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Title: **Lincoln Road Corridor Improvements**
Assessment of Construction Noise and Vibration Effects and Operational Noise Effects

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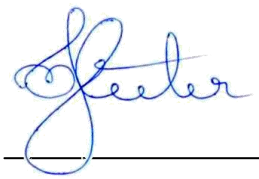

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Appendices

Terms of Reference

Styles Group has been engaged by MWH New Zealand Limited to provide technical noise and vibration advice relating to the Auckland Transport Lincoln Road Corridor Improvements project (LRCI). This report comprises an assessment of the construction noise and vibration effects, Part I, and an assessment of the operational noise effects, Part II, for the project described in the following section. This document has been prepared to accompany an integrated application package including a Notice of Requirement for a designation and applications for several resource consents.

The Project

The Auckland Transport LRCI project applies to a 1.3 kilometre length of Lincoln Road, Henderson, between its intersection with Te Pai Place to the south and the State Highway 16 on-ramp to the north. The project area is illustrated in the attached Appendix B.

The project will upgrade Lincoln Road to maintain two lanes for general traffic in each direction, while also providing for a transit lane, dedicated cycle lane and footpath in each direction. Additional and/or longer turning lanes will be constructed at controlled intersections. A raised median will be installed in the centre of the road, and u-turns will be enabled at controlled intersections. The project will also involve storm water upgrades and a new public road at the rear of 300 – 312 Lincoln Road. In order to construct the improvements, the existing road reserve will be widened by varying amounts on each side, and some left turn lanes are constructed close to existing dwellings.

Based on our walkovers of the site, we have determined that there are 91 Protected Premises and Facilities (PPFs) along the alignment comprising two childcare centres, Te Wananga o Aotearoa, Laidlaw College and 87 residential units, with a large proportion of the receiving environment comprising retail and business activity.

For a more detailed description of the project please refer to the AEE which accompanies the Notice of Requirement and resource consent applications.

Part I - Construction Noise & Vibration Effects

Executive Summary

During the construction phase of the project the *best practicable option* will be adopted to ensure compliance as far as practicable with the project noise and vibration criteria recommended within this report. Where predicted or measured levels for a construction activity on site exceed the project noise or vibration criteria, the first response will be to implement further mitigation measures with reference to the guidelines of a Construction Noise and Vibration Management Plan (CNVMP) which will be finalised and certified by Auckland Council prior to works commencing. Further measurements will be undertaken to demonstrate the effectiveness of the mitigation measures implemented. If the noise and/or vibration criteria are still exceeded with all practicable mitigation measures implemented, the works shall cease and a Site Specific Noise and Vibration Management Plan (SSNVMP) will be prepared and submitted to Council for certification. This process will ensure that noise and vibration emissions during the construction phase are controlled to be no greater than *reasonable* (in terms of s16 of the Act) at all times.

In our view, whilst at times there may be short term periods when the noise or vibration effects are significant at some receivers, the mitigation measures that have been proposed will ensure that the noise and vibration effects are minimised to the greatest extent practicable or avoided by temporary relocation of those affected. This approach has been adopted successfully on numerous roading and infrastructure projects previously including projects where the noise and vibration effects have been greater than what is predicted for this project.

Introduction

The advice in Part I of this document relates to the construction phase of the project only and forms part of the overall Assessment of Environmental Effects (AEE). The operational noise effects are addressed in Part II of this assessment.

A CNVMP will be prepared to allow appropriate management of construction noise and vibration emissions during the construction phase of the project. The CNVMP is discussed herein but will be provided as a separate document prior to the commencement of any construction works on site. This assessment and a draft version of the CNVMP have been prepared for inclusion within the application package.

A glossary of acoustical terms used in this report is attached to this report as Appendix A.

Existing Noise Environment

Styles Group has undertaken unattended noise logger measurements over several days, outside of school holidays, to quantify the existing ambient noise environment in terms of the $L_{Aeq(24hour)}$ noise descriptor and to investigate the existing background noise levels.

Noise loggers were deployed at two locations, 182 Lincoln Road and 1B Daytona Road, to continuously log data in 1 second intervals. Audio files were recorded with the noise levels simultaneously so noise sources could be identified on playback. The noise levels in the area were clearly controlled by road traffic. Meteorological conditions throughout the measurements were suitable for noise measurements and no adjustments or exclusions were required for inclement weather. From the logged data we have calculated the 24 hour L_{Aeq} levels, as presented in Table 1. The night time background noise levels are presented in Table 1 as the range of $L_{A95(15min)}$ noise levels measured between 20:00 and 06:30 the following day. The monitoring locations are illustrated in Figure 1.

Table 1: Existing Noise Environment

Address	Distance to edge of nearest lane on Lincoln Rd	Date	$L_{Aeq(24hr)}$	$L_{A95(15min)}$ 20:00 to 06:30
182 Lincoln Rd	7.3 m	20.10.15 - 21.10.15	69 dB	30 dB – 54 dB
		21.10.15 - 22.10.15	66 dB	32 dB – 52 dB
		22.10.15 - 23.10.15	67 dB	34 dB – 55 dB
		23.10.15 - 24.10.15	69 dB	34 dB – 54 dB
		24.10.15 - 25.10.15	67 dB	37 dB – 52 dB
		25.10.15 - 26.10.15	66 dB	29 dB – 50 dB
		26.10.15 - 27.10.15	66 dB	31 dB – 52 dB
1B Daytona Rd	9.0 m	20.10.15 - 21.10.15	64 dB	31 dB – 58 dB
		21.10.15 - 22.10.15	63 dB	32 dB – 57 dB
		22.10.15 - 23.10.15	63 dB	34 dB – 57 dB
		23.10.15 - 24.10.15	65 dB	35 dB – 56 dB
		24.10.15 - 25.10.15	63 dB	40 dB – 56 dB
		25.10.15 - 26.10.15	63 dB	31 dB – 54 dB
		26.10.15 - 27.10.15	63 dB	32 dB – 56 dB

The measured noise levels, presented in Table 1, demonstrate that the existing environment includes high levels of road traffic noise.

Figure 1: Map of Noise Monitoring Locations

Noise and Vibration Performance Criteria

District Plan

The construction works along Lincoln Road and on the intersecting side roads are to be authorised by way of designation. The Auckland Council District Plan – Operative Waitakere Section 2002 references the 1984 standard NZS 6803:1984P *The Measurement and Assessment of Noise from Construction, Maintenance and Demolition Work* for permitted activity noise criteria for construction works within the surrounding zones. The District Plan does not specify permitted activity criteria for ground-borne vibration arising from construction works.

The 1984 provisional version of NZS 6803 has long been superseded by NZS 6803:1999 *Acoustics – Construction Noise*. The 1999 version of the standard adopts the L_{Aeq} metric in place of the L_{A10} statistical descriptor for the assessment of construction noise, which in our opinion is appropriate. We recommend that the 1999 version of the NZS 6803 Standard is adopted for the measurement and assessment of construction noise during this project. This is a typical approach for large-scale infrastructure projects in New Zealand.

Table 2 displays the upper limits for construction noise received with residential zones recommended by NZS 6803:1999 *Acoustics – Construction Noise*. Table 3 displays the upper limits for commercial and industrial areas. These limits apply to construction works taking place at any one location for more than 20 weeks (long-term duration).

Table 2: NZS 6803:1999 Residential Zone Noise Limits for Long-term Duration Construction Works

Time of week	Time period	L_{Aeq} noise limit	L_{Amax} noise limit
Weekdays	06:30 – 07:30	55 dB	75 dB
	07:30 – 18:00	70 dB	85 dB
	18:00 – 20:00	65 dB	80 dB
	20:00 – 06:30	45 dB	75 dB
Saturdays	06:30 – 07:30	45 dB	75 dB
	07:30 – 18:00	70 dB	85 dB
	18:00 – 20:00	45 dB	75 dB
	20:00 – 06:30	45 dB	75 dB
Sundays and public holidays	06:30 – 07:30	45 dB	75 dB
	07:30 – 18:00	55 dB	85 dB
	18:00 – 20:00	45 dB	75 dB
	20:00 – 06:30	45 dB	75 dB

Table 3: NZS 6803:1999 Commercial/Industrial Area Noise Limits for Long-term Duration Construction Works

Time Period	L_{Aeq}
07:30 – 18:00	70 dB
18:00 – 07:30	75 dB

Section 7.2.6 of NZS 6803:1999 recommends that within urban areas, a high background noise level may warrant a less stringent noise limit being applied to construction works during the evening and night time periods. We have undertaken measurements of the existing noise environment. These are discussed further herein together with appropriate noise limits for the period 20:00 to 06:30 on weekdays and Saturdays.

Resource Management Act

Section 16 *Duty to avoid unreasonable noise* of the Resource Management Act 1991 (the Act) states:

1) *Every occupier of land (including any premises and any costal marine area), and every person carrying out an activity in, on, or under a water body or the costal marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level.*

Noise is defined by the Act as "*includes vibration*".

Construction Noise

Construction Activities and Noise Levels

The construction works will span over a 1.3 kilometre length of Lincoln Road, between the State Highway 16 on-ramp and the Te Pai Place intersection. Specific construction activities that will likely generate noise during the works include:

i. Excavation;

ii. Compaction;

iii. Concrete pours, paving and associated works;

iv. Manoeuvring trucks and heavy plant on site;

v. Grinding and concrete drilling.

