

BOARD OF INQUIRY

**Northern Corridor
Improvements Proposal**

IN THE MATTER

of the Resource Management
Act 1991 (the RMA)

AND

IN THE MATTER

of a Board of Inquiry appointed
under s149J of the Resource
Management Act 1991 to
consider notices of requirement
and resource consents made by
the New Zealand Transport
Agency in relation to the
Northern Corridor Improvements
Proposal.

Joint Witness Statement: Noise – Operational, Construction and model

Dated: 27 and 28 June and 3 to 5 July 2017

Experts participating

Party	Name
The New Zealand Transport Agency	Siri Wilkening
The New Zealand Transport Agency	Andrew Hale – Attended on 27 June all day and until lunchtime on 28 June to provide construction information to the noise experts. He also provided additional information on request for the rest of the conference
Auckland Council	Rhys Hegley
Board Expert	Jon Styles

Facilitator: Environment Commissioners Ross Dunlop (27 and 28 June only) and Jim Hodges

Preamble

This Joint Witness Statement (“JWS”) records the outcomes of five days of conferencing that was directed towards providing the Board with as complete an understanding as possible of the predicted noise and vibration effects resulting from the construction and operation of the Northern Corridor Improvement Project (“the NCI Project”). This required a methodical and comprehensive approach to documenting the durations and levels of effects on the many sensitive receivers and Protected Premises and Facilities (“PPFs”) in eight separate project areas. The JWS also attempts to explain as simply as possible the technical background to the assessments made. It takes into account a significant amount of new information available and additional analysis undertaken since the evidence was prepared.

As a consequence, the JWS is significantly longer than would normally be expected or considered desirable by the experts. However, they were unable to find a way of shortening the document without risking providing incomplete answers to questions raised by the Board and in Mr Styles’ report entitled “Northern Corridor Improvements Review of Noise and Vibration Effects, Construction and Operational Phases (2 June 2017) (“the Styles Review Report”). In the event that the experts have provided too much detail, they sincerely apologise to the Board.

As a result of the length of the JWS, Annexures are included in a separate document.

Introduction

1 All experts confirm that:

- (a) They have read the Environment Court Consolidated Practice Note 2014 Code of Conduct and agreed to abide by it, and in particular:
- (b) They have read the Environment Court Consolidated Practice Note 2014 in respect of Expert Witness Conferencing (section 7) and Alternative Dispute Resolution (section 5) and agreed to abide by it.

2 Purposes of expert conferencing

The primary purpose of expert conferencing is to assist the Board of Inquiry and to reduce hearing time.

As part of the process the experts provided their expert opinions on:

- (a) The extent to which the proposal is consistent, from a technical perspective, with relevant statutory provisions identified by planning experts (as set out in **Annexure 2**); and
- (b) The extent to which the proposed conditions (as set out in **Annexure 3**) will address potential adverse effects from a technical perspective.

3 Issues in contention

Through the expert conference, the experts reached agreement on most matters. Any remaining points of difference are discussed in the JWS and summarised in Section 30.

Background

4 Terminology

- (a) A glossary of the terminology used in this JWS is attached as **Annexure 1**.
- (b) Where the term “the experts” is used in this JWS, it means the noise experts, Ms Wilkening, Mr Styles and Mr Hegley. Mr Hale, the construction expert, is referenced separately.

- (c) Upper Harbour Highway is used in this JWS to describe the existing road between SH1 and the eastern end of the SH18 motorway section. SH18 is used to describe the new motorway connection between the two points.

5 Statement of key facts

- (a) The NCI Project comprises a widening to part of the existing SH1, an upgrade to Upper Harbour Highway to full motorway standard and new northbound ramps connecting the extended SH18 with SH1. Both SH1 and SH18/Upper Harbour Highway carry significant traffic volumes and adjacent PPFs are affected by traffic noise levels from these roads.

Noise and vibration during construction

- (b) The nature of construction means that noise and vibration levels generated are generally higher than on-going activities. Where buildings are in close proximity (both dwellings and businesses), there is a risk of exceeding the NCI Project noise and vibration criteria for some of the time during construction.
- (c) A Construction Noise and Vibration Management Plan (“CNVMP”) and communication with affected parties are measures proposed to manage the effects of noise and vibration during construction. Construction noise and vibration can be managed at the source by using low-noise and low-vibration construction techniques (e.g. drilled piling rather than vibro or impact piling) and managing the timing of works.

Operational noise and vibration

- (d) The assessment of the operational noise and vibration effects from the NCI Project focused on PPFs. It excludes industrial and business sites which are noise producers in their own right and not considered to be noise sensitive.
- (e) Noise level surveys and computer noise modelling provided the baseline of the existing environment. In addition, several scenarios were modelled including future do-nothing, do-minimum and several mitigation options.

- (f) The road surface material proposed for the NCI Project is a low noise surface (open graded porous asphalt) for the main alignment, which is a structural mitigation measure. For safety reasons, ramps are proposed to be surfaced with dense asphalt, which generates slightly more noise than open graded porous asphalt, but still achieves low noise levels.
- (g) In addition, to mitigate adverse noise effects for the PPFs surrounding the NCI Project, mitigation is focused around noise barriers within the designation, and building modification mitigation should be considered for some dwellings on a case by case basis.
- (h) Traffic vibration is generally caused by heavy vehicles driving over dips and bumps in the road. A new road surface would not have such defects.

Relevant standards

- (i) New Zealand Standard NZS 6806:2010 'Acoustics – Road-traffic noise – New and altered roads' ('NZS 6806')
- (j) New Zealand Standard NZS 6803:1999 'Acoustics – Construction Noise' ('NZS 6803')
- (k) BS5228-2:2009 – British Standard BS5228-2:2009 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration (used for this NCI Project to assess both amenity and building damage from construction)
- (l) DIN4150-3:1999 – German Standard DIN4150-3:1999 Structural vibration – Effects of vibration on structures
- (m) NS8176.E (2005) – Norwegian Standard – Vibration and Shock: Measurement of Vibration in Buildings from Landbased Transport and Guidance to Evaluation of its Effects on Human Beings
- (n) Transport Agency's *State Highway construction and maintenance noise and vibration guide*, August 2013

6 Key drawings

The following drawings relating to the topic area are relevant for this expert conference:

- (a) General Arrangement plans lodged with the notices of requirement and revisions to Sheets 1 and 2 (Version H).
- (b) Drawings in the Assessment of Operational Noise and Vibration Effects report, Appendix G and the Assessment of Construction Noise and Vibration Effects report lodged with the AEE: Appendix E - Construction Noise Mark-ups.
- (c) All drawings are included in Annexure 4 of the JWS.

7 Context

This is included in the statement of the key facts and shown on the listed drawings.

8 Matters considered by experts at the conference

In addition to the information used in preparing their evidence, the experts took into account the following matters:

- (a) The questions raised by the Board.
- (b) The matters raised by Mr Styles in the Styles Review Report.
- (c) Advice from Mr Hale at the conference that on-going work has been undertaken by the Transport Agency in relation to piling methods. This has resulted in a reduction in vibration effects on private property from those assessed by Ms Wilkening in the Assessment of Construction Noise and Vibration Effects, which was based on worst-case construction techniques.
- (d) Advice from Mr Hale at the conference in relation to the outcomes of on-going consultation with stakeholders and owners of private properties that could be affected directly by the NCI Project in relation to property acquisition and related matters.
- (e) The results of additional investigations and modelling undertaken by Ms Wilkening

since preparation of her evidence.

9 Preliminary matters

Methodologies

- (a) Construction noise was assessed by Ms Wilkening by undertaking modelling. The other experts accepted this modelling as sufficiently robust for the purposes of this assessment. The results are included in the Construction Noise and Vibration Report Appendix E, dated 2 December 2016 and show the 70 dB and 75 dB noise contours resulting from construction activities. These are reproduced in Annexure 4 of this JWS.
- (b) As noted in paragraph 8 (c) above, predicted construction vibration levels resulting from piling will be less than shown in the Construction Noise and Vibration Report, Appendix F - Vibration. Revised vibration levels at different sensitive receivers, and the numbers or sensitive receivers affected, were agreed by the experts at the conference, based on their experience and the updated information available.
- (c) The experts agreed with the operational noise level predictions and the measurement methods used by Ms Wilkening for the NCI Project. They agreed that NZS6806 provides an appropriate basis for evaluating the Best Practicable Option (BPO) in accordance with s16 of the Resource Management Act (the Act). The assessment using NZS6806 has been supplemented with additional information discussed in this JWS.

Definition of day and night for the purpose of construction activities

- (d) The experts and Mr Hale noted that for the purpose of construction, day-time is defined as 7 a.m. to 10 p.m. and night-time is defined as 10 p.m. to 7 a.m, but there are shoulder periods where reduced daytime criteria apply.
- (e) Operational noise is assessed as an average over 24 hours.

Proposed construction activities at night

- (f) Mr Hale noted in the JWS Transport and Traffic – Construction, that:
 - i) Based on current knowledge, the main night-time works will occur as a result of bridge construction. This will occur at all bridges.
 - ii) The night-time component of bridge construction could typically be expected to take 4-5 working days per construction activity per bridge.
 - iii) Based on his experience, that it would be unlikely for contractors to undertake piling work at night, but that he will provide additional information for use by the noise experts at their conferencing.

- (g) By way of clarification at this noise conference, Mr Hale advised that bridge construction activities at night-time will include bored piling within the median, lifting bridge beams and pouring of concrete for the bridge decks. This work would take place in three separate phases, taking up to five days each, and with some weeks in between each phase.

- (h) Mr Hale advised that there will be other night-time construction activities such as pavement resurfacing, traffic management switches (moving temporary traffic barriers), line markings and slip form concrete barriers. These activities generate noise levels that are at least 10 and up to 20 dB lower than piling noise level.

- (i) Mr Hale advised that demolition of the existing McClymonts Road Bridge would be likely to take several nights and possibly up to a few weeks, over an approximate two to three-month period and involve:
 - i) Temporarily tying the bridge beams together;
 - ii) Saw cutting and/or breaking out of the bridge deck during the day and/or night, which is the noisiest of these activities;
 - iii) Closing the motorway during night-time works to lift the beams out; and
 - iv) Removing the abutments (during the day) and central median (during the night).

