TE TUPU NGĀTAHI
SUPPORTING GROWTH

North West Strategic Assessment of Construction Noise and Vibration Effects

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Version 1

WAKA KOTAHI NZ TRANSPORT AGENCY

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Responsibility	Name
Author	Owen Li / Siiri Wilkening
Reviewer	Claire Drewery
Approver	John Daly

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Abbreviations

Acronym/Term	Description
AEE	Assessment of Effects on the Environment
ASH	Alternative State Highway
AT	Auckland Transport
AUP:OP	Auckland Unitary Plan Operative in Part
BCI	Brigham Creek Interchange
BOL	Block of Line
BPO	Best Practicable Option in accordance with Section 16 of the RMA
CC2W	City Centre to Westgate
FTN	Frequent Transit Network
FULSS	Future Urban Land Supply Strategy
FUZ	Future Urban Zone
NAL	North Auckland Line
NoR	Notice of Requirement (under the Resource Management Act 1991)
OPW	Outline Plan of Works
PPF	Protected Premises and Facilities, including residences, schools, marae and parts of hospitals
RMA	Resource Management Act 1991
RTC	Rapid Transit Corridor
RAMC	Regional Active Mode Corridor
RUB	Rural Urban Boundary
SG	Te Tupu Ngātahi Supporting Growth
SH16	State Highway 16
The Council	Auckland Council
Waka Kotahi	Waka Kotahi NZ Transport Agency

Glossary of Acronyms / Terms

Acronym/Term	Description
Auckland Council	Means the unitary authority that replaced eight councils in the Auckland Region as of 1 November 2010.
Strategic Assessment Package	Four Notices of Requirement (for ASH, RTC, Station Road and SH16) and one alteration to an existing designation (SH16 Main Road) for the Whenuapai Arterial Transport Network for Auckland Transport.
Projects	North West Strategic Projects and Kumeū Huapai Local Arterials Notices of Requirement for Waka Kotahi NZ Transport Agency and Auckland Transport

1 Executive Summary

Construction noise and vibration has been assessed against relevant standards and guidelines, and mitigation and management measures recommended to manage effects on neighbouring buildings.

Construction noise has been assessed against the requirements of NZS 6803:1999. This Standard is referenced both in the AUP:OP and the Waka Kotahi Guide. Construction of each Project is proposed to take longer than 20 weeks, which means that the long duration criteria have been used as basis of the assessment, with the relevant daytime criterion being 70 dB L_{Aeq}. We have recommended using the same construction noise criteria for all Projects.

Construction vibration has been assessed against two criteria; Category A broadly relating to the management of amenity effects and being based on BS5228 guidance, and Category B relating to the avoidance of any (including superficial) building damage, based on DIN4150-3:1999. These criteria are applied progressively by implementing the Best Practicable Option management on site to reduce vibration levels.

An envelope of effects has been identified for both construction noise and vibration, based on noise setback distances at which compliance with the relevant noise criteria can be achieved, and vibration radii at which compliance with the Category A or B criteria can be achieved. Buildings inside these effects envelopes have been identified.

Mitigation and management measures have been recommended, ranging from common on site measures that should be commonly used on all construction sites, to the requirement of a Construction Noise and Vibration Management Plan and associated Schedules for specific activities and receivers as required.

NoR S1 Alternative State Highway (ASH) including Brigham Creek Interchange (BCI)

Results of assessment and recommended measures

The ASH corridor, including the BCI, is within a largely rural area, with the exception of the connections to the existing SH16, where residential and business uses prevail. Intermittent rural dwellings and buildings are located at some distance from most of the designation corridor boundary (generally 20m to 60m), with the closest buildings less than 10m from the potential works.

Predicted noise may intermittently be as high as 80 dB L_{Aeq} at closest dwellings where earthworks are undertaken in close proximity. At such levels, mitigation and management as recommended in Section 4.5 will need to be implemented. Noise levels inside the dwellings may be up to 55 to 60 dB L_{Aeq} and result in adjustment in behaviour (e.g. avoiding rooms facing the noise source). As construction will occur in a staged approach, predicted exceedances will be of limited duration only. Overall, as the designation width means that the majority of works will be at a sufficient distance from buildings to that for most of the time compliance with the 70 dB L_{Aeq} daytime noise criterion is predicted.

Construction vibration from the use of vibratory roller is predicted to potentially exceed the Category B criteria at a number of buildings (refer Table 7-4) without mitigation in place. We recommend that mitigation and management through the CNVMP are implemented, such as using alternative construction methodologies, undertaking building conditions surveys and monitoring vibration levels.

Conclusion

Construction noise and vibration can be managed to be at a reasonable level for most of the construction duration. Intermittent high noise and vibration levels are likely during specific activities or at distinct locations and will be managed and mitigated through the recommended CNVMP and Schedules.

The use of a management framework through the CNVMP and Schedules is considered to be the BPO approach to construction noise and vibration and this has been included in the conditions of the draft designation.

NoR S2 SH16 Main Road Upgrade

Results of assessment and recommended measures

The SH16 Main Road upgrade will occur mostly within an existing designation which already authorises the works. Some additional areas have been identified beyond the existing designation which will need to be designated. We have assessed the construction noise and vibration effects of all works, irrespective of their location inside or outside the existing designation, against the same criteria.

The SH16 Main Road corridor is an existing State highway corridor which affects the ambient noise environment of the area. It traverses well-established retail, commercial and residential areas through Kumeū-Huapai, as well as more rural zones which are currently sparsely populated.

The works required for the walking and cycling facilities generally require slightly smaller equipment than would be required for a new road. Nevertheless, predicted noise may intermittently be as high as 80 dB L_{Aeq} at closest dwellings where earthworks are undertaken in close proximity. These levels would only occur for a matter of hours or (at most) days. For the construction of the bridge, piling may generate noise levels up to 85 dB L_{Aeq} at the closest dwellings. This work would occur only for a very limited time of a few days.

At such levels, mitigation and management as recommended in Section 4.5 will need to be implemented. Noise levels inside the dwellings may be up to 55 to 60 dB L_{Aeq} and result in adjustment in behaviour (e.g. avoiding rooms facing the noise source). As construction will move along the alignment in a linear fashion, predicted exceedances will be of limited duration only. Overall, as the designation is relatively wide, the majority of works for most of the time are predicted to comply with the 70 dB L_{Aeq} daytime noise criterion.

Construction vibration from the use of vibratory rollers is predicted to potentially exceed the Category B criteria at a number of buildings (refer Table 8-4) without mitigation in place. We recommend that mitigation and management through the CNVMP are implemented, such as using alternative construction methodologies, undertaking building conditions surveys and monitoring vibration levels.

Conclusion

Construction noise and vibration can be managed to be at a reasonable level for most of the construction duration. Intermittent high noise and vibration levels are likely during specific activities or at distinct locations and will be managed and mitigated through the recommended CNVMP and Schedules.

The use of a management framework through the CNVMP and Schedules is considered to be the BPO approach to construction noise and vibration.

NoR S3 Rapid Transit Corridor (RTC) and Regional Active Mode Corridor (RAMC); NoR KS Kumeū Rapid Transit Station and NoR HS: Huapai Rapid Transit Station

Results of assessment and recommended measures

The RTC and RAMC will straddle the Rural Urban Boundary and connect Kumeū-Huapai with Westgate and Auckland City. The alignment traverses two distinct sections. The rural section connects BCI with the existing SH16 via the North Auckland Line. In this area, existing noise levels are in the 50s dB L_{Aeq} with intermittent noise from trains passing. The urban section along SH16 Main Road, with elevated noise levels of mid-60 to low 70 dB L_{Aeq}. The corridor will be co-located with other SGA North West Strategic Projects (i.e. NoR S1 ASH and NoR S2 SH16 Main Road). Should the ASH have already been implemented, existing noise levels would be higher than currently, due to the increased traffic in a currently rural area. The RTC will be used by electric buses.

The two stations are both located in the vicinity of the existing SH16. The Kumeū Station is located in a business area with ambient noise levels in the mid to high-60 dB L_{Aeq}, which is unlikely to change in the future. Huapai Station is located in land used for rural activities adjacent to SH16, with ambient noise levels affected by SH16 and in the low to mid-60 dB L_{Aeq}.

The works required for the rapid transit corridor will be as for normal road formation, with the noisiest works involving earthworks and bridge construction. Predicted noise may intermittently be as high as 75 – 80 dB L_{Aeq} at closest dwellings where earthworks are undertaken in close proximity. This work would occur only for a very limited time as works move along the alignment.

At such levels, mitigation and management as recommended in Section 4.5 will need to be implemented. Noise levels inside the dwellings may be up to 55 to 60 dB L_{Aeq} and result in adjustment in behaviour (e.g. avoiding rooms facing the noise source). As construction will occur in a staged approach, predicted exceedances will be of limited duration only. The majority of works for most of the time are predicted to comply with the 70 dB L_{Aeq} daytime noise criterion.

Station construction will occur for a more sustained period in the same location. Noise levels up to 75 dB L_{Aeq} are predicted at the few buildings in the vicinity. With mitigation, compliance with 70 dB L_{Aeq} can be achieved for most works.

Construction vibration from the use of vibratory rollers is predicted to potentially exceed the Category B criteria at three buildings (refer Table 9-6) without mitigation in place. We recommend that mitigation and management through the CNVMP are implemented, such as using alternative construction methodologies, undertaking building conditions surveys and monitoring vibration levels.

Conclusion

Construction noise and vibration can be managed to be at a reasonable level for most of the construction duration. Intermittent high noise and vibration levels are likely during specific activities or at distinct locations and will be managed and mitigated through the recommended CNVMP and Schedules.

The use of a management framework through the CNVMP and Schedules is considered to be the BPO approach to construction noise and vibration.

NoR S4 Access Road

Results of assessment and recommended measures

Access Road is an existing road in a currently rural area. Existing noise levels are relatively low, given the distance from any major transport or commercial areas. Should the ASH have been implemented already, ambient noise levels would be somewhat more elevated due to the new transport route.

A large number of dwellings front the existing Access Road and will therefore be affected by construction noise. Predicted noise may intermittently be as high as 80 dB L_{Aeq} at closest dwellings where earthworks are undertaken in close proximity. At such levels, mitigation and management as recommended in Section 4.5 will need to be implemented. Noise levels inside the dwellings may be up to 55 to 60 dB L_{Aeq} and result in adjustment in behaviour (e.g. avoiding rooms facing the noise source). As construction will occur in a staged approach, predicted exceedances will be of limited duration only. Overall, the majority of works for most of the time are predicted to comply with the 70 dB L_{Aeq} daytime noise criterion.

Construction vibration from the use of vibratory rollers is predicted to potentially exceed the Category B criteria at a number of buildings (refer Table 10-4) without mitigation in place. We recommend that mitigation and management through the CNVMP are implemented, such as using alternative construction methodologies, undertaking building conditions surveys and monitoring vibration levels.

Conclusion

Construction noise and vibration can be managed to be at a reasonable level for most of the construction duration. Intermittent high noise and vibration levels are likely during specific activities or at distinct locations and will be managed and mitigated through the recommended CNVMP and Schedules.

The use of a management framework through the CNVMP and Schedules is considered to be the BPO approach to construction noise and vibration.

2 Introduction

This construction noise and vibration assessment has been prepared for the North West Strategic Projects and Kumeū Huapai Local Arterials Notices of Requirement (**NoRs**) for Waka Kotahi NZ Transport Agency (**Waka Kotahi**) and Auckland Transport (**AT**) (the "**Strategic Assessment Package**" and the "**Projects**").

The NoRs are to designate land for future strategic and local arterial transport corridors as part of Te Tupu Ngātahi Supporting Growth Programme (Te Tupu Ngātahi) to enable the construction, operation and maintenance of transport infrastructure in the North West area of Auckland.

The Strategic Assessment Package will provide route protection for the strategic projects, which include:

- Alternative State Highway (**ASH**), including Brigham Creek Interchange (**BCI**)
- the Rapid Transit Corridor (**RTC**), including the Regional Active Mode Corridor (**RAMC)**
- Kumeū Rapid Transit Station
- Huapai Rapid Transit Station
- State Highway 16 (**SH16**) Main Road Upgrade

It also includes the upgrade of Access Road, an existing local arterial corridor within Kumeū-Huapai.

This report assesses the construction noise and vibration effects of the North West Strategic Assessment Package identified in Figure 5-1 and Table 2-1 below.

Refer to the main AEE for a more detailed project description.

Table 2-1: North West Strategic Assessment Package – Notices of Requirement and Projects

Notice	Project
NoR S1	Alternative State Highway (**ASH**), including Brigham Creek Interchange (**BCI**)
NoR S2	SH16 Main Road Upgrade
NoR S3	Rapid Transit Corridor (**RTC**), including the Regional Active Mode Corridor (**RAMC**)
NoR KS	Kumeū Rapid Transit Station
NoR HS	Huapai Rapid Transit Station
NoR S4	Access Road Upgrade

2.1 Purpose and Scope of this Report

This assessment forms part of a suite of technical reports prepared to support the assessment of effects within the Strategic Assessment Package. Its purpose is to inform the AEE that accompanies the Strategic Assessment Package sought by Waka Kotahi and AT.

This report considers the actual and potential effects of the Strategic Assessment Package on the existing and likely future environment as it relates to construction noise and vibration effects and recommends measures that may be implemented to avoid, remedy and/or mitigate these effects.

The key matters addressed in this report are as follows:

a) Identify and describe the ambient noise context of the Strategic Assessment Package area;
b) Identify and describe the actual and potential construction noise and vibration effects of each Project corridor within the Strategic Assessment Package;
c) Recommend measures as appropriate to avoid, remedy or mitigate actual and potential construction noise and vibration effects (including any conditions/management plan required) for each Project corridor within the Strategic Assessment Package; and
d) Present an overall conclusion of the level of actual and potential construction noise and vibration effects for each Project corridor within the Strategic Assessment Package after recommended measures are implemented.

Operational noise effects are assessed against different standards and criteria and are addressed in a different report.

2.2 Report Structure

The report is structured as follows:

a) Identification of the assessment criteria and any relevant standards or guidelines;
b) Overview of the methodology used to undertake the assessment;
c) Recommended measures to avoid, remedy or mitigate potential adverse construction noise and vibration effects;
d) Description of each Project corridor and project features within the Strategic Assessment Package as it relates to construction noise and vibration;
e) Description of the existing and likely future environment and how this affects the construction noise assessment;
f) Description of the actual and potential construction noise and vibration effects of the Strategic Assessment Package; and
g) Overall conclusion of the level of potential adverse construction noise and vibration effects of the Strategic Assessment Package after recommended measures are implemented.

This report should be read alongside the AEE, which contains further details on the history and context of the Strategic Assessment Package. The AEE also contains a detailed description of works to be authorised for the Strategic Assessment Package, likely staging and the typical construction methodologies that will be used to implement this work. These have been reviewed by the author of this report and have been considered as part of this assessment of construction noise and vibration effects. As such, they are not repeated here, unless a description of an activity is necessary to understand the potential effects, then it has been included in this report for clarity.

