommended noise criteria of NZS 6803:1999 are summarised in Table 2 and Table 3 below.

As most aspects of the Project construction will exceed 20 weeks' duration, we consider that the "long-term duration" criteria are most appropriate for this Project, in accordance with Section 7.2.1 of NZS 6803:1999. The long-term criteria are five decibels more stringent during day-time than the criteria for "typical duration" (up to 20 weeks' duration). While construction in some areas may take less than 20 weeks, we recommend applying the same criteria to the entirety of the Project. Retaining the same noise criteria for the entire Project will avoid confusion as to where each noise criterion will apply, and will be more practicably managed and measured as equipment passes from one area of the works to another.

Shading in the following Table 2 shows the low noise times in accordance with NZS 6803:1999 nomenclature.

The criteria apply at a distance of 1m from the closest occupied building façades, or, where external measurement is not appropriate, inside the building with doors and windows closed. In that instance, the noise criteria are reduced by 20 decibels.[3] Noise levels (L_{Aeq}) are time-based. All criteria and levels quoted in this report are referenced to (T), with T being a representative assessment duration between 10 and 60 minutes.

Table 2: Recommended upper limits for construction noise received in residential zones and dwellings in rural areas[4]

Time of week	Time period	Duration of work	
		Long-term duration	
		dB $L_{Aeq(T)}$	dB L_{Amax}
Weekdays	0630-0730	55	75
	0730-1800	70	85
	1800-2000	65	80
	2000-0630	45	75
Saturdays	0630-0730	45	75
	0730-1800	70	85
	1800-2000	45	75
	2000-0630	45	75

[3] NZS 6803:1999 Acoustics – Construction Noise, Section 7.2.7.

[4] NZS 6803:1999 Acoustics – Construction Noise, Section 7.2.3 Table 2.

Time of week	Time period	Duration of work	
Sundays and public holidays	0630-0730	45	75
	0730-1800	55	85
	1800-2000	45	75
	2000-0630	45	75

Table 3: Recommended upper limits for construction noise received in industrial or commercial areas for all days of the year[5]

Time period	Duration of work
All days of the year	Long-term duration
	$L_{Aeq(T)}$
0730-1800	70
1800-0730	75

For residential areas and rural dwellings, the Standard allows higher noise criteria for construction activities during day-time hours. For Sundays and public holidays, lower noise criteria are set to provide days of rest from construction noise. Similarly, night-time criteria are low and only allow very quiet operations to be carried out. We consider that these criteria are reasonable, given the long duration of individual construction elements as part of the construction programme.

For commercial and industrial areas, the Standard sets out less stringent noise criteria during night-time when it is less likely that persons or business activities would be affected by construction noise. In addition, criteria for day-time and night-time are consistently high, seven days per week, as businesses are generally less noise sensitive than residences.

The Standard does not anticipate that full compliance with the construction noise criteria of Table 2 and Table 3 will necessarily be achieved at all times and at all receivers. It focuses on the implementation of the BPO for construction noise management and mitigation rather than requiring that the criteria must be achieved. Management options and the BPO are further discussed in Section 4.2.6 below.

3.2 Blasting noise

Noise from explosives is normally described as “airblast” or blasting noise. Blasting noise is the pressure wave that radiates out from the blasting area.

[5] NZS 6803:1999 Acoustics – Construction Noise, Section 7.2.4 Table 3.

Blasting noise is caused by ground vibration, air movement around the rock face being blasted and air pressure venting from the holes that are drilled in the face. There is often sub-audible low-frequency noise associated with blasting, which can result in the rattling of structures even when the blast is not clearly audible outdoors.

In relation to blasting, NZS 6803:1999 states:

> *"8.1.4*
>
> *Noise from use of explosives is also a special case. The adoption of good blasting practices will reduce the inherent and associated impulsive noise and vibration. Practices should conform with the provisions of documents such as AS 2187: Part 2, provided that the airblast noise limit shall be a peak sound level of 120 dBC measured at a suitable location as specified in 6.2."*

Section 6.2 of the Standard sets out the measurement locations at buildings, i.e. generally at 1m from the most exposed façade.

Blasting noise can cause annoyance or discomfort at low levels, and potentially damage structures or result in personal injury at very high levels. The NZS 6803 limit of 120 dBC is a human comfort noise limit related to annoyance and therefore a conservative limit at which no building damage will occur.

3.3 Recommendation

We have based our assessment of construction noise from the Project on the methodology and noise criteria of NZS 6803:1999 because in our opinion it is the most appropriate and applicable New Zealand document. The Standard has successfully been used on several large roading projects in New Zealand, for instance, the Victoria Park Tunnel Project and the Newmarket Viaduct Improvement Project, and has been tested and accepted in numerous hearings at all levels (Council to Board of Inquiry).

We recommend that, should the designation be confirmed, the relevant construction noise criteria set out in Sections 3.1 and 3.2 above be included in the conditions.

4. Assessment methodology

We used the following methodology for our assessment of Project construction noise:

- In the early stages of the Project, we provided input into the route selection, which resulted in the indicative alignment avoiding some noise sensitive areas;
- We reviewed the extent of the proposed designation and indicative alignment and identified nearby receivers;
- For each construction task or activity, we determined the equipment likely to be used and its sound levels;
- We determined the most appropriate criteria that should apply to the Project;
- We predicted noise levels from each noise generating construction activity and determined appropriate setback distances from the activity to achieve compliance with the relevant noise performance standards; and
- For each dwelling where there is a risk that the criteria may be exceeded, we recommend mitigation and management measures.

Our assessment methodology also takes account of issues such as:

- The duration and variability of construction activities, e.g. through staging and equipment moving along the alignment;
- Changes in noise level. For construction, the change in noise level is greater than would be acceptable for ongoing operational noise;
- Possible adverse effects, which need to be balanced against development needs; and
- The potential for exceedance of construction noise criteria and what this means in the context of temporary activities.

4.1 Construction methodology

4.1.1 Duration of Project construction

We understand that the construction duration of the entire Project is expected to be approximately 5.5 years (refer AEE, Section 6). This duration will allow for an October to April earthworks season each year.

As the construction will move along the alignment, generally no one location will be affected by construction noise levels for the entirety of the Project. The exceptions are the construction yards which will operate for most of the construction duration.

4.1.2 Staging

As the contractor has not yet been appointed, details on staging are not yet known. However, construction staging for the Project is likely to involve the progressive construction of the alignment, with material from cuts being used at adjacent fill sites. This methodology reduces transport times and distances, and therefore noise generation from heavy vehicles hauling material along the alignment.

4.1.3 Main construction activities

The Project is 18.5km in length and traverses some hilly terrain in its southern and mid-sections, from the Pūhoi Sector to the Moirs Hill Sector. There are only a few dwellings in close proximity to the Project and these are mainly concentrated in and around Pūhoi and in the rural/residential area to the west of Warkworth.

The areas of potential noise criteria exceedance of anticipated construction activities along the indicative alignment are shown in Drawings CN-001 to CN-117. The construction noise effects of the main activities are shown as follows:

- Bulk earthworks (noise effects shown in blue in Drawings CN-001 to CN-117) will be the most significant activity with respect to noise from the Project. It will involve large numbers of earthmoving plant. There will be a significant amount of overburden which will need to be either reused in a fill situation (approximately 75% of the earthworks), or removed and processed (the remaining 25% of the earthworks). Haulage of this overburden will occur along the Project alignment rather than along SH1. For this reason, we consider the haul route as part of the bulk earthworks operation. Bulk earthworks are likely to take around 3.5 to 4 years to complete.
- Rock breaking (noise effects shown in green in Drawings CN-001 to CN-117) is generally a part of the bulk earthworks. However, we have considered it as a separate activity as rock breaking may involve blasting where necessary. Based on Drawings C-001 to C-117, there are few areas where rock breaking and blasting would need to occur. These are at Pūhoi, from Moirs Hill Road north, south of Perry Road and at Wyllie Road south of Woodcocks Road. Blasting generally occurs in the vicinity of rock breaking, and its noise effects are shown in yellow in Drawings CN-001 to CN-117.
- There are seven viaducts along the route (noise effects of their construction shown in turquoise in Drawings CN-001 to CN-117). Depending on the length and complexity of construction, each could take upwards of two years to complete. As part of the viaduct construction, a pre-casting yard will be established where precast concrete bridge segments are produced (noise effects shown in light pink in Drawing CN-115). Since night-time operations are proposed at these yards they will need to be located and laid out appropriately to avoid exceedance of night-time noise criteria.
- Paving and road finishing (noise effects shown purple in Drawings CN-001 to CN-117) will be completed once bulk earthworks are completed. Some of this finishing may require night-time works where the Project ties in with the existing SH1. Pavement construction will occur in the last 12 to 18 months of the Project construction.
- Establishment and operation of approximately 15 construction yards and staging areas (noise effects shown in pink in Drawings CN-001 to CN-117) along the Project alignment will require access off local roads or SH1. While operations in these yards will generally generate less noise than the construction activities, yards are often operated for more sustained periods (e.g. for the duration of construction of the entire Project) and potentially at night. Access to the yards is shown on Drawings C-001 to C-117.

