IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	applications for resource consents and notices of requirement in relation to the Ōtaki to North of Levin Project
BY	**WAKA KOTAHI NZ TRANSPORT AGENCY**
	Applicant

ŌTAKI TO NORTH OF LEVIN HIGHWAY PROJECT

TECHNICAL ASSESSMENT B: NOISE AND VIBRATION

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EXECUTIVE SUMMARY

Project description

1. The Ōtaki to North of Levin Highway Project ("**Ō2NL Project**" or "**Project**") involves the construction, operation, use, maintenance and improvement of approximately 24km of new four-lane state highway between Taylors Road (to the north of Ōtaki) and State Highway 1 ("**SH1**") north of Levin.

2. My evidence outlines the assessment of operational and construction noise and vibration effects for the Ō2NL Project and proposed mitigation.

Existing environment

3. The Ō2NL Project spans predominantly rural communities from North Levin, Levin East, Ohau East, Manakau, and North Ōtaki. As part of my assessment, I have considered the existing environment based on site observations, measurement, and acoustics modelling of existing road traffic.

4. In some areas, the existing environment is influenced by local and distant traffic noise (including from SH1 and State Highway 57 ("**SH57**")) and the hum of activity within Levin. However, in other areas or at certain times of the day, there may be few man-made sounds, with nature sounds such as birds and wind in trees dominating. While much of the land is zoned rural, there is generally little noise from farming activities in the area.

Operational noise

5. Road-traffic is a major contributor to environmental noise in New Zealand. The Ō2NL Project will redistribute some exposure from some people and communities to others. Those currently exposed to state highway noise along the existing sections of SH1 and SH57 to be superseded by the Ō2NL Project will experience a benefit from this Project. While much of the focus of my evidence is on the adverse noise effects from the Project, there are positive noise effects, both for people living by the existing state highway corridors, and also for the Levin town centre itself.

6. The human response to noise is complex and it is not possible to determine effects based on noise level or change in noise level alone. Factors that influence the human response to noise include non-acoustic factors such as an individual’s sensitivity to noise, underlying health conditions, prior

exposure to noisy environments, relationship with the noise source and expectations in general. The character of the noise and other sounds present also influence the human response.

7. I have assessed operational road-traffic noise effects for the Ō2NL Project with reference to criteria from the New Zealand Standard for road-traffic noise (NZS 6806:2010)[1] and health-based guidelines from the World Health Organisation ("**WHO**"). I have estimated the number of people likely to experience potential health effects from road-traffic noise, and also the burden of that disease in terms of Disability Adjusted Life Years ("**DALYs**"). I have also estimated subjective responses to noise in terms of whether residents would find the noise intrusive, disruptive, or very disruptive applying my expert judgement and referencing published guidelines.

8. I have used the noise mitigation evaluation process from NZS 6806, with input from other specialists, to develop what I consider to be the Best Practicable Option ("**BPO**").

9. Recognising that annoyance from road-traffic noise often relates to noise with specific character or from individual vehicles, I have recommended the development and then adoption of design principles to avoid or reduce these effects (and they are contained in the Cultural and Environmental Design Framework ("**CEDF**"),[2] attached as Appendix 3 to Volume II). In particular, I have:

   (a) recommended that Audio Profile Tactile markers not be used within 200m of dwellings;

   (b) identified that roundabouts and interchanges require landscape and highway design to encourage smooth braking and acceleration;

   (c) recommended that, where mechanical bridge joints are required, a control process is put in place to ensure they are installed consistent with Waka Kotahi New Zealand Transport Agency ("**Waka Kotahi**") specifications to avoid excessive noise generation.

10. A low-noise porous asphalt was selected as the default road surface, rather than as a mitigation option. This alone has resulted in a reduction in road

[1] New Zealand Standard NZS 6806:2020 Acoustics – Road-traffic noise – New and altered roads.
[2] See Appendix Three in Volume II.

traffic noise levels of approximately 6 dB $L_{Aeq(24h)}$ at all properties adjacent the highway.

11. I have predicted road-traffic noise levels at all relevant receivers for six different scenarios. As a baseline I considered the existing (2019) environment, and the future environment with the Peka Peka to Ōtaki Expressway ("**PP2O**") open (2029 and 2039). I then modelled noise levels with the Ō2NL Project (using the highest traffic growth forecasts[3] and assuming a speed limit of 110km/h,[4] in order to provide conservative noise predictions), both initially without specific noise mitigation measures, and again with the recommended mitigation discussed below. I have also modelled the opening year with the scenario, where the final low-noise road surface (discussed below) has not been installed. For this scenario I have used a medium-growth traffic forecast and a posted speed limit of 100km/h.

12. I have considered specific noise mitigation throughout the Project area to further reduce noise levels and effects. The forms of mitigation considered were noise walls of different heights, earth bunds, and a high-performance low-noise road surface. These mitigation options were subject to a multi-disciplinary analysis guided by NZS 6806 which balanced the noise reductions achieved with engineering constrains, as well as effects that the mitigation would have on visual effects / landscape values, ecology, and social and heritage values.

13. The preferred mitigation was established by consensus at Noise Mitigation Workshops attended by a range of experts. The mitigation comprises a total of 18 km of a high-performance road surface in three sections, and 4.2 km of 1.1m high concrete safety barriers in 5 sections. This forms what I consider to be the BPO for operational noise.

14. With the recommended mitigation, there will be 21 dwellings where operational noise levels will not achieve the preferred Category A criterion from NZS 6806. Fifteen of these are currently Crown-owned, or within the proposed designation corridor, but there are six which are privately owned and/or outside the proposed designation corridor. NZS 6806 considers that noise within Category A levels, which will be achieved at all other dwellings,

[3] 95th% growth forecast has been used which is the High Growth forecast that has been adopted by Horowhenua District Council. This is discussed in more detail in Mr Phil Peet's Transport Assessment (provided as Technical Assessment A in Volume IV)
[4] The anticipated speed limit for this section of new road is 100km/h, as described in Mr Jamie Povall's Design and Construction Report provided as Attachment Four to Volume II)

allow for reasonable residential amenity and some protection from health effects.

15. NZS 6806 Category B will be achieved at all 21 dwellings where Category A is not achieved (no dwellings will be in Category C). For the 21 PPFs (of which 15 are Crown owned or within the proposed designation corridor) in NZS 6806 Category B, while external noise levels will be higher than desirable, appropriate internal noise levels can be achieved by keeping widows closed. Where necessary and subject to landowner agreement, Waka Kotahi will design and implement modifications to buildings to allow this (windows to be closed) to occur. This will likely entail providing mechanical ventilation, but sometimes other building modifications will be appropriate.

16. I have identified that there is likely to be residual intrusive (a small actual or perceived change in the quality of life of people living there) or disruptive (the quality of life for people affected is moderately diminished) noise (at times) at some locations after mitigation has been applied.

17. The full extent of the effect will depend on the individuals' exposed to road-traffic noise.[5] Nevertheless, I have estimated the range of likely subjective responses[6] within each community, and collectively over the entire Project area, as shown below.

Community	**Present and not intrusive**	**Present and intrusive**	**Present and disruptive or very disruptive**
North East Levin	11	11	4
Levin East	25	21	3
Ohau East	42	24	7
Manakau	51	54	4
North Ōtaki	14	3	2
Total	**143**	**113**	**20**

18. While there is likely to be a degree of behavioural adaption for most people living in the Project area, for the 20 PPFs where the subjective response has

[5] Factors that affect sensitivity to noise are discussed in paragraph 67 below.
[6] These categories are explained further in Table B.3 below.

been identified as disruptive or very disruptive, the likely consequence is that the residents will change how they use their property. That is, some activities will be undertaken inside rather than outside, and other activities may be avoided. This is consistent with expectations for Category B PPFs.

19. While road-traffic noise will still be audible inside, the sound reduction provided by the building facade will allow most tasks to be undertaken with minimal disturbance. Where windows are required to be closed to achieve these internal noise levels, Waka Kotahi will provide alterative ventilation to allow this. While this is not an optimal outcome, this is consistent with the construction of major infrastructure where effects cannot reasonably be internalised.

20. Absolute noise levels (with the Project) will be reasonable, as guided by the identified performance standards, and they are likely to be acceptable to the general population. That said, I have identified that for 20 PPFs, noise may be disruptive or very disruptive noise, and for a further 113 PPFs noise may be intrusive.

21. With the Ō2NL Project, noise levels along the existing state highway corridors (SH1 and SH57) will be lower than the scenario without the Project, such that in 2039:

    (a) the number of PPFs exceeding 67 dB $L_{Aeq(24h)}$ (Category C) is predicted to reduce from 105 to 23 - a reduction of 78%.

    (b) the number of PPFs exceeding 64 dB $L_{Aeq(24h)}$ (Categories B and C combined) is predicted to reduce from 225 to 65 - a reduction of 71%.

    (c) The number of PPFs exceeding 50 dB $L_{Aeq(24h)}$ (WHO Guidelines) is predicted to reduce from 997 to 680 - a reduction of 32%.

22. While some people are likely to experience annoyance and sleep disturbance (and to a much lesser degree increased risk of heart disease) from noise from the new Ō2NL Project highway, the number of DALYs from these effects is much lower than those associated with the current, parallel, state highway network. The number of DALYs on the current state highway network once Ō2NL Project opens reduces. The Ō2NL Project provides an overall positive DALY outcome, representing a reduction compared to the current state highway network situation (16.9 DALYs) and the 2039 position without the Ō2NL Project (23.8 DALYs) to 16.9 DALYS with the Project. This number relates to total number of years of reduced health over the entire

population, not an average number of years per person. Also, while the Ō2NL Project is providing a net improvement in health effects due to road-traffic noise on a population basis, caution should be used when combining positive and adverse health effects which relate to different people.

23. I have developed the BPO approach to respond to local context and sought to minimise noise wherever practicable, focussing on acoustic effectiveness, not just for high noise exposures. To some extent, it is the introduction of a new noise source to the area which causes the effect, rather than the absolute level. Therefore, even with additional mitigation over and above that which I have recommended for the Ō2NL Project, effects would remain. In my opinion the proposed mitigation appropriately manages the actual and potential noise effects from the operation of the proposed Ō2NL Highway Project.

24. The noise modelling and assessment is based on a concept design. Should RMA approvals be granted then this design will be developed and as part of the outline plan process it will be necessary to confirm that effects remain consistent with the consented design, and provide the details of the proposed mitigation, including for individual properties. The mitigation that I have proposed will form the basis of the construction design. To manage this process, conditions similar to those that have been used successfully on other Waka Kotahi Projects are proposed in Appendix Five of Volume II. These conditions will ensure that effects remain consistent with what I have assessed.

25. Again, my report focusses on potential adverse effects and how those should be addressed. That said the Project will have positive effects on people living at the approximately 1200 receivers within proximity of the existing SH1 and SH57, by reducing their overall exposure to state highway noise by between 2 and 6 dB $L_{Aeq(24h)}$.

Operational vibration

26. Vibration from road-traffic (particularly heavy vehicles) has the potential to cause disturbance for people near roads, particularly roads in poor condition. Road-traffic vibration is largely caused by steps or other discontinuities in the road surface. For a well-built pavement such as a new highway, operational vibration will be limited to 15m from the road edge, and there are no sensitive receivers within this distance. As such, there will be minimal operational vibration effects from the Ō2NL Project. The reduction in traffic on SH1 and

SH57 (particularly heavy vehicles) will reduce the number of vibration events from effects from the existing network.

Construction noise and vibration

27. Construction of the Ō2NL Project will require a range of standard equipment. The Ō2NL Project involves extensive earthworks, paving and compaction, but there are also structures requiring piling, and there will be general construction activities including construction traffic. Construction noise has the potential to be intrusive and/or disruptive to residents, and therefore proactive management will be required to adequately manage these effects.

28. As the construction methodology has not been developed conservative parameters were applied to determine unmitigated construction noise levels. The levels of conservatism include assuming equipment are operating continuously and at the closest point within the construction footprint to the receiver. The modelled, unmitigated construction noise assessment showed approximately 55 houses might have daytime noise levels 5-10 dB above the long-term construction noise limits for a period of time, from bulk earthworks. For a project of this scale, this number and extent of potential exceedance is small, which confirms the low risk compared to other projects. This is primarily due to the distance between the construction area and houses.

29. In my opinion it is misleading to apply a mitigated noise level assessment at this stage as I do not have the detail. That is usual in such projects, and why there is well established and tested processes for ensuring construction noise BPOs are adopted. In my experience, despite the scale of equipment used, mitigation methods are effective and well-practiced.

30. Further flexibility of mitigation methodology is key and specific responses and parameters should not, in my opinion, be implemented now, in order to enable the best outcomes for affected people at the time of construction.

31. Key to ensuring appropriate construction noise management is having clear conditions with limits and a flexible tool kit of actions set within a clear process framework. To implement the conditions, a Construction Noise and Vibration Management Plan ("**CNVMP**") will be prepared, which will detail the project specific actions required to appropriately manage actual and potential construction noise and vibration effects. Key to the flexibility of this plan will be the use of Schedules to the CNVMP to address activities and properties

that may cause an exceedance of the noise limit. Again, that is standard practice which in my experience works well.

32. A key component of the project design is the selection of a low-noise porous asphalt road surface, and in some locations a high-performance low-noise road surface. The construction methodology requires the road to be trafficked for up to a year with a chipseal road surface. This to ensure an appropriate level of waterproofness to the road, before the final porous asphalt is installed. This is common practice.[7] I have considered the temporary noise effects that occur in this period between the road being open to traffic and when the final surface is laid. Whilst undesirable, these temporary effects are assessed as being minor provided that they are adequately communicated.

INTRODUCTION

33. My full name is Michael James Smith.

34. I am a Principal Acoustics Engineer and a director of Altissimo Consulting Ltd. I have previously been employed by multi-disciplinary firms AECOM and URS, and specialist acoustics firm Marshall Day Acoustics.

35. I am responsible for the assessment of operational and construction noise and vibration effects for the Ō2NL Project and for recommending options to achieve the BPO and mitigate potential adverse noise effects.

36. I have been assisted in my assessment by Dr Stephen Chiles (Chiles Ltd). Dr Chiles made acoustics assessments for the multi-criteria analyses in the Detailed Business Case, and has provided strategic advice, facilitated workshops, and reviewed all aspects of the present phase of work, including this report.

37. My colleague Dr Robin Wareing has assisted with analysis, and has performed detail checking of noise models and calculations.

Qualifications and experience

38. I have the following qualifications and experience relevant to this assessment:

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[7] For example, Christchurch Northern Corridor, Christchurch Southern Motorway Stage 2, Waikato Expressway (Tamahere-Cambridge).

(a) I hold the degrees of Bachelor of Engineering (Mechanical) and Bachelor of Mathematical and Computer Sciences from the University of Adelaide.

(b) I have practiced in the field of acoustics since 2006. I am a full member of Engineering New Zealand (MEngNZ), the Acoustical Society of New Zealand (MASNZ) and the Australian Acoustical Society (MAAS).

(c) In relation to road noise effects and management, I have been involved with:

  (i) the consenting and/or delivery of key parts of the Wellington Roads of National Significance ("**RoNS**") projects over the past decade:

    (1) For the PP2Ō section, I prepared the assessment report that was lodged with the notices of requirement for designations.

    (2) On Transmission Gully, I assisted with the consenting phase for Waka Kotahi, and I also modelled the detailed design for the contractor during the tender process, and again after its award. I prepared numerous assessments verifying that changes were in accordance with the design, and assisted with construction noise management.

  (ii) I was the acoustics lead for a Waka Kotahi programme to provide retrospective noise mitigation for those most affected by road-traffic noise on a national basis. I worked with transport planners to define the problem statement, investment objectives, and different potential intervention strategies. I then performed a multi-criteria analysis of the available options to determine a recommended programme.

  (iii) I recently led the acoustics component of the Ministry of Transport's *Domestic Transport Costs and Charges* project. This involved reviewing international literature to determine current best practice for evaluating the costs of health effects from road, rail, air and port noise. I applied these in a New Zealand context by approximating noise exposure from each source using a range of approaches and prepared a working paper to be included in the overall study. The paper was reviewed by the Institute for Transport Studies (ITS) Leeds in the UK.

(iv) I am a key member of Waka Kotahi ART 19/28 *Individual vehicle noise* research project, which is an investigation of why certain noise events have a greater level of annoyance than regular traffic.

(v) I have provided independent advice to Waka Kotahi over the past decade. In particular, I prepared the most recent updates to the guidance to consultants on how to assess and manage both road-traffic and construction noise and vibration.

Code of conduct

39. I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014. This assessment has been prepared in compliance with that Code, as if it were evidence being given in Environment Court proceedings. In particular, unless I state otherwise, this assessment is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Purpose and scope of assessment

40. I have been engaged to assess the effects of operational and construction noise and vibration caused by the Ō2NL Project, and to recommend any measures appropriate to avoid or mitigate those effects.

41. This assessment considers operational noise, operational vibration, and construction noise and vibration. Each topic has been assessed to a different degree of detail, depending on the significance of the effects and the necessary design detail at this current phase of the project to adequately identify and develop mitigation and management options for those effects.

42. My evidence describes both the acoustics engineering design processes that have led to the concept design presented in the application, and also an assessment of the residual effects and the mitigation and management options to address them and implement the BPO.

43. I have visited the area of, and around, the Ō2NL Project on several occasions between 2020-2022. I have attended several open days,

community events and had numerous meetings with landowners along the length of the Project where I have provided information about noise and vibration and discussed the concerns and comments of residents. These interactions are informative to my assessment.

44. Most of my evidence is focussed on operational road-traffic noise effects. This is not unique to this project. I understand that Waka Kotahi receives complaints about road-traffic noise from the state highway network, particularly when a new highway opens or there is a change to the form of the network, eg, intersection improvements.

45. Throughout New Zealand and internationally, road-traffic (operational) noise has adverse health effects on people. Research undertaken in 2019 estimated that more than 500,000 people in New Zealand are currently exposed to road traffic noise levels that exceed the WHO's noise guidance levels. This includes approximately 2,600 people in Horowhenua District and 4,000 within Kāpiti Coast District. The guidance levels are representative of desirable noise levels. WHO notes that the evaluation of control options must take into account technical, financial, social, health, and environmental factors and therefore the guideline levels are not expected to be achieved in all circumstances.[8]

46. Vehicles on new state highways generally cause negligible adverse vibration effects due to the quality of the road surface and distance between the highway and nearest dwellings. Consequently, Waka Kotahi does not routinely assess vibration for specific new state highway projects, unless, for example, there are dwellings immediately adjacent to a new traffic lane.[9] For completeness, I have included a vibration screening assessment for the Ō2NL Project.

47. If not adequately managed, elevated noise and vibration levels during construction are likely to cause disturbance. The role of this assessment is to determine whether construction noise and vibration effects can be appropriately managed to an acceptable level, and to provide the key construction noise and vibration parameters that will be applied within the consent conditions and the CNVMP. These key parameters will be prescribed as conditions. Due to the generally large distances between construction activities and dwellings, I consider this project to be low risk,

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[8] See NZS 6806:2010 at Section 4.7.2.
[9] NZ Transport Agency (2013) Tech memo #3 *State highway noise and vibration management.*

particularly in comparison to urban motorways, urban projects, or other projects that require extensive night works.

48. As the construction methodology has not been confirmed and the construction equipment used will depend on the appointed contractor, only indicative predictions have been made of the noise and vibration levels from construction activities.

49. The various noise and vibration assessment and mitigation tasks that have occurred at different stages in the Project's investigation (and which are to follow) are summarised in Figure B.1.[10]

[10] Adapted from Figure 4 of *Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects* (Reference 17).

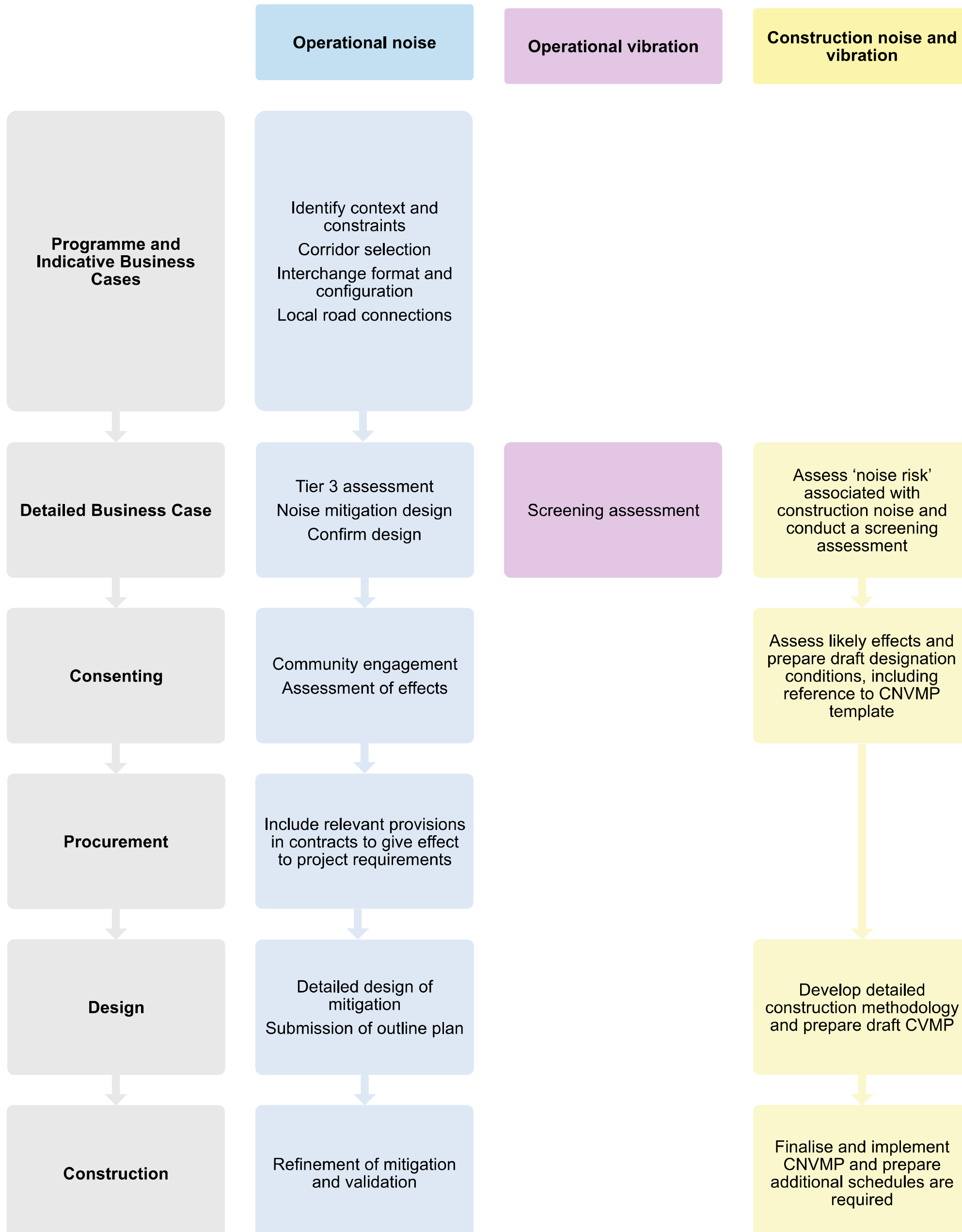

Figure B.1 Noise and vibration tasks at different project phases

Assumptions and exclusions in this assessment

50. In my assessment I have liaised with other members of the Ō2NL Project team. In particular, I have relied on:

    (a) indicative road and earthwork locations and design constraints as shown in Volume III - Drawings of the AEE and described by **Mr Jamie Povall**'s Design and Construction Report ("**DCR**") (provided as

Appendix Four to Volume II). The DCR also provides an indicative construction methodology;

(b) current and future traffic volumes, compositions and speeds provided by **Mr Phil Peet**'s Technical Assessment A (Transport);

(c) the Cultural and Environmental Design Framework ("**CEDF**") provided as Appendix Three to Volume II;

(d) social context as provided by **Ms Amelia Linzey** and **Ms Joanne Healy**'s Technical Assessment E (Social Impacts); and

(e) **Mr Gavin Lister**'s Technical Assessment D (Landscape, Visual and Natural Character).

51. My assessment relates to noise and vibration effects on people and buildings.

52. A number of potential highway corridors to either side of Levin have been investigated over the past decade. To a large extent, the selection of a preferred corridor has determined which houses will experience road-traffic noise. I was not involved in, but have read, the Indicative Business Case[11] investigations which is supported by a Noise Assessment.[12] I have satisfied myself that all corridors that were considered affected a significant and similar number of houses, with no clear noise preference for any particular option.[13]

Acoustics terminology

53. I have set out key acoustics terms and abbreviations that I use in my assessment in Table B.1. A full glossary is provided in Appendix B.1.

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[11] Ōtaki to north of Levin, Indicative Business Case, (December 2018).
[12] Malcolm Hunt Associates (2019) Ōtaki to north of Levin Expressway Project, Preliminary Traffic Noise Review Report. Note I understand that this report was originally prepared in April 2018 but was only finalised in March 2019.
[13] Tables 4 and 5 from Malcolm Hunt Associates (2019) report.

Table B.1 Acoustics terminology

Metric	Definition
Background sound $L_{A90(t)}$	The level in decibels equalled or exceeded for 90% of the measurement interval, expressed as $L_{A90(t)}$ (defined by NZS 6801:2008). It can also be considered as the sound which is heard continuously or frequently enough to form part of a background which other sounds are perceived (ISO 12913-1).
Façade effect	Where sound levels are measured 1m from the façade of a building, the level is approximately 2.5-3dB higher than if the façade was not there. The only sound levels which include a façade correction are construction sound levels in accordance with NZS 6803. The opposite of a façade level is a 'free field' level.
$L_{Aeq(24h)}$	Time-average sound level over a 24h period. This is the primary noise metric used to describe road-traffic noise in New Zealand.
$L_{Aeq(15min)}$	Time-average sound level over a 15 minute period. This is the typical duration of an attended measurement. Metric used for assessment of construction noise
L_{den}	Time-average sound level, over a 24-hour period, after the addition of 10 decibels to sound levels at night, and the addition of 5 decibels to sound levels in the evening L_d is the $L_{Aeq(12h)}$ over the 12-hour daytime period 0700-1900h. L_e is the $L_{Aeq(3h)}$ over the 3-hour evening period 1900-2200h. L_n is the $L_{Aeq(9h)}$ over the 9-hour night-time period 2200-0700 h the following day.
L_{night}	Time-average sound level between 2300-0700h. Note that this is a different time period than the L_n term from the L_{den} metric.
PPF	Protected Premises and Facilities.

PROJECT DESCRIPTION

54. The Ō2NL Project involves the construction, operation, use, maintenance and improvement of approximately 24 kilometres of new four-lane median divided state highway (two lanes in each direction) SUP between Taylors Road, Ōtaki (and PP2Ō) and SH1 north of Levin. The Ō2NL Project includes the following key features:

(a) a grade separated diamond interchange at Tararua Road, providing access into Levin;

(b) two dual lane roundabouts located where Ō2NL crosses SH57 and where it connects with the current SH1 at Heatherlea East Road, north of Levin;

(c) four lane bridges over the Waiauti, Waikawa and Kuku Streams, the Ohau River and the North Island Main Trunk ("**NIMT**") rail line north of Levin;

(d) a half interchange with southbound ramps near Taylors Road and the new Peka Peka to Ōtaki expressway to provide access from the current SH1 for traffic heading south from Manakau or heading north from Wellington, as well as providing an alternate access to Ōtaki.

(e) local road underpasses at South Manakau Road and Sorenson Road to retain local connections;

(f) local road overpasses to provide continued local road connectivity at Honi Taipua Road, North Manakau Road, Kuku East Road, Muhunoa East Road, Tararua Road (as part of the interchange), and Queen Street East;

(g) new local roads at Kuku East Road and Manakau Heights Road to provide access to properties located to the east of the Ō2NL Project;

(h) local road reconnections connecting:

    (i) McLeavey Road to Arapaepae South Road on the west side of the Ō2NL Project;

    (ii) Arapaepae South Road, Kimberley Road and Tararua Road on the east side of the Ō2NL Project;

    (iii) Waihou Road to McDonald Road to Arapaepae Road/SH57;

    (iv) Koputaroa Road to Heatherlea East Road and providing access to the new northern roundabout;

(i) the relocation of, and improvement of, the Tararua Road and current SH1 intersection, including the introduction of traffic signals and a crossing of the NIMT;

(j) road lighting at conflict points, that is, where traffic can enter or exit the highway;

(k) median and edge barriers that are typically wire rope safety barriers with alternative barrier types used in some locations, such as bridges that require rigid barriers or for the reduction of road traffic noise;

(l) stormwater treatment wetlands and ponds, stormwater swales, drains and sediment traps;

(m) culverts to reconnect streams crossed by the Ō2NL Project and stream diversions to recreate and reconnect streams;

(n) a separated (typically) three metre wide SUP, for walking and cycling along the entire length of the new highway (but deviating away from being alongside the Ō2NL Project around Pukehou (near Ōtaki)) that will link into shared path facilities that are part of PP2Ō (and further afield to the Mackays to Peka Peka expressway SUP);

(o) spoil sites at various locations along the length of the Project; and

(p) five sites for the supply of bulk fill /earth material located near Waikawa Stream, the Ohau River and south of Heatherlea East Road.

METHODOLOGY FOR ASSESSING EFFECTS AND IDENTIFYING MITIGATION

Operational noise

55. In respect of operational noise effects, this Technical Report:

    (a) sets out the acoustics inputs into the engineering design undertaken since 2021 when the preferred corridor was selected;

    (b) provides an assessment of potential effects of the concept design presented in this application; and

    (c) recommends mitigation options to manage adverse effects and deliver the BPO.

56. There have been multiple iterative design and assessment cycles through the development of the present design and mitigation options.

57. The design and assessment methodology adopted is shown graphically in Figure B.2, and discussed in sequence in the remainder of this section. This section discusses performance standards in detail, but for other topics an outline is provided and further detail is provided in the relevant chapter.

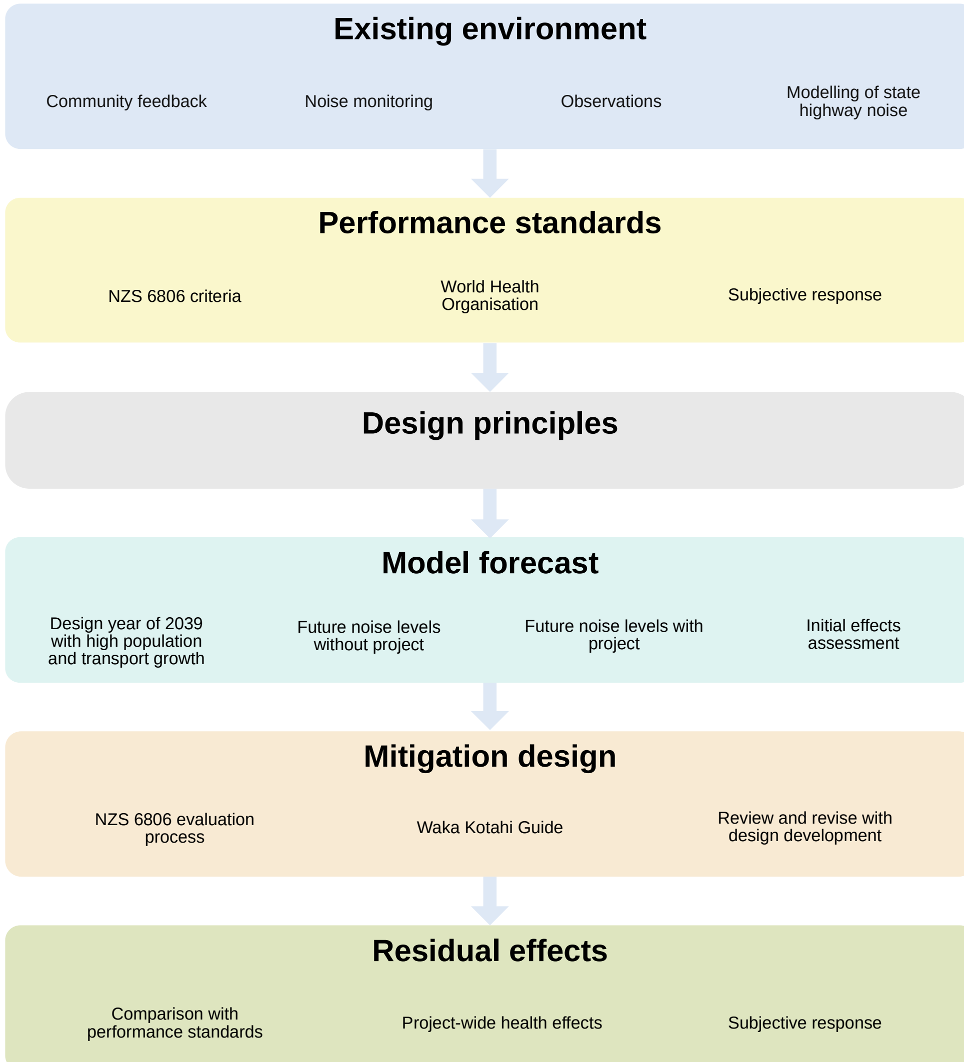

Figure B.2 Operational noise assessment framework

A note on NZS 6806

58. NZS 6806 was published in 2010 after development by an independent Standards New Zealand technical committee representing stakeholders. NZS 6806 fundamentally changed the way noise mitigation measures are designed. Rather than dogmatic adherence to a specific noise limit, regardless of practicality or adverse effects such as shading by barriers, NZS 6806 promotes an integrated design process to establish the BPO.[14]

59. Unlike a National Environmental Standard, a New Zealand Standard is not a resource management document unless referenced by a district or other plan. Nevertheless, NZS 6806 was written with the Resource Management Act 1991 ("**RMA**") in mind[15] and specifically for use on projects like the Ō2NL Project.

60. Waka Kotahi has adopted NZS 6806 for the assessment of road-traffic noise in place of the previous in-house 'Transit Guidelines'.[16] Waka Kotahi has published a *Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects*[17] that sets out its general approach to giving effect to NZS 6806.

61. The guide sets out Waka Kotahi's understanding of the relationship between NZS 6806 and an assessment of effects (as quoted below). This understanding has evolved over the past decade in response to decisions on previous projects and other lessons learned.

> *All road projects requiring approvals under the Resource Management Act require an assessment of environmental effects. While closely related, this assessment is independent of the mitigation selection process and criteria from NZS 6806.*
>
> *A clear assessment of the residual noise effects after mitigation is required. An evaluation of these impacts on indoor/outdoor amenity and health effects should be presented. While the NZS 6806 process should*

[14] While the Best Practicable Option is defined by the RMA. Specific guideline considerations are provided in section 6.3 of NZS 6806.
[15] The foreward to NZS 6806 states that NZS 6806 was intended to be a 'relevant matter' in terms of RMA applications.
[16] Transit New Zealand (1999) Guidelines for the Management of Road Traffic Noise.
[17] NZ Transport Agency (2016) Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects, v1.1.

result in appropriate noise levels, this consideration may require additional actions to ensure amenity is preserved to a reasonable level.

62. My assessment is consistent with NZS 6806, but also directly assesses potential effects as required by the RMA.

63. NZS 6806 is a complex standard, and contains the following elements:

    (a) Definitions on relevant receivers – Protected Premises and Facilities (PPFs);

    (b) Guidelines on relevant criteria;

    (c) Guidance on measurements and prediction;

    (d) A process for identifying where mitigation may be appropriate, and a method for conducting a multicriteria analysis; and

    (e) Recommendations on reporting.

64. For clarity, where I reference NZS 6806 I will be specific to which aspects of the standard I am referring to.

Existing environment

65. The existing environment has been investigated through a combination of:

    (a) noise monitoring, site observations identifying audible noise sources and their relative contribution (refer to Appendix B.6);

    (b) modelling of existing state highway noise (refer to Appendix B.5);

    (c) interactions with the community at Project events and hui with residents and landowners; and

    (d) social surveys reported in Technical Report E (Social Impacts).

66. The methodology for establishing the existing environment is discussed further below.

Performance guidance

67. Human response to noise is complex and it is not possible to determine effects based on noise level or change in noise level alone. Factors that influence the human response to noise include the following:

    (a) An individual's;

        (i) sensitivity to noise, including any underlying health conditions,

        (ii) prior exposure to noisy environments,

        (iii) relationship with the noise source,

        (iv) expectations.

    (b) The character of the noise; and

    (c) Other noise sources present.

68. In an attempt to identify and address some of the above factors, performance standards exist in both absolute form, and also relative to the existing environment (either ambient (L_{Aeq}) or background (L_{A90})).

69. For this Project, I have identified performance guidance to benchmark various design options from the following documents:

    (a) New Zealand Standard NZS 6806; and

    (b) The WHO's *Environmental Noise Guidelines for the European Region* 2018.

70. To assist on qualifying people's likely subjective response to noise, I have used a structured method based on UK Planning Guidance.[18] This method uses the terms present, intrusive and disruptive and provides examples of when they might apply. I discuss this further below.

71. Based on the factors listed in this section, it is common for people in the same household to have differing responses to the same noise exposure.

<u>New Zealand Standard NZS 6806</u>

72. Rather than providing a pass/fail criterion that must be met in under all circumstances, NZS 6806 provides three noise categories, which provide

[18] UK Planning Guidance 005 Reference ID: 30-005-20190722.

varying levels of external and internal amenity. For new roads these categories are shown in Figure B.3 and are explained below:

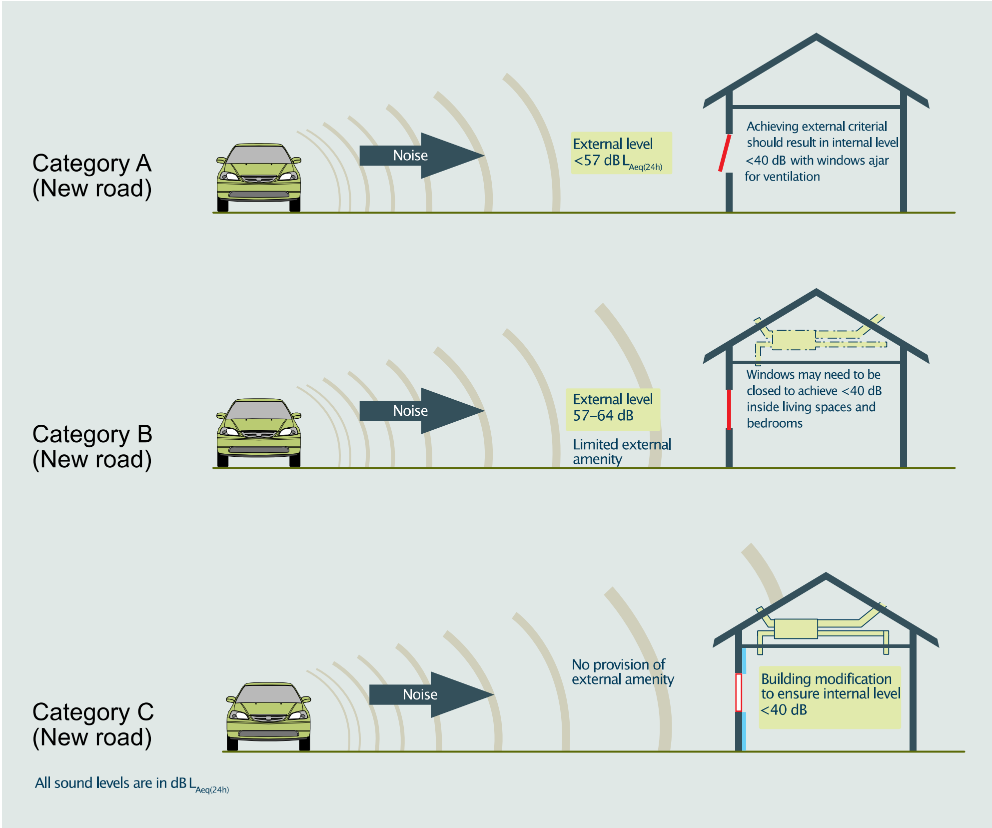

Figure B.3 Application of criteria from NZS 6806 for new roads

73. **Category A**

This is the preferred category with external noise levels of 57 dB $L_{Aeq(24h)}$ or below. At these noise levels, NZS 6806 considers that there will be reasonable external residential amenity and protection from health effects. Appropriate internal noise levels can be achieved with windows ajar for ventilation and cooling.

74. **Category C**

At high noise levels (above 64 dB), an internal criterion of 40 dB $L_{Aeq(24h)}$ is provided as a backstop for the protection of health effects. At these levels it is anticipated that windows will need to be kept closed, modification to the building envelope might be required (eg additional plasterboard linings and/or window upgrades) and, where doors and windows are required to be closed, alternate (mechanical) ventilation is required. Treatment is called Building Modification Mitigation, and the investigation process is discussed further below.

75. **Category B**

This is the middle ground, and is included in the standard for when providing mitigation to achieve Category A is not considered practicable or desirable (for example, very high noise barriers that may be impractical to build or not compatible with the cultural and/or visual landscape). NZS 6806 anticipates that appropriate internal noise levels will occur without requiring windows to be kept closed. However, following early determinations from RMA decision-makers that questioned whether this will occur in practice, Waka Kotahi now investigates and treats Category B PPFs[19] to achieve internal noise levels below 40 dB $L_{Aeq(24h)}$.

76. NZS 6806 provides a second set of criteria for 'altered roads' where higher noise levels are permitted. This partly addresses the existing environment, and likely constraints to mitigation.

77. Category A applies up to 64 dB $L_{Aeq(24h)}$ and Category B to 67 dB $L_{Aeq(24h)}$. For the Ō2NL Project, the altered road criteria have only been used for reporting noise levels for PPFs adjacent to the existing SH1 / SH57 as these PPFs meet the altered road definition from NZS 6806.

78. NZS 6806 provides limited explanation of its criteria and there is some implicit balancing of practicability and cost. While the NZS 6806 framework of criteria should result in reasonable external and internal noise levels, I do not consider that achieving Category A will necessarily result in a good standard of outdoor residential amenity in all Ō2NL Project cases. While an external noise level 57 dB $L_{Aeq(24h)}$ is typical for many urban areas in New Zealand, it will often result in a significant change in environment in a rural area.

79. As set out above, NZS 6806 has a mixture of internal and external criteria. The noise level reduction between outside and inside will initially depend on whether doors and windows are open or closed. The typical level reduction for different window configurations is shown below, with indicative internal noise levels for an external noise level of 57 dB.

[19] This only applies to Category B PPFs for new roads.

Table B.2 Level differences for typical building facades[20]

Scenario	Level Reduction	Internal level with 57 dB applied externally
Windows / doors open	8 – 12 dB	49 – 45 dB $L_{Aeq(24h)}$
Windows ajar for ventilation	14 – 17 dB	43 – 40 dB $L_{Aeq(24h)}$
Windows closed – poorly sealing windows / average construction	23 – 28 dB	34 – 29 dB $L_{Aeq(24h)}$
Windows closed / well-constructed and sealed	> 30 dB	< 30 dB $L_{Aeq(24h)}$

World Health Organisation Guidelines

80. It is widely accepted internationally that noise from road-traffic (and other sources) has the potential to cause adverse health effects on people living nearby. This has been documented by authoritative bodies such as the WHO[21] which has been referenced by acoustics specialists in New Zealand for decades. The relatively recent publication by WHO Europe in October 2018 ("**2018 WHO Guidelines**")[22] sets out guidelines for managing environmental noise in Europe.

81. Recent research sponsored by Waka Kotahi[23] showed that international noise response curves for annoyance are broadly appropriate for the local context, although the New Zealand population may be slightly more sensitive than international comparisons. Further work is currently being undertaken by Waka Kotahi on the response of communities to transport noise as part of research project ART19/27.[24]

82. The 2018 WHO Guidelines are based on a review of current academic literature, including an evaluation as to the quality of the evidence of adverse effects. The 2018 WHO Guidelines identify a relationship between people exposed to road traffic noise and the occurrence of ischaemic heart disease, high annoyance and sleep disturbance. Accordingly, the 2018 WHO Guidelines recommend that policy makers reduce road-traffic sound exposure to below a range of guideline values.

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[20] G Bellhouse (2000) Testing of the sound insulation of the external envelope of six houses.
[21] World Health Organisation, Guidelines for community noise, 1999; World Health Organisation, Burden of disease from environmental noise, 2011.
[22] World Health Organisation, Environmental noise guidelines for the European region, 2018.
[23] NZ Transport Agency research report 656 Evidential basis for community response to land transport noise.
[24] Waka Kotahi research project Community Response to Transport Noise Exposure in New Zealand (ART 19/27).

83. I have addressed these potential health effects in two separate ways:

(a) I have adopted the "guideline values" referenced above as a performance standard. The 2018 WHO Guidelines state that average noise levels of 53 dB L_{den} are associated with adverse health effects, and that night-time noise levels above 45 dB L_{night}, are associated with adverse effects on sleep. Using the conversions referenced by WHO[25] both these thresholds can be represented by using 50 dB $L_{Aeq(24h)}$ as a health-based performance standard.

(b) As the prevalence of health effects gets progressively greater with increasing noise levels, I have also performed a quantitative analysis as detailed above. This identifies the number of people (on a per population basis) that are likely to experience adverse health effects, and the subsequent burden of disease. As these values apply on a population basis, I have not treated these as a performance standard, but rather as part of the assessment of residual effects.

Subjective response to noise

84. For people currently exposed to road-traffic noise, the subjective response to change depends on the combination magnitude of the change, the nature of the noise, as well as overall noise levels.[26]

85. For locations where the existing environment primarily consists of natural sounds, the amenity effects will often result as much from the change in character as from the change in level.

86. I have assessed the impact on amenity values by considering both the overall noise levels, as well as the change in noise level and character. I have presented amenity effects in terms of the outcomes in Table B.3 below. I have derived these amenity descriptors from UK Planning Guidance Document 005.[18] This approach provides a structured description of the likely response to noise from the highway. I have applied these categories based on the future road-traffic noise levels, giving consideration of the existing environment.

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[25] Different parameters defined in Table B.1. Conversion between L_{den} / L_{night} and $L_{Aeq(24h)}$ using Brink (2018) *Conversion between noise exposure indicators L_{eq24h}, L_{Day}, $L_{Evening}$, L_{Night}, L_{dn} and L_{den}: Principles and practical guidance.*

[26] LTNZ Research Report No. 292: Road traffic noise: determining the influence of New Zealand Road surfaces on noise levels and community annoyance, Table 18.

87. I am not aware of this document or categories being used in New Zealand. I note that the UK Planning document has an “Increasing effect level” and “Action” column that I have not used. I have used the response and examples of outcomes in their literal form, rather than as part of the broader UK planning framework.

Table B.3 Responses and examples of outcomes

Response to new transportation noise	**Example of outcomes**
Not present	No effect
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, eg turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life of people living there.
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, eg avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Quality of life for people affected is moderately diminished due to change in acoustic character of the area.
Present and very disruptive	The noise causes extensive and regular changes in behaviour, attitude or other physiological response. Quality of life for people affected is significantly diminished due to change in acoustic character of the area.

Summary

88. To summarise, I have used the following performance guidance:

(a) NZS 6806, which recommends that noise levels should be below 57 dB $L_{Aeq(24h)}$ for new roads, where practicable;

(b) 2018 WHO Guidelines, which recommend that noise levels be below 50 dB $L_{Aeq(24h)}$ to avoid health effects; and,

(c) The subjective assessment framework that I have derived from UK Planning Guidance.

Design principles

89. At the beginning of the concept design phase, a number of principles were identified to assist in minimising noise effects as set out below.

90. These have been incorporated into the Project concept design either directly in the road geometrics, noise mitigation (refer to the DCR, Appendix Four to Volume II), or through the CEDF (Appendix Three to Volume II).

Modelling

91. Modelling of noise has been performed consistent with standard practice as an objective basis for evaluating mitigation options and assessing effects. This is discussed further below (refer to Appendix B.7 which provides details of the noise modelling).

Mitigation selection and evaluation

92. Mitigation evaluation and selection was completed using the methodology from NZS 6806 and used the NZS 6806 and 2018 WHO Guidelines performance standards as detailed above.

93. The Project was divided into several smaller assessment areas, and multiple mitigation options were tested, being:

    (a) The inclusion of a high-performance road surface (over and above the standard open graded porous asphalt which will be in place for the entire route);

    (b) Road-side concrete safety barriers, replacing the wire rope barriers for that section of road;

    (c) 2 or 3 m high noise walls, either near the road or on the outside of the swales, depending on the topography in the area; and

    (d) 3m high earth bunds.

94. Each option was assessed by relevant specialists from the Ō2NL Project team and selected by consensus at a mitigation workshops. These workshops were also attended by Ō2NL Project team members, Project partners, and staff or consultants representing the two district councils (Horowhenua District Council ("**HDC**") and Kāpiti Coast District Council ("**KCDC**")).

95. In many instances, additional investigations (generally noise modelling) were required to confirm the preferred mitigation. In addition, the effectiveness of mitigation was re-checked as the concept design was updated. Where the form of mitigation changed, such as a change in vertical alignment of the

road resulting in a barrier location becoming ineffective, input from relevant evaluators was sought to ensure it was consistent with principles established at the workshops.

96. The outcomes from mitigation evaluation process is discussed in detail below.

Assessment of residual effects

97. As explained above, to assess the noise effects of the Project on the environment I have compared predicted noise levels to the performance standards from NZS 6806 and the 2018 WHO Guidelines, and also considered the likely subjective response to noise. In addition, I have considered the long-term health impacts, as discussed below.

Long-term health impacts

98. As part of the assessment of residual effects, I have made a quantitative analysis of health effects in terms of:

(a) The population likely to experience health outcomes, and

(b) The burden of disease in terms of the above outcomes expressed in Disability Adjusted Life Years ("**DALYs**")

99. As discussed in above, the WHO Guidelines note the following health effects are linked to noise by population: ischaemic heart disease ("**IHD**"); high annoyance and sleep disturbance.

100. The relationship between the prevalence of effects and environmental noise exposure on a population is typically expressed as a dose response curve. The 2018 WHO Guidelines and a subsequent European Environmental Agency report[27] collated dose response curves from several research projects. The selected dose response curves are for annoyance,[28] sleep disturbance[29] and IHD[30] are presented in Figure B.4.

[27] European Environmental Agency (2020) *Environmental noise in Europe — 2020.*
[28] Guski, R. et al., 2017, 'WHO environmental noise guidelines for the European region: a systematic review on environmental noise and annoyance', International Journal of Environmental Research and Public Health 14(12), p. 1539 (DOI: https://doi.org/10.3390/ ijerph14121539).
[29] Basner, M. and McGuire, S., 2018, 'WHO environmental noise guidelines for the European region: a systematic review on environmental noise and effects on sleep', International Journal of Environmental Research and Public Health 15(3) (DOI: https://doi.org/10.3390/ ijerph15030519).
[30] van Kamp, I., 2018, Study on methodology to perform environmental noise and health assessment, RIVM Report No 2018-0121, National Institute for Public Health and the Environment (Netherlands) (https://www.rivm.nl/ bibliotheek/rapporten/2018-0121.pdf).

101. The dose response curves for annoyance and sleep disturbance are an absolute percentage of the population affected. It should be noted that dose-response curves for annoyance and sleep disturbance generally do not reach 0%. This is because typically a small percentage of a population will report annoyance or sleep disturbance in the absence of significant environmental noise.

102. Unlike annoyance and sleep disturbance which can be directly caused by exposure to road-traffic noise, there is only an increase in the 'Relative Risk' for IHD. Therefore to determine the actual incidence rate, I have considered the baseline rates of IHD incidence and mortality for all of New Zealand. Incidence and mortality data is shown below (Ministry of Health, 2019):

(a) IHD incidence – 4.9% in 2017.

(b) IHD mortality – 0.05% in 2017.

103. The majority of studies that form the body of evidence for the recommendations in the WHO Guidelines refer to noise levels measured outdoors, usually at the most exposed façade of dwellings.[31]

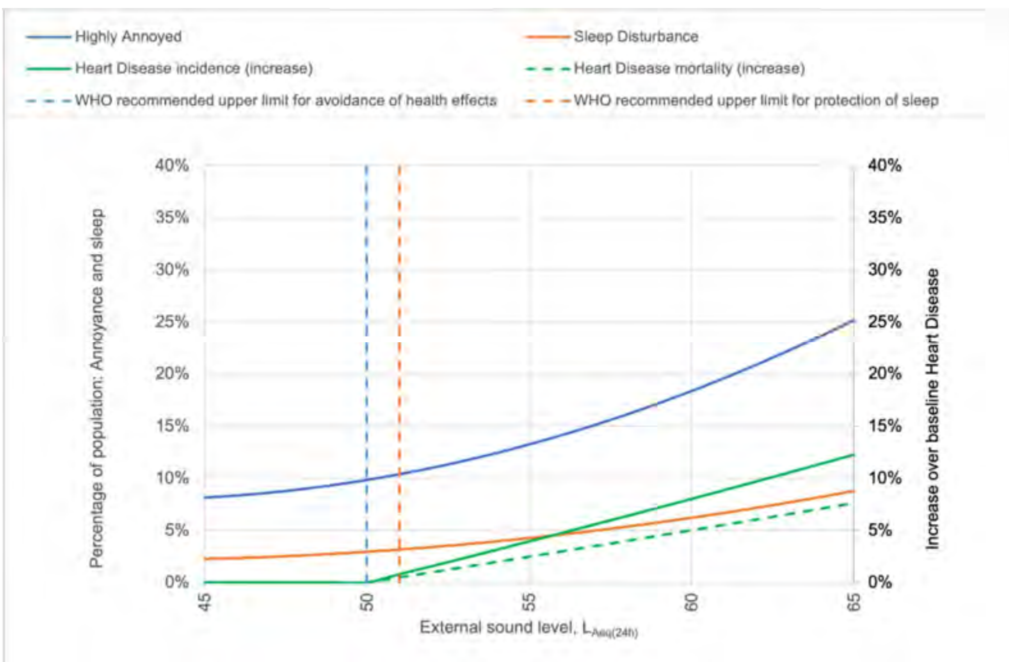

Figure B.4 Dose response curves for multiple conditions

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[31] This is consistent with the Category A and B criteria from NZS 6806.

104. The sum of mortality and morbidity is referred to as the ‘burden of disease’ and can be measured by a metric called ‘Disability Adjusted Life Years’ ("**DALYs**"). DALYs are a standardised metric that allow for direct comparisons of disease burdens of different diseases across countries, between different populations, and over time. Conceptually, one DALY is the equivalent of losing one year in good health because of either premature death or disease or disability.

105. The burden of disease can be thought of as a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability.[32]

106. The European Environment Agency[33] provides a method for determining DALYs for different health conditions, using published disability weights.[34] A disability weight is a weight factor that reflects the severity of the disease on a scale from 0 (perfect health) to 1 (equivalent to death). Disability weights are widely used, and the WHO publishes a comprehensive list of disability weights for wide range of diseases and injuries. The disability weightings that apply to the conditions identified in this report are provided in Figure B.5.

Table B.4 Disability Weights for different health conditions

Effect	Disability weight
Ischaemic heart disease	0.405
Sleep disturbance	0.07
Annoyance	0.02

107. Essentially, the number of DALYs is the exposed population multiplied by the disability weight.

108. To explain these concepts, I have provided the following examples, for the hypothetical scenario where 1000 people are exposed to a road-traffic noise level of 57 dB $L_{Aeq(24)}$. In doing so, and for my analysis of the Project later in this report, I have applied the dose response curves and disability weights as discussed above. This allows an acoustics specialist to infer the extent of health outcomes based on noise levels, without needing public health expertise.

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[32] https://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/.
[33] European Environment Agency (2010) *Good practice guide on noise exposure and potential health effect.*
[34] WHO (2004) Global burden of disease 2004 update: disability weights for diseases and conditions.

109. Firstly, the dose response curve is applied to the number of people exposed to road-traffic noise to estimate the population likely to experience the health outcome.

Table B.5 Example application of dose response curve

Health outcome	**Number of people exposed to 57 dB**	**Dose response (**Figure B.4**)**	**Number of people likely to experience outcome**
Annoyance	1000	15%	150.8
Sleep disturbance	1000	5%	49.5
Ischaemic heart disease	1000	0.3%	2.7
Premature mortality due to IHD	1000	0.002%	0.017

110. The disability weights are then applied, to calculate the DALYs.

Table B.6 Example application of disability weights

Health outcome	**Number of people likely to experience outcome**	**Disability weight (**Table B.4**)**	**Disability Adjusted Life Years**
Annoyance	150.8	0.02	3.0
Sleep disturbance	49.5	0.07	3.5
Ischaemic heart disease	2.7	0.405	1.1
Premature mortality due to IHD	0.017	1	0.017
Total			7.6

111. The calculation in this example shows that the population (1000 people) exposed to this level of noise for a year would theoretically have a reduction in 7.6 years of good health. This number relates to total number of years of reduced health over the entire population, not an average number of years per person. It is a potential effect on that population that may or may not be felt by any individual or individuals in the population.

112. While reference to WHO guidance is common, I am not aware of an objective analysis of DALYs associated with environmental noise previously being undertaken for other infrastructure projects in New Zealand. My assessment is not reliant on this 'new' method and I have been cautious in my

interpretation of the results given that the approach has not been extensively tested in New Zealand. However, I have used this in conjunction with other considerations.

Operational vibration

113. For operational road-traffic vibration there is no relevant National Environmental Standard and no relevant district plan rules, but there are policies to avoid unacceptable vibration effects.[35]

114. There are no relevant New Zealand Standards. Waka Kotahi policy[36] is to use the Norwegian Standard NS 8176[37] and in particular Class C criterion of 0.3 mm/s $v_{w,95}$ It is said to, "c*orrespond to satisfactory vibration conditions for a large proportion of the exposed population*". I consider this criterion to be appropriate and consistent with good practice.

115. I have previously undertaken measurements of road vibration from SH1 in Porirua,[38] and I am aware of measurements at other sites that have demonstrated that the 0.3 mm/s $v_{w,95}$ criterion is readily achieved near to a well-constructed state highway, without unusual ground conditions or buried services. To make a screening assessment, I have reviewed the location of the proposed designations and indicative alignment to confirm whether any new traffic lanes could be close enough to houses for there to be a risk of exceeding the criterion. The outcome is that there are no receivers within the 0.3 mm/s $v_{w,95}$ criterion and I am confident that operational vibration will not result in adverse effects.

Construction noise and vibration

116. With respect to construction noise and vibration there are no relevant National Environmental Standards, but both district plans[39, 40] require use of the New Zealand Standard NZS 6803[41] for construction noise.

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[35] KCDC Policy 11.33 c ii.
[36] NZ Transport Agency (2013) Technical memorandum NV3 state highway noise and vibration management.
[37] Norwegian Standard NS 8176:2017 Vibration and shock – Measurement of vibration in buildings from land based transport and guidance to evaluation of its effects on human beings.
[38] These were undertaken at 4 different distances from a 100km/h section of SH1 with a porous asphalt surface. Measurements were of individual car and heavy vehicle movements, which were combined to calculate the 95% percentile weighted velocity.
[39] HDC Rule 19.6.8 (c).
[40] KCDC Rule NOISE-R10.
[41] New Zealand Standard NZS 6803:1999 Acoustics – Construction noise.

117. In addition to the specific rules on operational noise, and construction noise vibration, the following objectives and policies are relevant.

Table B.7 Relevant construction noise and vibration policies

Policy	**Text**
KCDC Policy 11.33	Avoid unacceptable levels of noise and vibration
KCDC Policy 11.4(b).	Minimise effects on amenity
HDC Policy 2.4.17	Maintain overall day and night-time noise conditions at levels compatible with the amenity and activity present in the rural environment
HDC Policy 10.2.3	Avoid adverse amenity impacts by ensuring that new roads are designed to, at least minimum standards.

Construction noise

118. NZS 6803 has been used on all major construction projects in New Zealand of which I am aware. Despite this, the Environment Court has raised concern in recent years on the adequacy of both assessments and management of effects.

119. The fundamental principle from NZS 6803 is that as noise from construction projects is generally of limited duration, people and communities will usually tolerate a higher noise level provided it is no louder than necessary, and occurs within appropriate hours of the day.[42]

120. To give effect to this principle, NZS 6803 gives “recommended upper noise limits” for three different construction durations – less than 2 weeks, between 2 and 20 weeks, and for greater than 20 weeks. These limits apply at the façade of dwellings or other sensitive locations.

121. For the Ō2NL Project, the long-term limits from NZS 6803 are applicable as set out in the following table. The limits for short-term activities as part of the long-term programme provide guidance as to how elevated noise levels may be tolerable for short periods of time.

[42] NZS 6803:1999 – See foreword.

Table B.8 Recommended upper limits for construction noise (Tables 2 and 3 from NZS 6803)

		Short-term duration (<2 weeks)		Typical duration (2-20 weeks)		Long-term duration (>20 weeks)	
Day	**Time**	$L_{Aeq(15min)}$	L_{AFmax}	$L_{Aeq(15min)}$	L_{AFmax}	$L_{Aeq(15min)}$	L_{AFmax}
Occupied PPFs (as defined in NZS 6806:2010)							
Weekdays	0630h – 0730h	55 dB	75 dB	60 dB	75 dB	55 dB	75 dB
	0730h – 1800h	80 dB	95 dB	75 dB	90 dB	70 dB	85 dB
	1800h – 2000h	75 dB	90 dB	40 dB	85 dB	65 dB	80 dB
	2000h – 0630h	45 dB	75 dB	45 dB	75 dB	45 dB	75 dB
Saturday	0630h – 0730h	45 dB	75 dB	45 dB	75 dB	45 dB	75 dB
	0730h – 1800h	80 dB	95 dB	75 dB	90 dB	70 dB	85 dB
	1800h – 2000h	45 dB	75 dB	45 dB	75 dB	45 dB	75 dB
	2000h – 0630h	45 dB	75 dB	45 dB	75 dB	45 dB	75 dB
Sundays and Public Holidays	0630h – 0730h	45 dB	75 dB	45 dB	75 dB	45 dB	75 dB
	0730h – 1800h	55 dB	85 dB	55 dB	85 dB	55 dB	85 dB
	1800h – 2000h	45 dB	75 dB	45 dB	75 dB	45 dB	75 dB
	2000h – 0630h	45 dB	75 dB	45 dB	75 dB	45 dB	75 dB

		Short-term duration (<2 weeks)		Typical duration (2-20 weeks)		Long-term duration (>20 weeks)	
Day	**Time**	$L_{Aeq(15min)}$	L_{AFmax}	$L_{Aeq(15min)}$	L_{AFmax}	$L_{Aeq(15min)}$	L_{AFmax}
Commercial and industrial receivers							
All	0730h – 1800h	75 dB		75 dB		75 dB	
	1800h – 0730h	80 dB		80 dB		80 dB	

122. Noise limits are provided for both the time-average[43] noise level (L_{Aeq}) and the maximum noise level (L_{AFmax}). For most activities other than impulsive activities such as piling, compliance with the L_{Aeq} limit will result in compliance with the L_{AFmax} limit.

123. These recommended limits are used in the following ways:

(a) As permitted activity standards within a district plan. If construction noise is predicted to exceed these limits, then a resource consent or a designation will be required.

(b) As part of a management framework, where if noise exceeds these limits, then enhanced management / additional mitigation is required.

124. For the Ō2NL Project, I support a condition adopting the long-term noise limit.

125. However, in my opinion, the use of noise limits alone cannot completely manage construction noise effects for the following reasons.

(a) NZS 6803 sets permissive noise limits during the day. However, construction activities at these noise levels at a single dwelling which is continuous or frequent for months or years is likely to be intolerable and unreasonable. Therefore, mitigation may be required despite compliance with limits. In addition, where design decisions or good

[43] NZS 6803 notes that "the measurement sample times should relate to the duration and characteristics of the sound based on observation of common construction activities at the site under investigation." This is generally between 15 minutes and 1 hour.

practices can reduce or avoid noise generation, then this should occur regardless of the set limit.

(b) The alternative perspective is that noise above these daytime limits (or night works) may be reasonable, provided they are of limited duration, and for a clearly defined purpose, which is well communicated to affected residents.

126. In addition to noise limits, NZS 6803 sets out recommended management methods for construction activities. I consider that these management practices are a fundamental part of the standard. These methods can be summarised as follows:

(a) the use of construction methods and equipment to avoid or minimise noise and vibration generation;

(b) physical screening to interrupt the propagation path;

(c) administration controls such as restriction of hours and providing respite periods / days of reduced work; and

(d) notification of works, community awareness and some construction activities may warrant individual property notification with more details on what is happening and for how long.

127. While not stated in NZS 6803, offering temporary relocation for affected residents may be the final step if effects cannot be adequately mitigated. Offering temporary relocation is the final step because it has its own level of disruption on residents.

128. Management controls are often considered in a hierarchy, whereby avoidance or minimisation at source is required to be considered prior to the use of administrative controls.

129. To promote good practices, Waka Kotahi has prepared the following resources to assist contractors and consultants in the implementation of construction noise and vibration management:

(a) The *State highway construction and maintenance noise and vibration guide* ("**CNV Guide**");[44]

[44] NZ Transport Agency (2019) State highway construction and maintenance noise and vibration guide, August 2019, Version 1.1.

(b) Case studies such as Community engagement (Victoria Park Tunnel, Arras Tunnel), widespread adoption of broadband reversing alarms (Victoria Park Tunnel), use of noise trials to improve prediction accuracy (Newmarket Viaduct) and nightworks (Newmarket Connection);

(c) Templates from CNVMPs, Schedules and monitoring reports; and

(d) An online construction noise calculator.

130. Controls are required to be adopted through the conditions and a CNVMP, with associated Schedules for specific activities. The CNVMP and Schedules should have the following objectives:

(a) The objective of the CNVMP shall be to provide a framework for the development and implementation of the BPO for the management and minimisation of noise and vibration effects *and* to achieve the noise and vibration limits to the extent practicable.

(b) The objective of the Schedule shall be to set out the BPO for the management of noise and/or vibration effects of the specific works activity, the specific characteristics of the site and receivers.

131. The contents / requirements for the CNVMP should be set out in designation conditions, and are discussed in detail below.

132. While the designation conditions apply to the requiring authority (Waka Kotahi), construction works will be undertaken by a contractor. In addition to stating that works must comply with all designation conditions, Waka Kotahi includes additional requirements in their contract, including requiring that works are undertaken in accordance with the CNV Guide. These requirements are currently addressed in Specification P47[45] however recognising the importance of construction noise and vibration management, Waka Kotahi is preparing a standalone specification, which is currently in draft form. I understand this specification will be published prior to the hearing.

133. At the outset of a project, once the detailed design has been completed and a contractor has been appointed, the CNVMP is prepared by an acoustics specialist engaged by the contractor. This CNVMP draws on specific

[45] NZTA P47: 2015 *Specification for Environmental, Social and Cultural Management During Construction.*

information about the works from the contractor including design details and a high-level construction programme. This allows determination of project wide noise and vibration mitigation measures, and identification of specific activities or locations where subsequent more detailed assessment will be required in due course. Specific items of equipment and detailed sequencing are generally not known when the CNVMP is first prepared prior to construction.

134. This CNVMP will be submitted as part of the Outline Plan.

135. The subsequent implementation of the CNVMP is normally led by environmental staff in the contractor's project offices (usually on site). The project environmental staff are in constant liaison with the construction teams planning upcoming works, usually being in the same office. They review specific works and where necessary make noise and vibration calculations and assessments to determine required mitigation measures. Support will be obtained from an external acoustics specialist when required.

136. For example, on the Transmission Gully Project:

(a) I prepared the initial CNVMP, which was issued as part of the Outline Plan. The contractor's Environmental Manager was the owner of this document, and responsible for its implementation.

(b) I arranged for noise monitoring equipment to be purchased by the contractor.

(c) Environmental Advisors were appointed for each construction zone, and I trained them on implementation of the CNVMP.

(d) I prepared a number of Schedules to the CNVMP, generally as part of Site Specific Environmental Management Plans ("**SSEMPs**"), which were required for other reasons.

(e) As the project progressed, and there was pressure to increase construction hours, I updated the CNVMP to include a process for out-of-hours work, including maps showing locations where works could be operated without restrictions.

137. In my opinion, this process works well.

Vibration

138. For general construction vibration, there are no relevant rules in the two district plans.

139. In the absence of any national standards, Waka Kotahi has developed construction vibration limits based on standards from other countries, as set out in the following table. The criteria relate both to perception of vibration resulting in disturbance for people, and also to potential cosmetic damage to buildings. I support the use of these standards.

Table B.9 Construction vibration criteria

Receiver	**Details**	**Category A**	**Category B**
Occupied PPFs	Night-time 2000h – 0630h	0.3 mm/s ppv	1 mm/s ppv
	Daytime 0630h – 2000h	1 mm/s ppv	5 mm/s ppv
Other occupied buildings	Daytime 0630h – 2000h	2 mm/s ppv	5 mm/s ppv
All other buildings	Vibration – transient	5 mm/s ppv	BS 5228-2* Table B2
	Vibration – continuous		BS 5228-2* 50% of table B2 values

*BS 5228-2:2009 'Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration'

140. These vibration criteria provide a tiered approach to allow the substantial variabilities in vibration sensitivities of people and buildings to be considered.

141. The human response criteria are derived from BS 5228-2.[46]

[46] British Standard BS 5228-2:2009 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration.

Table B.10 Explanation of vibration criteria

Vibration level, PPV	Subjective response
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

142. The inclusion of higher "Category B" criteria allows a graduated response whereby more intense assessment and monitoring is required above the Category B criteria than between the Category A and B criteria.

143. The approach for vibration management is similar to that for noise, however vibration does not propagate as far as noise.

Predictions

144. I have used the same PPFs identified as receivers for operational noise effects in my assessment of construction noise and vibration.

145. With reference to the DCR (Appendix Four to Volume II), I have identified the following significant activities, and I have predicted noise and vibration levels for these (refer below):

    (a) Earthworks,

    (b) Material supply sites,

    (c) Bridge construction,

    (d) Vehicle movements / haulage,

    (e) Site compounds.

146. Based on construction noise and vibration levels for similar infrastructure projects, I have identified PPFs within a 200 metre buffer distance from the proposed designation. These properties are likely to be affected to some extent, but compliance with noise and vibration criteria will generally be achieved using standard practices. I have then identified PPFs within 50 and 100 metre buffer distance where enhanced mitigation might be required to

maintain compliance with noise and vibration criteria. These are shown in Figures NV301-318 in the plan set.

147. The number of PPFs exposed to construction noise is reported later in this report.

Mitigation

148. Mitigation is discussed in detail later in this report.

EXISTING ENVIRONMENT

149. My evidence describes the Ō2NL Project area based on the communities affected[47] rather than specific Project sections.