2.3 Preparation for this Report

When preparing this report, we have relied on information from other experts, namely traffic, design and planning. We attended several team meetings where the information was discussed and undertook a site visit along all NoR alignments where this was publicly accessible.

Where information we rely on was provided by other experts, this is noted in the report.

3 Performance standards

Construction noise and vibration levels are generally higher than would be expected from ongoing day to day operations of the proposed transport corridors. However, higher noise and/or vibration levels are not necessarily unreasonable as long as they are managed and mitigated by implementing the best practicable option (**BPO**).

New designations are sought for the Strategic Assessment Package, for all NoRs, except for NoR S2 (SH16 Main Road), which is an alteration to an existing designation. Therefore, we have reviewed a variety of criteria and standards and have recommended noise and vibration performance standards that in our opinion should apply to all Projects irrespective of the road controlling authority implementing it.

3.1 Noise

3.1.1 Guidelines and Standards reviewed

We reviewed the following guidelines and standards for the assessment of construction noise:

- AUP:OP, specifically rules E25.6.27 and E25.6.29 relating to construction noise in all zones except the City Centre and Metropolitan Centre zones, and construction noise in the road
- NZS6803:1999 Acoustics – Construction Noise
- Waka Kotahi's "State Highway Construction and Maintenance Noise and Vibration Guide" (**Guide**), V1.1, August 2019

We recommend applying the requirements of the Guide to the projects. The Guide takes account of the intended application of NZS6803 criteria and provides a solid management structure to achieve the best practicable outcome for construction noise. NoR S4 (Access Road) is an AT project. The Guide and AUP:OP provide the same construction noise criteria, therefore the recommended criteria in Section 3.1.2 below are directly applicable to all NoRs.

3.1.2 Recommended Criteria

Table 3-1 below shows the relevant noise standards for long duration works (more than 20 weeks), which applies to all projects. These criteria are those of the Guide and NZS 6803, and largely reflect the AUP:OP criteria.

Table 3-1: Construction noise criteria at occupied buildings

Day of week	Time period	Noise criteria	
		dB L_{Aeq}	dB L_{AFmax}
Dwellings and other buildings containing activities sensitive to noise			
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
Sundays and public holidays	0630 – 0730	45	75
	0730 – 1800	55	85
	1800 – 2000	45	75
	2000 – 0630	45	75
Other occupied buildings			
All days	0730 – 1800	70	n/a
	1800 – 0730	75	n/a

While the Project works are generally of longer duration, each individual building would likely be affected only for brief periods of high noise levels due to staging and management of the works.

3.1.3 Exceedance of criteria

During construction some activities will likely occur close to buildings. In some instances, there is the potential for noise levels to exceed the recommended construction noise standards. For most large-scale construction projects, exceedances of the construction noise standards for brief periods of time are common, and management will ensure that effects are reasonable.

NZS6803 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"*[1] suggest that intermittent exceedances are not unreasonable, as long as the BPO has been applied to the management and mitigation of that construction noise.

The AUP:OP in its Objectives and Policies also appropriately anticipates exceedances from construction noise and states:

> *"(4) Construction activities that cannot meet the noise and vibration standards are enabled while controlling duration, frequency and timing to manage adverse effects."*

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

and

> *"(10) Avoid, remedy or mitigate the adverse effects of noise and vibration from construction, maintenance and demolition activities while having regard to:*
>
> *[…]*
>
> *The practicability of complying with permitted noise and vibration standards."*

Whether the duration of a construction activity that exceeds the standards can be considered reasonable, depends on site specific circumstances, and may vary from site to site and activity to activity. For instance, where daytime noise standards 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.

If night-time works occur, this would likely only happen for few nights in any one location. In that instance, this may be acceptable if 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 alternative strategies may need to be implemented, such as offering temporary relocation for those affected residents. Such management measures are further discussed in Section 4.5.

3.2 Vibration

3.2.1 Guidelines and Standards reviewed

We reviewed the following guidelines and standards for the assessment of construction vibration:

- AUP:OP, specifically rule E25.6.30 relating to construction vibration, with two parts: amenity and avoidance of any damage to buildings
- German Standard DIN4150-3 (1999) Structural vibration – Part 3 Effects of vibration on structures
- British Standard (BS) 5228-2: 2009 "Code of practice for noise and vibration control on construction and open sites"
- Waka Kotahi's "State Highway Construction and Maintenance Noise and Vibration Guide" (**Guide**), V1.1, August 2019

Both the AUP:OP and the Waka Kotahi Guide reference relevant vibration standards for construction works. These criteria are similar insofar as they address two vibration responses:

- One set of standards are based on the provisions of German Standard DIN 4150-3:1999 "Structural Vibration - Part 3: Effects of Vibration on Structures" which avoids cosmetic building damage (**building standards**); and
- The other set has reference criteria for human amenity which act as trigger levels for consultation and communication (**amenity standards**).

The amenity standards of the AUP:OP are slightly less stringent (2mm/s PPV vs the 1 mm/s PPV used by the Waka Kotahi Guide), while the building standards of the Guide make allowance for unoccupied buildings by allowing higher vibration levels to be generated where this is safe.

3.2.2 Recommended Criteria for NoRs S1, S2, S3, HS and KS

Table 3-2 below shows the recommended vibration criteria for all NoRs which are sought by Waka Kotahi. These criteria are based on the Guide and are underlaid by a framework of management approaches to ensure that the BPO is implemented and risk of annoyance or building damage minimised.

Table 3-2: Vibration limits for all buildings

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

* Protected Premises and Facilities

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

If Category A is not practicably achievable, the focus is then shifted to avoiding building damage rather than avoiding annoyance by applying the Category B standards. If the Category B standards are complied with, then building damage is unlikely to occur. If Category B standards are predicted to be exceeded, prior to the relevant construction activities commencing, building condition surveys, must be undertaken and vibration levels must be monitored during those works. This allows an assessment of and response to any effects.

The DIN 4150-3:1999 Standard, which the 5mm/s Category B criterion is taken from, is a conservative standard designed to avoid all (including cosmetic) damage to buildings, e.g. superficial damage like cracking in plaster. Significantly higher standards would be applied if damage to structural foundations was the only consideration.

3.2.3 Recommended Criteria for NoR S4

NoR S4 is sought by AT. AT generally applies the requirements of the AUP:OP which sets criteria similar to those of the Guide, relating to the avoidance of building damage and protection of amenity. Table 3-3 shows the recommended vibration criteria for NoR S4.

Table 3-3: NoR S4 Vibration standards at all buildings

Receiver	Details	Category A	Category B
Occupied activities sensitive to noise	Night-time 2000h-0630h	0.3 mm/s PPV	2mm/s PPV
	Daytime 0630h-2000h	2mm/s PPV	5mm/s PPV
Other occupied buildings	Daytime 0630h-2000h	2mm/s PPV	5mm/s PPV
All other buildings	At all times	Tables 1 and 3 of DIN4150-3:1999	

4 Assessment Methodology

We have used the following methodology for the construction noise and vibration assessment for all of the NoRs in the Strategic Assessment Package:

- We reviewed noise and vibration emission data for each construction task / process based on data previously measured by MDA for similar activities. Data from appropriate noise and vibration standards (e.g. BS5228-1:2009) has also been considered, where relevant;
- We measured ambient noise levels along the route to determine the existing environment which forms the basis of the effects assessment;
- We predicted noise and vibration levels from construction based on relevant standards and guidelines and determined setback distances where compliance with the relevant standards can be achieved. These setback distances have been plotted on the Project drawings and are shown in Appendix 1 for noise and Appendix 2 for vibration; and
- Where construction is predicted to exceed the noise or vibration standards, we recommend management and mitigation through a framework of management plans.

4.1 Assumptions

The assessment of construction noise and vibration effects is based on assumptions of construction activities and equipment, particularly for projects that will be implemented many years in the future. We have assumed that the Projects are not constructed concurrently, or, where they are, that the construction activities are sufficiently separated to avoid increased noise levels at individual receivers. In any event, effects will be managed through the CNVMP required by the designation conditions, For NoRs that are adjacent to each other (e.g. NoRs S1, S2 and S3), construction may occur at the same time. However, the space required for equipment to operate safely will ensure that no more than the assumed maximum construction activity would occur in any one area. Therefore, our predictions are also relevant should this occur.

We have also assumed that all existing buildings inside each designation boundary will be removed or will be vacant during the time of construction. We have therefore not assessed these buildings. Should they be retained and occupied during construction, they will need to be assessed at the time of construction. Some of these buildings may be affected by more than one NoR. We have identified the buildings in each of the NoRs that may affect them.

The detailed methodology for works is not confirmed; therefore, we have based this assessment on similar construction projects we have worked on. Although contractors have not been appointed, it is considered that the methodology set out is representative of activity that has occurred on similar projects and forms a reasonable baseline for the purposes of assessment during the design phase of the Projects.

Information sufficient for the NoR stage has been provided (e.g. the location of potential compounds and stockpile areas, and an indicative construction methodology) in a Construction Method Statement and drawings provided by the Project team and has been incorporated in this assessment as relevant.

4.2 Construction Sequence and Methodology

The construction methodology provided by the Project team is proposed to follow the following sequence, which is similar for all NoRs. Only noise and/or vibration generating aspects are included in the list below:

Site establishment

- Site access construction.
- Establishment of site compound and laydown areas:
  - Each Project will require site compounds and one or more laydown areas
  - The main site compound will contain office and meeting room facilities, break rooms, ablution block and carparking facilities
  - Satellite site offices or compounds will contain portable office blocks, lunchroom, ablution facilities and parking as well as laydown areas for storage or stockpile of relevant materials for that site.
  - Laydown areas/construction yards will contain material storage and are generally located inside the designation.
- Tree removal and vegetation clearance.
- Remove footpath, streetlights, grass verge berm (where required).
- Property/ building modification or demolition, including fencing, driveways and gates.
- Construct access tracks/ haul roads (if any).

Advance works

- Relocation of utilities services.
- Major earthworks (generally only undertaken during the summer earthworks season from October to April) to include the following:
  - Ground improvements, undercuts, embankment foundations.
  - Cut and fill works along the alignment to formation level, including preload if required.
  - Remove preload upon settlement completion, and subgrade preparation.

Main works

- Minor earthworks (cut and fill).
- Remove verge and prepare subgrade formation.
- Construct new longitudinal drainage facilities.
- Construct new pavement, widening works in available areas. (Following that, move traffic to newly constructed pavement areas and continue with the remaining widening works.)
- Pavement reconstruction or reconfiguration of existing road furniture.
- Complete tie in works, footpaths, cycleways, lighting and landscaping.
- Construct permanent stormwater wetlands.
- Construct new culverts including rip rap and headwalls.
- Install road safety barriers (if any).
- Bridge construction works (if any) as follows:
  - Mobilisation and site establishment.
  - Enabling works such as access construction, staging areas and temporary works.
  - Piling, pile caps, and abutment construction.
  - Columns and pier headstock construction.

  - Bridge beam installation.
  - Deck construction and barrier installation.
  - Finishing works, such as approach construction, settlement slabs, and end terminals
- Retaining wall construction (if any).
- Accommodation works.
- Install signage and lighting.

Finishing works and demobilisation

- Final road surfacing and road markings.
- Finishing works e.g. landscaping, street furniture, fencing and outstanding accommodation works.

Construction times

Construction hours will generally be 7am to 6pm, Monday to Saturday. During the summer earthworks seasons, extended hours may be worked (6am to 8pm, Monday to Sunday) where this can be undertaken in compliance with the relevant noise and vibration limits.

Only critical work will occur outside these hours (or on public holidays) where it cannot be undertaken safely within normal working hours.

Similarly, night-time works will only be undertaken where it is impractical to undertake the works during daytime, e.g. where road closures are required.

Where works are undertaken outside normal working hours, they will need to be assessed and mitigated through a Schedule (refer Section 4.5.4).

Construction duration

Construction for all projects will generally be in a linear nature, moving along the alignments. This means that high noise and/or vibration levels are experienced by individual buildings only for a short period (e.g. weeks or months) compared with the overall construction duration of the projects (generally years).

The exception are laydown areas and site yards, which will remain in place for generally the full duration of construction of any one project. However, these yards do not generate high noise level (refer Section 4.3.2).

4.3 Construction Noise

4.3.1 Predictions

Noise level predictions for construction projects take into account 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. We have calculated indicative noise levels in accordance with NZS6803:1999 and ISO 9613-2:1996 *"Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation"* for all relevant construction scenarios, assuming multiple items of equipment operating simultaneously, but taking account of spatial separation and time component. This approach is deliberately conservative to represent the reasonable worst-case noise levels that may infrequently occur.

Other than the variations in noise level due to the factors discussed above, there are numerous additional aspects that affect construction noise generation. Some of these aspects 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. However, the conservative approach outlined above is considered to generally provide for these variables.

Predictions are based on existing buildings in the vicinity of the projects. However, if new buildings in the vicinity of a project are occupied by the time of construction, these will also be assessed and considered when mitigation is determined.

4.3.2 Activity noise levels

We have predicted construction noise levels based on experience with similar projects and in similar circumstances. We assembled a list of likely equipment that would be used on a large-scale roading project throughout New Zealand. Table 4-1 sets out 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.

Table 4-1: Construction Equipment Noise Levels

Activity	Plant type	Sound power level (dB L_{WA})
Site establishment (clearance, haul roads, compound construction)	Chain saw Chipper Dump trucks Hydraulic excavator Vibratory roller	114 117 106 113 108
Earthworks (alignment works, haul roads, drainage and culvert construction)	Dump truck Hydraulic excavator Bulldozer Compactor Water truck	106 113 114 112 105
Retaining Wall Construction	Vibration piling rig Rotary Piling Rig Concrete trucks Crane On road trucks	120 111 107 106 100
Bridge foundations (piling)	Rotary piling rig Concrete trucks	111 107
Foundations and structures (bridge construction)	Crane Concrete pump Vibratory pokers Concrete trucks	106 100 114 107
Pavement preparation	Vibratory roller Water trucks	108 105

Activity	Plant type	Sound power level (dB L_{WA})
Surfacing	Paver Road rollers Asphalt delivery trucks	113 106 108
Yard activities	Vehicle movements Material handling Administration area Workshop	102 105 50 80

Based on the sound power levels in Table 4-1, we predicted combined "activity sound power levels" (refer Table 4-2 below). We note that not all equipment will operate consecutively and continuously. For instance, for the site establishment, the chain saws and chipper will operate at the same time, but trucks and vibratory rollers will be used at a later stage of the site establishment when site compounds are constructed.

Although the contractor may use different plant from what is on this list, based on experience on other infrastructure construction projects we consider that noise emissions will be similar for each activity.