Proposed construction activities during the day

- (j) The experts noted that they referred to the drawings in **Annexure 4**, which show construction activities in different areas of the NCI Project.

- (k) The experts agreed that the type of daytime construction activities that may result in the proposed NCI Project noise limits being exceeded (“high noise activities”) are:
 - i) Pile construction (retaining walls and bridges);
 - ii) Temporary sheet piling (installation and removal);
 - iii) Earthworks machinery;
 - iv) Concrete pumping (where it is close to buildings);
 - v) Demolition;
 - vi) Construction Support Areas (CSAs); and
 - vii) Compaction.

- (l) The experts noted that source noise levels from each of these activities are set out in the Assessment of Construction Noise and Vibration Effects Appendix A.

- (m) The experts also noted that other construction activities would occur but would not be expected to result in the proposed NCI Project noise limits being exceeded.

- (n) Mr Hale advised and the noise experts agreed that the type of daytime construction activities that may result in the proposed NCI Project vibration limits being exceeded (“high vibration activities”) are:
 - i) Vibro-impact piling;
 - ii) Compaction using vibratory rollers; and
 - iii) Heavy machinery (greater than approximately 10 tonne) moving within 10-15m of any buildings, structures or utilities.

- (o) Mr Hale advised indicative overall times for individual bridge construction, as shown in the table in **Annexure 5**. He noted that the time estimates need to be used with caution and could vary either way, as they will depend on detailed design and the construction methodology chosen by the contractor, neither of which are known at present. While the durations of bridge construction are long, high-noise activities will occur for only a small proportion of the total time.
- (p) Mr Hale noted that no high vibration activities are currently proposed at night.

Technical terminology used in the JWS

- (q) The experts agreed and provided the following information to assist the Board in understanding some of the technical considerations used in their assessments.

Noise descriptors used in this JWS

- (r) Noise levels are described differently throughout the JWS, depending on the noise source assessed. The following descriptors have been used:

- i) Ambient noise:

L_{A90} or L_{A95}

- Background noise level. This noise level describes the sound level that is near constantly present (e.g. distant traffic, surf, wind in trees);
- Is always lower than the other noise descriptors below;
- Is not generally affected by construction activities unless stationary equipment is operated (e.g. a generator); and
- Often used to determine appropriate construction noise criteria, where night time noise is elevated from existing sources – not the case for the NCI project;

L_{Aeq} over a 15 minute, 1 hour or 24 hour period (refer graph below)

- Measurements are undertaken in 15 minute intervals, as recommended by NZS 6802;
- The 15-minute survey results are combined to 1 hour levels as reported in the survey summaries in the Construction Noise and Vibration Effects Assessment;

- The 15-minute results are combined to 24 hour levels to compare with predicted traffic noise levels; and
- Measurements are undertaken as possible. Cannot be too close to a dwelling because of façade reflection and household noise levels, cannot be too close to vegetation because of noise from wind in foliage. Measured L_{Aeq} levels generally correlate well to predicted levels at the same location;

ii) Construction:

$L_{Aeq(10\text{ to }60\text{ min})}$

- Measured and assessed at 1 metre from the façade of the building to be assessed. Therefore, includes façade effect, i.e. reflection from the façade to the assessment position; and
- Each individual measurement/assessment period should comply with the noise criteria. The variable time descriptor depends on the source measured (e.g. short duration steady noise can be measured for 10 minutes only and obtain an appropriate level, while operations with large fluctuations can be measured up to 60 minutes to obtain a representative level for the activity);

L_{Amax}

- Measured and assessed at 1 metre from the façade of the building to be assessed. Therefore, includes façade effect, i.e. reflection from the façade to the assessment position;
- Maximum noise level over each individual assessment period as above; and
- Difficult to control/predict as maximum noise levels are often independent from activity sound power levels;

iii) Operational/Traffic

$L_{Aeq(24h)}$

- Measured and assessed at the façade of the building to be assessed. Therefore, does not include a façade correction as it is an incident level; and
- Measured based on 15-minute continuous measurements across one or more 24 hour periods. The 15-minute levels are energy averaged to obtain a 24 hour energy average noise level across

the entire day. (Refer to the graph below);

iv) Internal noise levels

L_{Aeq}

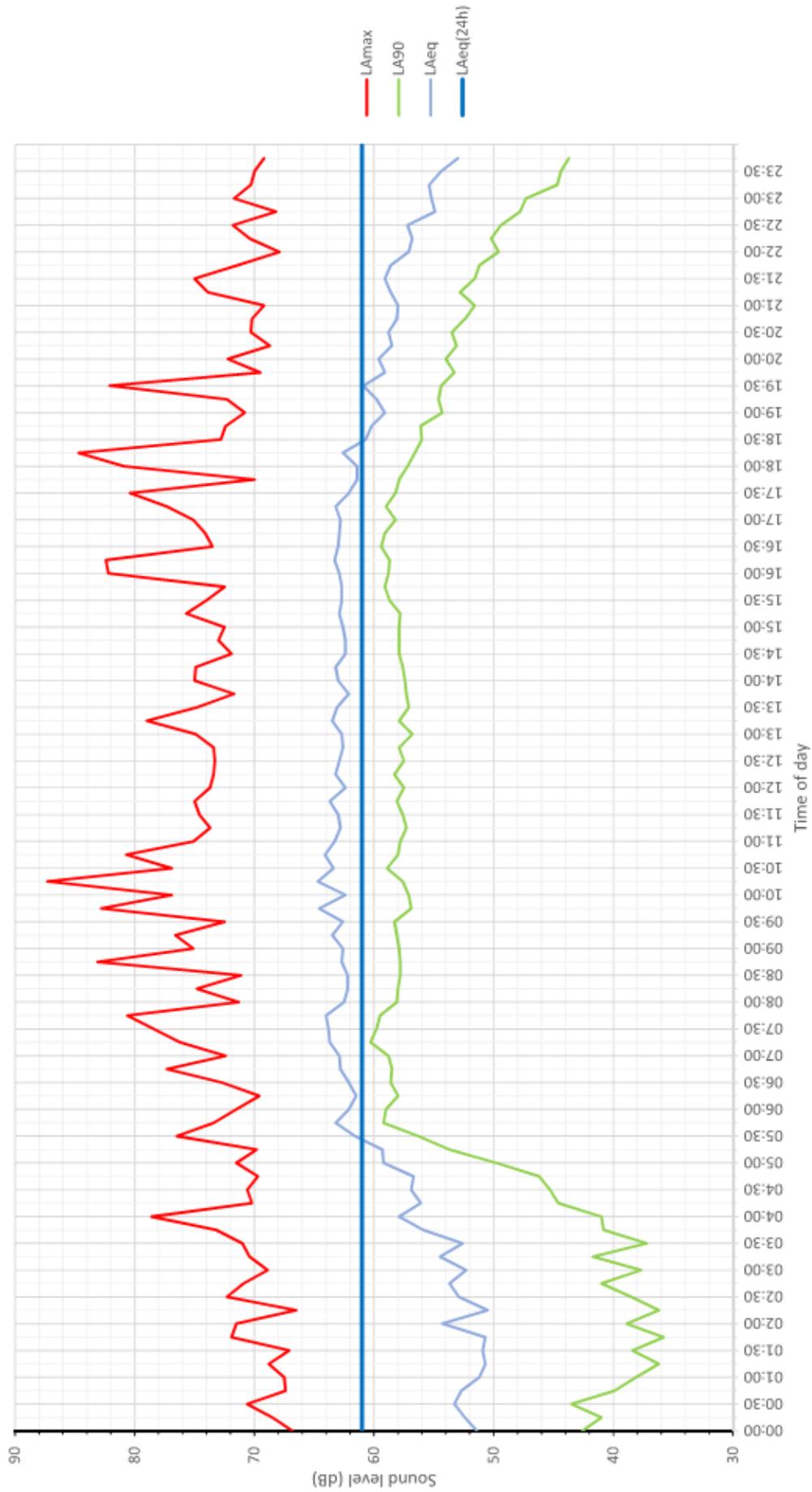
- Measured as an average through the room, i.e. not right behind glass;
- Reduction from outside to inside depends on façade construction (e.g. large glazed areas, thickness of glass, how well joinery and seals perform);
- For slightly open windows, reduction is generally 12-15 dB; and
- For closed windows/doors, reduction ranges from 20 to 30 dB. New dwellings have higher noise level reductions due to improved building construction. For example, at 60 Masons Road, measured façade noise reduction with windows closed ranges from 24 to 26 dB.

v) The experts noted that the North Shore District Plan High Noise Route rules related to situations where the external traffic noise levels of 65 dB $L_{Aeq(6am-10pm)}$ or greater. In such situations the rule required that internal noise levels of 40 dB $L_{Aeq(6am-10pm)}$ had to be achieved (with windows open).

vi) The following graph shows measured ambient noise levels at one location within the NCI Project area. $L_{Aeq(15 min)}$ values range from up to 2 dB above the $L_{Aeq(24 hour)}$ average between 6 a.m. and 6 p.m. to up to 10 dB below the average between 6 p.m. and 6 a.m. For each group of sensitive receivers referred to later in this JWS the predicted upper and lower ambient noise levels are set out.

vii) The experts noted that where construction noise levels used in the report are expressed as dB, that is the $L_{Aeq(15 min)}$, and where operational noise levels are expressed as dB, that is the $L_{Aeq(24 hour)}$, unless stated otherwise.