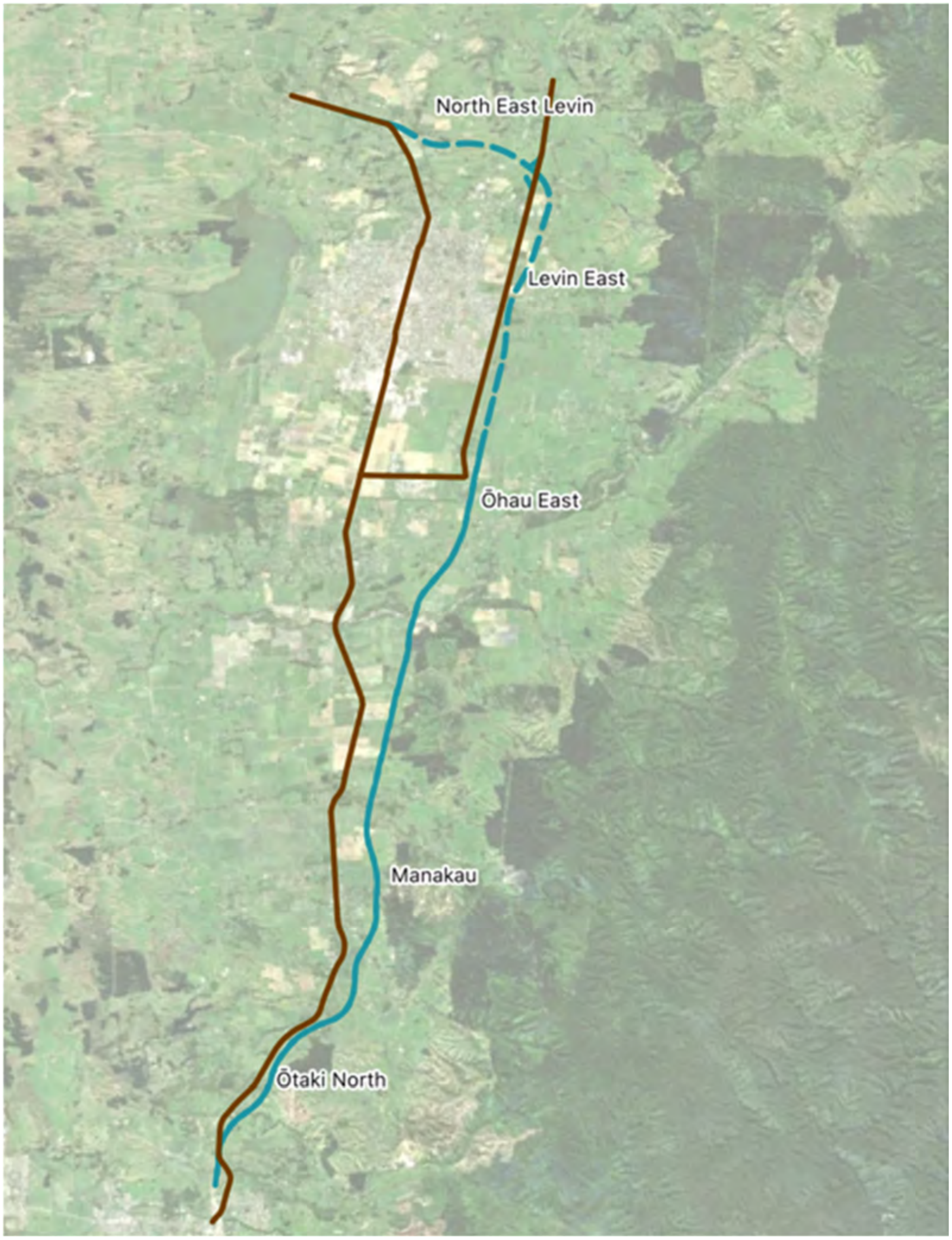

Figure B.5 Communities in Ō2NL Project area

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[47] These communities are broadly consistent with Technical Assessment E (Social Impacts), other than the fact that I have split Levin into North-East and East.

150. The existing acoustic environment varies significantly along the route, between areas where road-traffic noise dominates the environment, to other areas where there are few human-made sources present and the environment mainly consists of nature sounds such as birds, insects, domestic and farm animals, and wind noise in trees and vegetation.

151. To better understand the existing environment, I have:

(a) Visited the project area at different times of the day and made observations;

(b) Performed a combination of attended and unattended measurements throughout the Ō2NL Project area;

(c) Predicted noise levels from the existing state highway network using a computer model;

(d) Spoken to residents both individually and collectively; and

(e) Spoken to the Project planners about permitted activities within the relevant zones.

Noise monitoring

152. I have performed noise monitoring throughout the Ō2NL Project area, using a combination of short-term attended measurements and observations, as well as longer-term unattended measurements. The full methodology and results are set out in the Noise Survey Report NV2 (attached as Appendix B.6), and a summary provided in this section.

153. Measurement locations were selected to be representative of the Project area, with varying levels of influence from existing noise sources.

154. For the longer-term unattended measurements (2 weeks for some, and 3 months for others), the key output is energy average of each days' value the $L_{Aeq(24h)}$. I have also determined the daytime[48] and night-time[49] averages. The results are presented in Table B.11.

[48] The 15 hours between 0700-2200h.
[49] The 9 hours between 2200-0700h.

Table B.11 Long-term noise monitoring results, dB $L_{Aeq(24h)}$

Community	Address	$L_{Aeq(24h)}$ dB	$L_{Aeq(day)}$ dB	$L_{Aeq(night)}$ dB
North-East Levin	46 Sorensons Road	46	47	39
Levin East	70 Waihou Rd	46	47	40
	190 Arapaepae Road	52	53	48
	246 Tararua Rd	47	48	43
Ohau East	378 Arapaepae Rd South	50	51	42
	459 Arapaepae Rd South	45	46	36
Manakau	10 Nikau Lane	46	47	44

155. To further understand how the ambient environment changes over time, I have provided the following figure which shows the number of days different $L_{Aeq(24h)}$ values occurred over the logging period. The following example is for 10 Nikau Lane, with 92 days of monitoring.

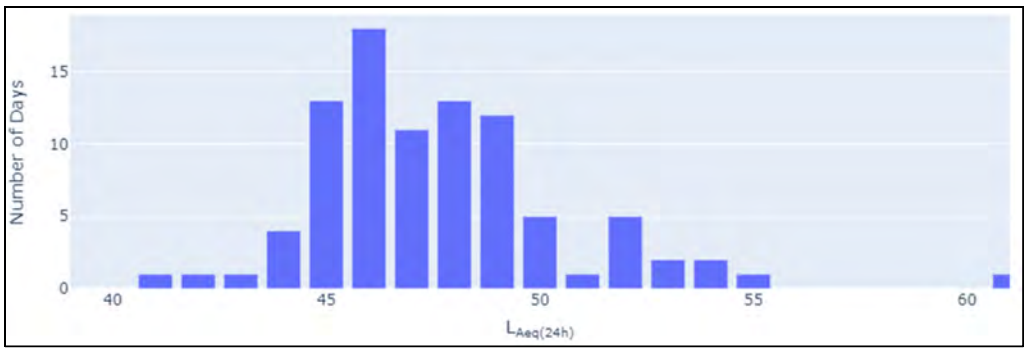

Figure B.6 Noise level distribution

156. For each location the diurnal profile has also been calculated to determine how the noise levels vary throughout the day. An example (246 Tararua Rd) is provided in Figure B.7, and shows both the average ($L_{Aeq(1h)}$) and background ($L_{A90(1h)}$) sound levels, as well as the range in each of those parameters. This shows that for any given time, the noise levels can vary by up to 10 dB over different days. This trend is common between sites.

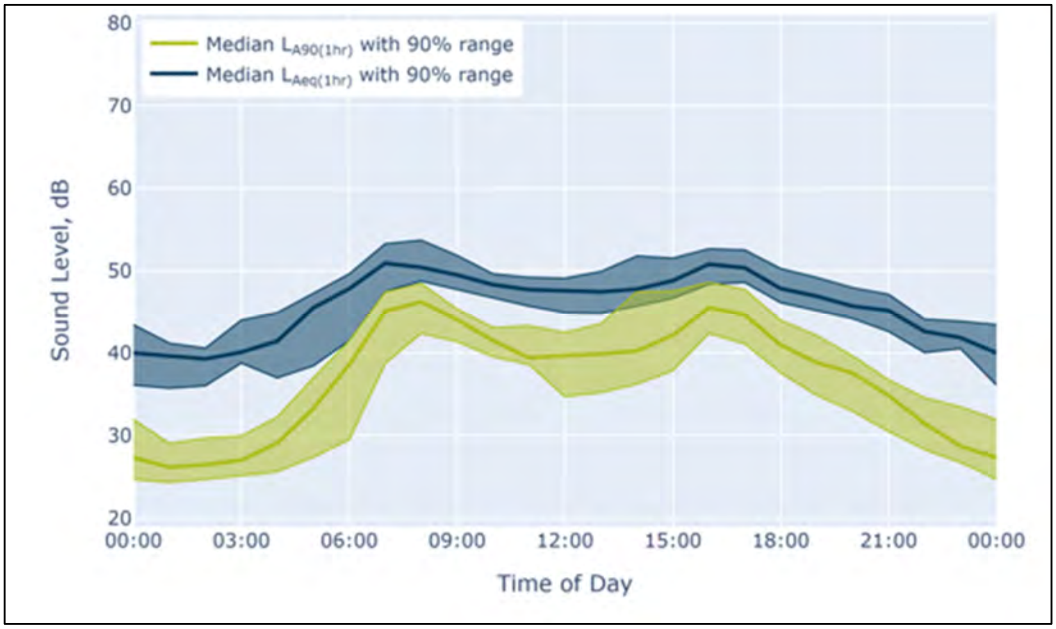

Figure B.7 Example diurnal noise profile of the existing environment

157. Attended measurements were undertaken typically for a 15-minute period, and at some locations they were repeated at a different time period. For each location, the $L_{Aeq(24h)}$ has been estimated in the form of a range. As shown in Figure B.6 and Figure B.7, there is considerable variation from day to day, and also throughout the day and therefore these estimates should only be used as a guide as to the existing noise levels.

158. More importantly, I made aural observations at each measurement location. The contribution to the measured sound level from state highway traffic, and other traffic, was rated on the following five-point scale,[50] in the context of an active listener:[51]

(a) Not at all;

(b) A little;

(c) Moderately;

(d) A lot;

(e) Dominates completely.

[50] Guided by ISO TS 12913-2:2018 *Acoustics — Soundscape Part 2: Data collection and reporting requirements*
[51] The observed contribution for someone not focussing on listening to the acoustic environment may lead to a different result.

159. A summary of attended measurements and observations is presented in Table B.12.

Table B.12 Summary of attended measurements

Address	Start	$L_{Aeq(t)}$	$L_{A90(t)}$	$L_{Aeq(24h)}$ (est)	Contribution from state highway	Contribution from other road traffic*	Other notable sound sources
North East Levin							
15 Koputaroa Rd	28/9/21 0915h	47	42	45-50	Moderately	A little	Birds
	27/9/21 2212h	41	27		A little	A little	
47 Sorensons Road	21/4/21 1524h	47	44	45-50	A lot	Not at all	
165 Fairfield Road	28/9/21 0839h	45	40	40-50	Moderately	Not at all	Birds, aircraft
	27/9/21 2254h	38	26		A little	Not at all	Transformer
Levin East							
32 McDonald Road	28/9/21 0845h	51	45	50-55	Moderately	Not at all	
	27/9/21 2236h	47	38		A little	Not at all	Flowing water in stream, birds, sheep
70 Waihou Road	20/7/21 2211h	44	36	50-55	A little	Not at all	
20 Redwood Grove	20/7/21 2136h	37	31	40-45	A little	A little	
246 Tararua Rd	27/5/21 1345h	42	33	46-49	A little	Not at all	
Ohau East							
183 McLeavey Rd	21/4/21 1503h	40	37	40-45	A little	A little	Birds, wind, insects
74 McLeavey Rd	22/4/21 0942h	54	43	53-57	Moderately	A little	Birds, wind, insects
22 McLeavey Rd	22/4/21 0919h	60	55	58-63	A lot	A little	
59 Railway Tce	28/9/21 0957h	48	44	45-50	Moderately	Not at all	Birds
17 Riveredge	21/4/21 1618h	44	37	40-50	A little	A little	Birds in trees and dogs barking.
514 Arapaepae Road South	21/4/21 1446h	42	39	40-50	Not at all	Moderately	Dogs. Cicada
205 Muhunoa Road East	21/4/21 1433h	42	39	40-50	A little	Moderately	Wind in trees, and cicadas.
	21/4/21 2155h	37	34		Not at all	Not at all	

Address	Start	$L_{Aeq(t)}$	$L_{A90(t)}$	$L_{Aeq(24h)}$ (est)	Contribution from state highway	Contribution from other road traffic*	Other notable sound sources
62 Kuku East Road	20/7/21 1638h	44	40	43-50	A little	A little	Birds
Manakau							
119 North Manakau Road	21/4/21 1557h	43	39	40-48	A little	Not at all	Insects, birds, cows, wind in flaxes
37 Martins Road	21/4/21 1614h	43	39	40-48	A little	Not at all	
44 Mokena Kohere	20/7/21 1705h	48	44	45-52	A little	Not at all	Wind in trees
5 Witako St	28/9/21 1014h	54	48	40-50	Moderately	Not at all	Birds chirping in trees
Tame Porati	21/4/21 1622h	50	47	45-55	Moderately	Not at all	
29 Eastern Rise	21/4/21 1342h	48	46	45-53	A little	Not at all	
Hanawera Ridge	21/4/21 1653h	45	43	44-49	A little	Not at all	
Mountain View	20/7/21 1341h	47	43	45-52	Moderately	Not at all	Water flowing in stream audible
North Ōtaki							
27 Taylors Road	21/4/21 1413h	44	42	42-48	A little	A little	Insects, birds, and wind in trees
108 Greenwood Rd	28/9/21 1048h	44	40	42-48	A little	Not at all	
11 Waitohu Rd	28/9/21 1037h	53	46	50-55	A little	Not at all	

* Local traffic observed, but paused/omitted from measurement.

Modelling

160. As set out later in this report, the contribution of road-traffic noise from SH1 and SH57 in the existing environment[52] has been quantified through acoustics modelling at PPFs.[53] The methodology and results are set out in the Noise Modelling Report NV1 (attached as Appendix B.5). The modelling is based on predicted traffic levels on the new state highway in 2039 using

[52] Noise modelling has been conducted using the 2019 traffic model, as this provides traffic volumes on all road segments, not just those with count stations on them.

[53] As well as dwellings outside of the project area (primarily on the existing SH1 through Levin, Ohau and Manakau), which are being modelled to determine some of the positive effects of the Project.

the 95th% growth forecast (the highest growth forecast available) and assuming that traffic is travelling at 110km/h (refer to Technical Assessment A (Transport)). As such the modelling is a conservative estimate.

161. The results of the model are in terms of the annual average daily noise level ($L_{Aeq(24h)}$). While this allows the existing environment to be represented as a single number, it should be noted that there will be day to day variations in road-traffic noise levels, and other noise sources will often influence the ambient noise level. As set out in Section 5.1 measured noise level variations of 3 - 5 dB over different days were common across the sites.

162. Both the long-term and short-term measurements show that natural sound in the Project area is in the order of 45-50 dB $L_{Aeq(24h)}$. For this reason, I have not predicted existing road-traffic noise levels below 50 dB, as other noise sources will often have a material impact on the existing environment. That is, the ambient noise level at these locations is likely to be higher than the modelled level. The modelled noise levels are from the operation of the proposed state highway only, and do not include noise from local roads.

Summary of existing environment by area

163. A discussion on the differing noise sources and sound levels across the Ō2NL Project areas is provided in this section. This discussion is informed by both measurements and predictions.

164. Maps showing the predicted 2019 road traffic noise from traffic on the operation of the existing SH1 and SH57 network are provided below. The noise levels are shown in 5 dB bands and the outline of the Ō2NL Project is shown for reference purposes. The figures and tables in the drawings (found in Volume III - Drawings) should be referred to for existing levels at specific properties.

North-East Levin

165. The area to the north-east of Levin spans the two road corridors of SH1 towards Foxton and SH57 towards Palmerston North. The North Island Main Truck also runs through this area.

166. The noise environment for dwellings along the existing SH1 is dominated by road-traffic. There will be some intermittent rail noise from the North Island Main Trunk. An increase in existing noise level is observed where the speed

limit changes just north of Koputaroa Road on SH1, seen in Figure B.8 where the noise contours expand.

167. There is a group of dwellings along Sorensons Road approximately 600m from SH1. Individual vehicle noise was audible at times, for example from trucks cornering on the approach to Levin. In this area sound levels were measured between 45-55 dB $L_{Aeq(15min)}$ during the day and between 35-45 dB $L_{Aeq(15min)}$ at night. Nature sound including birds and wind blowing in trees was present. I expect that the 24h sound level is likely to range between 50-55 dB $L_{Aeq(24h)}$. Due to the complex topography in this area, there is likely to be localised screening of state highway noise which would result in variations in character between houses.

168. Further afield (eg Fairfield Road / Heatherlea East Road) the noise environment reduces to the general hum of distant traffic and urban development without a clear source.

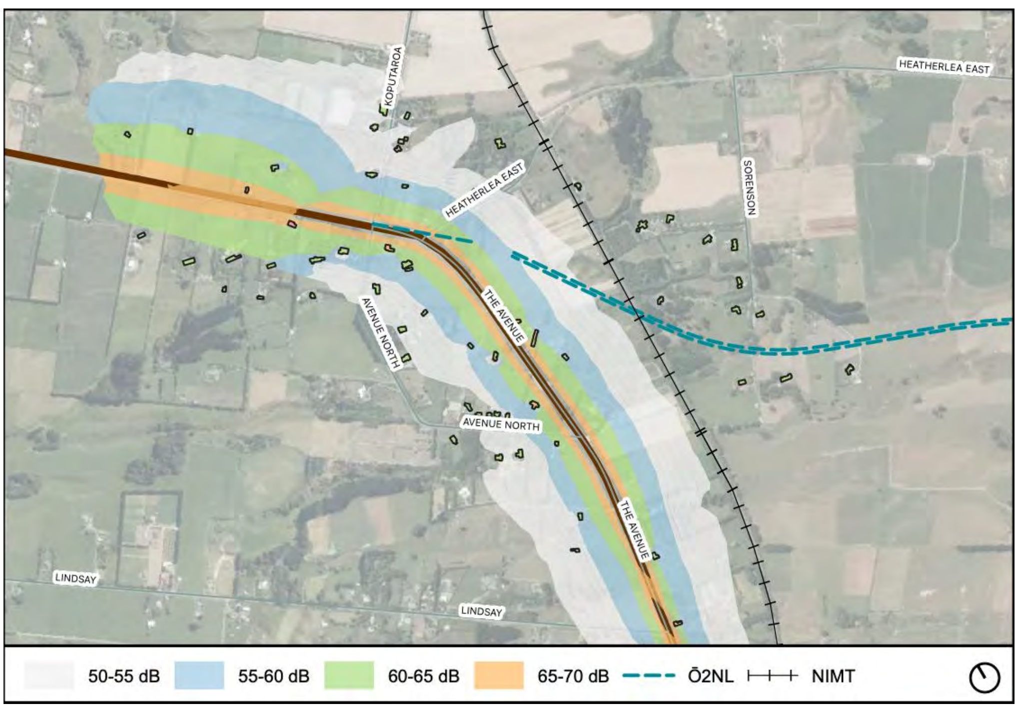

Figure B.8 Existing traffic noise environment (North East Levin)

Levin East

169. This area is on the urban fringe of Levin with a combination of residential properties on standard section sizes, as well as larger rural sections.

170. Noise measurements were taken prior to the safety improvements in this area, including the speed reduction from 100km/h to 80 km/h on SH57, and roundabout at Queen Street, which was still under construction at time of reporting. While the change in average speed will reduce the noise from free-flowing traffic, I understand there is currently extra braking and acceleration noise with the temporary traffic management in place. Any additional character from vehicles approaching and negotiating the roundabout will depend on driver behaviour, which is influenced the broader road environment and the speed management control in use.

171. Arapaepae Road (SH57) is a dominant source of noise. This is particularly the case during the morning and afternoon busy peaks, where there are often steady streams of traffic. At night, traffic becomes sparse and individual vehicles are audible over longer periods (say 30 seconds to 2 minutes).

172. To the east of the proposed highway are rural properties on Waihou and McDonald Roads, which are generally set back from the local road. In this area sound levels were measured between 45-55 dB $L_{Aeq(15min)}$ during the day and between 35-45 dB $L_{Aeq(15min)}$ at night. The 24h sound level is likely to range between 47-52 dB $L_{Aeq(24h)}$.

173. On Queen Street East there are several dwellings on rural sections, including the historic Prouse Homestead “Ashleigh”. On Redwood Grove there are dwellings on residential sections. Measured sound levels at Redwood Grove were below 40 dB $L_{Aeq(15min)}$ at night. At Redwood Grove the 24h sound level is likely to range between 40-50 dB $L_{Aeq(24h)}$.

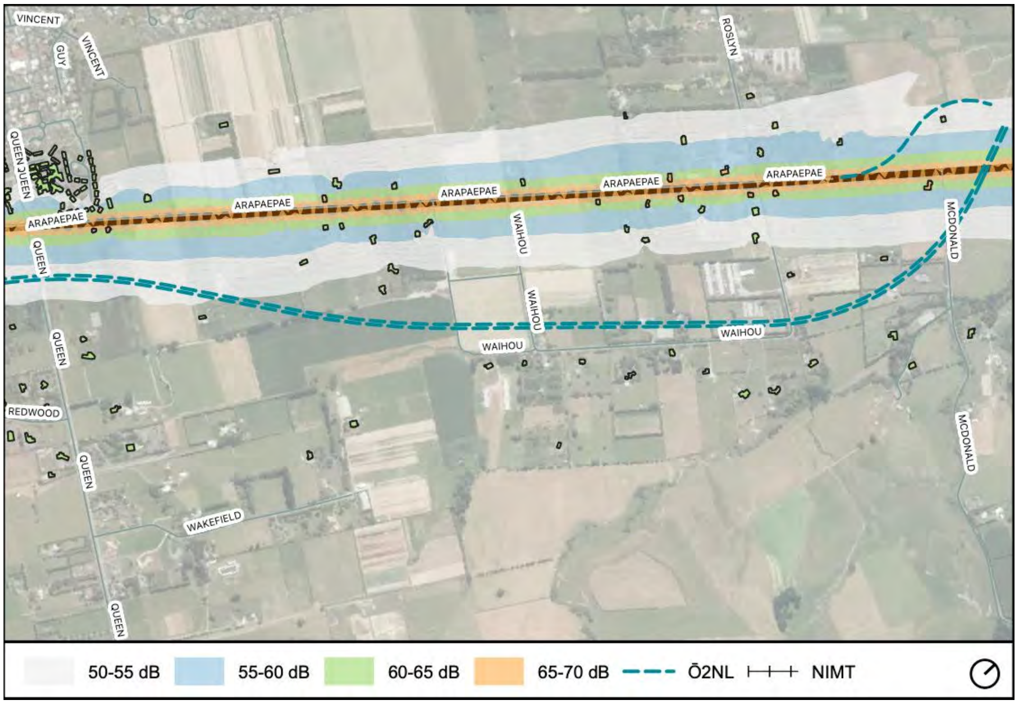

Figure B.9 **Existing road traffic noise environment (Taitoko/Levin East – rural)**

174. To the west of Arapaepae Road there is a relatively dense sub-urban residential area. Sound levels at dwellings fronting Arapaepae Road are likely to range between (55-65 dB $L_{Aeq(24h)}$) depending on their setback from the road as shown in the predictions in Figure B.10.

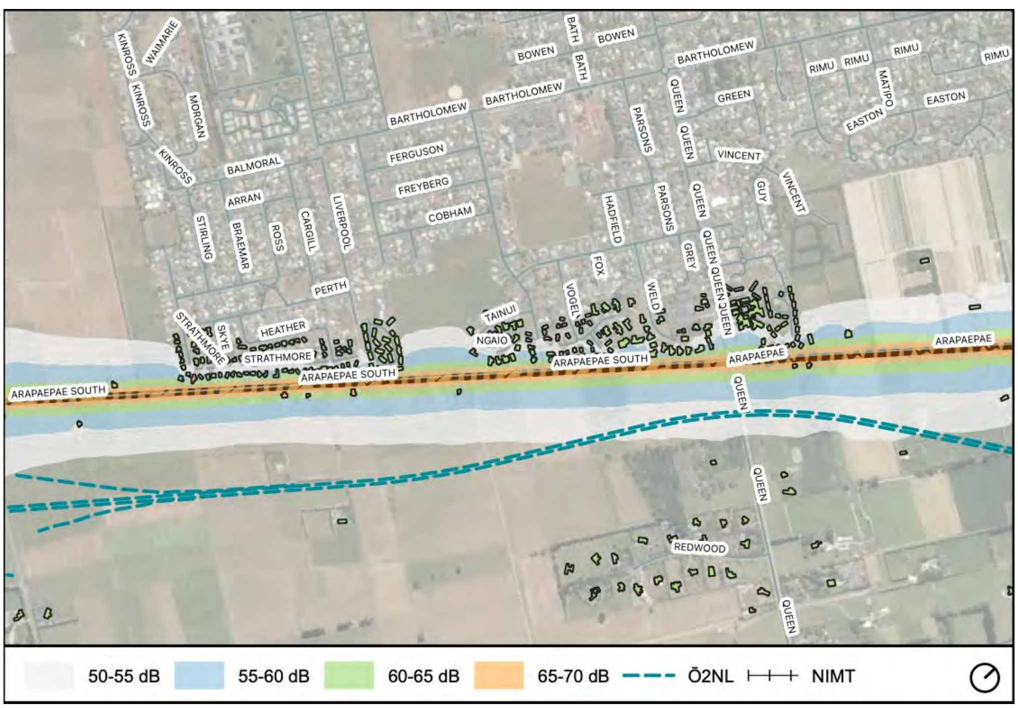

Figure B.10 **Existing noise environment (Levin East – residential)**

Ohau East

175. This area runs south of Kimberley Road through to Kuku East and consists mostly of dwellings on rural sections.

176. South of Kimberley Road (SH57), the influence of road-traffic noise progressively diminishes, due to limited traffic on Arapaepae Road South and Muhunoa Road East. This traffic is audible as individual vehicle movements, rather than steady traffic.

177. Closer to Kimberley Road, road-traffic is a significant contributor with sound levels between 50-55 dB $L_{Aeq(15min)}$ during the day, and 35-45 dB $L_{Aeq(15min)}$ at night. The 24h sound level is likely to range between 47-53 dB $L_{Aeq(24h)}$.

178. Further south on Arapaepae Road South (south of Kimberley Road), ambient sound levels were measured between 40-45 dB $L_{Aeq(15min)}$ during the day, with nature sounds becoming more dominant. At night, traffic noise was not present and measured sound levels ranged between 35-40 dB $L_{Aeq(15min)}$ with wind noise in vegetation being the main noise source. The 24h sound level is likely to range between 40-45 dB $L_{Aeq(24h)}$.

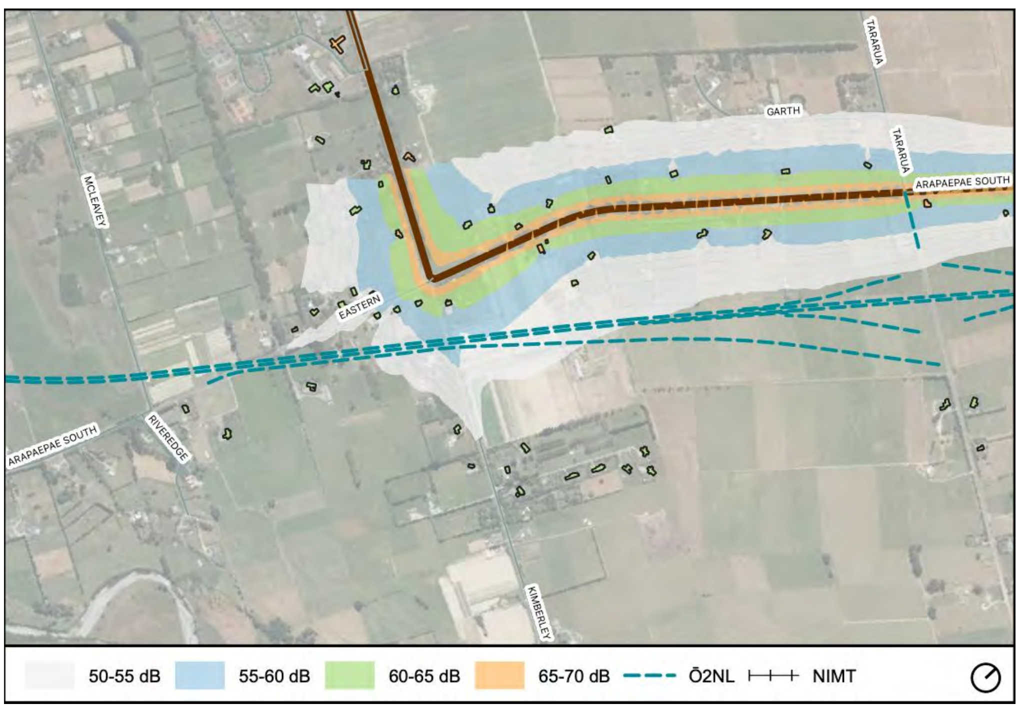

Figure B.11 Existing noise environment (Ohau East – residential)

Manakau

179. This section spans a large area with differing property density and topography:

    (a) North Manakau comprises dwellings on rural sections mostly on the plains, with some undulations further east.

    (b) The western slopes of Manakau Village are residential sections, overlooking the existing SH1.

180. The eastern area of Manakau Village will overlook the proposed alignment and is partially screened from the existing SH1.

181. In Manakau Heights and Eastern Rise, dwellings are on rural sections on undulating terrain.

182. In North Manakau, road-traffic noise from SH1 was audible as a distant rumble without specific character. Daytime sound levels were measured between 40-45 dB $L_{Aeq(15min)}$. Complex topography in places provides localised screening. Daily average sound levels are predicted between 40-50 dB $L_{Aeq(24h)}$. The North Island Main Truck also runs through this area, which will provide intermittent periods of elevated noise.

183. The Western slopes of Manakau are exposed to traffic noise from SH1. Daily average sound levels are predicted between 50-55 dB $L_{Aeq(24h)}$ at the closest properties.

184. On the eastern area of Manakau Village, traffic noise is less prominent than nature sounds. Sound levels in the area were measured between 40-50 dB $L_{Aeq(15min)}$ during the day and 35-45 dB $L_{Aeq(15min)}$ at night. Daily average sound levels are predicted between 40-50 dB $L_{Aeq(24h)}$.

185. Traffic on SH1 is visible and audible from elevated locations such as Hanawera Ridge / Manakau Heights. In general, traffic was audible as a consistent hum, with no specific character. Sound levels in the area were measured between 40-50 dB $L_{Aeq(15min)}$ during the day and 35-45 dB $L_{Aeq(15min)}$ at night. The 24h sound level is likely to range between 45-50 dB $L_{Aeq(24h)}$.

186. Existing noise contours are shown in Figure B.12 and Figure B.13.

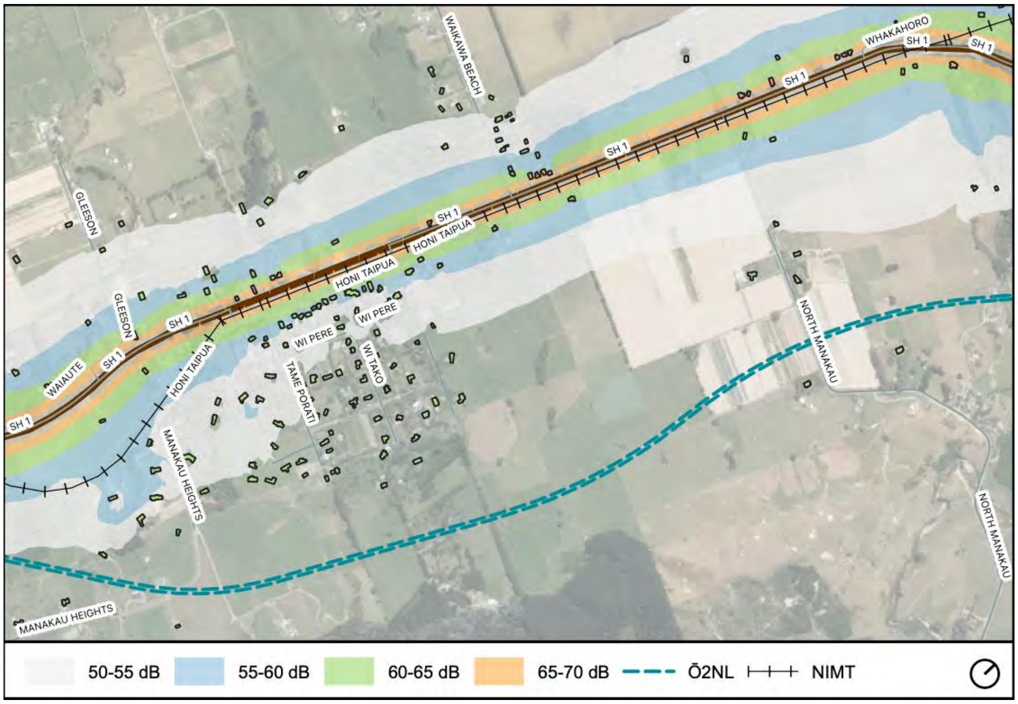

Figure B.12 Existing noise environment (North Manakau)

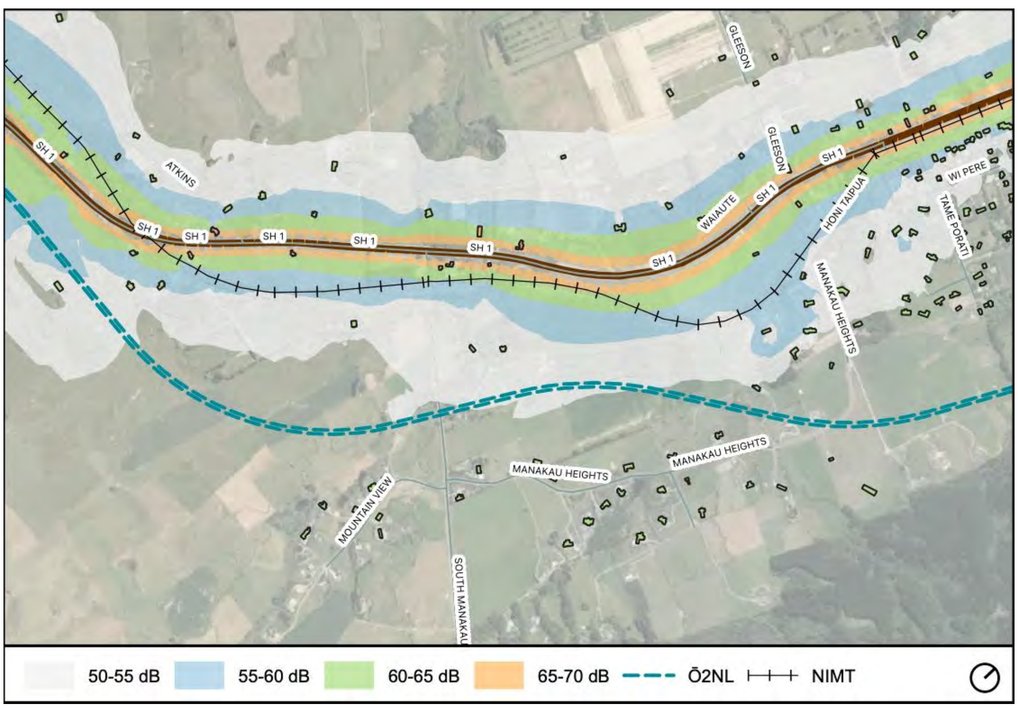

Figure B.13 Existing noise environment (South Manakau)

187. A number of residents in this area have noted that sound can be heard reflecting off the Tararua Ranges.

North Ōtaki

188. The Ōtaki urban area ends at Waitohu Road, north of which dwellings are on rural sections.

189. Road-traffic noise from SH1 is a dominant source with levels between 55-65 dB $L_{Aeq(24h)}$ for the closest dwellings. At locations more remote from the state highway (for example, Taylors Road), daily average sound levels are predicted between 40-50 dB $L_{Aeq(24h)}$.

190. In this area the Ō2NL Project will tie into the PP2Ō expressway (currently under construction) rather than the existing road network. Dwellings within Ōtaki (ie, south of Waitohu Valley Rd) will experience a reduction in noise due to the PP2Ō Project with the majority of traffic diverting from Ōtaki main street to PP2Ō. The following figure shows the noise environment (2029) with the inclusion of PP2Ō, whereas all the other figures were for existing (2019) traffic.

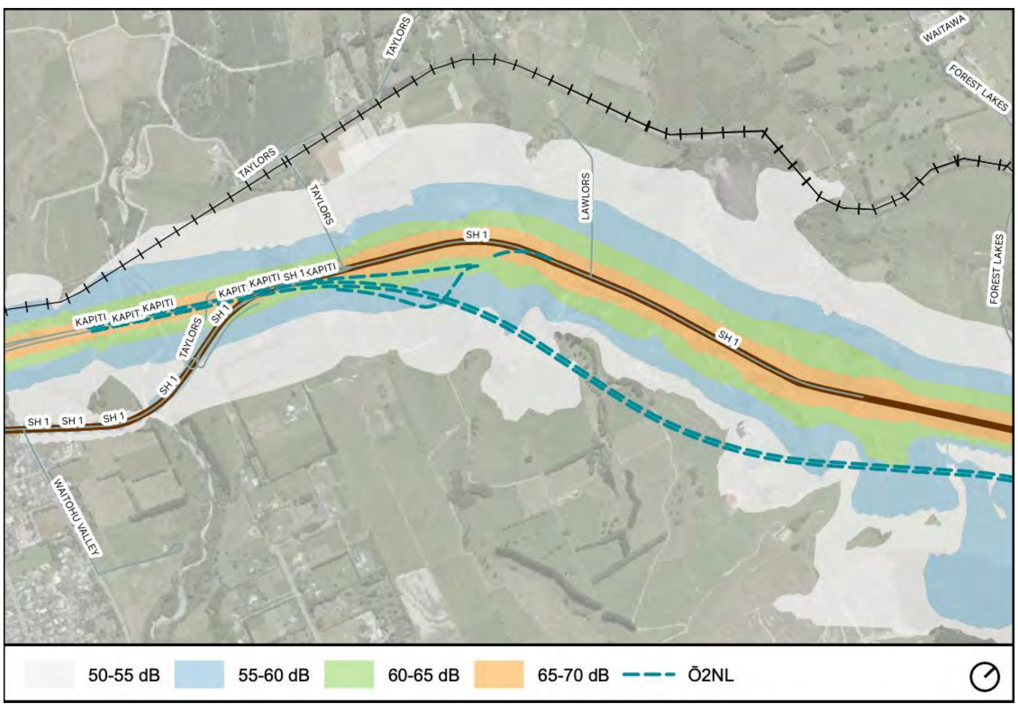

Figure B.14 Noise environment (2029) with inclusion of PP2Ō (North Ōtaki)

PROJECT SHAPING

191. Two workshops were held in May and June 2021, and specific principles to avoid or minimise effects that do not relate to the specific alignment were established, and are listed below:

(a) The use of a low-noise porous asphalt surface rather than noisier chipseal has been included in the Ō2NL Project description as a core principle. This surface reduces road traffic noise by approximately 5dB $L_{Aeq(24h)}$.

(b) High-performance low-noise surfaces should be considered as a mitigation option particularly where noise barriers would be ineffective due to topography.

(c) The road layout, approaches to roundabouts, and interchange configurations should incorporate design elements to minimise rapid acceleration and braking.

(d) The SUP alignment should, where practicable, be separated from the highway and on the protected side of any noise mitigation structures to provide a more pleasant user experience.

192. Some options for reducing noise effects were unable to be confirmed as general principles, but have been considered in specific and appropriate circumstances, due to confounding factors:

(a) The noise benefits of concrete safety barriers should be evaluated on a case-by-case basis as there is a safety disbenefit compared to a wire rope barrier. Concrete safety barriers can be an effective and efficient form of noise mitigation on elevated road segments.

(b) There is also a safety disbenefit to not including ribbed Audio Tactile Profile ("**ATP**") edge lines, although it is Waka Kotahi policy[54] to consider alternative treatment such as structured "splatter" markings where noise nuisance is likely. I understand that these splatter markings have a higher visibility compared to standard line markings, but provide minimal tactile warning to drivers if they cross them.

193. Noise from bridge joints was raised as a design challenge, however in this instance all bridges near dwellings are single span and can be constructed without mechanical expansion joints. Mechanical joints will only be used on the multi-span bridges over Waikawa Stream and the Ohau River, and these bridges are remote from dwellings. Waka Kotahi has specifications that have maximum values for discontinuities or steps in the road surface, which can

[54] Waka Kotahi (2020) Traffic control devices manual: Part 5 – traffic control devices for general use – between intersections (Section 2.7.1 (d)).

exacerbate noise generation. I have recommended that the Project conditions include specific controls to ensure that these specifications are achieved, as installation defects can be difficult to remedy after the fact.[55]

194. The principles above are shown graphically in Appendix B3. These principles are captured in the CEDF (Appendix 3 to Volume II).

195. Many of the principles above, and contained in the CEDF, are consistent with the suggestions and comments of various local residents[56, 57] who have formed an interest group self-titled as "Noise Mitigation 2018".

MODEL FORECAST

Receiver identification

196. The method in NZS 6806 provides guidance as to locations where noise should be assessed (PPFs). PPFs include houses in all areas and visitor accommodation in residentially zoned areas.[58]

197. NZS 6806 provides a spatial restriction to PPFs of within 100 metres of a road in an urban area defined by Statistics New Zealand, or within 200 metres of a road in a rural area. Dwellings beyond this distance are unlikely to affect the mitigation strategy. However, to capture broader corridor effects, I have taken a more conservative approach than required under NZS 6806, and included all dwellings where noise from either the existing or future state highway network would exceed 50 dB[59] $L_{Aeq(24h)}$. In open areas this can extend up to 350 metres from the highway. Assessment locations are identified in Section NV1-2 of the Noise Modelling Report.

198. In accordance with NZS 6806, I have not modelled noise at possible future (unbuilt) PPFs, unless they have building consent. Waka Kotahi has made enquiries with both HDC and KCDC to identify any unimplemented building consents for new houses within 200 metres of the proposed designation.

199. I have assumed that all properties with dwellings within the designation will be purchased by the Crown (Waka Kotahi) for the Ō2NL Project. Unless a

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[55] As detailed in Jacobs (2017) Mackays to Peak Peka Expressway, *Road-traffic noise review*, the poor installation detail is one factor that led to increased noise generation and disturbance experienced by residents.
[56] Bats and Zander (2018) O2NL Noise Mitigation 2018 submission.
[57] 2020 flyer "Noise mitigation and the NZTA proposed corridors for the Otaki to North of Levin O2NL" circulated by local residents.
[58] It also includes schools, marae and health facilities with overnight care, but there are none of which in the project area.
[59] As discussed earlier in this report, above this level there is the potential for adverse health effects from road-traffic noise.

dwelling has been identified as to be removed, I have assumed that it will be on-sold following the construction of the Ō2NL Project and that it will remain in residential use and the conditions as to noise mitigation offers will apply to them. This has resulted in a greater number of Category B PPFs than if Crown-owned properties were excluded. I have clearly identified the number of Crown owned properties.

Operational noise

200. I have predicted road-traffic noise levels at PPFs for six scenarios:

(a) existing network (2019);

(b) with inclusion of the PP2Ō expressway which will be completed by the time the Ō2NL Project opens, and the Safety Improvements Programme ("**SIP**") on the existing state highway network (the 2029 scenario);

(c) as for scenario (b) but with future traffic (2039);

(d) Ō2NL Project (2039) without specific noise mitigation;

(e) Ō2NL Project (2039) with the proposed noise mitigation as set out in Section 9;

(f) Ō2NL Project at road opening (2029) prior to the installation of low-noise surfaces.

201. A detailed acoustics model has been developed to predict road-traffic noise, consistent with the Waka Kotahi guide to state highway noise mapping.[60] The model uses the UK Calculation of Road Traffic Noise[61] ("**CRTN**") algorithm.

202. The model calculates the noise level at each receiver by determining an emission level, and then applies a series of corrections to account for the propagation. The modelled level is for an “annual average” and not for any specific day.

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[60] NZ Transport Agency (2013) Guide to state highways noise mapping (v1.0 DRAFT).
[61] UK Department of Transport and the Welsh Office. (1988) Calculation of Road Traffic Noise.

203. The noise model is sensitive to the following inputs:

(a) Traffic volumes: I have been cognisant that some recent projects have opened with higher traffic volumes that were forecasts for 10-20 years after the scheduled opening. While I cannot comment on the accuracy of the traffic forecasts, I have used the highest (95%) traffic forecast available in order to be conservative.

(b) Speeds: The project team have advised that there is no specific plan to seek a 110km/h speed limit, however we have applied this speed for the long-term operation of the highway out of conservatism.

(c) Road surface: I have used the road-surface corrections published by Waka Kotahi for the relevant surfaces. I note that there is some variability in their noise generation characteristics,[62] however the published corrections are considered to be conservative.

(d) Road geometry, earthworks and surrounding topography: The model uses this information to identify any terrain screening. Where the road is going uphill, the model also increases the emission levels to account for additional engine load. I have used the 3D data provided by Stantec supplemented with LIDAR data for the existing topography.

(e) Ground absorption: The model requires the user to identify the proportion of ground that is reflective (eg pavement / water) or absorptive (eg grass / vegetation).

204. The correction for the propagation is based on the distance from road, any obstructions present, and some degree of air and ground absorption. A correction is made for reflections off hard objects (buildings / barriers) on the opposite side of the road to the receiver.

205. The following factors can affect the noise generation and propagation, but are not considered by the model:

(a) Variations in meteorological conditions (eg downwind or temperature inversions).

(b) Localised screening by boundary fences or subtle terrain features.

[62] See for example Bull et al. (2021). Investigating the effect of layer thickness on the variability of porous asphalt tyre/road noise. PIARC International Seminar.

(c) Complex geometric effects and reflections off buildings on the same side of the road.

(d) Fleet composition and changes that may occur in the future.

(e) Vehicle behaviour at intersections (braking and acceleration).

(f) Noise from individual vehicles with atypical characteristics (eg cars or trucks with mud tyres, modified exhausts, loud motorbikes, sirens, engine braking).

206. I consider the use of a noise model to be an appropriate method for performing an objective assessment, and to test the effectiveness of different mitigation options. In my experience, noise modelling is generally conservative when appropriate inputs are chosen. I have compared[63] the model of existing traffic (SH57) to monitoring conducted as required by NZS 6806, and it is within expected ranges.

207. I have considered the sensitivity of the noise model to the traffic volumes. As set out in the following table, the difference between the 75 and 95% traffic volume is 0.2-0.4 dB.

Table B.13 Comparison of traffic volumes (south of Tararua Rd) and effects on noise level

Traffic scenario	2029	2039
75%	21,400 vpd	26,400 vpd
95%	22,600 vpd	29,000 vpd
Increase in noise level	+ 0.2 dB	+ 0.4 dB

208. A full set of modelling assumptions and details are included in the Noise Modelling report (Appendix B.5).

209. Tables of predicted noise levels for each of the above scenarios are presented in Appendix B.4.

210. Noise contours for the future traffic (2039) without the Project (NV101-118) and with the Ō2NL Project including the selected mitigation (NV201-218) are presented in Volume III - Drawings.

[63] Noise Modelling Report (NV1) at Section 2.6.

Operational vibration

211. Road-traffic vibration should comply with the 0.3 mm/s $v_{w,95}$ criterion beyond 15 metres of a new road, and some previous measurements[64] at new roads have shown compliance at much shorter distances. All PPFs are further than this distance from the new road.

212. Some PPFs are closer to existing roads (SH1 and SH57) and local roads but the Ō2NL Project should not result in increased vibration levels at those locations. The reduction in traffic volumes on the existing road network should result in an improvement in operational vibration for many receivers, primarily due to the reduced number of heavy vehicles. A reduction in magnitude is also likely due to speed reductions on the network,[65] although I note that speed reductions are likely to be already in place prior to the Ō2NL Project opening (Technical Assessment A (Transport)).

Construction noise and vibration

213. Construction of the Ō2NL Project will require a range of standard equipment as discussed below. The majority of the Ō2NL Project involves extensive earthworks (including five material supply sites), paving and compaction, but there are also structures requiring piling, and there will be general construction activities including construction traffic.

214. I have based my assessment on an indicative methodology (described in the DCR (Appendix Four to Volume II)), which I consider to be sufficient to understand the potential range of effects and time frames for the necessary works.

215. Predicted noise and vibration levels are set out in this section.

216. As the precise methodology and equipment have not been selected, I have included the following conservative assumptions in my predictions:

    (a) Equipment source levels are at the upper end of typical values;

    (b) Equipment is assumed to be operating continuously, and at the closest point within the construction footprint to the dwellings; and

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[64] For example, the Porirua measurements discussed above.
[65] Once the Ō2NL Project is open it is likely that the role and function of sections of the existing SH1 and SH57 that are parallel to the Ō2NL Project will be modified. Investigation activity is currently occuring in discussion with the Councils, stakeholders and iwi partners and is likely to result in design changes to the form of the road network and / or speed reductions.

(c) It is also assumed that no mitigation, such as screening or muffling of equipment occurs.

217. Key construction activities and resultant effects areas (based on distance setbacks) are shown in Figures NV301-318 in Volume III.

Earthworks

218. It is expected that motor scrapers may be used to cut and transport material over short haul distances, with excavators and dump trucks used over longer haul distances. Cut material will be transported to fill areas placed and recompacted in layers to the underside of the pavement formation, as described in the fill methodology included in the Design Constructability Report.

219. It is expected that the cut and fill operations will result in 120 heavy movements per day in the northern section, and 100 heavy movements per day in the southern section.

220. Based on this methodology, I have conservatively predicted[66] the following noise levels at a range of distances. The shaded cells exceed the daytime guideline limits from NZS 6803.

Table B.14 Predicted noise levels ($L_{Aeq(15min)}$) at a range of distances - earthworks

Activity	50m	100m	200m
Bulk earthworks (3x scrapers, 1x excavator)	79 dB	73 dB	67 dB
Minor earthworks (1x excavator + dump truck)	66 dB	60 dB	54 dB
Mass haul along alignment	63 dB	57 dB	51 dB

221. I have estimated the following number of PPFs in different noise level ranges based on the above predictions. I note the conservatism within the measurements (unmitigated) such that these PPFs will not experience these

[66] Using geometric spreading, with no ground or air absorption. Assumes plant running continously, and at a constant distance from the receiving location.

levels for the entire time the activity is occurring (if at all). This table excludes PPFs which are within the designation or Crown owned.

Table B.15 Number of PPFs in different noise ranges (unmitigated) - earthworks

Activity	60-70 dB	70-75 dB	>75 dB
Bulk earthworks (3x scrapers, 1x excavator)	447	101	55
Minor earthworks (1x excavator + dump truck)	81	19	0
Mass haul along alignment	23	0	0

Pavement

222. Preparing the basecourse and surface will involve the spreading of fill, distributing the chips / asphalt, and compaction. In addition to the road, kerbing, safety barriers and roadside furniture will be installed, and line marking conducted. The following noise levels are predicted:

Table B.16 Predicted noise levels ($L_{Aeq(15min)}$) at a range of distances – pavement

Activity	50 m	100 m	200 m
Paving	63 dB	57 dB	51 dB
Milling (at tie ins)	68 dB	62 dB	56 dB
Compaction	63 dB	57 dB	51 dB

223. I have estimated the following number of PPFs in different noise level ranges based on the above predictions. I have not included the number of PPFs exposed to noise from milling (at tie-ins) as this is only a short-term activity (hours), although it is likely to occur at night.

Table B.17 Number of PPFs in different noise ranges (unmitigated) - pavement

Activity	60-70 dB	70-75 dB	>75 dB
Paving / compaction	38	2	0

Bridges

224. There are 15 bridges in the project area as listed in Table B.18. Bridges will generally require some form of piling and also compaction activities.

Table B.18 Bridges

Ref #	Structure name	Chainage	Comment
1	NIMT Rail Overbridge	CH10700	Highway over NIMT railway line
2	Queen Street Overbridge	CH16100	Highway in cut, local road over (but close to current surface level)
3	Tararua Interchange	CH18250	Highway in cut, local road over (but close to current surface level)
4	Muhunoa East Road Overbridge	CH21500	Highway under local road
5	Ohau River Bridge	CH22600	Highway over river
6	Ohau River Flood Relief Bridge	CH22435	Highway over river
7	Kuku Stream Bridge	CH23820	Highway over stream
8	Kuku East Road Bridge	CH24000	Highway over local road (at grade)
9	Waikawa Stream Bridge	CH26500	Highway over stream
10	North Manakau Road Overbridge	CH27100	Highway in cut, local road over
11	Honi Taipua Street Overbridge	CH28900	Highway at grade, local road over
12	Manakau Stream Bridge	CH30200	Highway over stream and local road
13	Waiauti Stream Bridge	CH30350	Highway over stream
14	SH1 Crossing near Taylors	CH34300	Highway over local road (at grade)
15	PP2Ō Culvert No. 1 Extension	CH34600	Highway over stream

Ref #	Structure name	Chainage	Comment
	(Greenwood Stream)[1]		

225. I have predicted noise levels for different activities that may occur as part of bridge construction.

Table B.19 Predicted noise levels ($L_{Aeq(15min)}$) at a range of distances from bridge construction activities

Activity	50m	100m	200m
Sheet piling - vibratory	74 dB	68 dB	62 dB
Bored piling	66 dB	60 dB	54 dB
Compaction	63 dB	57 dB	51 dB

226. I have estimated the following number of PPFs in different noise level ranges (unmitigated) based on the above predictions:

Activity	60-70 dB	70-75 dB	>75 dB
Sheet piling (vibratory)	75	0	0

227. In addition, I have predicted vibration levels for piling and compaction activities using the methods from BS 5228-2:

Table B.20 Predicted vibration levels (PPV) at a range of distances from bridge construction activities (5% exceedance probability)

Activity	10 m	20 m	50 m	100 m
Vibratory piling	13.0 mm/s	5.0 mm/s	2.0 mm/s	0.7 mm/s
Compactor (high)	18.0 mm/s	8.0 mm/s	2.0 mm/s	0.8 mm/s
Compactor (low)	6.0 mm/s	2.0 mm/s	0.6 mm/s	< 0.3 mm/s

[1] PP2Ō Culvert 1 is included in this Table because the size of the culvert meets the definition of a bridge as defined in the Bridge Manual SP/M/022 (Third edition up to and including Amendment 3, October 2018, New Zealand Transport Agency).

Vehicle movements on public roads

228. There will be several access points to the Ō2NL Project area via the state highway network. However, some construction areas will need to be accessed via local roads. This includes delivery of aggregate, concrete and other components. The number of peak movements for each road is listed in Table B.21.

Table B.21 Estimated peak construction heavy vehicle movements per day on local roads[67]

Road	Movements per day
Sorensons Road	40
Queen Street East	130
Tararua Road	70
Kimberley Road	60
Arapaepae Road	130
Muhunoa Road / Bishops Road	130
Kuku East Road	22
North Manakau Road	120
South Manakau Road	150

229. While the effects of vehicle movements on public roads do not warrant assessment (and is not required to be undertaken by the district plan), I have predicted the following noise levels from construction traffic at a range of distances, for a conservative scenario where the traffic is not uniformly distributed over the day, with a peak of 10 movements in 15 minutes. This excludes other traffic that may be on the roads.

Table B.22 Predicted noise levels from heavy vehicles on public roads

Item	50m	100m	200m
Average noise level (10 movements in 15min) – $L_{Aeq(15min)}$	46	43	40
Individual pass-by (L_{AFmax})	66	60	54

[67] Refer to Technical Report A (Transport).

SUMMARY OF OPERATIONAL NOISE EXPOSURE PRIOR TO SPECIFIC MITIGATION

230. A summary of PPFs in each NZS 6806 category is provided below, in addition to a comparison to the 2018 WHO guidelines discussed above. As expected, there are a large number of PPFs exposed to elevated operational noise levels without mitigation. While a review of noise exposure does not directly determine effects, the absolute exposures indicate that consideration of mitigation is appropriate.

Table B.23 Summary of noise categories without mitigation

Scenario	WHO Guidelines		NZS 6806 Categories		
	<= 50 dB	>50 dB	Cat A	Cat B	Cat C
Ō2NL without specific mitigation (2039)	80	196	230	46	0
Total	276		276		

MEASURES TO MITIGATE NOISE AND VIBRATION EFFECTS

231. Unless stated otherwise, the content of this section relates to operational noise only.

Design process

232. The process for determining where and what mitigation is appropriate is a combination of noise modelling to determine potential effects, testing of mitigation options, and a multi-criteria analysis to determine the selected option. This process is set out in detail in the Waka Kotahi guide,[17] based on the requirements from NZS 6806. I have summarised the process in the following figure.

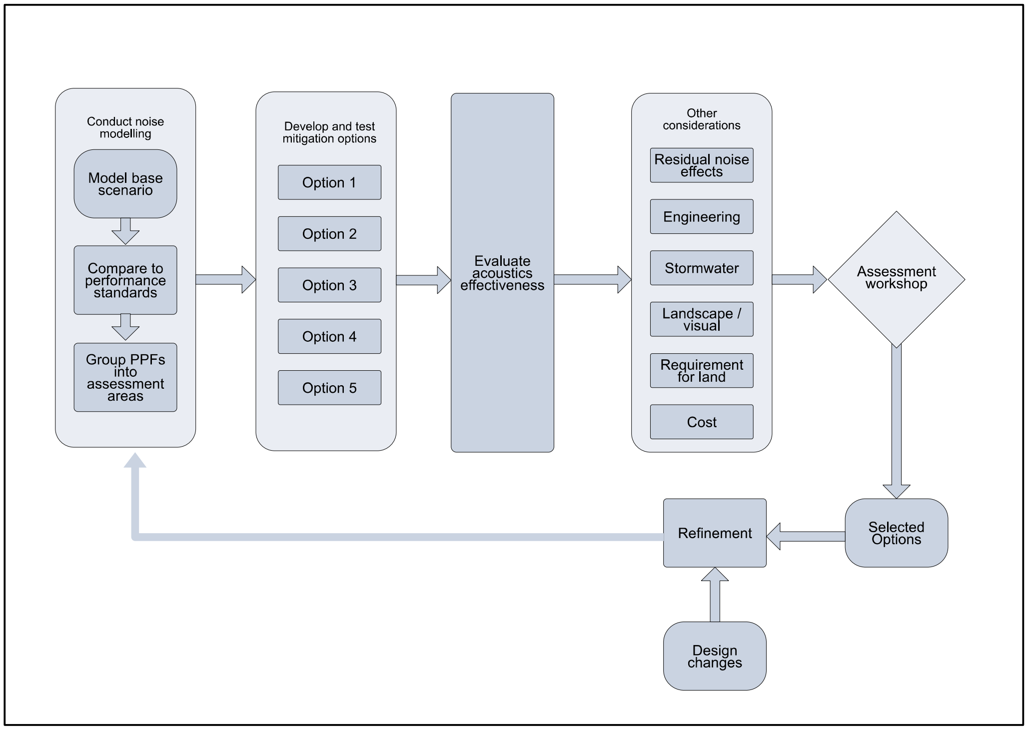

Figure B.15 Mitigation design process (adapted from NZS 6806 and Waka Kotahi Guide)

233. The full details of the mitigation options and the evaluations by the project team are provided in the Noise Modelling Report (Appendix B.5), and summarised below.

Assessment areas

234. Following initial modelling of the operational noise, the future road-traffic noise contours were reviewed to identify where mitigation should be considered. This included where multiple PPFs would benefit from common mitigation. This resulted in 16 discrete assessment areas, referred to by NZS 6806 as ‘clusters’. These are listed in Table B.24. The area codes were based on a previous project segmentation that ran south to north.

235. By applying all of the performance standards detailed above, I have not limited myself to only considering mitigation options where PPFs exceed the NZS 6806 Category A criterion.

Table B.24 Assessment areas

Area	Community	Description	Side of highway
A1	North Ōtaki	North Ōtaki	West
B1	North Ōtaki	South Manakau	West
B2	Manakau	Mountain View	East
B3	Manakau	Manakau Heights	East
C1	Manakau	Manakau Village	West
C2	Manakau	Eastern Rise	East
D1	Manakau	North Manakau Road	East
D2	Manakau	Kuku East Road	West
E1	Ohau East	Arapaepae South Road: McLeavey to Muhunoa East	West
E2	Ohau East	Arapaepae South Road: McLeavey to Muhunoa East	East
F1	Ohau East	Arapaepae South Road / Kimberley Road	West
F2	Ohau East	Corner of Tararua Road and Arapaepae Rd	West
G1	Levin East	Queen Street East	East
H1	Levin East	Waihou Road	East
L1	North East Levin	Sorensons Road	North
L2	North East Levin	Sorensons Road	South

Forms of mitigation

236. In addition to the adoption of design principles to reduce operational noise effects, physical forms of mitigation have been considered in some locations. The preferred approach to noise control is to implement structural mitigation measures within or adjacent to the road reserve. In some circumstances, it may be appropriate to undertake building modification or other mitigation works on a landowner's property.

237. Effective structural mitigation measures within the road corridor include noise walls, earth mounds/bunds, roadside concrete safety barriers and low noise pavement surfaces.

238. Noise walls are commonly used to reduce noise emissions by essentially blocking the line-of-sight between the noise source and the receiver. While internationally some very tall noise walls are used, for New Zealand, particularly in a rural context, these are typically limited to 3m high because of landscape / visual / cultural effects). Noise walls either need to be

integrated into a concrete safety barrier or set back beyond the deflection zone of a barrier.

239. Earth mounds or bunds can be used instead of noise walls and are often a good solution in rural areas, because they can fit into the landscape more naturally than any vertical structure, especially where they support planting which improves its appearance in rural contexts. The major constraint of using earth mounds is that they need space. For example, a 3-metre-high earth mound with 1:3 slopes and a 1 metre wide crest requires a minimum land width of 19 metres.

240. Roadside concrete safety barriers (in the order of 1 metre high) can provide effective noise mitigation, particularly when the road is elevated compared to the surrounding terrain. However, as noted above, these come with a slight safety disbenefits when compared to wire rope barriers.

241. Various forms of road surfaces have been tested over the past decade with the aim of reducing noise emissions. Waka Kotahi has an active research programme[68] and the following surfaces are considered good practice for where noise is an issue.[69]

   (a) Standard low-noise surface: A 30mm thick porous asphalt with 10mm grade aggregate or smaller; and

   (b) A high-performance surface: a 50mm thick porous asphalt with 7mm grade aggregate. This surface has been installed on parts of the Christchurch Northern Motorway, and a 40mm thick EPA7 was installed for the Christchurch Southern Motorway Stage 2.

242. As there are cost (and environmental) implications of a thicker surface, the use of a high-performance surface requires evaluation through the NZS 6806 mitigation design process.

243. By the time of construction there may be alternative high-performance surfaces, or other options, with either better noise or engineering characteristics. Therefore, care is required when drafting conditions to ensure flexibility and provision for innovation while still ensuring appropriate noise mitigation outcomes.

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[68] https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/noise-and-vibration/surfaces/.
[69] NZ Transport Agency (2020). Noise and Vibration Technical Memorandom NV5 Version 2.

244. Where structural mitigation measures alone cannot achieve the desired level of mitigation, building modifications on a landowner's property may be required to ensure that internal noise levels do not exceed 40 dB $L_{Aeq(24h)}$. In most instances this consists of the provision of mechanical ventilation (and cooling) so that windows can be kept closed, however at higher noise exposure, upgrades to the building façade, including glazing may be required. The details of any building modification mitigation would not normally be determined at the consenting phase of a project.

245. Building modification is generally considered a last resort, as unlike structural mitigation measures, it does not improve the outdoor amenity.

246. While not strictly 'building modification', localised barriers / noise walls (ie located on private property) are another potential measure considered when assessing mitigation options on private property. Examples can include courtyards that provide an area of reduced noise levels. However, localised noise barriers are less preferable than barriers within the designation, as landowner approval and acceptance is required and there are complications around ongoing maintenance and access for construction.

247. Waka Kotahi has an established process for investigating dwellings for building modification.[70] I note that these investigations are not required to be completed during the current consenting phase of the project. This is for two reasons:

(a) Firstly, noise levels in the detailed design may reduce such that building modification mitigation is no longer required, and

(b) Secondly, the exact detail of the building modification mitigation is not needed to assess the noise effects. An internal noise level of 40 dB $L_{Aeq(24h)}$ can be readily achieved with minimal works.

248. The general mitigation strategy included the mitigation options as outlined in Table B.25. In some locations noise barriers were tested in combination with the high-performance surface, however the benefit of the high performance surface is additive to mitigation in all areas.

[70] NZ Transport Agency (2015) State highway guide to acoustic treatment of buildings. At Section 4.

Table B.25 Noise mitigation options

Topic	Considerations
Option 1	High performance road surface
Option 2	1.1m high concrete safety barrier
Option 3	2.0 m high noise wall
Option 4	3.0m high noise wall
Option 5	3.0m high earth bund (3H:1V slope)

Acoustic effectiveness

249. The effectiveness of the mitigation is determined through modelling. The effectiveness has been reported both as the resulting absolute noise level for each option, and also the reduction achieved. The following is an example of the material given to the workshop attendees.

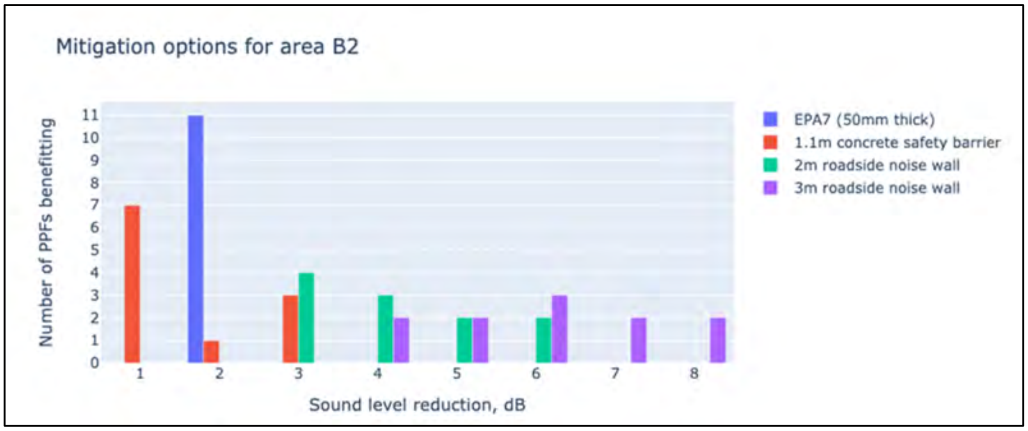


Figure B.16 Example of reductions

Multi-disciplinary assessment

250. To determine the preferred noise mitigation option, multi-disciplinary evaluations were undertaken in accordance with the NZS 6806 process (illustrated in Figure B.15 above). The objective of this process is to minimise noise levels subject to engineering constraints, costs, and taking into account that the inclusion of mitigation can have its own adverse effects on the environment. Table B.26 outlines the evaluations factors considered:

Table B.26 Evaluations factors for mitigation

Topic	Assessor	Considerations
Acoustics	Michael Smith (Altissimo Consulting)	• Compliance with NZS 6806 criteria • Comparison with Environmental Noise Guidelines (WHO 2018) • Effectiveness of noise mitigation • Requirement for building modification mitigation • Value for money
Engineering / roading	Jamie Povall (Stantec)	• Engineering degree of difficulty with cost implications (excluding the mitigation itself) • Effects on earthworks • Stormwater treatment and/or potential flooding effects
Safety	Keith Weale (Stantec)	• Effects on road user safety
Landscape / visual effects (Gavin)	Gavin Lister (Isthmus)	• Effects on visual aspects of amenity values from dwellings • Effects on experience for travelling public
Planning	Chris Hansen	• Alignment with District Plan objectives and policies • Additional planning authorisations required
Property	Various (Waka Kotahi)	• Additional land required for mitigation
Cultural	(Iwi Partners)	• Potential effects of operational noise on known cultural values • Effects of mitigation structures on cultural values (eg. Bund or barrier traverses an important site)
Heritage	Ian Bowman	• Potential effects of operational noise from the Project on heritage buildings and sites • Effects of mitigation structures on cultural values (eg. Bund or barrier traverses an important site)
Ecology	Tim Martin / Della Bennet (Wildlands)	• Mitigation allows for integration of ecological treatment
Social	Jo Healy (Beca)	• Social effects of mitigation

251. The noise mitigation design and evaluation process comprised the following steps:

(a) For each area and mitigation option, predicted noise levels post mitigation and the noise reduction achieved were reported, and a drawing set issued to assessors.[71] Completed evaluations were compiled and circulated prior to the workshop.[72]

(b) A workshop was held on 22 July 2021. In addition to evaluators[73] and key design team members, HDC and KCDC regulatory planning, HDC acoustics, and Muaūpoko representatives were in attendance.[74]

(c) The noise modelling results and mitigation options for each assessment area were discussed collaboratively at the workshop. The "Selected Option" for each assessment area was determined by consensus at the workshop.

(d) The noise model was updated with the Selected Options, to confirm mitigated noise levels, and to make any refinements necessary as to the start and end points of noise mitigation treatments.

252. To address the change in design in East Levin and North Ōtaki (in late 2021), the following steps were undertaken:

(a) The noise model was updated and PPFs reviewed for any changes in categories, or where previous assumptions were no longer valid.

(b) Mitigation options were revisited for the 2 areas (East Levin and North Ōtaki), and a drawing set issued to evaluators. Evaluations were received prior to the workshop.

(c) Workshop N4 was held on 11 February 2022 and the "Selected Option for each assessment area (see below) was determined by consensus at the workshop.

[71] Noise Modelling Report, Appendix NV1-B.
[72] Noise Modelling Report, Appendix NV1-C.
[73] Assessments were received from roading / engineering, landscape / visual, planning, ecology (avifauna), social, heritage.
[74] Ngati Raukawa was provided the workshop briefing material, however a representative was unable to attend.

Selected mitigation options

Introduction

253. The maps in this section progress through the same communities as shown earlier in this report. The maps show assessment areas with a dashed line and a label. Crown-owned land is shaded green, and the designation boundary is shown as a dashed purple line. Buildings that will be removed as part of the project are shown with a dashed red outline.

254. The Selected Options for mitigation are shown, and in the case of noise barriers, the length and height are also shown. Noise contours (with mitigation) are shown for context. PPFs are colour coded against NZS 6806 Categories: Green for Category A, and Orange for Category B. There are no Category C PPFs by the new highway.

255. The purpose of this section is to summarise the selected mitigation for each community. It should be read in conjunction with:

(a) The Noise Modelling Report, which includes the full information considered at the workshops (including evaluation matrices).