- Establishment of more than 20 spoil locations where the 2M m^3 of spoil will be deposited permanently. These possible spoil locations are shown in grey on Drawings C-001 to C-117. Noise effects from operations within these spoil locations generally involve large earthmoving machinery, and have therefore been included in the blue line depicting noise effects from earthworks on Drawings CN-001 to CN-117.

The following table summarises the key construction noise issues for each of the six Project Sectors.

Table 4: Key construction noise issues[6]

Sector	Noise generating activities	Closest receiver areas
Pūhoi	• Significant earthworks • Rock breaking and blasting • Viaduct construction at Billings Road and Pūhoi Road • Road construction and sealing • Construction staging areas near Okahu Creek Viaduct and Pūhoi River Viaduct • Ramp construction works south of Pūhoi • Spoil areas	Billings Road, Pūhoi Close, Pūhoi Road, SH1
Hungry Creek	• Significant earthworks • Rock breaking and blasting • Viaduct construction at Hikauae and Schedewys Hill • Road construction and sealing • Construction yards and construction staging area new Schedewys Hill Viaduct • Spoil areas	Pūhoi Close, SH1
Schedewys Hill	• Earthworks • Rock breaking and blasting • Moirs Hill Road realignment • Road construction and sealing • Construction yards • Spoil areas	Moirs Hill Road

[6] Refer to Drawings CN-101 to CN-117.

Sector	Noise generating activities	Closest receiver areas
Moirs Hill Road	• Significant earthworks • Rock breaking and blasting • Road construction and sealing • Construction yards • Construction yard access establishment off SH1 • Spoil areas	n/a
Perry Road	• Significant earthworks • Rock breaking and blasting • Viaduct construction at Perry Road • Wyllie Road alternate property access • Road construction and sealing • Construction yards and construction staging areas near Perry Road Viaduct and Mahurangi River Viaduct • Possible precast yard • Spoil areas	Perry Road, Wyllie Road, Woodcocks Road
Carran Road	• Significant earthworks • Viaduct construction at Woodcocks Road • Roundabout construction at Warkworth • Road construction and sealing • Construction yard • Spoil areas	Carran Road, Woodcocks Road, Viv Davie-Martin Drive, SH1

4.2 Construction noise assessment

4.2.1 Methodology

We used the following methodology for our assessment of construction noise emitted by the Project:

- In the early stages of the Project, we provided guidance on the preferred route option to the project team. This guidance involved analysis of several route options, reporting, and attendance at route selection workshops. Acoustic considerations were one factor in determining the preferred route. We consider that the indicative alignment avoids some adverse effects at the outset by increasing the distance between the road and the closest receivers;

- We then reviewed the extent of the proposed designation and indicative alignment and identified nearby receivers**;**
- For the finalised designation area, we reviewed the possible locations for construction yards and precast yard, and their respective access roads. We provided feedback on potential noise issues, which resulted in avoiding some locations due to sensitive receiving environments;
- For each construction task or activity, we determined the equipment likely to be used and its sound power levels. We based our assessment of the noise generated by each item of equipment on our previous measurements we have undertaken for similar equipment and NZS 6803:1999 Annex C;
- We reviewed several relevant construction noise performance standards and determined the most appropriate criteria that should apply to this Project (as discussed in Section 3 above);
- We took noise measurements along the route to help understand the existing noise environment; and
- We predicted noise levels from each noise generating construction activity and determined appropriate setback distances from the activity to achieve compliance with the noise performance standards. Risk areas are shown in Drawings CN-001 to CN-117 where we consider that the noise criteria are likely or very likely to be exceeded.

4.2.2 Construction noise predictions

In order to predict construction noise levels and understand where areas are at risk of receiving noise levels that exceed the recommended criteria, we have assumed what equipment will be used for this Project. We assembled a list of likely equipment, based on our previous experience with other large roading projects throughout New Zealand. (For example, Victoria Park Tunnel, Newmarket Viaduct and Alpurt B2)

Typical noise level predictions consider the sound power levels of each item of equipment, and model the noise propagation characteristics over distance, including the effects of ground and air absorption. The terrain through which the Project traverses varies greatly. Cuts will result in effective shielding, while fills will expose a construction site to the surrounding area. We did not take account of any topographical shielding. Accordingly, we consider our predictions to be conservative.

We calculated all relevant construction scenarios and assumed that multiple items of equipment will operate simultaneously. This approach is deliberately conservative in order to represent the reasonable worst-case noise levels that may infrequently occur.

In addition to these definable variations in noise level, there are numerous additional factors that affect construction noise generation. Some of these factors are variations among individual items of equipment, the state of equipment repair, exact locations of each item and operator idiosyncrasies. Generally, these factors cannot be accounted for as they cannot be reasonably quantified.

It should be kept in mind that the predicted noise levels and compliance distances are applicable to a worst case scenario which would generally not be present.

4.2.3 Duration of activities

The total construction period of this Project is approximately 5.5 years. Earthworks would occur for approximately four years and individual viaducts may take up to three years to complete.

It is important to bear in mind that these durations relate to the entire activity. For instance, the Pūhoi viaduct construction in the Pūhoi Sector will take approximately 2.5 years. This overall duration does not, however, mean that associated works would occur for the entire time, and affect all of the closest receivers throughout these 2.5 years.

Instead, certain activities will occur over limited times (e.g. the piling of bridge abutments would take approximately one month) and at varying distances from dwellings. Therefore, each dwelling will receive varying noise levels throughout the construction of the viaduct.

The effect of varying noise levels is even more pronounced for straight road sections where equipment will move along the alignment and therefore will be in close proximity to individual dwellings for short times only, e.g. for half a day, before moving on.

4.2.4 Change in noise level

In terms of the RMA, noise effects can be described in relation to the potential noise level change that will be experienced by a person. Using the noise level change as the basis of an effects assessment is especially appropriate for ongoing noise such as traffic or industrial activities.

Construction is inherently noisy and generally results in a large noise level increase over existing levels, but for limited periods. This increase in noise level occurs particularly for existing low noise environments, where construction would introduce not only a new noise source, but may be the dominant noise source for the duration of construction.

The ambient noise levels in the Project area are generally low. Therefore, even when achieving compliance with the recommended day-time construction noise criteria if NZS 6803:1999, there will be a significant increase in overall noise level during the construction phase. This increase is an expected and inevitable result of large construction projects in the vicinity of receivers, and is anticipated by the Standard.