Ambient noise survey results for one day period

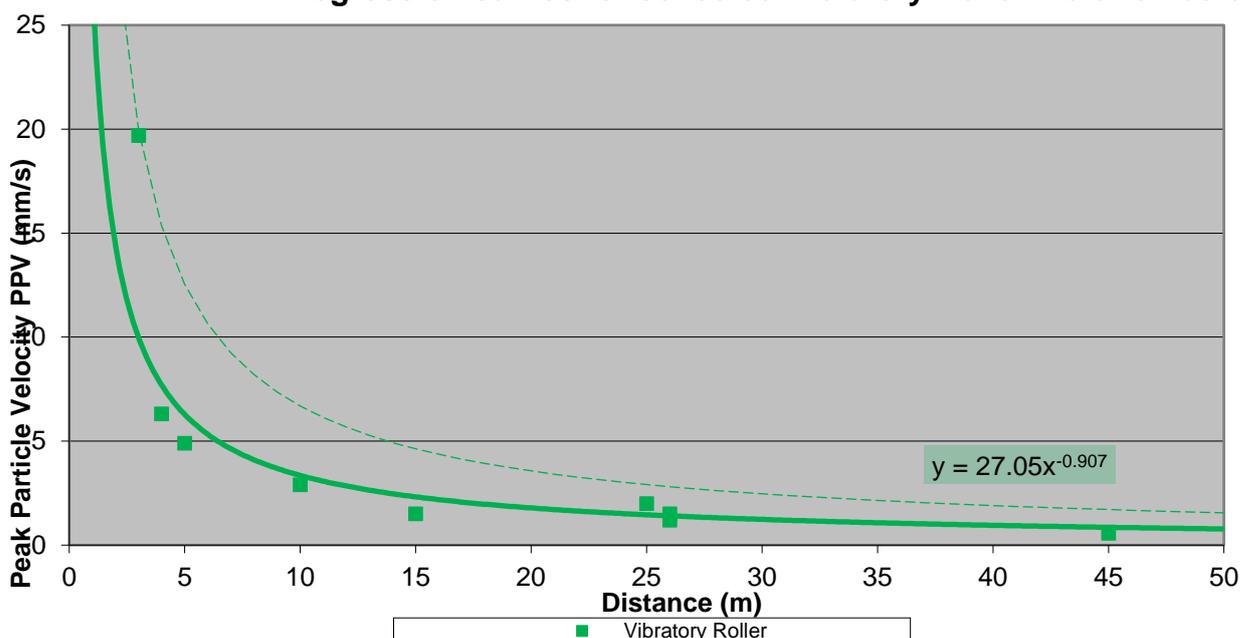


Construction vibration descriptors used in this JWS

- (s) Construction vibration criteria are expressed as peak particle velocity (mm/s PPV). This is the largest velocity of a building element at the measurement position, in any of the three axes (longitudinal, transverse and vertical).
- (t) The criteria in the table in Condition CNV.6 include both amenity and cosmetic damage avoidance criteria. These are explained below.
- (u) Night-time criteria for occupied sensitive buildings are:
 - i) 0.3mm/s (Category A) where vibration may be just perceptible and generally no adverse effect would be expected;
 - ii) 1mm/s (Category B) where vibration is likely to cause complaint but could be tolerated with prior warning;
 - iii) The Category A criterion is the same as set out in the AUP for night-time construction vibration; and
 - iv) Both criteria are amenity criteria.
- (v) Daytime criteria for occupied sensitive buildings are:
 - i) 1 mm/s (Category A) where vibration is likely to cause complaint but could be tolerated with prior warning;
 - ii) 5 mm/s (Category B) where vibration would be highly disturbing. No damage to buildings (including cosmetic damage) would occur. This criterion is from DIN4150-3;
 - iii) The Category A criterion is lower than that set in the AUP (which is 2mm/s); and
 - iv) Category A is an amenity criterion and Category B is a conservative damage avoidance criterion.
- (w) Daytime criteria of other occupied buildings (e.g. offices) are:
 - i) 2mm/s (Category A) where vibration is likely to cause complaint but can be tolerated with prior warning in a less sensitive environment;
 - ii) 5mm/s (Category B) where vibration would be highly disturbing. No damage to buildings (including cosmetic damage) would occur. This criterion is from

- DIN4150-3;
- iii) The Category A criterion is that of the AUP; and
 - iv) Category A is an “amenity criterion” and Category B is a “damage avoidance criterion” at a low level.
- (x) All other buildings, which means unoccupied buildings, e.g. factories at night, or potentially dwellings during the day. The originally proposed criteria are:
- i) 5 mm/s (Category A) were no damage to buildings (including cosmetic damage) would occur. This criterion is for continuous vibration for dwellings, from DIN4150-3;
 - ii) 15 to 50 mm/s for transient vibration or 7.5 to 25 mm/s for continuous vibration. These criteria are limits above which cosmetic damage could occur, in accordance with BS5228-2;
 - iii) The BS5228 criteria are for transient vibration 5 to 50 mm/s and for continuous vibration 5 to 10 mm/s (the experts agreed that this is now to be DIN4150-3 criteria); and
 - iv) All of these criteria are damage avoidance criteria.
- (y) The experts noted that vibration levels initially reduce very quickly with distance from the source, as shown in the following example regression curve (full green) for a vibratory roller. The dotted green line indicates the 100 percent factor of safety curve. This curve should be taken as an example only, noting that the attenuation over distance will vary significantly depending on the actual ground conditions, and machinery used.

Regression curves for collected Vibratory Roller vibration data



Appropriateness of noise criteria used in the NCI Project

- (z) The experts agreed that the construction noise standards adopted for the NCI Project are appropriate. They are the same as those set out in Table 2 of NZS 6803:1999 – Acoustics - Construction Noise for long-term construction works exceeding 20 weeks duration, with no adjustment for external elevated background noise, as provided for in the Standard. These criteria are the same as those in the AUP, which references NZS6803:1999.
- (aa) The NCI Project adopts NZS6806:2010 ‘Acoustics – Road-traffic noise – New and altered roads’ criteria for operational noise. NZS6806:2010 is a requirement in the AUP for the assessment of new and altered roads.
- (bb) Mr Styles noted that NZS6806 does not require any noise mitigation until the noise level reaches 64 dB at the façade of a PPF for an Altered Road. This level is approximately 10 dB above the World Health Organisation (WHO) recommended guidelines, as set out in Section 4.5 of the Styles Review Report. Mr Styles considered that the noise effects arising from the NCI Project should be assessed against the WHO criteria as the starting point, with the decision-maker being responsible for deciding the relative merits or weight of any positive benefits or adverse effects, the ambient noise levels, or any other factors considered relevant

when deciding what a reasonable level of noise might be to satisfy the requirements of s16 of the RMA. This would require an understanding of the effects of noise at levels between 55 dB and 64 dB, and the practicability of mitigating such effects.

- (cc) Ms Wilkening noted that the predicted existing traffic noise levels ranged from the lowest at 48 dB at Wren Place (not fronting Upper Harbour Highway) to 68 dB at 60 Mason Road, with the majority of houses fronting Upper Harbour Highway having a level of 55 to 62 dB. Ms Wilkening noted that if the NCI Project did not go ahead these levels would remain, and increase over time.
- (dd) Ms Wilkening considered that in her opinion, the WHO guidelines are aspirational, and are not practically achievable in urban environments with noise generators such as road, rail and businesses, and that much of Auckland's urban environment is currently receiving noise above this guideline level.
- (ee) Mr Hegley considered that there is merit in investigating practical measures of controlling traffic noise below those currently presented in the Assessment of Operational Noise and Vibration Effects, which could be undertaken as part of a s16 analysis.
- (ff) The experts agreed that the best way to address this matter was to consider practical measures that could be available when undertaking their assessment of effects, which they do later in this JWS.

Appropriateness of construction vibration criteria used in the NCI Project

- (gg) The experts agreed that the NCI Project criteria adopted for construction vibration are based on the relevant codes/standards listed above, and that they are appropriate, except for Condition CNV.6 - the reference to BS5228-2 described in category B for "all other buildings."
- (hh) Mr Styles considered that the criterion for structural damage resulting from vibration should be based on the 'no damage threshold' from DIN4150-3. For typical residential and lightweight structures, this threshold begins at 5mm/s and increases as the frequency of vibration increases up to 20mm/s at the very highest frequencies. His reasons for this are set out in full in section 3.3 of the Styles Review Report, with the key points being:

- i) That the criteria is not a limit, but a trigger for the contractor/ Transport Agency to thoroughly investigate the BPO and to engage with those affected;
 - ii) That the BS5228-2 criteria are higher than the DIN4150 criteria, where the latter are well recognised as being appropriate 'no damage thresholds' for buildings which are already sensitive to movement (such as old or already damaged buildings). To assist the Board, he advised that the BS5228-2 criteria were 15 to 50 mm/s compared to 5 to 20 mm/s in DIN4150-3 for a typical house;
 - iii) That there may be damage to loose fixtures or ornaments falling at levels at or above the DIN4150 criteria; and
 - iv) Because the Category B criteria in CNV.6 are used as the threshold for requiring additional management rather than a hard limit, they should be set at a level where the likelihood of damage begins rather than at a point where damage is already anticipated.
- (ii) Mr Styles considered that the DIN4150 criteria should be applied in full as part of Condition CNV.6 for the management of damage to unoccupied buildings as the threshold for additional mitigation, survey and engagement with those affected.
- (jj) The experts noted that an unoccupied building is a building that is not occupied by people when the works generating the vibration are underway, such as commercial premises at night time, or a house during the day time when no one is home. To assist the Board, the experts noted that occupied buildings are addressed in a different way using more stringent criteria, and the experts consider them to be appropriate.
- (kk) The experts considered that based on the information on construction methodology provided by Mr Hale, it is unlikely that unoccupied buildings would be subject to vibration levels higher than the DIN criteria. While Ms Wilkening and Mr Hegley do not fully agree with Mr Styles on the issues he raised regarding the BS5228 criteria, and are satisfied that those are suitable in this situation, the two experts can accept the DIN criteria for this particular NCI Project.
- (ll) The agreed changes are proposed in Condition CNV.6, attached to this JWS in

Annexure 3.