The majority of the noisy works for the project will be carried out between the hours of 07:30 – 18:00. The relevant NZS 6803:1999 noise limits during this time are 70 dB L_{Aeq} and 85 dB L_{Amax}. These are applicable at 1 m from the most exposed facade of the building on the site where the construction noise is being measured. If an assessment of the noise levels within the building is required, the noise levels will be measured with reference to Clause 6.2.2 of NZS 6803:1999 and the provisions of NZS 6801:1999. The expected timeframe for completion of all construction works on site is approximately 2 years. However, due to the span of the works, the total duration of the noise effects experienced at any one site will be much shorter.

The overall aim of the project with respect to construction noise is to adopt the best practicable option to comply with the noise limits recommended by NZS 6803:1999. A CNVMP will be produced to facilitate this and to enable appropriate management of noise emissions from the works at all times. The CNVMP is discussed further herein.

Where modelled, predicted or measured noise levels for a construction activity on site exceed the applicable noise limits, the first response will be to implement further mitigation measures with reference to the guidelines of the CNVMP. Further measurements will be undertaken to demonstrate the effectiveness of the mitigation measures implemented. If the noise limits are still exceeded with all practicable mitigation measures implemented, the works shall cease and a SSNVMP will be prepared and submitted to Council for certification. The purpose of the SSNVMP is to set out specific details of the activity and to demonstrate that the best practicable option is being adopted to mitigate the noise emissions and effects. SSNVMP's are discussed further herein.

Construction activity during the night time period will be required at times during the project for works such as the construction of the median barrier and paving. This is to allow lane closures for additional working width so the works can be completed. The methodology and time frames for these night works have not yet been confirmed and in many cases the specifics will not be known until the project construction is underway. Notwithstanding, all adjacent residents will be notified no less than 5 days before the commencement of any night-works and a SSNVMP will be submitted to Council for any night-works that may be predicted to exceed the applicable night-time controls.

The noisiest construction activities expected to take place on site are detailed in Table 4 together with the shortest distances these activities can approach neighbouring dwellings whilst remaining compliant with the 70 dB L_{Aeq} daytime noise limit. Table 4 is provided as a guide only and will be updated in the CNVMP when noise measurements of the site specific equipment are undertaken as the project progresses. If works are required closer than the distances in Column (1) where no natural or existing screening is available, then noise barriers will be installed where practicable. If works are required closer than the distances set out in Column (2), further noise mitigation measures may be necessary, such as additional localised screening. Details of such mitigation will be set out in the CNVMP. Please note that the

distances in Table 4 are measured between the sound source and 1 metre from the most exposed facade of the nearest dwelling. The source L_{Aeq} noise levels for the various items of plant are derived from numerous measurements undertaken by Styles Group on similar projects and with reference to NZS 6803:1999 Appendix C *Guide to Sound Level Data on Site Equipment and Site Activities*.

Table 4: Separation Distances for Noisy Activities

Activity on site	Reference L_{Aeq} at 10 m from plant (free-field level)	Column 1: Minimum compliance distance between noise source and 1 m from dwelling facade (unmitigated)	Column 2 : Minimum compliance distance including mitigation from 2 m high acoustic barrier
40 t excavator breaking up concrete or road surface	86 dB	80 m	32 m
Concrete cutter (low noise saw blade)	82 dB	51 m	21 m
Excavation with 30 t excavator	75 dB	23 m	9 m
Excavation with 22 t excavator	71 dB	15 m	6 m
22 t compaction roller	80 dB	41 m	16 m
12 t vibratory compaction roller	80 dB	41 m	16 m
Concrete pump and truck discharging	67 dB	9 m	4 m
140H Grader	83 dB	57 m	23 m
D6 Bulldozer	85 dB	72 m	29 m
Bored Piles	79 dB	36 m	15 m
100 t mobile crane lifting load	71 dB	15 m	6 m
Generator	66 dB	8 m	4 m
Grinder cutting 225 mm diameter pipe	80 dB	41 m	16 m
Asphalt paver and tipper truck	75 dB	23 m	9 m

Recommended Construction Noise Limits

Because the noise levels in the existing environment are high (dominated by road traffic noise), we recommend that it is appropriate to increase the night time noise limit for residential receivers to 55 dB L_{Aeq} on weekdays and Saturdays for the period between 20:00 and 06:30 the following day. This approach is in accordance with Section 7.2.6 of NZS 6803:1999 and has been adopted for numerous large roading projects in Auckland where raising the noise limit by 10 to 15 dB at night will not permit any appreciable increase in noise exposure to the residents along the route yet will allow for more work to be undertaken at night and will shorten the duration of the project overall. In this case, we suggest that an increase of 10 dB is appropriate for weekdays nights and Saturday nights (through to the morning after). The noise limit through the night on Sundays and Public Holidays, when existing transport noise levels may be lower, is to remain the same at 45 dB L_{Aeq}. The recommended construction noise limits for the project are set out in Table 5:

Table 5: Project Construction Noise Limits

Residential Receivers			
Time of week	**Time period**	**L_{Aeq} noise limit**	**L_{Amax} noise limit**
Weekdays (and Saturday mornings)	06:30 – 07:30	55 dB	75 dB
	07:30 – 18:00	70 dB	85 dB
	18:00 – 20:00	65 dB	80 dB
	20:00 – 06:30	55 dB	75 dB
Saturdays (and Sunday mornings)	06:30 – 07:30	45 dB	75 dB
	07:30 – 18:00	70 dB	85 dB
	18:00 – 20:00	55 dB	75 dB
	20:00 – 06:30	55 dB	75 dB
Sundays and Public Holidays (and the morning after)	06:30 – 07:30	45 dB	75 dB
	07:30 – 18:00	55 dB	75 dB
	18:00 – 20:00	45 dB	75 dB
	20:00 – 06:30	45 dB	75 dB
Commercial Receivers			
All Days	07:30 – 18:00	70 dB	n/a
	18:00 – 07:30	75 dB	n/a

Construction Vibration

Structural Vibration

We recommend that activities generating vibration are subject to compliance with the guideline vibration values set out in the German Standard DIN 4150-3:1999 *Structural vibration – Effects of vibration on structures*. The provisions of this Standard are typically adopted for controlling construction vibration emissions during roading projects in New Zealand. The Standard uses a three-tiered classification system for buildings according to their susceptibility to vibration damage. Thus:

1. Buildings used for commercial purposes, industrial buildings and buildings of similar design;

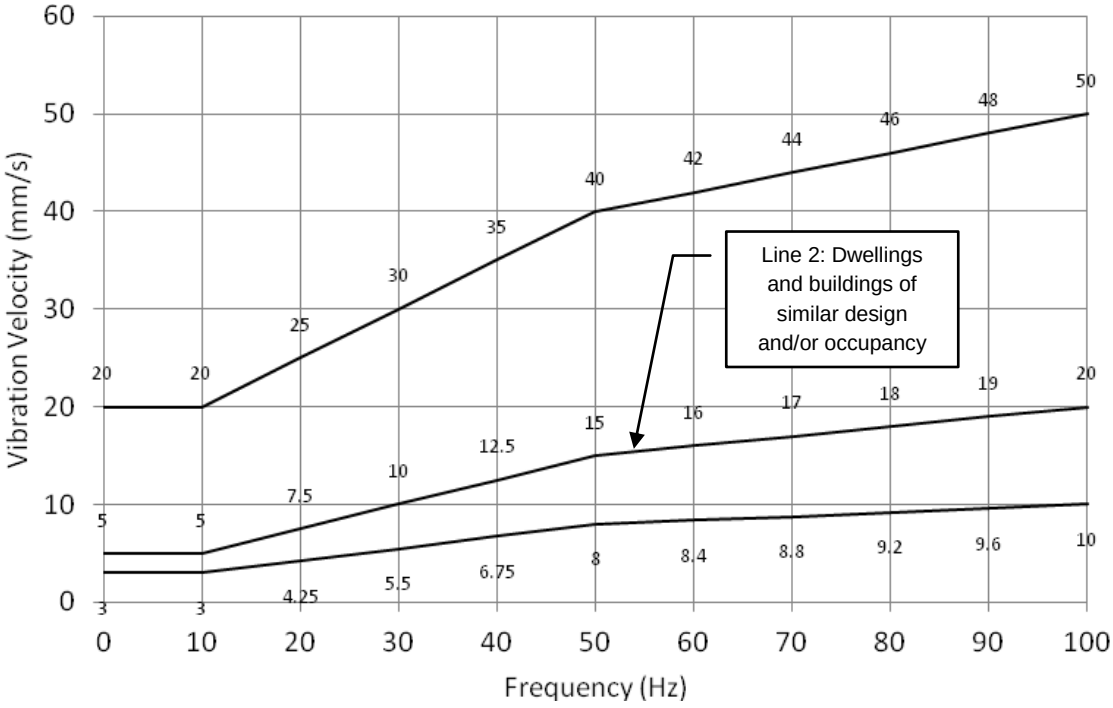
2. Dwellings and buildings of similar design and/or occupancy;

3. Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order).

The DIN classifications are according to the sensitivity of the building to vibration. The DIN Standard is specifically concerned with the structure of the building, not the effect of the vibration on the people within the building. Higher or lower limits may be set if the receiving structure's susceptibility to vibration can be more accurately determined. Assessment is in terms of a reduction in 'serviceability' as defined in the DIN 4150:1999 standard, which includes cracked plaster. We are not aware of any buildings in the area that have been classified as being particularly sensitive to vibration. Because the surrounding residential buildings are predominantly dwellings, we would compare the results of monitoring for these sites with the guideline limits under Category 2 – dwellings and buildings of similar design and/or occupancy. The vibration limits prescribed in DIN 4150 are presented in graphical form in Figure 2 for reference. The values pertaining to residential dwellings are illustrated by Line 2.