NZS 6803:1999 provides for construction noise criteria that are higher than criteria for ongoing operational noise levels, because it is commonly accepted that for any construction to occur, noise criteria must be less stringent, with the understanding that construction is a temporary activity with a finite duration. The Standard states in the Foreword:

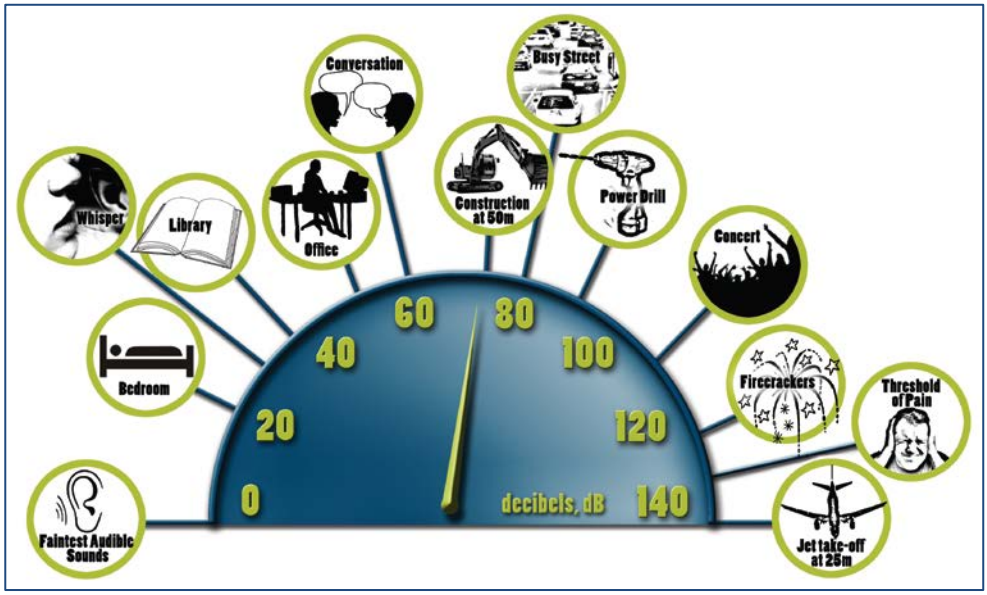
> *"The generally acceptable level of intrusive noise in the community is assessed under the provisions of NZS6802:1999. However, construction noise is outside the scope of NZS6802:1999 because it usually cannot be kept within the specified limits. Although this may mean that the noise is undesirable, it is not necessarily unreasonable when all the relevant factors are taken into consideration. Construction noise is an inherent part of the progress of society. "*

Our construction noise level predictions are conservative and are based on reasonable assumptions as to the construction methodology and equipment to be used. The predicted noise levels and compliance distances are our best estimates based on experience of other large infrastructure projects. However, construction methodologies may change prior to, and even throughout, construction. This uncertainty reinforces the need for flexible management approach that includes appropriate checks and balances.

4.2.5 Potential adverse effects

Due to the finite duration of construction, the variability in construction noise and the need to undertake construction in general, construction noise criteria are set considerably higher than noise limits for ongoing activities. Therefore, even when compliance with the day-time construction noise criterion of 70 dB L_{Aeq} is achieved, resulting noise levels may still be above those desirable for noise sensitive activities, e.g. conversations or watching TV. (Generally, external noise levels above 65 dB L_{Aeq} can cause annoyance and disruption to noise sensitive activities.)

To illustrate where construction noise levels fit within a scale of activities, the following Figure 2 shows approximate noise levels that can be related to everyday activities:



(Source: http://acoustics.nzta.govt.nz/basics/acoustics-principles)

Figure 2: Typical noise levels for various activities

We, and the wider acoustic community, consider that the construction noise criteria of NZS 6803:1999 represent a balance of allowing construction activities to be progressed without undue restriction while ensuring that people's health is not adversely affected.

4.2.6 Exceedance of criteria

At times during construction of the Project, construction activities will occur in close proximity to noise sensitive receivers. Therefore, in some instances, there is the potential for noise levels to exceed the recommended construction noise criteria. For most large scale construction projects, minor exceedances of the construction noise criteria for brief periods of time are common.

The Standard anticipates that at times construction noise cannot be made to comply with the recommended criteria. Statements such as *"construction noise from any site should not generally exceed the numerical noise limits"* [7] suggest that intermittent exceedances are not unreasonable, as long as the BPO has been applied to the management and mitigation of that construction noise. We concur with the Standard's intention that not every exceedance of the criteria is unreasonable, provided these exceedances are temporary and of limited duration, and practicable mitigation measures have been implemented.

Whether the duration of a construction activity, which exceeds the criteria, can be considered reasonable depends on site specific circumstances and may vary from site to site and activity to activity. For instance, where day-time noise criteria are exceeded for several days, but neighbouring residents are not at home, no one would be affected and therefore mitigation may not be required beyond communication with the residents.

In the event that night-time works occur for one or two nights, this may be acceptable provided that residents have been informed and a clear time frame has been provided. However, if night-time works are expected to be ongoing for several consecutive nights, and at a noise level that affects residents' ability to sleep, then we recommend that alternative strategies should be implemented, such as offering temporary relocation for those affected residents.

[7] NZS 6803:1999 Acoustics – Construction Noise, Section 7.1.2.

5. Management and mitigation

Construction activity is inherently noisy. Nevertheless, the RMA and NZS 6803:1999 require that noise levels are managed and mitigated so as not to exceed a reasonable level. The focus of a construction noise assessment is on managing the noise levels and resulting effects, rather than meeting a specific criterion.

We consider such management and mitigation measures are best formulated through the Outline Plan of Works (OPW) process, at a time when a contractor has been appointed. We consider a Construction Noise and Vibration Management Plan (CNVMP) that provides details on a methodology for pro-actively avoiding, or responding in a timely manner to, any noise issues would be a useful tool. The framework of the CNVMP would enable the construction team to take ownership of the noise issues that may arise.

The NZTA has developed a "State highway construction and maintenance noise and vibration guide", which contains information on the content of CNVMPs and management and mitigation measures. This guide is a useful tool when preparing a CNVMP and developing appropriate measures prior to and during construction.

For this Project, there is a low number of dwellings where the day-time construction noise criteria may be exceeded. As a result, the contractor can manage effects on these dwellings specifically.

Our recommended approach to construction noise management and mitigation involves both on and off-site measures, all of which should be implemented throughout the entire construction phase as best practice. Examples of on-site measures include training of personnel, maintenance of equipment, noise barriers and enclosures and considerate behaviour and use of equipment. Examples of off-site measures include public liaison and communication, temporary barriers, offers of resident relocation and noise level monitoring.

The NZTA will prepare an OPW for the Project as required by the RMA. At the OPW stage, detailed information will be available regarding equipment, durations and staging of the construction works.

We recommend that the requirement for a CNVMP (through the OPW process) and its framework be contained in the designation conditions.

5.1 Management of construction noise

Construction is inherently noisy and therefore potentially disruptive. However, we have found repeatedly that construction noise is generally accepted by the community as inevitable for the development of society, so long as any potential issues, e.g. noisy night-time works or noisy activities close to dwellings, are well communicated in advance to potentially affected residents. Therefore, we consider that the recommended construction noise criteria of NZS 6803:1999 we have adopted for this Project, while permissive, are nevertheless an acceptable compromise between amenity and progress.

The focus of a construction noise assessment is on managing the noise levels and resulting effects, rather than meeting a specific criterion. For instance, for potential exceedances of long duration or

great magnitude, measures should be implemented to manage or mitigate noise generation as far as practicable. Where exceedances are still likely, alternative mitigation measures should be implemented in order to achieve acceptable outcomes for all parties affected. Mitigation and management measures (which may include the offer of temporary relocation of residents), would be determined on a case-by-case basis throughout the construction process when construction equipment, methodologies and timing have been ascertained.

Such management and mitigation measures will best be formulated through the OPW process, at a time when a contractor has been appointed. We consider a CNVMP that provides detail as to the methodology for proactively avoiding, or responding to, any noise issues would be a useful management tool (refer Section 5.2).

The NZTA has issued a "State highway construction and maintenance noise and vibration guide (August 2013)" (Guide), which contains useful information on construction noise management and mitigation measures, including processes, tools and templates that may be used by the contractor. We recommend that the contractor refer to the Guide when developing the Project CNVMP and its associated mechanisms, e.g. communication with residents and response to complaints.

For this Project, there is a low number of dwellings where the day-time construction noise criteria may be exceeded. This means that the contractor can more easily manage effects on these dwellings specifically. These dwellings are identified in Table 6 in Section 6.2 below.