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

Table 4-2: Activity Sound Power Levels and Compliance Distance

Activity	Activity Sound Power Level	Distance at which compliance with day-time limit (70 dB L_{Aeq}) is achieved without noise barriers
	dB L_{WA}	metres
Site establishment	115	76
Earthworks	116	83
Retaining wall construction	116	83
Bridge foundations (piling)	111	52
Foundations and structures (concreting)	108	40
Pavement construction	108	40
Surfacing	110	48
Compounds/construction yard	100	18

Some buildings are close to the potential works. While some may receive screening from natural features, others will be exposed to the works and will need mitigation in the form of barriers or similar.

4.3.3 Envelope of noise effects

Based on the predicted noise levels, we have developed effects envelopes, i.e. distances at which compliance with the daytime noise criteria can be achieved without noise mitigation in place. These distances have been plotted onto aerial photographs to show those areas where mitigation would

need to be considered and implemented (refer Appendix 1). We note that any shielding of intervening buildings has not been included in the predictions, which means that the distances are conservative.

For those areas not included in Appendix 1, we predict that noise levels will comply with the relevant limits, and no noise mitigation beyond normal best practice site management would be required. We recommend that these figures be updated for the Construction Noise and Vibration Management Plan (**CNVMP**) to reflect the proposed scope of works, at the time when the CNVMPs are prepared just prior to construction. In any event, Section 16 of the RMA (Duty to avoid unreasonable noise) applies and the BPO will need to be implemented to manage noise effects on all areas, irrespective of compliance.

The following activities have been used to determine the envelope of effects. These are the activities we consider have the greatest impact on construction noise or will be used across the widest part of the NoRs;

- Piling and construction of bridges and retaining walls may generate high noise levels due to the likely direct line-of-sight between dwellings and machinery and the high sound power levels of the equipment – these activities will be localised and apply only for small areas within each NoR; and
- Earthworks will occur across all NoRs and generate elevated noise levels due to the equipment noise levels and the number of equipment items likely used across the network. However, works will move along the alignments and therefore only be in any one location for limited times (e.g. a few weeks out of several years of construction).

4.4 Construction vibration

4.4.1 Predictions

Construction vibration is a separate issue from construction noise. Construction equipment that produces high noise levels does not necessarily also produce high vibration levels and vice versa.

Vibration prediction is less reliable than noise prediction as it is dependent on accurate modelling of ground conditions. Ground conditions are often non-homogeneous and complex in three dimensions, and consequently difficult to quantify across large construction extents.

As a result, we have determined “safe distances” based on vibration measurements[2] previously performed for high vibration sources such as vibropiling and vibratory rollers. The safe distances are based on vibration prediction tools as contained in Hassan (2006)[3]. These have been cross-checked against empirically derived relationships as contained in BS 5228-2:2009 *Code of practice for noise and vibration control on construction and open sites* Part 2: Vibration, the Transport Research Laboratory Report referenced by that standard, and previous measurements carried out by MDA. In addition, a 100% safety margin has been applied to the regression curve derived from the measured data, to take account of ground condition uncertainty, making the predictions conservative. That means that measured vibration levels were not used directly to predict potential vibration levels, but rather that the measured levels have been increased by 100%.

2 Measurements performed at State Highway 18, MacKays to Peka Peka, AMETI and other projects

3 Hassan, O., “Train Induced Groundborne Vibration and Noise in Buildings”, Multi-Science Publishing Co Ltd, ISBN 0906522 439, 2006.

We have used the results from these measurements and predictions to determine risk radii within which buildings are at medium or high risk of receiving vibration levels within Category B (refer Table 3-2). The risk radii also consider human annoyance effects.

4.4.2 Equipment vibration levels

The activities that pose the greatest risk of exceeding the vibration criteria are vibratory rolling and vibropiling. This assessment has focused on these activities. The regression curves for vibratory rollers and vibropiling are shown in Figure 4-1.

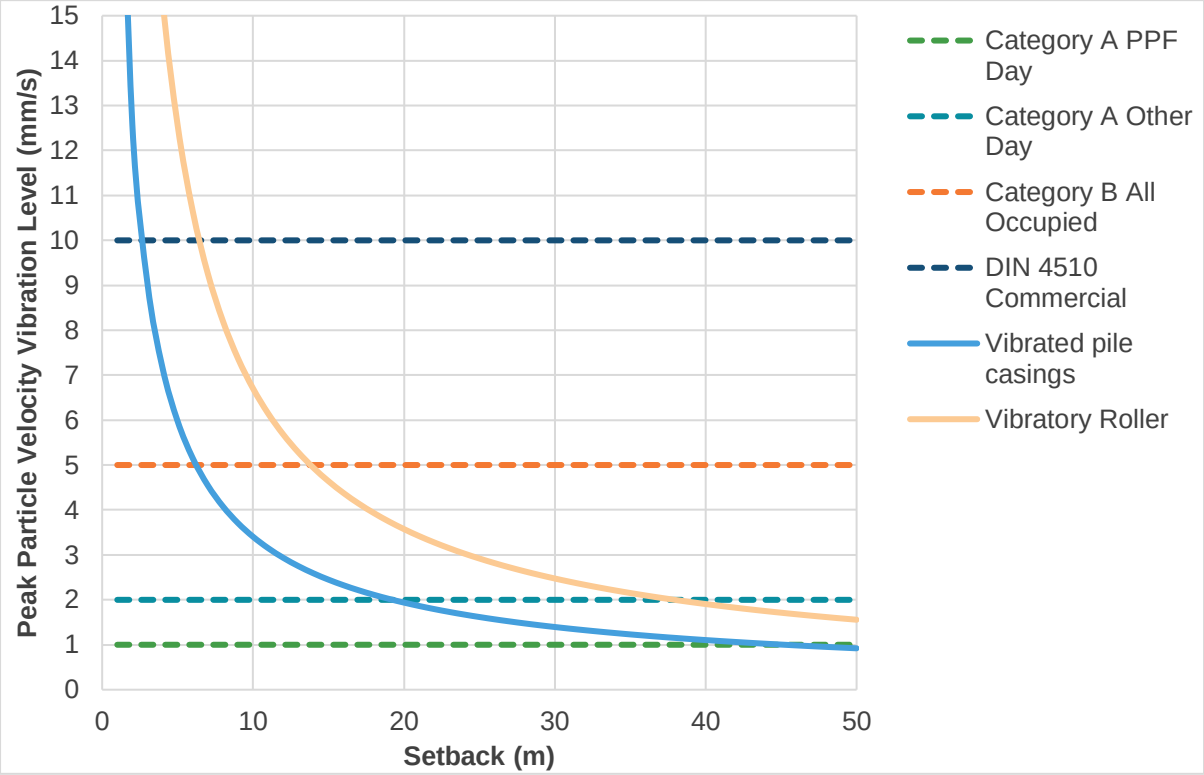

Figure 4-1 Vibration Regression Curves (Criteria for occupied buildings)

4.4.3 Envelope of vibration effects

There is a risk that the Category A criteria may be exceeded at dwellings close to retaining wall construction where vibropiling may be used, and where vibratory rollers are used for the compaction of new or widened traffic lanes.

The risk categories in Table 4-3 relate to the risk of exceeding Category A and B criteria for occupied buildings at various distances from the vibration inducing works. Note that these distances include a 100% safety factor a described in Section 4.4.2 above.

The risk categories are defined as follows:

- High Risk — Predicted to exceed both Category A (amenity) and Category B (building) criteria (refer Section 3.2);
- Medium Risk — Predicted to exceed Category A (amenity) criteria, but comply with the Category B (building) criteria; and
- Low Risk — Predicted to comply with both Category A and B criteria.

Table 4-3: Activity and risk zones

Activity/Equipment	Risk Zones	
	Occupied PPFs	**Other Occupied Buildings**
Vibratory Roller	High: <15m Med: 15 – 80m Low: >80m	High: <15m Med: 15 – 40m Low: >40m
Vibropiling	High: <7m Med: 7 – 45m Low: >45m	High: <7m Med: 7 – 20m Low: >20m

Drawings showing the approximate risk zones for the highest vibration inducing equipment (vibratory rollers) along each NoR extent are included in Appendix 2. Most residential buildings are more than 15 metres from the closest extent of the works, and there are only a few areas where dwellings are in the high-risk zone where the Category B criteria may be exceeded without adjusting the construction methodology or equipment.

Vibration criteria are significantly more stringent at dwellings during the night (0.3 mm/s PPV) and have the potential to be exceeded at distances greater than 200m from any works using vibratory rollers or piling. On this basis, vibration intensive activities adjacent residential areas should be generally scheduled for the daytime wherever practicable.

4.5 Mitigation and management

The most effective way to control construction noise is through good on-site management and communication between managers, staff and affected receivers. We have included recommended measures in this report, based on the assumed construction equipment and methodologies.

Good noise and vibration management is essential in reducing adverse effects as far as practicable, irrespective of the low number of dwellings potentially affected or if noise levels may already be compliant with the relevant criteria.

The following mitigation and management measures would apply to each of the NoRs.

4.5.1 Mitigation and Management Measures

The following general noise mitigation measures will be required to be implemented throughout the construction of all Projects. These measures should be implemented as a matter of good practice and are considered the baseline mitigation for most circumstances.

Where an exceedance of the construction noise or vibration standards is likely due to a specific activity or in a specific area, and the general mitigation measures as discussed below are not sufficient to achieve full compliance, further mitigation and management should be investigated and implemented where practicable. Such information would be contained in the Schedule as attachment to the CNVMP.

4.5.1.1 Communication and Consultation

The most important and effective management measure is public liaison and communication with people occupying buildings in the vicinity of the projects. Providing timely and detailed information to

those potentially affected helps to alleviate uncertainty and concerns and builds trust between the contractor and the receivers.

A contractor environmental manager or appointed representative should be available for residents to contact by phone and/or email at times when construction occurs. Communication also includes complaints responses, which should be included in the CNVMP.

At sensitive times (e.g. when night-time or Public holiday works are required), communication is particularly important, and needs to increase in frequency and content, to ensure residents have the ability to plan around the works where that is practicable.

4.5.1.2 Training

All staff should participate in an induction training session prior to the start of construction, with attention given to the following matters:

- Construction noise and vibration limits;
- Activities with the potential to generate high levels of noise and/or vibration;
- Noise and vibration mitigation and management procedures; and
- The sensitivity of receivers and any operational requirements and constraints identified through communication and consultation.

Awareness of current noise and vibration matters on, or near active worksites, should be addressed during regular site meetings and/or ‘toolbox’ training sessions.

4.5.1.3 Equipment Selection

When selecting construction equipment, where practicable:

- Prioritise quieter construction methodologies (e.g. bored piling instead of drop hammer piling);
- Prioritise electric motors over diesel engines;
- Prioritise rubber tracked equipment over steel tracked equipment;
- Equipment will be suitably sized for the proposed task;
- Equipment will be maintained and fitted with exhaust silencers and engine covers; and
- Avoid tonal reversing or warning alarms (suitable alternatives may include flashing lights, broadband audible alarms or reversing cameras inside vehicles).

4.5.1.4 Timing of Works

Where practicable, we recommend that night-time works are avoided. However, where projects affect existing major transport corridors (e.g. at tie ins and intersections or during the construction of new bridges) where potential closures or limitations are required to construct the projects, night-time works will likely be required from time to time. Where necessary, noisy works should be prioritised early in the evening or night-time period to avoid sleep disturbance. People tend to be less disturbed by low frequency, continuous engine noise, than intermittent noise or activities with special audible character (e.g. reversing beepers, whistling, banging tailgates or shouting).

Stakeholder engagement should be undertaken for occupiers of properties within 200m of any high noise night (and weekend) works and within the setback distance for buildings receiving vibration levels meeting or exceeding 1mm/s PPV (Category A for occupied PPFs).

4.5.1.5 Noise Barriers

Temporary noise barriers should be used where a construction noise limit is predicted to be exceeded and the barriers would noticeably reduce the construction noise level. They should be installed prior to the relevant works commencing and maintained throughout those works. Effective noise barriers typically reduce the received noise level at ground level by up to 10 decibels.

Where practicable, the following guidelines should be incorporated in the design and utilisation of temporary noise barriers:

- to be constructed from materials with a minimum surface mass of 6.5 kg/m^2.
- a minimum height of 2 m, and higher if practicable to block line-of-sight;
- abutted or overlapped to provide a continuous screen without gaps at the bottom or sides of the panels; and
- positioned as close as practicable to the noisy construction activity to block line-of-sight between the activity and noise sensitive receivers. Where positioned on the site boundary, additional local barriers will be considered near the activity to ensure effective mitigation for sensitive receivers on upper floor levels.

If traffic noise barriers are recommended (refer to the relevant report), these should be installed as early as practicable during construction as they would be effective to also mitigate construction noise.

4.5.1.6 Alternative mitigation options

Where all practicable noise and vibration mitigation measures have been implemented and considered, and noise or vibration levels are predicted to exceed relevant limits by a significant margin or for an extended period (e.g. more than two consecutive nights), an offer of temporary resident relocation should be considered. Such a measure should be considered as a last resort as it will generally inconvenience the building occupiers. Note that temporary relocation offers are generally associated with night-time works and sleep disturbance rather than daytime noise levels, and that this will be similar for these projects.

4.5.1.7 Best Practice General Measures

Complaints can arise irrespective of compliance with the noise and vibration limits. To minimise complaints, general mitigation and management measures include, but are not limited to, the following:

- Avoid unnecessary noise, such as shouting, the use of horns, loud site radios, rough handling of material and equipment, and banging or shaking excavator buckets;
- Avoid high engine revs through appropriate equipment selection and turn engines off when idle;
- Maintain site accessways to avoid potholes and corrugations;
- Mitigate track squeal from tracked equipment, such as excavators (may include tensioning and watering or lubricating the tracks regularly);
- Minimise construction duration near sensitive receivers;
- Stationary equipment (e.g. generators) will be located away from noise sensitive receivers and site buildings and material stores used to screen them;
- Orient mobile machinery to maximise the distance between the engine exhaust and the nearest sensitive building façade (e.g. excavators);
- Utilise noise barriers where appropriate;

- Implement specialised mitigation measures for particularly high noise and vibration generating activities such as concrete breaking, piling and vibratory roller use;
- Ensure advanced communication is complete prior to commencing activities that are predicted to exceed the noise and vibration performance standards; and
- Undertake monitoring as appropriate.

4.5.2 Building Condition Surveys

For construction activities with buildings within the High and Medium Risk zones (refer Section 4.4.3 and Appendix 2) we recommend that low vibration construction methods be investigated and implemented wherever practicable, with the aim of achieving Category A compliance. This may include using screw piling methods, non-vibrating rollers or pre-drilling piles.