In the event that vibration greater that the DIN 4150:1999 guideline values are measured, the activity causing the vibration must cease until the subject structure has been assessed by a suitably qualified and experienced person until it is deemed safe to continue. When considering the proposed construction methodology and separation distances, it appears unlikely that the DIN 4150:1999 will be exceeded at any residential use building.

Figure 2: DIN 4150:1999 Vibration Velocity Guideline Values



The following activities are likely to generate levels of vibration requiring monitoring and mitigation where appropriate:

i. Movement of heavy tracked plant along the work site, including tracked excavators weighing 20 t or more;

ii. Breaking of concrete with excavators;

iii. Ground improvements and compaction (not including handheld equipment such as plate compactors).

Because vibration emissions are equipment and site specific, it is difficult to make accurate predictions at the nearest affected structures. However, based on our extensive experience in measuring construction vibration, the abovementioned activities can comply with the guideline values of DIN 4150:199 depending on separation distance and responsible operation of heavy plant within proximity of structures. Examples of similar activities measured by Styles Group at other sites are provided in Table 6. It must be noted that these are indicative only because a difference in ground conditions can make an appreciable difference to the vibration velocity and frequency. These measurements were undertaken from the ground and not at the foundations of a structure; they may therefore be a slightly conservative reference. The DIN 4150-3:1999 limits displayed in Table 6 are determined by the fundamental frequency with reference to Line 2 of the Standard.

Table 6: Examples of Vibration Velocity Levels from Similar Activities

Plant	Activity	Distance	Peak Particle Velocity (PPV)	Dominant Frequency	DIN 4150:1999 residential dwelling limit
30T Excavator	Shaking soil from bucket	25 m	1.3 mm/s	29 Hz	9.8 mm/s
20T Excavator	Impact of bucket on ground	3 m	2.6 mm/s	54 Hz	15.4 mm/s
Truck & Trailer	Laden truck and trailer manoeuvring	22 m	1.7 mm/s	9 Hz	5.0 mm/s
Hamm HD–75 8 t vibratory smooth drum roller	Compacting backfill with vibration set to 36 Hz	5 m	4.7 mm/s	37 Hz	11.8 mm/s

Human Annoyance

When construction vibration is assessed from within occupied dwellings and workplaces during the daytime, a Peak Particle Velocity (PPV) of 1.0 mm/s represents a typical threshold for human annoyance; 0.3 mm/s is the typical threshold of perception. A level of 1.0 mm/s or greater within occupied buildings may give rise to discomfort and a complaint being made to the project. During the daytime, this effect can generally be mitigated by notifying the occupants in advance of the activity and maintaining compliance with the DIN 4150-3:1999 guideline values for protection of structures. During the night-time period, vibration levels greater than 0.3 mm/s within occupied dwellings have the potential to cause sleep disturbance and must therefore be avoided or relocation offered to the residents if the works causing the vibration will extend late into the night.

Recommended Construction Vibration Limits

The following recommended construction vibration limits reflect the overall aim to comply with the human comfort threshold but recognise that it will not always be practicable during daytime works. A tiered approach to vibration limits is typical for large scale roading projects and is generally due to the required methodology and proximity of the works to the nearest receivers. With no piling or rock-breaking anticipated for the project, it will be practicable to comply with the

guideline values of DIN 4150-3:1999 when the human comfort limits (Category A) cannot be met. When measurements or predictions show that 1 mm/s will be exceeded within any occupied dwelling or workplace during the day, the relevant receivers will be notified in accordance with the provisions of the project CNVMP. The DIN 4150-3:1999 guideline values (Category B) will then be applied to the works and complied with. The recommended vibration limits for the project are summarised in Table 7.

During the night-time period, vibration emissions to occupied dwellings will not fall under the "Category" assessment criteria. To avoid sleep disturbance, it will be necessary to comply with a night-time PPV limit of 0.3 mm/s at all occupied dwellings. Where a dwelling is unoccupied at night, the DIN 4150-3:1999 limits will apply at that structure.

Table 7: Recommended Project Vibration Limits

Receiver	Time of day	Category A	Category B
Occupied dwellings Including dwellings, hospitals and rest homes.	07:00 to 22:00	1 mm/s	DIN 4150-3:1999
	22:00 to 07:00	0.3 mm/s	
Other occupied buildings Including offices and workspaces, schools and childcare facilities.	At all times	1 mm/s	DIN 4150-3:1999
Other buildings Including industrial buildings (occupied or unoccupied) and all other unoccupied buildings.	At all times	DIN 4150-3:1999	

Noise and Vibration Management Plans

Construction Noise and Vibration Management Plan

In our experience, a CNVMP is crucial to the successful management of noise and vibration effects that may arise during large scale construction projects. The management and monitoring of noise and vibration emissions and the response to neighbour's concerns is most appropriately dealt with by the implementation of a CNVMP. A CNVMP will allow for the process to be adapted to the final construction methodology and if required it can be amended and updated throughout the project.

We have prepared a draft CNVMP to be submitted in conjunction with this assessment for certification by Auckland Council. It is important that it is considered as a draft only, and that the conditions for the project allow for its finalisation before works commence.

The CNVMP contains little detail on the construction methodologies at this early stage and likely will not until a final methodology and plant list is confirmed. Notwithstanding, the important aspects of the CNVMP attached relate to noise monitoring and complaint response procedures. We do not expect these to change appreciably in the final approved version of the plan.

The general principal for noise monitoring will be to undertake the monitoring at the commencement of each noisy activity on the site, as well as responding to any complaints from neighbouring properties that may arise. This process has been implemented successfully on the vast majority of roading construction projects we have been involved with. The monitoring at the commencement of each activity may require immediate mitigation to be implemented for some items of plant or may confirm that other activities can continue without further mitigation.

This approach allows for a fast response if any complaints are received regarding a particular activity as measurements can be undertaken and compliance with the limits determined quickly. Corrective action measures can then be implemented without delay by referring to the provisions of the CNVMP, where necessary.

The process of responding to any concerns or complaints from the neighbours during the construction phase will include the contractor / consent holder maintaining a complaints register where the time, day, complainant's details and the nature of the complaint are recorded, as well as the investigation undertaken to determine the correct response or corrective action measure. The complaints register must be available for inspection at the reasonable request of Auckland.

Site Specific Noise and Vibration Management Plan

Where modelled/predicted or measured levels for a construction activity on site show that the applicable noise and/or vibration criteria will be exceeded, mitigation measures will be implemented with reference to the guideline of the CNVMP. Further modelling or measurements will be undertaken to demonstrate the effectiveness of the mitigation measures implemented. If the noise and/or vibration (Category B) criteria are still exceeded with all practicable mitigation measures implemented, the works shall cease and a SSNVMP will be prepared and submitted to Council for certification. The purpose of the SSNVMP is to set out specific details of the potential noise and vibration effects and demonstrate that the *best practicable option* to reduce emissions is being adopted at all times.

All SSNVMP's will:

i. Be submitted to Council for certification at least 5 working days prior to the proposed works commencing;

ii. Set out the proposed activity and equipment to be used, location, duration and timing of the works;

iii. Detail the proposed mitigation methods;

iv. Set out the predicted noise levels in accordance with NZS 6803:1999 and the project noise criteria at the nearest affected receivers;

v. Identify all receivers where the project criteria will be exceeded;

vi. Identify any properties where a reasonable level of noise will be exceeded during the night-time period. Temporary relocation of the residents at these sites may be appropriate to avoid sleep disturbance;

vii. Works will not commence until certification is received from Auckland Council.

If monitoring shows that the levels specified in the approved SSNVMP are being exceeded, the work generating the exceedance will stop and will not recommence until compliance is achievable or an amended SSNVMP stating the higher noise levels has been certified by Auckland Council.

Potentially Affected Properties

The properties potentially affected by noise and vibration are generally restricted to those that lie along the proposed route of the works on either side of the road (refer to Appendix B).

For vibration effects, generally only those properties immediately adjacent to the works will be potentially affected. Buildings more distant will be subject to vibration at lower levels; therefore, if compliance is achieved at the foremost buildings, then compliance will typically be achieved at buildings more distant. Similarly for noise, those receivers lying immediately adjacent to the works will be exposed to higher levels of noise, and those more distant will be deemed to comply where the noise levels at the closest receivers are compliant.

It is possible that in unusual circumstances, dwellings that are further removed from the site may be affected by noise or vibration to a degree that requires management by the CNVMP. Such events are rare and the potential effects on these properties will be dealt with by responding to complaints.

No less than three working days prior to works commencing within 100 m of each dwelling, the contractor will notify the residents by letter-drop. The notification will contain contact details for the stakeholder manager to receive any noise complaints. A complaints register will be

maintained by the contractor, as well as a record of what action was taken for each complaint. The complaints register shall be available for inspection at the reasonable request of Auckland Council and must remain on site at all times. The complaints register shall include as a minimum:

i. Details of each complaint, including date and time received and the nature of the complaint;

ii. Methods used to investigate the complaint;

iii. The results of any measurements undertaken as a result of the complaint; and

iv. Details of how and when the complaint was resolved

Corrective Action Measures

Should noise or vibration measurements undertaken by either the Council (or its representative) or the consent holder's representative identify non-compliance with the project limits, the activity responsible for the exceedance shall cease as soon as practicable (and only if safe to do so) and mitigation options shall be investigated. Mitigation deemed practicable will be implemented and monitoring will be undertaken to confirm performance of the mitigation measures. A report detailing the applied mitigation and measured levels will be submitted to the Auckland Council within 5 working days of the non-compliance being identified.