We consider that at the present time there is not enough detail available to formulate specific mitigation measures for individual receiver positions. Such detail will only be available from the construction contractor. Therefore, we recommend deferring specific mitigation design to the OPW stage in order to be most effective and practicable.

We recommend that the general noise mitigation measures set out in Sections 5.1.1 and 5.1.2 be implemented throughout the construction of the Project as a matter of good practice. We consider them to be the baseline mitigation for most circumstances. The Guide contains further explanation on most of these measures, and should assist the contractor to determine the BPO mitigation and management prior to, and throughout, construction.

5.1.1 On-site management and mitigation

On-site mitigation and management involves any measures that are used on-site, which may include equipment, personnel and specific mitigation measures, as set out below.

We recommend that these measures be implemented throughout construction, where necessary to avoid effects of people in the vicinity.

- **Training of personnel** with regard to quiet and considerate operating procedures;
- **Maintenance of equipment** to ensure noise levels remain as low as practicable;
- **Considerate behaviour and use of equipment** to ensure unnecessary noise is avoided, e.g. avoid using the truck horn to indicate when a truck is fully laden, avoid shouting or leaving radios on;

- **Low noise plant** should be selected wherever practical. Noisy plant shall have noise mitigation measures (such as silencers or enclosures) fitted;
- **Night time operation** should generally only occur when the night-time noise criteria can be complied with, unless night-time operation is critical to the Project. If night-time operation is required, all practicable noise mitigation measures will need to be implemented;
- **Temporary noise barriers** should be considered where necessary. These should be erected prior to commencement of construction activity that is predicted to cause the exceedance;
- **Enclosures** of noisy stationary equipment should be implemented if necessary and where practicable;
- **Tonal reversing alarms** should be deactivated or replaced with a suitable alternative such as a visual or broadband alarm if required for night-time works;
- **Blasting** should only occur where necessary, at specified times (e.g. between 10am and 4pm) and after appropriate warning is given to affected receivers. We recommend that the restriction of blasting to daytime only should be set out in a condition; and
- **Noise level monitoring of specific equipment** in order to enable predictions of future construction noise levels.

5.1.2 Off-site management and mitigation

Off-site management involves liaison with the community and the use of any measures placed outside the designation boundaries. For instance, at times, temporary construction noise barriers may be erected along a private property boundary outside the designation. Examples are given below.

We recommend that these measures be implemented throughout the entire construction period where appropriate and practicable.

- **Public liaison and communication:** we consider this to be the most important management measure, at all times, irrespective of compliance. Communication is needed to ensure potentially affected people are reasonably informed. Proactive communication and information is needed, letting people know what, where and how long they can expect construction noise to last in their area. A contractor environmental manager or appointed representative should be available for residents to contact at all times when construction is being carried out. Guidance contained in http://acoustics.nzta.govt.nz/management/communications and Section 5.2 of the Guide should be referred to where relevant;
- **Temporary noise barriers** should be used where they are required, would achieve effective mitigation for specific dwellings and where agreement can be reached with the resident;
- **Temporary resident relocation** should be considered to be offered where all other practicable noise mitigation measures have been implemented and noise levels are still predicted to exceed the Project construction noise limits. Such a measure should be considered generally as a last resort; and
- **Noise level monitoring at potentially affected dwellings** should occur during critical phases of construction. This monitoring ensures that the contractor is aware of and informed

about the noise levels generated at those times. It also enables pro-active mitigation to be used for future instances of similar activities.

5.2 Outline plan of works

The NZTA will prepare an OPW for the Project, as required by the RMA. At the OPW stage, detailed information will be available regarding equipment, durations and staging of the works.

We recommend that through the OPW, a CNVMP be prepared which would contain detailed information on construction noise management and mitigation. CNVMPs are commonly used for large construction projects where details are not all fully known at the outset of construction and where flexibility is required to respond to construction issues as they occur. The framework of the CNVMP enables the construction team to take ownership of the noise issues they may encounter.

We recommend that the requirement for a CNVMP be contained in the designation conditions. Such condition should also set out a framework of content of the CNVMP, which, at a minimum, should include the following (based on NZS 6803:1999[8]):

- The construction noise criteria for the Project;
- Description of the work, anticipated equipment/processes and their scheduled durations;
- Machinery and equipment to be used;
- Hours of operation, including times and days of the week when construction activities causing noise would occur;
- Identification of affected houses and other areas where construction noise management and mitigation would be required;
- Management and mitigation measures that would be employed to achieve compliance with the Project noise criteria;
- Methods for communicating and consulting with affected residents;
- Methodology of dealing with specific circumstances where full compliance with the Project noise criteria cannot be achieved, to ensure acceptable outcomes;
- Methods for engaging with affected parties and responding to complaints appropriately; and
- Methods for monitoring and reporting on construction noise, including for those circumstances where full compliance cannot be achieved, or in response to complaints.

The Guide, in Section 5.10, contains recommended content for the CNVMP, which is based on the requirements of NZS 6803:1999. The NZTA has provided templates for CNVMPs on their website: http://acoustics.nzta.govt.nz/tools/templates. The contractor may refer to these tools when preparing the CNVMP.

[8] NZS 6803:1999 "Acoustics – Construction Noise", Section 8 and Annex E.

6. Assessment of construction noise effects

Our assessment of construction noise effects involved the following steps:

- We determined those dwellings closest to the construction works;
- Based on the noise levels for each activity, we calculated the distances at which there is a low, medium and high risk of exceeding the relevant criteria;
- For each activity, we determined the dwellings that may be at risk of receiving noise levels exceeding the day-time noise criteria;
- For each Sector, we specifically reviewed the construction activities and affected dwellings, and recommended potential mitigation options. We note where these mitigation options should result in compliance with the criteria; and
- We have assessed the mitigated construction noise levels against compliance with the relevant criteria.

In general, Project construction activities can be undertaken in compliance with the day-time construction noise criteria without the need to implement mitigation measures beyond best practice general mitigation. Where night-time construction is required (for instance for the construction yards and tie-in with the existing SH1), we predict mitigation, such as solid site hoardings, enclosure or similar common mitigation will generally achieve compliance with the relevant criteria.

Blasting may be undertaken at several sites along the alignment. While generally blasting can be undertaken in compliance with the relevant noise limit, there are two dwellings where the noise limit may be exceeded with the use of blast charges of 12 kg or more. For these dwellings, if blasting is required, we recommend using a reduced blast charge to achieve lower noise levels. As general best practice, we recommend a regime of notification of residents and warning sirens prior to blasts.

In addition to construction activities along the alignment, we reviewed the anticipated construction traffic, including potential new access ways to the staging areas and construction yards. We have predicted construction traffic noise levels and assessed potential noise effects.

Generally, trucks will use existing local roads such as SH1 and Woodcocks Road to reach the construction yard access roads. Those local roads carry comparatively large traffic volumes, including trucks, each day, which means that construction trucks will be of the same character and at a lower level than existing traffic noise. Therefore, we consider noise effects from construction traffic will be negligible to minor.

6.1 Noise level predictions

6.1.1 Required construction equipment

In order to predict construction noise levels and understand where areas of the Project are at risk of exceeding the noise criteria, we need to assume what equipment will be used for construction of the Project. From experience with previous large roading projects throughout New Zealand, we have assembled a list of equipment that is likely to be used for this Project. **Appendix A** contains this list of equipment and its respective sound power levels.

It is important to keep in mind that this list is indicative only and is essentially the "best estimate" of equipment that could be used. Although the contractor may use different plant from what is on this list, we know from experience on other infrastructure construction projects that noise emissions will be similar for each activity.

6.1.2 Combined activity noise levels at distance

From the table in Appendix A, we calculated an "activity sound power level" (refer Table 5 below). The activity sound power level is a hypothetical level, assuming that all equipment required for an activity is operating simultaneously at a location. We have calculated these activity sound power levels based on the number of plant items, the expected operation time of each and the sound power level for the individual item.