However, if low vibration methodologies are not deemed practicable, for dwellings in the High and Medium Risk zones we recommend that the following process be implemented before construction commences:

- Engage with the building owner and occupier to discuss the proposed construction activities and likely vibration effects;
- Undertake a pre-construction building condition survey. This will be required where the proposed construction methodology is predicted to reach or exceed the Category B vibration limits, and should be undertaken at a trigger level lower than the Category B limits; and
- Monitor vibration levels during the construction activities which are within the High Risk distance (refer Table 4-3).

If low vibration methodologies are not deemed practicable for buildings in the Medium Risk Zone of a construction activity, we recommend that all buildings within the Medium Risk Distance be notified of the works in advance via a letter drop which outlines the proposed construction activities and likely vibration effects.

Detailed management and mitigation options for construction vibration will be contained in the CNVMP but follow the guidelines in Section 4.5 of this report.

Additional vibration monitoring and follow-up building condition surveys will need to be undertaken at all buildings that had pre-construction building condition surveys. They should also be undertaken in response to complaints, to ensure construction activities comply with the Category B criteria and that no building damage has occurred. If any construction-induced damage were shown to have occurred as a result of Project construction activities, this should be remedied by the contractor.

4.5.3 Construction Noise and Vibration Management Plan

All appropriate mitigation and management are generally set out in a CNVMP, which would be used to manage works on site and sets out how the construction contractor interacts with the neighbouring affected parties. A CNVMP is a condition of the proposed designations.

The CNVMP should also include information set out in NZS6803:1999 in Section 8 and Annex E, and the requirements of the AUP:OP such as:

- Summary of noise and vibration standards;
- Summary of assessments/predictions;
- General construction practices, management and mitigation that will be used for the Project;

- Noise management and mitigation measures specific to activities and/or receiving environments, particularly for high noise and/or vibration activities, and all night-time works;
- Monitoring and reporting requirements;
- Procedures for handling complaints; and
- Procedures for review of the CNVMP throughout the works.

Where appropriate, the CNVMP should also follow the approach outlined in the relevant Waka Kotahi Guide.[4] This includes a requirement for high noise and vibration risk construction projects to have an independently peer reviewed CNVMP and include a comprehensive risk-based quality assurance programme to ensure risks are appropriately managed.

Each NoR should have its own CNVMP. While the base information in each CNVMP will be similar, management and mitigation depend on the works undertaken and the receiving environment. The construction methodology is not yet finalised, therefore, the CNVMPs should be prepared when more detail is available. In addition to the CNVMPs, Waka Kotahi standard procedures for the management of noise and vibration should be implemented. These will be relied on to avoid, remedy and mitigating adverse effects where appropriate.

4.5.4 Schedules

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

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

The following information would normally be included in a Schedule:

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

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

4 https://www.nzta.govt.nz/assets/Highways-Information-Portal/Technical-disciplines/Noise-and-vibration/Standards/Templates/Construction-noise-and-vibration/NZTA-Construction-noise-and-vibration-management-plan-v1.2.doc

5 Strategic Assessment Package Overview

An overview of the Strategic Assessment Package is provided in Figure 5-1 below, with a brief summary of the Strategic Assessment Package projects provided in Table 5-1 below.

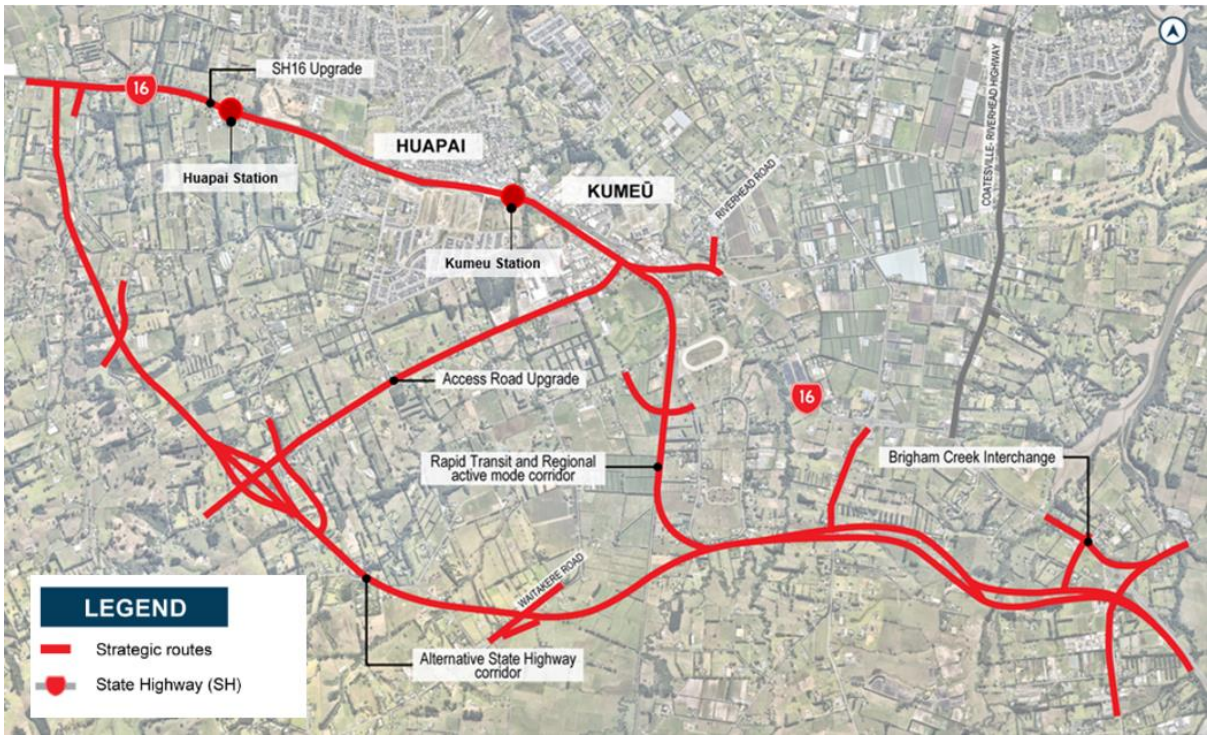

Figure 5-1: North West Strategic Assessment Package – Overview of NoRs for Assessment

Table 5-1: Strategic Assessment Package Project Summary

Corridor	NOR	Description	Requiring Authority
Alternative State Highway	S1	A new four-laned dual carriageway motorway and the upgrade of Brigham Creek Interchange	Waka Kotahi
State Highway 16 Main Road Upgrade (alteration to existing designation 6766)	S2	Upgrade to urban corridor including active modes and realignment of Station Road intersection with SH16.	Waka Kotahi
Rapid Transit Corridor	S3	New Rapid Transit Corridor and active mode corridor in one co-located corridor.	Waka Kotahi
Kumeū RTC Station	KS	New rapid transit station, including transport interchange facilities and accessway.	Waka Kotahi
Huapai RTC Station	HS	New rapid transit station, including transport interchange facilities, park and ride and accessway.	Waka Kotahi
Access Road Upgrade	S4	Upgrade of Access Road to a four-lane cross-section with separated cycle lanes	Auckland Transport

Corridor	NOR	Description	Requiring Authority
		and footpaths on both sides of the corridor.	

Please refer to the AEE for further information on these projects, including a project description, key project features and the planning context.

6 Construction Effects

Construction noise and vibration effects are dependent on several factors. These include the sensitivity of the receiving environment (e.g. an inpatient hospital may be more sensitive than an office), the construction of buildings (e.g. a solid concrete or brick façades reduces noise significantly better than a lightweight façade with louvred windows) and the presence of people near construction (e.g. if all people in the area are at work during daytimes, they are not affected by the construction activity).

Construction effects are assessed for all occupied buildings present at the time of construction. Therefore, for future projects such as these the receiving environment may have changed, in some instances significantly, by the time construction commences.

This can be responded to appropriately by preparing and implementing a CNVMP (refer Section 4.5.3) and additional Schedules (refer Section 4.5.4). Since these documents are prepared and finalised at the time of construction, with input from the contractor, the actual environment present at that time will form their basis.

Nevertheless, in the following sections we provide an overview of the potential effects in relation to likely responses of people to various noise and vibration levels.

6.1 Noise Effects

6.1.1 Daytime

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

Generally, construction noise is assessed in relation to people inside buildings. It is assumed that people will choose to not spend any extended periods in an outdoor area next to high noise construction activities. It is also assumed that people will keep their windows and doors closed to reduce internal noise levels. Generally, New Zealand dwelling facades reduce noise levels by 20 to 25 decibels. We have assumed conservatively a noise level reduction of 20 decibels, though any new dwellings would achieve 25 to 30 decibels noise level reduction, and commercial buildings with concrete or brick façades can even achieve noise level reductions of more than 35 decibels if there are no windows or doors facing to the works.

How people may experience noise inside or outside a building is described in Table 6-1. That table does not take account of non-sensitive activities such as factories, storage spaces and similar uses.

Table 6-1: Potential noise effects for varying noise levels

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

6.1.2 Night-time

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

The Construction Noise Standard (NZS 6803) recommends noise limits assessed at 1m from the external façade of a building, assuming a façade sound level difference of 20 decibels. However, a 20-decibel reduction is particularly conservative for modern buildings. The sound insulation

performance can be measured, or generally be estimated with knowledge of the façade glazing type as follows:

- Sealed glazing: 30 decibels façade sound level difference
- Closed windows (openable): 20 – 25 decibels façade sound level difference
- Open windows: 15 decibels façade sound level difference

Table 6-2 provides guidance on the potential night-time effects inside sensitive spaces, depending on the external noise level and façade glazing type. The potential effects are colour coded as follows:

Typically acceptable

Sleep disturbance for some occupants

Sleep disturbance for most occupants

Table 6-2 Night-time noise levels in bedrooms of dwellings

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

The above table shows that consultation and management may be required if night-time works are proposed in the vicinity of dwellings, where internal noise levels would affect sleep.

6.2 Vibration Effects

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

The below table shows how people may react to various vibration levels. These effects do not consider less sensitive uses such as factories, manual works (e.g. the concrete batching plant) and similar.

Table 6-3: Vibration effects

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

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

7 NoR S1: Alternative State Highway, including Brigham Creek Interchange

7.1 Project Corridor Features

The ASH extends from the existing State Highway 16 (**SH16**) / BCI (north of Redhills) to a proposed new intersection with SH16 near/at Foster Road on the western edge of the FUZ, west of Huapai. This proposed state highway corridor will be approximately 11km long, travelling westward across rural farmlands to the southwestern side of Kumeū and Huapai, with an additional interchange proposed at Tawa Road.

An overview of the proposed design is provided in Figure 7-1 below.

Figure 7-1: Overview of the Alternative State Highway, including Brigham Creek Interchange

Key features of the proposed new ASH corridor and BCI likely to generate construction noise and/or vibration effects include the following:

- The construction of a new four-lane motorway corridor with a cross-section of approximately 50m to accommodate a four-lane dual carriageway and separated cycle lanes and footpaths. The typical cross section includes an active mode corridor with central and side barriers.
- The replacement of the existing SH16 / Fred Taylor Drive / Brigham Creek Road Roundabout with a fully grade separated interchange with on and off ramps in a 'Split-Fork" type arrangement

- An underpass at Taupaki Road and bridges over the NAL with further grade separations at Waitakere Road, Pomona Road, Tawa Road, Puke Road and Foster Road. Tawa Road is designed to future proof for a full diamond interchange.
- The western end of the alignment ties-in at a proposed three-legged roundabout with SH16 Main Road, immediately west of Foster Road.
- The re-alignment of the following local roads:
  - Pomona Road, approximately 1.5km (two sections);
  - Motu Road, approximately 200m; and
  - Puke Road, approximately 500m.
- Construction of stormwater dry ponds, wetlands and culverts.
- Batter slopes to enable the construction of the corridor, and associated cut and fill activities.
- Vegetation removal within the proposed corridor.
- Other construction related activities required outside the permanent corridor including the re-grade of driveways, construction traffic manoeuvring and construction laydown areas. Proposed laydown areas and site office locations are shown on the General Arrangement Layout Plans.

The construction of this NoR is proposed to take approximately 5.5 years; however, the construction timeframes will be confirmed at the detailed design / Outline Plan of Works (**OPW**) stage.

7.2 Existing and Likely Future Environment

7.2.1 Planning context

The ASH corridor, including the BCI, is largely rural and is proposed to traverse land zoned under the AUP:OP as Rural – Countryside Living Zone, Rural – Mixed Rural Zone and Rural – Rural Production Zones.

The ASH corridor will also traverse two separate areas of FUZ in Redhills North and Kumeū-Huapai with the BCI also currently sitting within the Redhills North FUZ land.

Table 7-1 below provides a summary of the existing and likely future environment as it relates to the ASH and BCI.

Table 7-1: Alternative State Highway and Brigham Creek Interchange Existing and Likely Future Environment

Environment today	Zoning	Likelihood of Change for the environment[5]	Likely Future Environment[6]
Rural	Rural - Mixed Rural Zone, Rural - Countryside Living Zone Rural - Production Zone	Low	Rural
Undeveloped greenfield areas	Future Urban	**High**	Urban

[5] Based on AUP:OP:OP zoning/policy direction
[6] Based on AUP:OP:OP zoning/policy direction

7.2.2 Existing and Future Noise Environment

The alignment traverses a range of areas with different ambient noise environments. These range from existing high noise levels in the mid-60 dB L_{Aeq} at the BCI, connecting with the existing SH16 near Foster Road, to mid-40 dB L_{Aeq} away from any major current roads.

These noise levels are expected to remain largely unchanged for most of the alignment. Only limited parts of the alignment will be within the Future Urban Zone, where the environment is expected to change significantly once developed and occupied.

Where the existing environment is materially different at the time of construction, any new occupied buildings will need to be assessed against the relevant noise and vibration limits and included in the relevant CNVMP.

7.2.3 Buildings inside designation

The following Table 7-2 shows the buildings that are inside the proposed designation. We have not assessed them further as the assumption is that they will be removed or unoccupied during construction. We only note the addresses where the main building is inside designation, and not those where auxiliary buildings such as sheds, or garages may be removed.