Monitoring & Reporting

Noise monitoring will be performed at the commencement of each new activity or phase of the construction process (e.g. night-works). The results of the monitoring will be used to determine/confirm what, if any, mitigation is required. The results shall be used to update and maintain the project CNVMP to ensure that minimum compliance distances and mitigation measures are specifically tailored to the equipment used on site.

If, in the opinion of the Site Manager, the noise or vibration arising from any activity on the site appears excessive, or following the receipt of any reasonable complaint, monitoring will be undertaken to assess compliance or otherwise with the noise and vibration limits. In the event that compliance is not being achieved with the Category B vibration limits, follow up building condition surveys shall be undertaken to ensure that no building damage has occurred.

Noise measurements will be undertaken using a sound level meter conforming to at least IEC651 Type 2 criteria. All noise measurements and assessments will be carried out in accordance with NZS 6803:1999 Acoustics – *Construction Noise*. All noise and vibration measurements and assessments shall be carried out by a suitably qualified and experienced person.

Assessment of Effects

The existing noise environment is dominated by road traffic noise. The ambient noise levels in the area are relatively high and are similar to the recommended noise limits for the construction project. In our opinion the existing ambient noise levels warrant an increase in the allowable noise emissions at night above those recommended by NZS 6803:1999. We have recommended a night time noise limit for residential receivers of 55 dB L_{Aeq} on weekdays and Saturdays for the period between 20:00 and 06:30 the following day. This will not permit any appreciable increase in noise for the residents but will allow for more work to be undertaken at night, thereby shortening the duration of the project and essentially reducing the duration of noise exposure.

For the majority of the construction phase, carefully designed and located acoustic screening and positioning of equipment in accordance with the provisions of the project CNVMP will allow compliance with the recommended noise limits. We consider that the recommended mitigation measures (within the CNVMP) and the use of SSNVMP's to manage the effects where the limits cannot practicably be met form part of the *Best Practicable Option* to reduce emissions in accordance with Section 16 of the Act.

When considering the District Plan permitted activity criteria, the exposure to construction noise for any one receiver and the existing ambient noise levels, we consider the potential degree of adverse noise effects to be *less than minor* on any site where compliance can be consistently maintained. However, it will not be practicable to comply with the NZS 6803:1999 limits at all residential sites at all times. The aim of the project will be compliance with the recommended limits but these will likely be infringed at times, which is allowed for in accordance with NZS 6803:1999 where there are high levels of noise in the existing environment. With the effects of any infringement managed in accordance with the CNVMP and the noise emissions mitigated to be no greater than *reasonable* under the guidance of a SSNVMP, the potential degree of adverse noise effects where compliance with the NZS 6803:1999 noise limits is not achieved will be *minor.* It is our opinion that it will be practicable at all times to control the noise emissions to be no greater than *reasonable* in accordance with s16 of the Act.

The recommended construction vibration limits reflect the overall aim to comply with the human comfort threshold but recognise that it will not always be practicable during daytime works. This is a typical approach for large scale roading projects and is generally due to the required methodology and proximity of the works to the nearest receivers. With no piling or rock-breaking anticipated for the project, it will be practicable to comply with the guideline values of DIN 4150–3:1999 when the human comfort limits (Category A) cannot be met. It is our opinion that compliance with the recommended limits will ensure that the construction vibration emissions will not exceed a *reasonable* level, in accordance with s16 of the Act.

Part II - Operational Noise effects

Introduction

The assessment in Part II relates to the operational phase of the project only and will form part of the overall assessment of environmental effects. The construction noise and vibration effects are addressed in Part I of this assessment.

A glossary of acoustical terms used in this report is attached as Appendix A.

Noise Performance Criteria

Waitakere District Plan

The District Plan references NZS 6801:1991 and NZS 6802:1991 for the measurement and assessment of environmental noise. However, these Standards cannot be appropriately applied to the assessment of road traffic noise arising from infrastructure improvements. Typically assessments of this nature will be undertaken in accordance with NZS 6806:2010 *Acoustics – Road-traffic noise – New and altered roads* (NZS 6806:2010), although this Standard is not usually referenced in District Plan rules.

Resource Management Act

Section 16 *Duty to avoid unreasonable noise* of the Resource Management Act 1991 (the Act) states:

> 2) *Every occupier of land (including any premises and any costal marine area), and every person carrying out an activity in, on, or under a water body or the costal marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level.*

NZS 6806:2010 *Acoustics – Road-traffic noise – New and altered roads*

New Zealand roading projects that require a new or altered designation are normally subject to a variety of conditions aimed at managing and minimising the potentially adverse public health and general amenity effects of noise. NZS 6806:2010 is a procedure-based standard for measuring, predicting, assessing and determining mitigation for road-traffic noise. It was developed to fulfil a need for guidance on methods and criteria and is designed to integrate

noise mitigation measures with other social and environmental factors to result in better standardised outcomes for stakeholders[1].

The outcome statement of NZS 6806:2010 states *"This Standard will assist road controlling authorities, developers and consent authorities to manage the effects of road-traffic noise from new and altered roads through the provision of consistent procedures and requirements for the measurement, prediction, assessment and mitigation of such noise"*.

The Standard fits each noise receiver into a receiver category which in-turn gives guidance to what mitigation must be applied to achieve the *best practicable option*.

The Standard states that compliance with its criteria will result in a *reasonable* level of noise for the receivers taking into account health issues associated with noise, the effects of relative changes in noise levels on people and communities and the potential benefits of new and altered roads to people and communities[2]. Clause C1.2.3 of the Standard introduces the importance of the assessment of the change in noise levels arising from a proposal.

Noise sensitive receivers under the Standard are referred to as PPFs and are spaces in buildings used for:

(i) Residential activities;

(ii) Marae;

(iii) Overnight medical care;

(iv) Teaching (and sleeping rooms) in educational facilities (including childcare centres); and

(v) Playgrounds which are located within 20 metres of an educational facility.

The Standard uses the $L_{Aeq(24hr)}$ descriptor for the assessment of road traffic noise based on it being the preferred metric in New Zealand. It does not include L_{Amax} criteria as it states that road controlling authorities do not have direct control over individual vehicle noise, whereas other laws and regulations do i.e. Warrant of Fitness, etc.

Design levels are based on:

(i) The categorisation of the road as new or altered. For a project including a mixture of new and altered roads the determination of what constitutes a new or altered road is determined by the road controlling authority that proposes to construct the project;

[1] Please refer to *Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects*

[2] Clauses 1.1.4 & 3.3.2 of NZS 6806:2010

(ii) The predicted Annual Average Daily Traffic (AADT), i.e. the vehicle count in both directions over the year divided by the number of days in the year, for the design year. The design year can be between 10 to 20 years after the opening of a new or altered road and is determined by the road controlling authority or developer. In this case, the design year is 2026.

The LRCI project involves the alteration of an existing road which may not be constructed for 10 years. The prediction of noise levels to reflect traffic flows 10 years after construction is complete is not possible due to there being no traffic flow predictions beyond 2026. However, the condition set recommends that this assessment be undertaken again immediately prior to construction which will enable the incorporation of the predicted traffic growth in ten years from that time. Whilst this method is not strictly in accordance with the Standards guidance, the noise modelling results are based on the most advanced traffic flow predictions that are available at this time.

A new access way is also proposed; however, the traffic flows on the access way are below the criteria for being assessed as a New Road in accordance with the Standard.

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

(i) Where consistent with the best practicable option for the mitigation of road-traffic noise, the criteria of Category A shall apply;

(ii) Where it is inconsistent with the adoption of the best practicable option to achieve the criteria of Category A , the criteria of Category B shall apply;

(iii) Where it is inconsistent with the adoption of the best practicable option to achieve the criteria of Category A or Category B and where the internal noise levels of any habitable space would be greater than 45 dB $L_{Aeq(24hr)}$, the criteria of Category C shall apply;

(iv) Where it is inconsistent with the adoption of the best practicable option to achieve the criteria of Category A, B or C the internal noise levels of any habitable space shall be mitigated to the extent that is practicable.

Table 8: Summary of NZS 6806:2010 Noise Criteria

Category	Altered roads $L_{Aeq(24hr)}$
A (primary free-field external noise criterion)	64 dB
B (secondary free-field external noise criterion)	67 dB
C	40 dB

(internal noise criterion)

For the criteria to apply, PPFs in urban areas must be within 100 metres from the edge of the closest traffic lane.

The assessment point for buildings is at the most exposed exterior wall at a height of 1.2 to 1.5 metres above each floor level of interest and excluding noise that would be reflected from the building, commonly referred to as the 'facade reflection'.

For Altered Roads the do-minimum noise environment, at any one or more PPFs, must be predicted to be equal to or greater than 64 dB $L_{Aeq(24hr)}$ and increase road-traffic noise by 3 dB $L_{Aeq(24hr)}$ or more at the design year when compared to the "do-nothing noise environment" for the provisions of the Standard to apply. The *do-nothing noise environment* is a prediction of the noise level at a PPF assuming no alterations are made to the existing road but allows for traffic growth that would occur at the design year.

The Standard helps to determine the *best practicable option* (BPO) for mitigating noise on the basis of the noise levels meeting or bettering a set of noise criteria that it deems to be *reasonable*.