(b) The assessment of effects set out later in this report.

(c) The table of predicted noise levels at each PPF in Appendix B.4.

(d) The full-sized contours are shown in the plan set in Volume III - Drawings.

North-East Levin

256. In this section, the Selected Option for Area L1 was to extend the concrete safety barrier from the railway overbridge (Ch10,700) east to Ch 11,500. The barrier provides efficient noise reduction and all PPFs achieve NZS 6806 Category A, although the closest PPFs remain exceeding the WHO Guidelines. A standard (30mm thick) porous asphalt surface will be used in this area.

257. In Area L2, no specific mitigation was selected on the basis that the modelling showed road-side noise barriers were not effective as the PPFs overlook the highway. Two Category B PPFs (72 and 82 Sorensons Road) would need to be investigated for building modification mitigation and/or

localised noise walls. Building modification mitigation was introduced in above, and the process for identification is detailed later in this report.

258. The mitigation and PPF Categories are shown graphically below. The three category B dwellings are all within the designation, two are already Crown owned and the third will become so. Noise levels at individual PPFs can be found in Appendix B4.

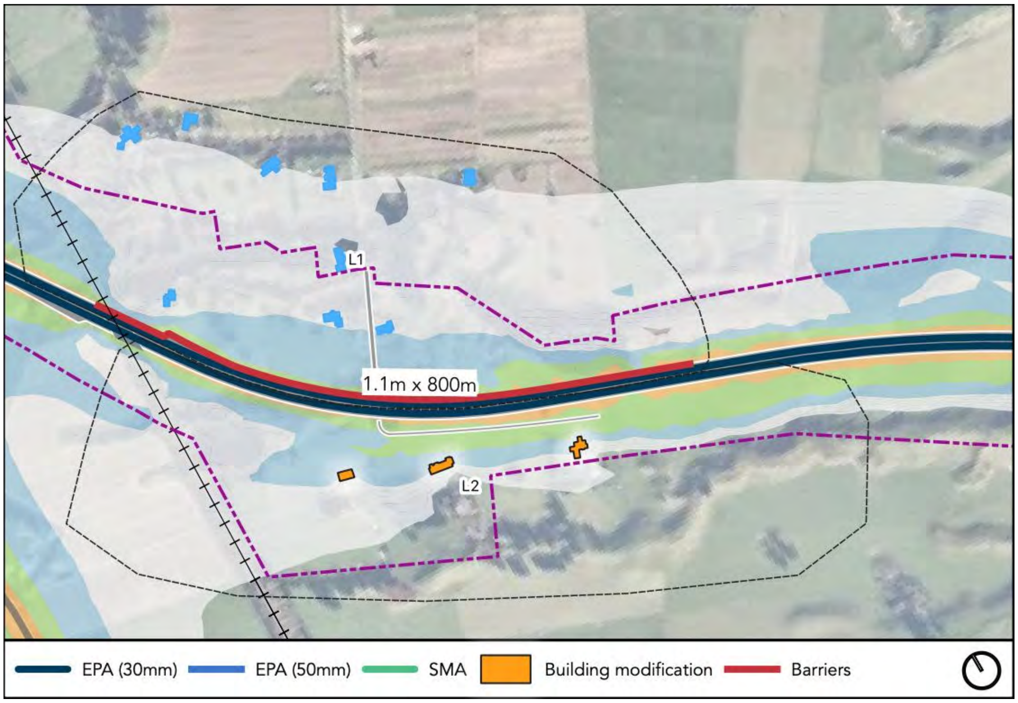


Figure B.17 Selected Options for North Levin (L1 and L2)

Levin East

259. The Selected Option, which I support, includes a high-performance road surface from the approach to the SH57 roundabout to Muhunoa East Road. The approach at the SH57 roundabout will require a surface that can handle the additional braking and cornering stresses, such as Stone Mastic Asphalt ("**SMA**") which generates more noise than the high-performance road surface. This has been included in the noise model for 200 m from the roundabout.

260. In addition to the high-performance road surface, a 2m high noise wall was initially selected between the highway and the Shared User Path by Waihou Road (Area H1). This was selected on the basis that the highway was lower than the surrounding road and the barrier would also serve a function as a boundary between the road and the SUP. With the revised vertical geometry

a concrete safety barrier is more effective, and is the selected mitigation in this area.

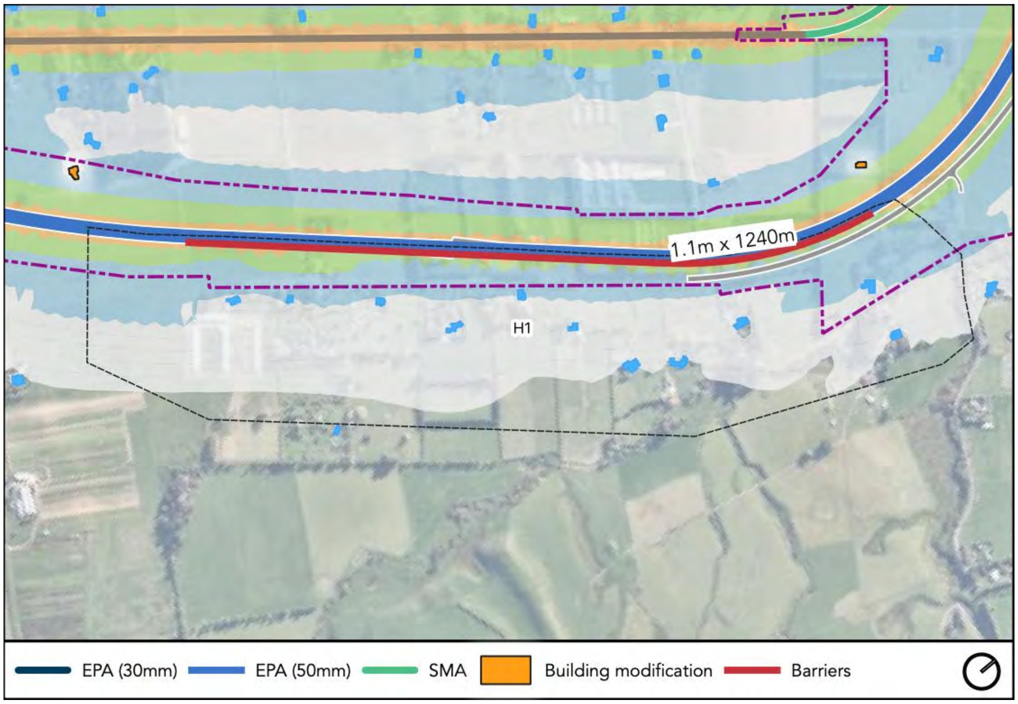


Figure B.18 Selected Options for Levin East (H1)

261. There are two PPFs (24 McDonald Rd and 96 Arapaepae Rd) to the west of the highway that are within the designation that will require investigation for building modification if they remain in residential use.

262. The PPFs south of Queen Street East (Area G1), include the Prouse homestead and the Redwood Grove Properties. There are also PPFs fronting Queen Street East. The highway in this area is close to the existing ground level. Noise barriers of different height were evaluated in this location. From an acoustics perspective, the only property to meaningfully benefit from noise walls is the Prouse homestead. A 5m high barrier could provide 4-5 dB of reduction in noise to the outdoor areas and ground floor, the upper floor would be less screened by the noise wall.

263. The evaluators noted that bunds are undesirable in this location, due to the significant extra fill required, and the area being a high flood risk location, where bunds would complicate flood flow paths.[75]

[75] Assessment matrix for Workshop 4 – Area G1. See Appendix B.5.

264. However, it was noted at the workshop that there may be opportunity in the detailed design phase to include landscaping or property boundary fencing that would further improve noise outcomes for the Prouse Homestead. For the purposes of conditions, this is not noise mitigation. I support this approach.

265. The Redwood Grove properties would only receive a 1-2 dB reduction from a 5m high barrier. Given the noise levels at these PPFs are already below 50 dB, this does not warrant additional mitigation.

266. To summarise, for the above reasons, the Selected Option, which I support, is high-performance road surface without noise barriers.

267. Solid safety barriers will be included on the Queen Street East overpass for both the ramp and bridge deck. The road surface should be an asphaltic mix, rather than chipseal.

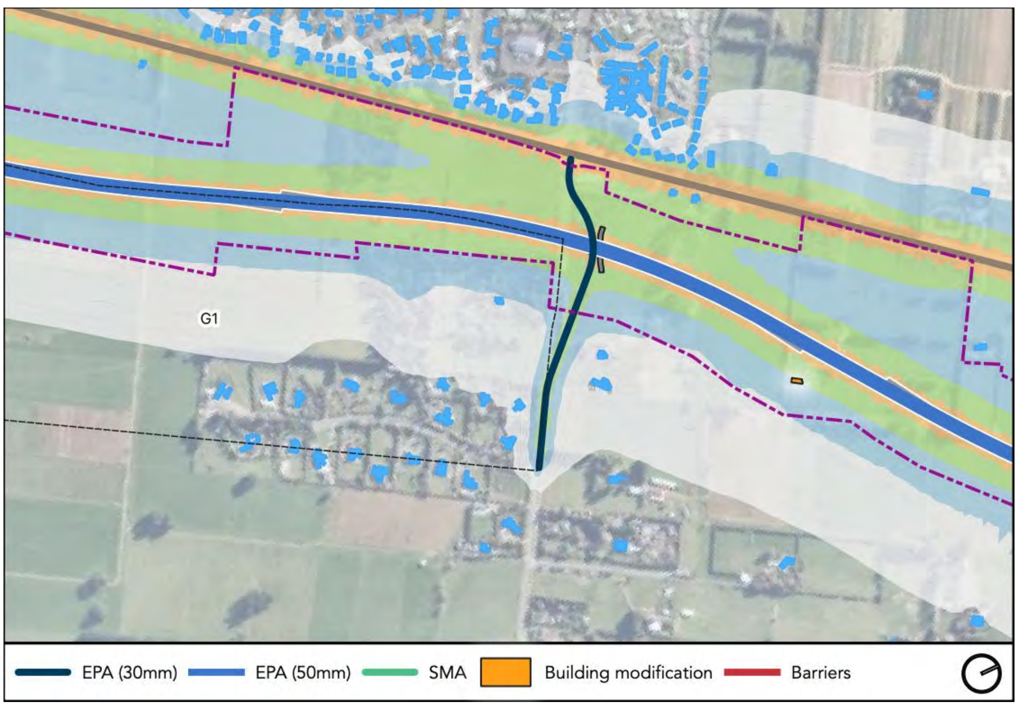


Figure B.19 Selected Options for Levin East (G1)

268. For the section of the Tara-Ika site to the east of the highway, with the selected high-performance road surface, noise levels will, in my opinion, be appropriate for urban development. Precise land-use controls to deliver an integrated design of Tara-Ika that either locates less sensitive uses closer to the highway, or allows well designed development that incorporates adequate outdoor amenity, is still appropriate.

269. Noise levels for the section of Tara-Ika to the west of the highway are predominantly from Arapaepae Road and not the Ō2NL Project. In my opinion no additional mitigation options are required.

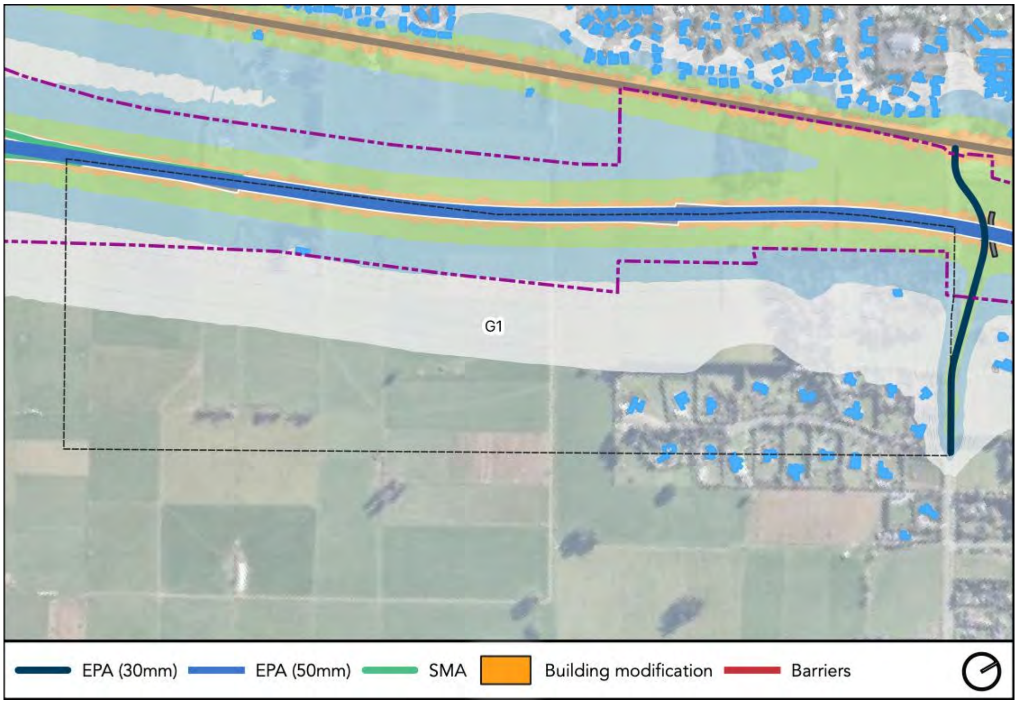


Figure B.20 Selected Options for Levin East (Tara-Ika)

Ohau East

270. Four different assessment areas were considered in this section (F1, E1, E2, D2). There was an additional area F2, however the PPF in this area will be demolished and so no further consideration is required.

271. There is also a single Category B PPF at 264 Tararua Road which is affected by traffic noise from the highway, the local road connection, and Tararua Road. I recommend that this PPF is investigated for building modification has part of the Ō2NL Project.

272. Area F1 comprises the cluster of houses on Arapaepae Road South just south of the Kimberley Road intersection (identified in Figure B.21 below). In this area the high-performance road surface means that road traffic noise levels from the Project are generally between 50-55 dB $L_{Aeq(24)}$ and hence I consider this to be reasonable. Noise barrier options were also evaluated and they would only offer a slight reduction in noise at some close by properties and no benefit to properties located further away. Accordingly, this approach was rejected.

273. There are 3 Category B PPFs which would need to be investigated for building modification, all of which are Crown owned (361, 363 and 390 Arapaepae South Rd).

274. In addition, 397 Arapaepae South Rd (to the east of the highway) requires investigation for building modification. This PPF is privately owned.

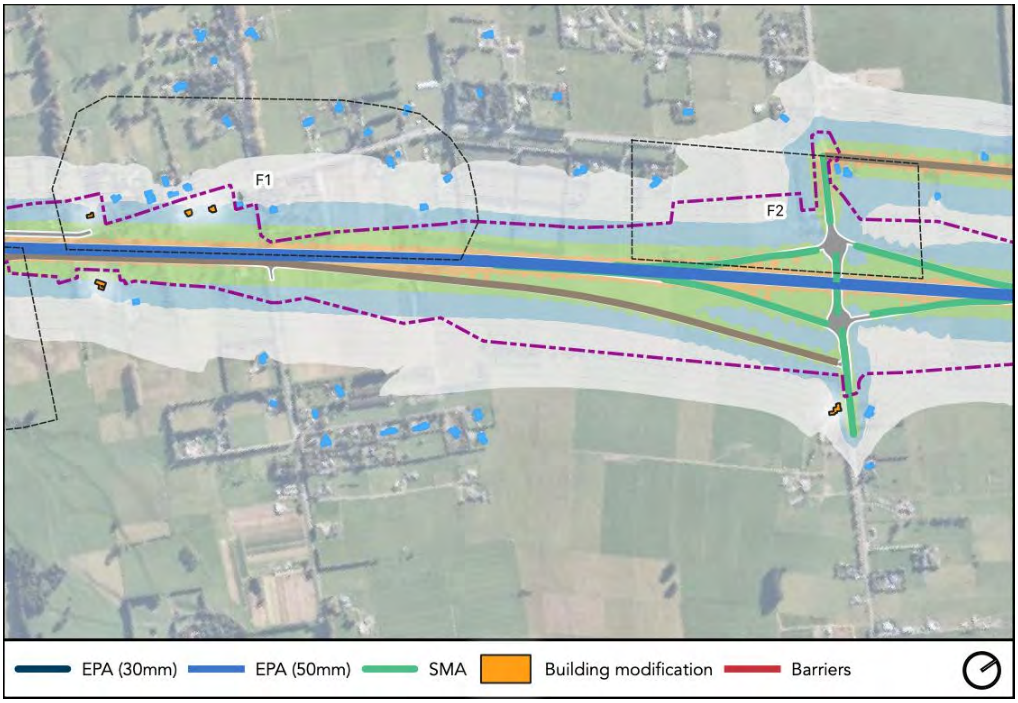


Figure B.21 Selected Options for Ohau East (F1)

275. Between McLeavey Road and Muhunoa Road are Areas E1 and E2. Considering these two areas together, if noise walls were required on both sides, they would confine road user views to a hard-edged 'tunnel' with reduced engagement with rolling rural terrain.[76]

276. In both of these areas, reasonable noise levels are predicted at all PPFs with the inclusion of a high-performance road surface, with the exception of three properties adjacent the highway. I therefore do not consider that additional mitigation is warranted. The 3 Category B PPFs (identified in orange in Figure B.22 below – 480 Arapaepae South Road, 247A Muhunoa East Road and 213 Muhunoa East Road) require investigation for building modification mitigation.

[76] Visual and Landscape Rating - Noise Modelling Report, Appendix NV1-C.

277. I note that the PPFs at 213A-C Muhunoa East Road were not initially modelled and considered at the mitigation workshop as they had only been recently constructed and had not been identified on aerial photographs. I have included these PPFs in my final assessment, and their inclusion does not change the strategy for noise mitigation.

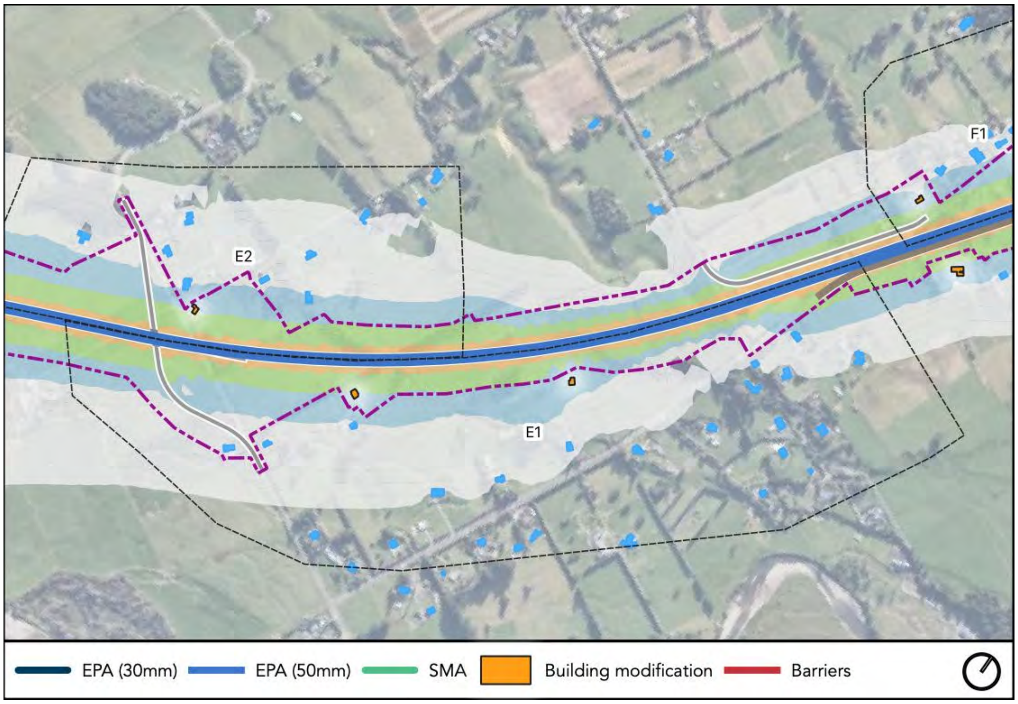


Figure B.22 Selected Options for Ohau East (E1 and E2)

278. At Kuku East (D2), a number of dwellings close to the highway will be acquired and demolished for the Ō2NL Project. There are also some dwellings that have been recently constructed and a caravan that is used for residential living. In my opinion noise levels are reasonable without specific mitigation for the remaining properties, with the exception of the two Category B PPF (679A and 679B SH1) that should be investigated for building modification.

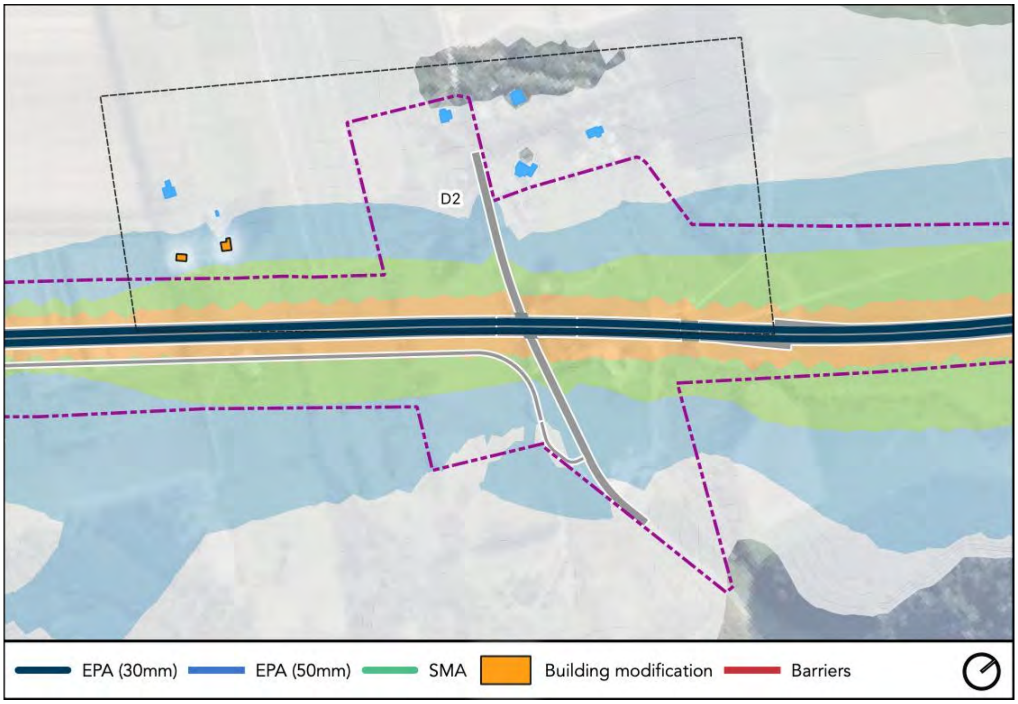


Figure B.23 Selected Options for Ohau East (D2)

Manakau

279. Six different assessment areas have been considered in this section (D1, C1-2, B1-B3).

280. At North Manakau (D1), both noise barriers and high-performance road surfaces are practical and effective in reducing road-traffic noise. Factors influencing the selection are discussed below:

  (a) Noise barriers could be installed at the top of the cut depending on the earthworks design, a safety / security fence may be required in this location, such that a noise barrier would provide a co-benefit. Noise barriers are also likely to be more cost effective than high-performance surfaces.

  (b) As discussed below, high-performance surfaces have been selected for the areas south of D1 in Manakau village (C1/C2), through to South Manakau (B1-3).

  (c) For reason (b) above, the Selected Option for the C1/C2 – B1-3 areas is for surface treatment to be extended through D1 north until the Waikawa Stream bridge, rather than noise barriers.

(d) The noise levels do not indicate a need to implement both forms of mitigation.

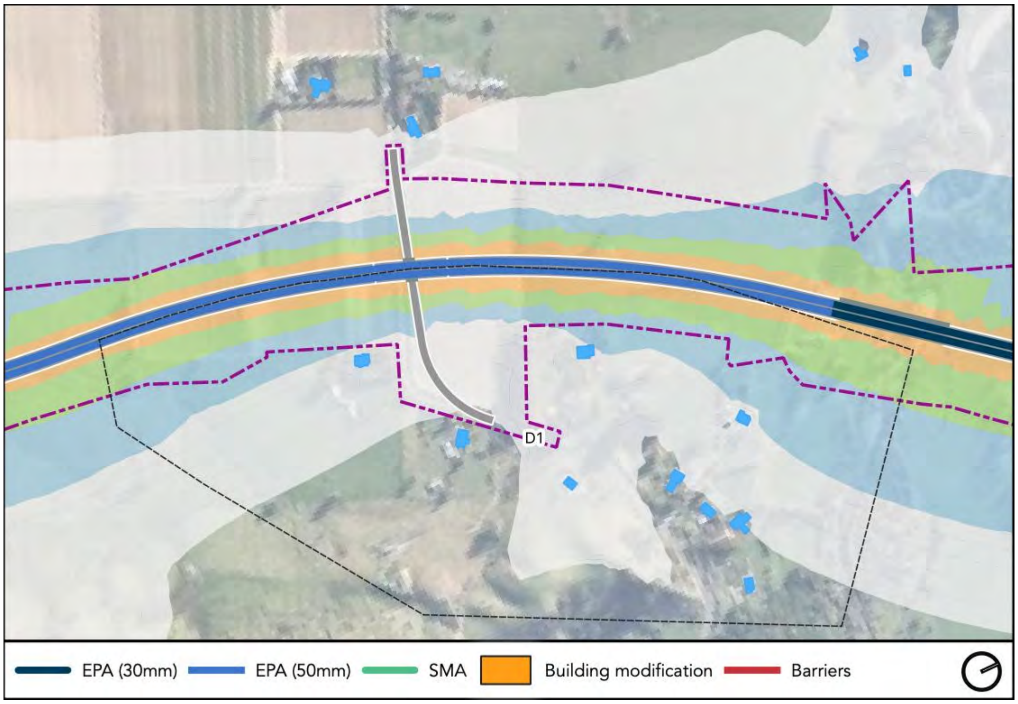


Figure B.24 Selected Options for Manakau (D1)

281. In Manakau Village (Area C1) as the affected properties are overlooking the highway roadside noise walls less than 3m high would be ineffective. The preferred mitigation in this area, which I support, is the adoption of a high-performance surface which provides for reasonable noise levels. There are no Category B PPFs in this area.

282. The PPFs to the east of the highway (Area C2) also benefit from the high-performance surface. In evaluating barriers for this area, Mr Lister noted that barriers over 2m in height would be visually dominant and wall off area the area from the wider landscape. Walls would reduce the outlook and accentuate severance from Manakau. The Selected Option for this area, which I support, is the high-performance surface without barriers.

283. There are no Category B PPFs in this area, other than 108 Manakau Heights Drive. This PPF is within the designation so will be acquired by the Crown. The section is impacted by the local road connection, and the viability of this dwelling is uncertain. If it is retained, it will need to be investigated for building modification mitigation.

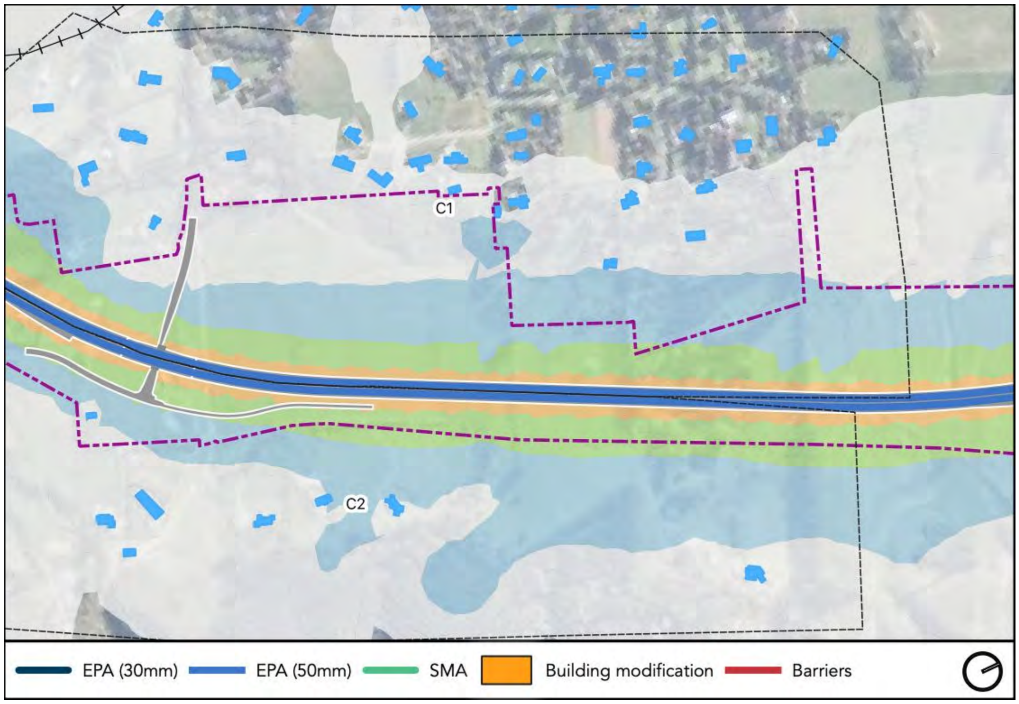


Figure B.25 Selected Options for Manakau (C1 and C2)'

284. Area B3 is near to the new Manakau Heights Drive (local road) overbridge. There will be some localised noise screening provided by the ground recontouring to link the realigned road to the bridges. While the road is lower than PPFs to the east, the road is still on fill in this area. Roadside noise walls would require widening the fill platform, which would require significant engineering. With the inclusion of the high-performance road surface, predicted noise levels are in my opinion reasonable without noise barriers, with the exception of one Category B PPF (75 Manakau Heights Drive) that will require investigation for building modification. There is also a Category B PPF to the west of area B3 (95 Manakau Heights Drive) that will require noise mitigation investigation.

285. In Area B2, extending the concrete safety barriers from the bridges over Waiauti Stream and South Manakau Road provide noise benefits. These barriers have been selected in addition to the high-performance road surface and result in reasonable noise levels. While not assessed prior to the workshop, a concrete safety barrier on the western side of the highway has also been included following discussion at the workshop (Appendix B.5) and I support this being included in the Selected Options.

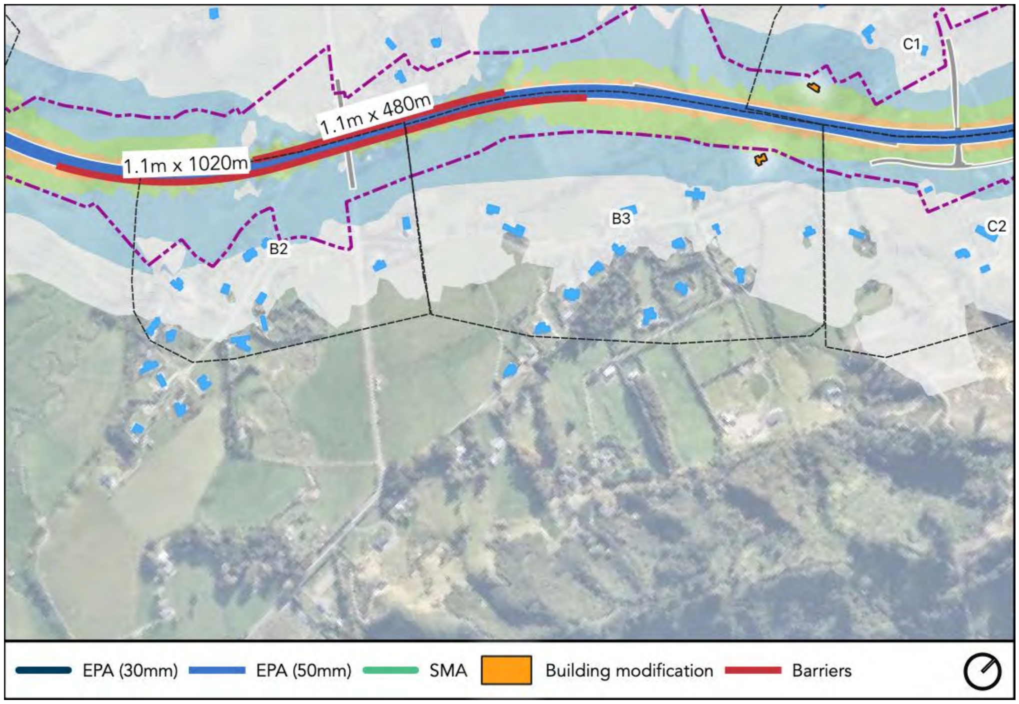


Figure B.26 Selected Options for Manakau (B2 and B3)

286. Area B1 is a small cluster of 3 PPFs between Manakau and Ōtaki (as shown in Figure B.27). The most affected property is Crown-owned. A high-performance road surface would in my opinion be required to provide reasonable noise levels at this property.

287. Given the uncertainty of the future land use of the Crown-owned dwellings, the noise barrier has not been included in the Selected Option, and instead only the high-performance road surface has been selected. I support this approach with the noise mitigation being reviewed as part of the property disposal process after the Ō2NL Project has been constructed.

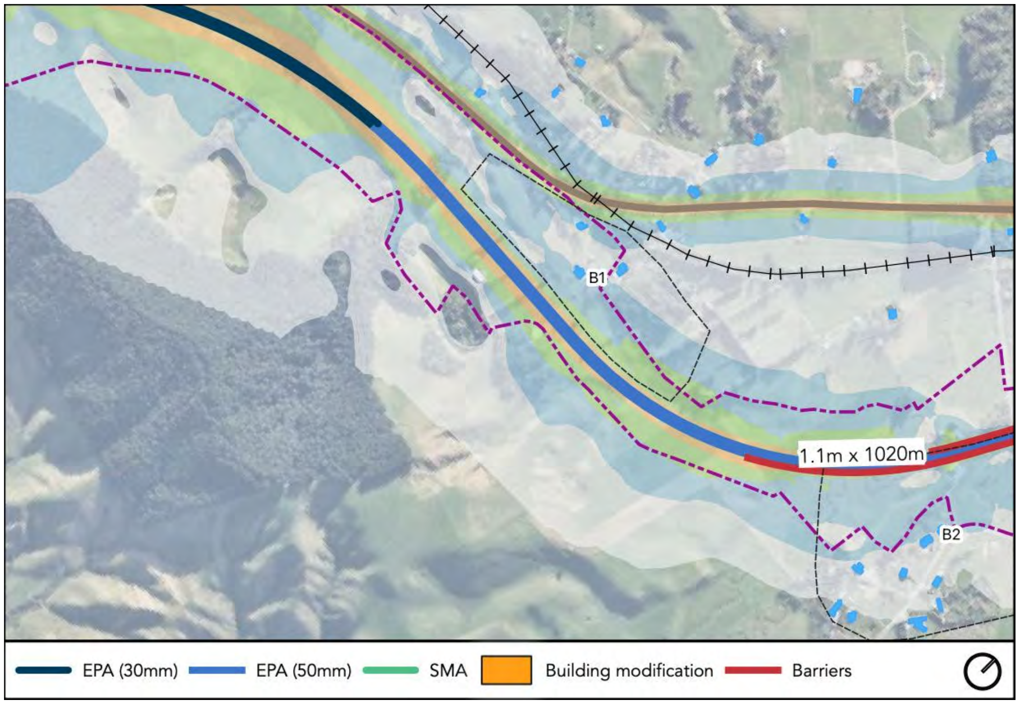


Figure B.27 Selected Options for Manakau (B1)

North of Ōtaki

288. The Project design includes a half interchange at Ōtaki to allow north bound traffic to exit PP2Ō to access existing SH1, and for south bound traffic to enter PP2Ō. The topography is complex in this area with the highway generally below the surrounding PPFs. This results in noise barriers being complex to construct and only providing limited benefit. The Selected Option is to include a high-performance surface and extend the concrete safety barrier on the northbound lane from the bridge up to CH 33600. I support this option. With this barrier all PPFs to the west achieve NZS 6806 Category A.

289. The single Category B PPF to the east of the highway (as shown in Figure B.28 below) should be investigated for building modification. This PPF overlooks the highway and road-side barriers are not effective.

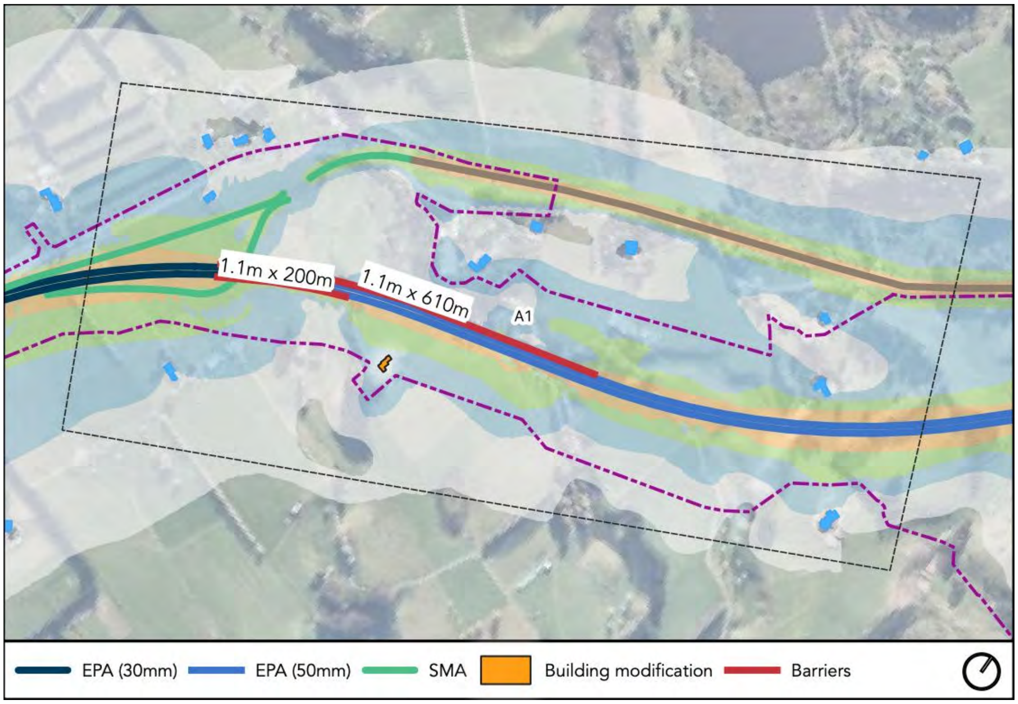


Figure B.28 Selected Options for North Ōtaki (A1)

Proposed mitigation summary for operational noise

290. In terms of specific mitigation, following discussion at the workshops I have recommended the mitigation detailed in Table B.27 and Table B.28. The location of this mitigation is shown at a high level in Figure B.29. In my opinion, with this mitigation in place, the adverse health and amenity effects of the Ō2NL Project will be mitigated to a reasonable and appropriate level, although with the residual effects discussed in detail later in this report.

Table B.27 Selected Options – Road surfaces

Location	Chainage	Length	Type
Muhunoa East through to the SH57 roundabout (Area E1-H1)	CH 22,200 CH 13,400	8.8 km	50 mm thick EPA7 or equivalent
South of Manakau to the Waikawa Stream Bridge, Manakau (Area B1-D1)	CH 31,700 CH 26,500	5.2 km	50 mm thick EPA7 or equivalent
North Ōtaki from tie-in with PP2Ō	CH 39,000 CH 34,900	4.1 km	50 mm thick EPA7 or equivalent

291. The noise mitigation for all of the areas not identified in Table 21 will be a standard thickness porous asphalt, unless this cannot be undertaken for specific engineering reasons in particularly defined sections (eg intersection and roundabouts).

292. Table B.28 identifies all locations where I propose noise barriers to further mitigate noise effects in addition to road surface types.

Table B.28 Selected Options – Noise barriers

Location	Chainage	Length	Type
Levin Rail Bridge, South Bound (L1)	CH 10,700 CH 11,500	810 m	1.1 m high concrete safety barrier
Waihou Road (H1)	CH 13,900 CH 15,000	1.2 km	1.1 m high concrete safety barrier
Waiauti Stream and South Manakau Road bridge North Bound (Opposite B3)	CH 29,700 CH 30, 400	530 m	1.1 m high concrete safety barrier
Waiauti Stream and South Manakau Road bridge, South Bound (B2-B3)	CH 29,700 CH 30,700	1.1 km	1.1 m high concrete safety barrier
North Ōtaki overbridge, north bound (A1)	CH 33,600 CH 34,200	600m	1.1 m high concrete safety barrier

293. Based on the concept design, the following PPFs should be investigated for building modification, using the process detailed below, if they are to be retained in residential use following the construction of the Project. The status of the PPF is shown, with privately owned properties outside of the designation shown in bold.

Table B.29 Selected Options – Investigation for building modification

Address	Area	Status	Level
82 Sorensons Road^	L2	Within designation	62
72 Sorensons Road*	L2	Crown owned	59
66 Sorensons Road*	L2	Crown owned	58
172 Fairfield Road*	L	Crown owned	58
24 McDonald Road^	H	Within designation	60
96 Arapaepae Road^	H	Within designation	58
48 Arapaepae Road^	G	Within designation	61
363 Arapaepae South Road*	F1	Crown owned	58

390 Arapaepae South Road*	F1	Crown owned	59
361 Arapaepae South Road*	F1	Crown owned	58
264 Tararua Road	F	**Privately owned**	58
397 Arapaepae South Road	F	**Privately owned**	60
213 Muhunoa East Road^	E2	Within designation	61
480 Arapaepae South Road	E1	**Privately owned**	59
247A Muhunoa East Road^	E1	Within designation	61
679A State Highway 1	D2	**Privately owned**	59
679B State Highway 1	D2	**Privately owned**	59
95 Manakau Heights Drive^	C1	Within designation	61
75 Manakau Heights Drive	B3	**Privately owned**	61
170 State Highway 1^	A1	Within designation	59
82 State Highway 1*	A	Crown owned	60

294. A summary of the selected mitigation is shown in Figure B.29. Only the privately owned PPFs requiring investigation for building modification mitigation have been labelled.

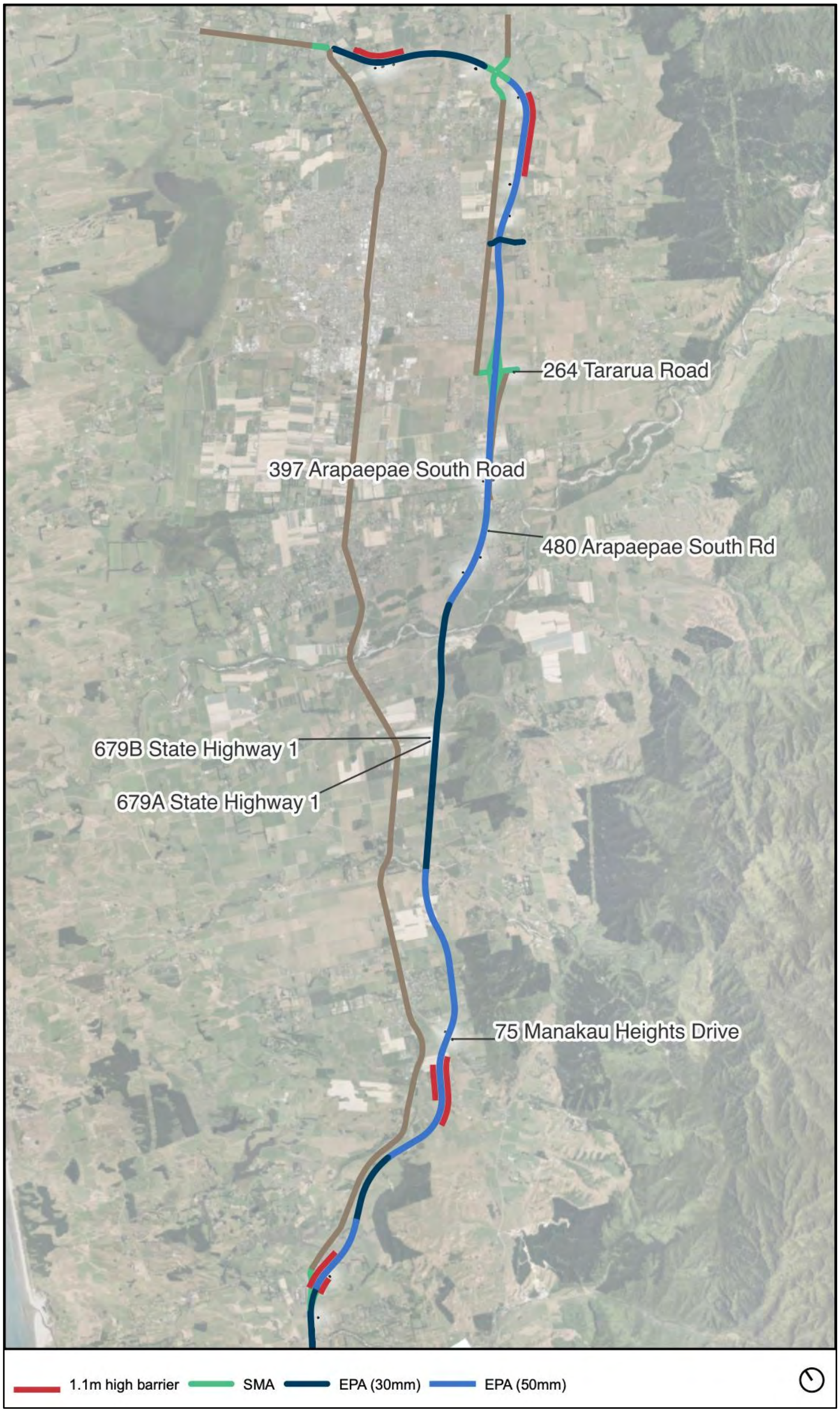


Figure B.29 Mitigation summary

Detailed Mitigation Options

295. While the overall layout of the Project's construction design will remain broadly in accordance with the application, the vertical and horizontal alignments of traffic lanes will almost certainly move within the designation during design development and refinement. This may result in minor changes to noise levels at PPFs and processes to ensure that any such change is appropriate will be included in conditions.

296. Waka Kotahi generally proposes conditions requiring that the predicted levels for the detailed design (Detailed Mitigation Options) maintain the same NZS 6806 category as the consenting design (Selected Options) or achieve a quieter category. That is, a Category B PPF can change to Category A, but not the other way, without going through a change management process whereby a suitably qualified expert with a holistic viewpoint (eg a planner) confirms whether the selected mitigation remains the BPO, or whether an adjustment is required considering the principles previously established for area.

297. I consider that a conditioned control of this form is an appropriate way of ensuring effects remain within the envelope of the application and as I have assessed them.

298. Waka Kotahi has a specification for noise mitigation (P40)[77] that it includes in contracts for capital projects. Part of this specification is that contractors must prepare a Noise Mitigation Plan ("**NMP**"). The NMP details how the noise mitigation design will comply with both designation conditions and other performance specifications (such as barrier performance and durability).

299. The NMP sets out:

    (a) Predicted noise levels at each PPF, and confirmation that predicted noise categories are maintained or enhanced through the detailed design process;

    (b) Design drawings for any noise barriers, including landscaping treatment; and

[77] NZ Transport Agency (2014) *NZTA P40 Specification for noise mitigation*.

(c) Specifications for the road surfaces, including a comparison of the noise performance to Selected Options.

300. I recommend that Waka Kotahi require the NMP to be peer reviewed by an independent acoustics expert at multiple stages throughout the Project design and construction process.

301. This will involve declarations by the designer and reviewer that the design meets the relevant performance requirements, prior to the final design being approved for construction. I consider this to be a robust process.

302. For any PPFs predicted in the detailed design to be in NZS 6806 Category B (new road), the following steps should occur:

(a) Waka Kotahi writes to the landowner requesting entry to the dwelling;

(b) If access is granted, an acoustics specialist inspects the building construction and performs sound insulation testing as appropriate;

(c) Waka Kotahi writes to the landowner setting out the identified mitigation option(s). In some instances, building modification may not be required to achieve internal noise levels below 40 dB $L_{Aeq(24h)}$ and in these cases this will be advised in writing;

(d) The landowner selects their preferred mitigation option (if multiple options are available), and the work is completed; and

(e) If the landowner does not agree to the offered mitigation, or respond to the above steps, then the requirements for building modification in accordance with the conditions are met.

303. It is common to perform post-construction noise monitoring to assist in validating the noise model after the project is open, however as set out in Research Report 446,[78] environmental noise measurements are subject to considerable uncertainty and are not the preferred method to confirm compliance with designation conditions. Monitoring also assists with community engagement.

304. Specification P40 includes a process for compliance verification which involves the as-built terrain contours and surveyed noise wall locations being

[78] Discussed further in NZ Transport Agency (2011) *Research Report 446 The variability of road traffic noise and implications for compliance with the noise conditions of roading designations*.

imported back into the acoustics model to confirm that screening assumed by the assessment has been maintained. Acoustics and pavement specialists will also verify that the installed mitigation matches the specifications.

Community engagement

305. If residents have an understanding of what noise and vibration to expect from the Project, this will help to reduce effects from both construction noise and vibration (discussed further in Section 9.10), and also from operational noise once the highway opens. In my experience this can, and needs, be effectively communicated to people face to face at the time actual information (such as machinery, mitigation options and timings) are known. For a long linear project there is also the opportunity for some people to visit various stages to gain an understanding of what is involved.

306. I recommend that the following information[79] is made available to the public:

(a) Links to general background information on sound, road-traffic noise, noise effects, mitigation, and frequently asked questions;

(b) A summary of Project designation condition requirements with respect to noise criteria and mitigation;

(c) A summary of noise mitigation options that were evaluated and reasons why the selected options were chosen;

(d) Details of who evaluated and selected the mitigation (eg independent experts), who approved the mitigation (eg RMA decision maker), and the role of the Road Controlling Authority in the selection (eg accepting recommendations);

(e) Maps showing predicted noise levels throughout the Project area, in the form of noise contours;

(f) Details of the noise mitigation to be implemented;

(g) Details of when the noise mitigation will be implemented and reasons for delayed implementation of any elements such as low noise surfaces;

[79] This list is based on a draft update to Specification P40.

(h) Tailored to specific locations, a lay person's description of what change people should expect to hear at their houses during and after construction, without reference to decibel noise levels or criteria;

(i) Details of the post-construction review of noise mitigation that will be conducted, and reasons why reliance is not placed on noise measurements, and

(j) Processes and contact details for raising concerns about noise, beyond the changes expected, including documenting details of specific noise disturbance.

307. This information should be provided to all identified PPFs within three months prior to construction, and again within one month prior to the road opening to traffic.

Construction noise and vibration management

308. Proactive management and consistent application of good construction behaviours is required to keep construction noise and vibration effects at acceptable levels.

309. This applies to all PPFs, but in particular those who have been identified as being at risk of exceeding noise and vibration limits.

310. Figure B.30 graphically shows the various aspects of construction noise and vibration management that will be adopted (through conditions and the CNVMP and its Schedules), to give effect to the principles discussed in detail above.

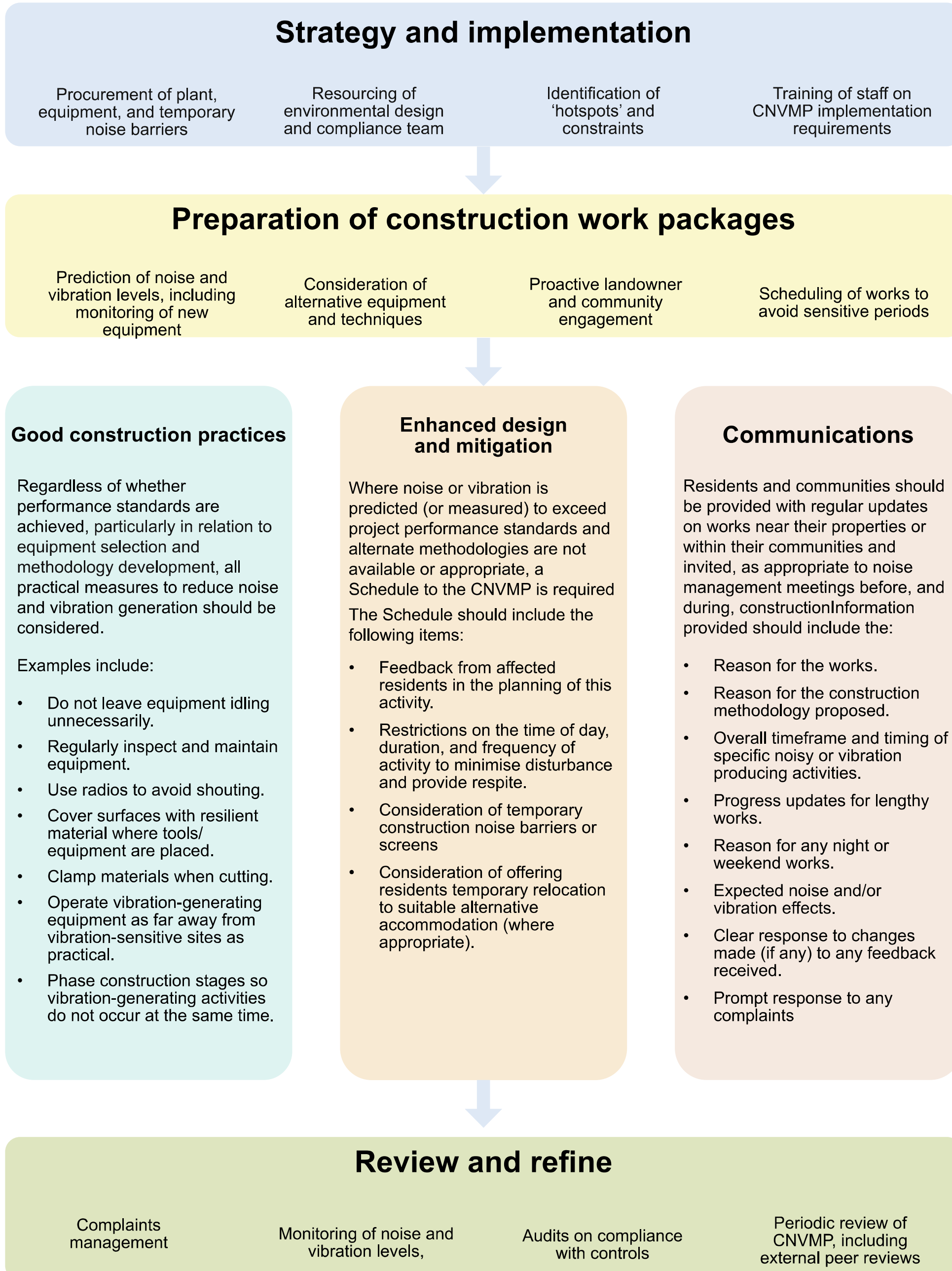


Figure B.30 Process for construction noise and vibration management

311. The contractor will have an overall Environmental Manager who is responsible for construction noise and vibration management and will be supported by a range of internal staff and external consultants. Staff will be trained on CNVMP implementation.

312. Noise and vibration should be considered when procuring equipment, for example ensuring all site vehicles have broadband reversing alarms rather than tonal beepers.

313. Prior to commencing work, the appointed contractor will need to establish their internal processes for converting the high-level design into individual work packages which are issued to teams for construction. This step is the key to managing effects, and it requires input from the right people at the right time.

314. During this process, the contractor will need to predict noise and vibration levels for this task. This can be done through a variety of means:

(a) Look-up table based on distances for given activities;

(b) Spreadsheets created for the contractor, with source levels for site equipment pre-populated;

(c) Maps showing where activities can be undertaken without restriction;

(d) The Waka Kotahi construction noise calculator;[80]

(e) Manually, using the relevant equations from the Waka Kotahi guide.

315. Where noise or vibration criteria are likely to be exceeded, a schedule to the CNVMP will be prepared which outlines the proposed works, predicted noise and/or vibration levels, mitigation required, and how this will be communicated to the affected parties. Schedules typically require approval by the contractor's environmental manager prior to works being undertaken.

316. I recommend that the conditions prescribe a quality assurance / audit requirement such that the initial schedules (and a percentage thereafter) are peer reviewed, to verify that they are meeting the objective of the Schedule and CNVMP (and therefore the designation conditions). Alternatively, the acoustic expert for the project could be agreed between the Applicant and the Consent Authorities. I consider this to be more appropriate than requiring individual Schedules to be certified by Council.

317. Regular communication with residents is essential to managing effects, residents should know who to speak to if they have any concerns.

318. Where night-time works are required and noise is predicted to be at a level where sleep disturbance is likely, temporary relocation of residents should be

[80] https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/tools/construction-noise-calculator/.

offered. Given that the majority of this Project will be constructed ‘offline’ this is not expected to be necessary.

319. Proposed conditions are attached as Appendix Fivet to Volume II and these should include the requirement that a CNVMP be prepared for the Ō2NL Project. The conditions specify the scope and process for development of the CNVMP. The CNVMP should be designed to be complementary to the appointed contractor’s processes.

320. Construction traffic has the potential for causing annoyance. Roads used for construction access may require ongoing maintenance to keep them free of potholes and other defects which could give rise to noise and vibration effects.

Conditions

321. A conditions framework is required to ensure that the processes detailed above occur. Specifically, the following actions are required in relation to operational noise:

(a) The form and extent of mitigation ("**Selected Options**") from this assessment design must be used as the starting point.

(b) The detailed design of mitigation should respond to the updated alignment and earthworks design. An acoustics specialist should predict noise levels at PPFs at the design year (2039). If PPFs change from Category A to B, a suitably qualified person (eg planner) must confirm that this change constitutes the Best Practicable Option.

(c) Audio Tactile Profile shall not be used within 200m of PPFs.

(d) Prior to the construction of any bridge with mechanical expansions joints, an inspection plan must be prepared to identify how compliance with Waka Kotahi specifications will be ensured.

(e) The CEDF must include road environment design principles to encourage vehicles to make gradual speed changes approaching and departing from the two roundabouts, and the Tararua Road Interchange.

(f) A Noise Mitigation Plan ("**NMP**") must be prepared, which provides:

(i) Predicted sound levels at each PPF.

(ii) Predicted noise categories in this report are maintained.

(iii) Design drawings for any noise barriers.

(iv) Specifications for road surfaces.

(g) Noise mitigation is to be constructed in accordance with the NMP.

(h) Immediately prior to opening, the likely change in noise environment is communicated to the public along with supporting information, particularly regarding temporary effect.

(i) A post-construction review is performed to confirm noise mitigation has been installed as designed.

322. The proposed conditions refer to Waka Kotahi Specification P40 as this document spells out the design and documentation processes required in more detail than is appropriate to specify directly in conditions. I note that Specification P40 is currently being reviewed by Waka Kotahi and is expected to be finalised prior to the hearing. The proposed conditions should be reviewed when the update to Specification P40 is published.

323. While the condition framework only required the BPO to be reconfirmed if a PPF changes NZS 6806 category, I consider the requirement to implement the Selected Options will result in operational noise effects remaining consistent with what I have assessed.

324. In regards to construction noise and vibration, I recommend that conditions require:

(a) A CNVMP to be prepared with the objective that it provides a framework for the development and implementation of the BPO for the management and minimisation of noise and vibration effects *and* to achieve the noise and vibration limits (set within the conditions themselves) to the extent practicable.

(b) The CNVMP will set out how noise and vibration is considered in the construction design process, with clear roles and responsibilities for Waka Kotahi and the appointed contractor.

(c) The CNVMP should be prepared by an independent consultant prior to being issued to the Council(s) for certification.

(d) Where any noise of vibration limit is predicted (or measured) to be exceeded, then the conditions shall set out the available responses and a Schedule to the CNVMP shall be prepared.

(e) The objective of that Schedule shall be to set out the BPO for the management of noise and/or vibration effects of the specific works activity and the specific characteristics of the site and receivers.

(f) A mechanism for residents being offered temporary relocation if noise and/or vibration levels warrant it.

(g) Regular community engagement and provision of relevant information.

(h) A quality programme (schedule of inspections, audits and reviews of plan and plan implementation).

325. The Construction Traffic Management Plan ("**CTMP**"), when drafted, should include methods to minimise heavy construction traffic passing through communities on local roads, including avoidance of heavy construction traffic passing through communities on local roads at night other than oversized loads and essential deliveries.

ASSESSMENT OF RESIDUAL EFFECTS

Operational noise

326. This part of my assessment considers residual effects. That is, the noise effects given the selection of BPO mitigation described in the preceding sections.

327. These residual effects are assessed with reference to performance standards (NZS 6806 and 2018 WHO Guidelines), the likely subjective response of affected people, and to a quantitative assessment of long-term health effects (DALYs). I have also considered the benefits of the project.

Summary of noise levels

328. Predicted noise levels at each PPF are detailed in Appendix B.4 for each scenario, along with an indication of existing noise levels.

329. With the inclusion of the recommended mitigation, the number of PPFs in each exposure category is shown in Table B.30, with comparison on the unmitigated scenario. This table covers only the PPFs not currently exposed to significant road traffic noise from the existing state highways.

Table B.30 Number of PPFs in categories (New Roads Only)

Scenario	WHO thresholds		NZS 6806 Categories		
	<= 50 dB	>50 dB	Cat A	Cat B	Cat C
Ō2NL without specific mitigation (2039)	81	195	227	49	0
Ō2NL with Selected Options (2039)	109	167	255	21	0
Total	276		276		

330. As discussed earlier in this assessment, 15 of the 21 NZS 6806 Category B dwellings are either Crown owned or within the proposed designation corridor.

331. The 'mitigated' totals have been further broken down by community, for the Selected Options (mitigated) scenario only.

Table B.31 Number of PPFs in categories for Selected Options (New Roads Only)

Community	Health thresholds		NZS 6806 Categories		
	<= 50 dB	>50 dB	Cat A	Cat B	Cat C
North East Levin	9	17	22	4	0
Levin East	21	28	46	3	0
Ohau East	34	39	65	8	0
Manakau	40	69	105	4	0
North Ōtaki	5	14	17	2	0
Total	276		276		

332. The discussion of subjective response and long-term health effects below will put the numbers in these tables numbers in context.

333. The following table shows the change in noise environment for PPFs near the existing state highway network. The numbers of PPFs exceeding NZS 6806 Category A and the 50 dB health threshold are shown graphically in Figure B.31.

Table B.32 Number of PPFs in NZS 6806 categories (Existing Road Network)

Scenario	Heath thresholds		NZS 6806 Categories		
	<= 50 dB	>50 dB	Cat A	Cat B	Cat C
State highway network without Ō2NL Project					

Existing state highway network (2019)	248	993	1017	122	102
With the inclusion of PP2Ō (2029)	342	899	1063	100	78
With the inclusion of PP2Ō (2039)	244	997	1016	120	105
*State highway network with Ō2NL Project**					
Selected Options (2039)	561	680	1176	42	23
Total	1241		1241		

* excludes PPFs near the Ō2NL alignment, which previously were not exposed to state highway noise

334. This table shows:

(a) The number of PPFs exceeding 67 dB $L_{Aeq(24h)}$ (Category C) is predicted to reduce from 105 to 23 as a result of the Project. This is a reduction of 78%.

(b) The number of PPFs exceeding 64 dB $L_{Aeq(24h)}$ (Categories B and C combined) is predicted to reduce from 225 to 65 as a result of the Project. This is a reduction of 71%.

(c) The number of PPFs exceeding 50 dB $L_{Aeq(24h)}$ (WHO Guidelines) is predicted to reduce from 997 to 680 as a result of the Project. This is a reduction of 32%.

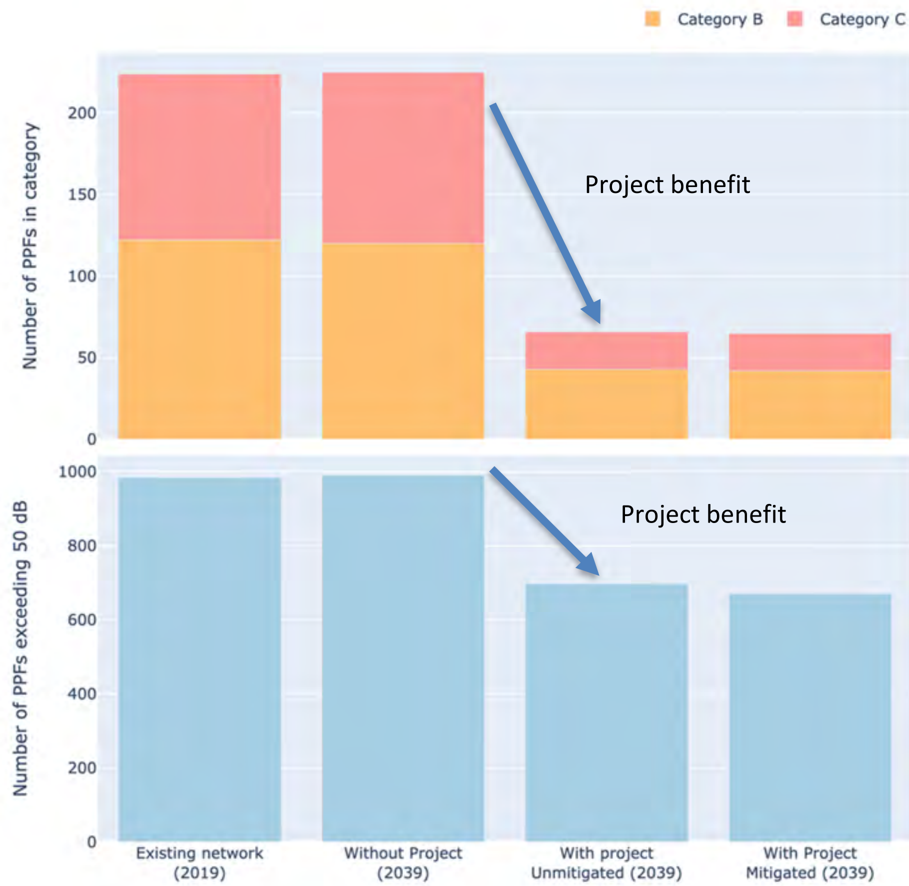


Figure B.31 Cumulative noise exposure for PPFs near existing state highways

Long term health effects

335. With the recommended mitigation, the number of PPFs exposed to noise levels from the Ō2NL Project levels over 50 dB will reduce from 146 to 123 (when compared to the without noise mitigation scenario). For those currently exposed to state highway noise, the number of PPFs exposed to noise levels from over 50 dB will reduce from 992 to 662.

336. I have estimated the population likely to experience long-term health effects from the Ō2NL Project using the methodology set out earlier in this report. The workings of this calculation are shown below. The 'population exposed' uses the predicted sound level at each PPF detailed in Appendix B.4 with an average of 2.7 people per PPF.

Table B.33 Population experiencing health effects (new roads only) – part 1

Noise level ($L_{Aeq(24h)}$)	Population exposed	Annoyance		Sleep Disturbance	
		Dose response	Population	Dose response	Population
50	68	10%	6.6	3%	2.0
51	73	10%	7.6	3%	2.3
52	57	11%	6.2	3%	1.9
53	62	12%	7.2	4%	2.3
54	41	12%	5.0	4%	1.6
55	59	13%	7.9	4%	2.5
56	32	14%	4.6	5%	1.5
57	16	15%	2.4	5%	0.8
58	11	16%	1.7	5%	0.6
59	16	17%	2.8	6%	0.9
60	16	18%	3.0	6%	1.0
61	5	20%	1.1	7%	0.4
62	0	21%	0.0	7%	0.0
63	0	22%	0.0	8%	0.0
Total	456.3		56.1		17.7

Table B.34 Population experiencing health effects (new roads only) – part 2

Noise level ($L_{Aeq(24h)}$)	Population exposed	Heart disease		Premature mortality due to heart disease	
		Dose response	Population	Dose response	Population
50	68	0.0%	0.0000	0.000%	0.00000
51	73	0.0%	0.0276	0.000%	0.00018
52	57	0.1%	0.0431	0.000%	0.00028
53	62	0.1%	0.0711	0.001%	0.00046
54	41	0.2%	0.0620	0.001%	0.00040
55	59	0.2%	0.1142	0.001%	0.00074
56	32	0.2%	0.0750	0.001%	0.00048
57	16	0.3%	0.0439	0.002%	0.00028
58	11	0.3%	0.0336	0.002%	0.00022
59	16	0.4%	0.0569	0.002%	0.00037
60	16	0.4%	0.0635	0.003%	0.00041
61	5	0.4%	0.0234	0.003%	0.00015
62	0	0.5%	0.0000	0.003%	0.00000
63	0	0.5%	0.0000	0.003%	0.00000
Total	456.3		0.61		0.0040

337. Combining the above populations with the disability weights from Table B.4 gives the following estimate of health outcomes in terms of the number of DALYs.

Table B.35 Estimation of health outcome from Ō2NL Project

Health outcome	Number of people likely to experience outcome	Disability weight	Disability Adjusted Life Years
Annoyance	56.1	0.02	1.123
Sleep disturbance	17.7	0.07	1.242
Ischaemic heart disease	0.61	0.405	0.249
Premature mortality due to IHD	0.0040	1	0.004
Total			**2.618**

338. The calculations for sleep disturbance assume that windows are ajar for ventilation. For well-treated buildings with windows closed, the number of DALYs for sleep disturbance (and thus the total) is likely to be overstated. My analysis is consistent with international reporting.

339. The results are presented in the table below alongside the burden of disease with and without the Project to people living adjacent the existing state highways in the Project area.

Table B.36 Comparison of the burden of disease from operational noise with and without the Ō2NL Project

	Burden of Disease (DALYs)		
Scenario	**From Ō2NL**	**From existing SH1/57**	**Total**
State highway network without Ō2NL Project			
Existing traffic volumes (2019)		18.7	18.7
Future traffic volumes (2039)		23.8	23.8
State highway network with Ō2NL Project			
Future traffic volumes (2039)	2.6	14.3	16.9

340. The DALYs in the table above Table B.36 represent a reduction compared to the current state highway network situation (16.9 DALYs) and the 2039 position without the Ō2NL Project (23.8 DALYs). While the Ō2NL Project is providing a net improvement in health effects due to road-traffic noise on a

population basis, caution should be used when combining positive and adverse health effects which relate to different people.

Subjective response

341. The Ō2NL Project will result in a change in noise environment for a number of communities along the route. The effect of this change will vary between individuals, depending on their own sensitivity to noise and how they currently use their spaces. This includes the layout of rooms and outdoor spaces, as well as any localised screening provided by buildings and other structures.

342. While there is no formula to determine the subjective response, I have estimated the likely response (from Table B.3) at each PPF based on absolute noise level and existing environment. To address the fact that the subjective response will vary from person to person (for the reasons outlined in paragraph 67) I have aggregated these responses to a community level, as shown in Table B.37. This is consistent with the analysis of to health effects.

Table B.37 Estimation of subject response (PPFs)

Community	**Present and not intrusive**	**Present and intrusive**	**Present and disruptive or very disruptive**
North East Levin	11	11	4
Levin East	25	21	3
Ohau East	42	24	7
Manakau	51	54	4
North Ōtaki	14	3	2
Total	**143**	**113**	**20**

343. Disruptive and very disruptive effects will generally correlate to the Category B PPFs, which have been identified in Table B.29.