We assume that the relevant requiring authority will acquire the parcels of land that these buildings are located on. In addition, auxiliary buildings are not generally occupied, so would not be relevant receivers in relation to this assessment,

Table 7-2: Buildings inside designation (not assessed)

Address	Address
134, 138, 142, 146, 149, 152, 154, 156, 162, 171, 176, 178, 182, 176A Boord Cres, Kumeū	36, 37, 41, 47, 54, 69, 78 Puke Rd, Kumeū
5, 7, 18, 21 Brigham Creek Rd, Whenuapai	191, 272, 278, 280, 727 SH16, Kumeū
30, 40, 62, 80, 104, 113 Foster Rd, Kumeū	380, 388, 389, 400, 401 Taupaki Rd, Kumeū
148 – 155 (uneven nos. only), 155, 159, 186, 188, 192, 202, 204, 206, 212 Fred Taylor Dr, Whenuapai	87, 97, 122 Tawa Rd, Kumeū
87 Joseph Dunstan Dr, Taupaki	249 Trigg Rd, Kumeū
146 Motu Rd, Kumeū	656, 660, 670, 691, 703 Waitakere Rd, Kumeū
2, 9, 34, 37, 55, 73, 103, 107, 121, 130, 138, 142, 144, 170, 191 Pomona Rd, Kumeū	

7.3 Assessment of Construction Noise and Vibration Effects

7.3.1 Construction Noise Effects

7.3.1.1 Predicted noise level exceedances

Overall, as the designation area is extensive to allow for the construction and associated areas such as laydown areas, wetlands and stormwater ponds, the majority of existing buildings will be more than 100m from the proposed works. Works in closer proximity are proposed at the following areas:

- BCI covers the area between Fred Taylor Drive, Brigham Creek Road and SH16. Closest buildings are as close as 60m from the works.
- At Waitakere and Pomana Roads, a small number of dwellings are within 40 to 60m from the road alignment and wetlands.
- A new interchange consisting of three roundabouts at Tawa and Motu Roads means that several buildings will be close to the works. Closest works include the construction of the ramps and connections with existing roads. Closest houses would be less than 10m from the works, with most houses at 20 to 40m distance.
- Where the project passes under Puke Road, a new local road bridge will need to be constructed, and Puke Road partially realigned. This means that a number of dwellings are as close at 10m from construction works in the vicinity of the Puke Road tie in.
- In the vicinity of Foster Road and the tie in with the existing SH16, a small number of dwellings are between 45 and 55m from the potential works.

The figures in Appendix 1.1 show the construction noise envelope within which mitigation will need to be implemented.

Based on the construction activities summarised in the bullet points above, we have identified 146 properties where construction noise levels have the potential to exceed the relevant criteria. These are shown in Table 7-3. Some buildings identified are auxiliary buildings (e.g. garages, or sheds) that may not be occupied during construction but have been included for completeness. These are shown in grey in the table.

At the time of construction the buildings existing at the time will need to be reassessed to ensure all relevant receivers are included in the CNVMP. Since part of the Project traverses the FUZ, additional buildings may have been developed by the time of construction. However, the designation is generally wide enough to avoid significantly larger effects than those predicted, i.e. noise levels received at future dwellings would not be substantially higher than predicted for existing dwellings.

Table 7-3: Potential noise criteria exceedances (based on earthworks activities)[7]

Address	Address
99, 102, 108, 111, 113, 186, 190, 202, 210, 214 Boord Cres, Kumeū	96, 228 Boord Cres, Kumeū
2, 4, 15, 26 Brigham Creek Rd, Whenuapai	6, 12, 14, 15, 18, 21, 23-27 Brigham Creek Road
116, 130, 131 Foster Rd, Kumeū	74 Brookvale Lane, Taupaki
133 – 143 (uneven nos. only), 172, 200, 208, 210 Fred Taylor Dr, Whenuapai	59, 81 Foster Road, Kumeū
2, 6 Hanham Rd, Kumeū	180 – 184 (even nos. only), 198 Fred Taylor Dr, Whenuapai
75, 91 Joseph Dunstan Dr, Taupaki	9 Hanham Rd, Kumeū
1, 3, 5, 9, 11 Kennedys Rd, Whenuapai	88 Joseph Dunstan Dr, Taupaki
135, 150, 158, 164 Motu Rd, Kumeū	2-6 Kennedys Rd, Whenuapai
28, 48, 66, 95, 96, 123, 191, 194 Pomona Rd, Kumeū	170 Motu Rd, Kumeū
18, 21, 22, 27, 37, 80, 104, 107, 157 Puke Rd, Kumeū	75, 90, 123, 130, 151 Pomona Rd, Kumeū
171 – 181 (uneven nos. only), 218, 222 SH16, Whenuapai	69 Puke Rd, Kumeū
238, 238A, 246, 393, 693, 695 SH16, Kumeū	239, 272, 284, 393, 726 – 728, 733, 741, 751 SH16, Kumeū
370, 374, 375, 377, 405, 412, 418, 419, 422, 434, 440, 443, 448, 454, 455, 466 Taupaki Rd, Kumeū	422 Taupaki Rd, Taupaki
73, 76, 79, 83, 86, 137, 141, 145 Tawa Rd, Kumeū	83, 148 Tawa Rd, Kumeū
637, 646, 670, 710 Waitakere Rd, Kumeū	221 Trigg Rd, Kumeū
	646 Waitakere Rd, Kumeū

7.3.1.2 Daytime works

The loudest activity across the entire project are earthworks, which move along the alignment. Because of that, mitigation in the form of barriers is not efficient unless there are special circumstances.

Piling for the construction of bridges is also a notable noisy activity. However, this will occur for only a brief period over the overall construction duration, and can be mitigated with equipment choice, barriers and placement of equipment.

Mitigation as set out in Section 4.5 will be implemented across the works. There are no specific construction activities close to buildings that would require mitigation in addition to common best practice.

[7] Black addresses reflect dwellings or other noise sensitive receivers, while grey addresses reflect auxiliary buildings such as garages or sheds that may not be occupied during construction

Predicted noise levels may be as high as 80 dB L_{Aeq} at the closest dwellings, during times of earthworks in close proximity. However, these works would occur only for a few days and then move along the alignment. Only a small number of buildings may be affected by such levels where works are particularly close, and then only for a brief period. The exceedances will be limited and passing. Good communication and timing of activities can assist in reducing effects. We consider that effects would therefore be reasonable provided relevant measures as set out in Section 4.5 are implemented.

For most of the construction works and construction duration, we predict that noise levels can comply with the 70 L_{Aeq} noise criterion at the surrounding receivers.

7.3.1.3 Night-time works

Night works may be required where major local roads or rail would need to be closed for the construction. We have identified the following locations where this may be the case:

- Southern tie in with SH16
- Tie in with Fred Taylor Drive
- Bridge construction across the North Auckland Rail Line (will require a Block of Line (**BOL**) and may occur at night or on a long weekend)
- Bridge construction across Pomana Road
- Bridge construction across Foster Road
- Northern tie in with SH16

These works are limited in duration, often requiring only two or three nights' work. In any event, such works will need to be managed through the CNVMP and require the preparation of a Schedule (refer Section 4.5.4).

We consider that with appropriate management the construction can be undertaken within reasonable noise levels that would be expected from construction of such infrastructure.

7.3.2 Construction Vibration Effects

Vibratory rollers are the most common high vibration generating equipment across the Project. In addition, piling for bridges also causes high vibration levels.

As discussed in Section 4.4.3, we have provided for a 100% safety margin when determining the envelope of vibration levels. For Category B for all occupied buildings, this is at a distance of 15m. For Category A, for occupied PPFs the relevant distance is 80m and for occupied other buildings it is 40m.

Appendix 2 includes figures showing the vibration envelopes for these three criteria.

Table 7-4 shows the addresses of identified buildings that, if existing at the time of construction and occupied, may receive vibration levels exceeding Category B. Eight of these buildings are identified as PPFs, while the remainder are auxiliary buildings and non-PPFs (shown in grey in the table below).

Table 7-4: Potential Category B vibration criteria exceedances (based on vibratory roller activities)[8]

Address	Address
141 Fred Taylor Dr, Whenuapai	139, 143, 180, 182 Fred Taylor Dr, Whenuapai
3 Kennedys Rd, Whenuapai	1 Kennedys Rd, Whenuapai
175, 179 State Highway 16, Whenuapai	170 Motu Rd, Kumeu
419, 455 Taupaki Rd, Taupaki	741 State Highway 16, Kumeū
79, 137 Tawa Rd, Kumeū	145 Tawa Rd, Kumeū
	646 Waitakere Rd, Kumeū

If on-site measurements confirm the predicted vibration levels, then alternative compaction methods should be considered, e.g. non-vibratory compaction.

An additional 57 PPFs have been identified that may receive vibration levels exceeding the Category A vibration criteria. Category A criteria should be used as a trigger to engage with potentially affected people.

Vibration generally occurs intermittently, when equipment passes the building, and can be tolerable if prior notification is given. However, high vibration generation is not appropriate for night-time and should be avoided as far as practicable.

7.4 Conclusions

We have predicted construction noise and vibration levels for the Project, based on the likely construction sequence and methodology set out in Section 4.2.

The construction activities likely to generate the highest levels of effects are earthworks and bridge constructions, with likely limited night works required where major roads or the rail would need to be closed for the works.

Overall, we predict that most activities can comply with the relevant noise and vibration criteria. Where non-compliance is predicted, this would occur for limited and defined periods only, when equipment operates close to occupied buildings or where works outside normal hours are required.

Common best practice mitigation and management should be implemented across the construction site, and this should be documented in the CNVMP. Schedules will need to be prepared for those activities that are predicted to exceed the criteria. This will involve communication with the affected persons.

[8] Black addresses reflect dwellings or other sensitive receivers, while grey addresses reflect auxiliary buildings such as garages or sheds that may not be occupied during construction

8 NoR S2: SH16 Main Road Upgrade

8.1 Project Corridor Features

It is proposed to submit a Notice of Requirement (NoR S2) to designate the land required to implement the upgrade of the existing State Highway 16 (**SH16**) to a two-lane corridor with walking and cycling facilities. Our assessment only relates to the alteration of the existing designation (Designation 6766), i.e. the additional area that has been identified for corridor widening beyond the existing designation. We understand that the noise and vibration effects of works inside the existing designation are already authorised. We note, however, that the management of noise and vibration effects within the existing designation will be confirmed through an Outline Plan of Works (**OPW**) process and will include the preparation and implementation of a CNVMP for the overall works and Schedules for specific activities and receivers as required.

The SH16 Main Road Upgrade extends approximately 4.5km between Old Railway Road, east of Kumeū to Foster Road, west of Huapai. The SH16 Main Road is currently a 20m wide two-lane urban arterial with no active mode facilities on either side of the corridor.

SH16 Main Road is proposed to be upgraded to a 24m urban corridor traversing through well-established retail, commercial and residential environs. The corridor generally follows the existing SH16 Main Road alignment and also includes a 600m section of active mode only upgrade between Oraha Road and Tapu Road. As part of this project, Station Road will be realigned to form a new signalised intersection with SH16 and Tapu Road.

An overview of the proposed design is provided in Figure 8-1 below.

Figure 8-1: Overview of the SH16 Main Road Upgrade

Key features of the proposed upgrade include the following:

- The widening of the existing 20m wide two-lane urban arterial to a 24m wide corridor with walking and cycling facilities on both sides of the corridor.
- The realignment of Station Road to form a new signalised intersection with SH16 and Tapu Road.
- Tie-ins with existing roads, stormwater dry ponds, wetlands and culverts.
- Batter slopes to enable widening of the corridor, and associated cut and fill activities (earthworks).
- Vegetation removal along the existing road corridor.
- Other construction related activities required outside the permanent corridor including the re-grade of driveways, construction traffic manoeuvring and construction laydown areas. Proposed laydown areas and site office locations are shown on the General Arrangement Layout Plans.

The construction of this NoR is proposed to take approximately 5 years; however, the construction timeframes will be confirmed at the detailed design / Outline Plan of Works (**OPW**) stage.

8.2 Existing and Likely Future Environment

8.2.1 Planning context

SH16 Main Road is proposed to be upgraded to a 24m urban corridor along the urban extent of SH16 traversing through well-established retail, commercial and residential environs through Kumeū Huapai. This corridor contains a range of business, residential and open space and rural land uses under the AUP:OP (see zoning column in Table 8-1) between the eastern extent of the Kumeū-Huapai township and the western extent of the upgraded corridor (the intersection with the proposed ASH).

Table 8-1 below provides a summary of the existing and likely future environment as it relates to the SH16 Main Road Upgrade.

Table 8-1: SH16 Main Road Upgrade Existing and Likely Future Environment

Environment today	Zoning	Likelihood of Change for the environment[9]	Likely Future Environment[10]
Rural	Rural Mixed Rural Zone, Rural Countryside Living Zone	Low	Rural
Business	Business (Industrial)	Low	Urban
	Business (Local Centre)	Low	Urban
	Business (Mixed Use)	Low	Urban
Residential	Residential	Low	Residential

[9] Based on AUP:OP zoning/policy direction
[10] Based on AUP:OP zoning/policy direction

Environment today	Zoning	Likelihood of Change for the environment[9]	Likely Future Environment[10]
Open Space	Open Space – Sport and Active Recreation	Low	Open Space
Undeveloped greenfield areas	Future Urban	**High**	Urban

8.2.2 Existing and Future Noise Environment

The alignment follows the existing heavily trafficked route of SH16. This means that neighbouring buildings are already affected by elevated noise levels from the road, and this is unlikely to change in the future. The surrounding area is unlikely to change in terms of it already being an existing urban area as it is already well developed for much of the alignment. Ambient sound levels range from 60 to 70 dB L_{Aeq} during daytime, with some buildings particularly close to the road predicted to experience noise level above 70 dB L_{Aeq} during daytime.

Only limited parts of the alignment will be within the Future Urban zone, where the environment is expected to change significantly once developed and occupied.

Where the existing environment is materially different at the time of construction, any new occupied buildings will need to be assessed against the relevant noise and vibration limits and included in the relevant CNVMP.

8.2.3 Buildings inside designation

The following Table 8-2 shows the buildings that are inside the proposed designation. We have not assessed them further as the assumption is that they will be removed or unoccupied during construction. We only note the addresses where the main building is inside the designation, and not those where auxiliary buildings such as sheds, or garages may be removed.

We assume that the relevant requiring authority will acquire the parcels of land that these buildings are located on. In addition, auxiliary buildings are not generally occupied, so would not be relevant receivers in relation to this assessment,

Table 8-2: Buildings inside designation (not assessed)

Address	Address
21 Riverhead Rd, Kumeū	1 Trigg Road, Kumeū
619 SH16, Kumeū	

8.3 Assessment of Construction Noise and Vibration Effects

8.3.1 Construction Noise Effects

8.3.1.1 Predicted noise level exceedances

This assessment relates to the new designation area that is intended to be added to the existing designation. In some areas there will be no material change in the designation area, which would result to unnoticeable changes to the already authorised effects of construction being carried out in the existing designation.

However, proposed road and bridge realignments, and a wider footprint for laydown areas will mean that in some areas additional land will be required during construction. This is particularly the case where land will be required outside the existing designation for stockpile areas and site compounds, and three temporary road realignments to facilitate Kumeu River bridge construction.

All works will be in close proximity to buildings as most of the alignment is bordered by established residential and commercial areas.

The figures in Appendix 1.2 show the construction noise envelope within which mitigation will need to be implemented. Note that this envelope does not take account of shielding from intervening buildings or structures and is therefore conservative. It is likely that less buildings will be affected by high construction noise levels given the smaller scale of works for parts of the project (where only walking and cycling will be established).

Based on the construction activities summarised above, we have identified 224 properties where construction noise levels have the potential to exceed the relevant criteria. These are shown in Table 8-3. Some buildings identified are auxiliary buildings (e.g. garages, or sheds) that may not be occupied during construction but have been included for completeness. These are shown in grey in the table.