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

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

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

   (i) an average reduction of at least 3 dB $L_{Aeq(24hr)}$ at the relevant assessment positions of all PPFs that are part of a cluster*;

   (ii) a minimum reduction of 5 dB $L_{Aeq(24hr)}$ at any assessment position(s) for each PPF that is not part of a cluster*.

   **A cluster is any teaching or medical facility; or a minimum of 3 PPFs that are on the same side of the road being assessed, and are not more than 100 m from one another*.

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

d) plan or policy statement noise management provisions;

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

f) visual;

g) urban design;

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

i) safety standards and guidelines;

j) technical feasibility;

k) land availability and associated cost;

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

The preferred approach to noise mitigation is by implementing structural measures within the road reserve or near the new or altered road to reduce the noise level outside the Designation. Where achieving external noise criteria is not consistent with adopting the BPO to achieve the criteria under Category A or B and where the internal noise levels of any habitable space would be greater than 45 dB $L_{Aeq(24hr)}$ then building modification measures are to be employed to achieve Category C. Please note that paragraph (d) of Clause 6.1.2 Noise Criteria still applies (i.e. where it is inconsistent with the adoption of the *best practicable option* to achieve the criteria of Category A, B or C the internal noise levels of any habitable space shall be mitigated to the extent that is practicable).

The definition of what constitutes a 'habitable space' is somewhat complex but for dwellings it primarily covers living rooms and bedrooms in residential dwellings. It also includes kitchens and dining rooms where these form part of the main living area.

Of note is Section 8 - *Building Modification Mitigation,* which states:

Building-modification mitigation shall only be implemented subsequent to the achievement of the lowest practicable external noise levels.

Building-modification mitigation measures typically include:

(i) Mechanical ventilation;

(ii) Sound insulation; and

(iii) Building relocation

Section 8 also details circumstances under which noise mitigation generally is not required, namely:

(i) If all PPFs meet Category A; or

(ii) Where consent of the landowner or occupier cannot be obtained.

Existing Noise Environment

Styles Group has undertaken unattended noise logger measurement over several days, outside of school holidays, to quantify the existing ambient noise environment in terms of the $L_{Aeq(24hour)}$ noise descriptor.

Noise loggers were deployed at two locations, 182 Lincoln Road and 1B Daytona Road, to continuously log L_{Aeq} data in 1 second intervals. Audio files were recorded with the noise levels simultaneously so noise sources could be identified on playback. Noise levels in the area were controlled by road traffic. Meteorological conditions throughout the measurements were suitable for noise measurements and no adjustments or exclusions were required for inclement weather. From the logged data we have calculated the 24 hour L_{Aeq} levels for each location, as presented in Table 9. The monitoring locations are illustrated in Figure 3.

It is our opinion that the existing noise environment is highly affected by road traffic noise and the level of acoustical amenity for PPFs that are directly exposed to road traffic noise is very low. Such a situation is typical for any receiver near to any major road and is characteristic of a large number of PPFs in the Auckland area.

Table 9: Existing Noise Environment

Address	Distance to edge of nearest lane on Lincoln Rd	Date	$L_{Aeq(24hr)}$
182 Lincoln Rd	7.3 m	20.10.15 - 21.10.15	69 dB
		21.10.15 - 22.10.15	66 dB
		22.10.15 - 23.10.15	67 dB
		23.10.15 - 24.10.15	69 dB
		24.10.15 - 25.10.15	67 dB
		25.10.15 - 26.10.15	66 dB
		26.10.15 - 27.10.15	66 dB
		Logarithmic Average	67 dB
1B Daytona Rd	9.0 m	20.10.15 - 21.10.15	64 dB
		21.10.15 - 22.10.15	63 dB
		22.10.15 - 23.10.15	63 dB
		23.10.15 - 24.10.15	65 dB
		24.10.15 - 25.10.15	63 dB
		25.10.15 - 26.10.15	63 dB
		26.10.15 - 27.10.15	63 dB
		Logarithmic Average	63 dB

Figure 3: Map of Noise Monitoring Locations

Operational Noise Assessment

NZS 6806:2010 Assessment

NZS 6806:2010 sets out criteria for determining whether the Standard applies to a roading project for altered roads. An "altered road" as defined by the Standard is an existing road that is subject to alterations of the horizontal or vertical alignment where at any assessment position at any one or more PPF:

a) The do-minimum specific sound would be greater than or equal to 64 $L_{Aeq(24hr)}$ and, if no specific noise mitigation was undertaken, the alterations would increase road-traffic noise at that assessment position by 3 dB $L_{Aeq(24hr)}$ or more at the design year, when compared with the do nothing environment; or

b) The do-minimum noise environment or greater than or equal to 68 $L_{Aeq(24hr)}$ and, if no specific noise mitigation was undertaken, the alterations would increase road-traffic noise at that assessment position by 1 dB $L_{Aeq(24hr)}$ or more at the design year, when compared with the do nothing environment.

Noise Level Predictions

Styles Group has used Brüel & Kjær Predictor computer noise modelling software to prepare noise level predictions, based on the International Standard ISO 9613-1/2. Road surface corrections for New Zealand conditions have been implemented into the noise model. The noise level predictions assume meteorological conditions that slightly enhance propagation in all directions in accordance with NZS 6802:2008. The Brüel & Kjær Predictor software is globally recognised and has been successfully implemented on a large number of projects throughout New Zealand. The Brüel & Kjær Predictor input parameters are set out in Table 10 below:

Table 10: Brüel & Kjær Predictor input parameters

Parameters / calculation settings	Details
Software	*Brüel & Kjær Predictor*
Calculation method	*ISO 9613.1/2 (Road)*
Meteorological parameters (CONCAWE)	*Single value, C0 = 0*
Ground attenuation	*General method, ground factor 0.2*
Air temperature	*293.15 K*
Atmospheric pressure	*101.33 kPa*
Air humidity	*60 %*

Air absorption (dB/km)	*31 Hz: 0.03, 63 Hz: 0.10, 125 Hz: 0.38, 250 Hz: 1.22, 500 Hz: 2.78, 1 kHz: 4.80, 2 kHz: 9.28, 4 kHz: 25.64, 8 kHz: 88.94.*
Source heights (relative)	*Vehicles 0.5 m*
Receiver heights (relative)	*1.2-1.5m above floor level*
Building heights (nominal)	*Single storey 4 m, double storey 7 m*

Terrain contours, land parcels and building footprints were acquired from the Auckland Council GIS service and the site plans. These have been checked and confirmed by site observations. The topographical contours encompass the entire alignment and a large area of the surrounding land. For the purpose of determining the noise level at any particular receiver location and for the purpose of calibrating the model we have used point receivers; these provide precise predictions.

The noise model representing 2015 traffic flows and noise levels has been calibrated to the ambient noise measurement data with a difference of 0.1dB and 1.8dB for the Lincoln Road and Daytona Place positions respectively. These differences are within the 2dB margin specified as acceptable by NZS6806:2010.

The traffic flow information has been based on the peak and AADT information provided to us with the appropriate adjustments for the average daily flows. The current 2015 noise model is based on contemporary traffic counts and modelling. The 2026 traffic flows are based on the results of traffic modelling provided to us. We understand that the use of the outside lanes will be for buses and transit lane vehicles only (as described on the project plans). For the transit / bus lane, we have based our predictions on them carrying 8% of the total light traffic volumes and up to 64 buses per day based on a service frequency of a service every 15 minutes in both directions between 7am and 7pm, and an average of one bus per hour through the night.

Do Nothing Environment

The Do Nothing environment is simply where no project works are undertaken and the traffic volumes continue to increase over time. No alterations to the alignment or noise mitigation measures are undertaken. The noise level will increase as a simple function of traffic growth.

Do-Minimum Design

The Do-Minimum scenario is based on the same 2026 traffic flows (34% increase over 2015 flows) but incorporating the widening, introduction of transit / bus lanes, removal of some dwellings and the general changes to the alignment as shown on the plans.

Although the widening project will in many cases bring the kerb lines of the roads closer to the PPFs, the extra width is to accommodate cycle lanes and transit/ bus lanes and in some cases left turn lanes carrying relatively low traffic flows. Cycle lanes generate an insignificant level of noise compared to traffic lanes and the transit / bus lanes carry only a modest flow of heavy vehicles compared to the main traffic lanes, resulting in only a minimal contribution to the overall noise levels in many cases. The main traffic lanes are often separated from the PPFs by a similar distance as they are currently, and in some cases a greater distance. Therefore, whilst the widening works bring some lanes closer to the PPFs, the noise levels do not rise appreciably due to these factors.

As set out previously, the triggers in NZS6806:2010 for a project to be considered an Altered Road are:

a) The do-minimum specific sound would be greater than or equal to 64 $L_{Aeq(24hr)}$ and, if no specific noise mitigation was undertaken, the alterations would increase road-traffic noise at that assessment position by 3 dB $L_{Aeq(24hr)}$ or more at the design year, when compared with the do nothing environment; or

b) the do-minimum noise environment or greater than or equal to 68 $L_{Aeq(24hr)}$ and, if no specific noise mitigation was undertaken, the alterations would increase road-traffic noise at that assessment position by 1 dB $L_{Aeq(24hr)}$ or more at the design year, when compared with the do nothing environment.

With reference to the noise level prediction results in Appendix D, there are no PPFs receiving noise levels of $L_{Aeq(24hr)}$ 64dB or greater *and* experience an increase in noise level of 3dB or greater. The thresholds of (a) are not therefore reached.

Additionally, the highest predicted noise level for the Do-Minimum design is $L_{Aeq(24hr)}$ 67dB, meaning that there are no PPFs that would trigger the thresholds of (b) above.