344. The following heatmap shows the areas where noise from the highway is likely to be intrusive or disruptive (including very disruptive).[81] The darker colours represent more PPFs affected.

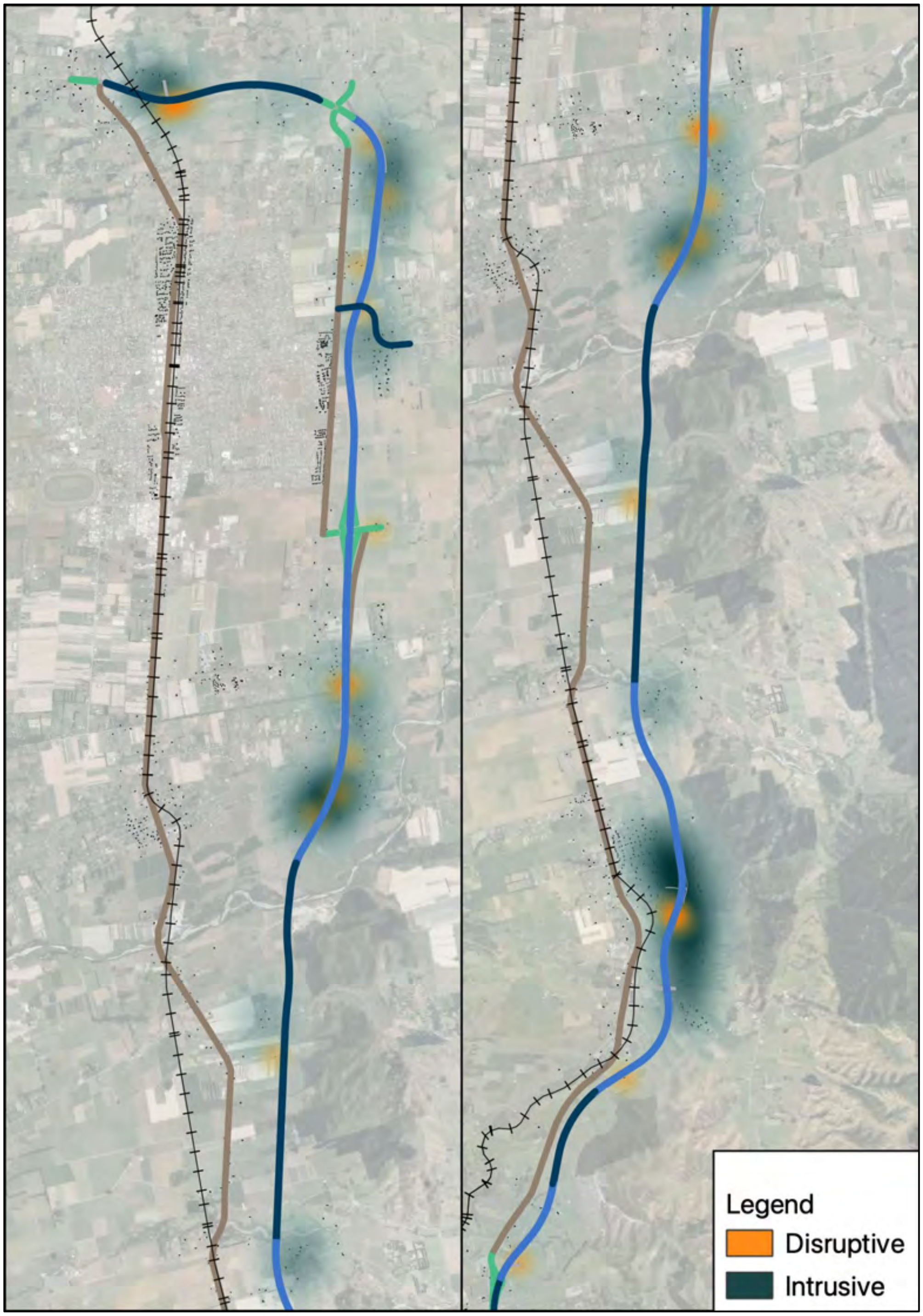


Figure B.32 Graphical representation of likely subjective response

[81] See above for examples of outcomes for each category.

Existing SH1 corridor including Levin Town Centre

345. The Ō2NL Project will result in positive noise effects to those communities adjacent to the existing SH1 and SH57 corridors because of:

(a) a reduction in the number of vehicle movements in general; and

(b) heavy vehicles being routed to the Ō2NL Project.

346. The typical reduction in noise level for PPFs along the SH1 corridor is 5-6 dB. The number of PPFs in each NZS 6806 Category and comparison to WHO criteria was presented in Table B.32. It showed the number of Category C dwellings dropping from 105 to 23, and the number exceeding 2018 WHO Guidelines from 997 to 680.

347. In an assessment against NZS 6806, the Levin main street precinct is not considered a noise-sensitive area. However, HDC's Transforming Taitoko / Levin Town Centre Strategy identifies that a pleasant acoustic environment is an important component of improving the vibrancy of the area. Without the Ō2NL Project, the number of vehicles using the main street is forecast to almost double from 2019 to 2039, including an extra 1000 heavy vehicles each day. With the Ō2NL Project, the 2039 traffic volumes remain similar to current levels, however a 47% reduction in heavy vehicles is predicted (refer to Technical Assessment A (Transport) for actual predicted volumes and details of change). This will improve the character of the noise environment in this area.

348. People are likely to find road-traffic noise less intrusive or disruptive, and the improved environment may allow more activities to be enjoyed at their property.

North-East Levin

349. While noise from existing SH1 is often audible in this area, it is also often quiet and there will be an appreciable increase in noise as a result of the Project. The extension of the safety barrier by the rail bridge will reduce noise to PPFs to the North on Sorenson Road. Noise levels are generally between 50-55 dB $L_{Aeq(24h)}$ and while they may be intrusive at times, these levels are compatible with residential use.

350. PPFs to the south overlooking the highway will have noise levels between 57-60 dB $L_{Aeq(24h)}$. Noise at these levels is likely to be disruptive at times and building modification mitigation will be investigated.

351. While only moderate noise levels (45-55 dB $L_{Aeq(24h)}$) are predicted for PPFs at the northern end of Fairfield Avenue, the residents will experience a change in environment such that noise may be intrusive at times, but I consider this to generally not be disruptive.

352. I anticipate a distribution of effects in the range as indicated in Figure B.33. I note that there is significant Crown ownership in this area. Residents who move in after the Project is completed will likely have a different response to the noise environment as compared with current residents, as they are moving in with the expectation of the highway being there.

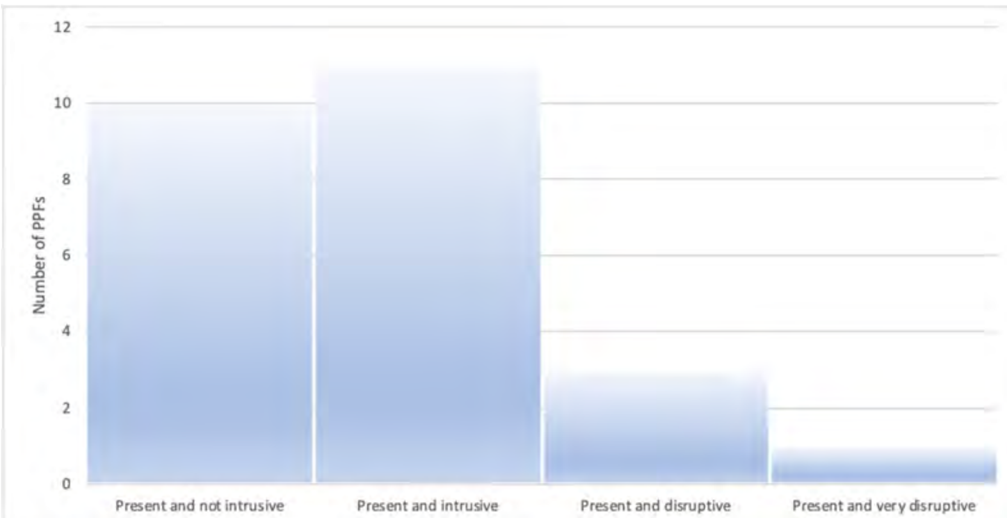


Figure B.33 Likely subjective response distribution – North East Levin

Levin East

353. For residents in the McDonald / Waihou Road area on the east of the highway, predicted noise levels from the Ō2NL Project are generally in the 50-57 dB range which will result in a distinct change from the existing noise environment which is mostly natural sounds. Road-traffic noise will often be intrusive and may, at times, be disruptive.

354. PPFs on Arapaepae Road will receive a reduction in noise as a result of the Project. For the majority of these PPFs, noise from Arapaepae Road will remain the dominant source, although may vary for certain aspects of properties where localised screening occurs.

355. Noise from the new highway is predicted to 50 dB or below for all Redwood Grove PPFs. While achieving NZS 6806 Category A and WHO criteria, highway noise will be present and at times may be intrusive. This area is expected to change from the current quiet rural residential environment to more of a suburban feel as the Tara-Ika development (HDC's Plan Change 4) is realised, which will bring an increase in traffic on local roads and will see the development of new roads. No additional noise mitigation is proposed.

356. The Prouse Homestead “Ashleigh” borders the designation and is approximately 110m from the road edge of the concept design. Noise levels at the ground level are predicted at 54 dB, and at 56 dB at the upper floor, with the inclusion of the high-performance road surface. Noise levels inside the dwelling are likely to be intrusive at times. Much of the western curtilage will experience noise levels between 55-60 dB. Road-traffic noise is likely expected to be either intrusive or disruptive to people using the outdoor spaces.

357. For the Tara-Ika site to the east of the new highway, the predicted noise levels from Ō2NL Project will be appropriate for this planned urban development. Noise levels for the section of Tara-Ika to the west of the highway are predominantly from Arapaepae Road. Therefore, no additional noise mitigation is proposed.

358. I anticipate a distribution of effects in the range as indicated in Figure B.34 below.

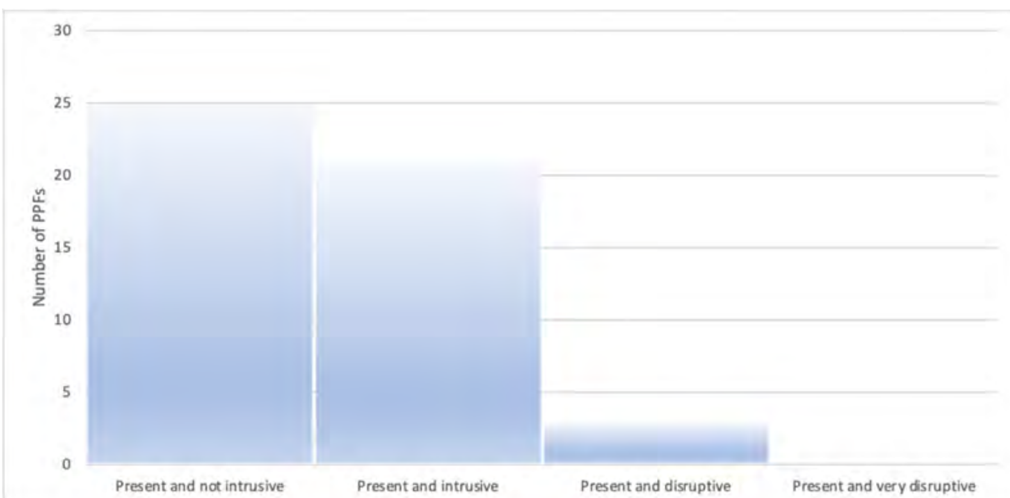


Figure B.34 Likely subjective response distribution – East Levin

Ohau East

359. Three PPFs near the Tararua Road interchange will experience a considerable increase in noise. However, this is predominantly from traffic on Tararua Road east of the highway and is an effect of the Tara-Ika development, rather than the Project. No further mitigation is therefore required.

360. PPFs on Kimberley Road east of the highway will notice a change in environment, with highway noise present, but not intrusive. No further mitigation is therefore required.

361. Between Kimberley Road and Muhunoa East Road, the PPFs on Arapaepae South Rd are close to the highway and have relatively high noise exposures. Several of these are currently identified as being needed to be acquired by the Project. Noise at these levels is likely to be disruptive and should these buildings be retained then building modification mitigation will be investigated for the Category B PPFs. For the remaining PPFs in this area, highway noise will be present and result in a change in environment. Noise may be intrusive at times for some PPFs but no additional noise mitigation is required.

362. At Kuku East and North Manakau, there are groups of PPFs that will experience a change in environment, which may at times be intrusive. No additional noise mitigation is required. There is the single Category B PPF which will be investigated for building modification.

363. I anticipate a distribution of effects in the range as indicated in Figure B.35.

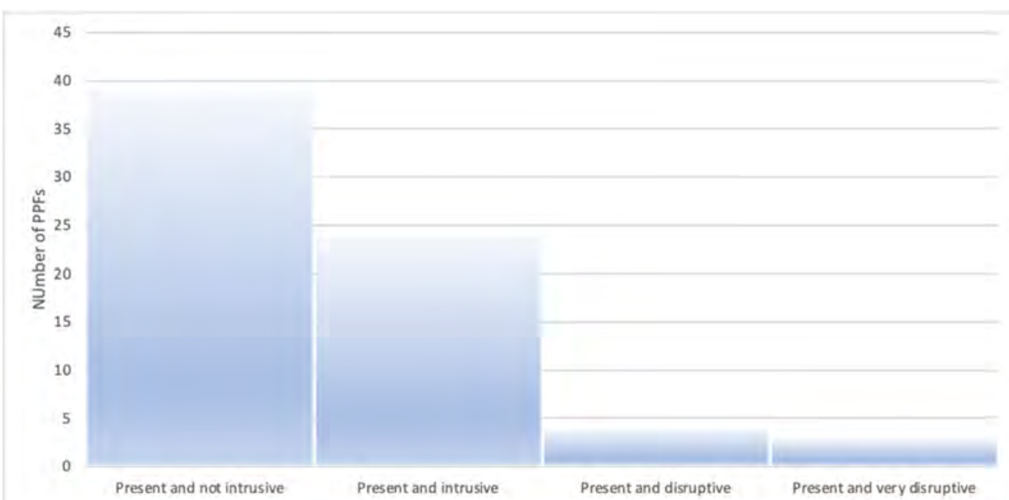


Figure B.35 **Likely subjective response distribution – Ohau East**

Manakau

364. In Manakau Village (Area C1) the properties are overlooking the expressway. The eastern-most are currently shielded from noise from the existing SH1, and with noise from Ō2NL the change in environment will be noticeable, but is only likely to be intrusive at times. For PPFs closer to Ihaka Hakuene Street, noise from the new highway is likely to be at comparable to noise from the existing SH1, although this may vary with localised screening at each property. While highway noise will be present, I expect that it should not be intrusive and no additional mitigation is proposed.

365. For PPFs in the Eastern Rise area through to Manakau Heights, the change in environment will be more significant. However, the noise levels are such that no additional mitigation is required aside from for two PPFs which I have scheduled for investigation for building treatment.

366. In the Mountain View area, there will be an increase in noise from the current environment. This traffic noise at the closest PPFs will be intrusive but is at levels such that no additional mitigation is needed. Further up Mountain View the environment will transition to distant traffic, which will be similar to the currently audible SH1 noise.

367. I anticipate a distribution of effects in the range as indicated in Figure B.36.

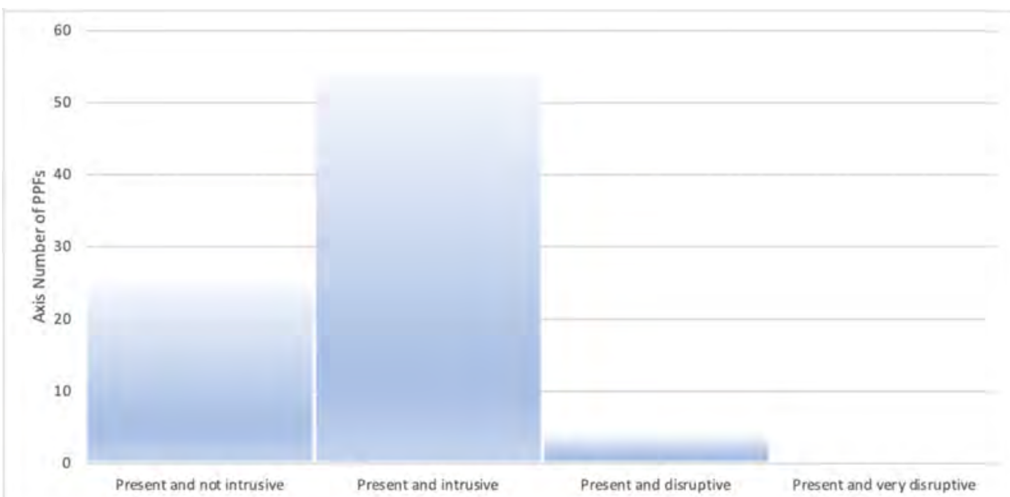


Figure B.36 Subjective response distribution – Manakau

North of Ōtaki

368. The topography is complex in this area with the highway generally below the surrounding PPFs. While PPFs in this area have a degree of existing road-traffic noise, there will be a change in environment and highway noise is likely to be intrusive at times such that further mitigation is not required. There are two PPFs scheduled for investigation for building modification.

369. I anticipate a distribution of effects in the range as indicated in Figure B.37.

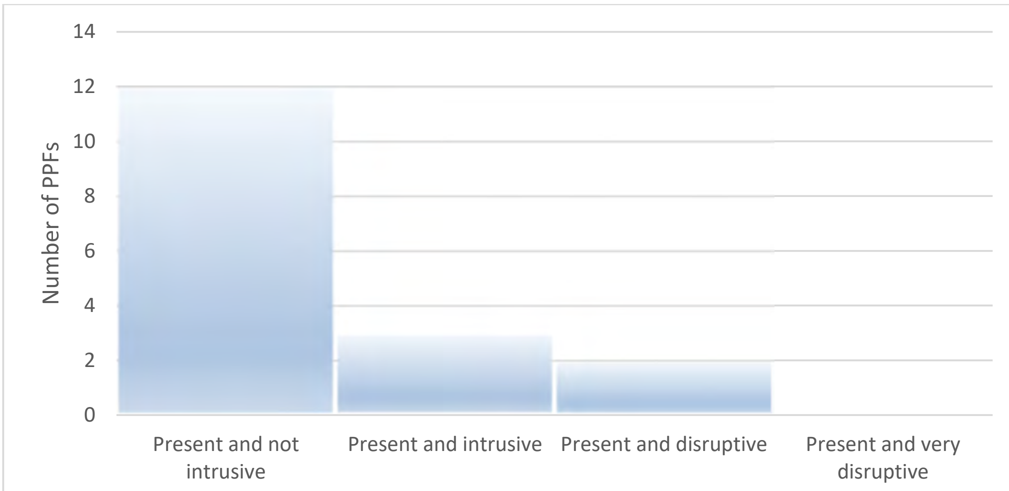


Figure B.37 Subjective response distribution – North Ōtaki

Temporary effects

370. The current road engineering pavement design does not allow construction of either the standard porous asphalt or the high-performance road surface prior to opening (refer to the DCR (Appendix 3, Volume II)). In this case, a chipseal surface would be installed for approximately 12 months, prior to the final asphalt being laid.

371. The current scenario is for an interim chipseal surface to be installed and used for the first year of the Ō2NL Project's operation. During this first year predicted noise levels will be up to 8 dB higher than those stated in my assessment.

372. Experience with other projects is that where this temporary effect is not effectively communicated, complaints from the community are likely. I have

recommended specific requirements for public engagement (above), which should also be addressed in the Noise Mitigation Plan.[82]

373. While it would be desirable from an effects perspective, if the engineering design precludes these, with effective communication, I consider that these temporary effects are reasonable. In many respects, I consider these effects similar to temporary effects during construction.

Operational vibration

374. While not quantified, by shifting traffic volumes to the new highway the Ō2NL Project will result in a reduction in the number of vibration events likely to cause disturbance to people living near existing SH1 and SH57.

375. As set out earlier in this report, there should be minimal adverse operational vibration effects from new roads constructed as part of the Ō2NL Project.

Construction noise and vibration

376. The Ō2NL Project is of a significant scale and will necessarily involve construction activity which is inherently noisy. As standard good practice, the construction industry uses well established and robust processes for managing noise and vibration, which I have discussed in detail above, and have recommended conditions specifying the use of this good practice. Accordingly, the assessment of construction noise and vibration effects from the Ō2NL Project is focused on identifying areas where enhanced mitigation, over and above standard practice might be necessary to maintain acceptable effects.

377. I have identified indicative construction activity, typical distances at which NZS 6803 criteria would be achieved, and the number of PPFs at risk of exceeding these criteria.

378. Due to the relatively sparse nature of PPFs around the majority of the proposed designation boundary, this assessment found that construction noise and vibration generated by daytime construction activities can generally be managed in a way that would meet the relevant criteria using standard site practices.

[82] Communication after construction will likely be the responsibility of Waka Kotahi rather than the contractor, however by inclusion in the NMP there is a mechanism for ensuring that a plan is in place.

379. There should not be significant night works near PPFs, other than potentially short-term activity that may be required to connect to the existing road network without causing daytime traffic disruption, or continuous concrete pours. Therefore, any potential sleep disturbance effects should be limited. If night works are required, construction activity will need to be significantly limited or specific mitigation methods adopted to manage effects.

380. Construction noise and vibration will be heard and felt respectively at many locations in the vicinity of the Project. Noise and vibration will often be significantly above existing ambient levels and will cause some disturbance and change to rural amenity during relevant construction periods.

381. However, on the basis of the predicted noise and vibration levels and the mitigation measures that I have detailed, it is my opinion that noise and vibration levels can be managed to generally maintain compliance with relevant limits. I consider the limits adopted, such as from NZS 6803, will provide appropriate protection for neighbouring activities including PPFs.

382. Noise and vibration from construction traffic using public roads should be reasonable, provided the conditions of the CTMP are followed.

M Smith

Michael Smith
14 October 2022

APPENDIX B.1: ACOUSTICS TERMS AND ABBREVIATIONS

Abbreviation	Term
AADT	Average Annual Daily Traffic
AEE	Assessment of Effects on the Environment
BCR	Benefit to Cost Ratio
BPO	Best Practicable Option
CEDF	Cultural and Environmental Design Framework
CEMP	Construction Environment Management Plan
CH	Chainage
CNVMP	Construction Noise and Vibration Management Plan
CTMP	Construction Traffic Management Plan
dB	Decibel
DBC	Detailed Business Case
HCV	Heavy Commercial Vehicles
HDC	Horowhenua District Council
IBC	Indicative Business Case
KCDC	Kāpiti Coast District Council
km	Kilometre(s)
km/h	Kilometres per hour
$L_{Aeq(24h)}$	Time-average noise level over a 24-hour period
L_{Afmax}	Maximum noise level
L_{den}	Community noise level
L_{night}	Time-average noise level between 2300-0700h
m	Metre(s)
MCA	Multi-Criteria Analysis
NoR	Notice of Requirement
Ō2NL	The Ōtaki to North of Levin Project
PP2Ō	Peka Peka to Ōtaki highway project
PPV	Peak Particle Velocity (vibration)
Requiring Authority	Has the same meaning as section 166 of the RMA and, in the case of the NoRs, is Waka Kotahi New Zealand Transport Agency
RONS	Roads of National Significance
RMA	Resource Management Act 1991
SH1	State Highway 1
SH57	State Highway 57
SNP	Safe Networks Programme
SUP	Shared Use Path

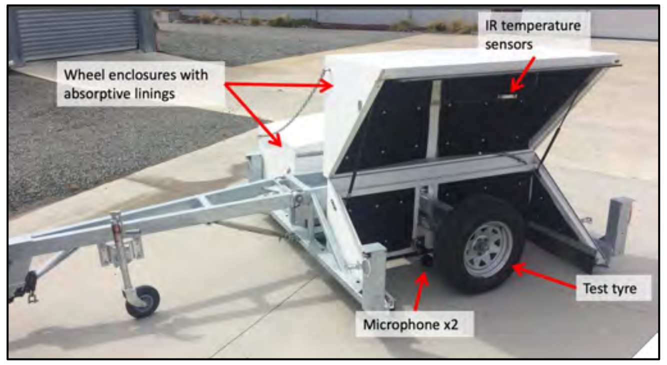
Abbreviation	Term
VPD	Vehicles per day
VPH	Vehicles per hour
Waka Kotahi	Waka Kotahi New Zealand Transport Agency
WHO	World Health Organisation

APPENDIX B.2: NOISE HIERARCHY FROM UK PLANNING DOCUMENT 005

Response	Examples of outcomes	Increasing effect level	Action
No Observed Effect Level			
Not present	No Effect	No Observed Effect	No specific measures required
No Observed Adverse Effect Level			
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

APPENDIX B.3: ACOUSTICS DESIGN PRINCIPLES

Acoustics design principles



Low noise road surface

Waka Kotahi has an active road surface research programme, trying to both reduce noise generation and also to increase longevity of surfaces.

The use of low-noise road surfaces is the best opportunity to mitigate at source. For this project, Open Graded Porous Asphalt (OGPA) is the default surface.

Allowance for high-performance (40-50mm thick) surfaces should be made.

Avoid noisy road features

Audio tactile profile (rumble strips) are known source of annoyance, even at significant distances from the road. ATP should not be part of the safety strategy for the project.

Surfacing should be continuous over bridges where no mechanical joints are required. Any bridge joints should be a low-noise type. The bridge joint types on M2PP were inappropriately installed, and effects were not assessed.

Integrate with landform

Noise emissions can be reduced by having the road depressed to the surrounding terrain (ie. in cut) or having bunds on the perimeter of the road.

Screen elevated segments

Where the road is elevated above natural ground level (for example on the approach to bridges) concrete safety barriers should be included in the road design.

Encourage free-flowing traffic

Road layout and features should be designed to minimise acceleration braking, and lane changes. These factors contribute to excessive noise from individual vehicles.

Road users need to transition from a high-speed environment to the two at-grade roundabouts at SH57 and northern SH1 interchanges.

Shared Use Path

Where the shared user path is nearby the road corridor, this can potentially be used to screen the road from the surrounding environment.

In addition, this should be designed to be a pleasant space for users of the path

Innovative roundabout design

Innovation is required to match vehicle speed profiles with the design speed of the roundabouts, and encourage smooth deceleration.

Integrated design for Tara-Ika

The development has a number of significant design challenges.

APPENDIX B.4: TABLE OF PREDICTED NOISE LEVELS

Ōtaki to North of Levin

Appendix B4: Predicted noise levels

This table provides predicted road-traffic noise levels as dB $L_{Aeq(24h)}$ using the methodology set out in Section 7.2 of Technical Report B.

Where the existing noise environment is not dominated by road-traffic noise (<50 dB $L_{Aeq(24h)}$), the acoustic environment is expressed as a range of noise levels based on measurements and observations in each area. Future non-traffic noise levels are not estimated, and are marked with "Note 1" in the table

Legend

NZS 6806 Category A
NZS 6806 Category B

* PPF is Crown owned

^ PPF is within the proposed designation

Area	Address	Type	Existing (2019)	With PP2O (2029)	Without Ō2NL (2039)	Ō2NL without specific mitigation (2039)	Ō2NL with Selected Options (2039)
L1	64 Sorenson Road*	New	50-55	Note 1	Note 1	57	55
L1	46 Sorenson Road	New	50-55	Note 1	Note 1	51	51
L1	44 Sorenson Road	New	50-55	Note 1	Note 1	51	51
L1	40 Sorenson Road	New	50-55	Note 1	Note 1	49	49
L1	47 Sorenson Road	New	50-55	Note 1	Note 1	50	50
L1	56 Sorenson Road	New	50-55	Note 1	Note 1	54	54
L1	42 Sorenson Road	New	50-55	Note 1	Note 1	52	52
L1	68 Sorenson Road*	New	50-55	Note 1	Note 1	58	56
L2	82 Sorenson Road^	New	50-55	Note 1	Note 1	62	62
L2	72 Sorenson Road*	New	50-55	Note 1	Note 1	59	59
L2	66 Sorenson Road*	New	50-55	Note 1	Note 1	58	58
L	165 Fairfield Road	New	45-55	Note 1	Note 1	45	45
L	157 Fairfield Road	New	45-55	Note 1	Note 1	45	45
L	25 Heatherlea East Road	New	50	49	50	49	46
L	46 Heatherlea East Road	New	45-55	Note 1	Note 1	49	48
L	21 Heatherlea East Road	New	55	53	55	55	53
L	278 Heatherlea East Road	New	45-55	Note 1	Note 1	48	48
L	161 Fairfield Road	New	45-55	Note 1	Note 1	55	55
L	319 Arapaepae Road	New	53	51	53	54	54
L	168A Fairfield Road	New	45-55	Note 1	Note 1	47	47
L	167 Fairfield Road	New	45-55	Note 1	Note 1	48	48
L	168 Fairfield Road	New	45-55	Note 1	Note 1	44	44
L	174 Fairfield Road^	New	45-55	Note 1	Note 1	52	52
L	172 Fairfield Road*	New	45-55	Note 1	Note 1	58	58
L	163 Fairfield Road	New	45-55	Note 1	Note 1	52	52

Area	Address	Type	Existing (2019)	With PP2O (2029)	Without Ō2NL (2039)	Ō2NL without specific mitigation (2039)	Ō2NL with Selected Options (2039)
L	60 Sorenson Road^	New	45-55	Note 1	Note 1	53	52
L	1 Koputaroa Road	Altered	65	63	65	65	55
H1	32 McDonald Road*	New	47-52	Note 1	Note 1	60	56
H1	54 Waihou Road	New	47-52	Note 1	Note 1	59	55
H1	70 Waihou Road	New	47-52	Note 1	Note 1	57	54
H1	73 Wakefield Road	New	47-52	Note 1	Note 1	52	50
H1	106 Waihou Road	New	47-52	Note 1	Note 1	55	52
H1	92 Waihou Road	New	47-52	Note 1	Note 1	57	54
H1	48 Waihou Road	New	47-52	Note 1	Note 1	51	49
H1	38 McDonald Road	New	47-52	Note 1	Note 1	54	52
H1	42 Waihou Road	New	47-52	Note 1	Note 1	59	57
H1	40 Waihou Road	New	47-52	Note 1	Note 1	58	55
H1	118 Waihou Road	New	47-52	Note 1	Note 1	59	54
H1	100 Waihou Road	New	47-52	Note 1	Note 1	55	52
H1	82 Waihou Road	New	47-52	Note 1	Note 1	61	56
H1	73A Wakefield Road	New	47-52	Note 1	Note 1	49	48
H	24 McDonald Road^	New	52	51	52	62	60
H	45 McDonald Road	New	47-52	Note 1	Note 1	55	53
H	27 Redwood Grove	New	47-52	Note 1	Note 1	48	47
H	1051 Queen Street East	New	47-52	Note 1	Note 1	51	49
H	98 Arapaepae Road	New	54	52	54	56	54
H	1033 Queen Street East	New	51	50	55	55	54
H	74 Arapaepae Road	New	57	56	57	57	56
H	96 Arapaepae Road^	New	52	50	52	60	58
H	11 Redwood Grove	New	47-52	Note 1	Note 1	49	47

Area	Address	Type	Existing (2019)	With PP2O (2029)	Without Ō2NL (2039)	Ō2NL without specific mitigation (2039)	Ō2NL with Selected Options (2039)
H	132 Waihou Road*	New	51	50	51	57	55
H	333 Arapaepae Road	New	54	53	54	55	55
G1	1046 Queen Street East	New	40-50	Note 1	Note 1	54	53
G1	31 Redwood Grove	New	40-50	Note 1	Note 1	48	46
G1	26 Redwood Grove	New	40-50	Note 1	Note 1	51	49
G1	20 Redwood Grove	New	40-50	Note 1	Note 1	50	49
G1	38 Redwood Grove	New	40-50	Note 1	Note 1	50	48
G1	32 Redwood Grove	New	40-50	Note 1	Note 1	50	48
G1	1040 Queen Street East	New	40-50	Note 1	Note 1	52	51
G1	39 Redwood Grove	New	40-50	Note 1	Note 1	48	46
G1	37 Redwood Grove	New	40-50	Note 1	Note 1	48	46
G1	1024 Queen Street East	New	53	53	56	59	57
G1	43 Redwood Grove	New	40-50	Note 1	Note 1	48	47
G1	22 Redwood Grove	New	40-50	Note 1	Note 1	52	50
G1	131 Arapaepae South Road^	New	40-50	Note 1	Note 1	59	57
G1	21 Redwood Grove	New	40-50	Note 1	Note 1	49	47
G1	15 Redwood Grove	New	40-50	Note 1	Note 1	49	47
G1	1052 Queen Street East	New	40-50	Note 1	Note 1	52	51
G1	42B Redwood Grove	New	40-50	Note 1	Note 1	51	49
G1	42A Redwood Grove	New	40-50	Note 1	Note 1	51	49
G	48 Arapaepae Road^	New	53	51	53	63	61
G	1041 Queen Street East	New	40-50	Note 1	Note 1	53	52
G	1068 Queen Street East	New	40-50	Note 1	Note 1	48	47
G	1070 Queen Street East	New	40-50	Note 1	Note 1	47	46
G	1063 Queen Street East	New	40-50	Note 1	Note 1	48	46

Area	Address	Type	Existing (2019)	With PP2O (2029)	Without Ō2NL (2039)	Ō2NL without specific mitigation (2039)	Ō2NL with Selected Options (2039)
G	1071 Queen Street East	New	40-50	Note 1	Note 1	50	49
F2	205 Arapaepae South Road	Altered	66	66	66	63	63
F1	313 Arapaepae South Road	New	54	54	54	58	56
F1	334 Arapaepae South Road	Altered	61	61	61	50	48
F1	353 Arapaepae South Road	New	62	62	62	59	57
F1	372 Arapaepae South Road*	New	55	55	55	56	54
F1	307 Arapaepae South Road	New	57	57	57	54	52
F1	370 Arapaepae South Road*	New	55	55	55	52	50
F1	366 Arapaepae South Road*	New	57	57	57	55	53
F1	345 Arapaepae South Road	New	63	63	63	59	57
F1	321 Arapaepae South Road	Altered	64	64	64	53	51
F1	324 Arapaepae South Road	Altered	65	65	65	51	49
F1	194 Kimberley Road	Altered	64	64	64	50	48
F1	326 Arapaepae South Road	Altered	59	59	59	49	47
F1	312 Arapaepae South Road	Altered	62	62	62	49	47
F1	380 Arapaepae South Road*	New	40-45	Note 1	Note 1	57	55
F1	363 Arapaepae South Road*	New	56	56	56	61	58
F1	390 Arapaepae South Road*	New	40-45	Note 1	Note 1	61	59
F1	361 Arapaepae South Road*	New	59	59	59	60	58
F1	378 Arapaepae South Road*	New	52	52	52	58	55
F1	315 Arapaepae South Road	Altered	65	65	65	51	49
F	249 Tararua Road	New	40-45	Note 1	Note 1	56	56
F	259 Kimberley Road	New	40-45	Note 1	Note 1	51	49
F	269 Kimberley Road	New	40-45	Note 1	Note 1	49	47
F	273D Kimberley Road	New	40-45	Note 1	Note 1	48	46

Area	Address	Type	Existing (2019)	With PP2O (2029)	Without Ō2NL (2039)	Ō2NL without specific mitigation (2039)	Ō2NL with Selected Options (2039)
F	273C Kimberley Road	New	40-45	Note 1	Note 1	49	47
F	273A Kimberley Road	New	40-45	Note 1	Note 1	50	48
F	248 Kimberley Road	New	40-45	Note 1	Note 1	53	51
F	264 Kimberley Road	New	40-45	Note 1	Note 1	50	48
F	264 Tararua Road	New	40-45	Note 1	Note 1	58	58
F	273B Kimberley Road	New	40-45	Note 1	Note 1	50	48
F	273E Kimberley Road	New	40-45	Note 1	Note 1	50	49
F	273 Kimberley Road	New	40-45	Note 1	Note 1	47	45
F	267 Tararua Road	New	40-45	Note 1	Note 1	49	49
F	397 Arapaepae South Road	New	40-45	Note 1	Note 1	62	60
F	249 Arapaepae South Road	New	59	59	59	52	51
F	397A Arapaepae Road South	New	40-45	Note 1	Note 1	58	56
E2	195 Muhunoa East Road	New	40-50	Note 1	Note 1	55	53
E2	213A Muhunoa East Road	New	40-50	Note 1	Note 1	57	55
E2	194 Muhunoa East Road	New	40-50	Note 1	Note 1	56	54
E2	211 Muhunoa East Road	New	40-50	Note 1	Note 1	53	51
E2	213 Muhunoa East Road^	New	40-50	Note 1	Note 1	63	61
E2	205 Muhunoa East Road	New	40-50	Note 1	Note 1	59	57
E2	213 Muhunoa East Road	New	40-50	Note 1	Note 1	59	57
E2	213D Muhunoa East Road	New	40-50	Note 1	Note 1	54	52
E2	211A Muhunoa East Road	New	40-50	Note 1	Note 1	51	49
E2	211B Muhunoa East Road	New	40-50	Note 1	Note 1	49	47
E2	197 Muhunoa East Road	New	40-50	Note 1	Note 1	54	52
E1	245 Muhunoa East Road	New	40-50	Note 1	Note 1	56	54
E1	514 Arapaepae South Road	New	40-50	Note 1	Note 1	54	51

Area	Address	Type	Existing (2019)	With PP2O (2029)	Without Ō2NL (2039)	Ō2NL without specific mitigation (2039)	Ō2NL with Selected Options (2039)
E1	530 Arapaepae South Road	New	40-50	Note 1	Note 1	49	46
E1	496 Arapaepae South Road	New	40-50	Note 1	Note 1	54	52
E1	247 Muhunoa East Road	New	40-50	Note 1	Note 1	58	55
E1	520 Arapaepae South Road	New	40-50	Note 1	Note 1	50	48
E1	480 Arapaepae South Road	New	40-50	Note 1	Note 1	61	59
E1	523 Arapaepae South Road	New	40-50	Note 1	Note 1	47	45
E1	461 Arapaepae South Road	New	40-50	Note 1	Note 1	47	45
E1	429 Arapaepae South Road	New	40-50	Note 1	Note 1	58	56
E1	6 Riveredge Terrace	New	40-50	Note 1	Note 1	51	49
E1	413 Arapaepae South Road	New	40-50	Note 1	Note 1	54	52
E1	481 Arapaepae South Road	New	40-50	Note 1	Note 1	48	46
E1	465 Arapaepae South Road	New	40-50	Note 1	Note 1	51	49
E1	507 Arapaepae South Road	New	40-50	Note 1	Note 1	49	47
E1	495 Arapaepae South Road	New	40-50	Note 1	Note 1	49	47
E1	242 Muhunoa East Road^	New	40-50	Note 1	Note 1	55	53
E1	17 Riveredge Terrace	New	40-50	Note 1	Note 1	50	47
E1	437 Arapaepae South Road	New	40-50	Note 1	Note 1	53	51
E1	435 Arapaepae South Road	New	40-50	Note 1	Note 1	53	51
E1	247A Muhunoa East Road^	New	40-50	Note 1	Note 1	63	61
E1	517 Arapaepae South Road	New	40-50	Note 1	Note 1	48	45
E1	459 Arapaepae South Road	New	40-50	Note 1	Note 1	51	49
E1	265 Muhunoa East Road	New	40-50	Note 1	Note 1	51	49
E1	501 Arapaepae South Road	New	40-50	Note 1	Note 1	48	46
E1	480A Arapaepae South Road	New	40-50	Note 1	Note 1	55	52
E1	28 Riveredge Terrace	New	40-50	Note 1	Note 1	47	45

Area	Address	Type	Existing (2019)	With PP2O (2029)	Without Ō2NL (2039)	Ō2NL without specific mitigation (2039)	Ō2NL with Selected Options (2039)
E1	20 Riveredge Terrace	New	40-50	Note 1	Note 1	50	48
E1	521 Arapaepae Road South	New	40-50	Note 1	Note 1	46	44
E1	26 Riveredge Terrace	New	40-50	Note 1	Note 1	48	46
E	218 McLeavey Road	New	40-50	Note 1	Note 1	52	50
E	197 McLeavey Road	New	40-50	Note 1	Note 1	47	45
E	198 McLeavey Road	New	40-50	Note 1	Note 1	46	44
E	207 McLeavey Road	New	40-50	Note 1	Note 1	48	46
D2	65 Kuku East Road	New	40-50	Note 1	Note 1	54	54
D2	61 Kuku East Road	New	40-50	Note 1	Note 1	51	51
D2	63 Kuku East Road	New	40-50	Note 1	Note 1	53	53
D2	679A State Highway 1	New	40-50	Note 1	Note 1	59	59
D2	62 Kuku East Road^	New	40-50	Note 1	Note 1	51	51
D2	679B State Highway 1	New	40-50	Note 1	Note 1	59	59
D1	121A North Manakau Road	New	40-50	Note 1	Note 1	56	55
D1	119 North Manakau Road	New	40-50	Note 1	Note 1	51	50
D1	90 North Manakau Road	New	40-50	Note 1	Note 1	52	50
D1	123 North Manakau Road	New	40-50	Note 1	Note 1	51	50
D1	94 North Manakau Road	New	40-50	Note 1	Note 1	53	52
D1	76 North Manakau Road*	New	40-50	Note 1	Note 1	56	54
D1	137 North Manakau Road	New	40-50	Note 1	Note 1	51	51
D1	137 North Manakau Road	New	40-50	Note 1	Note 1	49	49
D1	101 North Manakau Road	New	40-50	Note 1	Note 1	57	55
D	37 Martins Road	New	40-50	Note 1	Note 1	45	45
D	51 North Manakau Road	New	40-50	Note 1	Note 1	52	50
D	46 North Manakau Road	New	40-50	Note 1	Note 1	50	48

Area	Address	Type	Existing (2019)	With PP2O (2029)	Without Ō2NL (2039)	Ō2NL without specific mitigation (2039)	Ō2NL with Selected Options (2039)
D	861 State Highway 1	New	54	52	54	52	51
D	180 North Manakau Road	New	40-50	Note 1	Note 1	40	40
D	47 Martins Road	New	40-50	Note 1	Note 1	46	45
D	13 North Manakau Road	New	54	52	54	52	51
D	883 State Highway 1	New	54	52	54	52	51
D	43 North Manakau Road	New	51	49	50	50	48
D	35 North Manakau Road	New	53	51	52	48	47
D	25 Martins Road	New	40-50	Note 1	Note 1	45	44
D	19 Martins Road	New	40-50	Note 1	Note 1	41	41
D	677A State Highway 1	New	40-50	Note 1	Note 1	55	55
D	685 State Highway 1*	New	40-50	Note 1	Note 1	53	53
C2	29 Eastern Rise	New	40-50	Note 1	Note 1	56	54
C2	29B Eastern Rise	New	40-50	Note 1	Note 1	58	56
C2	32 Eastern Rise	New	40-50	Note 1	Note 1	56	53
C2	108 Manakau Heights Drive^	New	40-50	Note 1	Note 1	58	56
C2	90 Manakau Heights Drive	New	40-50	Note 1	Note 1	54	52
C2	30 Eastern Rise	New	40-50	Note 1	Note 1	55	52
C2	29A Eastern Rise	New	40-50	Note 1	Note 1	57	55
C2	59 Wi Tako Street*	New	40-50	Note 1	Note 1	57	55
C1	1 Ihaka Hakuene Street	New	40-50	Note 1	Note 1	51	49
C1	31 Ihaka Hakuene Street	New	51	49	50	49	47
C1	1 Honoiti Ranapiri Place	New	50	48	49	52	50
C1	42 Wi Tako Street	New	40-50	Note 1	Note 1	52	50
C1	5 Honoiti Ranapiri Place	New	40-50	Note 1	Note 1	55	53
C1	119 Honi Taipua Street	New	56	55	56	55	54

Area	Address	Type	Existing (2019)	With PP2O (2029)	Without Ō2NL (2039)	Ō2NL without specific mitigation (2039)	Ō2NL with Selected Options (2039)
C1	141 Manakau Heights Drive	New	56	55	56	55	54
C1	107 Honi Taipua Street	New	55	54	55	50	50
C1	53 Wi Tako Street	New	40-50	Note 1	Note 1	56	53
C1	95 Manakau Heights Drive^	New	51	50	51	64	61
C1	117 Honi Taipua Street	New	55	54	55	57	55
C1	3 Ihaka Hakuene Street	New	40-50	Note 1	Note 1	50	48
C1	43 Tame Porati Street	New	51	49	50	48	47
C1	47 Tame Porati Street	New	40-50	Note 1	Note 1	57	54
C1	46 Wi Tako Street	New	40-50	Note 1	Note 1	56	54
C1	45 Wi Tako Street	New	50	48	49	56	54
C1	50 Wi Tako Street*	New	40-50	Note 1	Note 1	58	55
C1	43 Tame Porati Street	New	40-50	Note 1	Note 1	52	49
C1	40 Wi Tako Street	New	50	48	49	48	47
C1	129 Manakau Heights Drive	New	40-50	Note 1	Note 1	54	52
C1	49 Tame Porati Street	New	40-50	Note 1	Note 1	57	55
C1	17 Ihaka Hakuene Street	New	40-50	Note 1	Note 1	48	47
C1	43 Mokena Kohere Street	New	40-50	Note 1	Note 1	52	50
C1	42 Tame Porati Street	New	40-50	Note 1	Note 1	56	54
C1	3 Honoiti Ranapiri Place	New	50	49	50	54	52
C1	7 Honoiti Ranapiri Place	New	51	50	51	55	53
C1	8 Honoiti Ranapiri Place	New	52	51	52	51	49
C1	4 Honoiti Ranapiri Place	New	53	51	52	50	49
C1	146 Manakau Heights Drive	New	51	50	51	54	52
C1	157 Manakau Heights Drive	New	57	56	57	54	53
C1	31 Eastern Rise	New	40-50	Note 1	Note 1	54	52

Area	Address	Type	Existing (2019)	With PP2O (2029)	Without Ō2NL (2039)	Ō2NL without specific mitigation (2039)	Ō2NL with Selected Options (2039)
C	24 Ihaka Hakuene Street	New	52	50	51	48	47
C	22 Ihaka Hakuene Street	New	51	49	50	48	47
C	4 Ihaka Hakuene Street	New	51	49	50	49	48
C	32 Tame Porati Street	New	55	53	54	50	50
C	16 Ihaka Hakuene Street	New	51	49	50	49	47
C	21 Tame Porati Street	New	53	51	52	47	47
C	12 Ihaka Hakuene Street	New	52	50	51	48	47
C	33 Mokena Kohere Street	New	52	50	51	50	48
C	31 Wi Pere Street	New	52	50	51	46	46
C	28 Wi Tako Street	New	51	49	50	47	46
C	27 Tame Porati Street	New	53	51	52	47	47
C	36 Ihaka Hakuene Street	New	52	50	51	47	47
C	32 Ihaka Hakuene Street	New	52	50	51	47	47
C	33 Wi Pere Street	New	53	51	52	47	47
B3	8 Hanawera Ridge Road	New	45-50	Note 1	Note 1	51	49
B3	4 Hanawera Ridge Road	New	45-50	Note 1	Note 1	54	52
B3	23 Manakau Heights Drive	New	45-50	Note 1	Note 1	54	52
B3	52 Manakau Heights Drive	New	45-50	Note 1	Note 1	54	52
B3	21 Manakau Heights Drive	New	45-50	Note 1	Note 1	56	54
B3	11 Hanawera Ridge Road	New	45-50	Note 1	Note 1	52	50
B3	32 Manakau Heights Drive	New	45-50	Note 1	Note 1	51	49
B3	10 Nikau Lane	New	45-50	Note 1	Note 1	51	49
B3	40 Manakau Heights Drive	New	45-50	Note 1	Note 1	52	51
B3	82 Manakau Heights Drive	New	45-50	Note 1	Note 1	55	53
B3	42 Manakau Heights Drive	New	45-50	Note 1	Note 1	53	51

Area	Address	Type	Existing (2019)	With PP2O (2029)	Without Ō2NL (2039)	Ō2NL without specific mitigation (2039)	Ō2NL with Selected Options (2039)
B3	75 Manakau Heights Drive	New	50	49	50	63	61
B3	63 Manakau Heights Drive*	New	50	49	50	58	56
B3	52 Manakau Heights Drive	New	45-50	Note 1	Note 1	55	53
B3	11 Hanawere Ridge Road Bldg 2	New	45-50	Note 1	Note 1	54	52
B3	18 Manakau Heights Drive	New	45-50	Note 1	Note 1	50	48
B2	38 Mountain View Drive	New	45-50	Note 1	Note 1	52	50
B2	20 Mountain View Drive	New	45-50	Note 1	Note 1	58	56
B2	63 South Manakau Road	New	45-50	Note 1	Note 1	57	55
B2	18 Mountain View Drive	New	45-50	Note 1	Note 1	58	56
B2	30 Mountain View Drive	New	45-50	Note 1	Note 1	57	55
B2	44 Mountain View Drive	New	45-50	Note 1	Note 1	52	51
B2	29 Mountain View Drive	New	45-50	Note 1	Note 1	52	50
B2	35 Mountain View Drive	New	45-50	Note 1	Note 1	52	50
B2	69 South Manakau Road	New	45-50	Note 1	Note 1	54	53
B2	28 Mountain View Drive	New	45-50	Note 1	Note 1	55	53
B2	27 Mountain View Drive	New	45-50	Note 1	Note 1	54	53
B1	424 State Highway 1*	Altered	65	64	65	57	57
B1	424 State Highway 1 (bldg 2)*	New	58	56	57	58	56
B1	426 State Highway 1	New	59	58	59	56	54
B	36 South Manakau Road	New	54	53	54	56	51
B	10 South Manakau Road	New	56	55	56	55	53
B	45 South Manakau Road	New	54	52	53	57	52
B	45 Mountain View Drive	New	45-55	Note 1	Note 1	48	47
B	44A Mountain View Drive	New	45-55	Note 1	Note 1	48	46
B	46 Mountain View Drive	New	45-55	Note 1	Note 1	47	46

Area	Address	Type	Existing (2019)	With PP2O (2029)	Without Ō2NL (2039)	Ō2NL without specific mitigation (2039)	Ō2NL with Selected Options (2039)
B	48 Mountain View Drive	New	45-55	Note 1	Note 1	44	43
B	47 Mountain View Drive	New	45-55	Note 1	Note 1	46	45
B	45A South Manakau Road^	New	53	51	52	56	51
A1	139 State Highway 1	Altered	66	65	66	55	54
A1	222 State Highway 1^	New	55	54	55	59	57
A1	170 State Highway 1^	New	55	54	54	61	59
A1	94 State Highway 1	New	53	52	53	57	57
A1	141 State Highway 1	Altered	68	67	68	55	53
A1	178 State Highway 1	New	60	59	60	61	56
A1	190 State Highway 1	Altered	66	64	65	51	49
A1	224 State Highway 1	Altered	66	64	65	57	57
A1	200 State Highway 1	Altered	65	64	65	52	51
A1	143 State Highway 1	Altered	68	68	68	55	53
A1	114 State Highway 1^	Altered	68	68	68	59	58
A1	210A State Highway 1	New	53	52	53	57	56
A1	178 State Highway 1 (sleepout)	New	57	56	57	63	57
A	82 State Highway 1*	New	55	55	55	60	60
A	84 State Highway 1	New	55-65	Note 1	Note 1	53	53

APPENDIX B.5: NOISE MODELLING REPORT (NV1)

ALTISSIMO
CONSULTING

Ōtaki to North of Levin Project

Noise modelling report

Client: Waka Kotahi / NZ Transport Agency
Date: 7 October 2022
Ref: NV1/C

Prepared for (the Client)
Stantec for Waka Kotahi / NZ Transport Agency

Prepared by the Consultant)
Altissimo Consulting Ltd

Project	Ōtaki to North of Levin
Report	Noise modelling report
Reference	NV1/C

Prepared by

Michael Smith
Principal Acoustics Engineer

Reviewed by

Robin Wareing
Principal Acoustic Engineer

Version history:

Version	Date	Comment
A	6/08/2021	Initial draft for planning review
B	4/07/2022	Issued to client for comment
C	7/10/2022	Issued for lodgement

Report disclaimer and limitations:

This report has been prepared in accordance with the usual care and thoroughness of the consulting profession for the use of the Client. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

1 Introduction

1.1 Purpose and scope of this report

This report sets out the operational noise modelling undertaken for the Ōtaki to North of Levin Project (the Ō2NL Project) and the details of the mitigation design process. It has been prepared to support the technical assessment report, and therefore the current report only presents factual information with minimal interpretation.

1.2 Assessment locations

NZS 6806 defines noise-sensitive receivers as *Protected Premises and Facilities (PPFs)*. Subject to 1.4.2 and 1.4.3, PPFs include:

(a) Buildings used for residential activities including:

(i) Boarding establishments

(ii) Homes for elderly persons

(iii) Retirement villages

(iv) In-house aged-care facilities, and

(v) Buildings used as temporary accommodation in residentially zoned areas, including hotels and motels, but excluding camping grounds;

(b) Marae

(c) Spaces within buildings used for overnight patient medical care, and

(d)Teaching areas and sleeping rooms in buildings used as educational facilities including tertiary institutions and schools, and premises licensed under the Education (Early Childhood Services) Regulations, and playgrounds which are part of such facilities and located within 20 m of buildings used for teaching purposes.

The following types of buildings are specifically excluded:

(e) Residential accommodation in buildings which predominantly have other uses such as commercial or industrial premises;

(f) Garages and ancillary buildings; and

(g) Premises and facilities which are not yet built, other than premises and facilities for which a building consent has been obtained which has not yet lapsed.

NZS 6806 specifies the distance from the road where road-traffic noise should be assessed. This varies based on whether the area is in urban or rural area as follows:

- Urban – 100 m
- Rural – 200 m

Whether an area is rural or urban is determined by Statistics New Zealand from census and data and is used as a proxy for property density and ambient noise levels – that is, urban areas are likely to be noisier and effects will be generally limited to receives within 100m. Urban areas are shown in Figure 1 (green). Rural settlements are also shown in orange, however NZS 6806 does not differentiate these from other rural areas.

NZS 6806 refers to specific definition of urban and rural which Statistics New Zealand no longer provides data for. The New Zealand Standard Areas Classification (NZSAC92) has been replaced with the Statistical Standard for Geographic Areas 2018 (SSGA18).

While not required by NZS 6806, we will calculate sound levels for dwellings near the existing SH1 to quantify an expected reduction in sound level.

To provide a conservative assessment, for this project we have considered all dwellings within 50 dB $L_{Aeq(24h)}$ for both the existing and do-minimum scenarios as PPFs. For areas with minimal topography this is roughly 300m from the road. This includes all mandatory PPFs as defined in NZS 6806.

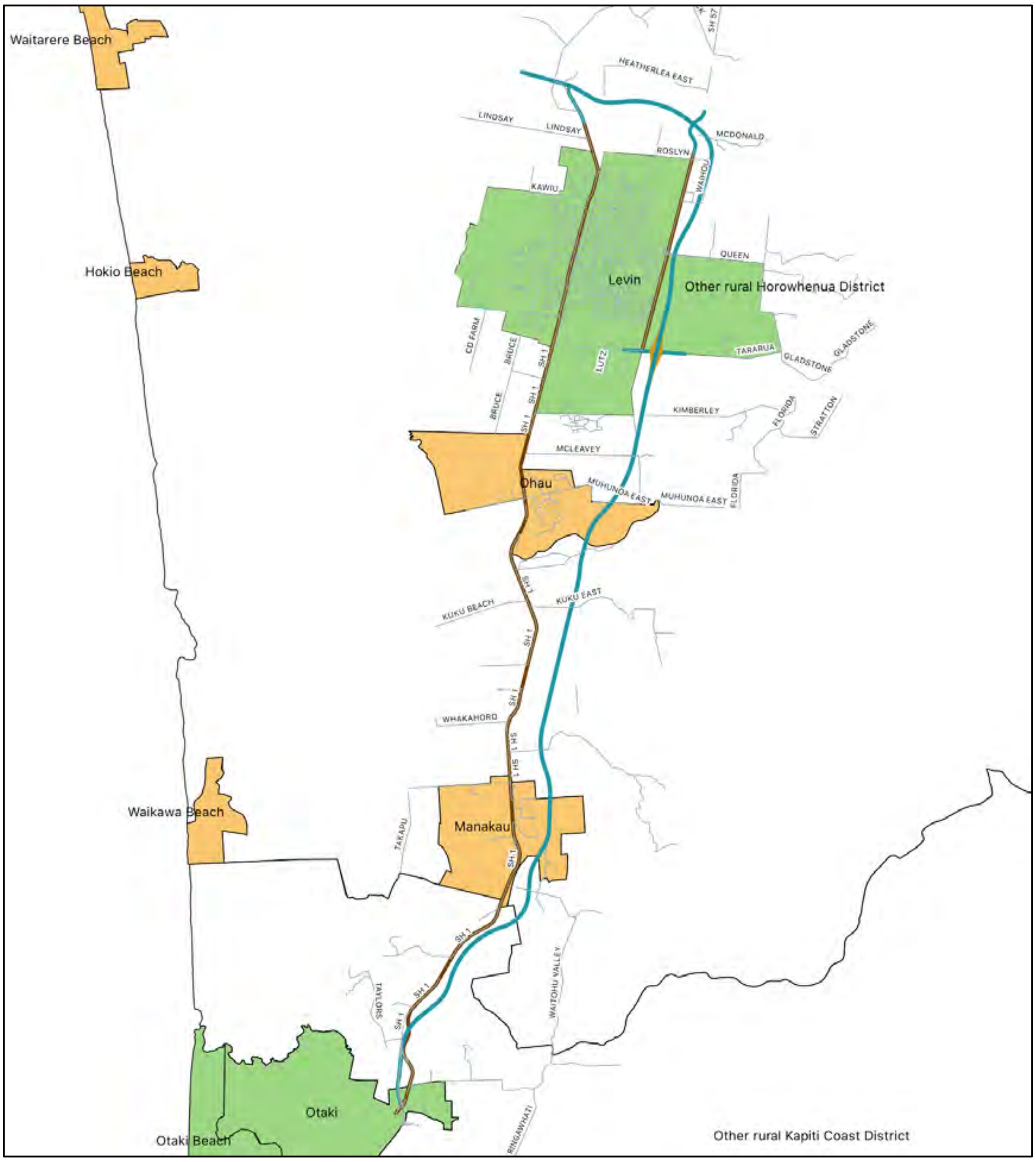


Figure 1 Urban areas (green) and rural areas (white and orange)

1.3 New and altered roads

NZS 6806 defines a new road as any road which is to be constructed where no previously formed legal road existed. The Ō2NL Project fits this definition and is therefore a new road for the purposes of NZS 6806, other than at tie-ins with existing roads at North Levin and Ōtaki as shown in Figure 2 and Figure 3.

Figure 2 Application of NZS 6806 criteria (North Levin)

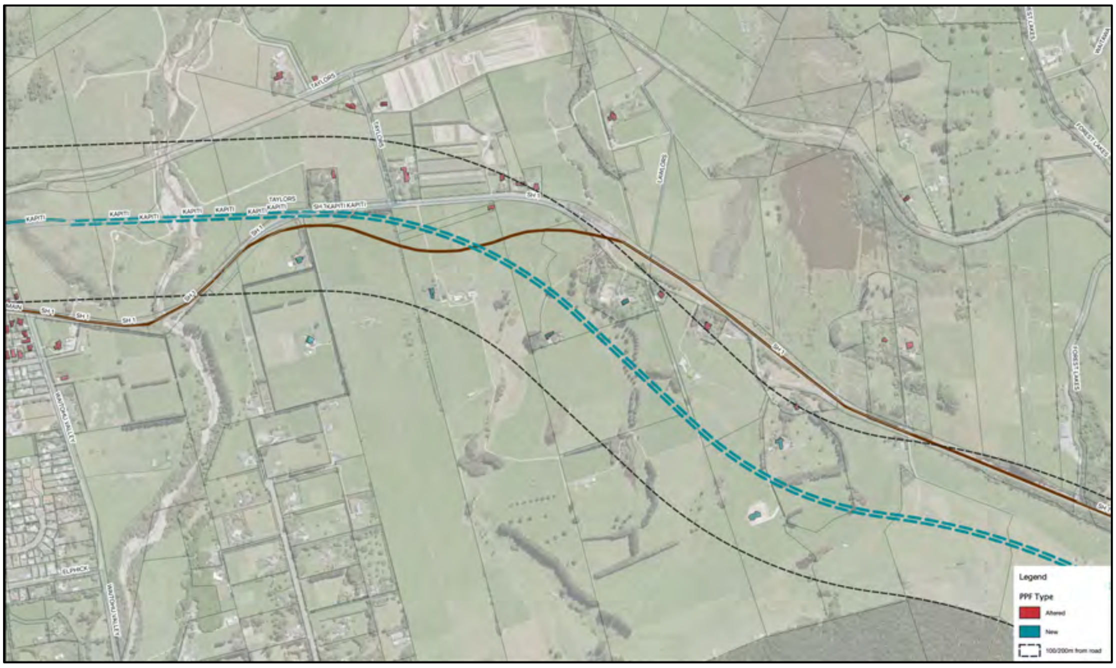


Figure 3 Application of NZS 6806 criteria (North Ōtaki)

For some areas in Levin East, road-traffic noise from Kimberley Road and Arapaepae Road (SH57) is and will remain the dominant source, and therefore it is appropriate to apply the altered road criteria. For this reason, all PPFs west of SH57 and within 100m to the east of SH57 have had the altered road criteria applied, as shown in Figure 4.

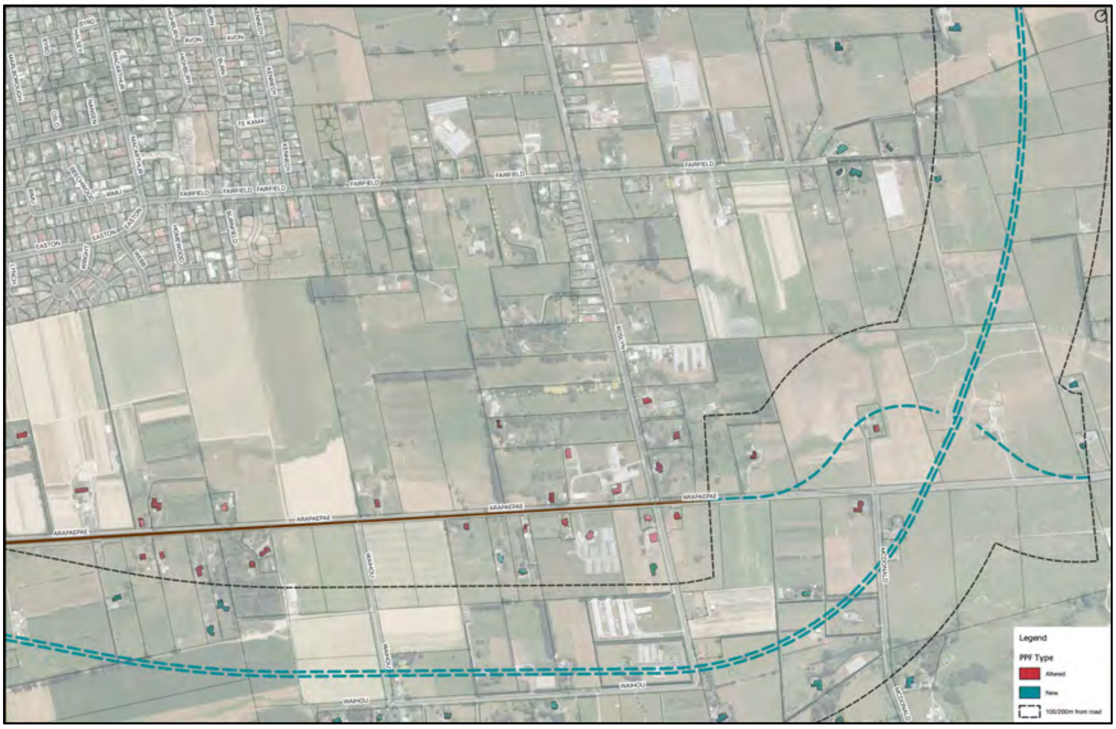


Figure 4 Application of NZS 6806 criteria (Levin East)

While different criteria have been applied to these two classes of PPFs, it has not affected the consideration of mitigation.

1.4 Project areas / zones

The project has been split into 10 different areas, labelled A though L, as shown in Figure 5. These are based on a structure used previously for several multi criteria analysis assessments, and work south to north from Ōtaki to Levin. The Ō2NL project is now being described from north to south. While the original lettering is maintained, the remainder of this report will work north to south.

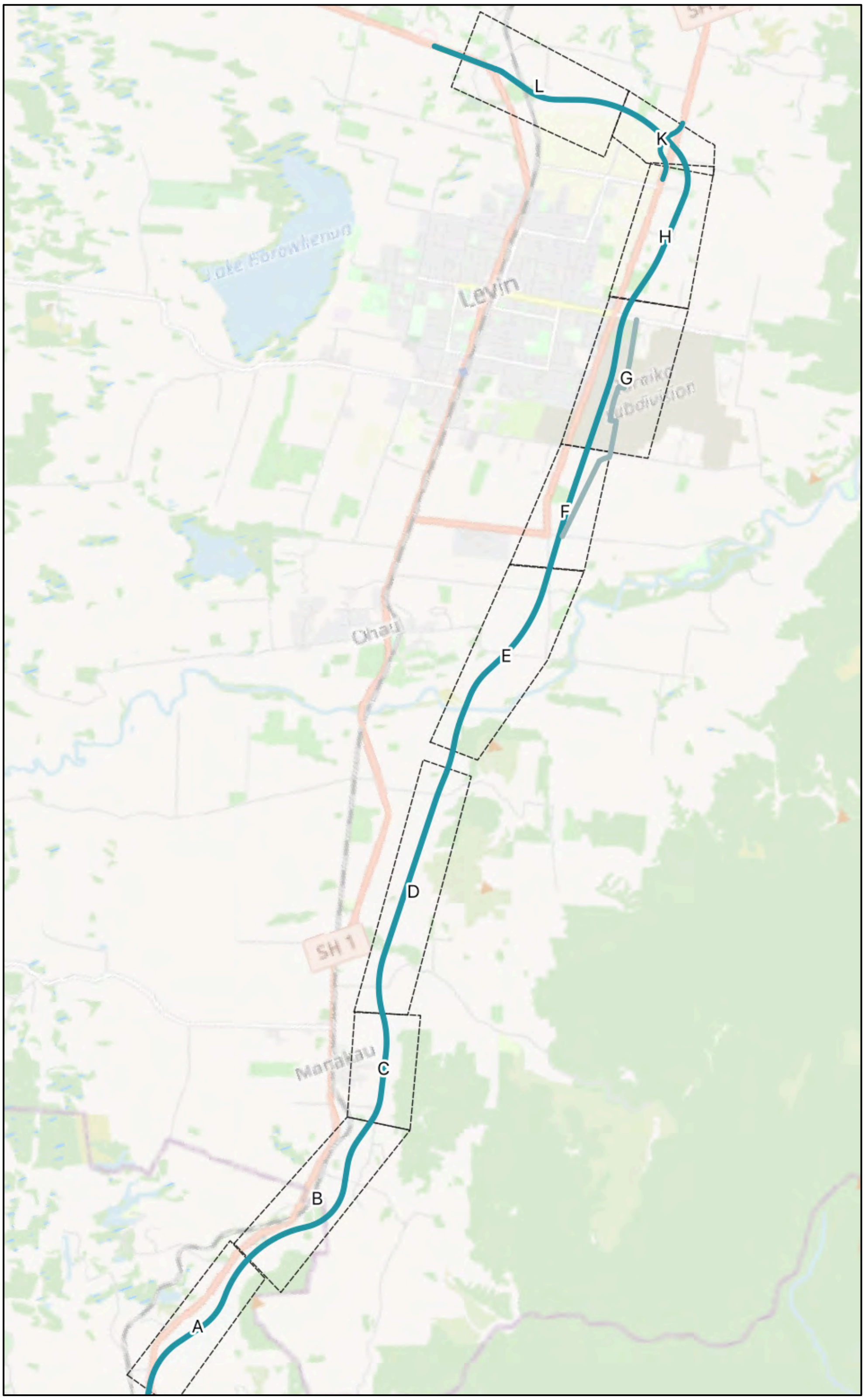


Figure 5 Project areas

2 Model details

2.1 Methodology

A detailed acoustics model has been developed to predict road-traffic noise, consistent with the Waka Kotahi guide to state highway noise mapping[1]. This section details the modelling procedure, inputs, and assumptions.

Table 1 Noise modelling details

Parameter	Setting/source
Operator	Michael Smith
Software	Predictor 7810-I v2021.1
Algorithm	CRTN (Calculation of Road Traffic Noise. UK Department of Transport and the Welsh Office. ISBN 0115508473. 1988)
Parameter	$L_{Aeq(24h)}$ (taken as $L_{10(18h)}$ - 3dB)
Receivers	Free-field, 1.5 m high (plus 3m for each additional floor)
Sound contour grid	Free-field, 1.5 m high
Ground absorption	1
Search radius	1.0km

NZS 6806 requires noise modelling to be performed for a number of scenarios:

- Existing;
- Do nothing (future, no project); and
- Do minimum (future, with project).

In RMA terms, the 'existing environment' includes consented activities. For this reason, we will consider an additional scenario where Peka Peka to Ōtaki has opened. Rather than opening year, we have allowed some time for the traffic network to settle and when traffic forecasting has been performed.

The scenarios to be assessed are summarised in Table 2

Table 2 Traffic scenarios for noise modelling and assessment

NZS 6806 terminology	Year	Scenario
Existing	2019	Existing road network (no Peka Peka to Ōtaki)
N/A	2029	After Peka Peka to Ōtaki expressway opens
Do nothing	2039	Future growth (including Peka Peka to Ōtaki)
Do minimum	2039	With project and no specific noise mitigation

2.2 Geometrics and earthworks

The geometrics and earthworks are based on the relevant design freeze at the time of modelling. The road string has been imported as a 3D polyline at the centre of each carriageway.

Terrain has been modelled using the road edge, top and bottom of swales, and the earthworks boundary, including the overbridges.

[1] NZ Transport Agency (2013) Guide to state highways noise mapping (November 2013, v1.0 DRAFT)

2.3 Traffic assumptions

The following posted speed limits have been used in the noise model. It is noted that the Safer Networks Programme will result in speed limit reductions along the existing state highway network.

Table 3 Posted speed limits

Section	Existing (2019)	2029/2039
SH1: Otaki to Levin*	100 km/h	80 km/h with passing lanes added
SH57:	100 km/h	80 km/h
Ō2NL: Ōtaki to Tararua Interchange	N/A	Posted 100 km/h Modelled 110 km/h
Ō2NL: Tararua Interchange to Levin	N/A	100 km/h

* 70km/h zones through Manakau and Ohau. 50km/h in Levin.