At the time of construction the buildings existing at the time will need to be reassessed to ensure all relevant receivers are included in the CNVMP. A section of the Project traverses the FUZ. This means that additional buildings may have been developed by the time of construction and will need to be assessed and mitigated at the time of construction.

Table 8-3: Potential noise criteria exceedances (based on earthworks activities)[11]

Address	Address
7 Main Road, Kumeū	1 – 8 (all no.), 10, 12, 14 Trigg Rd, Huapai
342 – 348 (even no. only) Main Road, Kumeū	1-7 Vintner Cl, Huapai (uneven no. only)
350 – 362, 364 – 368 Main Road, Kumeū (all no.)	22 – 28 (even no. only), 32, 36, 40 Weza Lane, Kumeū
370, 372, 376, 382, 395, 399, 401, 405, 407, 407A Main Rd, Huapai	22 Wookey Lane, Kumeū
402, 411 Matua Road, Kumeū	1 Grivelle St. Kumeū
30 Meryl Avenue, Kumeū	40, 42, 46, 48, 64, 66, 68, 74, 78 – 88 (even no. only), 106, 132, 134, 154, 190, 223, 246, 248, 250, 280, 282, 296, 300, 304, 322, 326, 330, 332, 334, 338, 340, 378, 380, 384, 395, 108-110, 134-152, 156A, 156B, 156G, 302-318, 50-54, 58-56, 90-92 Main Road, Kumeū
5 – 21 Oraha Rd, Kumeū	3, 392 Matua Road, Huapai
22 – 24, 26 – 45, 47, 21A, 39A Riverhead Road, Kumeū (all no.)	43 Old Railway Road, Kumeū
529, 573, 583, 587, 601, 623, 631, 641, 643, 647, 665, 677, 695, 631A State Highway 16, Kumeū	1 Putaki Drive, Kumeū
4 – 10 Station Road, Huapai (even no. only)	31 Riverhead Rd, Kumeū
14, Station Road, Huapai	1 – 5, 7 – 11, 8A, 18, 19, 22, 14-16 Shamrock Drive, Kumeū
20 – 28, 34 – 38 Station Road, Huapai (even no. only)	550, 641 State Highway 16, Kumeū
25 Station Road, Huapai	4, 16 Sunny Crescent, Huapai
8 Sunny Crescent, Huapai	1, 1A, 2 ,20 Tapu Road, Huapai
3 – 21 Tapu Road, Huapai (uneven no. only)	9 Tokay Place, Huapai
2 – 14 Trigg Rd, Huapai (even no. only)	993 Waitakere Rd, Kumeū
3, 5 Trigg Rd, Huapai	1, 9A, 11A-C Weza Lane, Kumeū
1 – 7 Vintners Close, Huapai (uneven no. only)	16 – 23, 35, 43 Wookey Lane, Kumeū
10, 14, 16, 16A, 18, 22, 24, 30 Tapu Road, Huapai	

8.3.1.2 Daytime works

The loudest activity across the entire project are the proposed road realignments and bridge constructions, which will occur over an extended period of several weeks or months in the relevant locations. Earthworks will be somewhat more minor for this project, particularly in areas where only

[11] Black addresses reflect dwellings or other noise sensitive receivers, while grey addresses reflect auxiliary buildings such as garages or sheds that may not be occupied during construction

walking and cycling improvements are proposed. For these activities, smaller equipment can be used (e.g. smaller rollers and excavators) which generate lower noise levels.

Mitigation as set out in Section 4.5 will be implemented across the works. Bridge construction both for the temporary bridges and ultimate permanent bridges will require careful management where existing buildings are close by.

Predicted noise levels may be as high as 85 dB L_{Aeq} at the closest dwellings, during times of bridge piling. However, these works would occur only for a limited period. Only a small number of buildings may be affected by such levels.

Other activities such as the earthworks required to form the proposed walking and cycling tracks may reach noise levels up to 75-80 dB L_{Aeq} when passing individual houses. However, such noise level would only be experienced for a matter of a few hours or at most days.

The exceedances will be limited and passing. Good communication and timing of activities can assist in reducing effects. We consider that effects would therefore be reasonable provided relevant measures as set out in Section 4.5 are implemented.

For most of the construction works and construction duration, we predict that noise levels can comply with the 70 L_{Aeq} noise criterion at the surrounding receivers.

8.3.1.3 Night-time works

Night works may be required where major local roads or rail would need to be closed for the construction. We have identified the following locations where this may be the case:

- Bridge construction across the North Auckland Rail Line in the vicinity of Station Road. which will likely require a Block of Line (**BOL**) and may occur at night or on a long weekend
- Resurfacing of SH16 following the upgraded bridges where the new and existing roads tie in together

These works are limited in duration, often requiring only two or three nights' work. In any event, such works will need to be managed through the CNVMP and require the preparation of a Schedule (refer Section 4.5.4)

We consider that with appropriate management the construction can be undertaken within reasonable noise levels that would be expected from construction of such infrastructure.

8.3.2 Construction Vibration Effects

If (small) vibratory rollers are to be used to form the walking and cycling facilities, they may generate elevated vibration levels at closest houses. In addition, bridge piling can cause high vibration levels depending on the methodology chosen.

As discussed in Section 4.4.3, we have provided for a 100% safety margin when determining the envelope of vibration levels. For Category B for all occupied buildings, this is at a distance of 15m. For Category A, for occupied PPFs the relevant distance is 80m and for occupied other buildings it is 40m.

Appendix 2 includes figures showing the vibration envelopes for these three criteria.

Table 8-4 shows the addresses of identified buildings that, if existing at the time of construction and occupied, may receive vibration levels exceeding Category B. Twenty-eight of these buildings are identified as PPFs, while the remainder are auxiliary buildings and non-PPFs (shown in grey in the table below).

Table 8-4: Potential Category B vibration criteria exceedances (based on vibratory roller activities)[12]

Address	Address
351 – 361 (uneven no. only) 365, 367,382, 399, 401, 405, 407, 407A Main Road, Huapai	40, 42, 68, 80, 82, 84, 86, 106, 108-110, 132, 134-152, 156G, 190, 250, 280, 302-318, 322, 384 Main Rd, Kumeū
24, 26, 34, 36 Riverhead Road, Kumeū	30 Meryl Avenue, Kumeū
665, 677 State Highway 16, Kumeū	43 Old Railway Road, Kumeū
22, 24, 38 Station Road, Huapai	1 Putaki Drive, Kumeū
10, 11, 14 Tapu Road, Huapai	1, 2 Shamrock Drive, Kumeū
1, 3 Trigg Road, Huapai	550 State Highway 16, Kumeū
	1A Tapu Road, Huapai, Kumeū
	1, 9A Weza Lane, Kumeū
	402 Matua Road, Kumeū

If on-site measurements confirm the predicted vibration levels, then alternative construction methods should be considered, e.g. non-vibratory compaction or bored piling.

An additional 104 PPFs have been identified that may receive vibration levels exceeding the Category A vibration criteria. Category A criteria should be used as a trigger to engage with the occupiers of potentially affected buildings.

Vibration generally occurs intermittently, when equipment passes the building or where there is particular ground resistance during piling and can be tolerable if prior notification is given. However, high vibration generation is not appropriate for night-time and should be avoided as far as practicable.

There are two heritage buildings within the existing heritage overlay along SH16 Main Road that are proposed to be repositioned along the corridor following works commencing on the RTC (NoR S3) to enable the construction of the Project. The buildings are transported to their new site, which will involve high levels of vibration through the loading, transport and unloading. Therefore, we consider that with appropriate siting and careful construction management, construction vibration is unlikely to cause damage to these buildings.

8.4 Conclusions

We have predicted construction noise and vibration levels for the Project, based on the likely construction sequence and methodology set out in Section 4.2.

[12] Black addresses reflect dwellings or other sensitive receivers, while grey addresses reflect auxiliary buildings such as garages or sheds that may not be occupied during construction

The works are generally of a smaller scale involving generally only the construction of walking and cycling facilities. However, the replacement of various bridges, and construction of temporary bridges in the meantime, are identified as the likely highest noise and vibration generating activities. Only limited night-time works may be required where the rail would need to be closed for installation, or where traffic on SH16 would be significantly affected.

Overall, we predict that most activities can comply with the relevant noise and vibration criteria. Where non-compliance is predicted, this would occur for limited and defined periods only, when equipment operates close to occupied buildings, e.g. during piling for bridge installation.

Common best practice mitigation and management should be implemented across the construction site, and this should be documented in the CNVMP. Schedules will need to be prepared for those activities that are predicted to exceed the criteria. This will involve communication with the affected persons.

9 NoR S3: Rapid Transit Corridor and Regional Active Mode Corridor; NoR KS: Kumeū Rapid Transit Station and NoR HS: Huapai Rapid Transit Station

9.1 Project Corridor Features

It is proposed to submit a Notice of Requirement (NoR S3) to designate the land required to implement the new Rapid Transit Corridor (**RTC**) and Regional Active Mode Corridor (**RAMC**) in one co-located and integrated corridor. In addition, new designations for two rapid transit stations, one each at Huapai (NoR HS) and Kumeū (NoR KS), are sought.

9.1.1 Rapid Transit Corridor

The proposed RTC is a new corridor which aims to complete a safe and frequent rapid transit system connecting Kumeū-Huapai with Westgate, Auckland City Centre and the North Shore. The RTC will extend the proposed City Centre to Westgate (**CC2W**) rapid transit corridor from the Brigham Creek Frequent Transit Network Station to the western edge of Kumeū-Huapai growth area near the Rural Urban Boundary (**RUB**).

The RTC will extend from the existing SH16 / Brigham Creek Interchange to the west of Huapai. The RTC predominately traverses rural land outside of the FUZ at a total length of approximately 9.5km and is intended to operate in an uninterrupted free flowing manner with all road crossings grade separated.

The RTC is split into the following sections:

- The **rural section** of the RTC runs from the BCI to NAL (and will be co-located with the ASH[13]) and along the eastern side of the NAL to the entry to Kumeū-Huapai township. The RTC is co-located with the RAMC for the entirety of the rural section. Within the rural section, the RTC requires an extended width to accommodate both the RTC and RAMC.
- The **urbanised section** of the RTC runs from northern end of Waitakere Road to Foster Road and is co-located with the proposed SH16 Main Road upgrade[14] along this section. Within this section, the RTC requires approximately 38m width to locate two FTN lanes, separated active mode facilities and the SH16 Main Road Upgrade.

It is proposed to route protect the RTC corridor for electric bus use.

[13] Another North West Strategic project – refer to Section 7 of this report
[14] Another North West Strategic project – refer to Section 8 of this report

The RTC corridor will be at grade except at key sections to pass over local arterial roads or the Alternative State Highway, including Brigham Creek Road. An overview of the proposed design is provided in Figure 9-1.

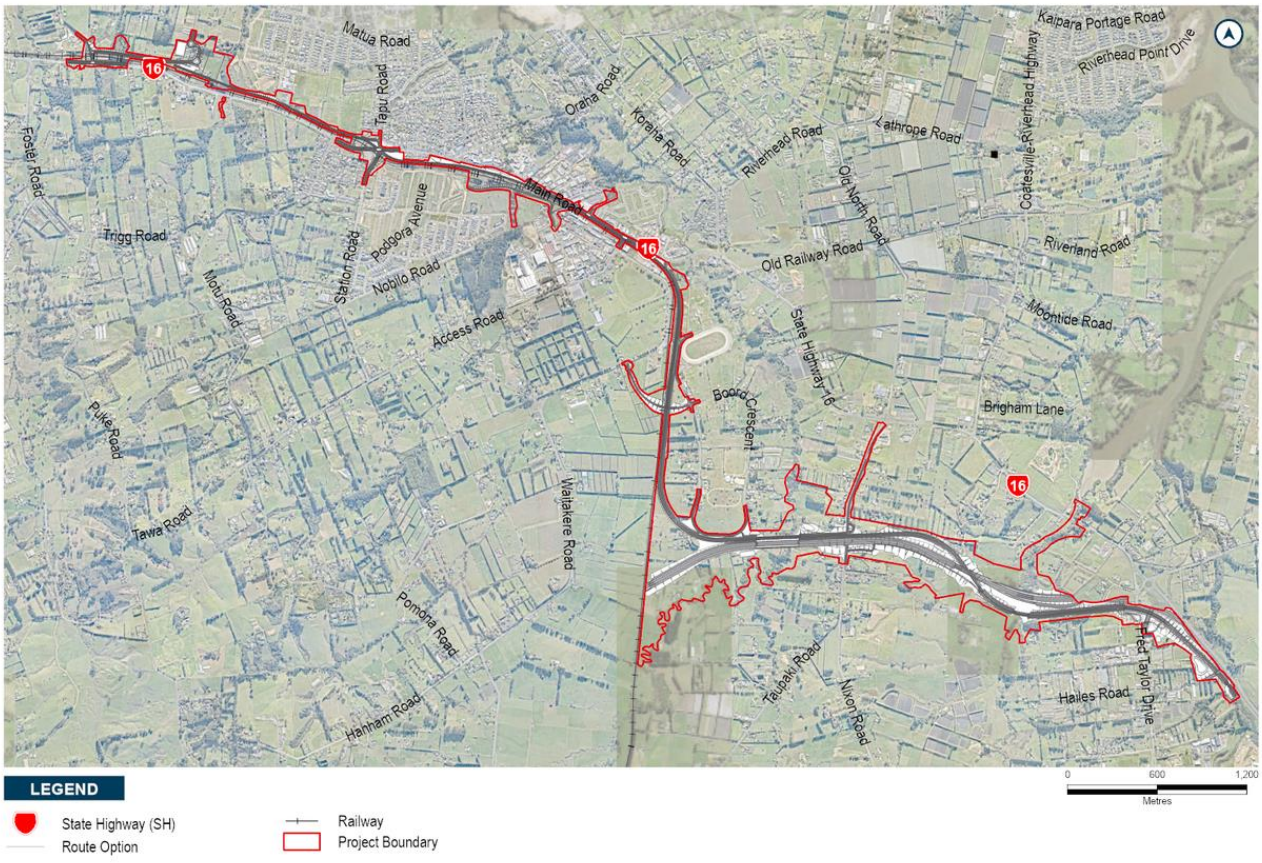

Figure 9-1: Rapid Transit Corridor and Regional Active Mode Corridor Overview

Key features of the proposed upgrade include the following:

- An approximately 9.5km long corridor intended to operate in an uninterrupted free flowing manner.
- The RTC will be at ground level except at key sections to pass over or under arterial roads (Fred Taylor Dr, Taupaki Rd, new Waitakere-Boord Cres Link Rd, Access Rd and Station Rd).
- The ASH goes over the RTC in the rural section.
- Grade separated road crossings at all intersections with adjoining roads.
- Within Kumeū-Huapai Township, upgrades of:
    - SH16 between Access Rd and John MacDonald Lane. At this section, the RTC abuts the KiwiRail boundary and the proposed SH16 upgrade which will need to be realigned north of its existing alignment.
    - Realignment of Station Road and Tapu Road to form a signalised cross-intersection. The RTC will pass under this proposed intersection to deviate to the north.
- Batter slopes to enable the construction of the corridor, and associated cut and fill activities (earthworks).
- Vegetation removal within the proposed new corridor
- Stormwater dry ponds, wetlands and culverts.
- The area to be route protected will include the transport corridor, FTN stations and additional land for tie-ins, stormwater infrastructure, batter slopes and retaining walls, and for other construction

related activities including re-grade of private driveways, construction of area for traffic manoeuvring and laydown areas.