From the activity sound power levels, we then determined the distance at which the 70 dB L_{Aeq} day-time noise criterion can be complied with, without mitigation by noise barriers.

Table 5: Activity sound power levels and compliance distance

Activity	Activity Sound Power Level (dB $L_{Aw,eq}$)	Distance beyond which compliance with day-time limit (70 dB L_{Aeq}) is achieved without noise barriers (metres)
Bulk earthworks/ground improvement/ retainment pond excavation/haul road/ spoil disposal	118	65
Rock breaking/crushing	120	75
Structures piling/foundations	110	30
Viaduct construction	110	30
Pavement construction	110	30
Precast yard	115	50
Staging area/construction yard	100	10
Blasting	12 kg charge weight assumed[9]	160

We used the activity sound power levels and compliance distance results to assess compliance with the noise criteria at receiver locations and determine which areas might require management or mitigation of construction noise (refer Section 6.2 below).

[9] Should different charge weights be used, then the distance beyond which compliance is achieved would change. However, because there is only a limited number of dwellings in proximity of anticipated blasting activity, changing the charge weight may have no effects on sensitive receivers.

6.2 Construction noise risk assessment

6.2.1 Daytime construction

For each of the activities noted above, the noise levels at receiver locations will vary depending on distance, shielding from structures, embankments and topography, mitigation measures, and construction management.

Based on the activity sound power levels in Table 5 above, we have developed a risk profile indicating the distances at which there is some risk (i.e. low, medium or high) of exceeding the Project day-time noise criteria, and the dwelling property numbers that are likely to be affected.

Risk is categorised as follows:

- High (H) – Receiver locations where noise levels are likely to exceed the Project limits frequently, without mitigation, when construction is being carried out in the vicinity. Noise levels are predicted to be above the noise criteria when activities are carried out without mitigation.
- Medium (M) – Receiver locations where noise levels will be at the Project limits, and where intermittent exceedance of the limit is likely, without mitigation. Noise levels are predicted to be at or up to 3 decibels below the noise criteria when activities are carried out without mitigation.
- Low (L) – Receiver locations where exceedance of the limits is unlikely even without mitigation. These receivers are not reported individually. Noise levels are predicted to be more than 3 decibels below the noise criteria when activities are carried out without mitigation.

These risk levels are indicative only. They are intended to inform the contractor of 'hot-spots', and to facilitate the community liaison process.

We anticipate that, as part of the CNVMP, Construction Noise Management Schedules would be prepared by the Contractor or its representative through the OPW process. These schedules would identify specific dwellings and the associated risk level and be the basis of construction noise management and mitigation decisions.

Any dwellings inside the designation will be uninhabited during construction. We have therefore excluded these from our assessment. As the alignment may move within the designation, we have conservatively included all dwellings in Table 6 that may be affected by the alignment moving a likely distance towards the designation boundary.

Table 6: Risk of exceeding day-time noise criteria (70 dB L_{Aeq})

Activity	Activity sound power level	Risk distances	Sector	Potential addresses (depending on alignment within designation)
Bulk earthworks/ground improvement/ retainment pond excavation/haul road/spoil disposal	118	High: <65m Medium: 65 – 90m Low: >90m	Pūhoi	**M:** 24, 26 Billings Road, 466 SH1
			Schedewys Hill	**M:** 187 Moirs Hill Road
			Perry Road	**M:** 70, 75, 161, 217, 221 Wyllie Road
			Carran Road	**M:** 63, 102, 104 SH1
Rock breaking	120	High: <75m Medium: 75 – 110m Low: >110m	N/A	**L:** No receivers within 110m of breaking
Piling/foundations	110	High: <30m Medium: 30 – 40m Low: >40m	N/A	**L:** No receivers within 40m of works
Viaduct construction	110	High: <30m Medium: 30 – 40m Low: >40m	N/A	**L:** No receivers within 40m of works
Pavement construction	110	High: <30m Medium: 30 – 40m Low: >40m	N/A	**L:** No receivers within 40m of works
Staging area/ construction yard	100	High: <10m Medium: 10 – 30m Low: >30m	N/A	**L:** No receivers within 30m of sites
Pre-cast yard	112	High: <50m Medium: 50 – 70m Low: >70m	N/A	**L:** No receivers within 50m of works
Blasting	12kg charge weight assumed	High: <160m Medium: 160 – 200m	Hungry Creek	**H:** 20 Pūhoi Close **M:** 446 SH1; 5, 6 Hungry Creek Road

Activity	Activity sound power level	Risk distances	Sector	Potential addresses (depending on alignment within designation)
		Low: >200m	Schedewys Hill	**M:** 187 Moirs Hill Road
			Perry Road	**M:** 83, 97 Perry Road, 221 Wyllie Road

The majority of dwellings along the alignment are located at distances of greater than 100m from the proposed designation. There are therefore very few locations where the risk of exceeding the day-time construction noise limits is high, regardless of the construction activity in question.

Rock breaking is not expected to be required in areas that are closer than 110m from dwellings, and hence there is only a low risk of these activities exceeding the day-time noise limits. Overall, for the scale of the construction works needed for the Project, we consider that the overall risk of exceeding day-time noise criteria is low, even without noise barriers in place.

Blasting may need to be undertaken at several separate areas along the alignment (refer to Drawings C-001 to C-117). Based on an assumed charge weight of 12kg the distance at which the relevant noise limit of 120 dBC can be met is 160m. There is one dwelling that may be within the 160m distance (20 Pūhoi Close) where we predict that the blasting noise limit may be exceeded with a 12kg charge weight. This dwelling is discussed in detail in Section 6.4 below.

The construction noise effects set out in Table 6 are summarised as risk contours in Drawings CN-001 to CN-117.

Based on the results in Table 6 above, we then assess the dwellings of each Sector separately in Sections 6.3 to 6.8 below. The assessment below is based on a conservative alignment within the proposed designation, i.e. close to the designation boundary and neighbouring buildings. For the finalised alignment within the designation, the predicted noise levels may be lower than those set out in the tables below as the alignment may be further away from some buildings. Nevertheless, the recommended mitigation measures are unlikely to change and can be seen as representative of what would be expected during construction, irrespecitve of the alignment chosen.

6.2.2 Night time construction

Generally, Project construction activities will occur during day-time only, particularly in areas where receivers are located. However, some operations may be undertaken during night-time.

Preparatory work may be undertaken in the construction yards and staging areas at night. As these areas do not contain particularly noisy operations, the night-time construction noise criteria can be complied with (without mitigation) at dwellings that are 140m or more from the relevant yard. If yards are closer than 140m from a dwelling (e.g. in Billings Road and some dwellings at SH1), mitigation may involve solid site hoardings and placement of activities in the yard as far as possible from dwellings.

Construction of the tie-in with the existing SH1 at the southern and northern ends of the Project may also require night-time works so as to avoid disruption to traffic on SH1. Such works will be communicated with the potentially affected residents in the vicinity and mitigation implemented as required and practicable.

6.3 Pūhoi Sector

The main construction activities in the Pūhoi Sector include significant earthworks, the construction of viaducts at Billings and Pūhoi Roads, ramp construction works south of Pūhoi, construction staging areas at the Okahu Creek and Pūhoi River Viaducts, rock breaking and blasting, a project office and road construction and sealing. In addition, some road widening will be undertaken on SH17 in the vicinity of Fowler Access Road.

The following table summarises our noise level predictions for relevant activities, dwellings potentially affected and the recommended mitigation to generally achieve compliance with the day-time noise limits (70dB L_{Aeq}).