The traffic volumes detailed in Table 4 have been used for the models presented in the "For lodgement" results, based on the Stantec traffic modelling report [Technical Report A]. This is for the 95% percentile model output. The 2039 scenarios include the proposed "East West Arterial" (**EWA**) which links Arapaepae Road to Tara-Ika.

Note that noise modelling for workshops N3 and N4 used the traffic volumes available at the time, which differ from the below values.

Table 4 Traffic volumes

Section	Existing without PP2Ō (2019)	With PP2O (2029) V22a w/o EWA	Without Ō2NL (2039) V22a w/ EWA	With Ō2NL (2039) V22a w/ EWA
Existing SH1				
North of Levin/Ō2NL	11,600 vpd 13%	14,200 vpd 11%	19,600 vpd 12%	19,250 vpd 10%
Levin	14,000 vpd 8%	17,100 vpd 9%	22,000 vpd 9%	13,500 vpd 6% vpd
Levin to Kimberley Rd	15,000 vpd 7%	20,600 vpd 12%	26,000 vpd 12%	11,000 vpd 5%
Kimberley Rd to Ohau	20,000 vpd 11%	27,500 vpd 12%	34,000 vpd 12%	11,000 vpd 5%
Ohau to Manakau	18,000 vpd 10%	24,700 vpd 13%	32,000 vpd 13%	8000 vpd 11%
Manakau to PP2Ō merge	9500 vpd 12%	21,300 vpd 12%	27,000 vpd 14%	3000 vpd 12%
PP2Ō merge to Ōtaki township	15,000 vpd 13%	200 vpd 8%	400 vpd 9%	4000 vpd 10%
Existing SH57				
Arapaepae Rd: Heatherlea East Rd to Ō2NL / Macdonald Rd	 9500 vpd 7%	 13,9700 vpd 10%	 18,400 vpd 11%	 19,250 vpd 10%
Ō2NL / Macdonald to Queen St	9500 vpd 11%	13,800 vpd 11%	18,900 vpd 11%	10,000 vpd 8%
Queen St to Tararua Rd	7200 vpd 12%	13,000 vpd 9%	21,300 vpd 10%	11,800 vpd 8%
Tararua Rd to SH1 (via Kimberley Rd)	5000 vpd 18%	9800 vpd 11%	12,200 vpd 11%	3300 vpd 15%

Section	Existing without PP2Ō (2019)	With PP2O (2029) V22a w/o EWA	Without Ō2NL (2039) V22a w/ EWA	With Ō2NL (2039) V22a w/ EWA
Ō2NL Expressway				
SH1 (Levin) to SH57				16,300 vpd 11%
SH57 to Tararua Interchange				24,300 vpd 14%
Tararua Interchange to Ōtaki				29,100 vpd 14%
Tararua Rd Interchange				
North bound offramp				5300 vpd 19%
North bound onramp				2500 vpd 26%
South bound offramp				2800 vpd 27%
South bound onramp				4200 vpd 26%
Local connections				
Tararua Rd to Kimberley Rd				1400 vpd 6%

2.4 Road surfaces

The existing state highway network has been modelled as chipseal, based on a review of RAMM / Mobile Road. The road surface corrections in Table 5 have been used[2].

[2] NZ Transport Agency (2014) *Guide to state highway road surface noise*, v1,

Table 5 Road surface corrections

Surface	Rc	Rt
EPA-10 (30mm thick)	0	-2
EPA-7 (50mm thick)	-3	-3
SMA	1.5	-1.5
Chipseal	6	1
AC-10	0	0

2.5 Terrain

The terrain outside the earthworks was derived from 1m LIDAR data captured for the project, supplemented with a digital surface model derived from LINZ 20m contours. The two surface models were merged in GIS and contours generated for importing into the noise model.

2.6 Verification

NZS 6806 requires that the noise model should be validated against measurements.The nearest long-term monitoring location to a State Highway was at 190 Arapaepae Rd. This location is 130m from SH57.

Noise levels were measured as 52 dB $L_{Aeq(24h)}$ in 2021, compared with a prediction of 55 dB $L_{Aeq(24h)}$ using 2019 traffic. Traffic counts during the monitoring period on this section of road have not been obtained.

The above result is consistent with CRTN being conservative, and prediction uncertainty increasing with distance from the road.

3 Mitigation

3.1 Assessment areas

Following initial modelling of the operational noise, the future road-traffic noise contours were reviewed to identify where mitigation should be considered. This included where multiple PPFs would benefit from common mitigation. This resulted in 16 discrete assessment areas, referred to by NZS 6806 as 'clusters'. These are listed in Table 6. The area codes were based on a previous project segmentation that ran south to north.

Table 6 Assessment areas

Area	Community	Description	Side of highway
A1	North Ōtaki	North Ōtaki	West
B1	North Ōtaki	South Manakau	West
B2	Manakau	Mountain View	East
B3	Manakau	Manakau Heights	East
C1	Manakau	Manakau Village	West
C2	Manakau	Eastern Rise	East
D1	Manakau	North Manakau Road	East
D2	Manakau	Kuku East Road	West
E1	Ohau East	Arapaepae South Road: McLeavey to Muhunoa East	West

Area	Community	Description	Side of highway
E2	Ohau East	Arapaepae South Road: McLeavey to Muhunoa East	East
F1	Ohau East	Arapaepae South Road / Kimberley Road	West
F2	Ohau East	Corner of Tararua Road and Arapaepae Rd	West
G1	Levin East	Queen Street East	East
H1	Levin East	Waihou Road	East
L1	North East Levin	Sorenson Road	North
L2	North East Levin	Sorenson Road	South

3.2 Options

The following mitigation options have been considered:

- High performance road surface. Waka Kotahi has an active road-surface research programme, and as of this assessment, the best performing surface is a 50mm thick EPA7 which is conservatively assumed to provide approximately 2 dB benefit over a standard 30mm thick EPA10. This enhanced surface has been approved by Waka Kotahi on a case-by-case basis where additional noise mitigation is required. However, by the time of construction, there may be alternative high-performance surfaces with either better noise or engineering characteristics.
- 1.1m high concrete safety barriers on the road edge, replacing wire rope barrier that would otherwise be in place.
- Roadside noise walls. In my assessment I have only considered 2 and 3m high options. Higher noise walls would likely to be out of character, and are not used elsewhere in the Wellington corridor.
- Noise walls and bunds on top of cut or outside of swale. Bunds have also been limited to 3m high with a 3H:1V slope, as the footprint (width) would often be impractical.

3.3 Framework for acoustics ratings

For each area and mitigation option, the noise levels the reduction provided from the do minimum scenario have been calculated.

Costs for each mitigation have been estimated using the following unit rates. These costs should only be used for comparative purposes and not for developing a project estimate.

Table 7 Indicative mitigation costs for comparative purposes

Treatment	Unit rate	Linear rate
High performance road surface	$20 / m^2	$280 / m Assumes 14m width of additional thickness
Concrete safety barrier (1.1m high)	$600 / m	$600 / m
Noise wall (2m high)	$1000 / m	$1000 / m
Noise wall (3m high)	$1400 / m	$1400 / m
Earth bund	$40 / m^3	$480 / m Assumes 1V:3H slope and 1m top width

Specialists from the Ō2NL Project team were requested to complete an assessment against their relevant discipline.

The acoustics ratings were determined using the following structure:

Table 8 Acoustics assessment matrix

Impact key	NZS 6806 compliance	Health compliance	Structural mitigation	Value for money
+++	All in Cat A	All PPFs < 50 dB	> 5 dB	BCR > 1.5
++	Cat A or 5% or fewer in Cat B	-	5 dB	BCR 1.25-1.5
+	All in Cat A or B	-	4 dB	BCR 1-1.24
o	-	Fewer than 25% of PPFs > 50 dB	3 dB	BCR 0.75-0.99
-	5% or fewer in Cat C	More than 25% of PPFFs > 50 dB	2 dB	BCR 0.5-0.74
--	10% or fewer in Cat C	More than 50% of PPFFs > 50 dB	1 dB	BCR 0.25-0.49
---	More than 10% in Cat C	More than 75% of PPFs > 50 dB	< 1 dB	BCR < 0.25

4 Workshop N3

4.1 Options

The options considered for each assessment area are listed in Table 9. The noise levels and reductions provided for each option are shown in Appendix B.

Table 9 Noise mitigation options considered for each assessment area

Community	Assessment Area	Noise mitigation options
North east Levin	L1	1. High performance road surface 2. Concrete safety barrier 3. 2m roadside noise wall 4. 3m roadside noise wall
	L2	1. High performance road surface 2. Concrete safety barrier 3. 2m roadside noise wall 4. 3m roadside noise wall
Levin East	H1	1. High performance road surface 2. 2m noise wall on top of cut 3. 3m noise wall on top of cut 4. 3m noise bund on top of cut
	G1	1. High performance road surface 2. 2m noise wall on top of cut 3. 3m noise wall on top of cut 4. 3m noise bund on top of cut
	F2	1. High performance road surface on main alignment (SMA on ramp) 2. 2m roadside noise wall on ramp 3. 3m roadside noise wall on ramp
	F1	1. High performance road surface 2. Concrete safety barrier 3. 2m roadside noise wall 4. 3m roadside noise wall
Ohau East	E1	1. High performance road surface 2. Concrete safety barrier 3. 2m roadside noise wall 4. 3m roadside noise wall 5. High performance road surface + 3m roadside noise wall
	E2	1. High performance road surface 2. Concrete safety barrier 3. 2m roadside noise wall 4. 3m roadside noise wall

Community	Assessment Area	Noise mitigation options
		5. High performance road surface + 3m roadside noise wall
	D2	1. High performance road surface 2. 2m noise wall on top of cut 3. 3m noise wall on top of cut 4. 3m noise bund on top of cut
Manakau	D1	1. High performance road surface 2. 2m noise wall on top of cut 3. 3m noise wall on top of cut 4. 3m noise bund on top of cut
	C2	1. High performance road surface 2. 2m roadside noise wall 3. 3m roadside noise wall 4. EPA7 + 3m roadside noise wall
	C1	1. High performance road surface 2. 2m roadside noise wall 3. 3m roadside noise wall 4. High performance road surface + 3m roadside noise wall
	B3	1. High performance road surface 2. Concrete safety barrier 3. 2m roadside noise wall 4. 3m roadside noise wall
	B2	1. High performance road surface 2. Concrete safety barrier 3. 2m roadside noise wall 4. 3m roadside noise wall
	B1	1. High performance road surface 2. Concrete safety barrier 3. 2m roadside noise wall 4. 3m roadside noise wall
North Ōtaki	A1	Not evaluated as part of N3

4.2 Discussion

A workshop was held on 22 July 2021 and Buddle Findlay in Wellington, with some attendees joining remotely. The workshop was attended by evaluators, other project team members, representatives from both councils including planning and acoustics advisors. A summary of the considerations and the selected option for each area is provided in Table 9, however reference should be made to the evaluations provided by each assessor are shown in Appendix C.

Table 10 Discussion of noise mitigation options

Community	Assessment Area	Discussion
North east Levin	L1	Continuing the safety barrier from rail bridge if effective at reducing noise levels to the north of the highway, and is the selected option. The population density and overall noise levels does not support a high-performance surface in this area.
	L2	PPFs are on a terrace overlooking the road, and unlike in area L1 noise barriers are not effective. Localised mitigation should be considered as part of the property disposal process
Levin East	H1	The highway is in cut at this location, and a barrier will be required to keep people away from the highway. A 2m high noise wall was selected to perform this function as well as provide noise mitigation. A high-performance surface was also selected
	G1	With the road in cut, noise barriers at the top are generally ineffective and reasonable noise levels are achieved without barriers. Future landuse uncertain with Tara-Ika Plan Change. Noted that NZS 6806 does not consider undeveloped land as a PPF unless building consent has been granted. High-performance surface selected.
	F2	Property to be purchased and PPF removed
	F1	Noise barrier options provide limited benefit. High performance surface selected as part of contiguous treatment. All PPFs within Cat A.
Ohau East	E1	Noise barriers are effective, particularly for PPFs closest to the road. Considering E1 and E2 together, if noise walls were required on both sides, they would confine road user views to a hard-edged 'tunnel' with reduced engagement with rolling rural terrain. With the high-performance surface, reasonable noise levels would be achieved at most PPFs, although 2x Cat B PPFs would remain. This was the selected option.

Community	Assessment Area	Discussion
	E2	Similar to E1, with the high-performance surface was selected with reasonable noise levels occurring, with 1x Cat B PPFs would remain.
	D2	2x PPFs are Cat B without mitigation. Noise walls would be challenging in this area with local road bridges and wetlands. The selected option was no additional mitigation over the standard OGPA surface, although it was noted that there may be options to form a bund using the fill from south-west ponds. This can't be confirmed until the contractor finalises the stormwater design.
Manakau	D1	All PPFs were within Cat A without mitigation, however effective mitigation options are available. Best option were a 2m high noise wall at the top of the cut slope where safety fencing would be required anyway, or continuing the high-performance surface from Manakau to the Waikawa Stream Bridge. The surface option was selected.
	C2	All PPFs are Cat A without mitigation. Road is slightly benched into terrain with provides some screening. High-performance surface selected throughout the area
	C1	PPFs on top of slope overlook road. Noise barriers not effective due to topography, although visual treatment will be required. Selected option is the high-performance surface.
	B3	B2 and B3 need to be consistent visually. Poor ground conditions would make expanding the embankment to allow higher noise walls would be challenging Selected option: high-performance surface with extended 1.1m high safety barriers
	B2	PPFs are on terraces, with western view from houses. Planting will be required for visual screening. Higher noise walls have significant engineering challenges. Selected option: high-performance surface with extended 1.1m high safety barriers
	B1	Most affected PPF is Crown-owned, and mitigation will be required if it is to remain in residential use. Noise barriers are effective, although quite long to protect a single PPF.

Community	Assessment Area	Discussion
		Selected option: high-performance surface, with additional mitigation to be considered as part of the property disposal process
North Ōtaki	A1	Options not assessed

4.3 Selected mitigation

The Selected Options based on Workshop in Table 11 and Table 12.

Table 11 Selected Options (road surfaces)

Chainage	Length	Detail
Ch 13,400 – 22,200	8.6 km	High performance road surface
Ch 26,500 – 31,700	5.2 km	High performance road surface

Table 12 Selected Options (barriers)

Chainage	Length	Detail
Ch 10700 – 11500 (SB)	800m	1.1m high concrete safety barrier
Ch 13,900 – 15,000 (SB)	1.1km	2m high noise wall between expressway and Waihou Road
Ch 29,700 – 30,400 (NB)	700m	1.1m high concrete safety barrier
Ch 29,700 – 30,700 (SB)	1.0km	1.1m high concrete safety barrier

5 Workshop N4

5.1 Options

The options considered for two assessment area are listed in Table 13. The noise levels and reductions provided for each option are shown in Appendix D.

Table 13 Noise mitigation options considered for each assessment area

Project section	Assessment Area	Noise mitigation options
Levin East	G1	1. EPA7 2. 2m noise wall on top of cut 3. 3m noise wall on top of cut 4. 3m noise bund on top of cut
North Ōtaki	A1	1. EPA7 2. 1.1m high concrete safety barrier 3. 2m noise wall on top of cut 4. 3m noise wall on top of cut

5.2 Discussion

A workshop was held on 11 February 2022 online. The evaluations provided by each assessor are shown in Appendix E. The workshop was attended by evaluators, other project team members, representatives from both councils including planning and acoustics advisors.

5.3 Selected mitigation

Table 14 Discussion of noise mitigation options

Community	Assessment Area	Discussion
Levin East	G1	While standard thickness EPA is presented as the do-min, the high performance surface is essentially the default mitigation option. This benefits PPFs at all distance from the road. PPFs / land to west of highway. Noise levels improve and/or dominated from Arapaepae Rd. No effects from project, and no need to mitigate. As a side note, barriers would be difficult due to property access. The road surface is currently chipseal. Asphalt would benefit, however would most likely require the entire pavement to be rebuilt. This is not to be considered as part of Ō2NL Project. 131 Arapaepae Rd in within the designation and is Cat A with surface the high performance surface. The remaining PPF is the Prouse homestead. Note that two buildings were shown on plans, however the western structure not the homestead Noise barriers generally ineffective, and it was noted that bunds are undesirable in this location, due to the

Community	Assessment Area	Discussion
		significant extra fill required and this is a high risk location, and bunds would complicate the flow paths Building treatment at Prouse homestead unlikely to be viable. The selected option was the high-performance road surface
North Ōtaki	A1	Multiple noise walls were evaluated that protect each of the PPFs. 2 or 3m high nois walls would affect the earthworks footprint. The selected option was an additional section of high-performance road surface. It was noted that 178 SH1 is 2-story with bedrooms to the east. Noise barriers are to be revisited for this PPF.

6 Additional assessments

The following minor changes to the mitigation design have been made after workshop N4. While not subject to the full mitigation evaluation process, input from the appropriate specialists have been sought in making these decisions.

6.1 East Levin (H1)

The vertical alignment in this area results in the 2m high noise wall selected in Workshop N3 no longer providing a co-benefit to pedestrian safety, nor being effective acoustically. This noise wall has been replaced with an equivalent length of 1.1 high concrete safety barriers.

The performance of this barrier is confirmed in Technical Report B.

6.2 North Ōtaki (A1)

The modelling for 178 SH1 has been reviewed, and the 1.1m high concrete safety barrier from the bridge has been extended north. The performance of this barrier is confirmed in Technical Report B.

7 Final selected options

The Selected Options presented in Technical Report B are summarised below:

Table 15 Selected Options (road surfaces)

Location	Chainage	Length	Type
Muhunoa East through to the SH57 roundabout (Area E1-H1)	CH 22,200-13,400	8.8 km	50 mm thick EPA7 or equivalent
South of Manakau to the Waikawa Stream Bridge, Manakau (Area B1-D1)	CH 31,700-26,500	5.2 km	50 mm thick EPA7 or equivalent
North Ōtaki from tie-in with PP2Ō	CH 39,000-34,900	4.1 km	50 mm thick EPA7 or equivalent

Table 16 Selected Options (noise barriers)

Location	Chainage	Length	Type
Levin Rail Bridge, South Bound (L1)	CH 10700 – 11500	810 m	1.1 m high concrete safety barrier
Waihou Road (H1)	CH 13,900 -15,000	1.2 km	1.1 m high concrete safety barrier
Waiauti Stream and South Manakau Road bridge North Bound (Opposite B3)	CH 29700 – 30400	530 m	1.1 m high concrete safety barrier
Waiauti Stream and South Manakau Road bridge, South Bound (B2-B3)	CH 29700 – 30700	1.1 km	1.1 m high concrete safety barrier
North Ōtaki overbridge, north bound (A1)	CH 33600 - 34200	600m	1.1 m high concrete safety barrier

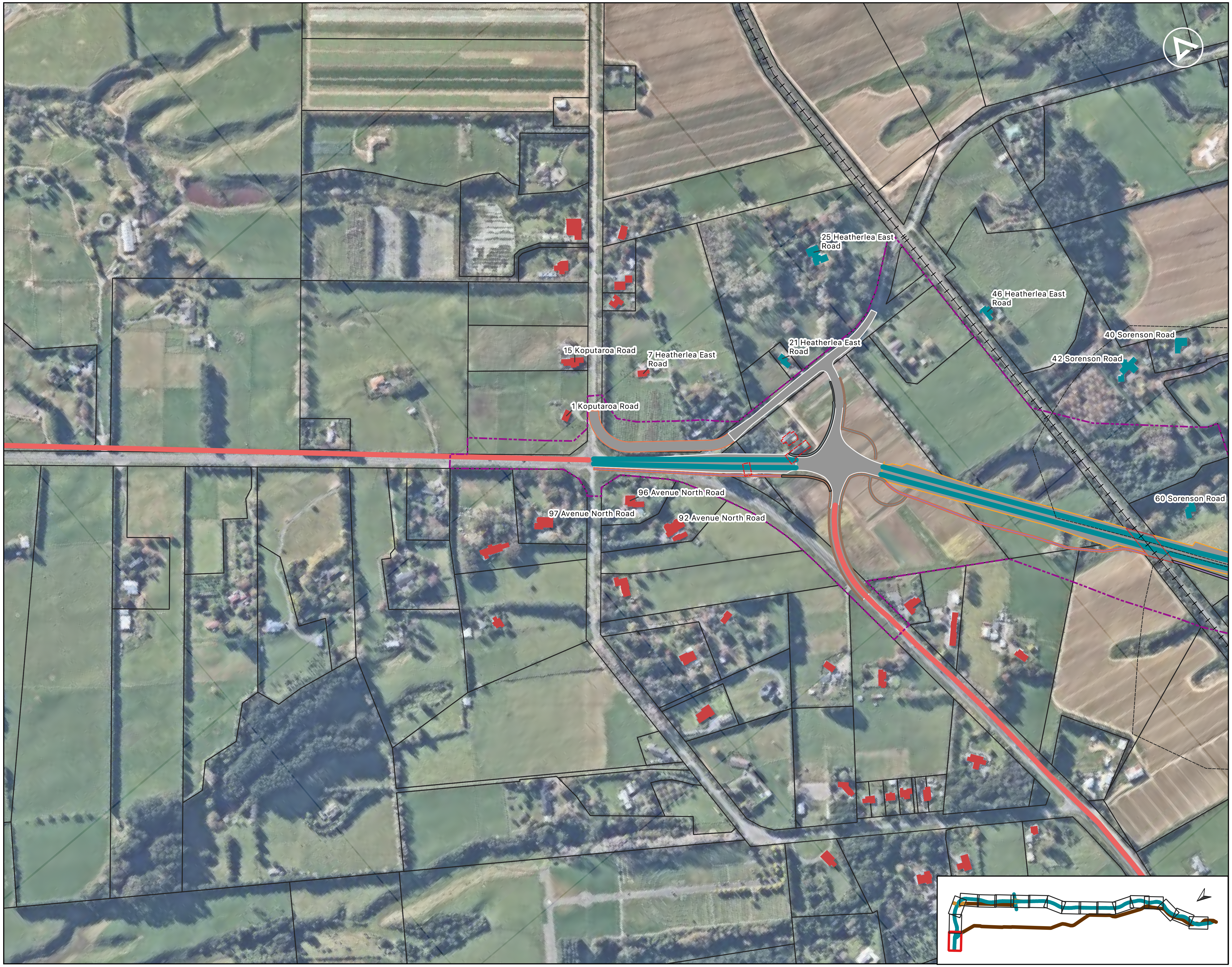
Table 17 Selected Options (investigation for building modification)

Address	Area	Status
82 Sorenson Road^	L2	Within designation
72 Sorenson Road*	L2	Crown owned
66 Sorenson Road*	L2	Crown owned
172 Fairfield Road*	L	Crown owned
24 McDonald Road^	H	Within designation
96 Arapaepae Road^	H	Within designation
48 Arapaepae Road^	G	Within designation

Address	Area	Status
363 Arapaepae South Road*	F1	Crown owned
390 Arapaepae South Road*	F1	Crown owned
361 Arapaepae South Road*	F1	Crown owned
264 Tararua Road	F	**Privately owned**
397 Arapaepae South Road	F	**Privately owned**
213 Muhunoa East Road^	E2	Within designation
480 Arapaepae South Road	E1	**Privately owned**
247A Muhunoa East Road^	E1	Within designation
679A State Highway 1	D2	**Privately owned**
679B State Highway 1	D2	**Privately owned**
95 Manakau Heights Drive^	C1	Within designation
75 Manakau Heights Drive	B3	**Privately owned**
170 State Highway 1^	A1	Within designation
82 State Highway 1*	A	Crown owned

Appendix A

Identification of PPFs



Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-1

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING

Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-2

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING

Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

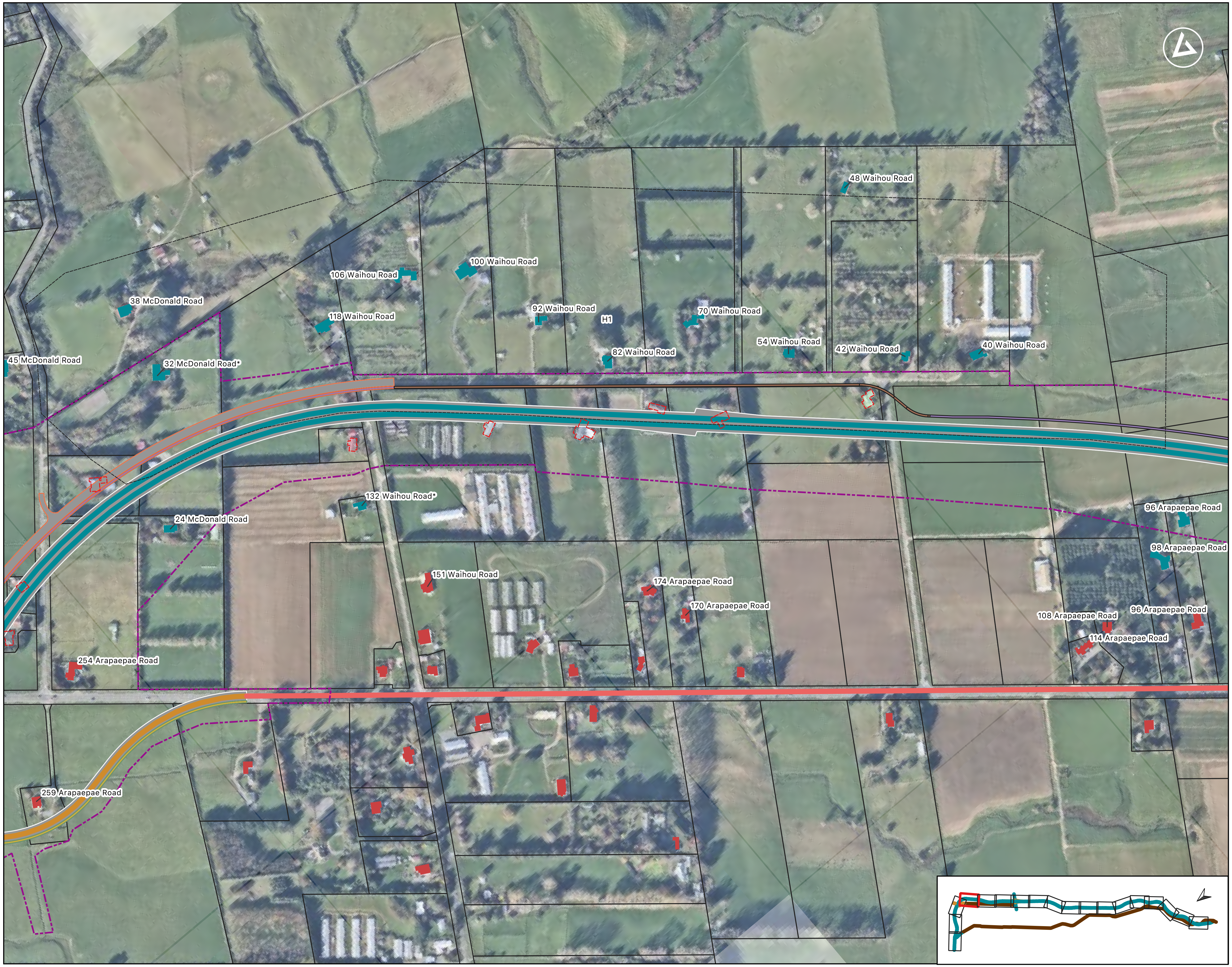
Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-3

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING



Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-4

Drawn
MS

Date
7 Oct 2022

ALTISSIMO
CONSULTING

Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-5

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING

Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

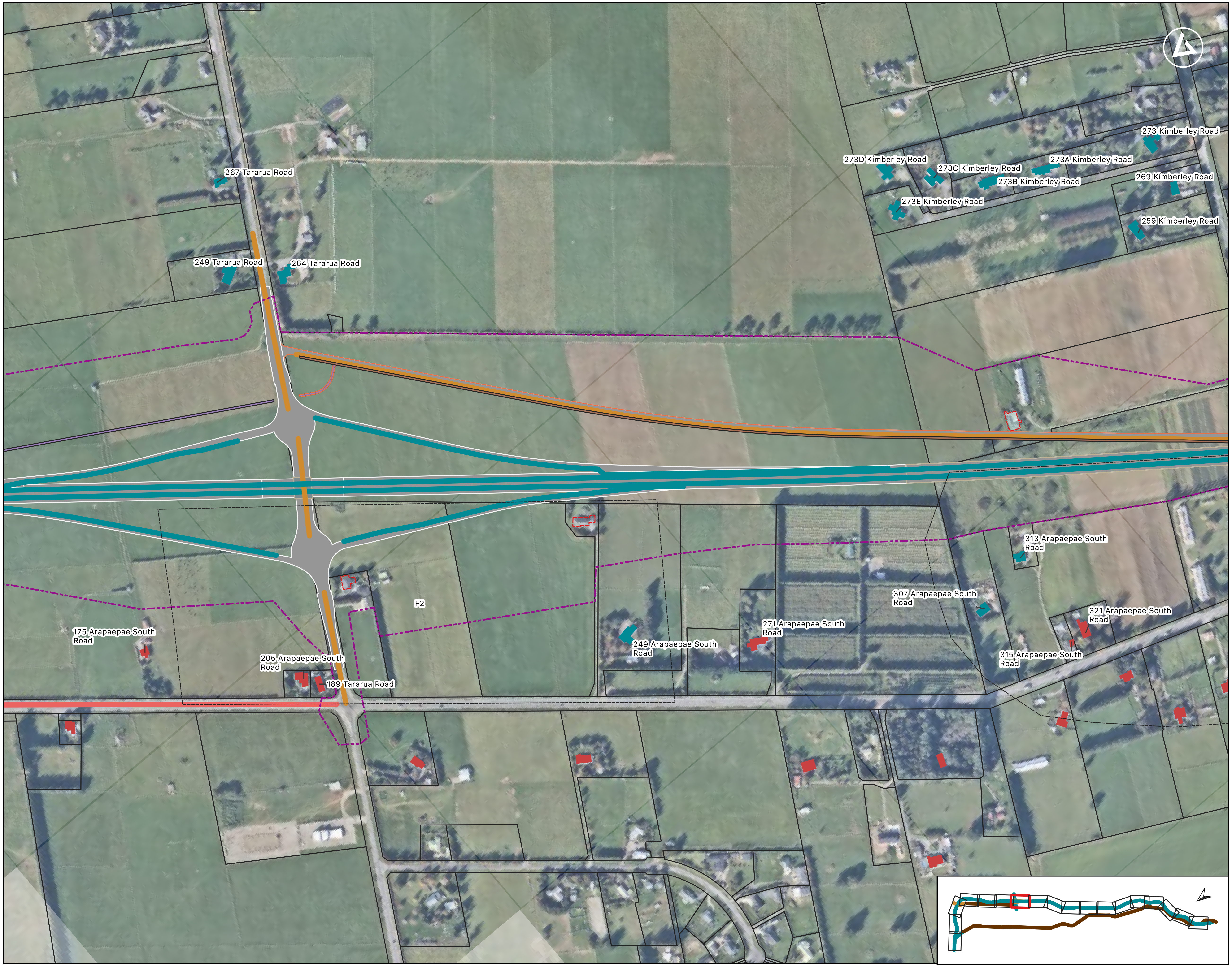
Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-6

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING



Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments

Imagery (C) Nearmap 2022

Building outlines (C) LINZ 2022

Scale 1:5000

Project

Ōtaki to North of Levin

Client

Stantec (for Waka Kotahi)

Title

PPF identification

Figure NV1-A-7

Drawn

MS

Date

7 Oct 2022

ALTISSIMO CONSULTING

Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-8

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING

Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-9

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING

Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-10

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING

Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-11

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING

Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-12

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING

Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments

Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

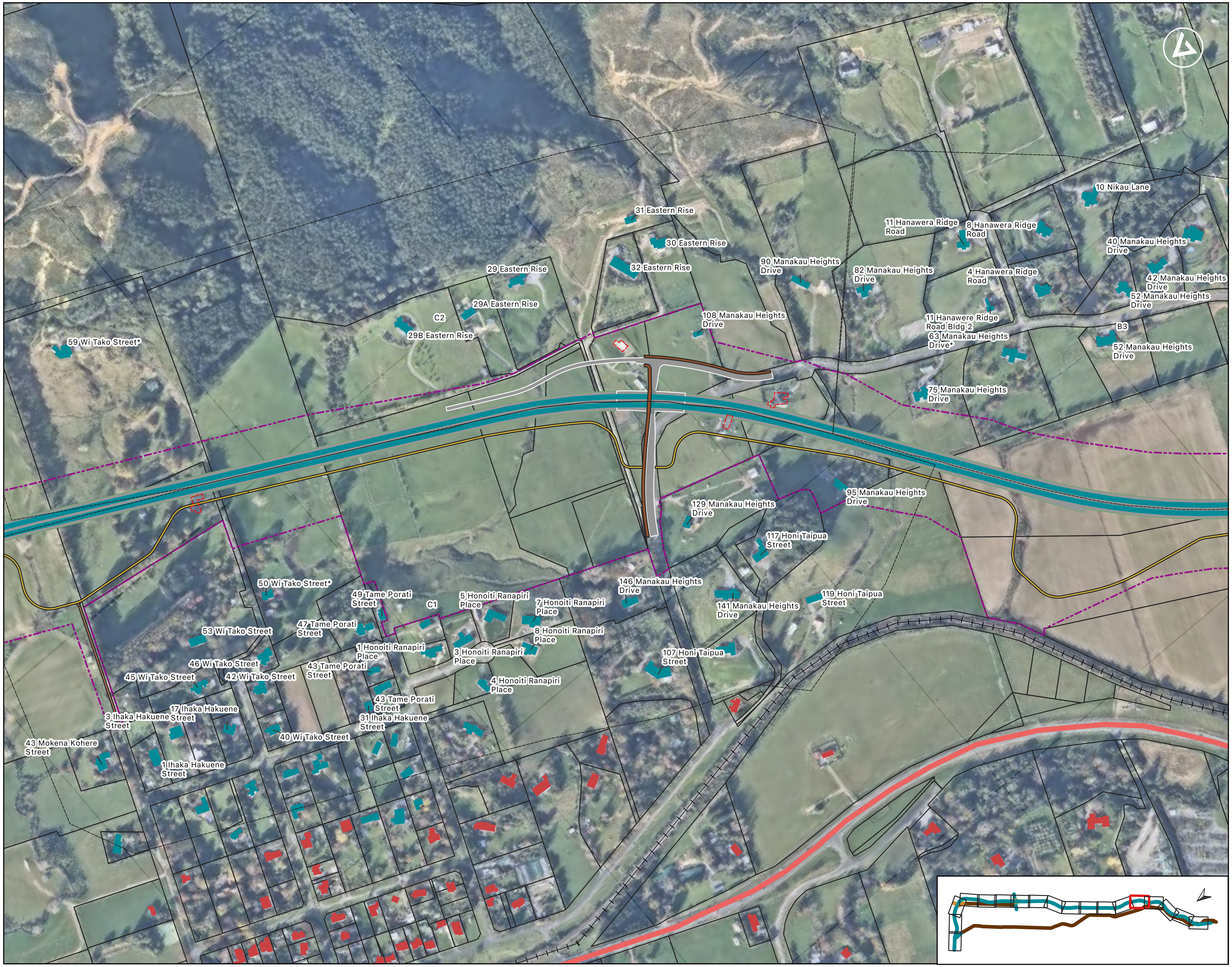
Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-13

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING



Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

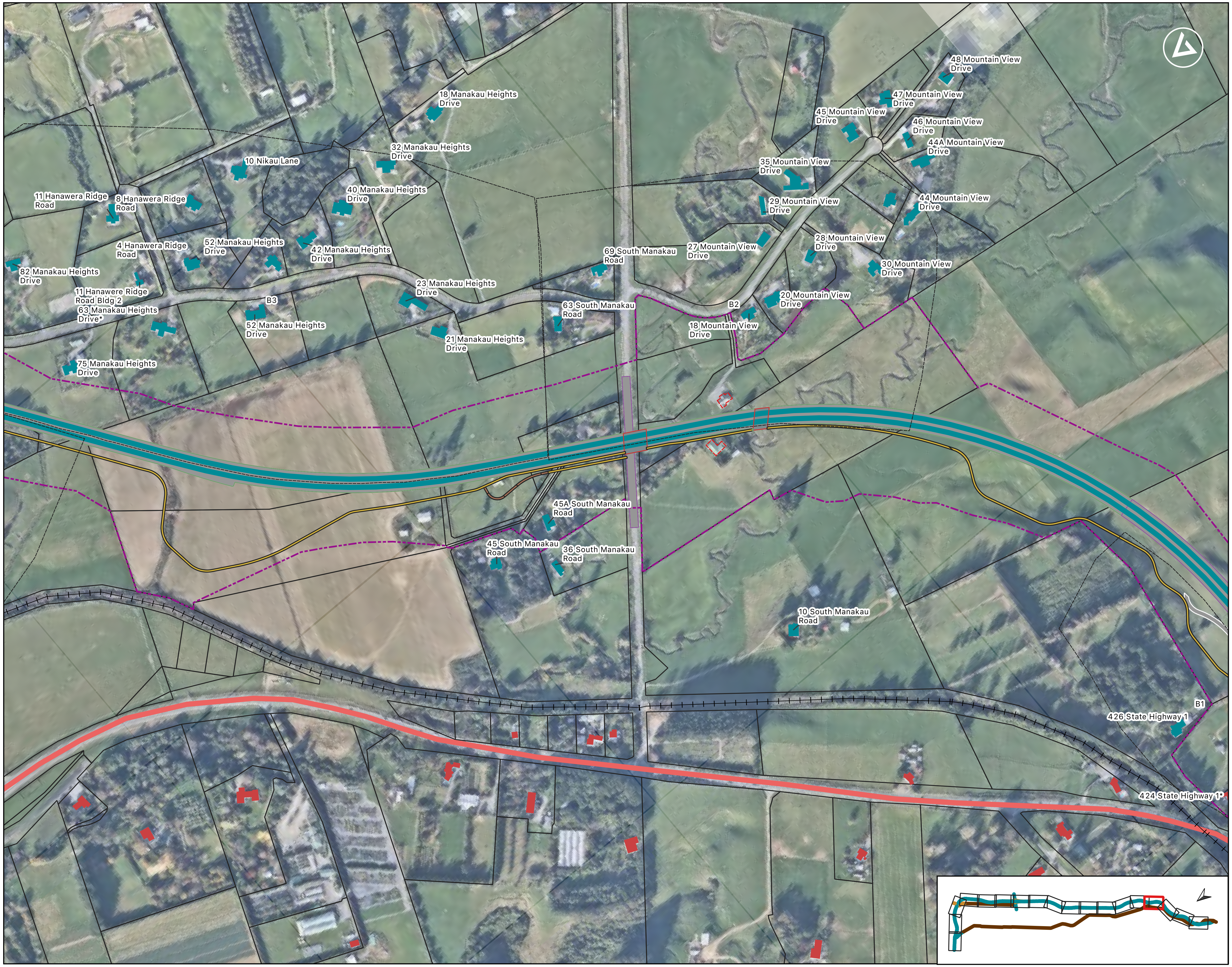
Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-14

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING



Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

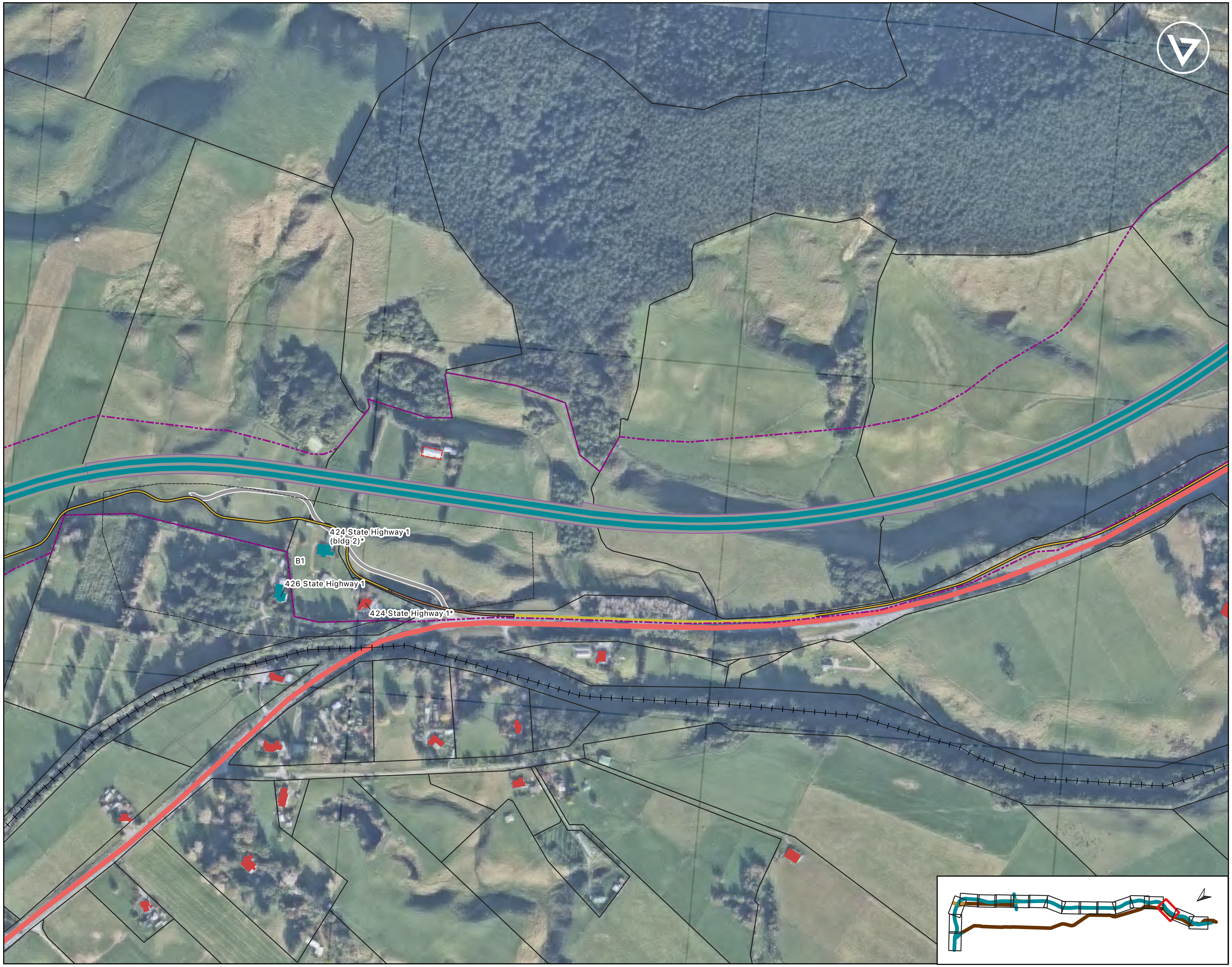
Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-15

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING



Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-16

Drawn
MS

Date
7 Oct 2022

ALTISSIMO CONSULTING

Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments

Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project

Ōtaki to North of Levin

Client

Stantec (for Waka Kotahi)

Title

PPF identification
Figure NV1-A-17

Drawn

MS

Date

7 Oct 2022

ALTISSIMO CONSULTING

Legend

Proposed Designation

Buildings

PPFs removed

PPFs type

New

Altered

Roads

New highway

New local connection

Existing

Comments
Imagery (C) Nearmap 2022
Building outlines (C) LINZ 2022

Scale 1:5000

Project
Ōtaki to North of Levin

Client
Stantec (for Waka Kotahi)

Title
PPF identification
Figure NV1-A-18

Drawn
MS

Date
7 Oct 2022

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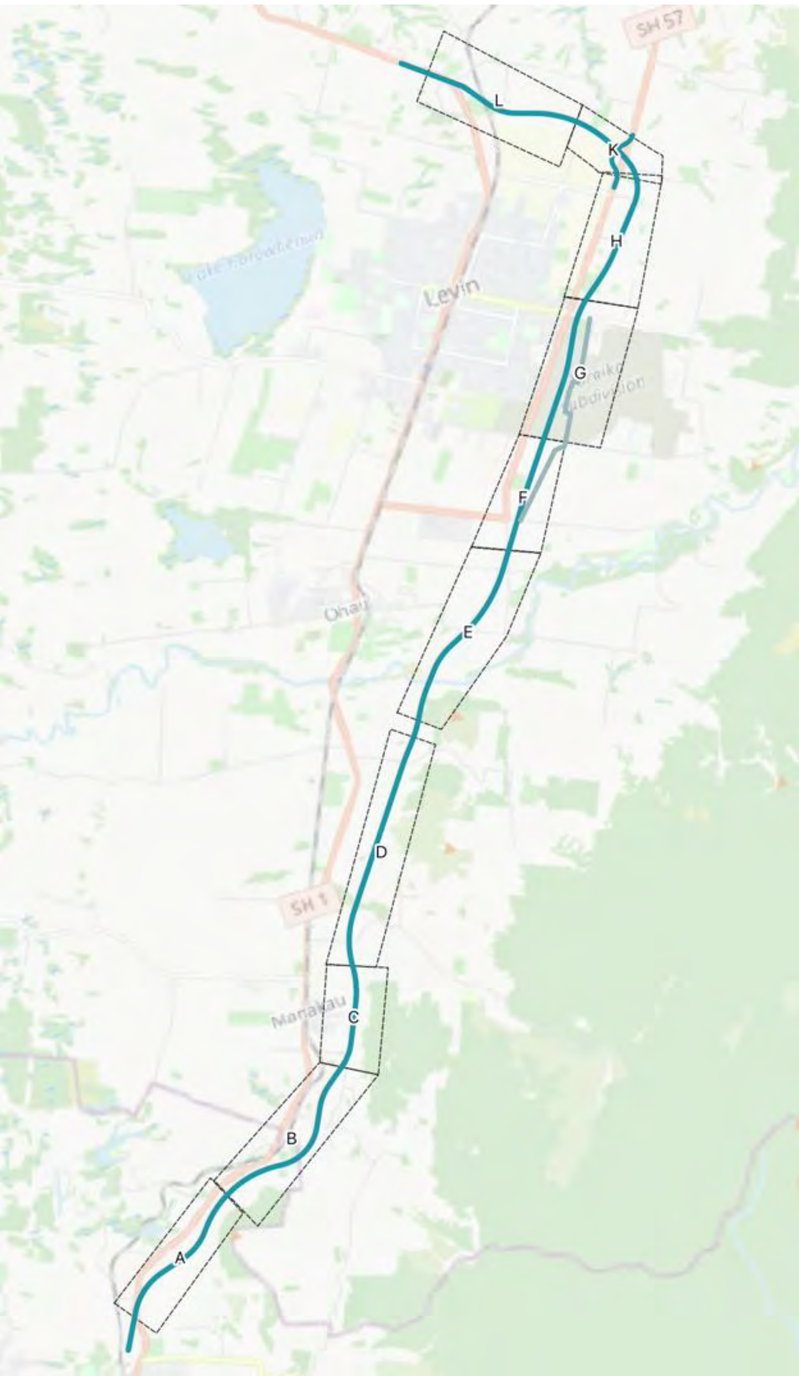
Appendix B

Noise mitigation options for Workshop N3

Index map



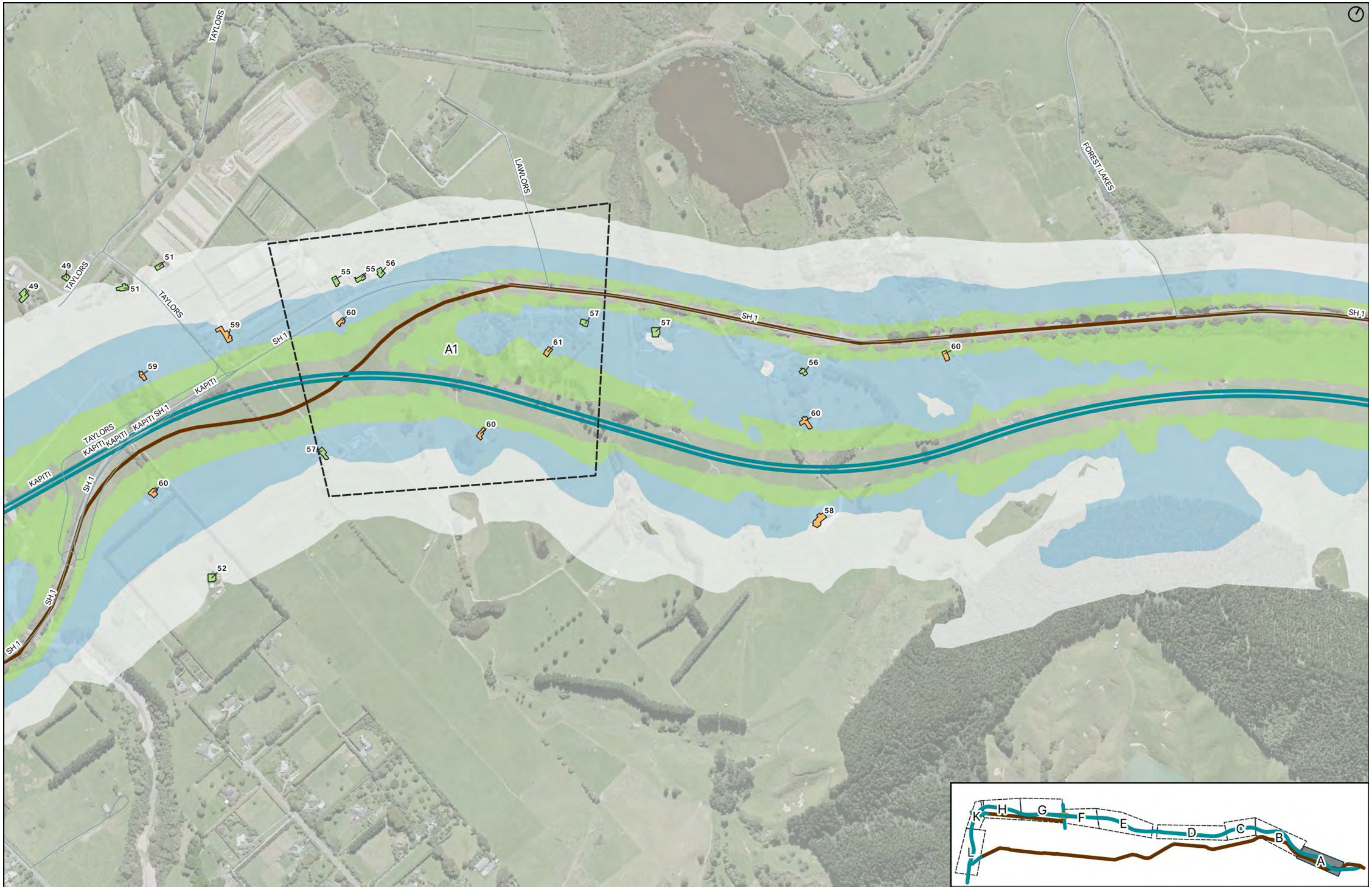
Drawing index

Legend

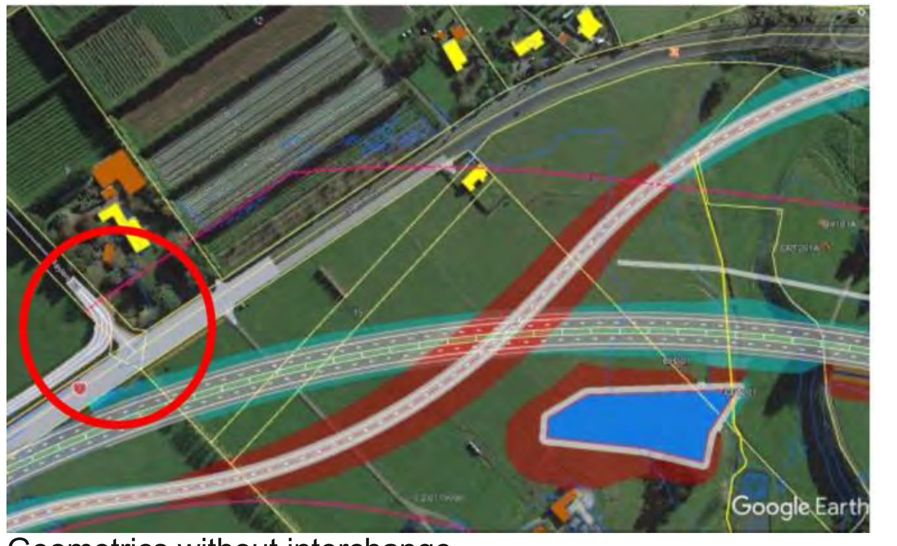
Noise contour, LAeq(24h)
- 50–55 dB
- 55–60 dB
- 60–65 dB
- 65–70 dB

PPF NZS 6806 Category
- Cat A
- Cat B
- Cat C

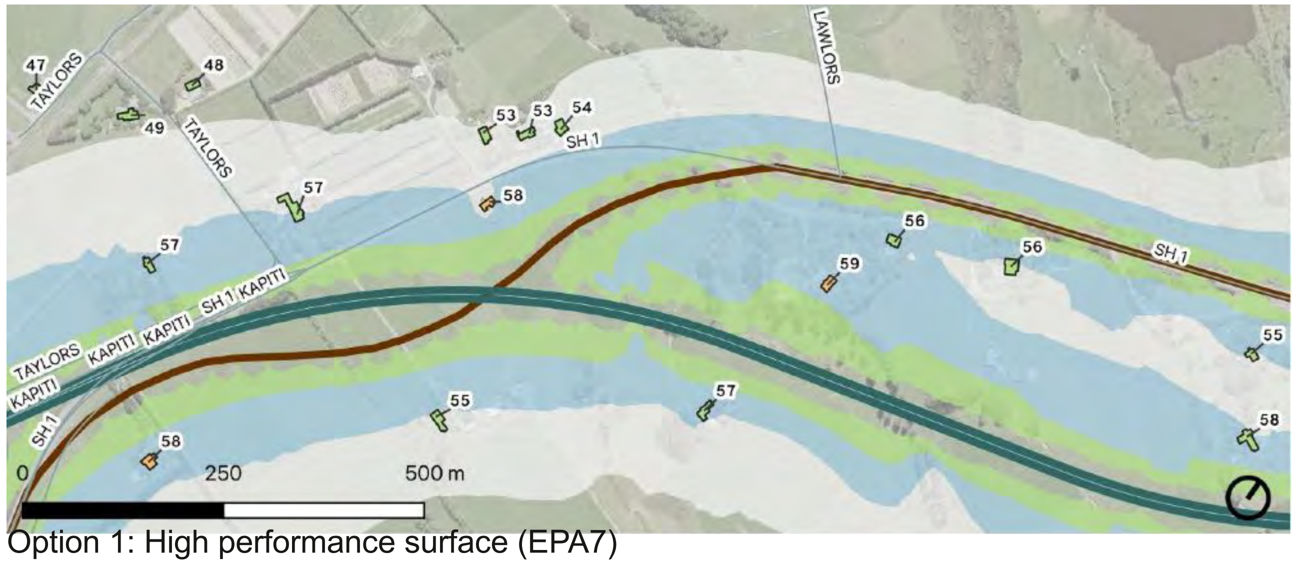
Road surface
- Chipseal
- EPA10
- EPA7
- SMA
- AC10


TAYLORS
LAWLORS
FOREST LAKES
SH 1
KAPITI
A1
A
B
C
D
E
F
G
H
K
L

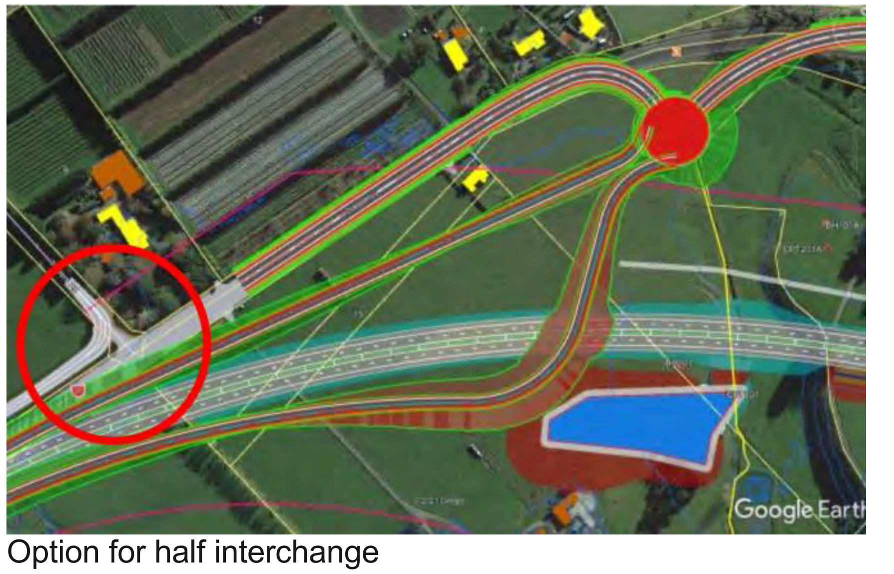
Assessment for Area A1 to be completed on confirmation of interchange configuration



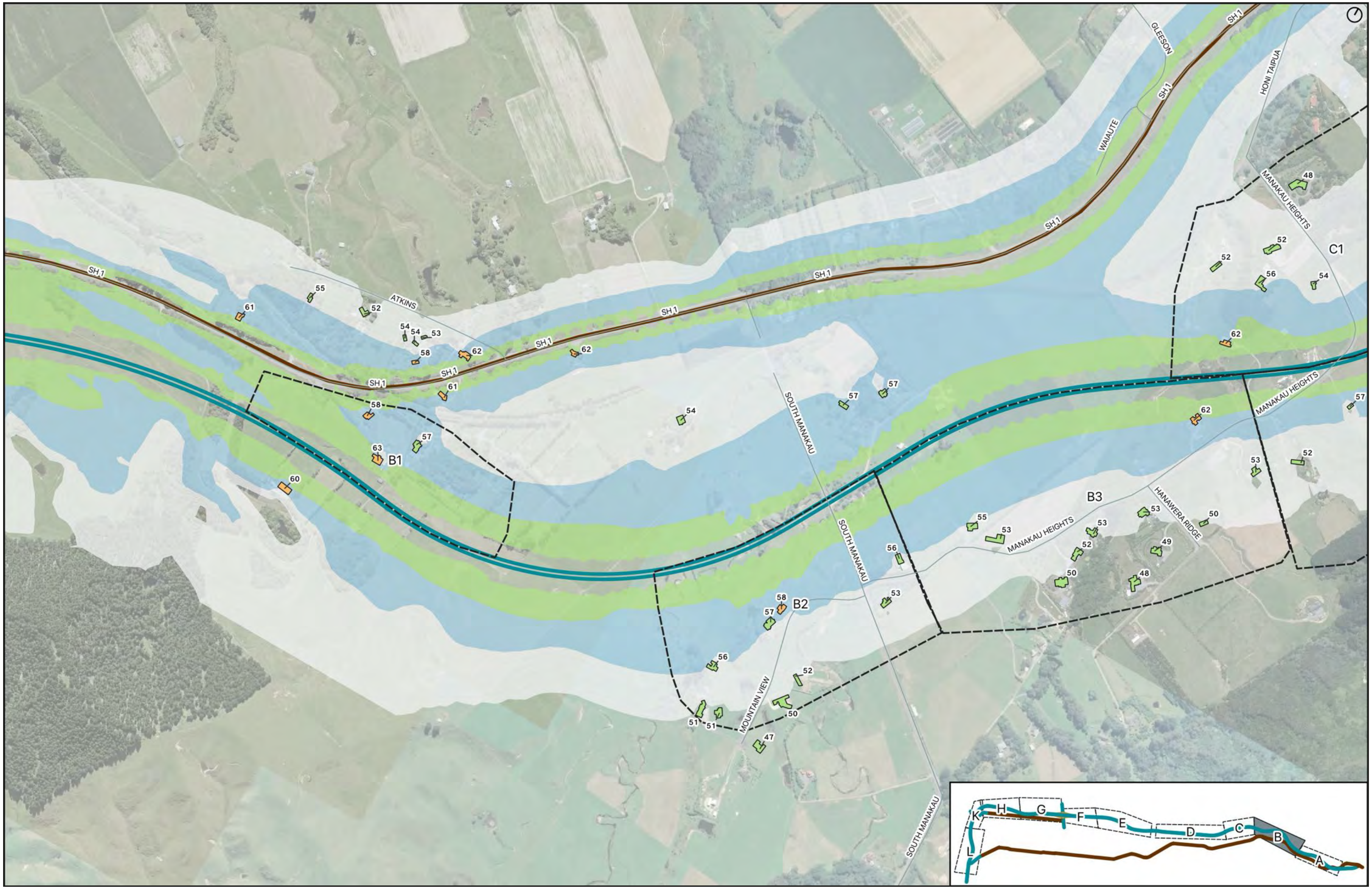
Geometrics without interchange

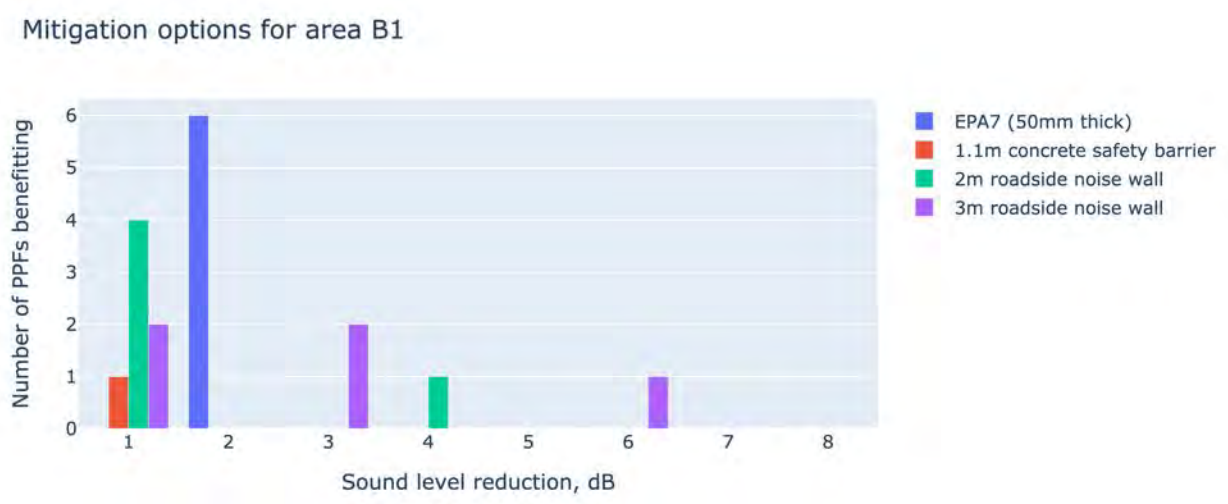


Option 1: High performance surface (EPA7)

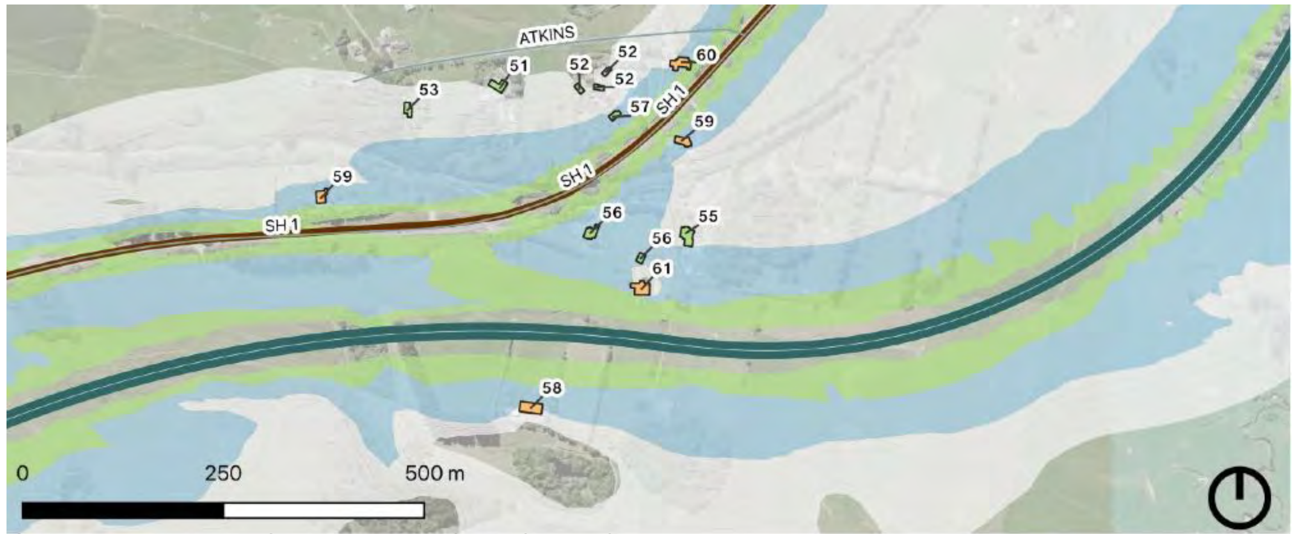


Option for half interchange


SH 1
ATKINS
GLEESON
WAIAUTE
HONI TAIPUA
MANAKAU HEIGHTS
SOUTH MANAKAU
MOUNTAIN VIEW
HANAWERA RIDGE
B1
B2
B3
C1
A
B
C
D
E
F
G
H
K
L

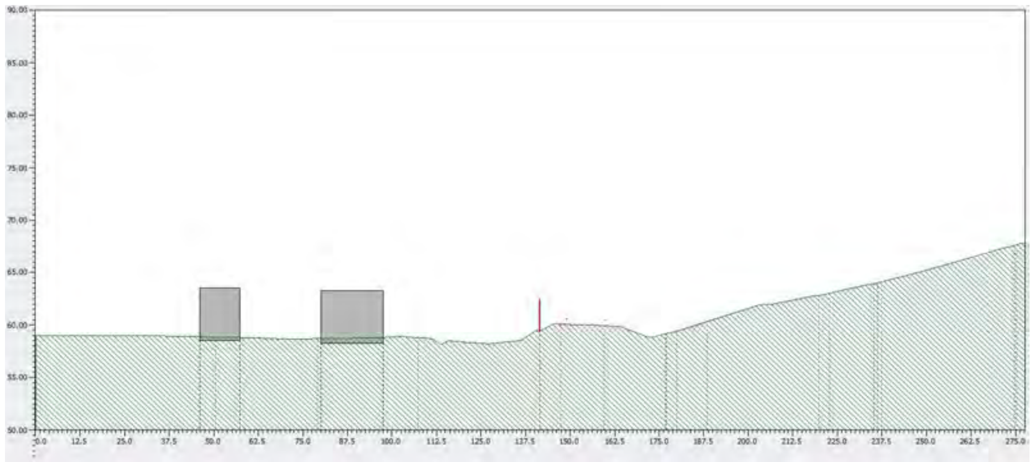


Option 2: concrete safety barrier

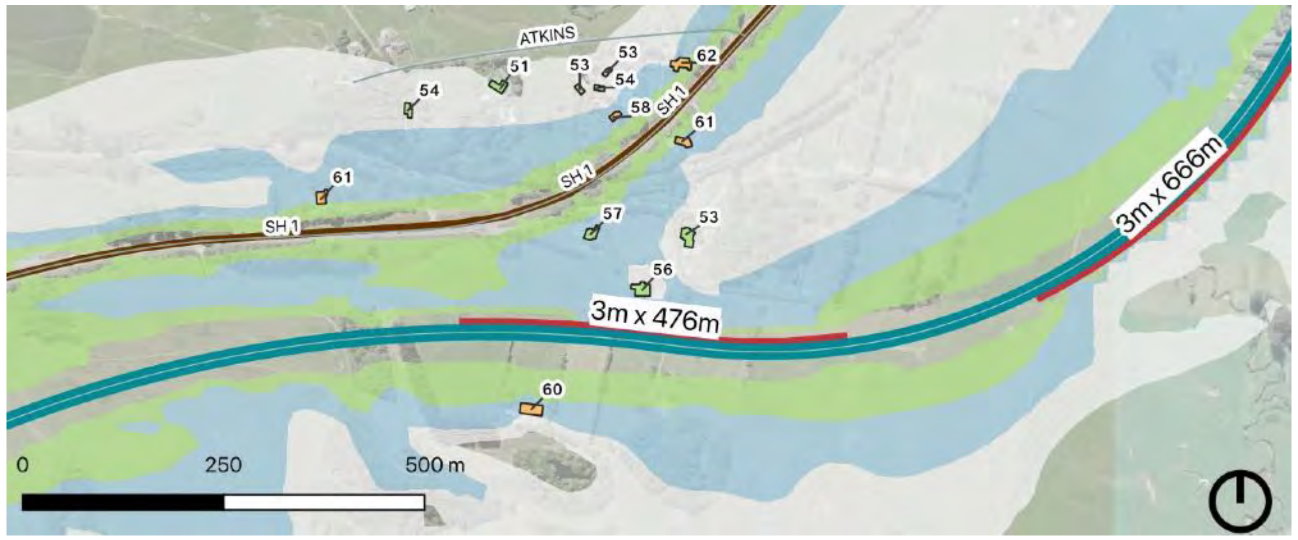


Option 1: High performance surface (EPA7)

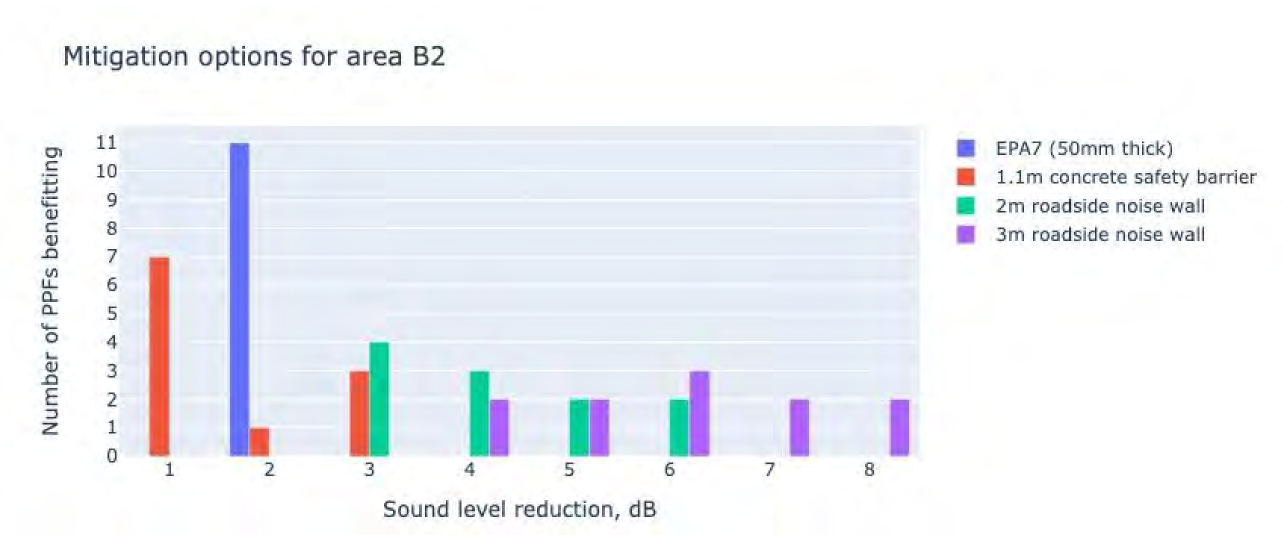
Option 3: 2m high roadside noise wall



Cross section of roadside barrier (2m)