The construction duration is anticipated to be around 5 to 5.5 years; however, the construction timeframes will be confirmed at the detailed design / Outline Plan of Works (**OPW**) stage.

9.1.2 Rapid Transit Stations

The RTC stations - Kumeū Rapid Transit Station and Huapai Rapid Transit Station - are located in the urban section of the RTC corridors.

- Kumeū Station is proposed to be located on land at 299 and 301 Main Road on the western side of a Kumeū River tributary.
- Huapai Station is proposed to be located on land at 29 and 31 Meryl Avenue on the western side of the Ahukuramu stream.

The construction of the stations is included in the overall construction duration of approximately 5.5 years.

9.1.3 Regional Active Mode Corridor

The RAMC is a segregated walking and cycling corridor that is located adjacent to the RTC alignment from the Brigham Creek Interchange to the western edge of Kumeū-Huapai, terminating at the signalised intersection of SH16 Main Road and Weza Lane. The corridor is co-located and integrated with the RTC and is proposed to be route-protected as a single NoR. The segregated corridor provides the opportunity for long-term amenity as a key cycling corridor, while connecting to the wider North Western Cycleway and ultimately to the Auckland city centre network.

The key features in terms of construction will be similar to those of the RTC and will be constructed simultaneously with the RTC.

9.2 Existing and Likely Future Environment

9.2.1 Planning context

The RTC, Rapid Transit Stations and RAMC form a single, integrated corridor (note the RAMC only extends to the eastern entrance to Kumeū). This corridor predominately traverses rural land outside of the FUZ, however for assessment purposes it can be split into two sections:

- The **rural section** of the RTC runs from the BCI to the entry to Kumeū-Huapai Township and is co-located with the RAMC along this section. This rural section traverses land zoned under the AUP:OP as Rural – Countryside Living Zone, with an area zoned as FUZ in Redhills North.
- The **urban section** of the RTC runs from northern end of Waitakere Road to Foster Road and is co-located with the proposed SH16 Main Road upgrade (NoR S2)[15] along this section. This urban section contains a range of land uses zoned under the AUP:OP as a mix of business zonings between the eastern extent of the Kumeū-Huapai township and Station Road.

[15] Another North West Strategic project – refer to Section 8 of this report

Table 9-1 below provides a summary of the North West existing and likely future environment as it relates to the RTC and the RAMC.

Table 9-1: RTC and RAMC Existing and Likely Future Environment

Environment today	Zoning	Likelihood of Change for the environment[16]	Likely Future Environment[17]
Rural	Rural	Low	Rural
Future Urban Zone / Undeveloped greenfield areas	Future Urban	High	Urban
Business	Business (Industrial)	Low	Urban
	Business (Local Centre)	Low	Urban
	Business (Town Centre)	Low	Urban
Residential	Residential	Low	Urban
Open Space	Open Space – Informal Recreation Open Space – Sport and Active Recreation	Low	Open Space

The RTC stations - Kumeū Rapid Transit Station and Huapai Rapid Transit Station - are located in the urban section of the RTC corridors.

Kumeū Station is proposed to be located on land at 299 and 301 Main Road on the western side of a Kumeū River tributary. The land is zoned under the AUP:OP as Business - Town Centre Zone. An active modes overbridge is proposed across the NAL with active mode connections to:

- the Huapai Triangle crossing land zoned in the AUP:OP as Green Infrastructure Corridor and Residential - Mixed Housing Suburban Zone; and
- Wookey Lane crossing land zoned in the AUP:OP as Green Infrastructure Corridor and Residential - Mixed Housing Suburban Zone; and Business - Light Industry Zone.

Table 9-2: Kumeū Rapid Transit Station Existing and Likely Future Environment

Environment today	Zoning	Likelihood of Change for the environment	Likely Future Environment
Business	Business (Industrial)	Low	Urban
	Business (Town Centre)	Low	Urban
Residential	Residential - Mixed Housing Suburban Zone	Low	Urban

[16] Based on AUP:OP zoning/policy direction
[17] Based on AUP:OP zoning/policy direction

Open Space (located to the north of the proposed station location)	Open Space – Informal Recreation Open Space – Sport and Active Recreation	Low	Open Space

Huapai Station is proposed to be located on land at 29 and 31 Meryl Avenue on the western side of the Ahukuramu. The land is zoned under the AUP:OP as Future Urban Zone. An active modes overbridge is proposed across the NAL and SH16 to FUZ land. Future connections will be determined as part of structure plan process.

Table 9-3: Huapai Rapid Transit Station Existing and Likely Future Environment

Environment today	Zoning	Likelihood of Change for the environment	Likely Future Environment
Residential (located to the east of the proposed station location)	Residential – Single House Zone	Low	Urban
Future Urban Zone / Undeveloped greenfield areas	Future Urban	High	Urban

9.2.2 Existing and Future Noise Environment

The alignment traverses a range of areas with different ambient noise environments. These range from existing high noise levels in the mid-60 to low-70 dB L_{Aeq} adjacent to the existing SH16, to lower noise environments around the 50s dB L_{Aeq} with intermittent noise from trains adjacent to the NAL. While the noise levels adjacent to the proposed alternative state highway would be currently low due to the rural character, this would change significantly in the future if the alternative motorway was in place.

The Kumeū Station is located in a business area bordered to the north and south by SH16 and the NAL respectively. Ambient noise levels are affected by both existing transport corridors and would be in the mid to high-60 dB L_{Aeq}. This is unlikely to change significantly in the future.

The Huapai Station is located in land currently used for rural activities adjacent to SH16. While the existing noise levels are still affected by SH16, they are likely to be in the low to mid-60 dB L_{Aeq} due to lack of other high noise activities in the area. This is unlikely to change with the future urbanisation as noise levels will still be controlled by traffic noise from the state highway.

Where the existing environment is materially different at the time of construction, any new occupied buildings will need to be assessed against the relevant noise and vibration limits and included in the relevant CNVMP.

9.2.3 Buildings inside designation

The following Table 9-4 shows the buildings that are inside the proposed designation. We have not assessed them further as the assumption is that they will be removed or unoccupied during construction. We only note the addresses where the main building is inside designation, and not those where auxiliary buildings such as sheds or garages may be removed.

We assume that the relevant requiring authority will acquire the parcels of land that these buildings are located on. In addition, auxiliary buildings are not generally occupied, so would not be relevant receivers in relation to this assessment,

Table 9-4: Buildings inside designation (not assessed)

Address	Address
42, 120, 122, 124, 130, 134, 138, 142, 146, 149, 152, 154, 156, 162, 176, 176A, 178, 182 Boord Cres, Kumeū	29, 30, 31 Meryl Ave, Kumeū
149 – 155 (uneven no. only), 186, 186, 188, 202, 204 Fred Taylor Dr, Whenuapai	191, 272, 278, 280, 609 SH16, Kumeū
51 Gilbransen Rd, Kumeū	2, 4, 6, 8 Tapu Rd, Huapai
87 Joseph Dunstan Dr, Taupaki	380, 388, 389, 400, 401 Taupaki Road, Taupaki
7 Main Road, Kumeū	9 Trotting Course Dr, Kumeū
335 – 347 (uneven no. only) Main Road, Huapai	903 Waitakere Road, Kumeū

9.3 Assessment of Construction Noise and Vibration Effects

9.3.1 Construction Noise Effects

9.3.1.1 Predicted noise level exceedances

The proposed designation allows for the construction area required, laydown yards and stormwater ponds, as well as connections with existing roads. Therefore, most buildings are at a sufficient distance to receive noise levels that are compliant with the relevant criteria.

Works in closer proximity are proposed where tie ins with existing roads occur (e.g. Fred Taylor Drive, Taupaki Road and Boord Crescent). Where the works occur adjacent to the existing SH16, the area is well developed and occupied by a mix of residential, commercial and industrial buildings.

The traffic lanes in the RTC would be constructed like any other road with asphalting equipment. In order to remain conservative and identify the widest potential construction noise envelope, we have based our predictions on the loudest activity (i.e. earthworks and bridge piling works). We anticipate that irrespective of transport mode similar earthworks extents will be required.

The figures in Appendix 1.3 show the construction noise envelope within which mitigation will need to be implemented.

Based on the construction activities summarised above, we have identified 181 properties where construction noise levels have the potential to exceed the relevant criteria. These are shown in Table 9-5. Some buildings identified are auxiliary buildings (e.g. garages, or sheds) that may not be occupied during construction but have been included for completeness. These are shown in grey in the table.

At the time of construction the buildings existing at the time will need to be reassessed to ensure all relevant receivers are included in the CNVMP. Since part of the Project traverses the FUZ, additional buildings may have been developed by the time of construction. However, the designation is generally

wide enough to avoid significantly larger effects than those predicted, i.e. noise levels received at future dwellings would not be substantially higher than predicted for existing dwellings.

Table 9-5: Potential noise criteria exceedances (based on earthworks activities)[18]

Address	Address
23, 37, 51, 51A, 62, 82, 99, 102, 108, 111, 113, 186, 190, 202, 210, 214 Boord Crescent, Kumeu	27 Access Rd, Kumeū
196, 200 Fred Taylor Dr, Whenuapai, Auckland	15, 96, 228 Boord Crescent, Kumeū
47, 50 Gilbransen Rd, Kumeū	119, 198 Fred Taylor Dr, Whenuapai, Auckland
75, 91 Joseph Dunstan Dr, Taupaki	1, 15, 33 Grivelle Street, Kumeū
7 Main Rd, Kumeu	88 Joseph Dunstan Dr, Taupaki
342, 344, 348, 351, 352, 353, 355, 357, 359, 361, 365, 367 370, 372, 376, 382, 399, 401, 405, 407, 407A Main Rd, Huapai	40, 42, 46, 48, 50-54, 56-58, 64, 66, 68, 74, 78, 80, 82, 84, 86, 88, 90-92, 106, 108-110, 132, 134-152, 156G, 154, 190, 223, 248, 250, 280, 282, 296, 300, 302-318, 322, 326, 330, 332, 334, 338, 340, 346, 378, 380, 384 Main Rd, Kumeū
239 Matua Rd, Kumeū	3, 4, 8-12, 14-20 Matua Rd, Huapai
6 Oraha Rd, Huapai	5-21 Oraha Rd, Kumeū
222, 238, 238A, 246, 293, 573, 583, 587 State Highway 16, Kumeū	1 Putaki Dr, Kumeū
16, 20 Sunny Crescent, Huapai	1 – 5, 7 – 11, 8A, 14 – 19, 22 Shamrock Dr, Kumeū
3, 5, 10, 12, 14, 18, 16A, 20, 16A Tapu Rd, Huapai	218, 239, 272, 284, 393, 601, 647 State Highway 16, Kumeū
370, 375, 405, 412, 418, 419, 422, 434, 440, 443, 448, 454, 455, 466 Taupaki Rd, Taupaki	1, 1A, 2 Tapu Rd, Huapai
13, 15 Trotting Course Dr, Kumeū	374 422, Taupaki Rd, Kumeū
901, 906 Waitakere Rd, Kumeū	903, 927, 933, 993 Waitakere Rd, Kumeū
22 Wookey Lane, Kumeū	1 Weza Lane, Kumeū
	20, 21-23, 25, 35, 43 Wookey Lane, Kumeū

9.3.1.2 Daytime works

The loudest activities across the entire project will be earthworks. These activities move along the alignment. Because of that, mitigation in the form of barriers is not efficient unless there are special circumstances.

Piling for the construction of bridges is also a notable noisy activity. However, this will occur for only a brief period over the overall construction duration, and can be mitigated with equipment choice, barriers and placement of equipment.

[18] Black addresses reflect dwellings or other noise sensitive receivers, while grey addresses reflect auxiliary buildings such as garages or sheds that may not be occupied during construction

Mitigation as set out in Section 4.5 will be implemented across the works. There are no specific construction activities close to buildings that would require mitigation in addition to common best practice.

Predicted noise levels may be as high as 75 to 80 dB L_{Aeq} at the closest dwellings, during times of earthworks in close proximity. However, these works would occur only for a few days and then move along the alignment. Only a small number of buildings may be affected by such levels, where works are particularly close.

Station construction will occur for a more sustained period in the same location. This means that neighbouring buildings will receive elevated construction noise levels for a longer time than those adjacent to the alignment only. For Kumeū Station, closest buildings are all commercial in nature (e.g. shops and Atlas Concrete at present) but also include the Huapai library. Construction works will be beyond SH16, which means that the receivers are currently experiencing elevated noise levels. Barriers can be employed to mitigate noise levels, as well as other commonly used BPO mitigation and management.

Huapai Station is in a currently semi-rural area, with some dwellings in close proximity. Exceedances of the daytime noise criterion are predicted at 239 Matua Road, with levels up to 75 dB L_{Aeq} predicted due to earthworks. Other dwellings in the vicinity are predicted to receive noise levels that comply with 70 dB L_{Aeq}. Daytime levels of up to 75 dB L_{Aeq} are unlikely to cause significant adverse effects given that the duration of such level would be limited to the time when earthworks occur close to the designation boundary only. We consider that effects would therefore be reasonable provided relevant measures as set out in Section 4.5 are implemented. For most of the construction works and construction duration, we predict that noise levels can comply with the 70 L_{Aeq} noise criterion at the surrounding receivers.

Should the area surrounding the Station have been urbanised prior to its construction, all buildings existing at the time of construction need to be assessed for construction noise effect. This is be done through the CNVMP and Schedules (refer Sections 4.5.3 and 4.5.4).

9.3.1.3 Night-time works

At this stage, we do not anticipate that night works would be required. All works appear to be offline from any major road or rail alignments, and are therefore unlikely to affect traffic on those corridors.

Should night works be required, these works would be of limited duration as they would relate to specific activities. In any event, such works will need to be managed through the CNVMP and require the preparation of a Schedule (refer Section 4.5.4). With appropriate management the construction can be undertaken within reasonable noise levels that would be expected from construction of such infrastructure.

9.3.2 Construction Vibration Effects

Vibratory rollers are the most common high vibration generating equipment across the Project. In addition, piling for bridges also causes high vibration levels.