This means with respect to NZS 6806:2010 the project is *not* deemed to meet or exceed the thresholds for consideration as an Altered Road and therefore does not require assessment in accordance with the Standard.

Notwithstanding that the Do-Minimum design does not comprise an Altered Road in terms of the Standard, we have recommended some noise mitigation measures be applied to reduce the noise levels at some PPFs, including where the project has resulted in the loss of screening through the removal of buildings. Our recommendations comprise the Preferred Design.

Noise Mitigation

This section prefaces the discussion of the Preferred Design. The opportunities for acoustic mitigation along the alignment are minimal because of the small separation distance between

the outside lanes and the PPFs along the alignment and the low speed environment. The use of acoustic fencing is limited due to the requirement to maintain access to private properties, where openings for vehicle access will severely compromise a fences' acoustic performance. This issue is the same as that faced for the recent Te Atatu Road improvements where very little mitigation was practicable to implement. There are however some locations where fences can be constructed to reduce noise levels without causing other issues, such as where dwellings have been removed as part of the project and along the Lincoln Road frontage of the dwellings that will have access from the new public road once the project is complete. Such mitigation is contingent on the owner of the affected PPF providing permission for access and construction where it is required.

The current and proposed road surface is Asphaltic Concrete (AC) which is a reasonably low noise pavement compared to chip seal, but is not as effective as Open Graded Porous Asphalt (OGPA) at open highways speeds. At the 50km/hr speed environment for this alignment, the difference in noise generation between OGPA and AC is minimal. When considering the (relatively) low acoustic benefits of using OGPA in this case and very high relative cost and high maintenance requirements of OGPA compared to AC, the use of OPGA becomes impracticable and AC is therefore preferred.

Beyond the use of AC as a low noise pavement and the construction of acoustically effective fencing adjacent to a small number of PPFs where it is practicable, there are no other effective and practicable mitigation measures that may be employed in this case.

Building Modification Mitigation in this case is limited to the dwellings that qualify for it in terms of the requirements of NZS6806:2010. Such works generally include the provision of a fresh air supply and a means of maintaining a comfortable internal thermal environment so that the windows and doors of the building can be kept closed to reduce the noise levels. In some dwellings there may also be a requirement to upgrade some facade elements to achieve the internal design noise levels. As detailed below, there are no buildings falling into Category C that would require Building Modification Mitigation, notwithstanding that the project does not trigger the requirements for an assessment as an Altered Road.

Preferred Design

The Preferred Design is essentially the same as the do-minimum scenario with the project implemented, but includes acoustically effective fencing along the boundaries of several properties as show in Appendix C. The fences are to be constructed of a material with a surface mass of not less than 10kg/m^2; must be 2m high and should have no gaps along their length or at their base. They should also be maintained to be acoustically effective. The locations for the proposed fences are shown in Appendix C.

The effectiveness of the fences are in some cases limited by the sloping topography, particularly in the region of Preston Ave and 296A Lincoln Rd and 3A Daytona Rd where the land slopes down in a westward direction away from Lincoln Road. Whilst the fence provides little reduction for the noise levels at 1.5m above the finished floor levels of the dwellings beyond it, the fence will provide a good level of noise reduction for the yard areas of the properties which would have otherwise been at least partially screened by the dwellings that are to be removed. The screening is also focused on mitigating the noise levels at the PPFs most exposed to traffic noise.

The noise level predictions for the Preferred Design show that:

(i) The introduction of the acoustically effective fences reduce the noise levels experienced by the properties by between 1 and 5 decibels as shown in 'Preferred – Do Minimum' column in Appendix D;

(ii) The predicted noise levels for the Preferred Design are very similar to the Do Minimum design and in some cases are lower owing to the introduction of the acoustically effective fences; and

(iii) The highest predicted noise level for the Preferred Design is $L_{Aeq(24hr)}$ 66dB, including the predictions for upper storey facades that generally do not benefit from screening.

(iv) There are 37 PPFs in Category A; 24 PPFs in Category B and no PPFs in Category C.

The predicted noise levels for the Preferred Design are displayed in Appendix D.

Whilst the project is *not* deemed to meet or exceed the thresholds for consideration as an Altered Road and therefore does not require assessment in accordance with the Standard, we have recommended that the noise mitigation measures incorporated into the Preferred Design are implemented to reduce the noise levels arising from the removal of buildings to construct the project.

Management of Reverse Sensitivity

Whilst the delivery of this project will likely include several noise reduction measures, including possible pavement treatments and acoustically effective fences, through this process it is not possible to manage the potential for reverse sensitivity issues to arise where sensitive development occurs near to the road in the timeframe between the designation being confirmed and when the project is constructed.

The management of this issue is important to ensure that all sensitive development that may occur close to the road prior to construction is designed and insulated properly to ensure that

noise levels are minimised. In rural or sparsely developed areas where major roads are planned but not constructed for some time this can be a significant issue.

In this case however, Lincoln Road is already regarded as a High Noise Route by the provisions of the Waitakere section of the Auckland District Plan. Rule 1.2 of the Citywide Rules requires that dwellings and rooms containing residential activities on sites fronting a High Noise Route are designed and constructed to ensure that noise levels of L_{Aeq} 45dB is not exceeded between 7am and 10pm; and L_{Aeq} 35dB in between 10pm and 7am. These design levels are to be achieved based on the noise generated by traffic flows that are anticipated 10 years after the completion of the dwelling or room containing residential activity.

Additionally, Rule J1.5.2.1 of the Proposed Auckland Unitary Plan[3] (PAUP) sets insulation controls for all activities sensitive to noise when locating within the High Land Transport Noise Overlay. The definition of activities sensitive to noise is similar to the definition of a PPF as found in NZS6806. This is broader than the simple reference to habitable rooms in dwellings as found in the Operative District Plan above. The PAUP rule requires that all noise sensitive spaces within any development are insulated to ensure that a noise level of $L_{Aeq(24hr)}$ 40dB is not exceeded. This limit is approximately equivalent to the limits in the Operative District Plan.

The provisions of the operative and proposed District Plans will ensure that new sensitive development close to Lincoln Road occurring before construction commences will be designed and constructed to achieve reasonable internal noise levels for the health and amenity of the occupants.

Conditions

We recommend that the following condition be applied to the designation. The condition essentially requires that an assessment of noise effects is undertaken immediately prior to construction to determine the mitigation necessary at that time and based on the future traffic predictions to ensure that the noise exposure category identified in Appendix D of this assessment remains the same for each PPF.

This approach to conditions dealing with road traffic noise over longer lapse periods has been used successfully on other projects and has formed the basis of the conditions for the Puhoi to Warkworth project, the Waterview Connection and others. In this case, and in conjunction with the PAUPs management of reverse sensitivity generated by future development, we consider that the adoption of this approach will adequately avoid, remedy or mitigate the noise effects.

[3] As set out in the Councils additional closing statement 31 July 2015 https://hearings.aupihp.govt.nz/

An Operational Noise Management Plan (ONMP) shall be prepared in accordance with NZS6806:2010 Acoustics - Road Traffic Noise - New and Altered Roads. The objective of the ONMP is to set out how the effects of road noise on PPFs existing prior to the designation being in place will be mitigated by the adoption of the Best Practicable Option.

The ONMP shall:

(a) identify how the Project will be designed and constructed so that using the best practicable option, predicted operational noise levels from the Project 10 years after opening; at the PPFs identified in Appendix D of the Styles Group report (Appendix D, "Table of Predicted Noise Levels", Operational Noise Assessment Report, June 2016); do not result in any upwards change to the specified "Noise Criteria Category" in Appendix D "Preferred Design Option" noise levels predicted by the acoustic modelling undertaken by Styles Group Acoustics and Vibration.

(b) detail the best practicable option for reducing noise levels for the PPFs in accordance with NZS6806:2010 and as agreed with the landowners where relevant.

The ONMP shall be prepared by an independent acoustic expert and shall be submitted with the Outline Plan(s) to confirm compliance with these conditions.

Conclusion

Styles Group has undertaken an assessment of the Auckland Transport Lincoln Road Corridor Improvements project and provided technical noise and vibration advice to be included in the integrated application package.

The operational noise assessment has shown that if no specific noise-reducing measures are undertaken (i.e. the Do-Minimum scenario) the noise level increases for PPFs from the change in alignment alone are minimal, but noise levels will increase noticeably in some cases where existing buildings are removed as part of the project that would have otherwise provided screening to the PPFs behind. The majority of PPFs experience relatively low levels from the high traffic flows due to the considerable screening afforded by the commercial buildings and PPFs fronting Lincoln Road.

Although the widening aspects of the project will in many cases bring the kerb lines of the roads closer to the PPFs, the extra width is primarily to accommodate cycle lanes and transit / bus lanes. Cycle lanes generate an insignificant level of noise compared to traffic lanes and the transit / bus lanes carry only a modest flow of heavy vehicles compared to the main traffic lanes, resulting in only a minimal contribution to the overall noise levels in many cases. The main traffic lanes for the design are often separated from the PPFs by a similar distance to the current alignment, and in some cases a greater distance. Therefore, whilst the widening works

bring some lanes closer to the PPFs, the noise levels do not rise appreciably due to these factors.

Importantly, and with reference to the noise level prediction results in Appendix D, there are no PPFs receiving noise levels of $L_{Aeq(24hr)}$ 64dB or greater *and* experience an increase in noise level of 3dB or greater. Additionally, the highest predicted noise level for the Do-Minimum design is $L_{Aeq(24hr)}$ 66dB. This means with respect to NZS 6806:2010 the project is *not* deemed to meet or exceed the thresholds for consideration as an Altered Road and therefore does not require assessment in accordance with the Standard.