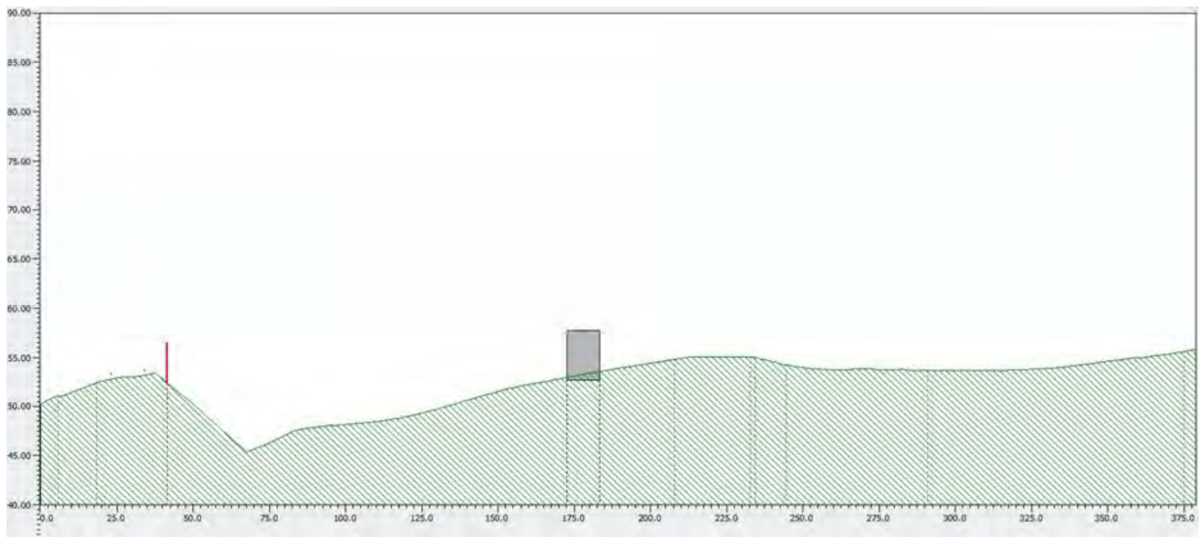
Option 4: 3m high roadside noise wall

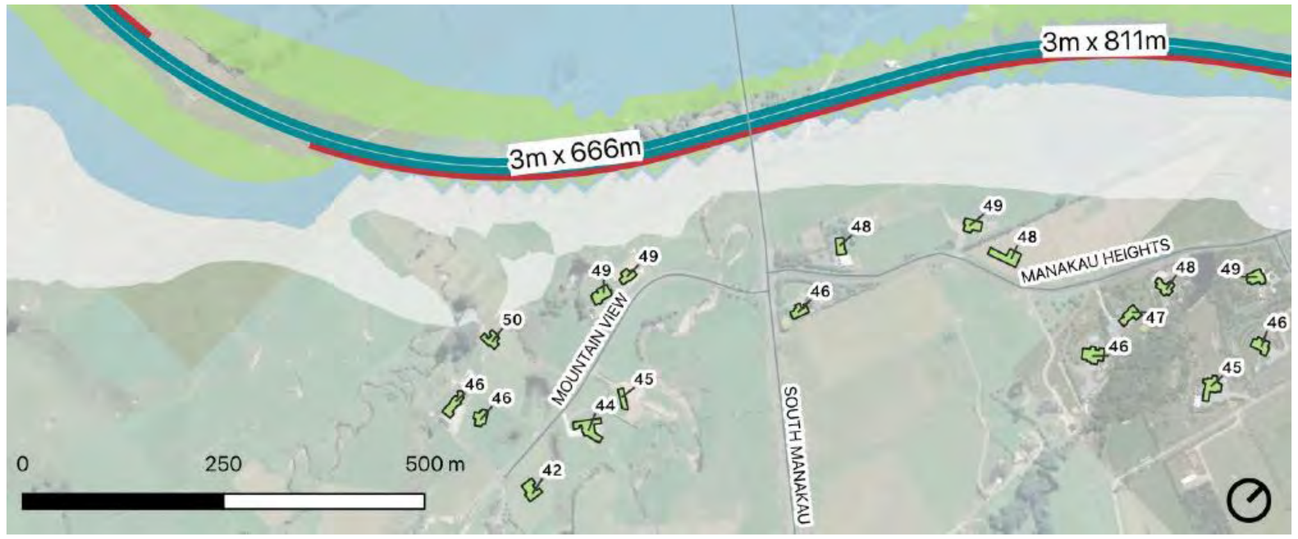


Option 2: concrete safety barrier

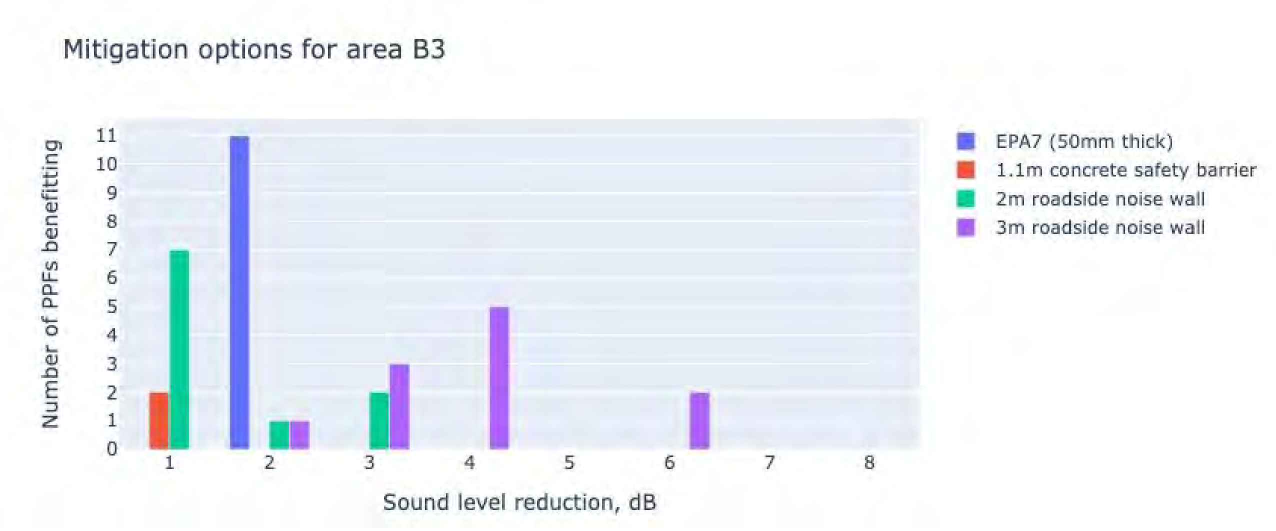
Option 1: High performance surface (EPA7)

Option 3: 2m high roadside noise wall


Cross section of roadside barrier (3m)



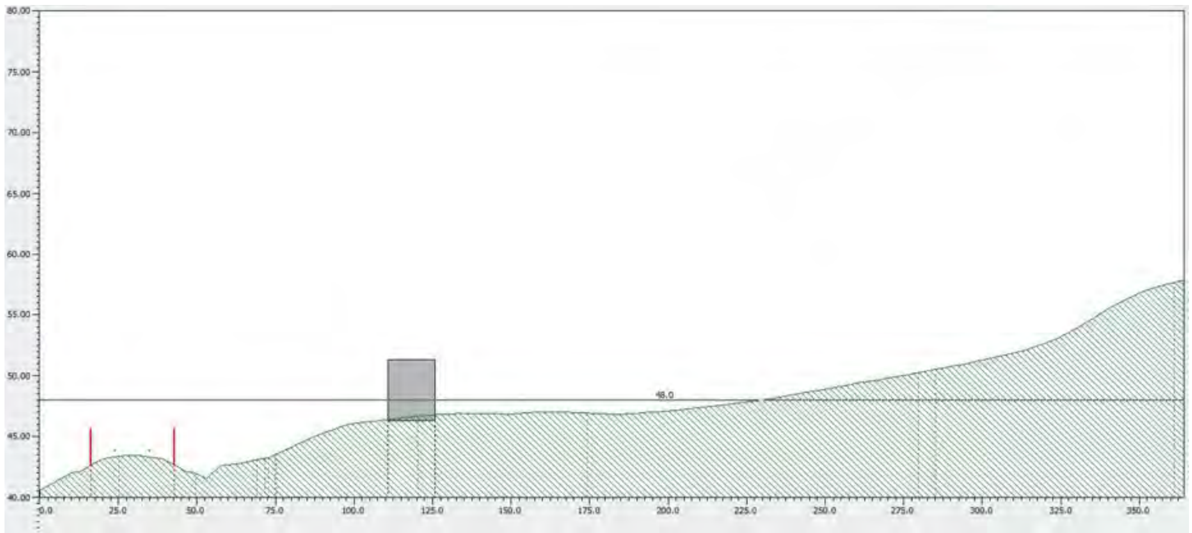
Option 4: 3m high roadside noise wall

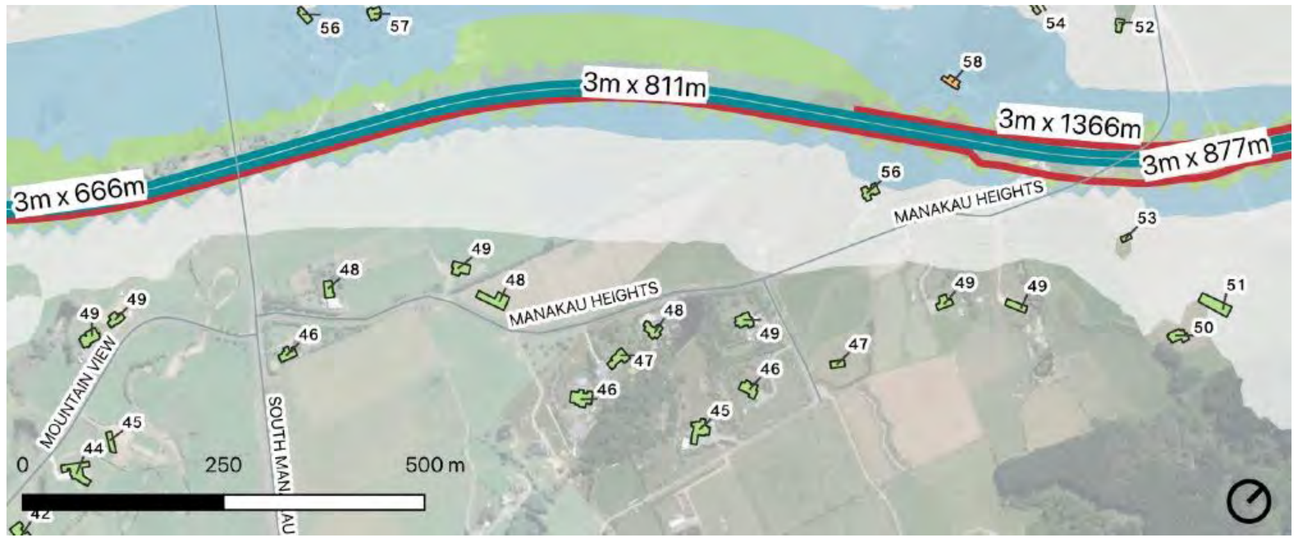


Option 2: concrete safety barrier

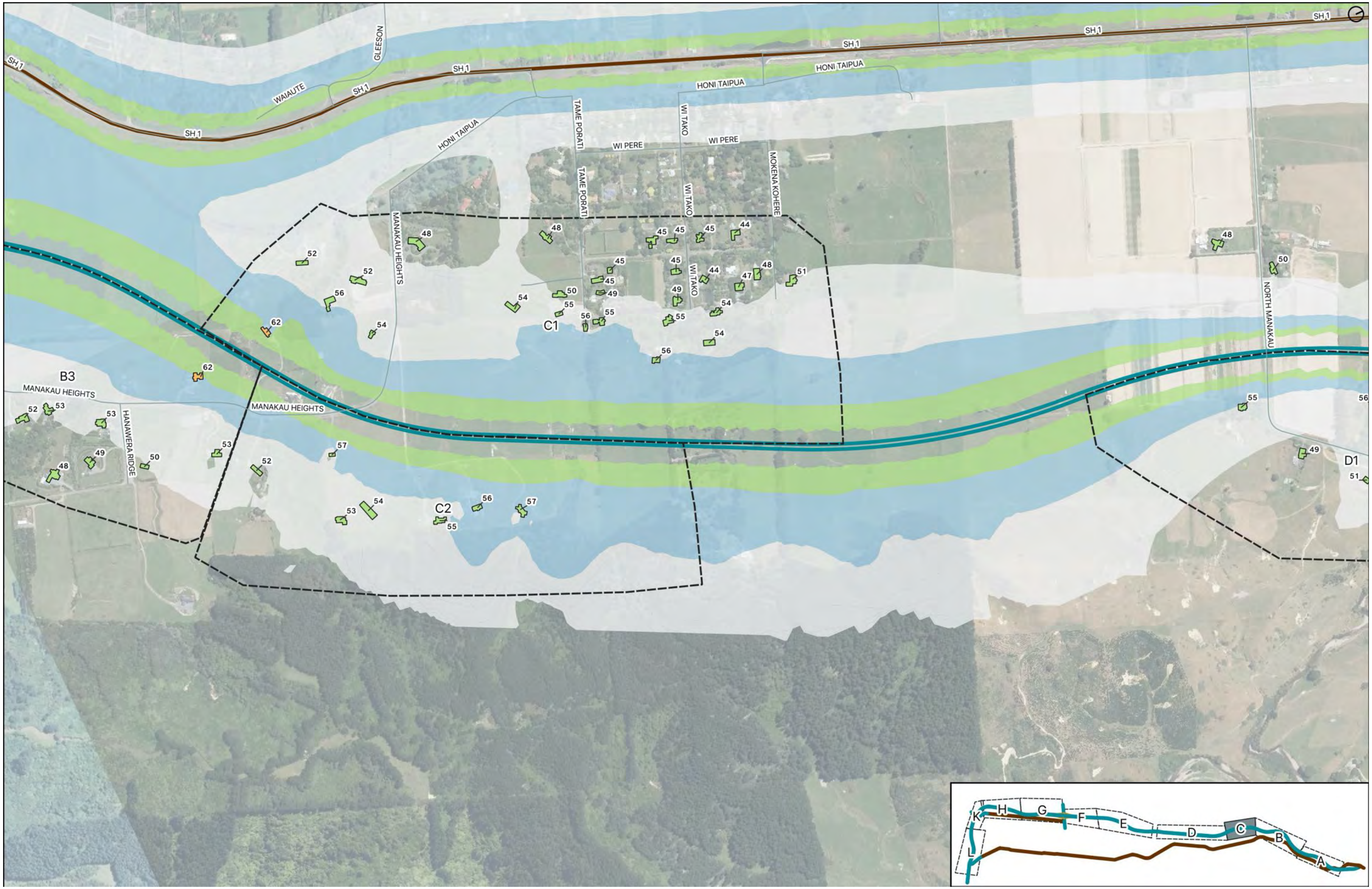
Option 1: High performance surface (EPA7)

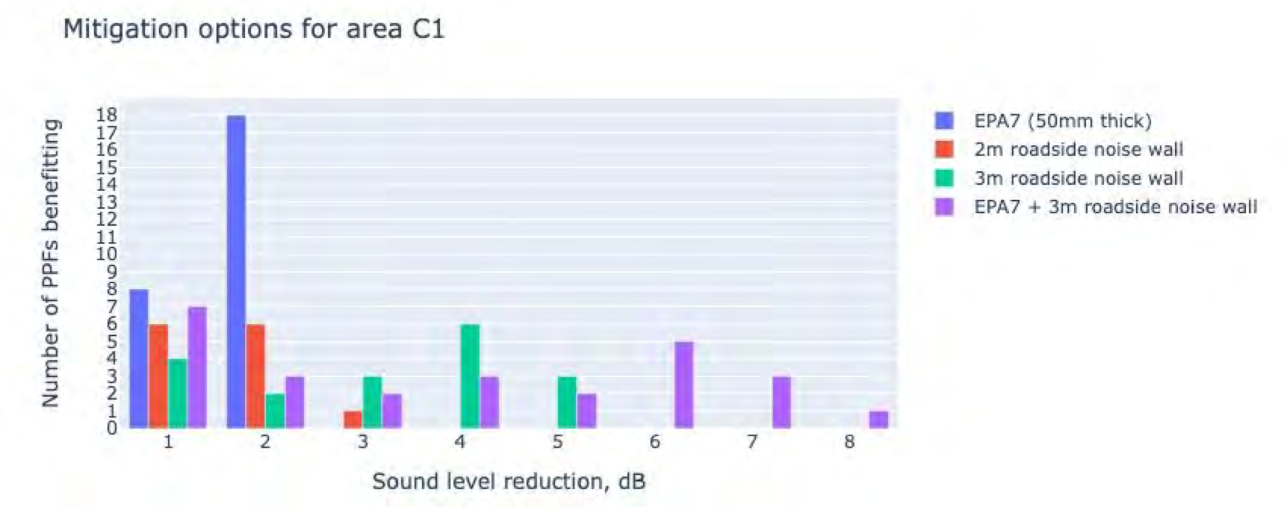
Option 3: 2m high roadside noise wall


Cross section of roadside noise wall (3m)



Option 4: 3m high roadside noise wall

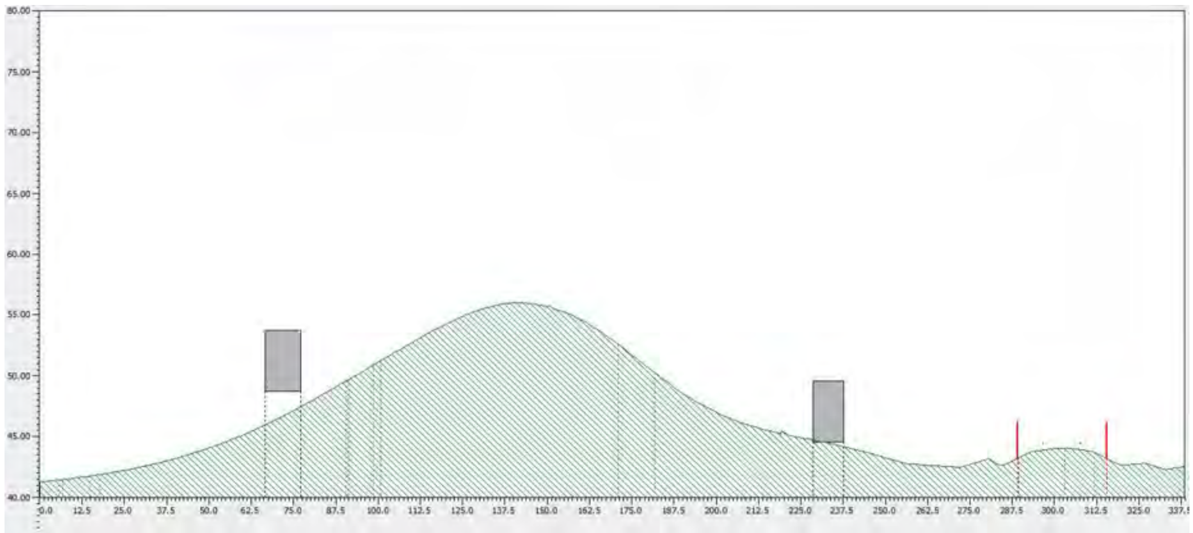

SH 1
GLEESON
WAIAUTE
HONI TAIPUA
TAME PORATI
WI TAKO
WI PERE
MOKENA KOHERE
MANAKAU HEIGHTS
NORTH MANAKAU
HANAWERA RIDGE
B3
C1
C2
D1
A
B
C
D
E
F
G
H
K
L



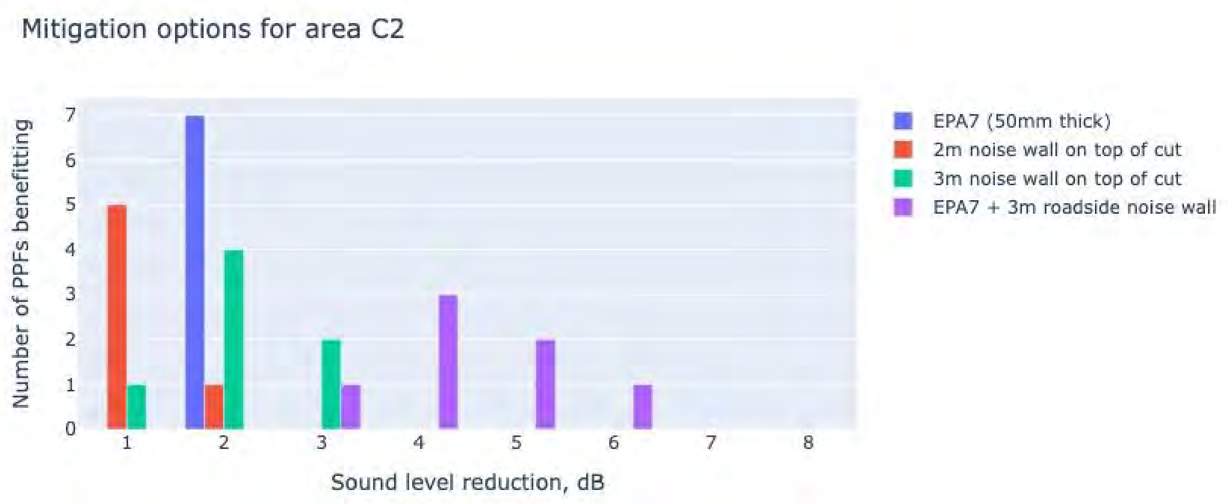
Option 2: 2m high roadside noise wall (top)

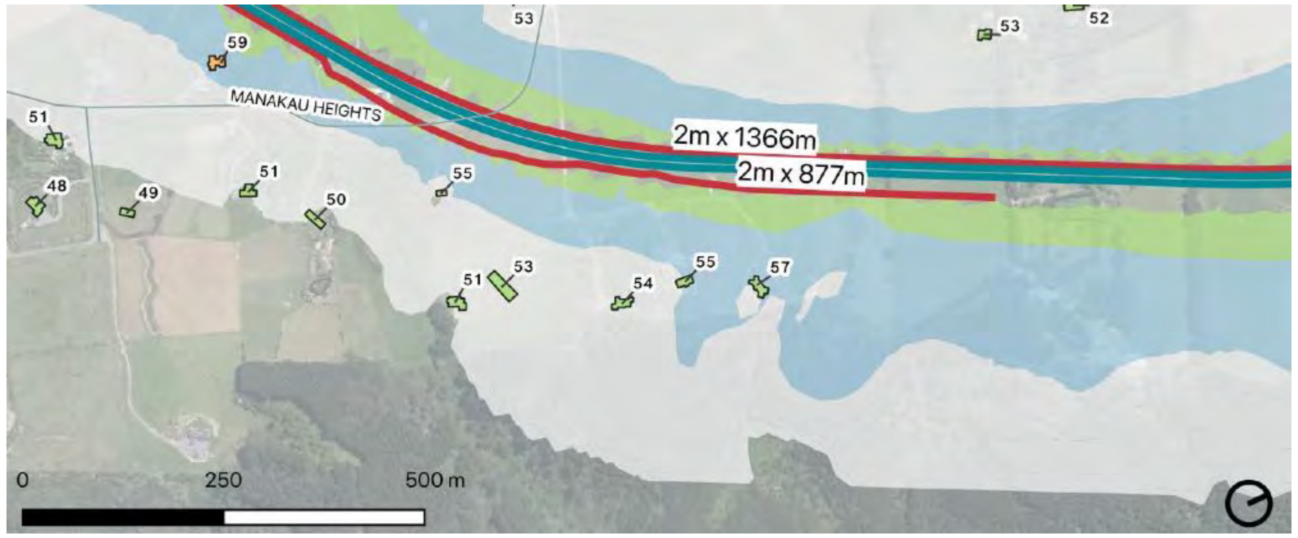
Option 1: High performance surface (EPA7)

Option 3: 3m high roadside noise wall (top)

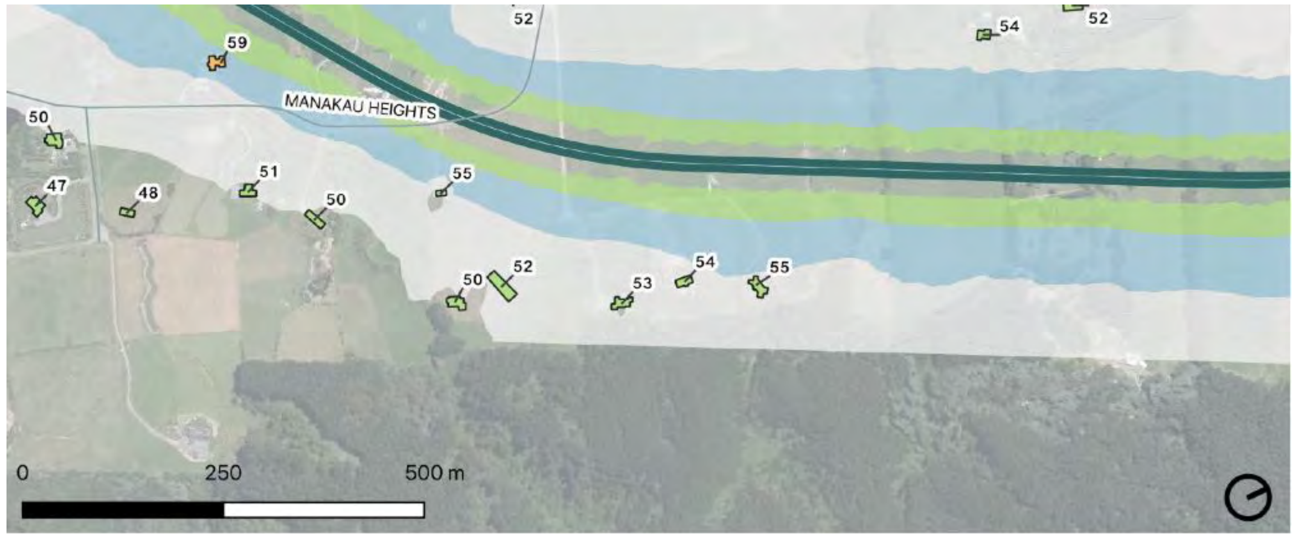

Cross section of roadside noise wall (3m)

Option 4: EPA7 + 3m high roadside noise wall

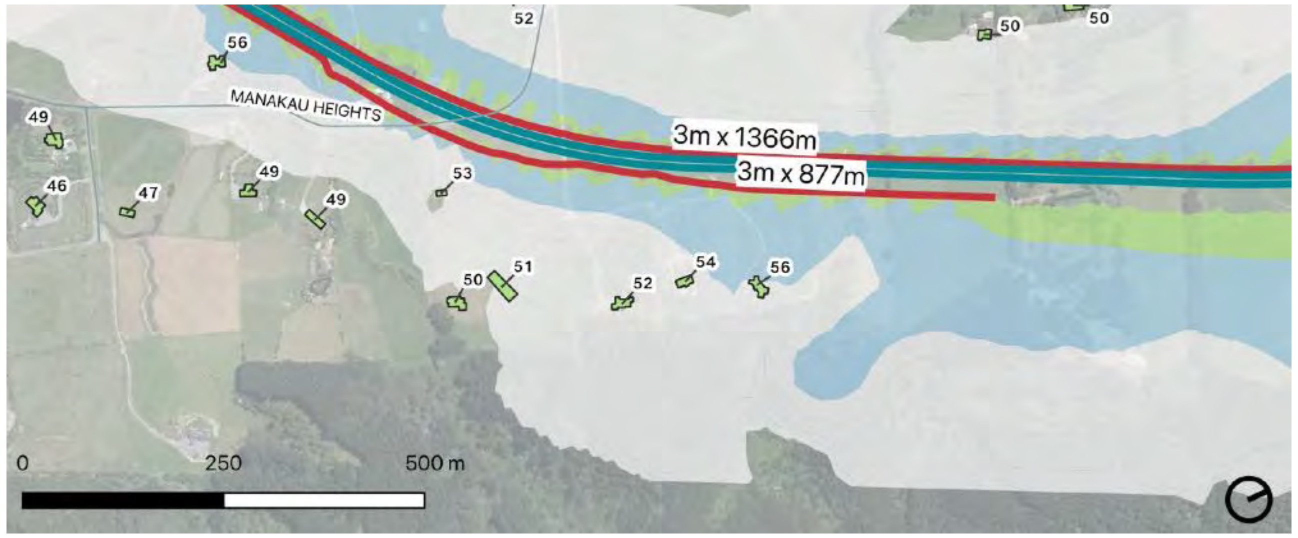




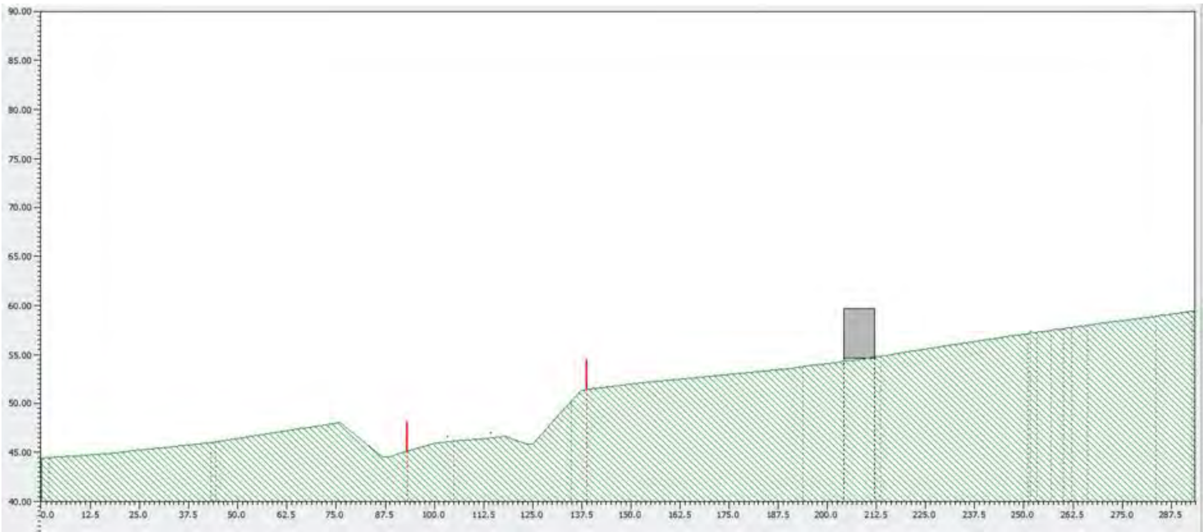
Option 2: 2m high noise wall on top of cut



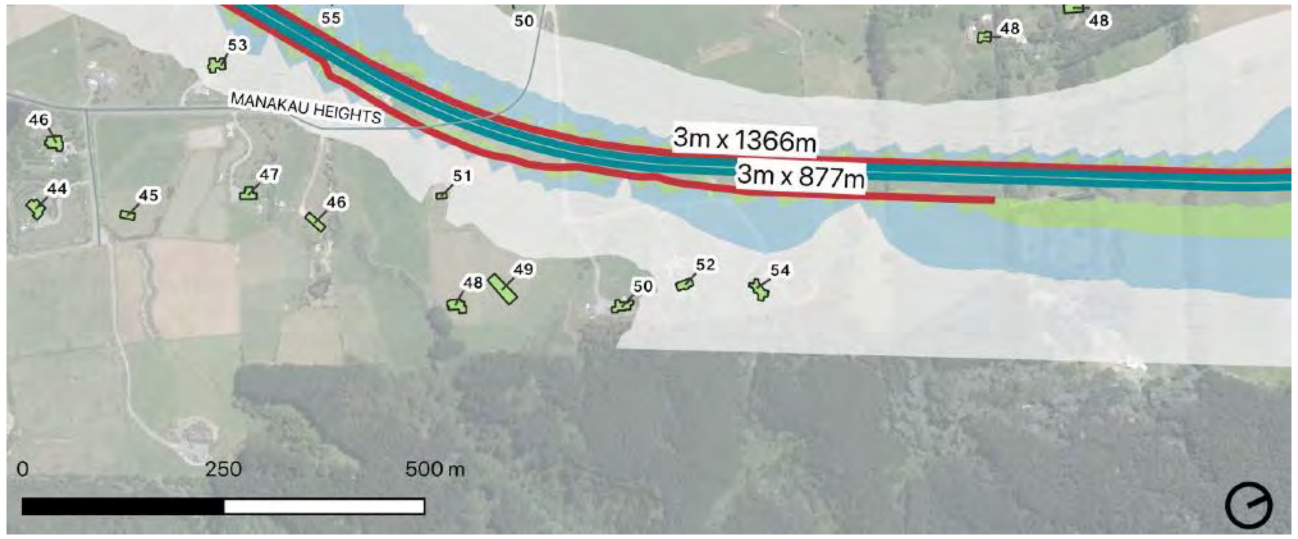
Option 1: High performance surface (EPA7)



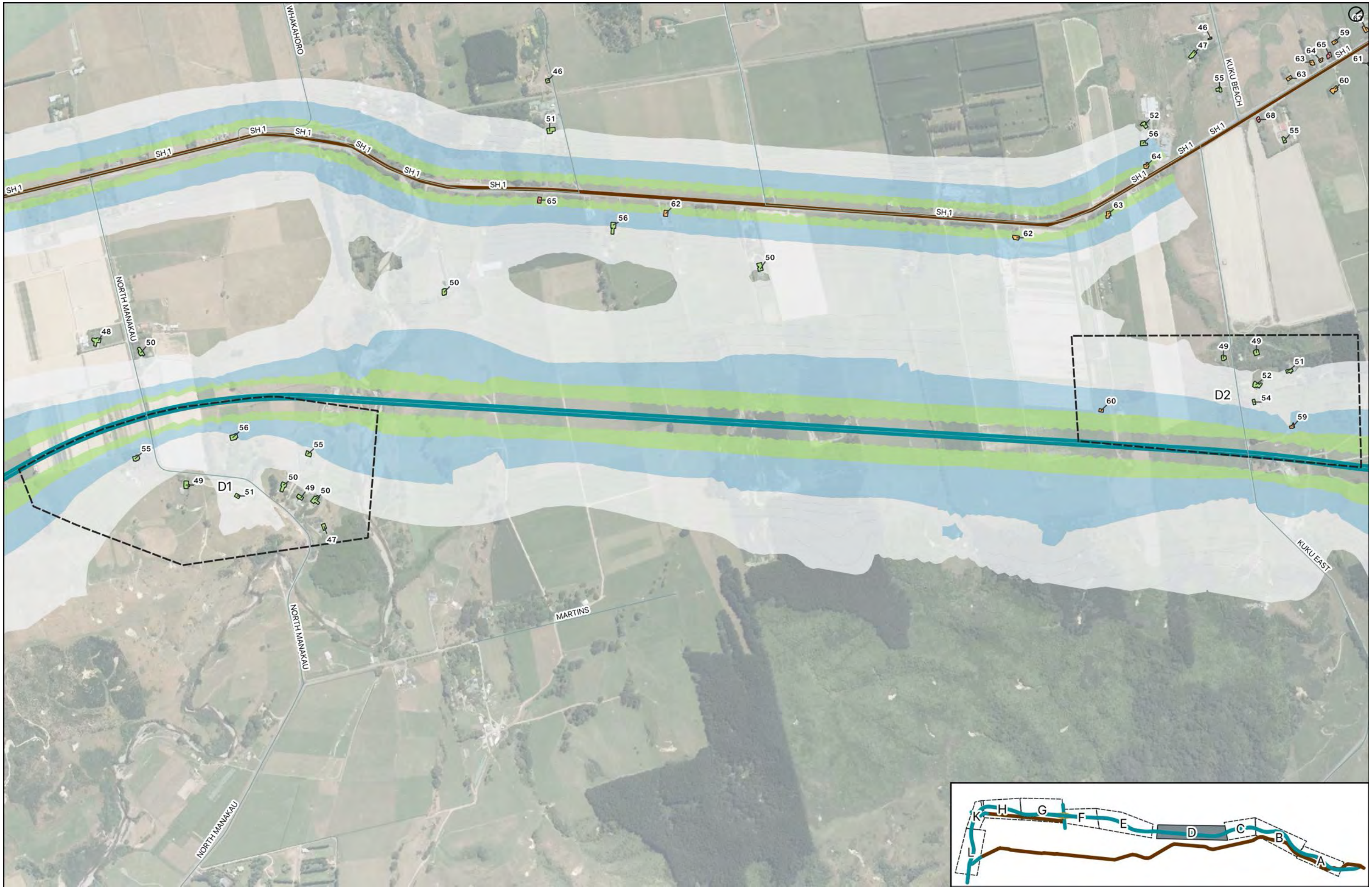
Option 3: 3m high noise wall on top of cut

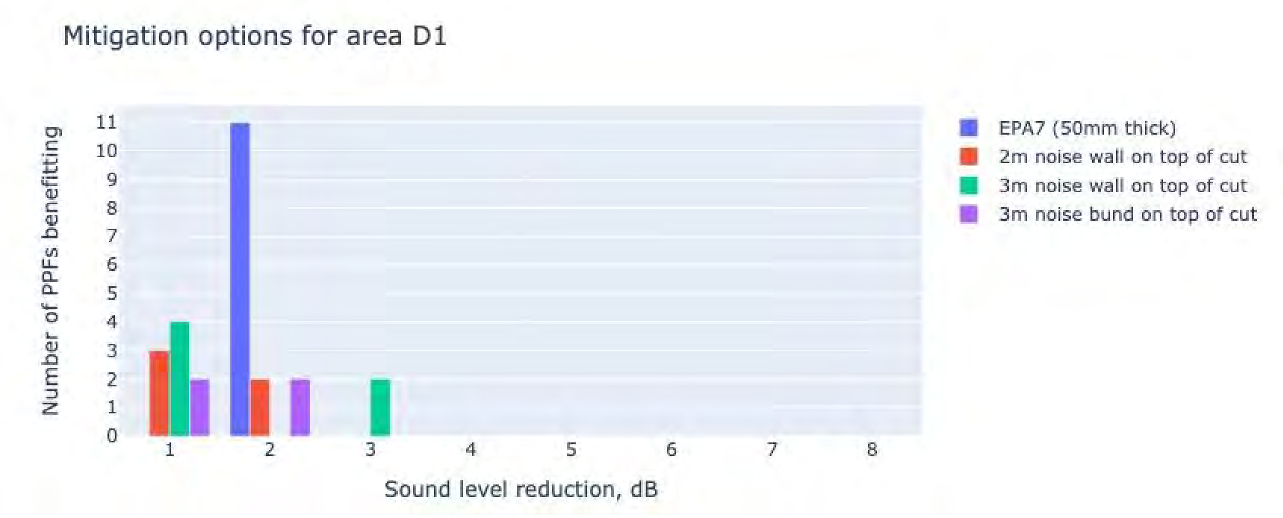


Cross section of roadside noise wall (3m)



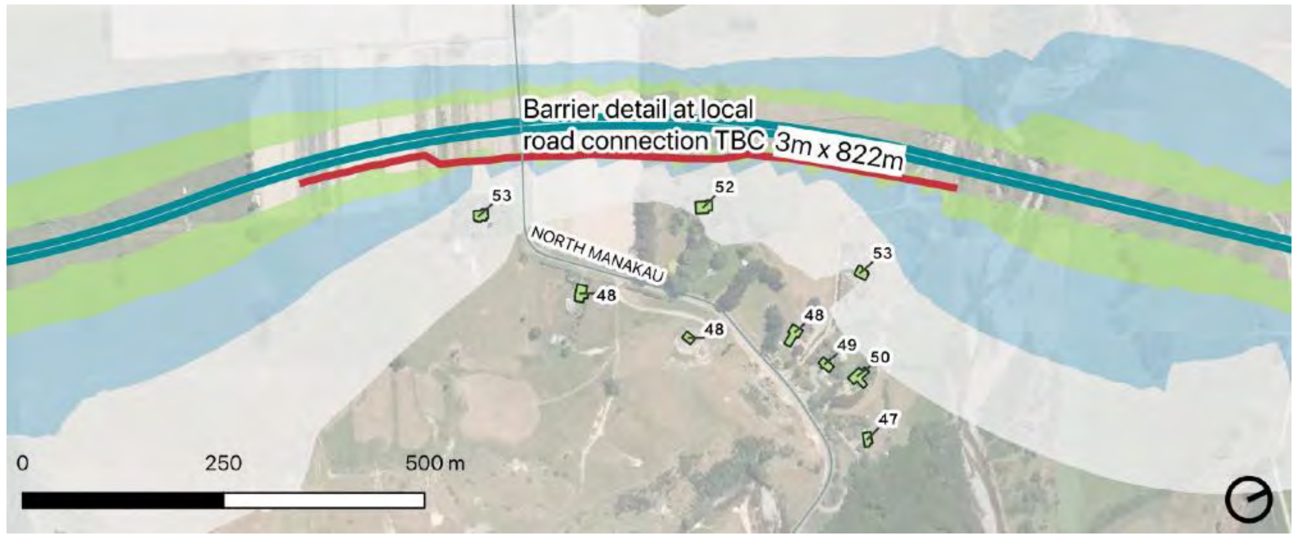
Option 4: EPA7 + 3m high noise wall on top of cut


WHAKAHORO
NORTH MANAKAU
KUKU BEACH
KUKU EAST
MARTINS
SH 1
D1
D2
A
B
C
D
E
F
G
H
K
L

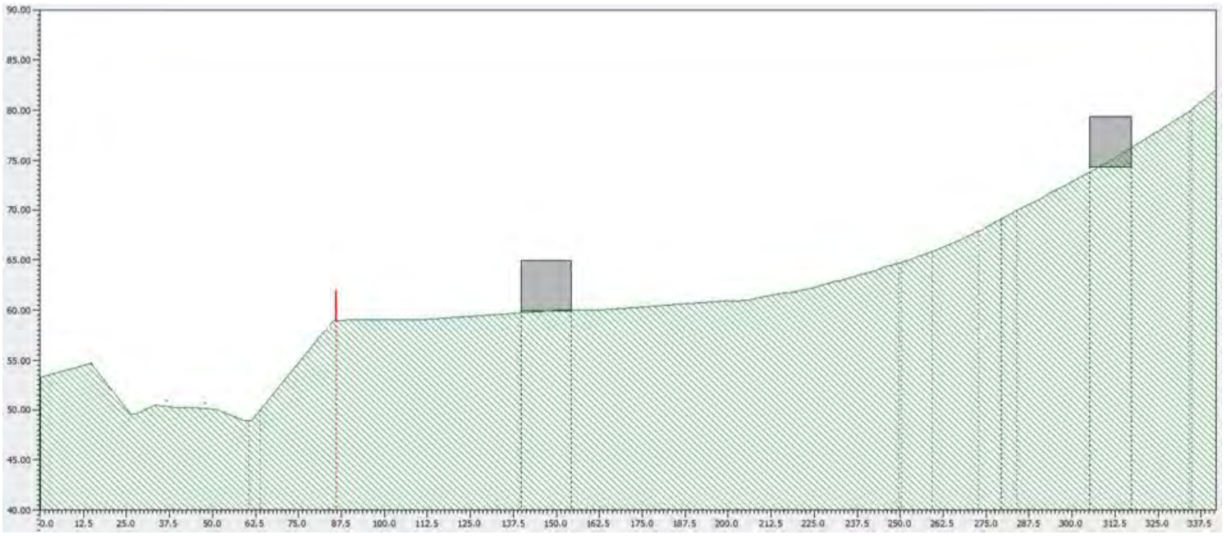


Option 2: 2m high noise wall on top of cut

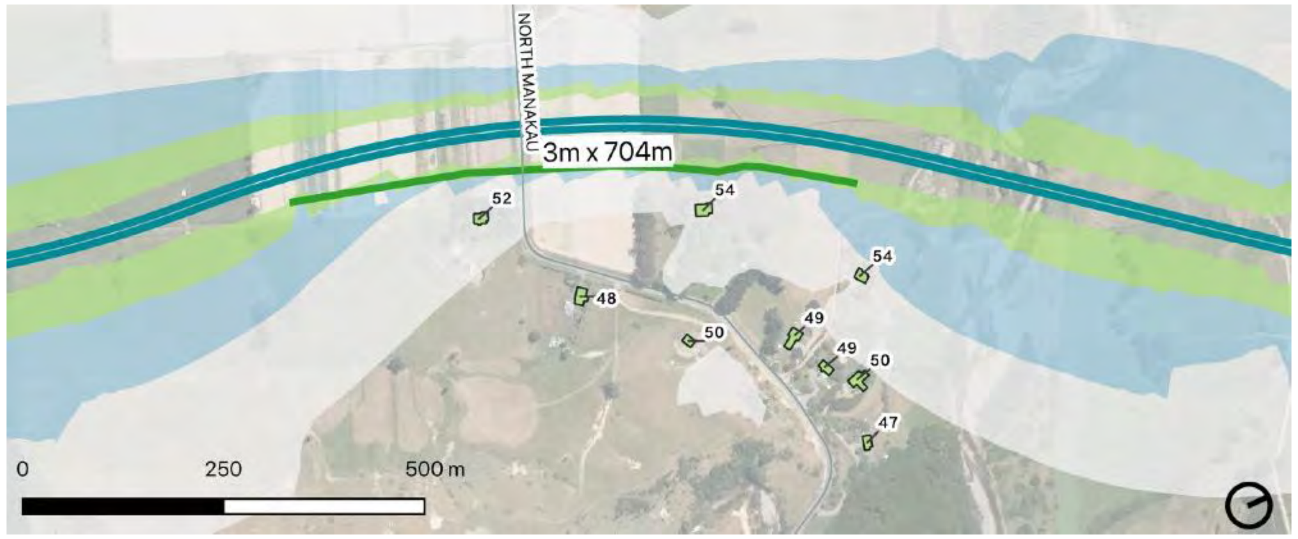
Option 1: High performance surface (EPA7)



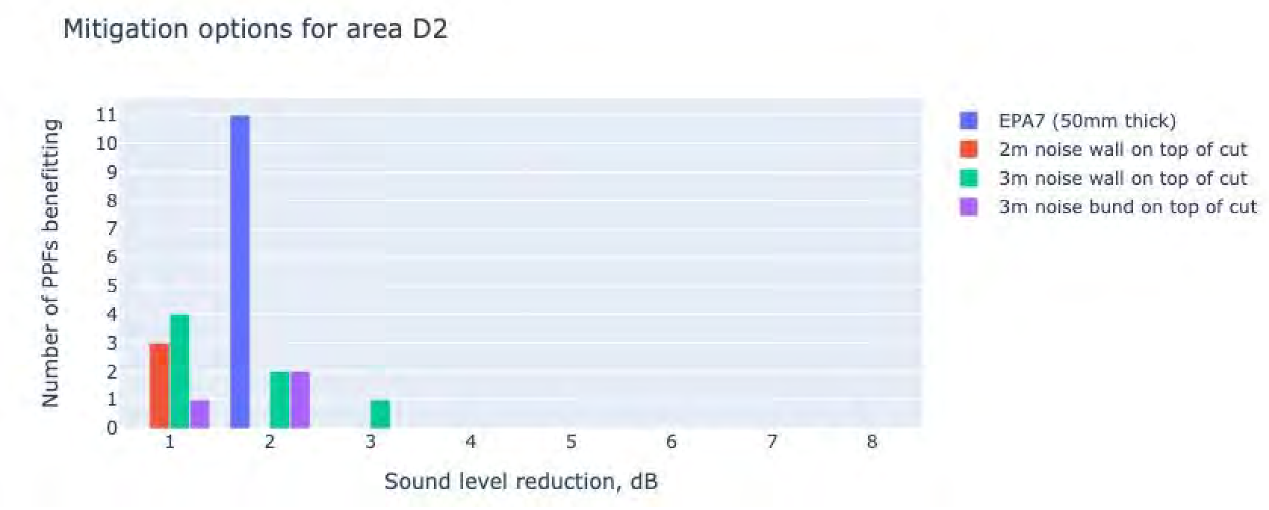
Option 3: 3m high noise wall on top of cut

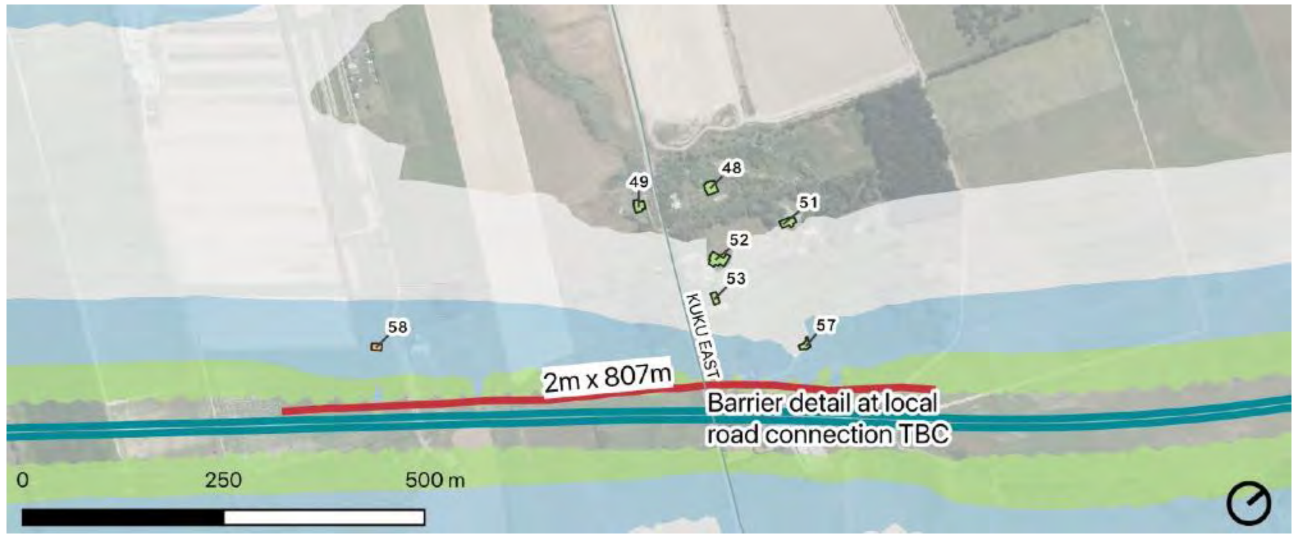


Cross section of noise wall top top of cut (3m)



Option 4: 3m high noise bund on top of cut

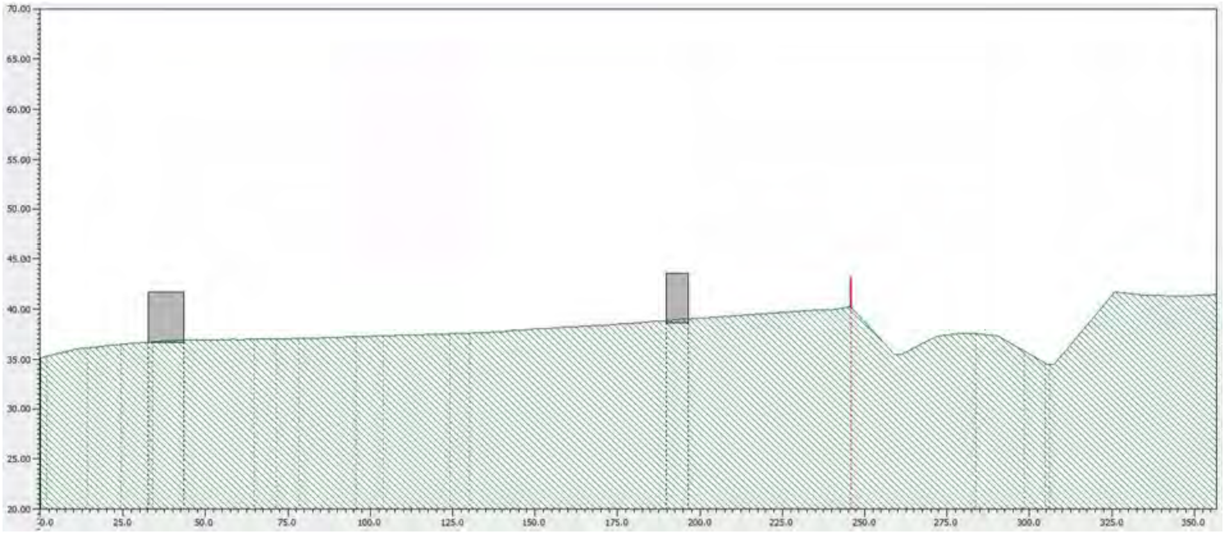




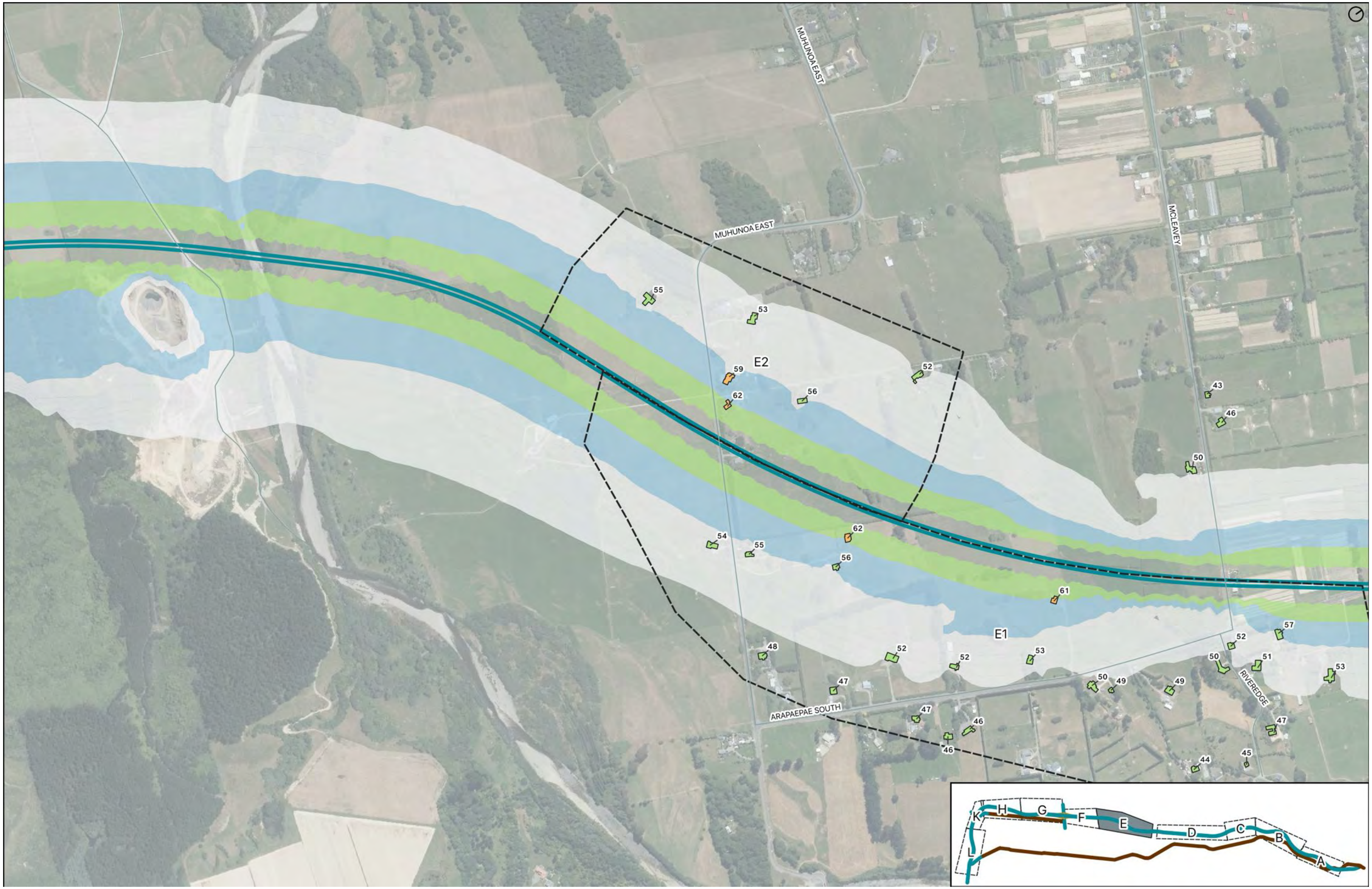
Option 2: 2m high noise wall on top of cut

Option 1: High performance surface (EPA7)

Option 3: 3m high noise wall on top of cut


Cross section of noise wall top top of cut (3m)

Option 4: 3m high noise bund on top of cut


MUHUNOA EAST
MUHUNOA EAST
MCLEAVEY
ARAPAEPAE SOUTH
RIVEREDGE
E2
E1
55
53
59
62
52
56
43
46
50
54
55
62
56
61
48
52
52
53
57
52
50
51
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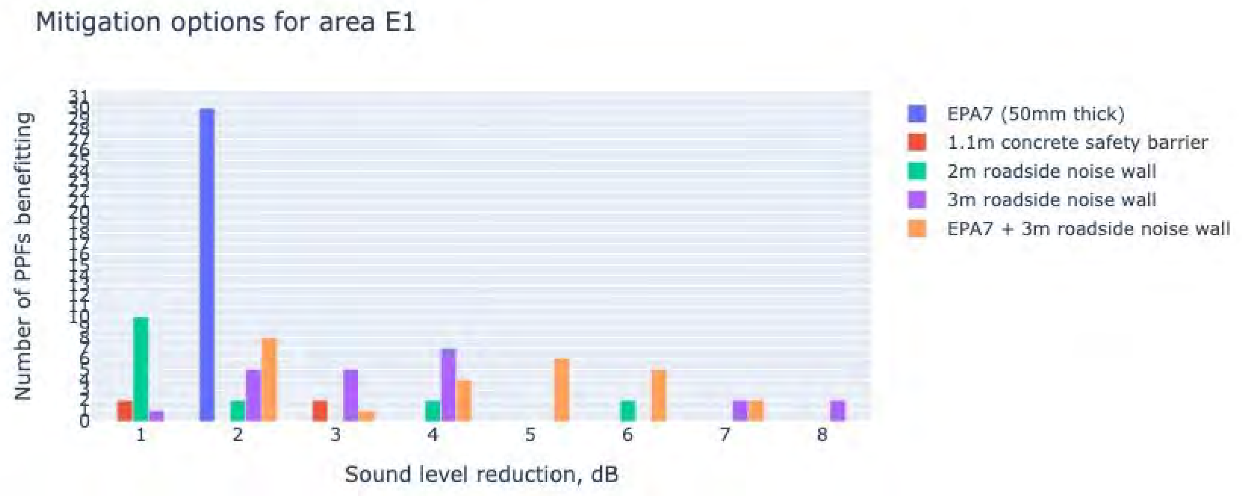
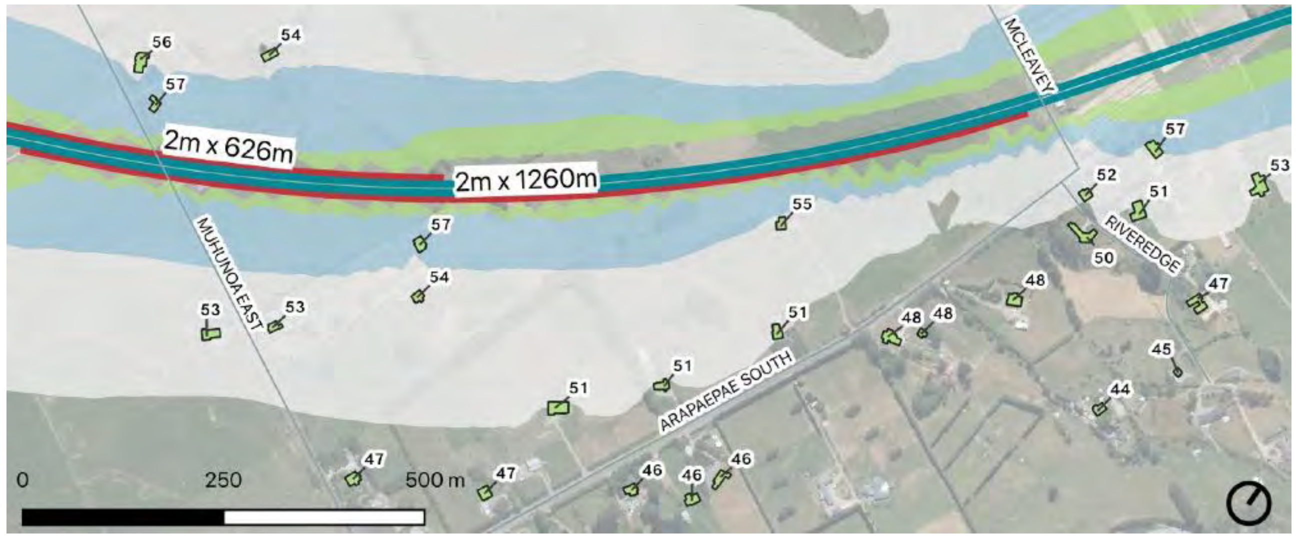
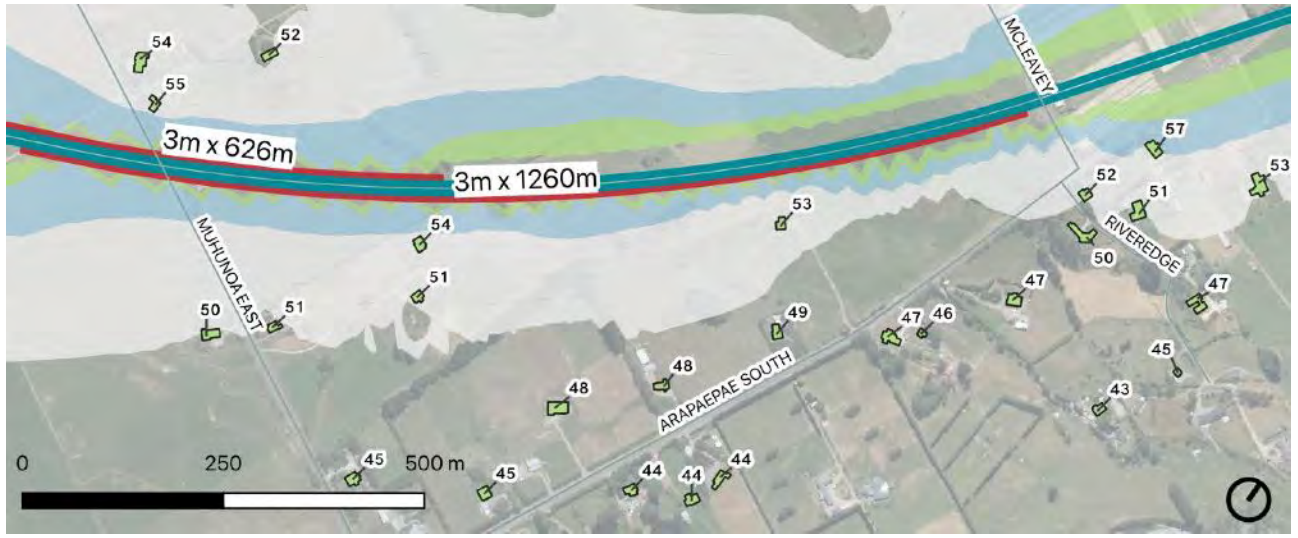
47
44
45
K
H
G
F
E
D
C
B
A
L



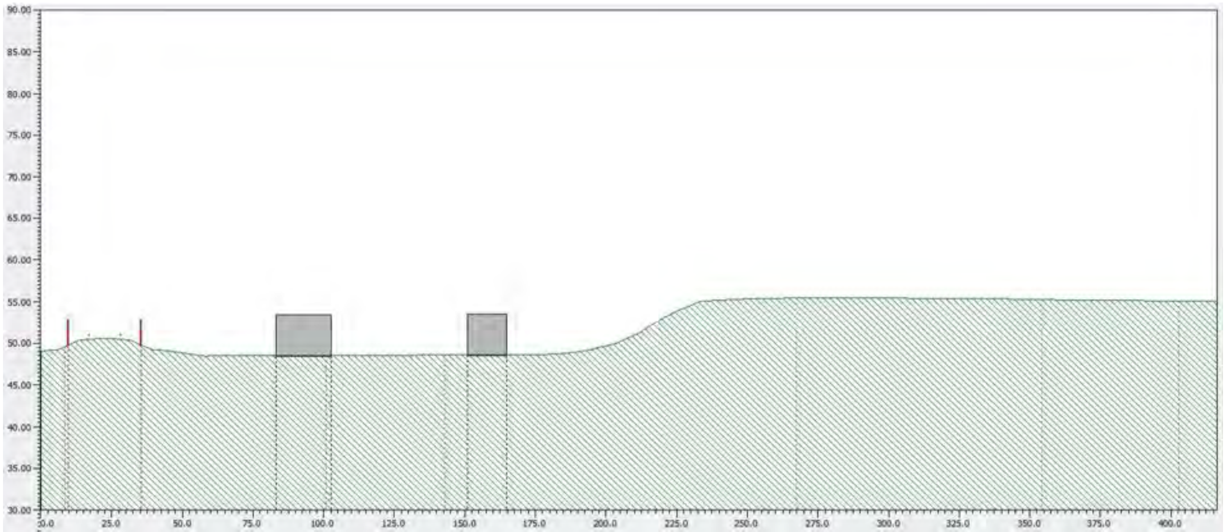


Option 2: 2m high roadside noise wall

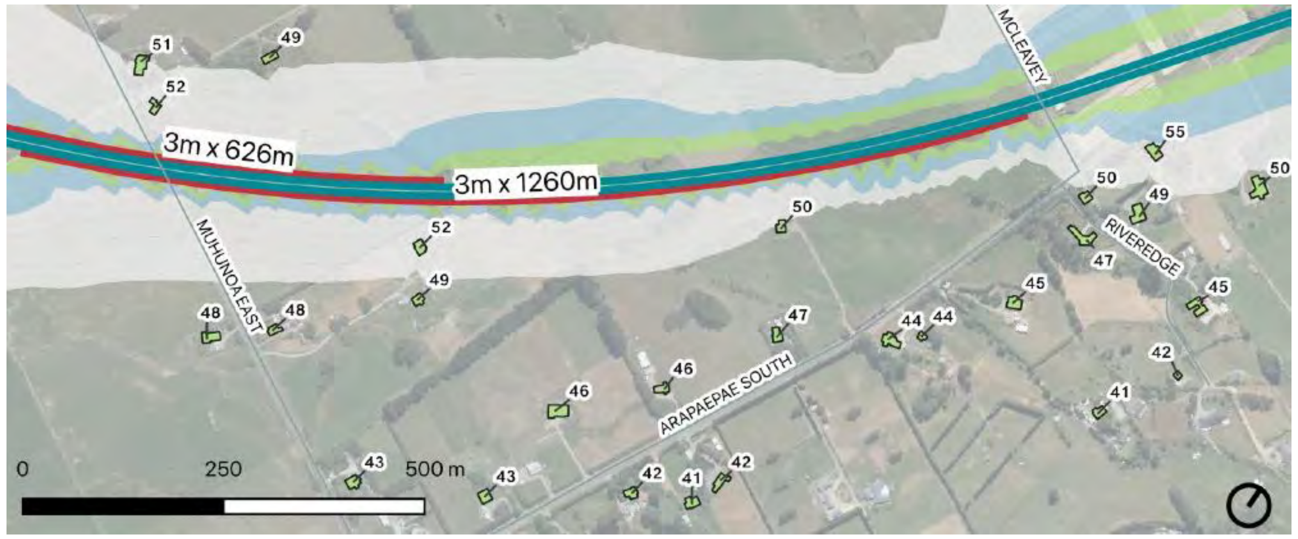
Option 1: High performance surface (EPA7)



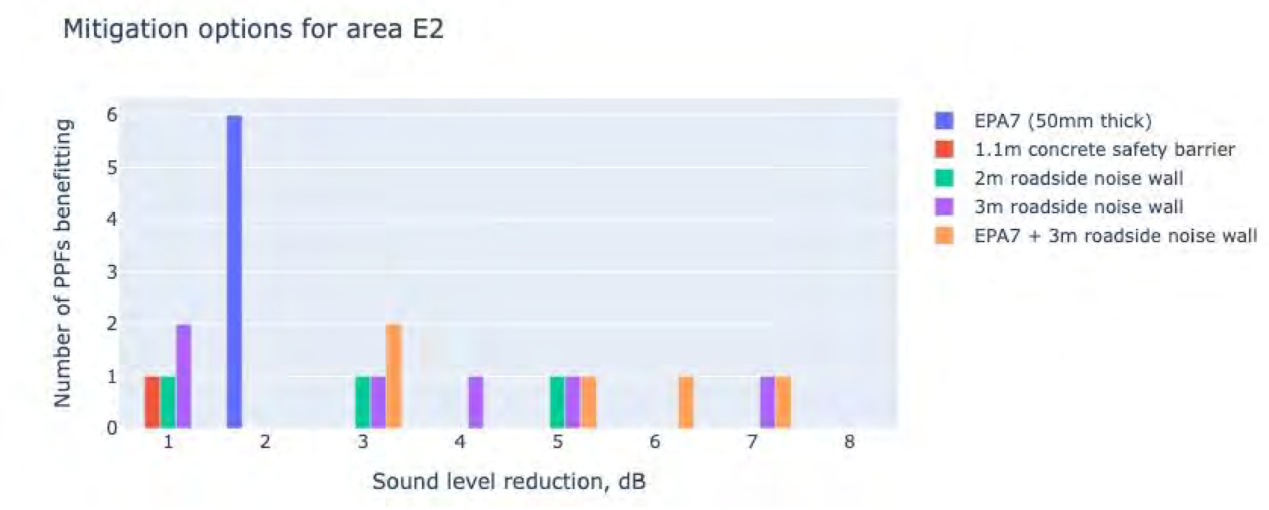
Option 3: 3m high roadside noise wall

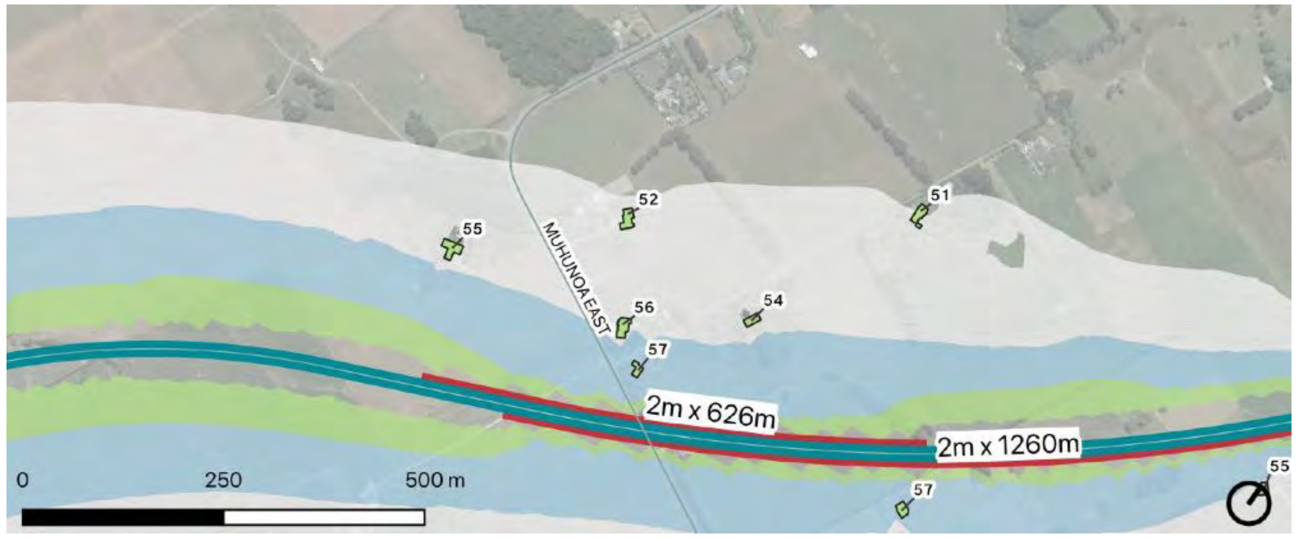


Cross section of roadside noise wall (3m)