As discussed in Section 4.4.3, we have provided for a 100% safety margin when determining the envelope of vibration levels. For Category B for all occupied buildings, this is at a distance of 15m. For Category A, for occupied PPFs the relevant distance is 80m and for occupied other buildings it is 40m.

Appendix 2 includes figures showing the vibration envelopes for these three criteria.

Table 9-6 shows the addresses of identified buildings that, if existing at the time of construction and occupied, may receive vibration levels exceeding Category B. Six of these buildings are identified as PPFs, while the remainder are auxiliary buildings and non-PPFs (shown in grey in the table below).

The construction of the rapid transit network is relatively narrow in a wide designation, with very few (three) buildings within 15m of the works.

Table 9-6: Potential Category B vibration criteria exceedances (based on vibratory roller activities)

Address	Address
51, 111 Boord Crescent, Kumeū	86, 353, 359, 361 Main Rd, Kumeū
419, 455 Taupaki Road, Kumeū	30 Meryl Ave, Kumeū
13 Trotting Course Drive, Kumeū	2, 4, 8, 8A, 10, 14-16, 18 Shamrock Dr, Kumeū
906 Waitakere Road, Kumeū	903, 993 Waitakere Rd, Kumeū
	20 Wookey Lane, Kumeū

If on-site measurements confirm the predicted vibration levels, then alternative construction methods should be considered, e.g. non-vibratory compaction or bored piling.

In relation to the corridor construction, an additional 51 PPFs have been identified that may receive vibration levels exceeding the Category A vibration criteria. Category A criteria should be used as a trigger to engage with potentially affected people.

The construction of the station is predicted to generate vibration levels that comply with the Category A and B vibration criteria at all times.

Vibration generally occurs intermittently, when equipment passes the building or where there is particular ground resistance during piling and can be tolerable if prior notification is given. However, high vibration generation is not appropriate for night-time and should be avoided as far as practicable.

There are two heritage buildings within the existing heritage overlay along SH16 Main Road that are proposed to be repositioned along the corridor following works commencing on the RTC (NoR S3) to enable the construction of the Project. The buildings are transported to their new site, which will involve high levels of vibration through the loading, transport and unloading. Therefore, we consider that with appropriate siting and careful construction management, construction vibration is unlikely to cause damage to these buildings.

9.4 Conclusions

We have predicted construction noise and vibration levels for the Project, based on the likely construction sequence and methodology set out in Section 4.2.

The identified noisiest activities covering the largest extent of the works will be earth works. We have therefore based our assessment on this activity.

Overall, we predict that most activities can comply with the relevant noise and vibration criteria. Noise effects are more extensive than vibration effects, due to the wider earthworks area. Only a very small number of PPFs are predicted to potentially receive vibration levels above the Category B criteria without mitigation.

Where non-compliance is predicted, this would occur for limited and defined periods only, when equipment operates close to occupied buildings.

Common best practice mitigation and management should be implemented across the construction site, and this should be documented in the CNVMP. Schedules will need to be prepared for those activities that are predicted to exceed the criteria. This will involve communication with the affected persons.

10 NoR S4: Access Road Upgrade

10.1 Project Corridor Features

It is proposed to submit a Notice of Requirement (NoR S4) to designate the land required to implement the upgrade of Access Road to a four-lane corridor with separated walking and cycling facilities.

Access Road/Tawa Road is an existing arterial corridor that runs along the eastern Rural Urban Boundary (**RUB**) of Kumeū- Huapai. The proposed upgrade extends from the intersection of Access Road with SH16 (and entry to the Kumeū-Huapai township) in the east and continues into Tawa Road to its intersection with Puke Road in the west. Access Road plays a key role in connecting the existing and likely future business zones to both the RTC and ASH. It is aligned along the south-eastern boundary of the southern FUZ, providing for an enhanced collector network to connect to it.

It is proposed to widen the existing Access Road/Tawa Road corridor from its current width of 20m to accommodate a 30m wide four-lane cross-section. The cross-section of the corridor transitions from the rural edge cross-section to an urban cross-section at Wookey Lane intersection. Along the western section of Access Road, which is a low-speed rural section, the corridor has a rural southern edge (swales, typically 9m wide top width) with walking and cycling facilities along its northern urban edge. Through the business and industrial area, a 30m urban corridor is provided, including walking and cycling infrastructure along both sides of this eastern section.

An overview of the proposed design is provided in Figure 10-1 below.

Figure 10-1: Overview of Access Road Upgrade

Key features of the proposed upgrade include the following:

- Upgrading the existing Access Road corridor to a 30m wide four-lane arterial road with walking and cycling provisions.
- Swales typically with a 9m wide top width along the western section of Access Road on the southern edge.
- Tie-ins with existing roads, stormwater dry ponds, wetlands and culverts.
- Batter slopes to enable widening of the corridor, and associated cut and fill activities.
- Vegetation removal along the existing road corridor
- Other construction related activities required outside the permanent corridor including the re-grade of driveways, construction traffic manoeuvring and construction laydown areas.

Construction is anticipated to take approximately 3 years.

10.2 Existing and Likely Future Environment

10.2.1 Planning context

Access Road/Tawa Road is an existing arterial corridor that runs along the eastern RUB of Kumeū-Huapai.

- The northern side of Access Road is zoned under the AUP:OP as FUZ, with Business – Light Industry Zoning at the north-eastern section of Access Road.
- The southern side of Access Road is predominantly zoned under the AUP:OP as Rural – Countryside Living, with exception to the Kumeū Showgrounds which are zoned as Rural – Mixed Rural Zone are identified as a precinct (I517 Kumeū Showgrounds Precinct) in the AUP:OP.

Table 10-1 below provides a summary of the existing and likely future environment as it relates to Access Road.

Table 10-1: Access Road Upgrade Existing and Likely Future Environment

Environment today	Zoning	Likelihood of Change for the environment[19]	Likely Future Environment[20]
Business	Business (Light Industrial) Zone	Low	Urban
Rural	Rural – Countryside Living Zone Rural – Mixed Rural Zone	Low	Rural
Undeveloped greenfield areas (Future Urban Zone)	Future Urban	**High**	Urban

[19] Based on AUP:OP zoning/policy direction
[20] Based on AUP:OP zoning/policy direction

10.2.2 Existing and Future Noise Environment

The existing environment is generally removed from major transport corridors apart from the immediate connection with the existing SH16. While the eastern section of the Project is somewhat affected by traffic and commercial noise, most of the Project is in a currently rural area with lower noise levels.

When the FUZ north of Access Road is developed, the environment is expected to change significantly. We anticipate increased noise levels from more intensive occupation. In addition, should the ASH (NoR S1)[21] have been implemented already, the ambient noise level would be elevated in the vicinity of that road

Where the existing environment is materially different at the time of construction, any new occupied buildings will need to be assessed against the relevant noise and vibration limits and included in the relevant CNVMP.

10.2.3 Buildings inside designation

The following Table 10-2 shows the buildings that are inside the proposed designation. We have not assessed them further as the assumption is that they will be removed or unoccupied during construction. We only note the addresses where the main building is inside designation, and not those where auxiliary buildings such as sheds or garages may be removed.

We assume that the relevant requiring authority will acquire the parcels of land that these buildings are located on. In addition, auxiliary buildings are not generally occupied, so would not be relevant receivers in relation to this assessment,

Table 10-2: Buildings inside designation (not assessed)

Address	Address
21, 123, 185, 187, 236 Access Road, Kumeū	166 Station Road, Kumeū

10.3 Assessment of Construction Noise and Vibration Effects

10.3.1 Construction Noise Effects

10.3.1.1 Predicted noise level exceedances

The designation area generally extends both to the south and north of Access Road, into the Rural zone and FUZ. Since part of the alignment borders established rural and residential areas, a number of dwellings are close to the proposed works and will be affected by them.

The figures in Appendix 1.4 show the construction noise envelope within which mitigation will need to be implemented.

Based on the construction locations described above, we have identified 76 properties where construction noise levels have the potential to exceed the relevant criteria. These are shown in Table 10-3. Some buildings identified are auxiliary buildings (e.g. garages, or sheds) that may not be

[21] Another North West Strategic Project, refer Section 7 of this report

occupied during construction but have been included for completeness. These are shown in grey in the table.

At the time of construction the buildings existing at the time will need to be reassessed to ensure all relevant receivers are included in the CNVMP. Since part of the Project traverses the FUZ, additional buildings may have been developed by the time of construction. However, the designation is generally wide enough to avoid significantly larger effects than those predicted, i.e. noise levels received at future dwellings would not be substantially higher than predicted for existing dwellings.

Table 10-3: Potential noise criteria exceedances (based on earthworks activities)[22]

Address	Address
24, 26, 27, 40, 44, 60, 64, 95, 116, 121, 127A, 127B, 161, 162, 165, 171, 174, 176, 181, 184, 199, 211, 218, 233, 236 Access Road, Kumeū	18, 26, 27, 35, 38, 50, 68, 72, 97-99, 121, 184, 221 Access Road, Kumeū
8 Grivelle Street, Kumeū	2 – 6, 29, 33 Grivelle Street, Kumeū (even no. only)
152 Station Road, Kumeū	4 – 6, 5 – 12 Loft Place, Kumeū
17, 25, 49, 56, 59, 63, 66, 73, 76, 79, 83, 86 Tawa Road, Kumeū	1 – 5, 7, 9 Shamrock Drive, Kumeū
	166 Station Road, Kumeū
	43, 48 Tawa Rd, Kumeū
	1 – 9 Wookey Lane, Kumeū

10.3.1.2 Daytime works

The loudest activity across the entire Project are earthworks, which move along the alignment. Therefore, mitigation in the form of barriers is not efficient unless there are special circumstances.

Mitigation as set out in Section 4.5 will be implemented across the works. There are no specific construction activities close to buildings that would require mitigation in addition to common best practice.

Predicted noise levels may be as high as 80 dB L_{Aeq} at the closest dwellings, during times of earthworks in close proximity. However, these works would likely occur only for a few days and then move along the alignment. The exceedances will be limited and passing. Good communication and timing of activities can assist in reducing effects. We consider that effects would therefore be reasonable provided relevant measures as set out in Section 4.5 are implemented.

For most of the construction works and construction duration, we predict that noise levels can comply with the 70 L_{Aeq} noise criterion at the surrounding receivers.

[22] Black addresses reflect dwellings or other noise sensitive receivers, while grey addresses reflect auxiliary buildings such as garages or sheds that may not be occupied during construction

10.3.1.3 Night-time works

Night works may be required where the road would need to be closed for the construction, e.g. during final surfacing and at the tie ins with SH16.

These works are limited in duration, often requiring only two or three nights' work. In any event, such works will need to be managed through the CNVMP and require the preparation of a Schedule (refer Section 4.5.4).

We consider that with appropriate management the construction can be undertaken within reasonable noise levels that would be expected from construction of such infrastructure.

10.3.2 Construction Vibration Effects

Vibratory rollers are the most common high vibration generating equipment across the Project.

As discussed in Section 4.4.3, we have provided for a 100% safety margin when determining the envelope of vibration levels. For Category B for all occupied buildings, this is at a distance of 15m. For Category A, for occupied PPFs the relevant distance is 80m and for occupied other buildings it is 40m.

Appendix 2 includes figures showing the vibration envelopes for these three criteria.

Table 10-4 shows the addresses of identified buildings that, if existing at the time of construction and occupied, may receive vibration levels exceeding Category B. Ten of these buildings are identified as PPFs, while the remainder are auxiliary buildings and non-PPFs (shown in grey in the table below).

Table 10-4: Potential Category B vibration criteria exceedances (based on vibratory roller activities)[23]

Address	Address
24, 64, 116, 184, 218 Access Road, Kumeū	18, 35, 72, 184, 236 Access Road, Kumeū
49, 56, 59, 76 Tawa Road, Kumeū	4, 6, 29, 33 Grivelle Street, Kumeū
	1 Shamrock Dr, Kumeū
	25, 63 Tawa Road, Kumeū

If on-site measurements confirm the predicted vibration levels, then alternative compaction methods should be considered, e.g. non-vibratory compaction.

An additional 33 PPFs have been identified that may receive vibration levels exceeding the Category A vibration criteria. Category A criteria should be used as a trigger to engage with potentially affected people.

Vibration generally occurs intermittently, when equipment passes the building, and can be tolerable if prior notification is given. However, high vibration generation is not appropriate for night-time and should be avoided as far as practicable.

[23] Black addresses reflect dwellings or other sensitive receivers, while grey addresses reflect auxiliary buildings such as garages or sheds that may not be occupied during construction

10.4 Conclusions

We have predicted construction noise and vibration levels for the Project, based on the likely construction sequence and methodology set out in Section 4.2. The works controlling the noise and vibration predictions are earthworks and vibratory rolling respectively. Both activities will be used across the entire project.

Overall, we predict that most activities can comply with the relevant noise and vibration criteria. Where non-compliance is predicted, this would occur for limited and defined periods only, when equipment operates close to occupied buildings while moving along the alignment.

Common best practice mitigation and management should be implemented across the construction site, and this should be documented in the CNVMP. Schedules will need to be prepared for those activities that are predicted to exceed the criteria. This will involve communication with the affected persons.

11 Conclusion

Construction noise and vibration has been assessed against relevant standards and guidelines, and effects have been assessed from the residual noise and vibration levels after mitigation and management measures as recommended have been implemented. The assessment takes into consideration the existing environment and makes allowances for potential changes to the environment that may occur prior to implementation of any of the Projects.

Construction noise and vibration will need to be managed and mitigated to achieve compliance, as far as practicable, with recommended standards and guidelines. Construction noise and vibration within all of the NoRs is predicted to largely comply with the relevant criteria, with only limited and specific activities predicted to generate high noise and/or vibration levels where buildings are in close proximity. These levels would only occur for limited and finite times and not extend across the full duration of construction.

The recommended management and mitigation measures are set out in Section 4.5. It is recommended that the management of construction noise and vibration effects is based on the methodology and framework of the recommended CNVMP and Schedules to ensure that the BPO is implemented.

The CNVMP for each NoR will be prepared prior to construction when more detailed information is available. At that time, effects and mitigation will need to be updated to incorporate all receivers that are present at the time of construction, i.e. if additional buildings are occupied adjacent to the construction site, these will need to be included in the CNVMP.

The effects from the construction noise and vibration levels are set out in Section 6. Overall, while for most of the works, compliance with 70 dB L_{Aeq} and Category A vibration levels can be achieved, at times noise levels may be up to 80-85 dB L_{Aeq} which would translate to approximately 55-60 dB L_{Aeq} inside if no further mitigation can be implemented. A number of buildings are predicted to receive vibration levels above Category A for certain activities (e.g. vibratory rolling). In both instances, the exceedances will be limited and passing, and management such as good communication and timing of activities can assist in reducing effects to a reasonable level.

Overall, construction noise and vibration can be managed and mitigated to a reasonable level, provided recommended mitigation is implemented.