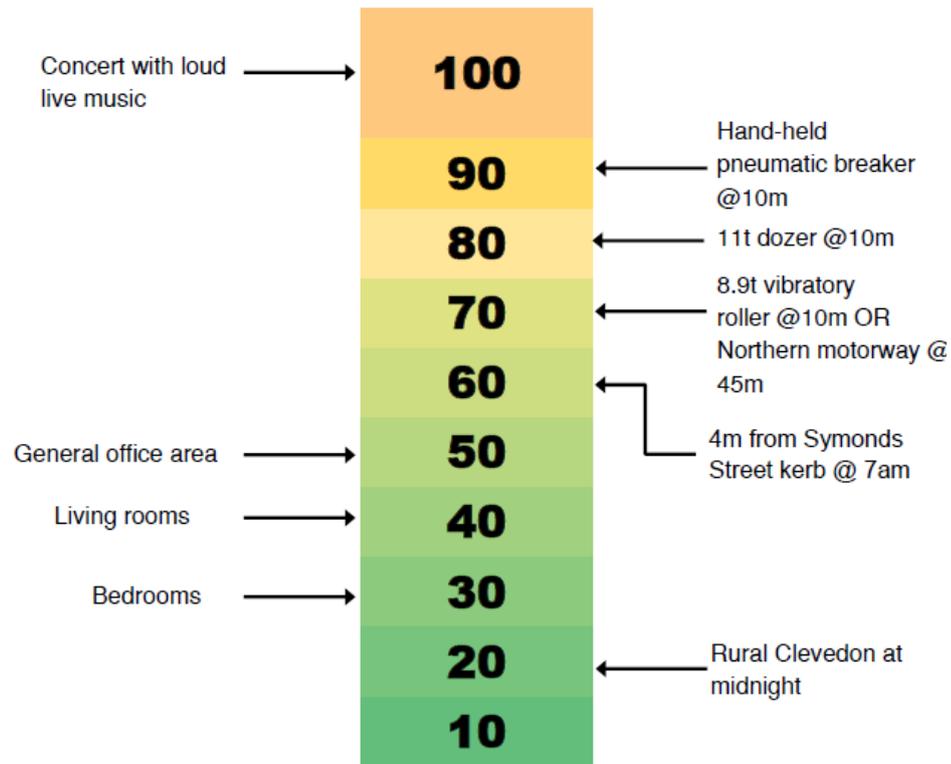
Methods used by the experts to quantify and assess construction noise and vibration levels and effects

- (mm) The experts used the project drawings sheets 1 to 10 included in **Annexure 4** of this JWS as the starting point for quantifying effects on the environment. They also referred to the noise contours shown of the drawings in the AEE Appendix E and also included in Annexure 4 of this JWS. The experts' comments relating to daytime noise are set out in Sections 10 to 18 for different sheets, with their assessment of effects summarised in Sections 19 and 20 of the JWS.
- (nn) Their assessments of night-time noise levels and durations are summarised in a table included in **Annexure 5** and in Section 23 of the JWS, and consider each bridge in turn. They address the assessment, management and mitigation of night-time construction noise effects in Section 24 of the JWS.
- (oo) In both cases, Mr Hale provided information on the proposed construction works, methods and anticipated durations for different activities that he considered provided a reasonable assessment of the likely upper limit of time required, but noted this will depend on the final design. The experts agreed the potential sensitive receivers in each location, with input from Mr Hale in some cases. The experts then estimated the likely upper noise levels at different sensitive receivers, and the numbers of sensitive receivers affected, based on their experience and currently available information.
- (pp) The potential to provide operational and other noise barriers and mitigation measures will need to be considered as part of the CNVMP.

Basis for understanding what different noise levels used in the assessment mean

- (qq) To assist the Court, the experts provided the following table to indicate what different noise levels sound like by reference to commonly experienced noise sources.

dBA Scale



10 Estimated day-time construction noise and vibration levels and durations – Sheet 1 (for all sheets, refer to drawing set in Annexure 4)

Noise

- (a) The experts agreed that there are currently four sensitive receivers within the 70 dB noise contour in Lagonda Rise. They could be affected by high noise activities for approximately two to three months at external noise levels between 70-73 dB, for a proportion of the time only. The experts note that the ambient noise levels in this area range between 56 and 67 dB L_{Aeq} (24 hour).
- (b) There are no bridges in the locality that would result in exceedance of the daytime construction noise criteria.

Vibration

- (c) The experts agreed that there are no high vibration activities that would result in non-compliance with the building damage vibration NCI Project criterion. There is potential for minor effects on amenity if the building at 38 Masons Road is

occupied and any other building that is occupied before construction is completed.

11 Estimated day-time construction noise and vibration levels and durations – Sheet 2

Noise

- (a) The experts agreed that there are approximately 100 sensitive receivers at 60 Masons Road, Lavender Garden Lane, 71 Spencer Road, and McClymonts Road south of the McClymonts Road Bridge. The apartments at 60 Masons Road are individually owned and represent 64 of the sensitive receivers.
- (b) The experts agreed that external noise levels at the northern end of 60 Masons Road and Lavender Garden Lane could be in the order of 75-80 dB during compaction of the fill material of the retaining wall. These works could take two to three months and will occur intermittently over much of that period.
- (c) The experts agreed that the external noise levels at the more exposed properties at the southern end of 60 Masons Road could be in the order of 80-85 dB during piling of the retaining wall. Piling works could take two to three months and will occur for much of that period.
- (d) The experts agreed that between Busway Chainage 1050 and 1100 where dwellings are being built, and at Chainage 1200 (71 Spencer Road), there will be earthworks and compaction for the construction of the SUP and busway. The external noise levels could be approximately 75-80 dB. The works could take two to three months and will occur intermittently over much of that period.
- (e) The experts agreed that following the adoption of the BPO, if the 70 dB limit is exceeded at any sensitive receivers, Condition CNV.7 will apply. Subject to appropriate wording of this condition, the experts agree that this is an appropriate approach. This will be the same in all other cases where there is an exceedance predicted.
- (f) Many of the above properties were developed under the North Shore District Plan High Noise Route rules, which required insulation to achieve an internal noise level of 40 dB (daytime) based on external traffic noise. This will help to reduce construction noise effects indoors.

- (g) To assist the Board, Mr Hale noted that the Spencer Road Bridge, which is to be constructed as a separate project, and the NCI Project are likely to coincide for a period of approximately three months. The noise experts considered that this is unlikely to have a material cumulative effect on the noise levels for the NCI Project.
- (h) Any other daytime bridge noise with regard to the McClymonts Road Bridge, daytime bridge construction works would result in noise levels generally similar to the above intermittently over 12 to 18 months.
- (i) Ambient noise levels in the area are currently 64 to 69 dB $L_{Aeq(24h)}$.

Vibration

- (j) The experts agreed that there could be vibration effects on amenity and on buildings.
- (k) The largest risk with regards to compaction, in terms of either or both of these effects, relates to Lavender Garden Lane. There is the potential to approach or exceed 5mm/s, in which case it will have to be managed through condition CNV.7.
- (l) The experts agreed that the largest risk in terms of piling relates to 60E Masons Road, where levels are unlikely to exceed 5mm/s (Category B) and could typically be between 1 to 4 mm/s when machinery is working close to the buildings. It is unlikely to be a significant risk elsewhere.

12 Estimated day-time construction noise and vibration levels and durations – Sheet 3 (including the southern end of sheet 2 to 14 Coxton Lane)

Noise

- (a) The experts agreed that the residential sensitive receivers in this sheet are located in the 141 lot Colliston Rise subdivision, which extends from Greville Road over the entire eastern side of the sheet to Spencer Road. The experts understand that the subdivision is subject to both a requirement to provide a noise barrier and consent notices for internal sound levels in habitable rooms. Stage 1 to the north is being physically developed and is partially built. There are a further two stages to complete.

- (b) Mr Hale noted that construction of the two retaining walls in this area could each take more than six months to complete, or 12 months overall. The noise experts agreed that noise levels of 75 to 80 dB could be received. However, individual properties will only be affected for part of this time.
- (c) The experts agreed that the various commercial premises which are sensitive receivers on this sheet are located on the western side of SH1. These properties will be intermittently affected by earthworks for a period of up to six months, with noise levels of up to 75 dB.
- (d) Mr Hale noted that a crusher will be potentially located in Construction Support Area (CSA) 6, most likely on the eastern side of SH1. The experts agreed that, while it could have less noise effects on the western side, noise would only be one consideration of a number. Noise effects cannot be predicted at this time and will be subject to Condition CNV.1 which requires a CNVMP.
- (e) Mr Hale noted that higher daytime noise levels associated with the Greville Road Interchange are likely to occur over two to three months. The experts considered that it would be unlikely that the noise in this location would exceed the daytime noise criteria.
- (f) The experts agreed that ambient noise levels in the area are 65 dB $L_{Aeq(24h)}$ at the front façade of the business premises.

Vibration

- (g) The largest risk with regards to compaction, in terms of either or both of these effects, relates to Lavender Garden Lane. There is the potential to approach or exceed 5mm/s, in which case it will have to be managed through condition CNV.7.

13 Estimated day-time construction noise and vibration levels and durations – Sheets 4 and 5

Noise - Eastern side

- (a) The experts agreed that east of SH1, to the north of Rosedale Road between Busway Chainages 2100 and 2500 there are no sensitive receivers as the Rosedale Closed Landfill is located there.

- (b) The experts agreed that south of Busway Chainage 2500 there are a number of commercial properties. The Transport Agency is in an on-going process of acquiring the title to some of these properties but details were not known to the experts.
- (c) Mr Hale advised that here could be a retaining wall in this area up to 13m in height, or the bridge at Rosedale Road could be extended over the Waste Management New Zealand (WMNZ) site, which would eliminate or reduce the length of the retaining wall. The worst case from a noise point of view would be a retaining wall, which could take up to 12 months to construct with high noise activities consistently over that period at levels of up to 85 dB. The bridge option would be constructed over a duration of six to 12 months, and would have very intermittent high noise activities with noise levels up to 80 dB.
- (d) Mr Hale noted that at 121 Rosedale Road, demolition of the westernmost block of units and the western portion of the northern block (Block C) is required, whilst the remaining units will be occupied. Demolition could take approximately one month, but high noise activities would only occur for a proportion of this. The experts agreed that those activities could generate levels of 80 to 90 dB. They also agreed that the demolition would be likely to significantly affect the two remaining units on the eastern side of the northern block. Mr Hale noted that the Transport Agency is having ongoing discussions with these affected businesses.
- (e) The experts agreed that daytime construction of the Rosedale Road Busway Bridge and the widening of the existing Rosedale Road Bridge is expected to comply with the daytime construction noise criteria.
- (f) Mr Hale noted that the proposed designation necessitates the relocation of Turners (Busway Chainage 2750), so this site does not need to be considered from the point of view of construction noise effects.
- (g) The experts agreed that there are approximately seven industrial properties and six mixed use (business and residential) premises south of the Turners site. Some will be physically impacted by a proposed cut retaining wall, requiring full or partial demolition. Construction of this retaining wall and demolition of the buildings is likely to take up to six months. The demolition and subsequent piling activities will result in noise levels up to approximately 75-80 dB. The Rosedale Road Busway Bridge construction is expected to comply with the daytime

construction noise criteria.