The existing and proposed alignments are constrained in size by the very proximate surrounding land uses. There is minimal separation distance between the alignment and the receivers of noise and the opportunities for the mitigation of road traffic noise by physical means are limited. In this case, the only practicable opportunities that exist are the use of AC for the road surface (the same as the current surface), and the construction of acoustically effective fencing along some short lengths of the alignment where it is practicable. This situation is similar to that encountered for the recent upgrades and widening of Te Atatu Road.

Notwithstanding that the Do-Minimum design does not comprise an Altered Road in terms of the Standard, we have recommended some noise mitigation measures be applied to reduce the noise levels at some PPFs, including where the project has resulted in the loss of screening through the removal of buildings. Our recommendations are included within the Preferred Design.

We consider that the mitigation proposed in the preferred design is part of the BPO, and that these measures should be implemented in the design of the project.

In addition to the mitigation that will be incorporated into the Preferred Design, the provisions of the operative and proposed District Plans will ensure that new sensitive development close to Lincoln Road occurring before construction commences will be designed and constructed to achieve reasonable internal noise levels for the health and amenity of the occupants.

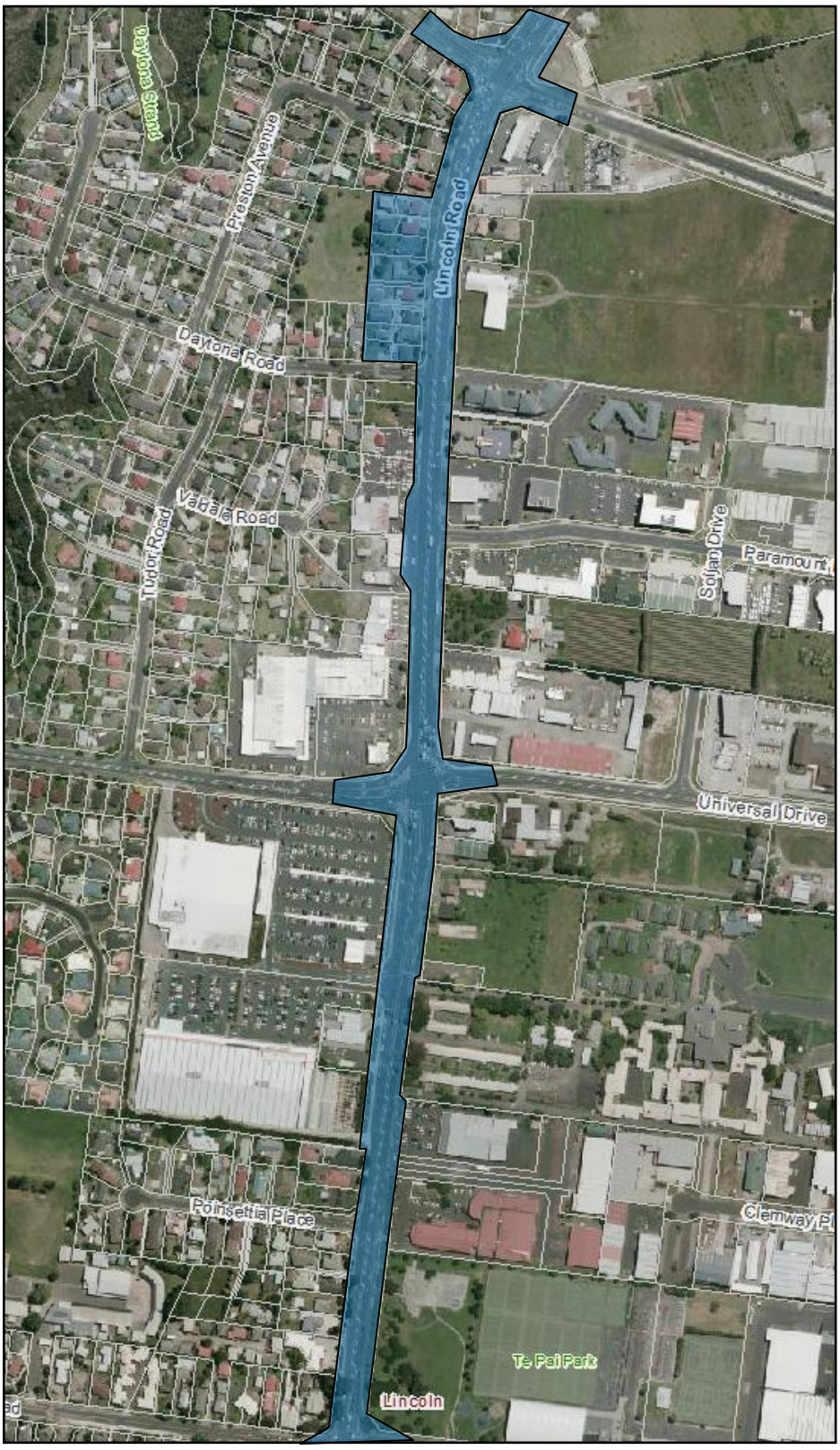
Appendices

Appendix A: Glossary of acoustical terms used in this document

Noise	A sound that is undesired by, or distracting to, the recipient.
dB (decibel)	The basic measurement unit of sound. The logarithmic unit used to describe the ratio between the measured sound pressure level and a reference level of 20 micropascals (0 dB).
A-weighting	A frequency filter applied to the full audio range (20 Hz to 20 kHz) to approximate the response of the human ear at lower sound pressure levels.
Ambient noise	Ambient noise is the total of all noise within a given environment, comprising a composite of sounds from sources near and far.
CNVMP	Construction noise and vibration management plan. A document to assist with the appropriate management of noise and vibration during construction works.
DIN 4150–3:1999	German Standard DIN 4150-3:1999 *Structural Vibration – Part 3: Effects of vibration on structures*. Typically adopted for the assessment of structure borne vibration in N.Z.
$L_{Aeq(t)}$	The A-weighted equivalent sound pressure level with the same energy content as the measured varying acoustic signal over a sample period (t). The preferred metric for sound levels that vary over time because it takes into account the total sound energy over the time period of interest.
$L_{A95(t)}$	The A-weighted sound level which is just exceeded for 95% of the measurement period (t). Used in New Zealand as the descriptor for background noise in the 1991 and 1999 versions of the Standards NZS 6801 and NZS 6802.
L_{Amax}	The maximum A-weighted sound pressure level recorded during the measurement period.
L_{Amax}	The maximum A-weighted sound pressure level recorded during the measurement period.
NZS 6801:1991	N.Z. Standard NZS 6801:2008 Acoustics – Measurement of environmental sound.
NZS 6802:1991	N.Z. Standard NZS 6802:2008 Acoustics – Environmental noise.
NZS 6803:1999	N.Z. Standard NZS 6803:1999 *Acoustics – Construction noise*.
NZS 6806:2010	N.Z. Standard NZS 6806:2010 *Acoustics – Road-traffic noise – New and altered roads*
PPV	Peak particle velocity, measured in mms^{-1}. The standard metric for the measurement of structure borne vibration in New Zealand.
SSNVMP	Sector Specific Noise and Vibration Management Plan. A document prepared when the project noise and vibration criteria cannot practicably be met. The purpose of the SSNVMP is to set out specific detail of the potential noise and vibration effects and demonstrate that the best practicable option to reduce emissions is being adopted at all times.
Suitably qualified	One who is sufficiently qualified and/or experienced in the relevant field to

and experienced person	undertake robust measurements and assessments e.g. for the measurement and assessment of noise, a Member of the Acoustical Society of New Zealand (MASNZ).

Appendix B: Map of General Project Area



Appendix C: Maps Showing Locations of Proposed Acoustically Effective Fencing (dark red)

Appendix D: Table of Predicted Noise Levels

Address	Existing	2026 Do Nothing	Do Nothing - Existing	2026 Do Minimum	Do Minimum - Do Nothing	Preferred Design	Preferred - Do Minimum	Preferred - Do Nothing	Category (NZS6806)
	$L_{Aeq\ 24hr}$ dB	$L_{Aeq\ 24hr}$ dB	dB	$L_{Aeq\ 24hr}$ dB	dB	$L_{Aeq\ 24hr}$ dB	dB	dB	
1 Poinsettia Place	54	55.4	1.4	55.5	0.1	55.5	0	0.1	A
1/17 Valdale Road	49.6	50.9	1.3	50.5	-0.4	50.8	0.3	-0.1	A
1/6 Daytona Road	50.1	51.4	1.3	51.3	-0.1	51.3	0	-0.1	A
10a Valdale Road	47.2	48.5	1.3	48.3	-0.2	48.4	0.1	-0.1	A
10b Valdale Road	48.6	49.9	1.3	49.6	-0.3	49.8	0.2	-0.1	A
11a Pomaria Road	50.8	52.1	1.3	52.3	0.2	52.3	0	0.2	A
11b Pomaria Road	50.8	52.1	1.3	52.3	0.2	52.3	0	0.2	A
11c Pomaria Road	49.8	51.1	1.3	51.3	0.2	51.3	0	0.2	A
11d Pomaria Road	49.7	51	1.3	51.2	0.2	51.2	0	0.2	A
11e Pomaria Road	49.1	50.5	1.4	50.6	0.1	50.6	0	0.1	A
11f Pomaria Road	50	51.3	1.3	51.5	0.2	51.5	0	0.2	A
12 Valdale Road	54.8	56.1	1.3	55.9	-0.2	55.9	0	-0.2	A
12A Valdale Road	56.1	57.4	1.3	57.2	-0.2	57.2	0	-0.2	A
14 Valdale Road	50.8	52.1	1.3	51.9	-0.2	52	0.1	-0.1	A
15 Valdale Road	50.5	51.8	1.3	50.5	-1.3	51.7	1.2	-0.1	A
150 Lincoln Road	61.7	63.1	1.4	63.1	0	63.1	0	0	B
152 Lincoln Road	63	64.4	1.4	64.4	0	64.4	0	0	B
154 Lincoln Road	63.8	65.2	1.4	65.2	0	65.2	0	0	B
156 Lincoln Road	60.6	61.9	1.3	61.9	0	61.9	0	0	A
156 Lincoln Road	63.9	65.3	1.4	65.3	0	65.3	0	0	B
159 Lincoln Road	61.6	63	1.4	63	0	63	0	0	A
168 Lincoln Road	62.1	63.5	1.4	63.6	0.1	63.6	0	0.1	B
17 Valdale Road	52	53.3	1.3	52.8	-0.5	53.2	0.4	-0.1	A