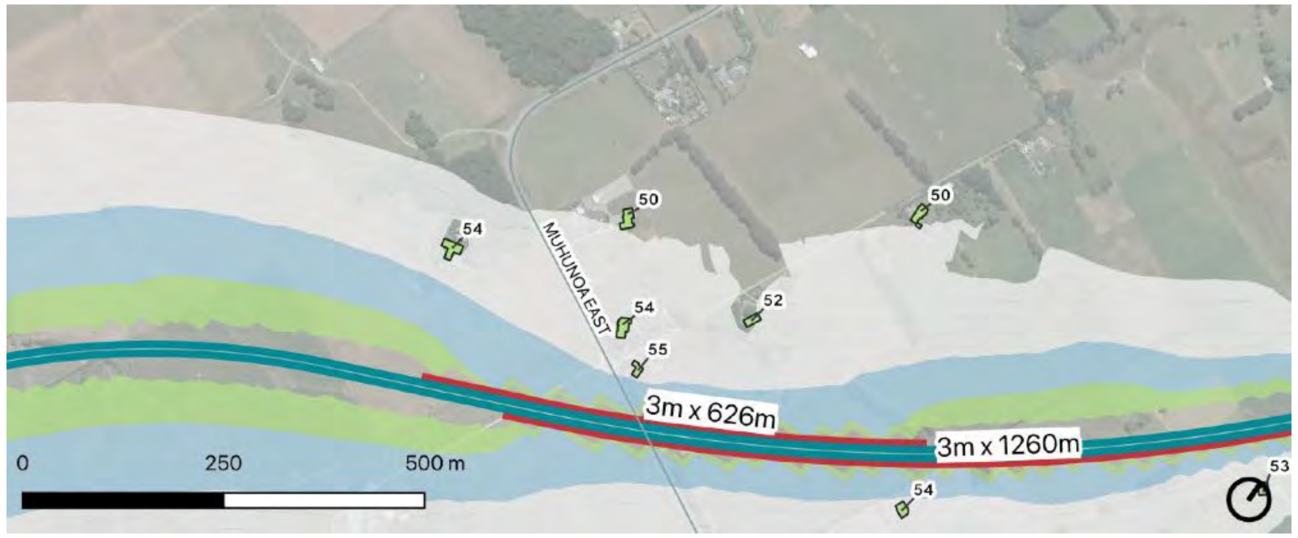
Option 4: EPA7 + 3m high roadside noise wall



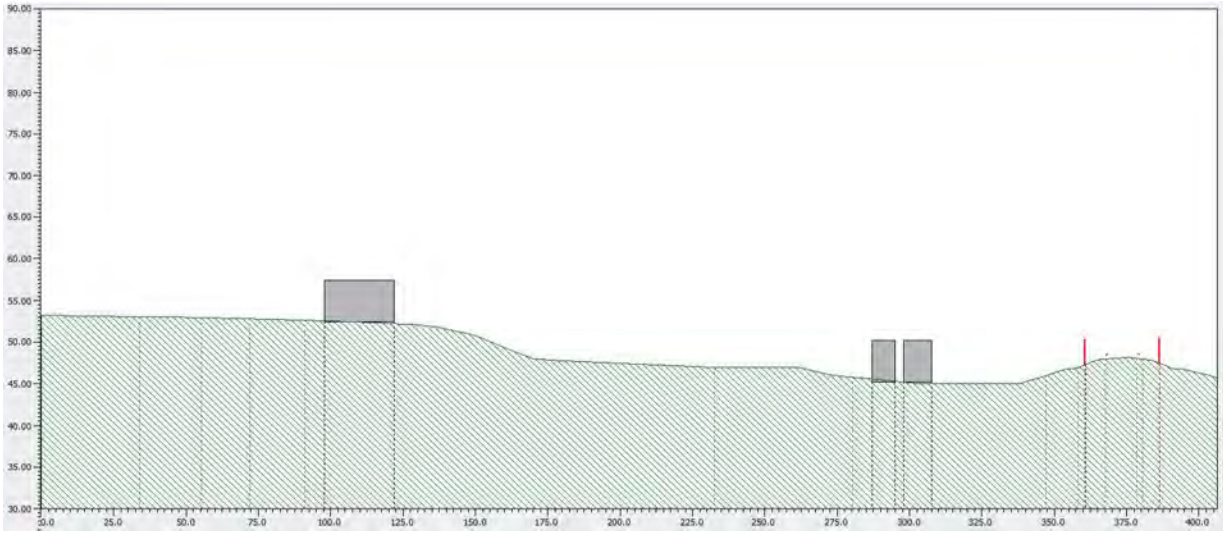


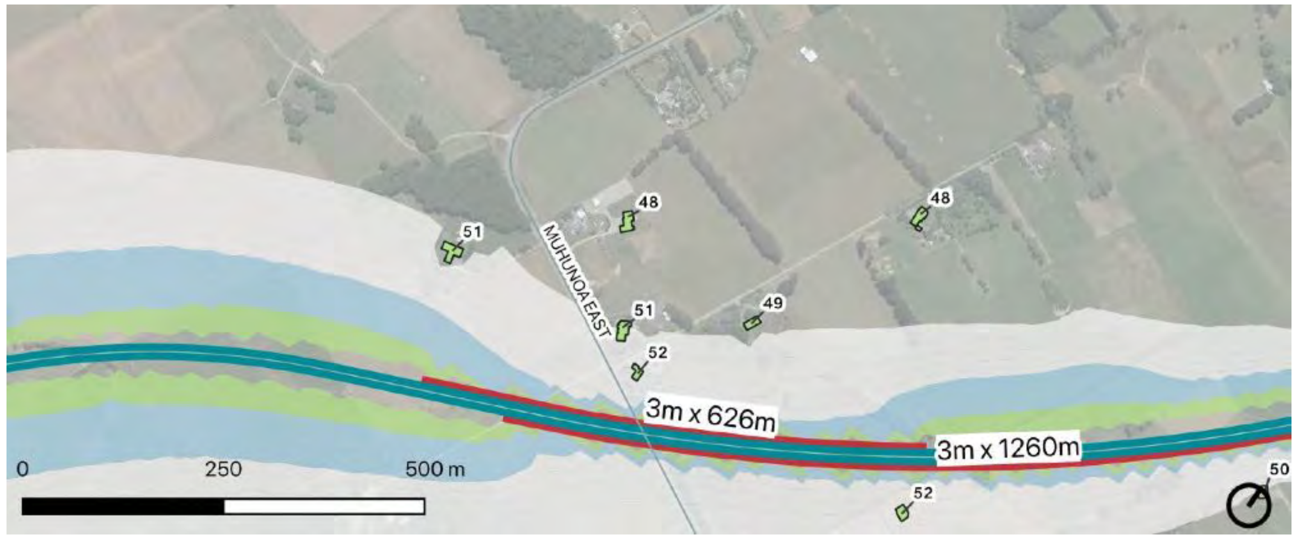
Option 2: 2m high roadside noise wall

Option 1: High performance surface (EPA7)

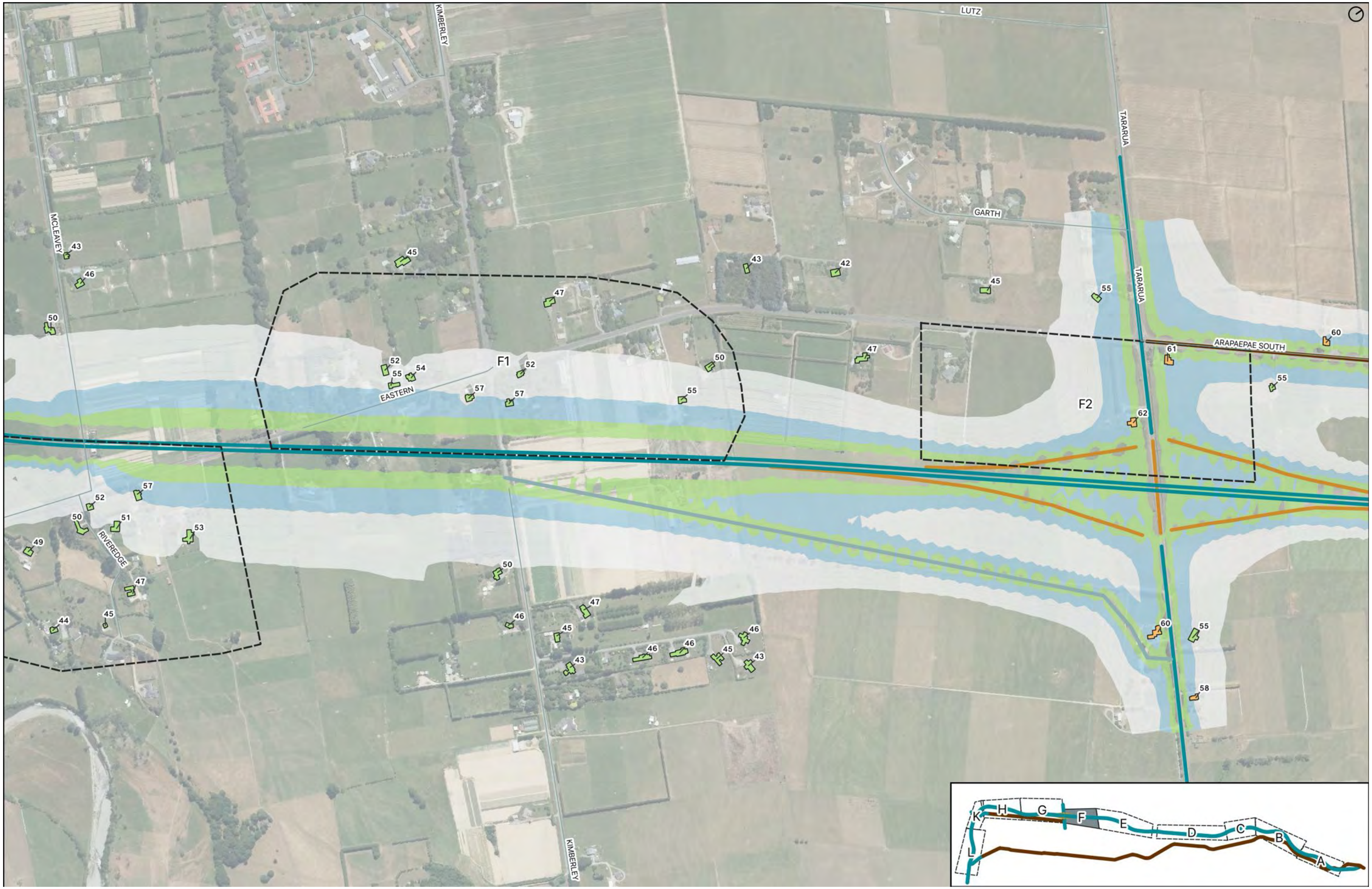


Option 3: 3m high roadside noise wall


Cross section of roadside noise wall (3m)



Option 4: EPA7 + 3m high roadside noise wall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TARARUA
GARTH
MCLEAVEY
ARAPAEPAE SOUTH
EASTERN
RIVEREDGE
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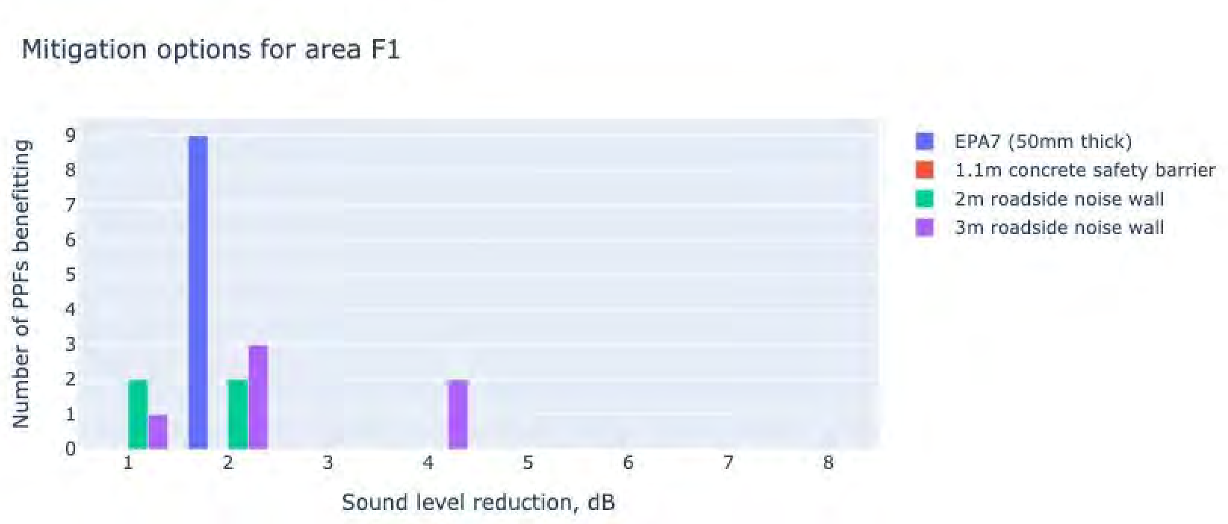
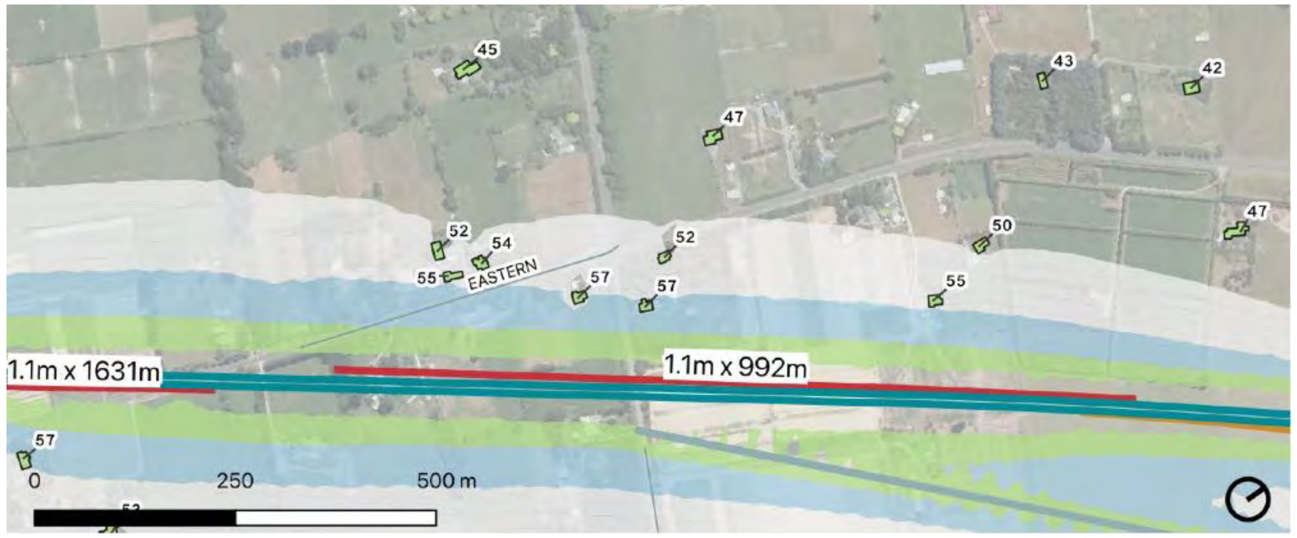
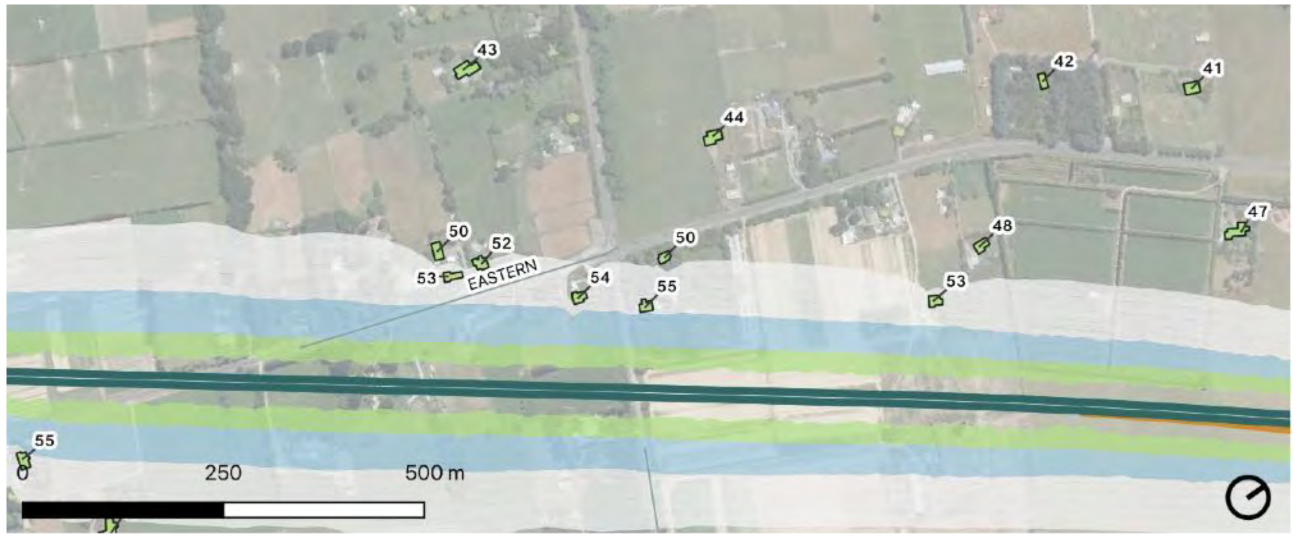
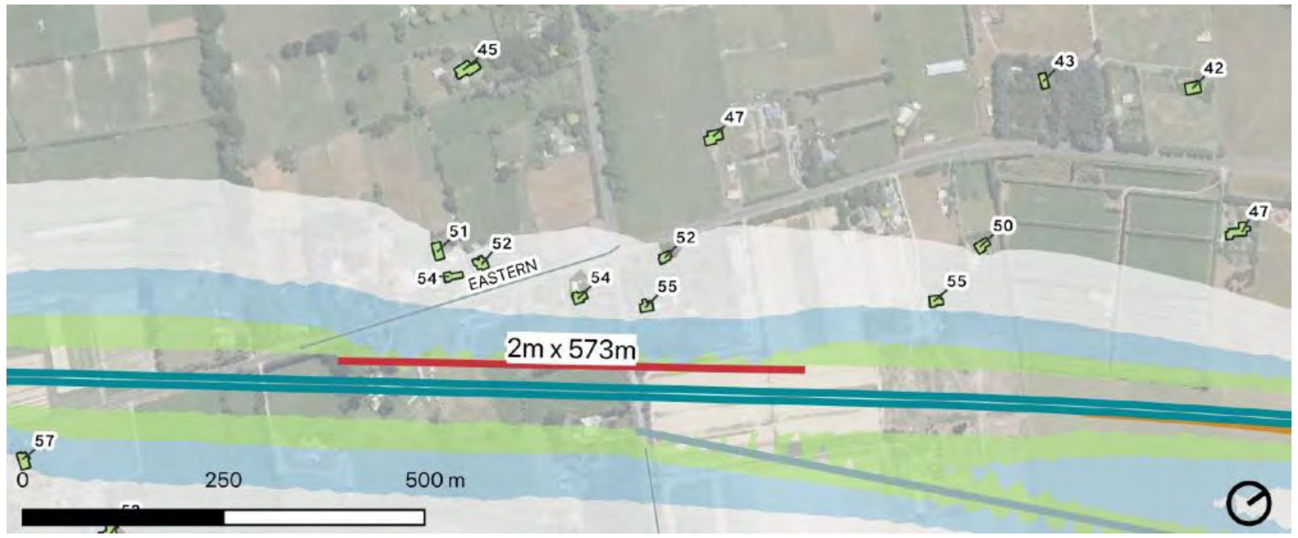




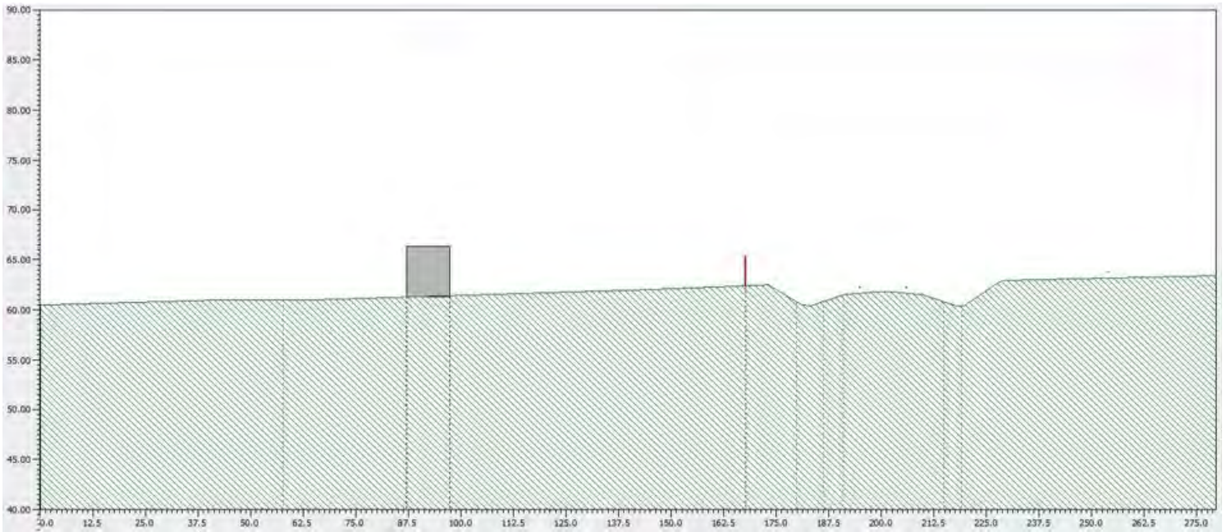
Option 2: concrete safety barrier

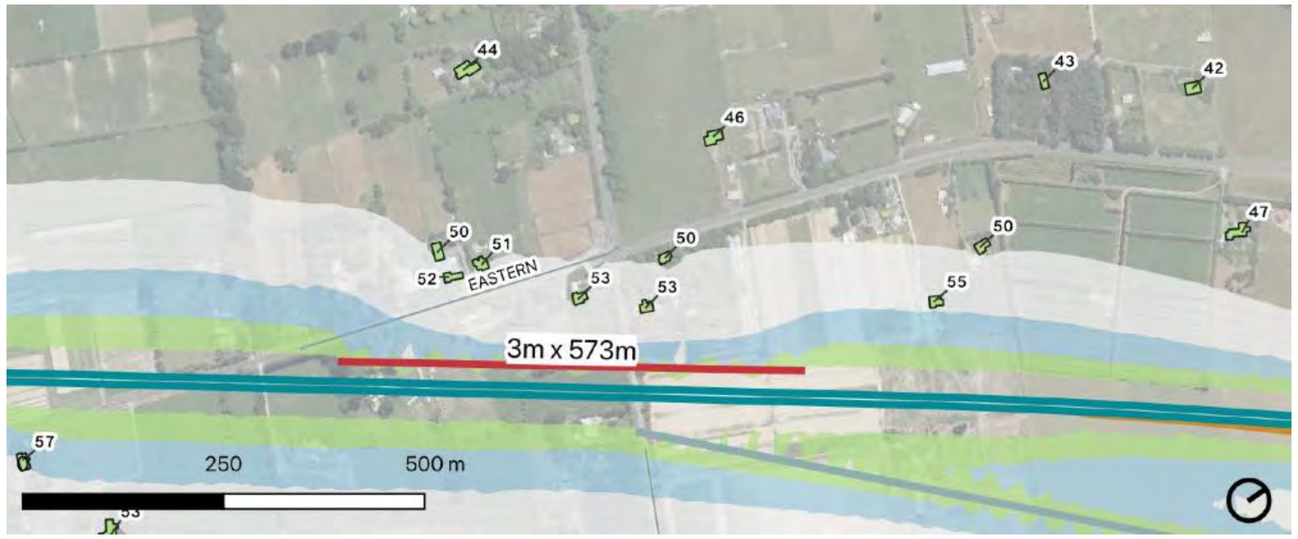


Option 1: High performance surface (EPA7)

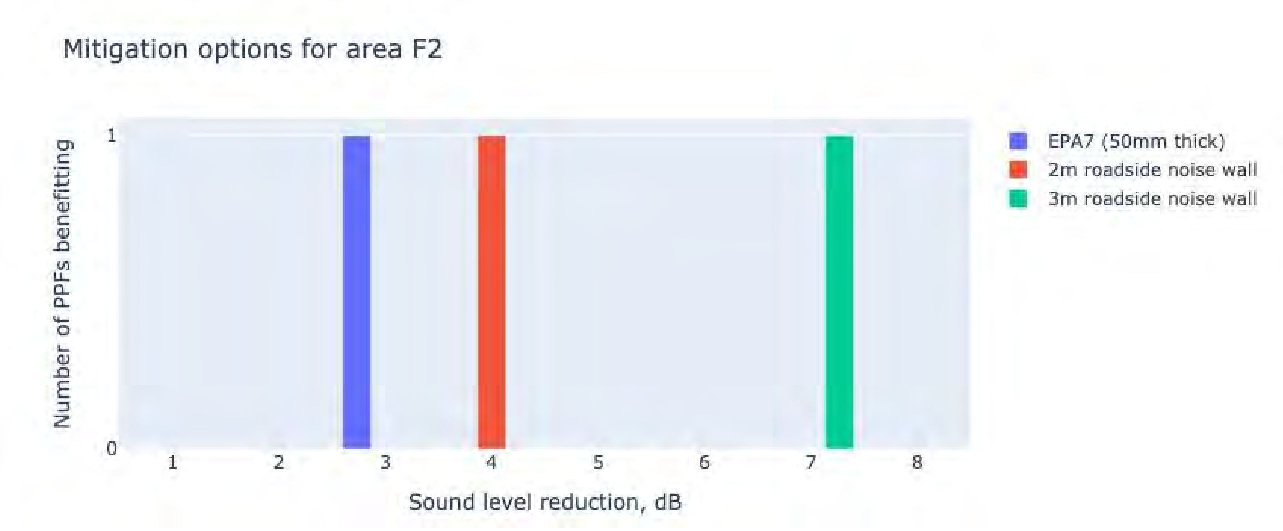


Option 3: 2m high noise wall outside of swale

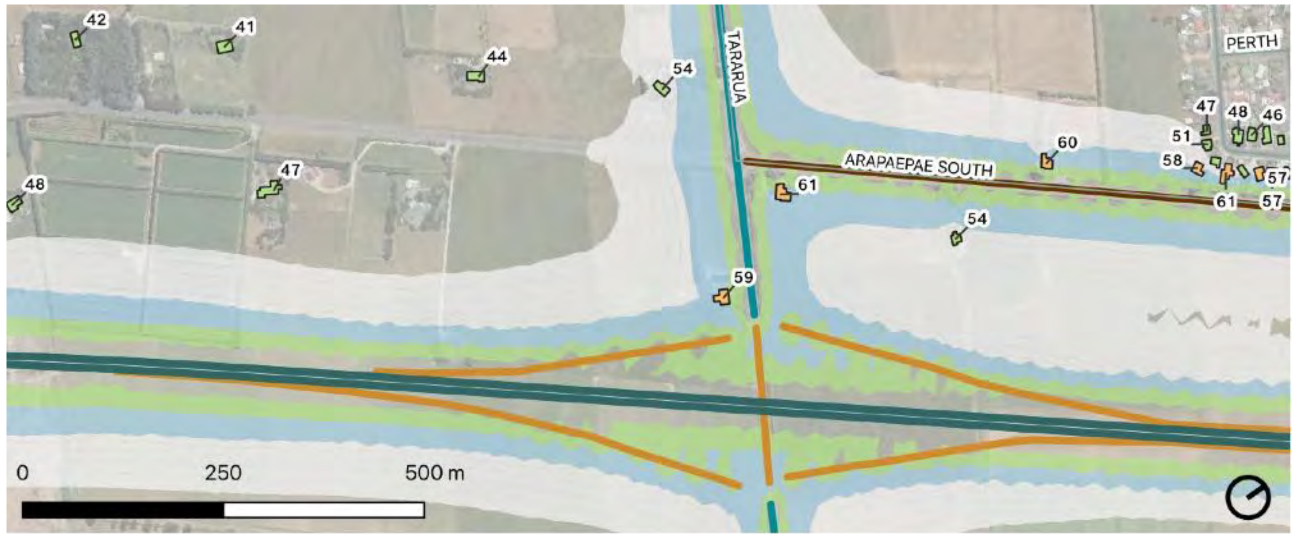

Cross section of noise wall outside of swale (3m)



Option 4: 3m high noise wall outside of swale

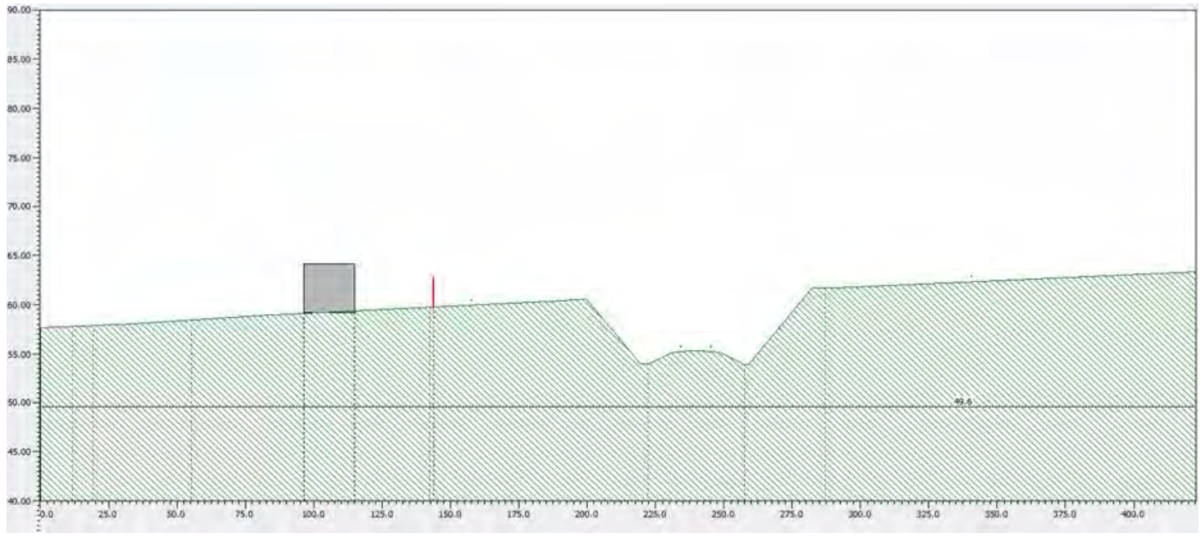


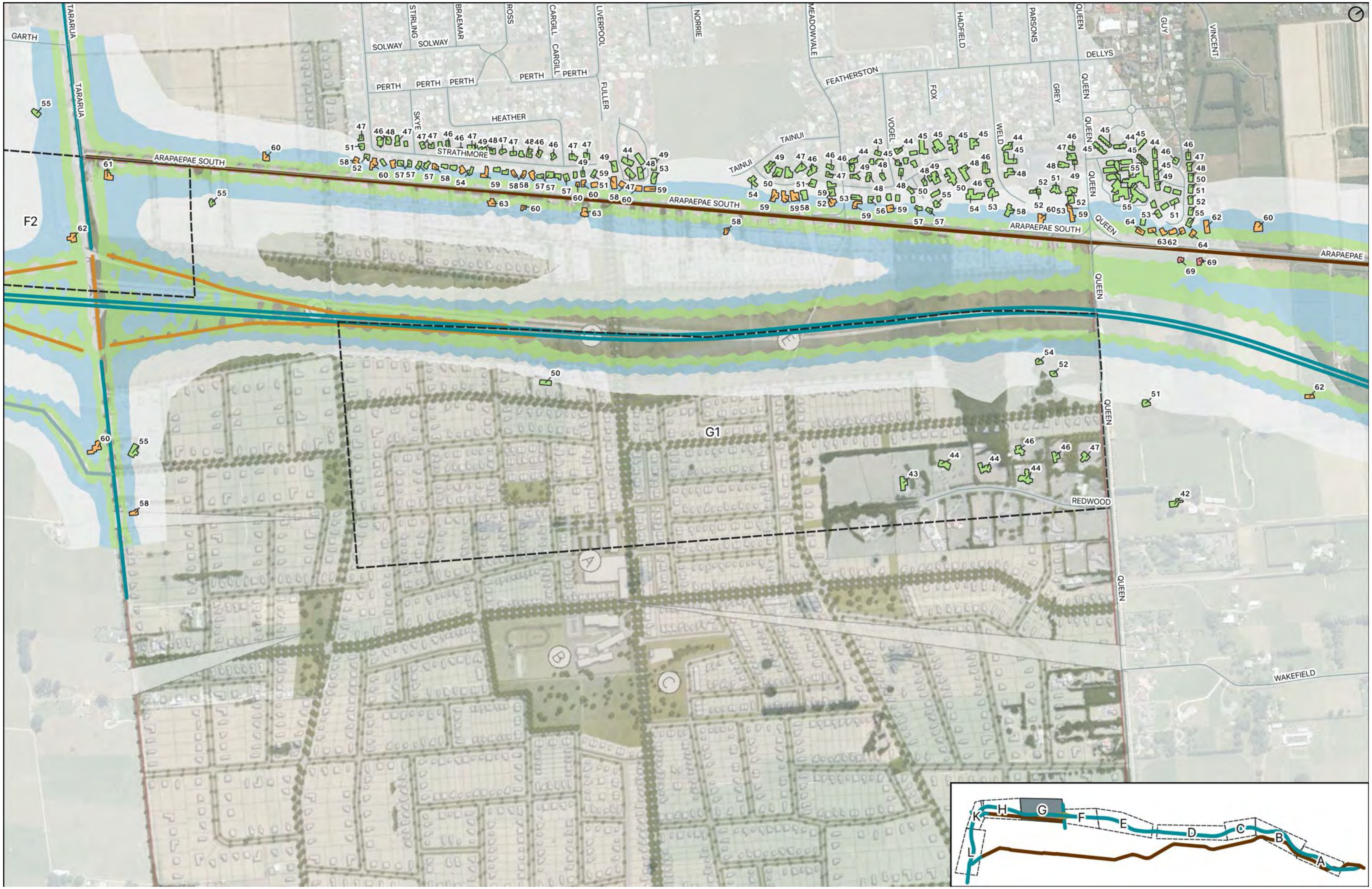
Option 2: 2m noise wall on property boundary



Option 1: High performance surface (EPA7)

Option 3: 3m noise wall on property boundary

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TARARUA
SOLWAY
STIRLING
BRAEMAR
ROSS
CARGILL
LIVERPOOL
NORRIE
MEADOWVALE
HADFIELD
PARSONS
QUEEN
GUY
VINCENT
DELLYS
FEATHERSTON
PERTH
FULLER
FOX
GREY
HEATHER
SKYE
STRATHMORE
ARAPAEPAE SOUTH
TAINUI
VOGEL
WELD
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F
G
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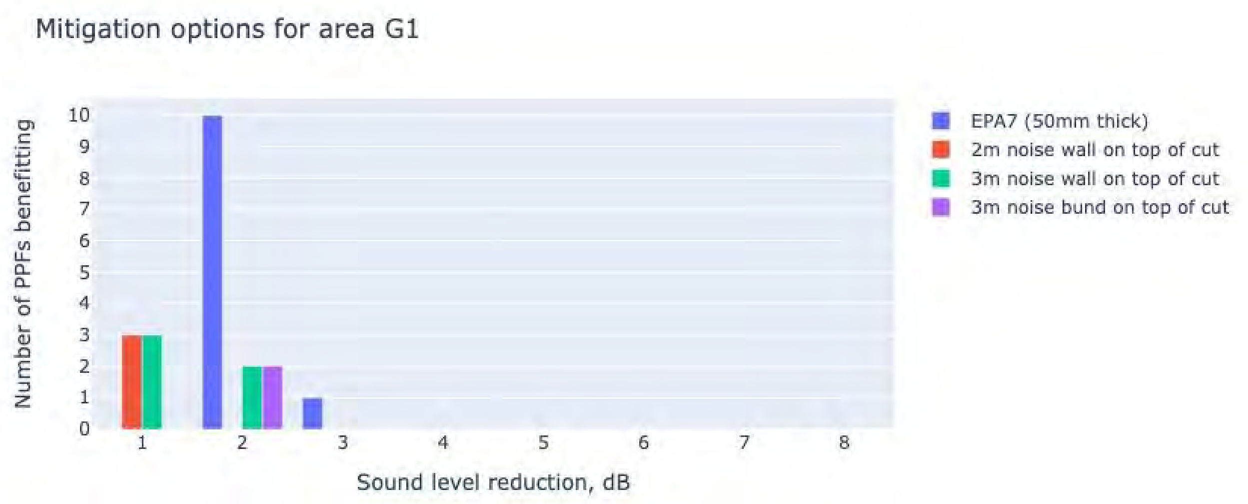
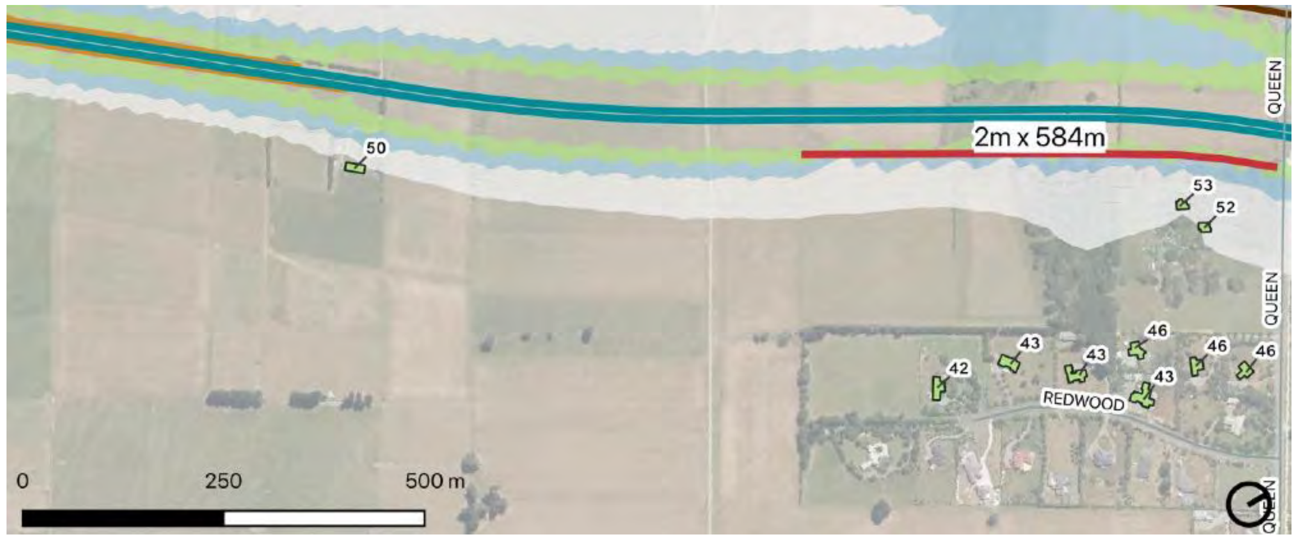
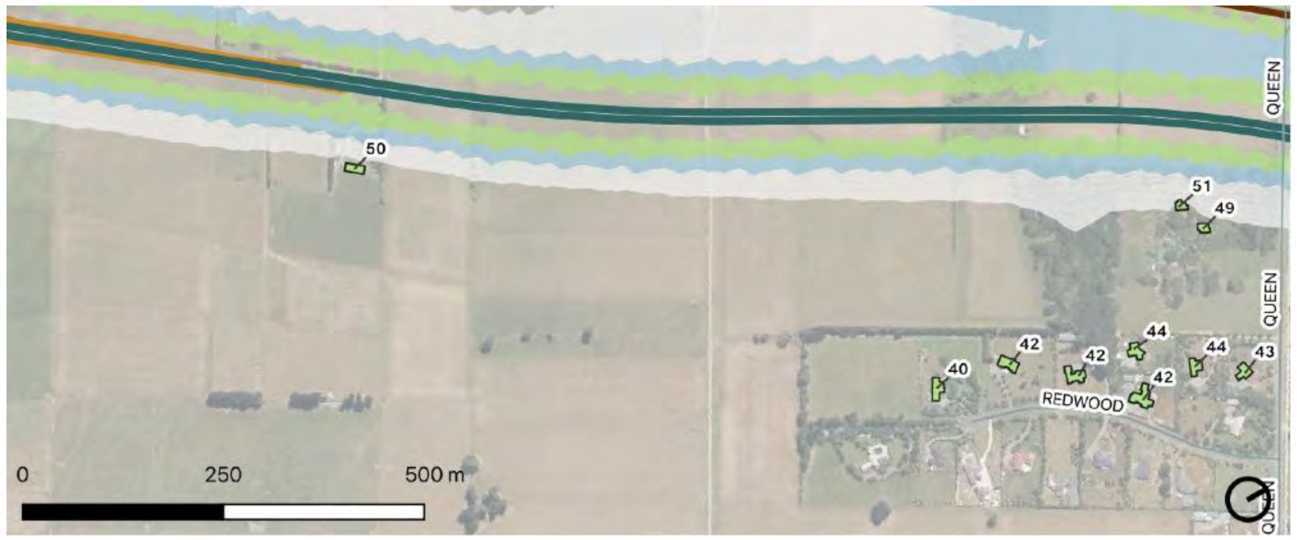
K
L

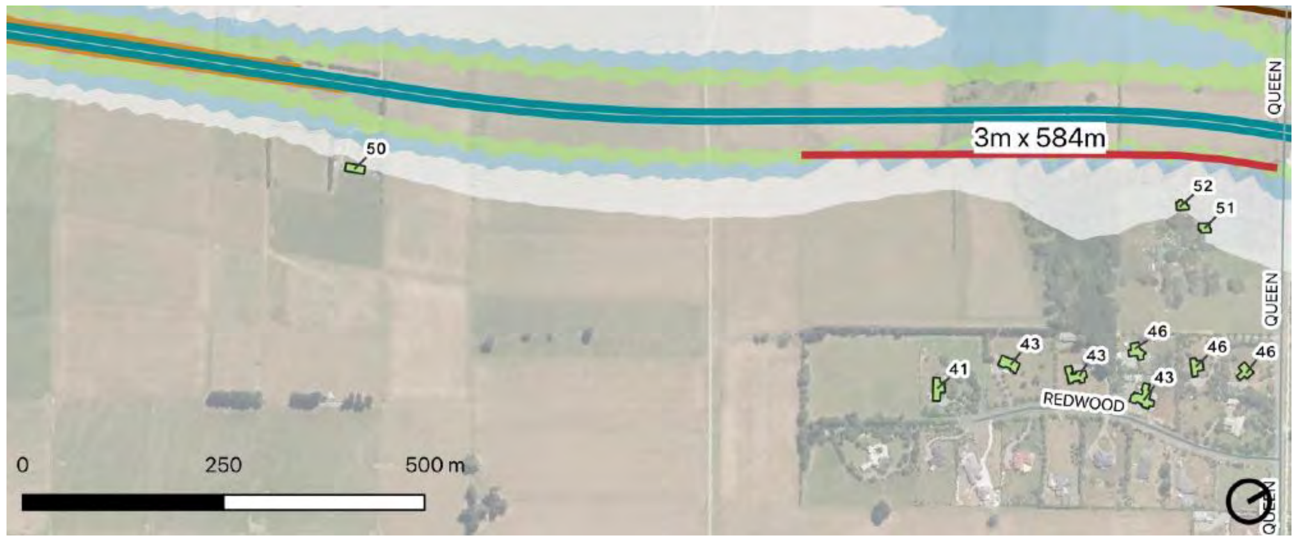




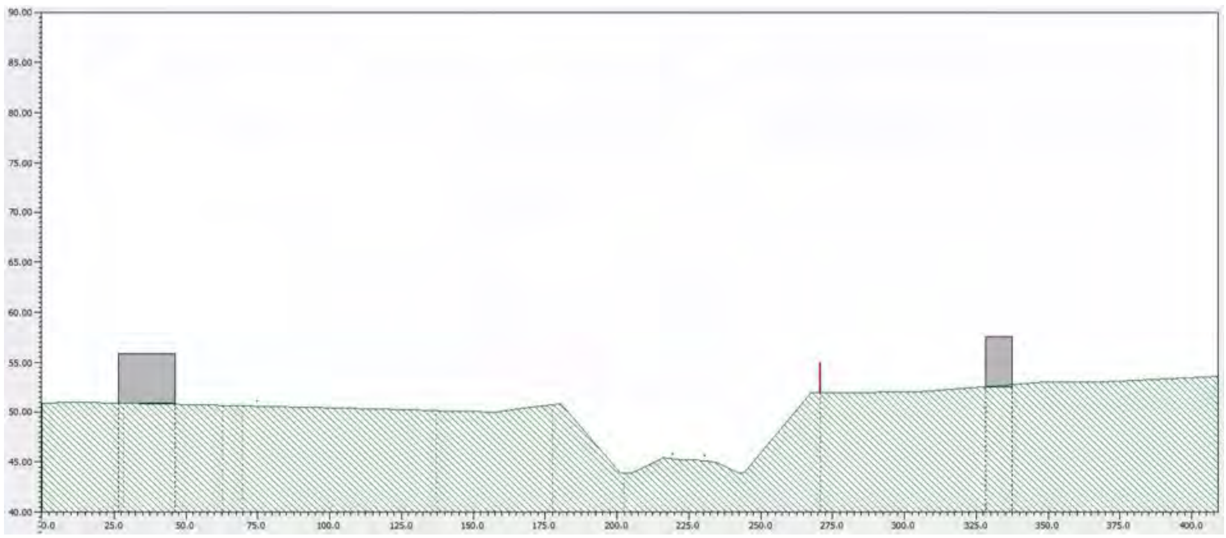
Option 2: 2m noise wall on top of cut

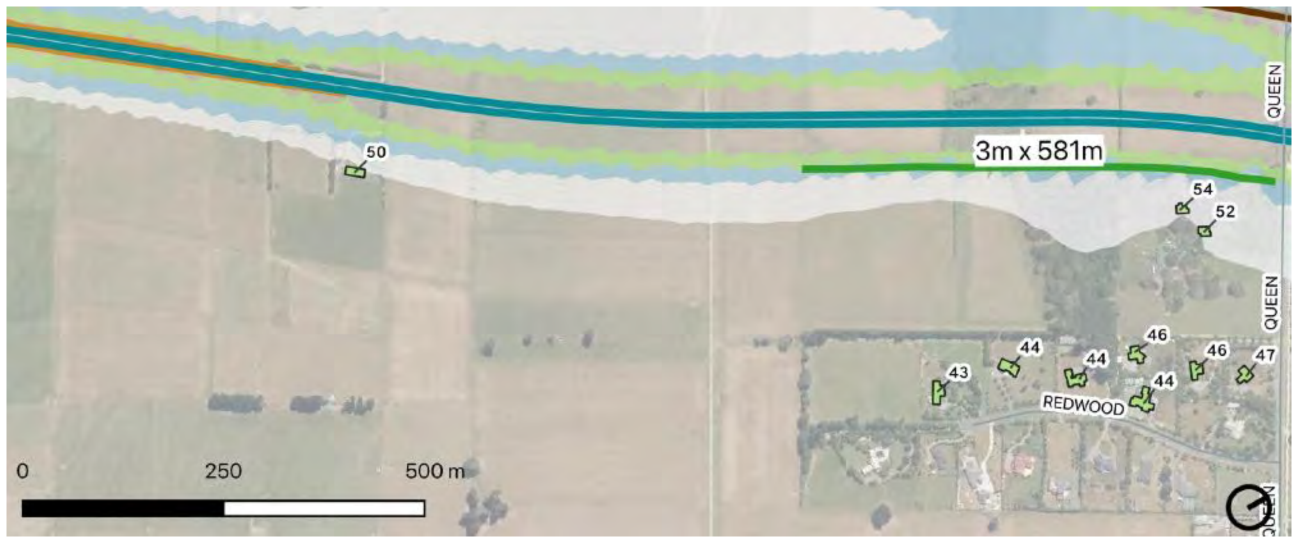


Option 1: High performance surface (EPA7)

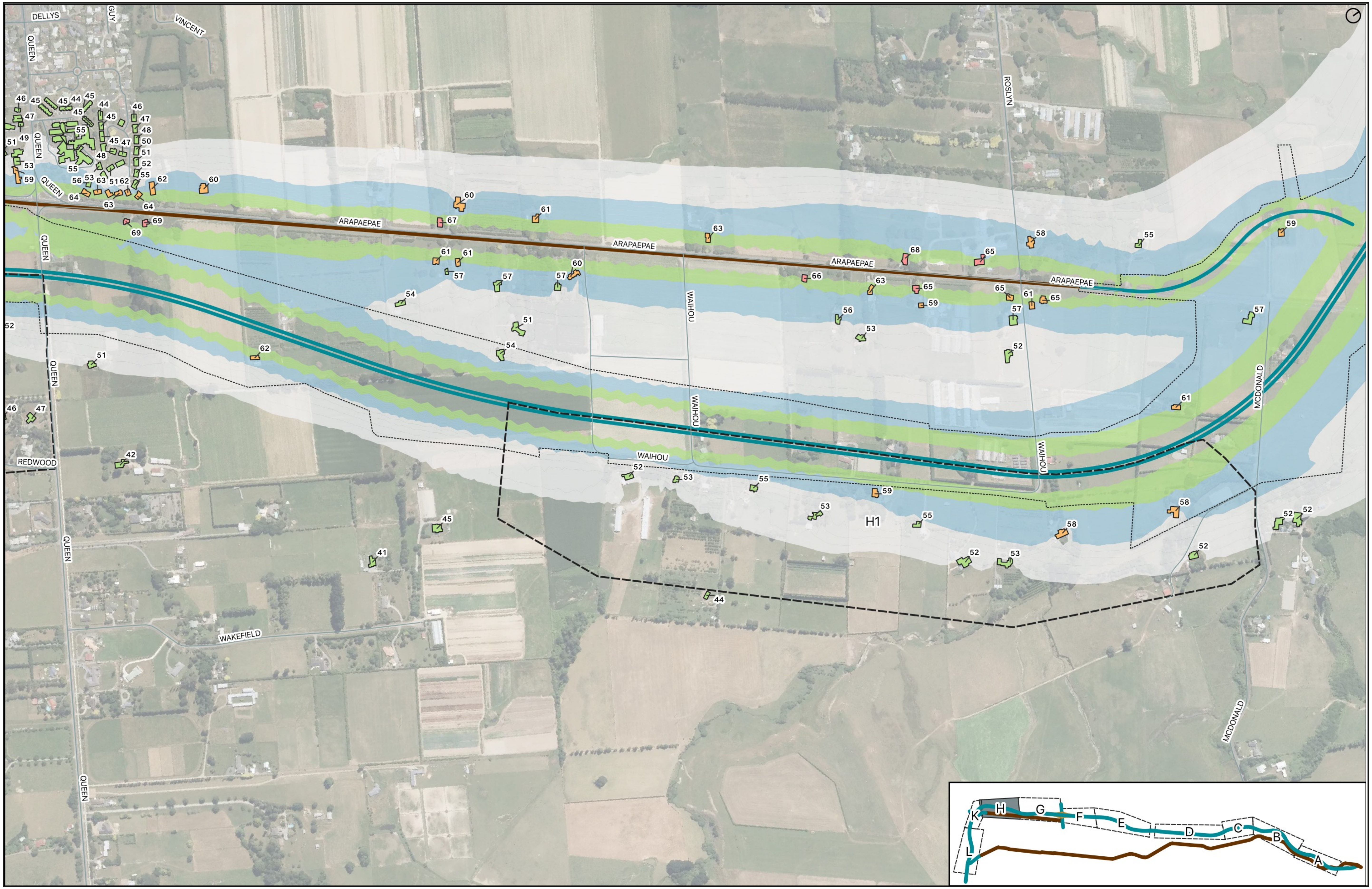


Option 3: 3m noise wall on top of cut

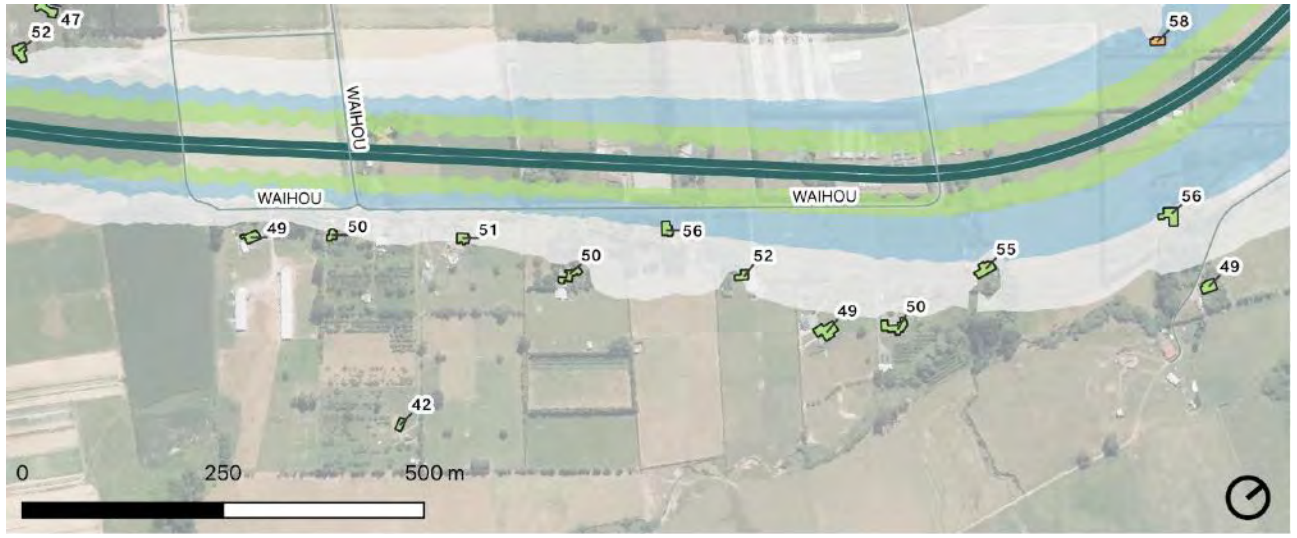

Cross section of noise wall top top of cut (3m)



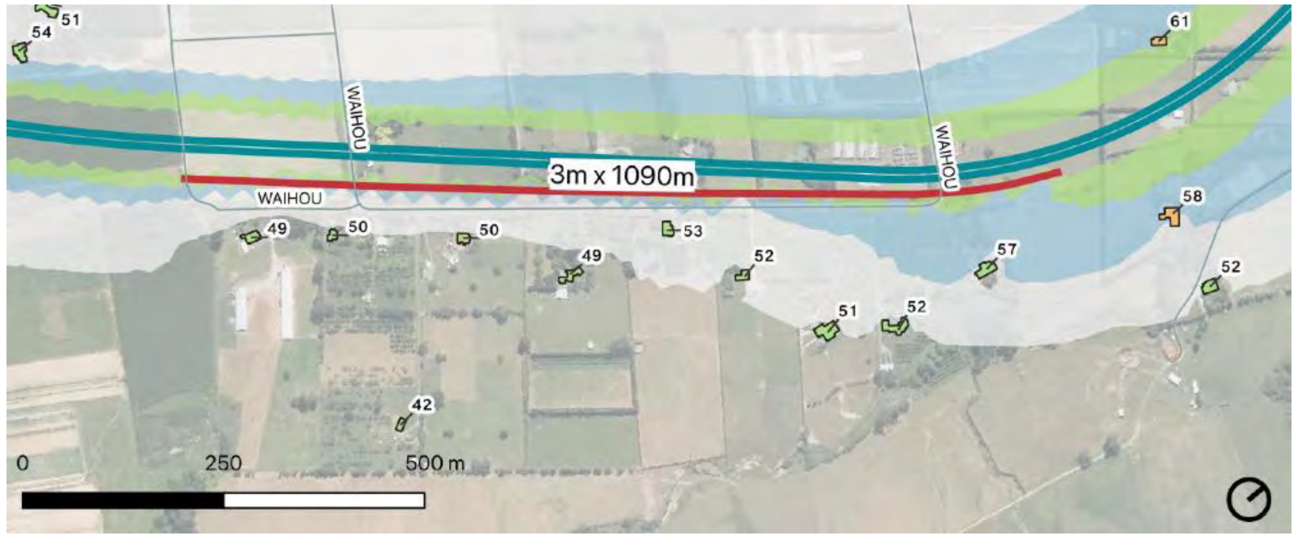
Option 2: 3m noise bund on top of cut


DELLYS
GUY
VINCENT
QUEEN
ARAPAEPAE
WAIHOU
ROSLYN
MCDONALD
REDWOOD
WAKEFIELD
H1
H
G
F
E
D
C
B
A
K
L

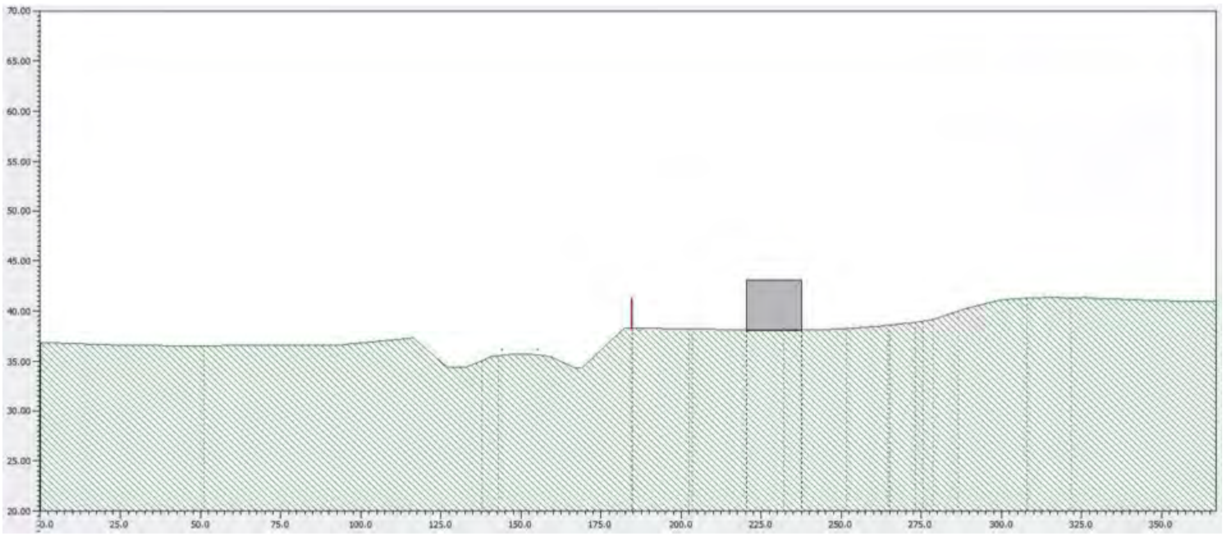
Option 2: 2m high noise wall on top of cut



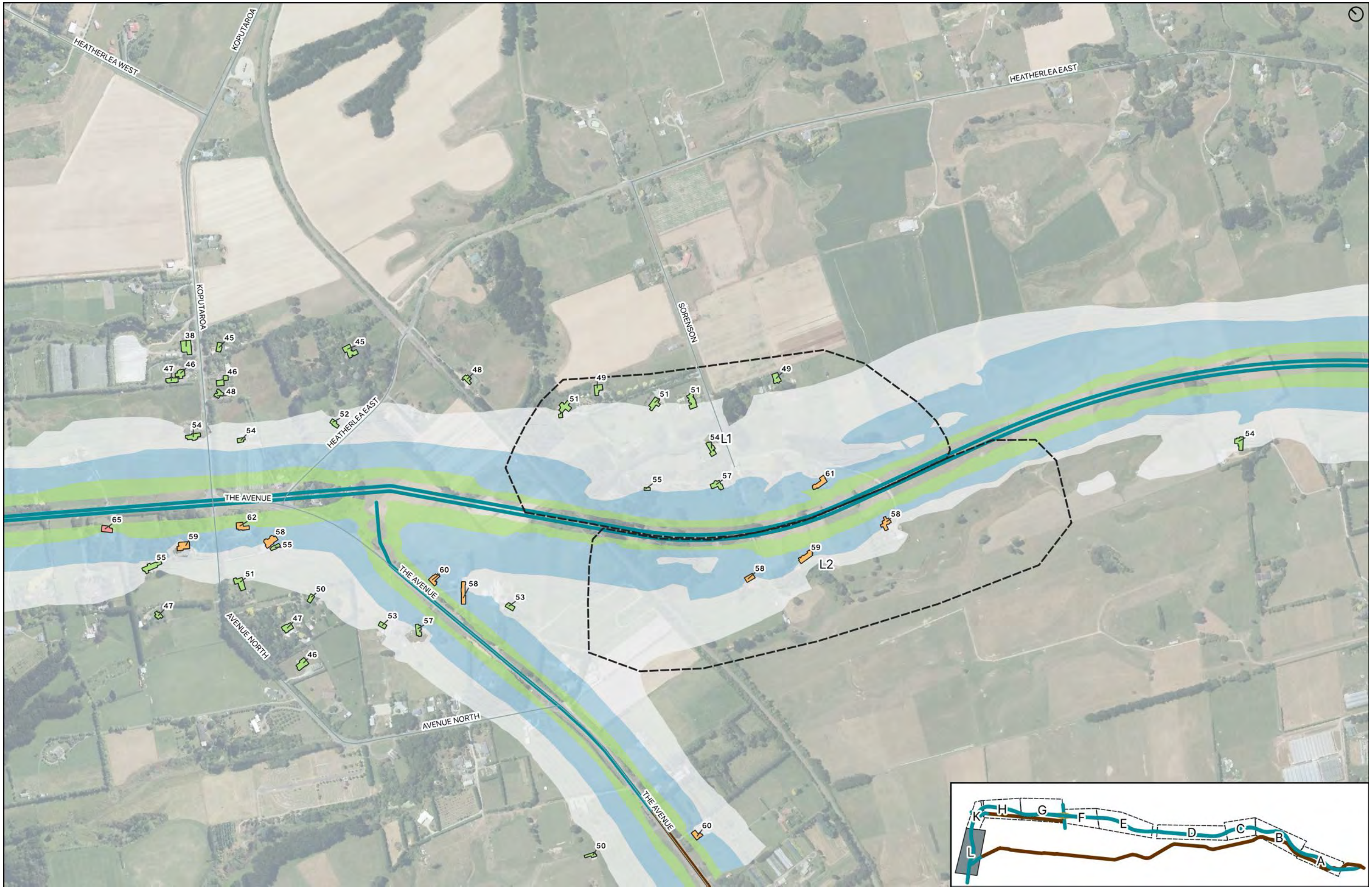
Option 1: High performance surface (EPA7)



Option 2: 3m high noise wall on top of cut


Cross section of noise wall at top of cut (3m)

Option 4: 3m high noise bund on top of cut


HEATHERLEA WEST
KOPUTAROA
HEATHERLEA EAST
SORENSON
THE AVENUE
AVENUE NORTH
L1
L2
K
H
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D
C
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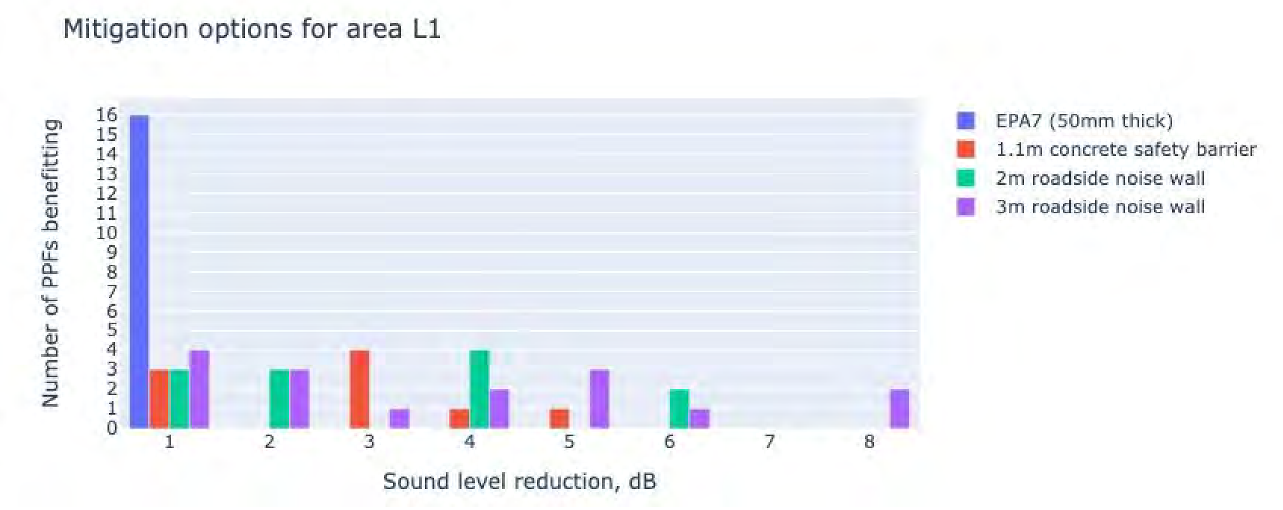
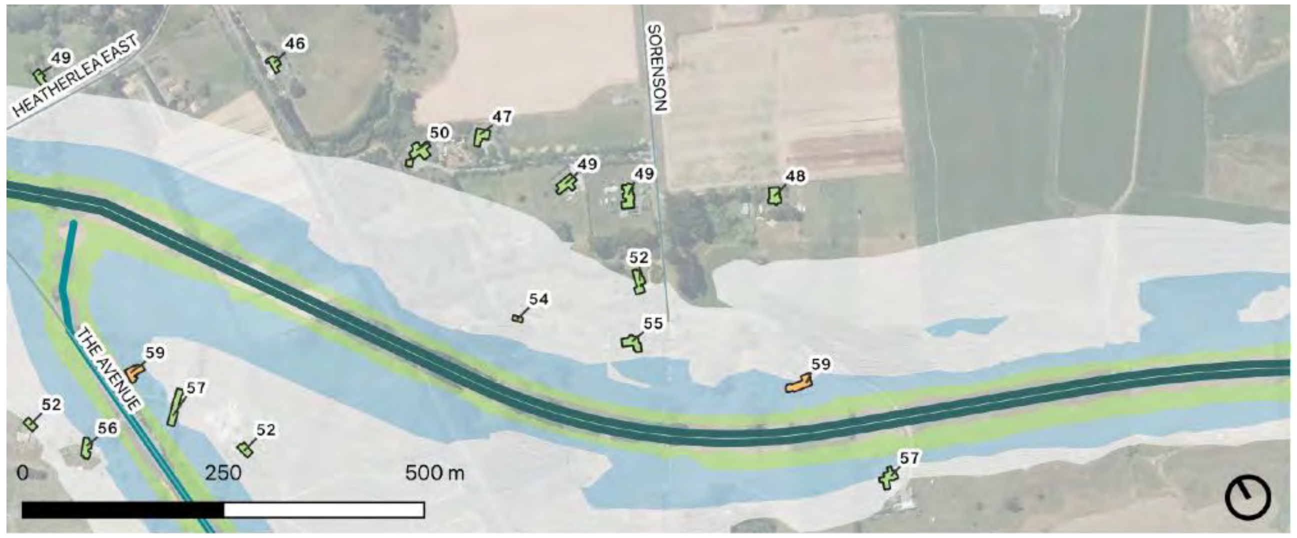
A
L