- (h) Ambient noise levels in the area are 65 to 68 dB $L_{Aeq(24h)}$ at the front façade of the business premises.

Noise - Western side

- (i) Greville Road Bridge piling will affect the business at 17 Tawa Drive, with noise levels of up to approximately 75 dB over a period of approximately two to three months intermittently.
- (j) Noise from the construction of stormwater treatment attenuation and earthworks (compaction) will affect the storage facility at Miro Place. However, the occupied office is screened by the storage units and is outside the 70 dB noise contour. The effects on the remainder of the storage site will be limited as visitors to the facility will only be there for a short time. The noise levels will be up to approximately 80 dB at the most exposed parts of the storage units. The construction could take approximately two to three months.
- (k) Further to the south of the storage facility at Miro Place, 12 commercial premises will be affected by the construction of two retaining fill walls either side of Rosedale Road and a pile retaining wall. The construction of these walls could take approximately six to nine months for all three, with high noise activities that will affect any individual business occurring intermittently over four to six months. The noise levels could be up to approximately 80-85 dB at most businesses, but at the closest buildings (Motorway Chainage 14600-14700) could be up to approximately 80-90 dB.
- (l) Ambient noise levels in the area are 60 to 65 dB $L_{Aeq(24h)}$ at the facades of the business premises.

Vibration – Eastern side

- (m) The experts agreed that the vibration levels arising from the part demolition of 121 Rosedale Road, Block C and construction of the nearby retaining wall will be at or above 5mm/s (Category B) on the remaining parts of Block C and will require careful management, including precondition surveys, engagement with the occupiers, and monitoring in accordance with Condition CNV.7. The amenity effects for this period are likely to be considerable.

- (n) On the basis that 15 Arrenway Drive (Chipmunks) will be vacant during its partial demolition, there will be no adverse vibration amenity effects on occupiers. The effects on the building will need to be managed as above.
- (o) The vibration resulting from the demolition and the retaining wall works affecting 13, 17 and 19 Arrenway Drive is unlikely to exceed 5mm/s, and could be 1-4mm/s, and will need to be managed in accordance with Condition CNV.6(a).
- (p) The vibration resulting from the retaining wall works and SUP construction affecting the three buildings from Busway Chainage 2970 to 3050 is unlikely to exceed 5mm/s, and could be 1-3mm/s, and will need to be managed in accordance with Condition CNV.6(a). The vibration resulting from the retaining wall works and SUP construction from Busway Chainage 3150 to 3250 is unlikely to exceed 2mm/s (Category A).
- (q) The experts understand that Watercare Services Limited owns and operates infrastructure including underground pipes that will be subject to vibration arising from works in the vicinity of Ponds 1 and 2. Because the location of the infrastructure is not well understood by the experts, they could not assess the likely vibration levels arising from the works. However, they considered that the vibration limits in Table CNV.3 in condition CNV.6 will provide a good basis for managing the effects to prevent any damage occurring.

Vibration – Western side

- (r) The experts agreed that the vibration levels arising from retaining wall construction when it is adjacent to the two buildings between Motorway Chainages 14250 and 14300 could be at or slightly above 5mm/s (Category B) and will need to be managed in accordance with Condition CNV.6(b).
- (s) The experts agreed that the vibration levels arising from retaining wall construction when it is adjacent to the building at Motorway Chainage 14350, and the businesses between Motorway Chainages 14800 and 14900 are unlikely to exceed 2mm/s (Category A).
- (t) The experts agreed that works associated with the Busway Bridge and lowering of Rosedale Road are not expected to exceed 2mm/s (Category A) at the closest buildings.

- (u) The experts agreed that the vibration levels arising from retaining wall construction when it is adjacent to the three buildings between Motorway Chainages 14600 and 14700 could be at or slightly above 5mm/s (Category B) and will need to be managed in accordance with Condition CNV.6(b).

14 Estimated day-time construction noise and vibration levels and durations – Sheet 6 (excluding dwellings adjacent to Upper Harbour Highway)

Noise

- (a) The experts agreed that on the eastern side of the motorway north of Constellation Drive there are a number of businesses that could be affected by high noise activities for approximately two to three months per business. The noise levels could be up to 75-80 dB for the closest businesses. This includes Kiwi Self Storage Limited, where the effects would be limited as visitors to the storage facility are only there for a short time.
- (b) The experts agreed that on the western side of SH1, south of existing Upper Harbour Highway and SH18 (Cabello Place) there are up to 20 front row residential properties that could be affected intermittently by high noise activities with noise levels up to 75 dB for approximately two to three months. Ms Wilkening noted that she had considered the potential for traffic noise barriers in this locality, but considered them to be ineffective in providing noticeable mitigation (see section 5.4.1 of the Assessment of Operational Noise and Vibration Effects).
- (c) Ambient noise levels in the area are currently around 60 dB $L_{Aeq(24h)}$ at the façade of the dwellings.

Vibration

- (d) The experts agreed that the vibration levels arising from retaining wall construction and piling for the Busway Bridge at Constellation Drive on the eastern side of SH1 between Busway Chainages 3720 and 4020 are unlikely to exceed 5mm/s (Category B) and will typically be between 1 and 3 mm/s.
- (e) The experts considered that there are unlikely to be any significant vibration effects on the Farro Fresh site on the eastern side of SH1 during the SUP and busway construction, but noted that there could be some minor vibration effects on amenity at the western end of the car park.

- (f) The experts agreed that there are likely to be only minor vibration effects from compaction on the amenity of the occupants of the residential properties on the western side of SH1 between 63 and 79 Santiago Crescent (Motorway Chainages 15900 to 16000).

15 Estimated day-time construction noise and vibration levels and durations – Sheet 7

The experts agreed that there will be no construction activities that will result in non-compliance with the noise or vibration criteria in this area.

16 Estimated day-time construction noise and vibration levels and durations – Sheet 8 westwards up to Chainage 1150 (also including last eastern part of sheet 6 with SH18)

Noise

- (a) Mr Hale noted that there will be major earthworks associated with the new alignment of SH 18 and the north facing ramps on SH1 in this area that could take approximately 24 to 30 months. Approximately 40-45 residential properties on the southern side of Upper Harbour Highway could be affected by the earthworks, with noise levels of up to 75 dB for the front row of properties during this time, without mitigation.
- (b) The experts noted that there is intended to be a 2.4m high visual barrier from Caribbean Drive westward (see UDLF revision 2, page 50, 20 April 2017). The noise experts recommended that this should be appropriately designed as a noise barrier in order to achieve a reduction in noise of up to 10 dB at the façade of the dwellings most affected by construction noise. The experts also recommended that a similar noise barrier between SH1 and Barbados Drive be provided. They consider that installation of both barriers at the time of construction should be triggered in accordance with Condition CNV.4.
- (c) Meadowood Community Creche is located at 55 Meadowood Drive. The experts agreed that consideration will need to be given to the effects on the learning environment of this and other childcare centres, meaning it will be essential that communication with each centre occurs as soon as possible. As set out in paragraph 16 (b), the experts noted that they recommended an additional 2.4m noise barrier which would result in reduced construction noise levels affecting the

Creche.

- (d) Mr Styles considered that childcare centres have a particular sensitivity to noise where the effects on the learning environment and communication with the children need to be taken into account. He believes that construction noise levels received in this area will likely disrupt or interfere with the operation of the childcare centre at times. The experts agree that this will have to be addressed through effective communication and management.
- (e) Ambient noise levels in the area range from 61 to 65 dB $L_{Aeq(24h)}$ at the façade of the dwellings fronting Upper Harbour Highway.

Vibration

- (f) The experts agreed that the vibration arising from construction works associated with the bridge at Chainage 800 and the earthworks north of Upper Harbour Highway, and west of SH1 to Chainage 1150 is not likely to exceed 1mm/s (Category A) for the buildings south of Upper Harbour Highway.
- (g) The experts agreed that the vibration arising from the construction of the SUP up to Chainage 1200 and roadworks at the Caribbean Drive intersection is unlikely to exceed 5mm/s (Category B) and would generally be less than 2mm/s (i.e. could be in excess of Category A) for the buildings south of Upper Harbour Highway.

17 Estimated day-time construction noise and vibration levels and durations – Sheet 8 from Chainage 1150 and Sheet 9 to Chainage 1600

Noise

- (a) Mr Hale noted that there will be high noise activities in this area for approximately 24-30 months, associated with the construction of the Paul Matthews Road Bridge. Mr Hale noted that this is likely to be the area with the most complex construction activities due to managing the existing traffic flows under temporary traffic management, whilst constructing the new Paul Matthews Road Bridge.
- (b) Mr Hale also noted that as part of the bridge construction, there will be a trench from Chainages 1220 to 1540, where driven sheet piles and excavation will be required.
- (c) The noise experts noted that for sheet piling, approximately 40 residential

properties on the southern side, and approximately 10 commercial buildings (some of which would include more than one business) on the northern side (up to the Alexandra Creek) could be affected, with noise levels up to approximately 80-85 dB.

- (d) The experts noted that a permanent traffic noise barrier is proposed for the Saturn place Childcare property. The need for temporary construction noise barriers for other properties will be determined as part of the CNVMP process (see also comment in paragraph 16(c) for childcare centres).
- (e) Ambient noise levels in the area range from 60 to 64 dB $L_{Aeq(24h)}$ at the façade of the dwellings and generally 65 dB $L_{Aeq(24h)}$ at the façade of businesses fronting Upper Harbour Highway.

Vibration

- (f) The experts agreed that the vibration arising from the installation and removal of sheet piling for the trench construction is likely to exceed 5mm/s (Category B) at the closest dwellings, and will need to be assessed in terms of Condition CNV.7. The experts agreed that it is very likely to be less than 10mm/s.

18 Estimated day-time construction noise and vibration levels and durations – Sheet 9 from Chainage 1600 south of existing Upper Harbour Drive/SH18 (and including Sheet 10)

- (a) Mr Hale commented that the duration of retaining wall construction on the southern side of SH18 could be for a one to two-week period intermittently. Ms Wilkening considered that with the existing noise barriers to the west of Chainage 1600, noise levels at the single storey units within the retirement village could be up to 75 dB. Mr Hegley and Mr Styles agreed with this figure.
- (b) Ms Wilkening noted that the retirement village was developed subject to a resource consent which was based on the North Shore District Plan High Noise Route rules. Mr Hegley noted that the resource consent conditions for the retirement village project specifically required alternative ventilation. The condition does not reference cooling requirements.
- (c) The experts agreed that noise levels as a result of SUP construction on the northern side of SH18 may exceed 70dB (up to 75dB). The experts noted that

there is a childcare centre on the ground floor of the building at 29 Omega Street (Chainage 1700) (refer to comment in paragraph 16(c) for childcare centres).