Table 7: Pūhoi Sector construction noise summary

Activity	Potentially Most Affected Dwellings	Predicted worst case noise level dB L_{Aeq}	Potential mitigation options	Daytime compliance with mitigation
Bulk earthworks/ground improvement/retainment pond excavation/haul road	24 and 26 Billings Road 466 SH1	70 70	Communication, considerate use of equipment	Yes
Viaduct construction: Billings Road	24, 26 Billings Road	61	n/a	Yes
Viaduct construction: Pūhoi Road	12, 16, 20 Pūhoi Close	55	n/a	Yes
Blasting	466 SH1, 20 Pūhoi Close 430 SH1	120 dBC <120 dBC	Communication of blast schedule, Pre-warning siren 15 and 5 min prior to blasts	Yes
Road construction/sealing	466 SH1	61	n/a	Yes
Ramp construction	466 SH1	61	n/a	Yes
Construction staging area Okahu Creek Viaduct	24 and 26 Billings Road	50	Solid site hoardings to achieve compliance with night-time criteria, layout to allow for noisy activities to be away from dwellings	Yes

Activity	Potentially Most Affected Dwellings	Predicted worst case noise level dB L_{Aeq}	Potential mitigation options	Daytime compliance with mitigation
Construction staging area Pūhoi River Viaduct	466 SH1	49	n/a	Yes
Construction yard 2	466 SH1	41	n/a	Yes
Project office site	12, 16, 20 Pūhoi Close	50	n/a	Yes
SH17 widening	5, 20 Fowler Access Road	66	n/a	Yes
Spoil disposal area 2	430 SH1	56	n/a	Yes

We predict that construction in this Sector can be undertaken in compliance with the day-time construction noise criteria. Nevertheless, should activities or locations other than those assessed be included in the detailed design, construction noise levels should be assessed through the OPW process and appropriate management and mitigation recommended.

6.4 Hungry Creek Sector

The main construction activities in the Hungry Creek Sector include significant earthworks, potential rock breaking and blasting, the construction of viaducts at Hikauae and Schedewys Hill and road construction and sealing.

The following table summarises our noise level predictions for relevant activities, potentially affected dwellings and the potential for mitigation to achieve compliance with the day-time noise limits. Schedewys Hill Viaduct is excluded from the table as there are no dwellings in the vicinity (the closest dwelling is more than 300m away), and therefore its construction will not cause any adverse noise effects.

Table 8: Hungry Creek Sector construction noise summary

Activity	Most Affected Dwellings	Predicted worst case noise level dB L_{Aeq}	Potential mitigation options	Daytime compliance with mitigation
Bulk Earthworks/ground improvement/retainment pond excavation/haul road	20 Pūhoi Close	59	No	Yes
Viaduct construction: Hikauae	841 SH1	52	n/a	Yes
Road construction/sealing	813 SH1	66	n/a	Yes

Activity	Most Affected Dwellings	Predicted worst case noise level dB L_{Aeq}	Potential mitigation options	Daytime compliance with mitigation
Rock breaking	5, 6 Hungry Creek Road 20 Pūhoi Close	63 63	n/a	Yes
Blasting	5 Hungry Creek Road 6 Hungry Creek Road 20 Pūhoi Close	<115 dBC 120 dBC >120 dBC	Reduction of charge weight to 7 kg or less Communication of blast schedule, Pre-warning siren 15 and 5 min prior to blasts Offer of temporary relocation of residents in high risk dwellings	Yes (with reduction of charge weight) No (if charge weight is 12 kg or more)
Construction staging areas Schedewys Hill Viaduct	815, 854 SH1	<40	n/a	Yes
Construction yard 4	656, 642 SH1	54	Solid site hoardings to achieve compliance with night-time criteria, layout to allow for noisy activities to be away from dwellings	Yes
Spoil disposal areas 2 and 3	600 SH1 628, 656 SH1	59 58	n/a	Yes

Generally, construction in this Sector can be undertaken in compliance with the day-time construction noise criteria.

An exception may be blasting in the vicinity of Pūhoi Village. We predict blasting with a charge weight of 12kg or more would cause noise levels that exceed the blasting criterion of 120 dBC. Such an exceedance could be managed by a good regime of pre-warning sirens. Alternatively, with a reduced charge weight, e.g. 7kg or less, compliance with the noise limit could be achieved.

Using a lower charge weight would require a greater number of blasts to achieve the same result. Some residents may prefer the shorter, louder option in the interest of completing the work quickly. Discussions with affected residents will need to be held. We have already noted that communication with affected residents is one of the most important management measures for large scale construction projects (refer Section 5.1.2 above).

6.5 Schedewys Hill Sector

In the Schedewys Hill Sector, there is only a small number of dwellings along Moirs Hill Road in the vicinity of the Project.

These dwellings are within 20m to 50m of the proposed designation boundary. We consider that it is impracticable that the alignment and associated earthworks would move immediately adjacent to the designation boundaries as this would result in a significantly tighter radius for the road.

Assuming that the alignment would be generally central within the designation, we have predicted noise levels in Table 9 below. Dwellings in Moirs Hill Road would be more than 125m from the road construction site, and would therefore be well outside the distance at which the day-time construction noise limits are predicted to be exceeded. Even if construction activities (except blasting) were to move to within 80m of the dwellings, the day-time construction noise limit would be complied with.

Table 9: Schedewys Hill Sector construction noise summary

Activity	Most affected dwellings	Predicted worst case noise level dB L_{Aeq}	Potential mitigation options	Daytime compliance with mitigation
Bulk earthworks/ground improvement/retainment pond excavation/haul road	187 Moirs Hill Road 101 Moirs Hill Road	62 60	n/a	Yes
Road construction/sealing	99 Moirs Hill Road	66	n/a	Yes
Rock breaking	187 Moirs Hill Road 101 Moirs Hill Road	61 58	n/a	Yes
Blasting	187 Moirs Hill Road 101 Moirs Hill Road	120 dBC <115 dBC	Communication of blast schedule, Pre-warning siren 15 and 5 min prior to blasts	Yes
Access to construction yard 7	99, 101 Moirs Hill Road	50	Solid site hoardings to reduce individual high noise events of trucks passing	Yes
Construction yard 8	187 Moirs Hill Road	45	n/a	Yes
Spoil disposal areas 7A and 7B	99,101 Moirs Hill Road 187 Moirs Hill Road	65 57	n/a	Yes

We predict that construction in this Sector can be undertaken in compliance with the day-time construction noise criteria.

6.6 Moirs Hill Sector

There are no receiver locations in the Moirs Hill Sector within a distance that would put them at risk at receiving noise levels above the construction noise criteria, including blasting. Dwellings in Moirs Hill Road that are in the vicinity of Construction yard 8 have been discussed in Section 6.5 above. The next closest dwellings are more than 630m from the construction site.

6.7 Perry Road Sector

Main construction activities in the Perry Road Sector include significant earthworks, potential rock breaking and blasting, the construction of a viaduct at Perry Road, the construction of an alternative property access for some Wyllie Road properties, potentially the location of a pre-cast yard and road construction and sealing.

The following table summarises our noise level predictions for relevant activities, potentially affected dwellings and the potential for mitigation to achieve compliance with the day-time noise limits.

Table 10: Perry Road Sector construction noise summary

Activity	Most affected dwellings	Predicted worst case noise level dB L_{Aeq}	Potential mitigation options	Daytime compliance with mitigation
Bulk earthworks/ground improvement/retainment pond excavation/haul road	221 Wyllie Road 75 Wyllie Road 371 Woodcocks Road 83, 97 Perry Road	67 68 65 65	n/a	Yes
Viaduct construction: Perry Road	83 Perry Road	50	n/a	Yes
Road construction/sealing	371 Woodcocks Road	55	n/a	Yes
Rock breaking	83, 97 Perry Road 221 Wyllie Road	63 60	n/a	Yes
Blasting	83, 97 Perry Road 221 Wyllie Road	120 dBC <120 dBC	Communication of blast schedule, Pre-warning siren 15 and 5 min prior to blasts	Yes
Construction staging area Perry Road Viaduct	371 Woodcocks Road	46	n/a	Yes
Construction yard 11	120 Wyllie Road	49	n/a	Yes

Activity	Most affected dwellings	Predicted worst case noise level dB L_{Aeq}	Potential mitigation options	Daytime compliance with mitigation
Construction yard 12	434 Woodcocks Road	35	n/a	Yes
Pre-cast yard	434 Wyllie Road 371 Woodcocks Road 152 Carran Road	55 51 50	n/a	Yes
Spoil areas 12 and 12A	97, 124 Perry Road	58	n/a	Yes
Spoil area 13A	221 Wyllie Road	60	n/a	Yes
Spoil areas 15, 15A, 16, 16A, 16B and 16C	70, 75 Wyllie Road 2, 12 Wyllie Road	72 60	n/a	Yes

For construction activities in this Sector, we predict that with appropriate management, the day-time noise criteria can be complied with at all dwellings.