Address	Existing	2026 Do Nothing	Do Nothing - Existing	2026 Do Minimum	Do Minimum - Do Nothing	Preferred Design	Preferred - Do Minimum	Preferred - Do Nothing	Category (NZS6806)
	$L_{Aeq\ 24hr}$ dB	$L_{Aeq\ 24hr}$ dB	dB	$L_{Aeq\ 24hr}$ dB	dB	$L_{Aeq\ 24hr}$ dB	dB	dB	
170 Lincoln Road	61.6	63	1.4	63.1	0.1	63.1	0	0.1	B
172 Lincoln Road	62.4	63.8	1.4	63.9	0.1	63.9	0	0.1	B
174 Lincoln Road	64.4	65.7	1.3	65.8	0.1	65.8	0	0.1	B
174A Lincoln Road	54.4	55.7	1.3	55.9	0.2	55.9	0	0.2	A
176 Lincoln Road	63.3	64.6	1.3	64.7	0.1	64.7	0	0.1	B
176A Lincoln Road	52.4	53.7	1.3	53.9	0.2	53.9	0	0.2	A
178 Lincoln Road	62.8	64.2	1.4	64.3	0.1	64.3	0	0.1	B
180 Lincoln Road	63.3	64.6	1.3	64.7	0.1	64.7	0	0.1	B
182 Lincoln Road	63	64.3	1.3	64.4	0.1	64.4	0	0.1	B
184 Lincoln Road	64.8	66.1	1.3	66.2	0.1	66.2	0	0.1	B
184A Lincoln Road	54.1	55.4	1.3	55.6	0.2	55.6	0	0.2	A
19 Valdale Road	48.8	50.1	1.3	49.9	-0.2	50	0.1	-0.1	A
199 Lincoln Road	62	63.4	1.4	63.7	0.3	63.7	0	0.3	B
19A Valdale Road	51.4	52.6	1.2	52.3	-0.3	52.5	0.2	-0.1	A
1A Daytona Road	64.9	66.2	1.3	66	-0.2	66	0	-0.2	B
1B Daytona Road	63.8	65.1	1.3	64.9	-0.2	64.9	0	-0.2	B
1C Daytona Road	57.2	58.5	1.3	58.4	-0.1	58.4	0	-0.1	A
207-209 Lincoln Road	59.5	60.9	1.4	61.2	0.3	61.2	0	0.3	A
211 Lincoln Road	62.5	63.9	1.4	64.3	0.4	64.3	0	0.4	B
221 Lincoln Road	62.6	64	1.4	64.4	0.4	64.4	0	0.4	B
225 Lincoln Road	63.1	64.5	1.4	64.9	0.4	64.9	0	0.4	B
27 Preston Ave	49.2	50.5	1.3	52	1.5	51.3	-0.7	0.8	A
283-285 Lincoln Road	60.4	61.7	1.3	61.5	-0.2	61.5	0	-0.2	A
29 Preston Ave	49.8	51	1.2	52.1	1.1	52.1	0	1.1	A

Address	Existing	2026 Do Nothing	Do Nothing - Existing	2026 Do Minimum	Do Minimum - Do Nothing	Preferred Design	Preferred - Do Minimum	Preferred - Do Nothing	Category (NZS6806)
	$L_{Aeq\ 24hr}$ dB	$L_{Aeq\ 24hr}$ dB	dB	$L_{Aeq\ 24hr}$ dB	dB	$L_{Aeq\ 24hr}$ dB	dB	dB	
296 Lincoln Road	64.8	66.1	1.3	66	-0.1	66	0	-0.1	B
296A Lincoln Road	51.6	52.9	1.3	56.1	3.2	56.1	0	3.2	A
2A Stephen Ave	57.1	58.4	1.3	58.4	0	58.4	0	0	A
2B Stephen Ave	50.4	51.7	1.3	51.8	0.1	51.8	0	0.1	A
3 Daytona Road	51.8	53.1	1.3	53	-0.1	53	0	-0.1	A
3 Poinsettia Place	51.9	53.3	1.4	53.5	0.2	53.4	-0.1	0.1	A
300 Lincoln Road	62.4	63.7	1.3	63.7	0	63.7	0	0	B
302 Lincoln Road	64.6	65.9	1.3	65.8	-0.1	65.8	0	-0.1	B
304 Lincoln Road	63.4	64.6	1.2	64.6	0	64.6	0	0	B
304A Lincoln Road	51.3	52.6	1.3	54.7	2.1	54.8	0.1	2.2	A
31 Preston Ave	51.9	53.2	1.3	55.8	2.6	53.8	-2	0.6	A
314 Lincoln Road	61.7	63	1.3	64.8	1.8	63.9	-0.9	0.9	B
33 Preston Ave	53.3	54.6	1.3	58	3.4	55.7	-2.3	1.1	A
35 Preston Ave	51.1	52.4	1.3	55.1	2.7	53.5	-1.6	1.1	A
377A Triangle Road	58.4	59.7	1.3	59.7	0	59.7	0	0	A
379 Triangle Road	55.2	56.5	1.3	56.5	0	56.4	-0.1	-0.1	A
381 Triangle Road	56.9	58.2	1.3	58.3	0.1	58.3	0	0.1	A
383 Triangle Road	54.6	55.9	1.3	59.5	3.6	54.9	-4.6	-1	A
385 Triangle Road	60.1	61.4	1.3	62.9	1.5	60.3	-2.6	-1.1	A
3a Daytona Road	49	50.3	1.3	53.8	3.5	53.8	0	3.5	A
4 Daytona Road	56.6	57.9	1.3	57.8	-0.1	57.8	0	-0.1	A
4 Poinsettia Place	51.8	53.1	1.3	53.3	0.2	53.3	0	0.2	A
4 Pomaria Road	60.2	61.5	1.3	61.5	0	61.5	0	0	A
4 Stephen Ave	49.2	50.6	1.4	50.6	0	50.6	0	0	A

Address	Existing	2026 Do Nothing	Do Nothing - Existing	2026 Do Minimum	Do Minimum - Do Nothing	Preferred Design	Preferred - Do Minimum	Preferred - Do Nothing	Category (NZS6806)
	$L_{Aeq\ 24hr}$ dB	$L_{Aeq\ 24hr}$ dB	dB	$L_{Aeq\ 24hr}$ dB	dB	$L_{Aeq\ 24hr}$ dB	dB	dB	
42 Preston Ave	50.4	51.7	1.3	51.8	0.1	52	0.2	0.3	A
44 Preston Ave	52.2	53.5	1.3	56	2.5	54.8	-1.2	1.3	A
46 Preston Ave	52.9	54.2	1.3	55.8	1.6	54.9	-0.9	0.7	A
4a Daytona Ave	55.3	56.6	1.3	56.4	-0.2	56.4	0	-0.2	A
4A Stephen Ave	48.7	50.1	1.4	50.1	0	50.1	0	0	A
5 Daytona Road	50.6	51.9	1.3	51.8	-0.1	51.8	0	-0.1	A
5 Poinsettia Place	51.6	52.9	1.3	53.1	0.2	53.1	0	0.2	A
5 Pomaria Road	55.6	56.8	1.2	56.9	0.1	56.9	0	0.1	A
6 Daytona Road	50	51.3	1.3	51	-0.3	51.1	0.1	-0.2	A
6 Poinsettia Place	50.1	51.4	1.3	51.6	0.2	51.6	0	0.2	A
6 Pomaria Road	56.5	57.8	1.3	57.8	0	57.8	0	0	A
6a Stephen Ave	50.1	51.5	1.4	51.5	0	51.5	0	0	A
6b Stephen Ave	45.7	47.1	1.4	47.1	0	47.1	0	0	A
7 Daytona Road	51	52.3	1.3	52.2	-0.1	52.2	0	-0.1	A
7 Poinsettia Place	50.4	51.8	1.4	51.9	0.1	51.9	0	0.1	A
8 Daytona Road	50.2	51.5	1.3	51.4	-0.1	51.5	0.1	0	A
8 Poinsettia Place	49	50.4	1.4	50.5	0.1	50.5	0	0.1	A
8A Daytona Road	48.4	49.7	1.3	49.5	-0.2	49.6	0.1	-0.1	A
9 Poinsettia Place	52.5	53.9	1.4	54	0.1	54	0	0.1	A
9 Pomaria Road	56.8	58	1.2	58.1	0.1	58.1	0	0.1	A