Vibration

- (d) The experts agreed that the vibration arising from the construction of the SUP from Chainage 1700 to Albany Highway would be less than 2mm/s (Category A) for the commercial buildings north of Upper Harbour Highway. The childcare facility on Omega Street adjacent to Chainage 1700 needs to be considered under the separate criteria (1mm/s - Category A for occupied PPFs). The vibration for the works is likely to exceed this criterion and careful management in accordance with CNV.7 will be required.

19 Summary of estimated noise levels and durations

- (a) The following table summarises the noise effects from Sections 10 to 19. All high noise activities, including those related to bridge works are included in the below table.

Sheet (s)	Estimated number of existing sensitive receivers where noise criteria could be exceeded		Possible period of exceedance (months) for individual properties	Estimated noise levels (dB) without mitigation
	Residential	Commercial		
1	4	0	2 to 3 intermittently	70 to 73
2 - General	100	0	2 to 3 intermittently	75 to 80
2 - at 60 Masons	20	0	2 to 3 for most of the period	80 to 85
3	141 lot subdivision just starting		Up to 12, for part of period only	75 to 80
3		Various	Around 6 intermittently	75
4 and 5	Up to 10	Various	Up to 6 for much of the period	Varies from 75 to 90
6	Up to 20		2 to 3 intermittently	Up to 75
6		Small number	2 to 3	75 to 80
7	0	0	0	0
8 and part 6	Around 45	0	Up to 24 for much of the period	Up to 75
8 and part 9	Around 40	10 with multiple tenancies	24 to 30 for most of the period	80 to 85
9 Retirement village	Various		0.25 to 0.5 intermittently	Up to 75 for short periods
9	0	Around 20 with multiple tenancies	2 to 3 intermittently	75 to 80
10	0	0	0	0

20 Assessment of effects of daytime construction noise

- (a) The experts agreed that the following table provides an appropriate basis for assessing the effects of different construction noise levels, subject to the notes below the table. In reading the table, it needs to be recognised that the focus of this JWS has only been on levels approaching or exceeding 70 dB and there will be many situations where noise levels will be much less, with relatively limited effects on residences or businesses. The table should not be taken as an indication that all construction noise effects as a result of the NCI Project are at levels of concern or will be continuous.

External Noise Level	Potential Daytime Effects Outdoors	Corresponding Internal Noise Level	Potential Daytime Effects Indoors
Up to 65 dB L _{Aeq}	Conversation becomes strained, particularly over longer distances.	Up to 45 dB L _{Aeq}	Noise levels would be noticeable but unlikely to interfere with residential or office daily activities.
65 to 70 dB L _{Aeq}	People would not want to spend any length of time outside, except when unavoidable through workplace requirements.	45 to 50 dB L _{Aeq}	Concentration would start to be affected. TV and telephone conversations would begin to be affected.
70 to 75 dB L _{Aeq}	Businesses that involve substantial outdoor use (for example garden centres such as Bunnings) would experience considerable disruption.	50 to 55 dB L _{Aeq}	Phone conversations would become difficult. Personal conversations would need slightly raised voices. Office work can generally continue, but 55 dB is considered by the experts to be a tipping point for offices. For residential activity, TV and radio sound levels would need to be

			raised.
75 to 80 dB L_{Aeq}	Some people may choose hearing protection for long periods of exposure. Conversation would be very difficult, even with raised voices.	55 to 60 dB L_{Aeq}	Continuing office work would be extremely difficult and become unproductive. In a residential context, people would actively seek respite.
80 to 90 dB L_{Aeq}	Hearing protection would be required for prolonged exposure (8 hours at 85 dB) to prevent hearing loss.	60 to 70 dB L_{Aeq}	Untenable for both office and residential environments. Unlikely to be tolerated for any extent of time.

(b) The experts considered the following to be relevant:

- i) The internal noise levels are based on an assumption that the windows in the building are closed, and that this provides a noise level reduction of 20 dB (outside to inside). Unless rooms facing construction activities have an alternative means of cooling/ventilation (e.g. air conditioning), occupants would need to make a choice between lower noise levels (i.e. windows closed) or fresh air/cooling (i.e. windows open), particularly in the warmer months. A noise level reduction through an open window could typically be between 10-15 dB, compared to the 20 dB assumed in the table above.
- ii) In many cases the receivers exposed to construction noise outdoors would be able to seek respite indoors and/or in locations screened from the construction noise.

21 Assessment of effects of vibration (daytime and night-time)

The experts agreed that the following table provides an appropriate basis for assessing the effects of different construction vibration levels.

Vibration level (mm/s PPV)	Potential effects indoors
0.14	The threshold of perception for stationary people.
0.3	<p>Can be perceptible during normal residential activities, particularly for more sensitive receivers. Levels above this would wake most people from their sleep.</p> <p>This is the AUP limit for construction vibration generated at night-time for sensitive receivers.</p>
1	Is generally tolerable, but complaint or adverse reaction is likely, particularly if there is no warning in office or residential environments. What people actually feel would be subject to the source, 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, either of which could rattle crockery and glassware. Sleep disturbance would be almost certain for most people.
2	<p>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. Effects experienced would be somewhere between levels of 1 and 5 mm/s.</p> <p>This is the AUP limit for large construction projects generating vibration.</p>
5	Unlikely to be tolerable in a workplace. Highly unsettling for both the workplace and residential. 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 threshold below which no cosmetic damage will occur in the DIN standard.
10	Likely to be intolerable for anything other than a very brief exposure.

22 Assessment, management and mitigation of daytime construction noise and vibration effects

- a) The experts agreed that mitigation could reduce noise levels by up to 10 dB. Mitigation options would need to be determined through the CNVMP required by Conditions CNV.1-4. There will be some locations where mitigation will not be practicable, and these are likely to include areas where there are retaining walls and piling, and other works that are elevated and unable to be screened (relative to the receiver).
- b) While reductions in levels of up to 10 dB in some locations may be possible, this is unlikely to be achievable in most locations, hence effective communication and engagement with affected parties will be critical.
- c) Vibration mitigation options are limited generally to the choice of equipment (e.g. smaller machinery) and construction methodology (e.g. drilling rather than driving piles). Often the trade-off is that works will take longer. Management options are set out in the Assessment of Construction Noise and Vibration Effects section 8.3.
- d) The experts agreed that there will be significant adverse effects from daytime construction noise and vibration, but these will affect individual receivers only for discrete parts of the overall construction period, as outlined above.
- e) Although there will be significant adverse effects at times, the experts agreed that there are methods that can be investigated to reduce effects on some receivers, and this will require careful management and consultation through the CNVMP process. The experts noted that at other times, the noise levels in many areas will be not significantly different from the existing ambient levels.

23 Durations and levels of construction night-time noise

- a) The noise experts have set out in **Annexure 5** their best assessments of the number of sensitive receivers that are likely to be exposed to night-time noise levels above NCI Project criteria (45 dB), based on currently available information for each bridge location. As in paragraph 9 (g) above, the duration of night-time noise at any individual bridge (except McClymonts Bridge demolition) could be up to 15 nights spread over three five night periods over the total periods of construction set out in **Annexure 5**. In the case of McClymonts Bridge, Mr Hale advised that this could take two to three months intermittently.

- b) As discussed in Section 9 (h) above there will be other night time construction activities but these are unlikely to exceed NCI Project criteria levels. Further, some of the work such as reconstruction and resealing of roads are necessary and common activities throughout the Auckland motorway network.
- c) There are dwellings where external noise levels will exceed the NCI Project criteria for limited times (see **Annexure 5**). In practice, the number of dwellings where sleep disturbance could occur is likely to be lower for the following reasons:
 - i) The level at which sleep is disturbed is likely to be higher than 45 dB (measured externally) for many people, as external levels of around 55 dB (or possibly higher if the dwelling is well insulated) may not disturb some people with windows closed.
 - ii) Some bedrooms are likely to be on the opposite side of the dwelling (relative to the works) and the noise levels in the bedrooms would therefore be lower.
- d) To assist the Board, the experts noted that ambient levels in the affected area are 30-40dB L_{A95} , and around 50 dB L_{Aeq} during night-time.
- e) As noted above, there will be no night-time activities generating vibration that will result in NCI Project criteria being exceeded.

24 Assessment, management and mitigation of night-time construction noise effects

- a) The experts agreed that there will be significant adverse effects from night-time construction noise, but this will affect a relatively small number of receivers, in the vicinity of the bridge works, and generally only for up to three periods of up to five nights each. The only exception is the McClymonts Road Bridge, as discussed in paragraph 23(a).
- b) The experts agreed that there are few mitigation options available to reduce the above noise levels, and that effective communication and engagement with affected parties will be critical. For the worst affected, the experts recommend that temporary relocation be offered.

25 Operational noise (Design year 2031)

- (a) Operational effects are discussed in the EIC of Ms Wilkening relating to operational noise

and vibration. Key information from that evidence is that Ms Wilkening:

- i) Predicted existing noise levels at all PPFs within 100 metres of the edge of the road (in accordance with NZS6806), using a calibrated computer noise model (paragraph 8.3);
- ii) Identified that there are over 300 PPFs within 100 metres of the proposed road edge (paragraph 9.1)
- iii) Assessed the traffic noise effects from the NCI Project against the “Altered Road” criteria in accordance with NZS 6806, which are (paragraphs 9.1 and 9.2):

Category	Altered Roads	Existing 2016
	dB (L_{Aeq} 24 hour)	Number of PPFs
A (primary external noise criterion)	≤ 64	285
B (secondary external noise criterion)	64–67	17
C (internal noise criterion)*	40	2

*This criterion is triggered if habitable rooms would receive internal noise levels greater than 45 dB $L_{Aeq}(24h)$ despite structural mitigation (e.g. barriers and road surface) being used. However, the NZTA provides building modification for all PPFs that are identified as Category C where the internal noise level would be otherwise higher than 40 dB $L_{Aeq}(24h)$.