6.8 Carran Road Sector

The main construction activities in the Carran Road Sector include significant earthworks, the construction of a viaduct at Woodcocks Road, the construction of a roundabout connecting the Project with SH1 and road construction and sealing.

The following table summarises our noise level predictions for relevant activities, potentially affected dwellings and any potential mitigation required to achieve compliance with the day-time noise limits.

Table 11: Carran Road Sector construction noise summary

Activity	Most affected dwellings	Predicted worst case noise level dB L_{Aeq}	Potential mitigation options	Daytime compliance with mitigation
Bulk earthworks/ground improvement/retainment pond excavation/haul road	78, 78A, 78B, 79A Viv Davie-Martin Drive 63, 102, 104 SH1	65 70	n/a Site hoardings, communication	Yes
Viaduct construction: Woodcocks Road	151, 152 Carran Road 371 Woodcocks Road	52 56	n/a	Yes

Activity	Most affected dwellings	Predicted worst case noise level dB L_{Aeq}	Potential mitigation options	Daytime compliance with mitigation
Road construction/sealing	104 SH1 371 Woodcocks Road	67 55	n/a	Yes
Roundabout construction and associated road realignment	102 SH1 104 SH1	64 60	n/a	Yes
Construction yard 14	102, 104 SH1	45	n/a	Yes
Spoil area 16E	78B, 79A Viv Davie-Martin Drive	60	n/a	Yes

We predict that construction can be undertaken in compliance with the day-time noise criteria for all activities in this Sector.

6.9 Construction traffic

Construction traffic will use the alignment as a haul road throughout construction, which has been assessed in Sections 6.3 to 6.8 above. However, in addition, construction traffic will need to enter the alignment at various points along the alignment. Therefore, new access roads will need to be constructed, connecting the Project with the local road network and SH1. Particularly the construction yards will require access for materials to be delivered and stored at the yards before being distributed along the Project.

We have based our construction traffic calculations on estimated daily average and peak vehicle numbers relating to indicative construction yards and staging areas.[10] We have also reviewed the potential access to the construction areas, and how they may impact on local roads. However, traffic on existing public roads is not subject to the construction noise criteria, because vehicles are on the road for a multitude of reasons. Nevertheless, we have assessed construction traffic noise as it may be an effect of this Project.

Construction traffic usually cannot be distinguished from general traffic (e.g. logging trucks). Therefore, we have described the potential change in noise level from traffic on public roads with the inclusion of construction traffic.

In our predictions, we have focussed on heavy vehicles and trucks only. Our predictions exclude cars because the few additional vehicles of this type as a result of the Project will not have a noticeable effect on the overall traffic noise levels.

[10] Refer Drawings CT-101 and CT-102 for further detail.

Table 12 below summarises our predictions of noise levels arising from construction traffic accessing possible locations for construction yards and staging areas along the indicative alignment.

Table 12: Construction traffic noise summary

Construction yard / staging area	Most affected dwellings	Truck movements per day (average / peak)	Description of noise effects
Bridge staging area 1	24, 26 Billings Road	<10 / 30	**Access to staging area from new Pūhoi Ramp and along the alignment.** Elevated existing noise levels from SH1 (around 60 dB $L_{Aeq(24h)}$). Existing daily truck numbers on SH1 approx. 1,020. Trucks accessing the staging area would have no effect on the overall noise level at the most affected houses. The character and level of noise would remain the same as existing.
Construction yard 2	466 SH1, 28 Pūhoi Road	30 / 100	**Access to yard from new Pūhoi Ramp and along the alignment.** 466 SH1 receives elevated existing noise levels from SH1 (67 dB $L_{Aeq(24h)}$). Adding 100 trucks to the traffic currently using SH1 in this area would have no effect on the overall noise level. 28 Pūhoi Road receives approx. 64 dB $L_{Aeq(24h)}$ from traffic on SH1. This level would not change with the additional trucks accessing yard 2. The character and level of noise would remain the same as existing.
Project office	12, 16 Pūhoi Close	<10 / <10	**Access to the office across the alignment from SH1.** Due to the small number of trucks and the distance from the dwellings (>100m) we predict that no change in overall noise level would occur. The character and level of noise would remain the same as existing.
Bridge staging area 3	466 SH1	<10 / 30	**Same access as for Yard 2, off SH1**. Combined daily peak truck number from all three areas <200 trucks. This small number of trucks would result in virtually no change in noise level (0.2 dB). The character and level of noise would remain the same as existing.

Construction yard / staging area	Most affected dwellings	Truck movements per day (average / peak)	Description of noise effects
Construction yard 4	628 SH1	30 / 100	**Access off SH1.** Closest house 80m from access. Due to high number of trucks on SH1, additional 100 trucks accessing the site would have no effect on the overall noise level. The character and level of noise would remain the same as existing.
Construction yard 5	n/a	60 / 100	**Access off SH1, along Watson Road (a private road).** There are no dwellings within 300m of the access. No noise effects are predicted.
Bridge staging areas 6a and b	851 SH1	<10 / 40	**Access off SH1.** Closest dwelling is beyond SH1, 150m from access. No noise effects are predicted. The character and level of noise would remain the same as existing.
Construction yard 7	99, 101 Moirs Hill Road	30 / 60	**Access off Moirs Hill Road and following the southern designation boundary.** Closest houses are 25m from the access. There are no significant noise sources in the area, and existing noise levels are low. Moirs Hill Road carries little traffic. Nevertheless, due to the small daily number of trucks (even combined with the trucks accessing Construction yard 8), the overall noise level of <50 dB L_{Aeq} would be well within construction and general operational noise criteria. Individual truck movements would be audible. Access would be immediately alongside two dwellings. We recommend providing solid site hoardings of 2m height between the access road and the dwellings to reduce the high noise events of individual truck passes.
Construction yard 8	187 Moirs Hill Road	60 / 160	**Access off Moirs Hill Road (from SH1).** Closest house at 100 m. Small increase in noise level over existing (from 46 dB up to 48 dB $L_{Aeq(24h)}$), which is well within acceptable noise criteria for construction and operation. Individual truck movements would be audible.

Construction yard / staging area	Most affected dwellings	Truck movements per day (average / peak)	Description of noise effects
Construction yards 9 and 9a, and Bridge staging area 10	1447 and 1509 SH1	100 / 220 (combined)	**Access off SH1 along new access road.** No dwellings within 120m of access, compliance with construction noise limits can readily be achieved. Dwellings facing SH1 already receive elevated noise levels. Additional trucks would have no effect on overall noise level. The character and level of noise would remain the same as existing.
Construction yards 11 and 12	2, 12 Wyllie Road	80 / 180	**Access off Wyllie Road in the vicinity of 40 Wyllie Road and along the east of the alignment.** Closest dwellings adjacent to the road are 2 and 12 Wyllie Road (35 and 45m respectively). Trucks on public road. Noise levels of less than 50 dB L_{Aeq} at these dwellings, well within construction and traffic noise criteria. No other dwellings within 150m of the access. No effects are predicted.
Bridge staging area 13	371, 372, 434 Woodcocks Road	<10 / <10	**Access off Woodcocks Road.** Closest dwelling at 150m. Woodcocks Road carries 5,500 vpd at present, and approximately 330 trucks per day. An additional 10 trucks per day would result in no change to the overall noise levels. The character and level of noise would remain the same as existing.
Construction yard 14	102, 104 SH1	60 / 100	**Access off SH1.** SH1 carries high traffic volumes (11,000 vpd), including trucks (approx. 660). An additional 100 trucks would result in less than 0.5 decibel noise level change. The character and level of noise would remain the same as existing.
Precast yard 15	371, 372, 434 Woodcocks Road	30 / 60	**Access off Woodcocks Road.** Woodcocks Road carries 5,500 vpd at present and approximately 330 trucks per day. Even with the peak number of trucks accessing the two areas (Staging area 13 and Precast yard 15) on the same day (i.e. up to 60 trucks), the overall noise level from traffic on Woodcocks Road would increase by less than 0.5 decibels. Therefore, construction trucks on Woodcocks Road would not result in any significant additional adverse effects. The character and level of noise would remain the same as existing.