- iv) Noted that those PPFs predicted to receive the highest noise levels, are generally multi storey apartment buildings adjacent to SH1. These PPFs are relatively new and have been constructed in recent years, since 2004.
 - v) New dwellings adjacent to SH1 and SH18 have been designed and constructed to take account of the existing high noise levels from the existing roads, under the High Noise Route provisions of the then operative North Shore Operative District Plan. For those dwellings, if they are predicted to receive noise levels within Category C, no further improvements may be required.
- (b) Operational noise contours in 5 dB intervals from 50 to 75 dB $L_{Aeq}(24h)$ are provided in Appendix G of the Assessment of Operational Noise and Vibration Effects, and

reproduced in **Annexure 4** of this JWS.

- (c) Ms Wilkening sets out predicted future noise levels in section 5 of the Assessment of Operational Noise and Vibration Effects.
- (d) The other experts accept the factual matters set out in (a) to (c) above as an appropriate basis for assessing effects, subject to the matters raised below.

26 Assessment of effects

- (a) Ms Wilkening noted that she divided the NCI Project into eight assessment areas (Areas), as shown in Appendix B of the Assessment of Operational Noise and Vibration Effects.
- (b) Ms Wilkening produced the graphs in Annexure 6 which show the changes in noise levels to individual PPFs (excluding Colliston Rise, which is discussed below) for SH1 and Upper Harbour Highway as a result of the NCI Project. The differences shown are between the 'do nothing' option and the NCI Project with Preferred mitigation. Both scenarios are for the design year 2031. The graphs also show the NZS6806 noise criteria categories for each PPF.
- (c) The experts noted that 'Preferred mitigation' above means the mitigation options that have been recommended by the NCI Project Team. These comprise of a combination of low noise road surface, noise barriers and building modifications. They also note that they have recommended extension of the proposed noise barrier in the UDLF.
- (d) The full blue bars in the graph show the 'do nothing' noise level, and the thin orange bars show the noise level with the NCI Project fully operational. The difference between the blue and orange bars for each PPF shows the change in noise level arising from the NCI Project. For increases, the orange bar extends above the blue bar, and for decreases, the orange bar remains below the blue bar. The green and red lines show the upper limits of NZS6806 categories A and B respectively.

Consideration of effects on, and structural mitigation for, PPFs in Category A

- (e) This issue was raised in the Styles Review Report in section 4.5 and is relevant to the

PPFs south of Upper Harbour Highway, which are in Category A. Mr Styles noted that with the noise barrier proposed in the UDLF, and with the extension recommended in paragraph 16 (b), this issue has now been addressed, albeit indirectly.

Assessment in accordance with NZS6806

- (f) This section is written in response to issues raised in section 4.6 of the Styles Review Report.
- (g) Ms Wilkening noted that the vast majority of PPFs (228 of 253, excluding Colliston Rise) is predicted to remain within the same noise criteria category as the 'do-nothing' situation with the Preferred mitigation option situation.
- (h) Ms Wilkening advised that there are a number of changes in noise criteria category, as outlined below:
 - i) Facing Upper Harbour Highway (Area 5), there is one PPF that is predicted to move into the next noise criteria category by 1 dB (14 Wren Place from A to B, with a noise level increase from 64 to 65 dB $L_{Aeq(24h)}$ with barriers in place). The dwelling at 14 Wren Pl is bordered by Rook Reserve to the west and would lose views to the open space with a barrier. Therefore, no further mitigation has been recommended.
 - ii) All remaining PPFs that move into another noise criteria category, are generally new dwellings that face SH1 (Areas 1 and 2). They are multi storey and elevated above SH1. Noise barriers would need to be more than five metres high to provide any meaningful noise mitigation. Those PPFs are at 60 Masons Road, 71 Spencer Road, Lavender Garden Lane and McClymonts Road. Therefore, building modification was recommended in preference to structural mitigation.
 - iii) There are also two older style PPFs in Area 3 (59B and 63 Santiago Crescent) that move from Category B to Category C by 1 dB (both from 67 to 68 dB $L_{Aeq(24h)}$). The Santiago Crescent properties are double storey and elevated above SH1. Therefore, building modification was recommended in preference to structural mitigation.
- (i) There are a small number of PPFs that are currently, and will remain, within Category C

with the NCI Project (at 60 Masons Road). All PPFs that are identified as receiving noise levels within Category C, will be assessed for building modification mitigation in accordance with Conditions ON. 9 to 14.

- (j) The other experts relied on the above for the purpose of expert conferencing, because Ms Wilkening has the only noise model of the NCI Project.

Assessment based on changes in noise levels resulting from the NCI Project

- (k) Ms Wilkening advised that of the 253 PPFs, (excluding Colliston Rise), 235 are predicted to receive a noise level reduction, no change, or increase of up to 4 dB. The remaining 18 PPFs are predicted to experience increases in levels of up to 5 dB. This is based on the newly proposed 2.4m barrier along Upper Harbour Highway as discussed in paragraph 16 (b) above.
- (l) The experts agreed that a noise level change of 2 dB or less would be imperceptible to receivers. They also agreed that a change of 3 to 4 dB is perceptible to receivers and in most circumstances the effect would be slight. However, Mr Styles considered that the NCI Project will result in traffic lanes moving closer to receivers in some locations and some large physical changes to the road alignment, and therefore in his view, the effect is different to a simple and gradual change in noise level over the same alignment in a ten-year period. For this reason, he considered that a description of “perceptible to noticeable” is more appropriate for a 3 to 4 dB change. Ms Wilkening and Mr Hegley do not share this concern, but accept his definition.
- (m) The experts discussed how best to explain the effect of changes in noise level of 5 to 8 dB, referred to in previous reports and evidence. After considerable discussion, the experts agreed that a change of 5 to 6 dB would be clear and obvious to receivers. As a result of new information available at this conference, the experts noted that there are no changes above 6 dB, which means that the concern about 8 dB raised in the Styles Review Report needs no further consideration.
- (n) In regards to (l) and (m) above, these descriptions of changes in noise levels apply to positive and adverse effects based on noise level decreases and increases respectively.
- (o) Ms Wilkening noted that all PPFs predicted to receive noise level increases of 5 dB or

greater will remain within Category A (up to 64 dB $L_{Aeq(24h)}$). The other experts agreed with this based on the graphs in Annexure 6.

- (p) The experts agreed that based on the graphs in Annexure 6, there will be nine PPFs adjacent to SH1 predicted to receive noise level increases of 4 dB, which would result in them moving into the next noise criteria Category (to either B or C). All of these PPFs are new dwellings constructed under the North Shore District Plan High Noise Route rules. Nevertheless, any PPFs within category C will be assessed for building modification.

Assessment based on changes in noise levels resulting from the NCI Project for Colliston Rise

- (q) Ms Wilkening noted that Colliston Rise is a new subdivision and therefore layout details are not readily available, and thus her model did not include any dwellings in the subdivision. Therefore, she was unable to accurately predict noise levels at individual dwellings. Dwellings fronting SH1 would provide screening for those constructed behind. In her opinion, the predictions for all but the front row Lots are overly conservative estimates. The model also did not include the noise fence that is required as a condition of the subdivision. Ms Wilkening noted that the noise fence would reduce noise levels at the ground floor by up to 8 dB. She noted that since the fence is only two metres high, and dwellings in the subdivision will be double-storey (according to the building reports available to Ms Wilkening), the results would not change for the upper floor.
- (r) Ms Wilkening noted that there are 19 Lots in Stage 1 of the development that are directly exposed to traffic noise from SH1. She predicted the noise level changes would range from a 3 dB reduction to a 5 dB increase. Seven PPFs were predicted to receive noise level increases of 3 to 4 dB, and two PPFs of 5 dB. All predictions were for the upper floor of the anticipated dwellings.
- (s) The other experts accepted the modelling outcomes in (q) and (r) above.

Assessment based on levels of annoyance

- (t) The experts agreed that a third method of assessing noise is describing the response of the community in terms of levels of annoyance, relative to the level of noise received. It is possible to consider the number of people who would be little annoyed, annoyed, and highly annoyed.
- (u) Ms Wilkening noted that she has used this method as a means of comparing the different roading scenarios, rather than as a means of assessing the effects on the community as a whole (for example, refer to Table 9 in section 5.1.1 of the Assessment of Operational Noise and Vibration Effects).
- (v) Ms Wilkening noted that she had only used the highly annoyed category for this purpose. She noted that other categories could be calculated, but that a sample analysis she had undertaken showed that the conclusions remain the same as for highly annoyed.
- (w) After considerable discussion on this matter, the experts agreed that further evaluation using this methodology would not change the outcome of Ms Wilkening's consideration of scenarios, discussed above. On the basis that the highly annoyed category has only been used to compare scenarios, the experts agreed that while an assessment of little annoyed, annoyed, and highly annoyed could be used to assess overall noise effects on receivers, it would be unlikely to change the outcome from the two methods discussed above.

Overall assessment of operational noise

- (x) The experts considered that the graphs in Annexure 6 provide a clear visual representation of likely operational noise effects. The graphs, read in conjunction with the description of changes in noise levels in paragraphs 26 (l) and (m) assist with understanding the likely effects.
- (y) With regards to SH1 the experts agreed that:
 - i) Based on the advice of Ms Wilkening, traffic noise barriers were not deemed to be practicable by the NCI Project Team;
 - ii) Approximately 2% of SH1 PPFs would experience a perceptible to noticeable reduction in noise level (3 dB) primarily due to the screening afforded by the

- construction of retaining walls;
 - iii) Approximately 60% of SH1 PPFs would experience no noticeable change in noise level (± 2 dB);
 - iv) Approximately 36% of SH1 PPFs would experience a perceptible to noticeable increase in noise level between 3 and 4 dB, generally because of the additional noise generated by the proposed busway; and
 - v) Approximately 2% of SH1 PPFs would experience a clear and obvious increase in noise level of 5 dB, again generally because of the additional noise generated by the proposed busway.
- (z) With regards to Upper Harbour Highway, the experts agreed that:
- i) Based on the advice of Ms Wilkening, traffic noise barriers have been recommended by the NCI Project Team at Wren Place, Metlifecare Retirement Village, Bluebird Crescent, and the two childcare centres at Saturn Place and Omega Street;
 - ii) The 2.4m barriers referred to in paragraph 16(b) above and the recommended extension from Caribbean Drive to SH1 would be of benefit to the NCI Project, and has been included in the below numbers;
 - iii) Approximately 9% of Upper Harbour Highway PPFs would experience a clear and obvious reduction in noise level (5 to 6 dB);
 - iv) Approximately 7% of Upper Harbour Highway PPFs would experience a perceptible to noticeable decrease in noise level between 3 and 4 dB;
 - v) Approximately 47% of Upper Harbour Highway PPFs would experience no noticeable change in noise level (± 2 dB);
 - vi) Approximately 28% of Upper Harbour Highway PPFs would experience a perceptible to noticeable increase in noise level between 3 and 4 dB;
 - vii) Approximately 9% of Upper Harbour Highway PPFs would experience a clear and obvious increase in noise level of 5 dB;
 - viii) Noise level reductions are due to barriers, movement of traffic further from the receivers, and screening afforded by the Paul Matthews Bridge Underpass; and
 - ix) Noise level increases are primarily due to traffic moving closer to receivers.