Overall, our assessment is that noise effects arising from Project construction traffic will be negligible to minor. Generally, trucks will use existing busy roads such as SH1 and Woodcocks Road, to reach the construction yard access roads. Those roads carry large numbers of vehicles, including trucks, each day, when compared with the expected construction traffic volumes. This comparatively low traffic volume means that construction trucks will be of the same character and at a lower level than existing traffic noise.

7. Recommendations and conclusions

We have assessed the construction noise effects from the Project. Construction noise criteria are generally less stringent than those for ongoing activities, but allow for rest periods at night-time and Sundays. Our assessment is based on the current New Zealand construction noise standard (NZS 6803:1999). We recommend adopting the criteria of the Standard without alteration for this Project.

Even when complying with the construction noise criteria, noise levels will increase significantly for many of the affected dwellings, compared with the existing noise levels, and will be evident to residents. In our opinion, the recommended noise criteria achieve a balance between the need for development to be progressed while avoiding adverse health effects of residents.

We recommend the adoption of general mitigation measures throughout construction, such as responsible management of operations on and off-site and appropriate communication with affected residents. In addition, we recommend for the “at risk” receivers, targeted mitigation such as individual engagement with the residents. Because the Project area is sparsely populated, only a small number of dwellings will be affected by the construction works. As a result, the contractor will be able to give particular attention to each affected dwelling.

Any potential exceedances of the recommended criteria can be managed and mitigated through a CNVMP, which we recommend should be developed during the OPW process. The CNVMP would be formulated by the construction contractor following the detailed design phase. A CNVMP has the advantage of being a flexible tool that can be adjusted as construction progresses. We therefore consider that it is the most appropriate instrument to respond in a proactive manner to any potential construction noise issue. Guidance as to the content of a CNVMP can be found in the NZTA “State highway construction and maintenance noise and vibration guide”.

We recommend that designation conditions include the noise performance criteria recommended in this report (both for general construction noise and blasting) and the requirement for a CNVMP to be produced prior to, and implemented and updated throughout, construction.

We have assessed the construction noise effects from the Project. Construction is inherently noisy but of limited duration. The noise criteria set out in various Standards and guidelines reflect this. Construction noise criteria are generally less stringent than those for ongoing activities, but allow for rest periods at night-time and Sundays.

Our assessment is based on the current New Zealand construction noise standard (NZS 6803:1999). We recommend adopting the criteria of the Standard for this Project without alteration.

The Project Area is sparsely populated, apart from the southern and northern ends. We have predicted noise levels for all major construction activities along the indicative alignment. We then determined which dwellings would be most affected by construction noise, including those that may be at risk of receiving noise levels exceeding the construction noise criteria. Only a small number of dwellings would fall into the medium to high risk category of receiving noise levels in excess of the criteria. Accordingly, the construction contractor can give particular attention to each affected dwelling with targeted communication and mitigation.

Even when complying with the construction noise criteria, noise levels will increase significantly for many of the affected dwellings, compared with the existing noise levels, and will be evident to residents. This increase could be interpreted as a significant effect. However, we consider that the Standard gives clear guidance in determining a balance between the need to progress development while providing for reasonable amenity for residents and avoiding unreasonable noise.

We recommend the adoption of general mitigation measures throughout construction. These include considerate operations on and off-site (e.g. by avoiding unnecessary noise), timely and appropriate communication with affected parties and noise monitoring. In addition, for the “at risk” receivers, we recommend targeted mitigation such as individual engagement with the residents. In particular, we consider good communication and timely information relating to potential construction noise issues is important for a Project of this magnitude.

Guidance on construction noise mitigation and management is given in the NZTA’s “State highway construction and maintenance noise and vibration guide”. The construction contractor can refer to this guide when determining appropriate measures.

Overall, based on our assessment, we conclude that the Project can be constructed generally within the criteria of NZS 6803:1999. Any potential exceedances can be managed and mitigated through a CNVMP, which we recommend should be developed during the OPW process and be based on Section 8 and Annex E of NZS 6803:1999.

The CNVMP would be formulated by the construction contractor at a stage of the Project, when equipment, activities, locations and timing is known. At that time, the contractor will be in a position to design reasonable and practicable mitigation and management measures that are specific to the Project. A CNVMP would generally contain the relevant noise criteria, details on construction activities and measures specifically designed to manage noise at individual dwellings. It would also contain communication procedures which should be employed prior to noisy events and in response to potential complaints. If noise level monitoring is required, this should be set out in the CNVMP, including durations and details on how to document and disseminate the information gained.

A CNVMP has the advantage of being a flexible tool that can be adjusted as construction progresses. We therefore consider that it is the most appropriate instrument to respond in a proactive manner to potential construction noise issues.

In order to ensure that the relevant construction noise information is captured for the construction contractor, we recommend that designation conditions include the recommended noise performance criteria of Section 3 (both for general construction noise and blasting). We also consider a condition should require for a CNVMP to be produced prior to, and implemented and updated throughout, construction. We recommend that, through a condition, blasting should be restricted to daytime only.

We consider that with the implementation of the recommended methodologies, compliance with the relevant criteria can generally be achieved and effects can be managed to a reasonable level, as anticipated by the relevant Standard.

8. References

NZS 6803:1999 *"Acoustics – Construction Noise"*

NZTA *"State highway construction and maintenance noise and vibration guide"*, New Zealand Transport Agency, ISBN 978-0-478-38065-1 (online).

Appendix A. Activity sound power levels

Activity	Plant type	Likely quantity per construction area	Sound power level (dB L_{Aw})	Notes
Earthworks/haul road				
Bulk earthworks and cut to fill/spoil disposal	Dump truck Hydraulic excavator Bulldozer Compactor Grader Water truck	4 4 1 2 1 2	106 113 114 112 110 105	Three fleets may work simultaneously along the alignment, equipment numbers are for one fleet
Rock blasting and breaking	Hydraulic breaker Hydraulic excavator Dump truck	1 1 3	122 113 105	Blasting is assessed against different criteria and not included in this table
Rock crushing	Mobile rock crusher	1	125	Crushing would occur in the vicinity of rock breaking. Mobile crusher can be moved to an appropriately shielded position.
Structures				
Piling for foundations	Rotary piling rig Concrete trucks	2 2	111 107	
Concrete foundations and structure	Crane Concrete pump Vibratory pokers Concrete trucks	1 1 3 4	106 100 114 107	
Viaducts				
Precast yard	General activity	1	105	Hammering, Metal Scraping, Vibrators on steel, etc.
Launching girder	Straddle carrier Launching girder Mobile crane	2 1 1	105 91 108	Girder noise source: generator at road deck level Viaducts are constructed either by girder or gantry

Activity	Plant type	Likely quantity per construction area	Sound power level (dB L_{Aw})	Notes
Launching gantry	Straddle carrier Launching gantry Mobile crane	2 1 1	105 91 108	Gantry noise source: generator at road deck level Viaducts are constructed either by girder or gantry
Pavement construction				
Preparation	Grader Vibratory roller Water trucks	1 1 2	110 108 105	Three fleets may work simultaneously along the alignment, equipment numbers are for one fleet.
Surfacing	Paver Road rollers Asphalt delivery trucks	2 6 6	113 106 108	Potential for night-time works where the Project connects with the existing SH1
Ground improvement works				
Ground improvement	Drill rig Cement truck	2 2	118 109	Each group deployed at different locations, but generally within 500m of each other
Staging areas/ construction yards				
Yard activities	Vehicle movements Material handling Administration area Workshop	N/A	102 105 50 80	Activities in staging areas and construction yards will vary, depending on their purpose. It is anticipated that construction yards will be in operation for the entire duration of works.