27 Other matters

Mitigation for parks and open spaces

- (a) The experts understand the following main reserves in residential areas provide recreation facilities for people, and will remain after completion of the NCI Project area are:
 - i) Meadowood Reserve, which is recommended to be protected by a 2.4m noise barrier (see paragraph 16 (b) above);
 - ii) Rosedale Park South (sports fields);
 - iii) Rook Reserve; and
 - iv) Bluebird Reserve.
- (b) They noted that these reserves are located alongside Upper Harbour Highway and currently are without any noise mitigation.
- (c) Ms Wilkening noted that the AUP does not provide noise limits at Open Space boundaries as a result of noise received from other zones.
- (d) The experts consider that where safety barriers are required on motorway edges, it would assist, to mitigate noise, if barriers were to be made solid and were acoustically effective.
- (e) To assist the Board, the experts noted that some noise mitigation could be possible at Bluebird and Rook Reserves by using a noise barrier, but that this would require assessment to determine whether this is practicable, with input from other disciplines.

Management of effects on sensitive businesses from construction noise and vibration

- (f) This issue was raised in section 3.4 of the Styles Review Report, and relates to the assessment and management of construction noise and vibration effects on businesses that are particularly sensitive due to their nature and operation, e.g. laboratories and printers.
- (g) The experts agree that a “sensitive business” means one that would be unreasonably disrupted despite compliance with relevant NCI Project construction vibration and noise

criteria.

- (h) The experts noted that there were no submissions on the NCI Project in relation to this matter, but this does not necessarily mean that there are no particularly sensitive businesses in the vicinity of the NCI Project works.
- (i) The experts do not have sufficient information on the receiving environment with which to provide the Board with any assistance with this matter. Mr Styles and Mr Hegley consider that such an assessment should have already been undertaken (and be updated prior to construction) to ensure that the effects on any such businesses are understood and can be managed. This would also provide insight into whether any particular construction activities would be problematic and may necessitate design changes. Ms Wilkening agreed that an assessment should be undertaken, but considers that the risk is low based on her visual inspections to date. She thinks that the timing should be closer to the time of construction when relevant information is available to respond appropriately.
- (j) Notwithstanding the above, and at this late stage of the process, the experts agreed that a possible way forward would be to include a condition on the NCI Project that required this assessment to be undertaken prior to, and taken into account at the detailed design stage.

The provisions of the old North Shore District Plan High Noise Route rule and the degree to which the mitigation carried out in accordance with those rules can be relied on

- (k) Mr Styles was initially concerned that it would be assumed that buildings constructed under this rule would not be affected by traffic noise. It was clarified at the conference that all buildings eligible for building modification will be treated the same, and assessed under the NCI Project. The issue requires no further consideration.

Matters raised relating to Colliston Rise

- (l) The Board requested the following information: "There appear to be no rules proposed to sound proof dwellings near to the proposal. Is this correct? And if so, why not? This is to be addressed in the both noise and planning expert conferencing sessions."
 - i) Ms Wilkening noted that any dwellings having building consent at the time of construction will be assessed in the same way as any other PPF, however at the time of her assessment, no other information could be obtained with regards to

location. She noted that in her opinion, Stage 1 of the subdivision should be assessed regardless of whether or not building consent has been obtained, and that this should be reflected in a condition. This is to protect individuals that have taken their dwelling design to an advanced stage prior to the NCI Project being notified. The other experts consider that this is appropriate, subject to a suitable condition being agreed.

(m) In relation to the report produced by Mr McGarr dated 6 June 2017, the experts understand that the Board would like further clarification on the following:

- i) Advise if there is the potential for noise to travel up from the road/construction area and thereby impact adversely on Colliston Rise properties to a greater extent than that which they currently experience.

The experts considered that some dwellings in Colliston Rise, directly abutting SH1, would experience increased traffic noise levels because of the proposed busway. Some others would experience a reduction in traffic noise levels as a result of the NCI Project, due to the construction of the retaining wall. Details are set out in section 5.3.2 of the Assessment of Operational Noise and Vibration Effects. **Annexure 7** contains a representative cross section through Stage 1 of Colliston Rise showing the propagation of traffic noise up the hill with and without a barrier.

- ii) Confirm if the approach taken by Mr McGarr to select a representative sample of the properties at Colliston Rise located close to the motorway was appropriate.

The experts regret that they did not have the relevant background information to answer this question, but consider that the only way to properly know the answer would be to consider every title to determine whether the same consent notice is on every title.

Should a draft Construction Noise and Vibration Management Plan be provided for consideration by the Board?

- (n) This issue was raised in the Styles Review Report because of a concern that there was insufficient information to assess effects and management of construction noise and vibration. This JWS now includes an assessment of construction noise and vibration effects for the NCI Project, so the need for a CNVMP at this stage is now diminished.

Subject to appropriate conditions setting out precisely what is required in a management plan, Mr Styles agrees with Ms Wilkening that a draft CNVMP is not necessary at this stage. Mr Hegley also agrees.

Noise and vibration issues raised by submitters

(o) These are generally addressed in the EIC of Ms Wilkening, with her additional comments set out below. Other experts were unable to comment.

(p) Kiwi Self Storage Limited (12 Holder Place)

Ms Wilkening provided the following information, which should replace that set out in paragraphs 12.47 to 12.49 of her EIC (Construction):

- i) The manager accommodation appears to be located at the eastern end of the southern storage unit. This location is well shielded from SH1 noise and will also be well shielded from construction noise, as discussed above.
- ii) Current noise levels are 50 dB $L_{Aeq(24h)}$ and below.
- iii) With the project in place (in 2031), the traffic noise levels are predicted to be similar, approximately 50 dB $L_{Aeq(24h)}$.

(q) Meadowood Community Crèche (55 Meadowood Drive)

- i) Existing noise level at the childcare is predicted to be 61 dB $L_{Aeq(24h)}$, which is predicted to remain unchanged to the design year.
- ii) With a 2.4m barrier in accordance with paragraph 16 (b) above, the noise level with the NCI Project is predicted to reduce to 59 dB $L_{Aeq(24h)}$ in the design year.

Operational vibration

(r) All experts agreed that there may be some effects of operational vibration, but that these are unlikely to be significant. Ms Wilkening's assessment states that Class C vibration limits in NS8176E are appropriate for this situation. Mr Styles noted the standard states that "about 15% of the affected persons in Class C dwellings can be expected to be disturbed by vibration." He considered that a condition limiting vibration to the Class C criteria is required in relation to this matter, as set out in section 28 of this JWS.

28 Conditions

The experts are working with the planning experts on this matter and will continue to do so over the next few days. The experts note that they agree in principle on the most of the issues and expect significant agreement to be reached.

29 Technical evaluation of the proposal in relation to relevant planning objectives and policies

The relevant objectives and policies identified by planning experts/counsel are set out in **Annexure 2** and listed in the following table. The objectives and policies were considered by the experts at the expert conference from a technical perspective only and their opinions as to the extent to which the proposal is consistent with the objectives and policies are set out in the last column of the table.

Relevant planning documents and provisions - Directive objectives and policies:

Document	Relevant Section	Relevant Provision	Theme	Expert comments (from a technical perspective only)
Auckland Unitary Plan: District Plan	Objectives	E25.2.4	Noise and Vibration	
	Policies	E25.3.1	Noise and Vibration	
		E25.3.2	Noise and Vibration	
		E25.3.5	Noise and Vibration	
		E25.3.7	Noise and Vibration	
		E25.3.10	Noise and Vibration	

Relevant planning documents and provisions - Non-directive objectives and policies:

Document	Relevant Section	Relevant Provision	Theme	Expert comments (from a technical perspective only)
Auckland Unitary Plan: District Plan	Objectives	E25.2.1	Noise and Vibration	
		E25.2.2	Noise and Vibration	
		E25.2.3	Noise and Vibration	

Relevant planning documents and provisions - Other provisions from the same documents:

None

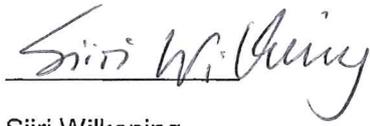
Relevant planning documents and provisions - Other relevant statutory documents:

None

30 Summary of key outcomes

- (a) The experts completed an assessment of construction noise and vibration effects during the conference using the most up-to-date information that was available to the experts (some of which was not available at the time evidence was prepared) and this addressed a number of concerns identified by Mr Styles and Mr Hegley regarding the ability to properly understand construction effects.
- (b) There are no substantive points of difference between the experts remaining on technical or assessment matters upon completion of the conference. While a number of more minor points of difference remain, those differences do not impact on the substantive outcomes, which are agreed.
- (c) The experts are continuing to work on the conditions and they note that they agree in principle on the most of the issues and expect significant agreement to be reached.

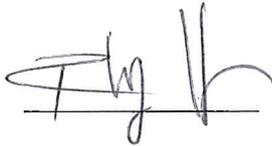
Signed this 5th day of July 2017

A handwritten signature in black ink, appearing to read "Siri Wilkening", written over a horizontal line.

Siri Wilkening

A handwritten signature in blue ink, appearing to read "Andrew Hale", written over a horizontal line.

Andrew Hale

A handwritten signature in black ink, appearing to read "Rhys Hegley", written over a horizontal line.

Rhys Hegley

A handwritten signature in black ink, appearing to read "Jon Styles", written over a horizontal line.

Jon Styles