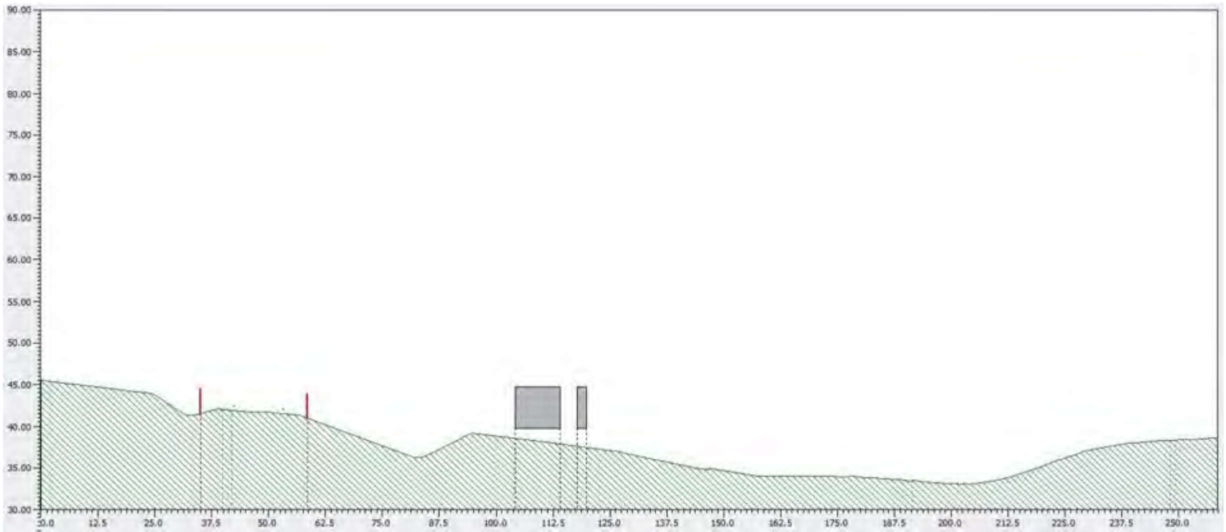


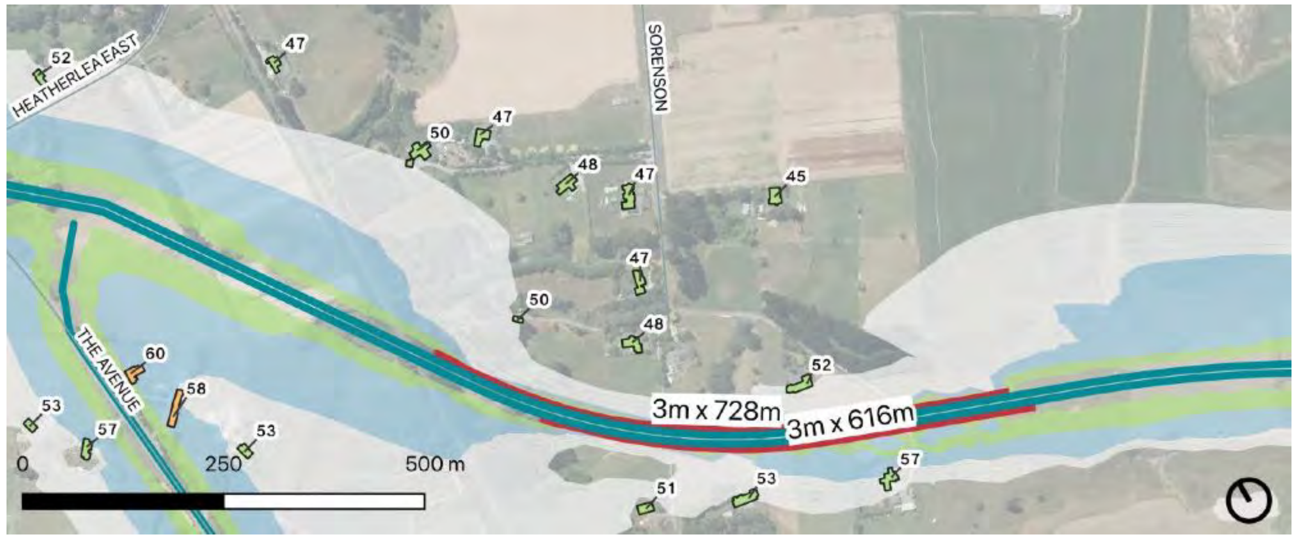
Option 2: concrete safety barrier



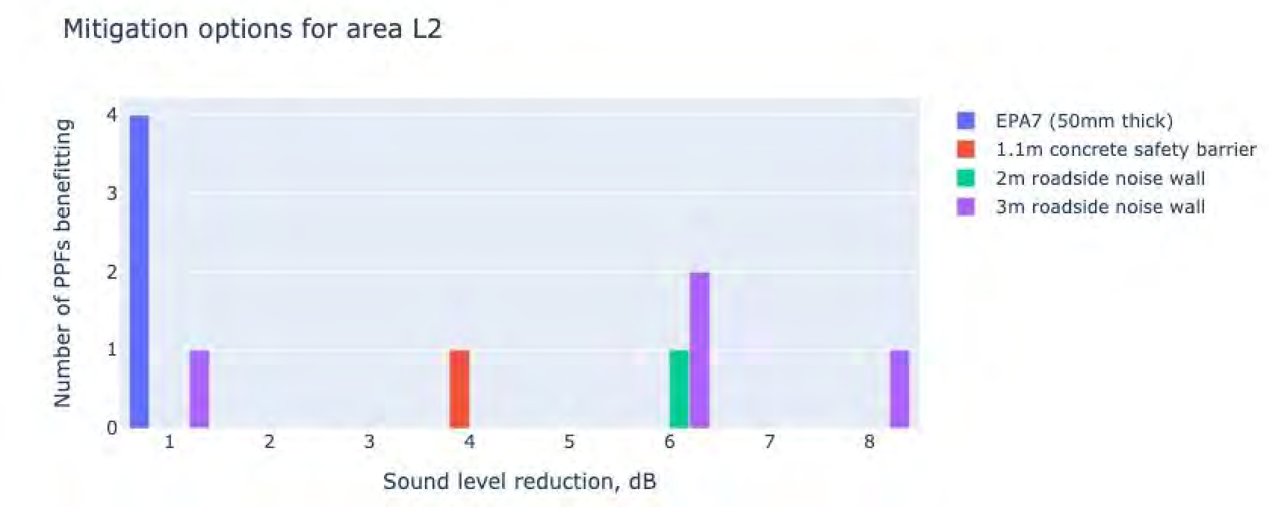
Option 1: High performance surface (EPA7)

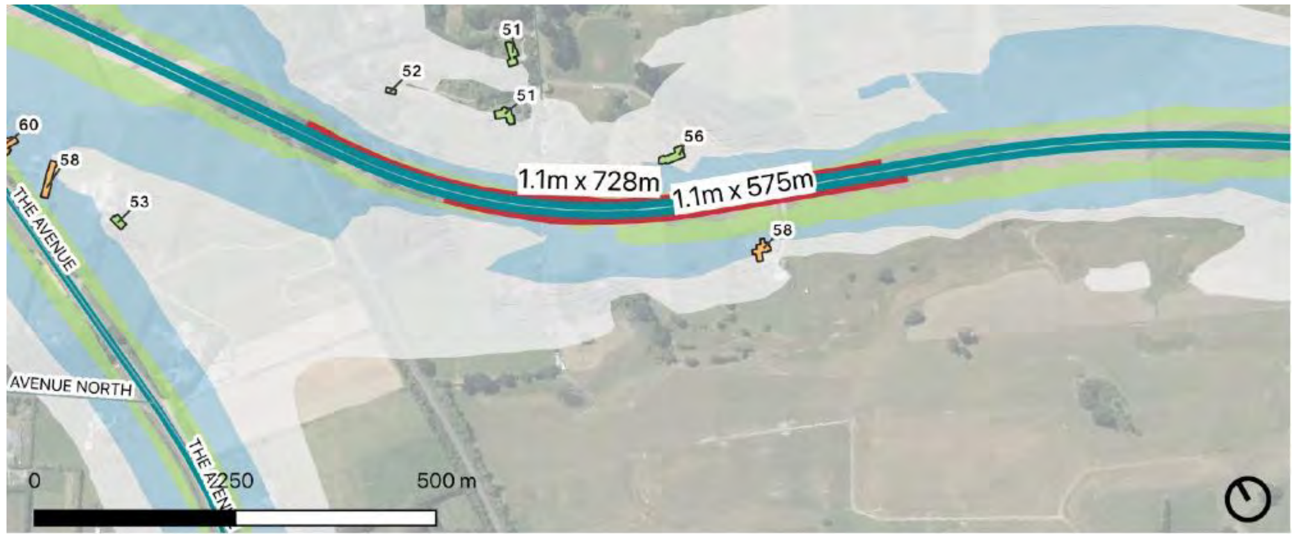
Option 3: 2m high roadside noise wall


Cross section of roadside noise wall (3m)



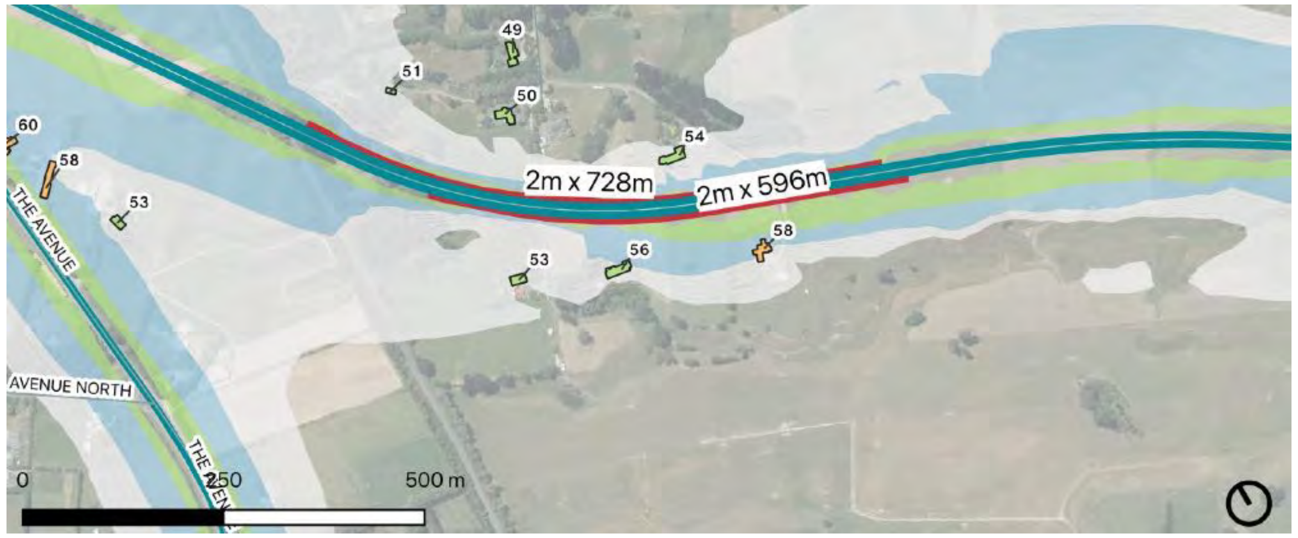
Option 4: 3m high roadside noise wall



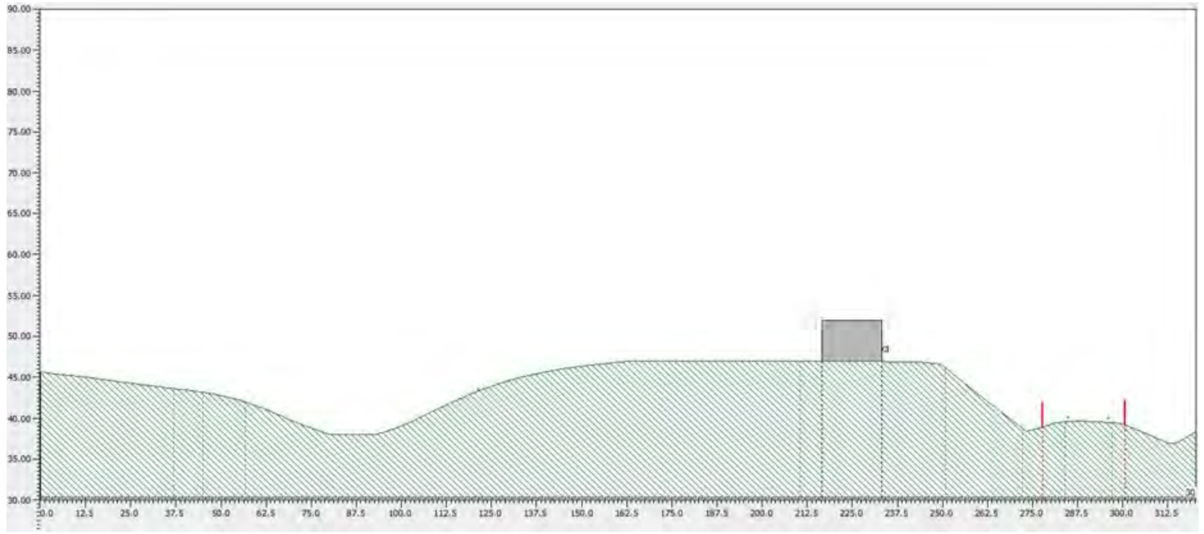


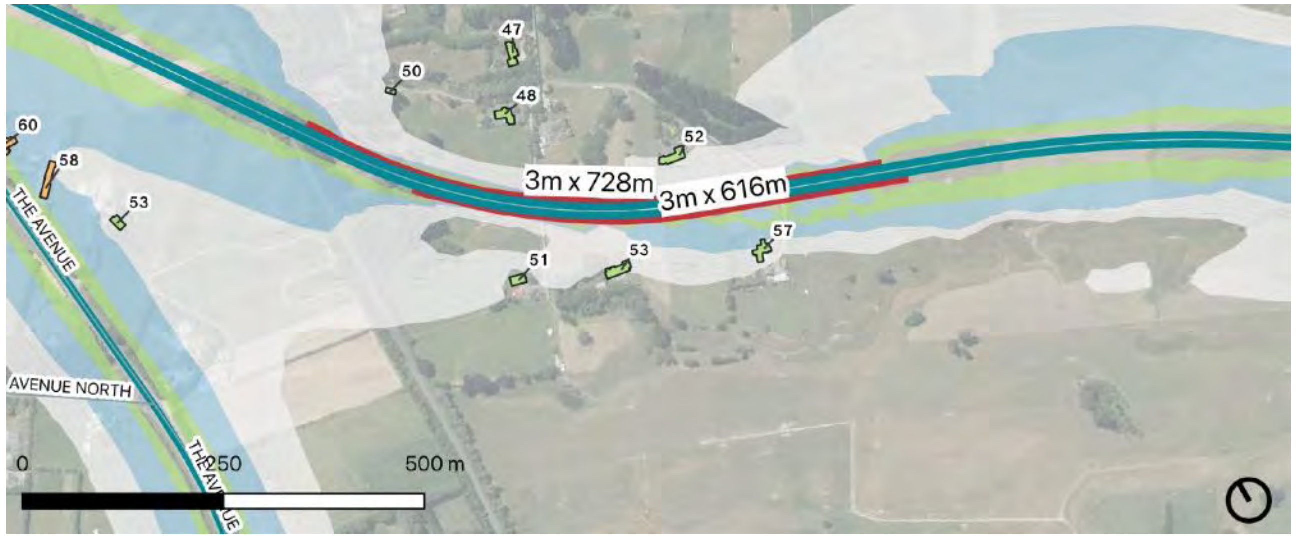
Option 2: concrete safety barrier

Option 1: High performance surface (EPA7)

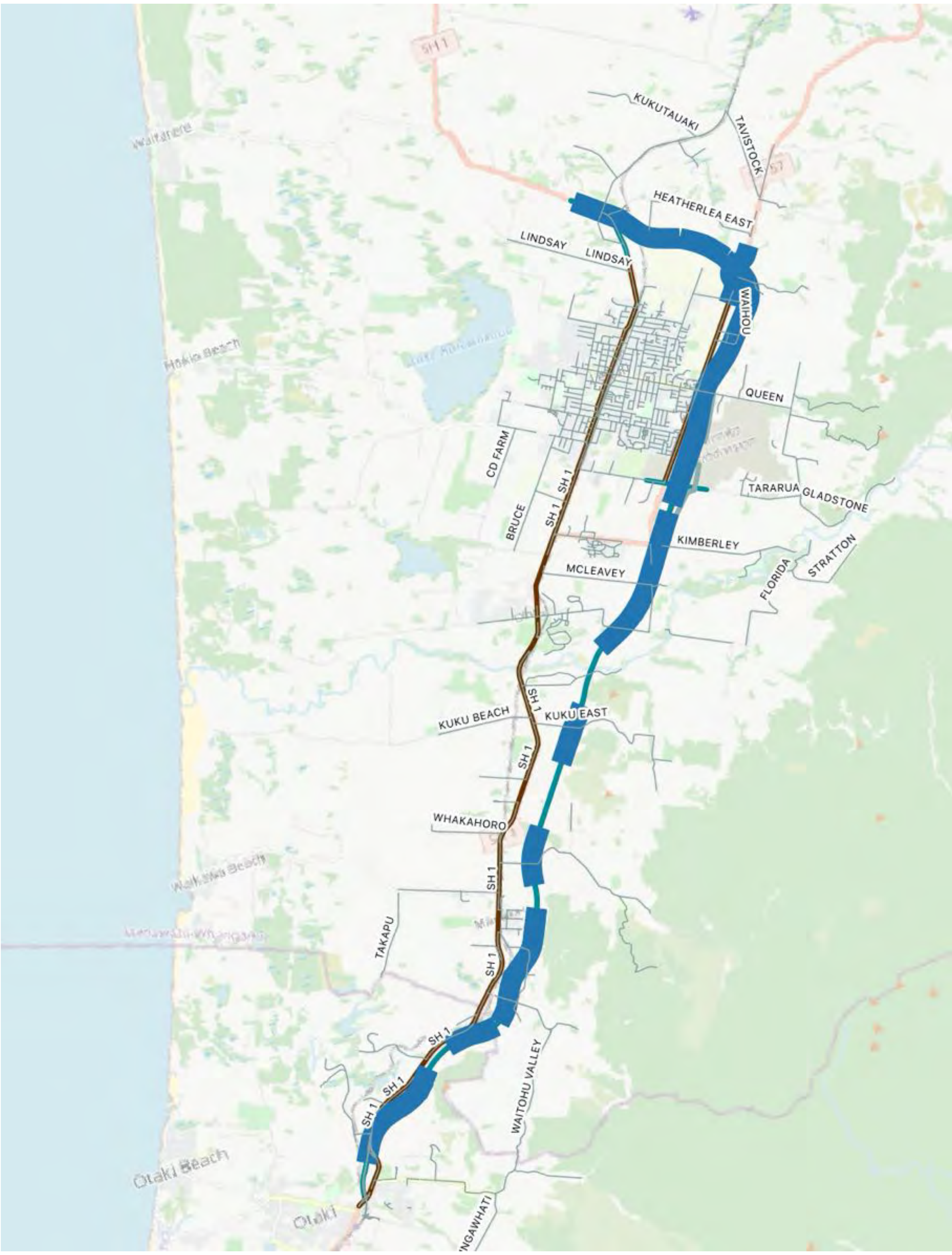


Option 3: 2m high roadside noise wall


Cross section of roadside noise wall (3m)



Option 4: 3m high roadside noise wall



This figure shows sections of road which are within 200m of a PPF. This has been extended to be continuous between Tararua Road and Queen Street, to include the entire Tara-Ika site.

This represents approximately 17.6km of the expressway.

ALTISSIMO CONSULTING

Appendix C

Collated evaluations for Workshop N3

NZS 6806 – Assessment matrix

Project	Assessment area	
Ōtaki to north Levin	B1 - B1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	Small cluster of PPFs, also exposed to noise from existing SH1. 2x Cat B (New Road) – would be Cat A (Altered Road)	+ + One PPF remains in Cat B (new road)	+ + One PPF remains in Cat B (new road)	+ One PPF remains in Cat B (new road)	+ + + All PPFs Cat A
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects All PPFs > 50 dB	– – – All PPFs > 50 dB	– – – All PPFs > 50 dB	– – – All PPFs > 50 dB	– – – All PPFs > 50 dB
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 2 dB reduction applies to all PPFs	– A 1 dB reduction is achieved for the most exposed PPF, with negligible reduction to all others	+ + A 4 dB reduction is achieved for the most exposed PPF, with 1 dB reduction to all others	+ + + A 4 dB reduction is achieved for the most exposed PPF, with 1 dB reduction to all others
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	– Door and windows may need to be closed to achieve reasonable internal sound levels	– Door and windows may need to be closed to achieve reasonable internal sound levels	– Door and windows may need to be closed to achieve reasonable internal sound levels	o Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	– – – Poor BCR due to low housing density. Surface would benefit PPF to east of road, which is not included in calculation	– – – Poor BCR due to low housing density.	– – – Poor BCR due to low housing density.	– – – Poor BCR due to low housing density.
Mitigation allows for integration of ecological treatment	Ecology	Noise level risk to birds within B1, surrounding area and flight paths between properties with indigenous forest fragments, including #38, #40, #42 and #43. Openwater is present on property #38.	+ + The EPA7 roading surface will reduce vehicle noise affecting indigenous forest birds. Extensive planting of native trees and shrubs will form a buffer to noise and form a flight corridor between sites for birds. Tree height should encourage birds to move between forests above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	+ The 1.1 m concrete safety barrier will not reduce any vehicle noise affecting indigenous forest birds. However, extensive planting of native trees and shrubs will create a buffer zone for noise and produce a flight corridor between sites for birds. Tree height should encourage birds to move between forests above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	+ + The 2 m noise wall will reduce some of the vehicle noise that could potentially affect indigenous forest birds. Planting native trees and shrubs will form a buffer to noise and form a flight corridor between sites. Tree height should encourage birds to move between forests above the proposed roading.	+ + The 3 m noise wall will reduce vehicle noise from affecting indigenous forest birds. Planting native trees and shrubs will form an additional noise buffer and will create a flight corridor between sites. Tree height and the roadside wall will encourage birds to fly at height between forest fragments and above the proposed roading.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	KCDC Objs & policies require: avoid unacceptable levels of noise & vibration (assume meeting NZS 6806 avoids unaceeptabe noise levels); minimise effects on amenity (assume combination noise/visual)	+ + All dwellings Cat A/B – unacceptable levels of noise avoided; no visual effects from noise mitigation; minimsed effects on amenity	+ All dwellings Cat A/B – unacceptable levels of noise levels avoided; minor visual effects of concerte barrier; minimised effects on amenity	– All dwellings Cat A/B – unacceptable levels of noise avoided; medium visual effects from 2m wall; minimised effects on amenity	– – All dwellings Cat A/B – unacceptable levels of noise avoided; higher visual effects from 3m wall; minimised effects on amenity
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading	Poor ground conditions in area	o High cost of surfacing but lower cost than walls	– Could tie-into bridge barriers but numrous transistions	– Costs of wall and extra EW	– – Costs of wall and extra EW
Effects on earthworks	Roading	Poor ground conditions, potentially	o	o	– –	– –

Project	Assessment area	
Ōtaki to north Levin	B1 - B1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
		requirig dig out / preload. Avoid additional EW in this section	No effect	No effect	Widening of footprint. Transition between cut and fill diffcult for walls	Widening of footprint. Transition between cut and fill diffcult for walls
Stormwater treatment and/or potential flooding effects	Roading	Waiauti and Manakau stream locations to north	o	o	o	o
			No effect	No effect	No effect	No effect
Social effects of mitigation	Social	Manakau Heights is a quiet area that values its existing rural/natural character (both interms of views and way of life - connecting with nature and tranquil lifestyle indoors ans outdoors). Noise mitigation will ideally minimise the amenity impacts on the quiet character of the area (and allow people to continue using outdoor spaces i.e their gardens) and minimise disruptions to activities such as working from home, relaxation and sleep but will also be of a size/bulk that does not impose on the natural/rural feel of the environment and alter the character of the community. Properties shown on the area map will be sandwiched between SH1 and the new road so noise mitigation will be important to minimise cumulative impacts on the amenities of the exisitng environment for the communities lifestyle, character and health and wellbeing.	+	-	- -	- -
			Provides some level of mitigation in terms of reducing the social impacts of changes to the amenity of the environment to the highest number of households (therefore potenital mitigation at a community level), and will not have a visual impact that would obstruct exisitng views valued by residents of the exisitng environement, but only a low level of sound reduction - may still impact on people's desire/ability to spend time outdoors, and on character of this area (currently quiet/rural). Those closest to the noise may still require property specific mitigation.	Low visual impact, but only provides a low level of mitigation to one property therefore property specific mitigation rather than community impacts - remaining properties will experience social impacts from noise from both SH1 and O2NL which could limit their use of outdoor areas and change the quiet rural feel of the area.	Provides a low level of noise reduction and therefore improved social outcomes to some properties (fewer than option 1) and a higher level of reduction to one property (therefore not at a community level). Positive impact on this property at an individual level, but little postive social impacts at a community scale, would still expect people's use/enjoyment of outdoor areas to be limited. Also has some visual impact which will affect people's views - would expect this to detract from the character of the area (currently a quiet rural feel) which residents value.	Highest levels of visual impact out of all 4 options - a high noise wall could exacerbate the feeling of being sandwiched between two roads, and adversely affect community cohesion for these properties (i.e feeling less connected to the rest of Manakau). Provides the highest levels of noise mitigation, but only to 1 property - at a community scale it will not adequately address noise impacts.
Effects on visual aspects of amenity values from dwellings	Visual and landscape	B1 consists of three houses to the north, oriented in the opposite direction from the highway (there is also a house to the south) Potential benefits include screening the road. Potential adverse effects include those on views behind the houses to Pukehou, appearance/dominance of walls.	o	-	+ +	- -
			Minimises prominence of highway itself, but will not screen traffic. Best maintains rural character including views of Pukehou.	Adds to prominence of highway itself without screening traffic. Creates more urban appearance.	Screens traffic. While it adds to prominence of highway, 2m is not overly dominant. Can be softened with planting. 'Behind' houses (outlook in oppostite direction). Small effect on views to Pukehou. (However, benefits only 3 properties).	Screens traffic but overly dominant structure, especially for outlook from house to south. Will detract from views and connection to Pukehou more than Option 3
Effects on experience for travelling public	Visual and landscape	This will be an attractive section of the highway with views of Pukehou on the inside of the curve, and slightly elevated views over a well-treed arcadian landscape on the outside of the curve. Potential adverse effects are closing the views on the outside of the curves. Also cumulative effects in conjunction with long section of walls in areas B2, B3, C1, C2.	o	-	-	- -
			Maintains views and experience of travelling through attractive countryside including views to key landmarks (Pukehou, Staples Bush). Avoids disrupting continuous wire-rope barrier. Maintains clean lines.	Maintains views of open countryside as for Option 1 but with less attractive foreground. Clutter of barrier transition. Disrupts clean lines of continuous wire-rope barrier.	Encloses highway from open views of countryside to north, but does not affect key views and engagement with Pukehou in opposite direction. Wall will be a prominent feature itself, but not overly dominant at 2m. Will maintain clean lines of continuous wire-rope barrier.	Encloses highway from open views of countryside to north to a greater extent than Option 3, and wall itself will be more dominant. Does not affect key views and engagement with Pukehou in opposite direction, and will maintain clean lines of continuous wire-rope barrier.

NZS 6806 – Assessment matrix

Project	Assessment area	
Ōtaki to north Levin	B2 - B2	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics		+ + +	+ + +	+ + +	+ + +
			All PPFs Cat A	All PPFs Cat A	All PPFs Cat A	All PPFs Cat A
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects 8 PPFs > 50	- -	- -	-	+
			5 PPFs exceed 50 dB	5 PPFs exceed 50 dB	3 PPFs exceed 50 dB	All PPFs no greater than 50 dB
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+	+	+ +	+ + +
			A 2 dB reduction applies to all PPFs	An average of 2dB reduction applies, spread between 1-3 dB	An average of 4 dB reduction occurs	An average of 5.5 dB reduction occurs
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	o	o	o	o
			Reasonable levels achievable with doors and windows ajar	Reasonable levels achievable with doors and windows ajar	Reasonable levels achievable with doors and windows ajar	Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	-	- - -	- -	- -
			BCR (0.4) improves if considering benefit to west of road	Low BCR (0.2)	Low BCR (0.3)	Low BCR (0.3)
Mitigation allows for integration of ecological treatment	Ecology	Noise level risk to birds within B2 and flight paths between properties with indigenous forest, treeland and mixed-forest, including #47, 52 and #55. Openwater is present on property #47.	+ +	+	+ +	+ + +
			The EPA7 roading surface will reduce vehicle noise affecting birds. Planting of native trees and shrubs, especially on the western side, will form a flight corridor between sites B2 and B3 for birds. This should encourage birds to move between forest sites and remain west of the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	The 1.1 m concrete safety barrier will not reduce vehicle noise affecting birds. However, planting native trees and shrubs will create a buffer zone for noise and produce a flight corridor between sites for birds. Tree height should encourage birds to move between forests above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	The 2 m noise wall will reduce some of the vehicle noise that could potentially affect birds. Planting native trees and shrubs will form a buffer to noise and form a flight corridor between sites. Tree height should encourage birds to move between forests above the proposed roading.	The 3 m noise wall will reduce vehicle noise. Planting native trees and shrubs will form an additional noise buffer and will create a flight corridor between sites on the western side. Tree height and the roadside wall will encourage birds to fly at height between forest fragments and above the proposed roading.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimum standards	+ +	+	-	- -
			All dwellings Cat A - compatible noise levels achieved; no visual effects from noise mitigation; effects on amenity minimised	All dwellings Cat A - compatible noise levels acheived; minor visual effects of concrete barrier; effects on amenity east of highway managed	All dwellings Cat A - compatible noise levels achieved; medium visual effects from 2m wall; minimised effects on amenity east of highway	All dwellings Cat A - compatible noise levels achieved; higher visual effects from 3m wall; minimised effects on amenity east of highway
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading	South Manakau Road E/W over local road	o	+	-	- -
			High cost of surfacing but lower cost than walls	Extension of concrete bridge barriers, avoid nultiple transistions, lower cost solution	East side have Waiauti stream bridge, so challneges with bridge barrier and walls. Extra fill	East side have Waiauti stream bridge, so challneges with bridge barrier and walls. Extra fill and high cost of walls
Effects on earthworks	Roading	Poor ground conditions, potentially requirig dig out / preload. Avoid	o	o	- -	- -
			No effect	No effect	Effects on fill footprint	Effects on fill footprint
Stormwater treatment and/or potential flooding effects	Roading	Waiauti and Manakau stream locations	o	o	-	-
			No effect	No effect	Potential widening of footprint, greater effect on existing w/c	Potential widening of footprint, greater effect on existing w/c
Social effects of mitigation	Social	Manakau Heights is a quiet area that	+	+	- -	- -

Project	Assessment area
Ōtaki to north Levin	B2 - B2

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
		values its existing rural/natural character (both interms of views and way of life - connecting with nature and tranquil lifestyle indoors ans outdoors). Noise mitigation will ideally minimise the amenity impacts on the quiet character of the area (and allow people to continue using outdoor spaces i.e their gardens) and minimise disruptions to activities such as working from home, relaxation and sleep but will also be of a size/bulk that does not impose on the natural/rural feel of the environment and alter the character of the community. Properties shown on the area map will be sandwiched between SH1 and the new road so noise mitigation will be important to minimise cumulative impacts on the amenities of the exisitng environment for the communities lifestyle, character and health and wellbeing.	Provides a low level of sound reduction to the highest number of properties - likely that noise will still be loud enough to deter people from spending time outside. No visual impact, so will not impact on the views that contribute to the character of the area to the same extent as other options.	Provides a low level of sound reduction to 7 properties (again, likely that noise may still be loud enough to affect people's daily routines), and a higher level to 3 properties. Lower visual impact than options 3 and 4 so will limit the extent to which noise mitigation detracts from the natural feel/character of the area.	Provides highest level of noise reduction but only benefits two properties - little benefit at a community level. Noise wall will be visible for approx 18 properties however - adverse impacts on community character.	Provides highest level of noise reduction but only benefits two properties - little benefit at a community level. Noise wall will be visible for approx 18 properties however - adverse impacts on community character.
Effects on visual aspects of amenity values from dwellings	Visual and landscape	Areas B1-B3 are amongst the most sensitive sections of the route in landscape terms because (i) the area is recognised as having special amenity values, (ii) there is a concentration of properties with outlook to the highway, and (iii) the highway alignment is in the centre of the northern outlook from properties on Mountain View Drive and Manakau Heights Drive. Issues include	o Minimises effects on openness and rural character. However, highway and moving traffic will be prominent focal point in valley outlook.	- Increases prominence and hard-edged character of highway itself while having on slight effect on screening traffic.	+ Best balance between screening moving traffic while avoiding an overly dominant structure. Wall will nevertheless be a dominant structure (given length, elevantion, and central location in outlook) and would appear incongruous on bridges. Could be softened with planting.	- - - Wall will screen traffic but at same time will be a dominant structure (considering length, height, and location) walling off the area and accentuating the highway. High noise walls will appear incongrous on bridges.
Effects on experience for travelling public	Visual and landscape	There is potential for travellers to enjoy travelling though a special amenity landscape including landmarks of Pukehou, backdrop hills, Manakau knoll, Waiauti Stream, Manakau Stream. The risks are closing off such views, and introducing noise mitigation that exacerbates the effect of the highway on the landscape.	+ Maintains views and experience of travelling through an attractive valley, including views of landmarks (Pukehou, backdrop hills, and Manakau knoll) and waterbodies (Waiauti and Manakau Streams). Maintains clean lines - avoids distrupting continous wire-rope barrier (except where necessary at bridges). Score elevated because of special character of area.	o Maintains views of surrounding countryside but with slightly less attractive foreground. Score elevated because of special character of area.	- Will reduce some views, backdrop hills will be visible over wall for northbound travellers, and views of Pukehou and Manakau knoll will be retained. Will diminish experience of Waiauti and Manakau Streams. Wall itself will be a prominent element given its length and sinuous form. But will retain clean lines of continuous wire-rope barrier.	- - - Will confine views to a greater extent than Option 3. Wall will also be more dominant, accentuated by its height, length and sinuous form. Wall will be particularly incongruous over Waiauti and Manakau Streams. Will significantly diminish the sense of passing through an attractive and fine-scale landscape. Score reduced because of special character of area.

NZS 6806 – Assessment matrix

Project	Assessment area	
Ōtaki to north Levin	B3 - B3	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	Single PPF in Cat B. 10 other Cat A PPFs in cluster	+ + Single Cat B PPF remains	+ + Single Cat B PPF remains	+ + Single Cat B PPF remains	+ + + All PPFs Cat A
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects	– – 10 PPFs > 50 dB	– – – 15 PPFs > 50 dB	– – 10 PPFs > 50 dB	+ 3 PPFs > 50 dB
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 2 dB reduction applies to all PPFs	– – A single PPF receives 2 dB reduction, and all other have no change	+ A single PPF receives 3 dB reduction, and several others have a minor change	+ + + On average a 4 dB reduction occurs
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	– Door and windows may need to be closed to achieve reasonable internal sound levels	– Door and windows may need to be closed to achieve reasonable internal sound levels	– Door and windows may need to be closed to achieve reasonable internal sound levels	o Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	o Moderate BCR (0.6) not including effects to the west of the road	– – – Poor BCR (0.1)	– – Low BCR (0.3)	– – Low BCR (0.4)
Mitigation allows for integration of ecological treatment	Ecology	Noise level risk to birds within B3 and flight paths between properties with indigenous forests, including #48 and #61	+ + The EPA7 roading surface will reduce vehicle noise affecting indigenous forest birds. Planting of native trees and shrubs, especially on the western side, will form a flight corridor between sites B2 and B3 for birds. This should encourage birds to move between forest sites. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading. Bird movements may occur between properties #48 and #61.	+ The 1.1 m concrete safety barrier will not reduce vehicle noise affecting indigenous forest birds. However, planting of native trees and shrubs will create a buffer zone for noise and produce a flight corridor between sites for birds. Tree height should encourage birds to move between forests above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	+ + The 2 m noise wall will reduce some of the vehicle noise, which could potentially affect indigenous forest birds. Planting native trees and shrubs will form a buffer to noise and form a flight corridor between sites. Tree height should encourage birds to move between forests above the proposed roading.	+ + The 3 m noise wall will reduce vehicle noise. Planting native trees and shrubs will form an additional noise buffer and will create a flight corridor between sites on the western side. Tree height and the roadside wall will encourage birds to fly at height between forest fragments and above the proposed roading.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimium standards	+ + All dwellings Cat A/B – compatible noise levels achieved; no visual effects from noise mitigation; effects on amenity managed	+ All dwellings Cat A/B – compatible noise levels acheived; minor visual effects of concrete barrier; minimised effects on amenity east of highway	– All dwellings Cat A/B – compatible noise levels achieved; medium visual effects from 2m wall; minimised effects on amenity east of highway	– – All dwellings Cat A/B – compatible noise levels achieved; higher visual effects from 3m wall; greater minimised effects on amenity east of highway
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading		o High cost of surfacing but lower cost than walls	+ Extension of concrete bridge barriers, avoid nultiple transistions, lower cost solution	– May limit access to swale, unlikley to need extra fill, wall costs	– – May limit access to swale, unlikley to need extra fill, wall costs
Effects on earthworks	Roading	Possible spil sites by extending embankment footprint / shallower grade	o No effect	o No effect	o Possible spoil sites in this location, no extra fill as perched swale	o Possible spoil sites in this location, no extra fill as perched swale
Stormwater treatment and/or potential flooding effects	Roading		o No effect	o No effect	– Access to swale	– Access to swale

Draft for discussion

Project	Assessment area
Ōtaki to north Levin	B3 - B3

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Social effects of mitigation	Social	Manakau is a quiet area that values its existing rural/natural character - noise mitigation will ideally help to retain this quiet environment without compromising the views that currently contribute to the character of the area. Properties in the B2 area are located on a ridge and enjoy views across to the west - maintaining these views will be important in retaining the character of this local community, and noise mitigation will be important in ensuring that people can still spend time outdoors i.e in their gardens. It is noted that this area includes both a school and church which are particularly sensitive receivers whose ability to operate could be affected by changes in noise levels.	- Provides a low level of benefit to the highest number of properties, but the level of sound reduction provided is likely not sufficient to avoid adverse impacts on people's way of life (i.e no longer spending time outdoors).	- - This option will have very little impact in terms of addressing noise impacts on people's way of life and community character - provides a low level of sound reduction to only one property.	- - Visual impacts are the same as for Option 4, however a less preferable option overall as sound reduction is less than option 4. Would expect that noise levels will still adversely impact upon way of life for properties in this area, particularly those closest to the road (i.e no longer spending time in their gardens)	- Provides a reasonable level of sound reduction for 5 properties. However a 3m noise wall will encroach on views from properties (and enjoyment of the rural/natural environment - this will be a particular issue for properties on the western side of O2NL whose views up towards the Tararua Ranges will be restricted. These properties are already between o2NL and SH1 so a noise wall may contribute to feelings of separation from the rest of the Manakau community.
Effects on visual aspects of amenity values from dwellings	Visual and landscape	Houses on Manakau Heights Drive (as with those on Mountain View Drive) are elevated with outlook toward highway. Relatively large and closely settled rural residential enclave. Issues are prominence of highway/moving traffic in centre of outlook, and potential dominance of noise mitigation walls.	o Minimises adverse effects on openness and rural character. However, highway and moving traffic will be prominent focal point in valley.	- Increases prominence and hard-edged character of highway itself while having on slight effect on screening traffic.	+ + Best balance between screening carriageway and moving traffic while avoiding an overly dominant structure. Wall will nevertheless be a prominent in outlook and will diminish rural character. Could be softened with planting	- - Wall will screen traffic but at same time will be a dominant structure (considering length, height, and location) walling off the area and accentuating the highway.
Effects on experience for travelling public	Visual and landscape	The area forms part of a landscape area with special character in conjunction with section to north and south. The risks are that noise mitigation could close off views, and become a dominant element that compromises the landscape.	+ As with B2. Maintains views and experience of travelling through an attractive valley, including views of landmarks (Pukehou, backdrop hills, and Manakau knoll) and waterbodies (Waiauti and Manakau Streams). Maintains clean lines - avoids distrupting continous wire-rope barrier (except where necessary at bridges). Score elevated because of special character of area.	o As with B2. Maintains views of surrounding countryside but with slightly less attractive foreground. Score elevated because of special character of area.	- As with B2. Will reduce some views, backdrop hills will be visible over wall for northbound travellers, and views of Pukehou and Manakau knoll will be retained. Will diminish experience of Waiauti and Manakau Streams. Wall itself will be a prominent element given its length and sinuous form. But will retain clean lines of continuous wire-rope barrier.	- - - As with B2. Will confine views to a greater extent than Option 3. Wall will also be more dominant, accentuated by its height, length and sinuous form. Wall will be particularly incongruous over Waiauti and Manakau Streams. Will significantly diminish the sense of passing through an attractive and fine-scale landscape. Score reduced because of special character of area.

NZS 6806 – Assessment matrix

Project	Assessment area
Ōtaki to north Levin	C1 - C1

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	Single Cat B PPF in Manakau Heights, with large cluster of Cat A PPFs in the Village	+ + PPF remains Cat B	+ + PPF remains Cat B	+ + PPF remains Cat B	+ + + All PPFs Cat A
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects	- - - 13 PPFs > 50 dB	- - - 13 PPFs > 50 dB	- - 5 PPFs > 50 dB	o 3 PPFs > 50 dB
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 2 dB reduction applies to all PPFs	- Low level of reduction applies (1 dB avg) due to elevated receivers	+ + 2 dB average reduction achieve. Limited due to elevated receivers	+ + + An average of 3 dB reduction, with significant reduction to PPFs near barrier
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	- Door and windows may need to be closed to achieve reasonable internal sound levels	- Door and windows may need to be closed to achieve reasonable internal sound levels	- Door and windows may need to be closed to achieve reasonable internal sound levels	o Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	o 0.9	- - - 0.1	- - - 0.2	0.3
Mitigation allows for integration of ecological treatment	Ecology	Noise level risk to birds within C1 and flight paths between properties with indigenous forest fragments and treeland, including #87 and #91.	+ The EPA7 roading surface will reduce vehicle noise affecting birds. Planting of native trees and shrubs will reduce noise and form additional habitat and flight corridor for birds. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	+ The 2 m noise wall will reduce some of the vehicle noise that could potentially affect birds. Planting native trees and shrubs will form a buffer to noise and form a flight corridor between sites. Tree height should encourage birds to move between forest fragments above the proposed roading.	+ + The 3 m noise wall will reduce vehicle noise. Planting native trees and shrubs will form an additional noise buffer and will create a flight corridor between sites. Tree height and the roadside wall will encourage birds to fly at height between forest fragments and above the proposed roading.	+ + + The combination of the EPA7 roading surface and the 3 m noise wall will greatly reduce vehicle noise. Planting native trees and shrubs will form an additional noise buffer and will create a flight corridor between sites. Tree height and the roadside wall will encourage birds to fly at height between forest fragments and above the proposed roading.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimium standards	+ + All dwellings Cat A/B – compatible noise levels achieved; no visual effects from noise mitigation; minimised effects on amenity	o All dwellings Cat A/B – compatible noise levels acheived; medium visual effects of 2m wall; minimised effects on amenity	- - All dwellings Cat A/B – compatible noise levels achieved; higher visual effects from 3m wall; minimised effects on amenity	- All dwellings Cat A/B – compatible noise levels achieved; higher visual effects from 3m wall; lesser effects on amenity through EPA7
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading		+ Expected to be less cost than other options	- Lengthy walls	- - Lengthy walls of greater height	- - - Greatest cost (surafcing plus 3m wall)
Effects on earthworks	Roading	Highway tracks close to existing grades through section	o No effect	o Minimal effect as highway close to grade / minor Cut/fill for much of section	o Minimal effect as highway close to grade / minor Cut/fill for much of section	o Minimal effect as highway close to grade / minor Cut/fill for much of section
Stormwater treatment and/or potential flooding effects	Roading	Numerous new culverts east of Manakau	o No effect	- Access to culverts may become more difficult with walls	- Access to culverts may become more difficult with walls	- Access to culverts may become more difficult with walls
Social effects of mitigation	Social	The Manakau village community is already	-	- -	-	o

Draft for discussion

Project	Assessment area	
Ōtaki to north Levin	C1 - C1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
		close to SH1 but sees themselves as tucked away and value the relatively quiet (especially those further from SH1), rural feel of their community. Minimising noise will be important in terms of retaining the character and potenital cumulative impacts of both roads. The C1 area will be sandwiched between SH1 and O2NL which could lead to this community feeling isolated and separated from the rest of Manakau; high noise walls could contribute to this feeling of division or alternately provide privacy and screening if wider views connecting to the ranges are maintained, landscaping will be an important factor. There are also a large number of receivers in this area, so impacts will be felt by a larger number of people than in some other areas.	Provides a low level of benefit to the highest number of properties, but the level of sound reduction provided is likely not sufficient to avoid adverse impacts on people's way of life (i.e no longer spending time outdoors).	Low levels of sound reduction compared to options 3 and 4, and will only benefit 6 properties – would still expect the rest of the area to be adversely	Same as option 4 – however sound reduction levels are less, so will have less of a positive impact on people's ability to go about their usual daily routines.	Provides the highest levels of sound reduction – for those properties in closest proximity to the road, sound reduction may be sufficient to allow people to go about their daily routines as normal (i.e spending time outside). However the 3m noise wall will potentially further decrease community cohesion (noting this community will already be cut off from the rest of the community by the road) by making the community between SH1 and O2NL feel increasingly cut off from the rest of Manakau, and will also somewhat restrict views for those on the other side of the road (detracting from the rural/natural character of the area).
Effects on visual aspects of amenity values from dwellings	Visual and landscape	C1 is part of Manakau village, on a terrace above the highway alignment. There will be low visibility because houses are elevated, oriented in opposite direction, and screened by vegetation. There are some exceptions such as the house at southern end of C1 area.	o Few effects on outlook from houses because of relatively low visibility. Moving traffic may attract attention through trees	o Few effects on outlook from houses because of relatively low visibility. Wall will not be prominent because at lower elevation and softened by trees. Neutral score given because of low visibility.	- Few effects on outlook from houses in Manakau because of relatively low visibility – wall will be at lower elevation, softened by trees, and will screen moving traffic. It will nevertheless be a substantial structure considering 3m height and 1.4km length. Score only slightly negative because of low visibility.	- Option 4 is same as Option 3 except for different pavement treatment. Therefore no difference in visual aspects.
Effects on experience for travelling public	Visual and landscape	The section of highway between C1 and C2 passes through an enclosed valley compared to open areas to the north and south. Issues include creation of an overly hard environment with walls on both sides – which could appear incongruous in rural context.	o Maintains engagement with valley and trees and sense of natural enclosure	- Will be consistent with passage through confined valley, but enclosure will be by structure – will diminish connection with natural landscape. Tree clad slopes will remain visible above walls. Could be softened with planting between wire-rope barrier and wall. Potential clutter from assymmetrical configuration of walls – specific design required.	- - - Will be consistent with passage through confined valley, but enclosure will be by structure. 3m high walls on both sides will create a hard-edged character that will significantly diminish experience of natural landscape. Could be softened with tree planting between wire-rope barrier and walls.	- - - As option 3.

NZS 6806 – Assessment matrix

Project	Assessment area
Ōtaki to north Levin	C2 - C2

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects All 7 PPFs > 50 dB	- - - All 7 PPFs remain > 50 dB	- - - All 7 PPFs remain > 50 dB	- - - 6 PPFs remail > 50 dB	- - 4 PPFs remain > 50 dB
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 2 dB reduction applies to all PPFs	o The mitigation achieves on average a 1 dB reduction, and performance is limited by topography	+ Achieves reasonable (3 dB) reduction	+ + + 5 dB reduction achieved
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	- - Low BCR (0.3) however would increase including PPFs on other side or road	- - - Poor BCR (0.1)	- - - Poor BCR (0.1)	- - Low BCR (0.3)
Mitigation allows for integration of ecological treatment	Ecology	Noise level risk to birds within C2 and flight paths between properties. Openwater is present on property #134/144.	+ The EPA7 roading surface will reduce vehicle noise affecting birds. Planting of native trees and shrubs will reduce noise and form additional habitat and a flight corridor for birds. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	+ + The 2 m noise wall on top of a cut will reduce vehicle noise that could potentially affect birds. Planting native trees and shrubs will form a buffer to noise and form a flight corridor between sites. Tree height should encourage birds to move between forest fragments or waterbodies above the proposed roading.	+ + The 3 m noise wall on top of a cut will reduce vehicle noise. Planting native trees and shrubs will form an additional noise buffer and will create a flight corridor between sites on the western side. Tree height and the roadside wall will encourage birds to fly higher and above the proposed roading.	+ + + The combination of the EPA7 roading surface and the 3 m noise wall will greatly reduce vehicle noise. Planting native trees and shrubs will form an additional noise buffer and will create a flight corridor between sites. Tree height and the roadside wall on top of the cut should encourage birds to fly higher and above the proposed roading.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimum standards	+ + All dwellings Cat A/B – compatible noise levels achieved; no visual effects from noise mitigation; effects on amenity minimised	- All dwellings Cat A/B – compatible noise levels acheived; higher visual effects of 2m wall on top of cut; effects on amenity managed	- - All dwellings Cat A/B – compatible noise levels achieved; high visual effects from 3m wall on top of cut; minimised effects on amenity	- All dwellings Cat A/B – compatible noise levels achieved; high visual effects from 3m wall on top of cut; less effects on amenity through EPA7
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading		o High cost of surfacing but lower cost than walls	o Limited wall extents and smaller wall	- Moderately more cost than Opt 2	- - Greatest cost (surafcing plus 3m wall)
Effects on earthworks	Roading	No issue with fence at top of cut note fills either side for local road bridge	o No effect	o Minimal effect as highway close to grade / minor Cut/fill for much of section. Options for spoil sites here	o Minimal effect as highway close to grade / minor Cut/fill for much of section. Options for spoil sites here	o Minimal effect as highway close to grade / minor Cut/fill for much of section. Options for spoil sites here
Stormwater treatment and/or potential flooding effects	Roading	New culverts	o No effect	- Access to culverts may become more difficult with walls	- Access to culverts may become more difficult with walls	- Access to culverts may become more difficult with walls

Draft for discussion

Project	Assessment area
Ōtaki to north Levin	C2 - C2

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Social effects of mitigation	Social	Manakau is a quiet area that values its existing rural/natural character – noise mitigation will ideally help to retain this quiet environment without compromising the views that currently contribute to the character of the area. Properties in the C2 area are located on a ridge and enjoy views across to the west – maintaining these views will be important in retaining the character of this local community, and noise mitigation will be important in ensuring that people can still spend time outdoors i.e in their gardens.	–	– –	– –	–
			Provides a low level of benefit to the highest number of properties, but the level of sound reduction provided is likely not sufficient to avoid adverse impacts on people's way of life (i.e no longer spending time outdoors).	Same as option 4 and 3, however levels of sound reduction are less so benefits for way of life are lessened.	Same as option 4, however levels of sound reduction are less so benefits for way of life are lessened.	Provides the highest levels of sound reduction but only benefits 3 properties – sound reduction will be beneficial for these properties in allowing them to retain their usual way of life without being adversely impacted by noise (i.e being able to spend time outdoors or work from home). For those properties who are not benefited, noise levels could still be expected to alter the quiet character of the community that is currently valued. For all properties, the noise wall will disrupt views to the west and will somewhat detract from people's enjoyment of the area/natural character of the area.
Effects on visual aspects of amenity values from dwellings	Visual and landscape	Houses in this 'Eastern Rise' area are slightly elevated above and oriented towards the proposed highway which will be a dominant foreground feature. Issues include the effects of highway and traffic on visual amenity, and the potential for noise mitigation walls themselves to detract from visual amenity.	o	+ +	– –	– –
			Maintains open outlook, but highway and moving traffic will be focus of view.	Walls will be reasonably prominent, will reduce outlook, and accentuate severance from Manakau. But walls will also screen highway and most moving traffic. Best balance between screening traffic and avoiding creating new adverse effects from walls. Could be softened by planting on outside of wall.	While walls will screen highway and moving traffic, their 3m height and length will have their own adverse effects. Walls will be visually dominant and wall off area from wider landscape. Will reduce outlook and accentuate severance from Manakau.	Option 4 is same as Option 3 except for different pavement treatment. Therefore no difference in visual aspects.
Effects on experience for travelling public	Visual and landscape	As for C1	o	–	– – –	– – –
			As for C1	As for C1	As for C1	As for C1

NZS 6806 – Assessment matrix

Project	Assessment area
Ōtaki to north Levin	D1 - D1

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	All 9 PPFs in cluster are Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects	- - 3 PPFs remain > 50 dB	- - 3 PPFs remain > 50 dB	- - 3 PPFs remain > 50 dB	- - 3 PPFs remain > 50 dB
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 2 dB reduction applies to all PPFs	- 2 dB reduction to most affected property, but at most 1 dB to others	o 2 dB reduction to most affected property, but 1 dB to others	+ 3 dB reduction to most affected property, but 1dB to others
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	- Low BCR (0.4)	- - - Poor BCR (0.1)	- - - Poor BCR (0.1)	- - - Poor BCR (0.1)
Mitigation allows for integration of ecological treatment	Ecology	Noise level risk to birds within D1 and flight paths of river and forest birds, including property #151 and #158.	+ The EPA7 roading surface will reduce vehicle noise affecting river birds. By removing weed species from the river bed, upstream and downstream of the bridge will allow birds to forage and nest at a distance from the proposed road. Planting of shrubland and groundcover on the banks adjacent to the bridge will provide a connection between the existing forest areas and will allow a corridor for birds to fly below the bridge.	+ + The 2 m noise wall on top of a cut will reduce vehicle noise, which could potentially affect birds. By removing weed species from the river bed up and downstream of the bridge will allow birds to forage and nest at a distance from the proposed road. Planting native trees and shrubs around the bridge will screen and form a buffer to noise.	+ + + The 3 m noise wall on top of a cut will reduce vehicle noise. By removing weed species from the river bed up and downstream of the bridge will allow birds to forage and nest at a distance from the proposed road. Planting native trees and shrubs around the bridge will screen and form a buffer to noise.	+ + + The 3 m noise bund on top of a cut will reduce vehicle noise. Planting of shrubland and groundcover on the banks adjacent to the bridge will provide a connection between the existing forest areas and will allow a corridor for birds to fly below the bridge. Tree height and the bund will encourage birds to fly higher and above the proposed roading. By removing weed species from the river bed up and downstream of the bridge will allow birds to forage and nest at a distance from the proposed road.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimium standards	+ + All dwellings Cat A/B – compatible noise levels achieved; no visual effects from noise mitigation; minimised effects on amenity	- All dwellings Cat A/B – compatible noise levels acheived; medium visual effects of 2m wall on top of cut; effects on amenity managed	- - All dwellings Cat A/B – compatible noise levels achieved; higher visual effects from 3m wall on top of cut; effects on amenity managed	- All dwellings Cat A/B – compatible noise levels achieved; lower visual effects from 3m noise bund on top of cut; effects on amenity managed
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading		- High cost of surfacing, bund better solution	- High cost of fence, bund better solution	- High cost of fence, bund better solution	+ Spoli site opportunity, low costs, not spatially constrained
Effects on earthworks	Roading	In cutting here, will have overburden to waste	o No effect	o Top of cut, no isisues	o Top of cut, no isisues	+ + Opportunity as spoil site for bund
Stormwater treatment and/or potential flooding effects	Roading		o No effect	o fence between cut off drain and cut, no issues	o fence between cut off drain and cut, no issues	o No issue with bund, overland flow redirected away from cut with cutoff drain
Social effects of mitigation	Social	This area is located slightly further north	o	-	-	o

Project	Assessment area	
Ōtaki to north Levin	D1 - D1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
		than Manakau village, but is seen as part of the Manakau community. As with the rest of Manakau, the community value the quiet, rural feel of the area. Houses in the D1 area are located on a natural ridge and views of the rural landscape to the west contribute to the character of this area. As with other parts of Manakau, key issues are minimising noise (to retain the character of the area and allow people to continue with their usual way of life) and minimising visual disturbance in order to retain a sense of the natural/rural character of the area.	This option provides a small benefit (2db) to 11 properties - this is not expected to be a large enough reduction to completely mitigate impacts on people's way of life (i.e their ability to enjoy time outdoors) or the quiet character of the area. No visual impacts compared to other options.	This option provides sound reduction of 2db to 2 properties - for these properties the noise wall may allow them to go about their daily lives without significant disruption from noise (i.e spending time outdoors), but some disruption is still likely to occur . These properties are further down the ridge line, however, so may also have their views partially blocked by the wall, which reduce the quality of their home environment. Properties further up the ridge will not receive the benefits of the noise wall, but will also be less visually impacted by the noise wall.	This option provides sound reduction of 3db to 2 properties - for these properties the noise wall may allow them to go about their daily lives without significant disruption from noise (i.e spending time outdoors) . These properties are further down the ridge line, however, so may also have their views partially blocked by the wall, which reduce the quality of their home environment. Properties further up the ridge will not receive the benefits of the noise wall, but will also be less visually impacted by the noise wall.	A noise bund would create a more natural looking barrier than a noise wall, which would be a less jarring interruption to existing views to the west, which would minmise impacts (in terms of character/quality of environment) for houses set further back from the road. However this option only benefits 2 properties and only provides a sound reduction of 2db.
Effects on visual aspects of amenity values from dwellings	Visual and landscape	Houses are generallly slightly elevated at the toe of the hills, and oriented towards highway. Issues include the effects of highway and traffic on visual amenity, and the potential for noise mitigation walls themselves to detract from visual amenity.	o Maintains open outlook across flat landscape to low horizon. Most consistent with rural character.	+ + Wall will screen highway and moving traffic, while largely retaining open outlook and big-sky character. Best balance between screening traffic and avoiding creating new adverse effects from walls.	- - Wall will screen highway and moving traffic, but wall itself will be more dominant feature, especially given flat landscape.	- Bund will screen highway and moving traffic, but 3m constructed bund will be unnatural element in this context. Potential to soften bund with contouring and planting which improves score.
Effects on experience for travelling public	Visual and landscape	The alignment follows a sweeping curve around the toe of a spur, and crosses the landmark Waikawa Stream on a bridge. Potential issues include maintaining outlook to the hills on the one side, and the open plains on the other, and legibility of the Waikawa Stream crossing. The proposed walls and bunds are on the inside of the curve towards the hills, and stop just short of the stream.	o Maintains open outlook across flat landscape to low horizon, and to Waikawa Stream. Most consistent with rural character. Maintains clean lines, continous wire-rope barrier (except at bridge over Waikawa Stream).	o Wall will be relatively unobtrusive on inside of curve against backdrop hills, and offset from highway. Will retain outlook to open flat landscape to west. Score elevated for these combined factors. Maintains clean lines, continous wire-rope barrier. Irregular offset will tend (in this case) to embed wall in landscape where it can be softened with planting on both sides of wall. Design attention required with respect to relationship between wall and Waikawa Stream crossing.	- Wall be less obtrusive because of its location on inside of curve, offset from road, and backdrop hills than it might otherwise be. Maintains clean lines, continous wire-rope barrier. As with Option 2, the irregular offset will tend (in this case) to embed wall in landscape where it can be softened with planting. However combination of height and length (3m x 820m) will make wall reasonably dominant and somewhat incongruous in this rural setting.	o Bund will be less dominant than it might otherwise be because of location on inside of bend, towards backdrop hills, and offset from road. It will nevertheless be an unnatural form in this location. It could be naturalised with contouring and some planting.

NZS 6806 – Assessment matrix

Project	Assessment area
Ōtaki to north Levin	D2 - D2

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	2x Cat B PPFs and 5 Cat A PPFs in cluster	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects	– 3 PPFs remain >50 dB	– – – 5 PPFs remain >50 dB	– – 4 PPFs remain >50 dB	– – 4 PPFs remain >50 dB
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 2 dB reduction applies to all PPFs	– – – Barrier generally ineffective	+ + Up to 3 dB reduction to most affected properties	+ Bund slightly less effective than wall
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	– Low BCR (0.3)	Poor BCR (<0.1)	Poor BCR (0.1)	Poor BCR (0.1)
Mitigation allows for integration of ecological treatment	Ecology	Noise level risk to birds within D2 and flight paths between properties with indigenous forest and scrub (#163, #167, #192, #207), wetland areas (#164, #166, #207), or openwater (#207).	+ The EPA7 roading surface will reduce vehicle noise affecting birds within the area. Replacement wetland and planting needs be established at a distance from the road. Replacement wetland areas should be established on one side of the road to reduce birds overflying the proposed roading.	+ The 2 m noise wall on top of a cut will reduce vehicle noise, which could potentially affect birds. Planting native trees and shrubs will form a buffer to noise and form a flight corridor between sites. Tree height should encourage birds to move between forest fragments above the proposed roading. Replacement wetland areas should be established on one side of the road to reduce birds overflying the proposed roading.	+ + The 3 m noise wall on top of a cut will reduce vehicle noise. The combination of planting native trees and shrubs and the height of the noise wall will form a flight corridor and additional habitat for birds. Replacement wetland areas should be established on one side of the road to reduce birds overflying the proposed roading.	+ + + The 3 m noise bund on top of a cut will reduce vehicle noise. This is a more bird friendly suggestion with native planting. Tree height and the planted bund will encourage birds to fly at height and above the proposed roading Replacement wetland areas should be established on one side of the road to reduce birds overflying the proposed roading.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimium standards	+ + All dwellings Cat A/B – compatible noise levels achieved; no visual effects from noise mitigation; minimised effects on amenity	– All dwellings Cat A/B – compatible noise levels acheived; medium visual effects of 2m wall on top of cut; effects on amenity managed	– – All dwellings Cat A/B – compatible noise levels achieved; higher visual effects from 3m wall on top of cut; minimised effects on amenity	– All dwellings Cat A/B – compatible noise levels achieved; lower visual effects from 3m noise bund on top of cut; effects on amenity managed
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading	Note complexity in this section with treatment wetlands, lcoal road bridge and Kuku stream bridge	+ Less complex than other options	– Challenging with wetland, bridges and swales here	– Challenging with wetland, bridges and swales here	o May be challenging to locate bund with treatment ponds and swales interface, also Kuku Stream bridge, but note opportunities for using spoil here
Effects on earthworks	Roading		o No effect	o No material effect (note some of highway in fill not cut, but no impact	o No material effect (note some of highway in fill not cut, but no impact	+ + Spoil site opportunities at this lcoation
Stormwater treatment and/or potential	Roading	Low point of alignment near Kuku, inflow	o	–	–	–

Project	Assessment area	
Ōtaki to north Levin	D2 - D2	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
flooding effects		from north and south	No effect	Walls/noise bund may limit access to swales and/or treatment wetlands	Walls/noise bund may limit access to swales and/or treatment wetlands	Walls/noise bund may limit access to swales and/or treatment wetlands
Social effects of mitigation	Social	This area is part of the Kuku community, which values both the quiet, rural feel of the area and the natural environment, including proximity and views to the Tararua ranges. This area will be sandwiched between two major roads and so noise mitigation will be important to retain quality of environment in this area and ensure that residents can go about their daily routines (i.e spending time in the garden, working from home etc) without significant disruption from noise. As the area is fairly flat, noise walls may somewhat disrupt views to the east (and detract from the natural/rural feel value of the area)	o This option has no visual impact and will still allow residents to enjoy the views to the east that they currently value (and which contribute to the character of the community). All properties are afforded some degree of sound reduction, however this is to a low level and some impacts on way of life would still be expected (i.e people limiting time spent outdoors).	- This option provides a small noise reduction for 3 properties but this is likely not enough to not affect people's ability to spend time outdoors. A noise wall may limit the currently uninterrupted views and connection to the natural environment that these residents have, however the road itself will somewhat impede these views regardless.	- This option provides limited benefit in terms of noise reduction with the exception of a 3db reduction for one property; overall it is expected that residents enjoyment of outdoor space would still be adversely impacted. A noise wall may limit the currently uninterrupted views and connection to the natural environment that these residents have, however the road itself will somewhat impede these views regardless.	- A noise bund would create a more natural looking barrier than a noise wall, which would be a less jarring interruption to existing views to the west, which would minmise impacts (in terms of character/quality of environment) for houses set further back from the road. However this option only benefits 2 properties and only provides a sound reduction of 2db.
Effects on visual aspects of amenity values from dwellings	Visual and landscape	The highway is 'behind' the group of houses which are typically oriented in the opposite diretion. The highway will be towards the hill backdrop. Issues include the effects of highway and traffic on visual amenity, and the potential for noise mitigation walls themselves to detract from visual amenity.	o Maintains outlook behind houses to hills. Highway will be reasonably prominent.	+ + 2m wall will screen highway and moving traffic, and will itself be relatively unobtrusive because it will be long and low against backdrop hills. Will not screen outlook to hills. Could be further softened with planting. However, wall would look incongruous on bridge over Kuku Stream.	- 3m wall will screen highway and moving traffic, but its height and 800m length will make it reasonably prominent. Score improved because of its location behind houses and against backdrop hills. 3m wall would be incongruous on bridge over Kuku Stream.	+ While bund will screen highway and moving traffic, its 3m height and 800m length will appear relatively unnatural. The bund could be naturalised with contouring (for example to mimic terrace scarps which would require a curved or sinous form in plan view) and planting. Score improved becuase of location behind houses, against backdrop hills, and likelihood the bund will appear less incongruous than wall in this context. Alternative design would be required for bridge over Kuku Stream.
Effects on experience for travelling public	Visual and landscape	Straight section of the route, following hills at back of plains. Main feature is crossing of Kuku Stream. Otherwise there are no particular issues with respect to views. Potential issues limited to the legibility of Kuku Stream and maintaining clean lines of highway.	o Will maintain engagement with landscape including views to hills on one side and outlook towards coastal skies over an open and flat landscape in the other direction.	- 2m wall will screen views over open and flat landscape to the west (although such views will be available north and south of this location) which will direct attention toward the hills to the east. The 'big sky' character will remain apparent above the walls. This option maintains clean lines of continous wire-rope barrier. Irregular offset will tend (in this case) to embed wall in landscape where it can be softened with planting. However, 2m walls would appear incongruous on bridge over Kuku Stream.	- - 3m wall will screen views over open and flat landscape to the west, and direct attention towards the hills to the east. However, the height and length of the wall will become a dominant element that will appear somewhat incongruous. It would be incongruous over Kuku Stream.	- The bund will screen views over open and flat landscape to the west, and direct attention towards the hills to the east. Compared to the 3m wall, however, the bund might be contoured to appear less obtrusive.

NZS 6806 – Assessment matrix

Project	Assessment area	
Ōtaki to north Levin	E1 - E1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	2x Cat B PPFs and 22 Cat A PPFs in area	+ + 2x Cat B PPFs remain	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects	- 7 PPFs remain >50 dB	- - 12 PPFs remain >50 dB	- 7 PPFs remain >50 dB	o 2 PPFs remain >50 dB
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 2 dB reduction applies to all PPFs	+ Barrier provides good proection for closest 2 PPFs but littler for others	+ + Barrier provides 6-8 dB reduction to closest PPFs and 2-3 dB to most others	+ + + Sutface provides additional 2dB to barrier
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	+ Good BCR (1.0)	Poor BCR (<0.1)	Low BCR (0.2)	Low BCR (0.2)
Mitigation allows for integration of ecological treatment	Ecology	There is noise level risk to birds within E1 and flight paths between properties with indigenous forest fragments,, scrub and open pasture. This area is not far from the Ōhau River, which includes mixed indigenous-exotic forest fragments on properties #209 and #212. Please refer to notes under D1.	+ The EPA7 roading surface will reduce vehicle noise affecting indigenous forest birds. Extensive planting of native trees and shrubs will form a buffer to noise and form a flight corridor between sites for birds. Tree height should encourage birds to move between forests above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	+ The 1.1 m concrete safety barrier will not reduce any vehicle noise affecting indigenous forest birds. However, extensive planting of native trees and shrubs will create a buffer zone for noise and produce a flight corridor along the eastern boundary of the road for birds. Tree height should encourage birds to move between forest fragments above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	+ + The 2 m noise wall will reduce some of the vehicle noise thatcould potentially affect indigenous forest birds. Planting native trees and shrubs will form a buffer to noise and form a flight corridor between sites. Tree height should encourage birds to move between forests above the proposed roading.	+ + The 3 m noise wall will reduce vehicle noise from affecting indigenous forest birds. Planting native trees and shrubs will form an additional noise buffer and will create a flight corridor between sites. Tree height and the roadside wall will encourage birds to fly at height between forest fragments and above the proposed roading.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimium standards	+ + All dwellings Cat A/B - compatible noise levels achieved; no visual effects from noise mitigation; effects on amenity managed	o All dwellings Cat A/B - compatible noise levels acheived; medium visual effects of 2m wall; effects on amenity managed	- - All dwellings Cat A/B - compatible noise levels achieved; higher visual effects from 3m wall; minimised effects on amenity	- All dwellings Cat A/B - compatible noise levels achieved; high visual effects from 3m wall; less effects on amenity through EPA7
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading	Note issues with option numbering/ grpahics was not consistent here (no image for 1.1m safety barrier)	+ High cost of surfacing but lower cost than walls	+ Similar costs to surfacing, concrete barrier required for bridge abutments to extend	- - High cost	- - High cost
Effects on earthworks	Roading	EXP in minor fill Option for bund here? Note extensive spoil site options	o No effect	o No effect, spoil sites in this location	o Located behind swale, spoil sites in this lcoation	o Located behind swale, spoil sites in this lcoation
Stormwater treatment and/or potential	Roading		o	o	+	-

Project	Assessment area	
Ōtaki to north Levin	E1 - E1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
flooding effects			No effect	No effect	walls could limit access to swales	walls could limit access to swales
Social effects of mitigation	Social	This flat area is on the outskirts of Ohau. Residents value the rural village feel of the community, the sense of serentiy, and connections to the natural environment (including being between the coast and the Tararua Ranges). A key issue here will be reducing noise to sufficient levels to retain the quiet, rural feel of the area, without compromising the views and connections to the natural environment that also contribute to the character of Ohau.	o This option benefits the largest number of properties but to a small extent in terms of sound reduction; residents (particularly those closest to the road) would likely still experience impacts to their way of life (i.e spending less time outdoors). No visual impacts.	- This option provides a reasonable level of sound reduction for 2 properties and at an individual property level may help these residents go about their daily lives undisturbed by noise. However very little sound reduction is provided at a larger scale. To some extent a noise wall would block views to the east and create a visual barrier between these properties and the rest of Ohau, however views of the rural environment and Tararua ranges to the west would not be affected.	o This option provides a reasonable level of sound reduction (7 and 8db reductions for two properties, and 4db for several more) and would assist in residents going about their daily lives without disturbance from noise. To some extent a noise wall would block views to the east and create a visual barrier between these properties and the rest of Ohau, however views of the rural environment and Tararua ranges to the west would not be affected.	+ Same as option 4, however the level of sound reduction provided is higher for more properties - so a more positive impact on people's way of life and on retaining the quiet rural character of the area.
Effects on visual aspects of amenity values from dwellings	Visual and landscape	Cluster of houses south of highway on Muhunoa East Road and Arapaepae South Road. Houses typically oriented toward highway. Outlook over rolling landscape. Issues include the effects of highway and traffic on visual amenity, and the potential for noise mitigation walls themselves to detract from visual amenity.	o Will maintain open outlook over rolling landscape. Traffic and highway will be visible, although rolling terrain will restrict extent of views and highway prominence.	+ + + 2m wall will screen carriageway and traffic. The wall will also partly restrict general rural outlook - although long views are limited and rolling terrain will reduce wall prominence. Score elevated for these combined factors. Best balance between screening the road and minimising effect on rural character.	- 3m wall will screen carriageway and traffic. However, combination of wall height and length (1.3km) means wall itself will be a relatively dominant feature, although mitigated to some extent by the terrain and short nature of views.	- Option 4 is same as Option 3 except for road surface.
Effects on experience for travelling public	Visual and landscape	Section of highway traverses a rolling landscape in contrast to the open landscape over the Ōhau River to the south, and the open Levin terraces to the north. Potential issues include maintaining expereince of this character type, screening of views by noise walls, and creating an overly hard character with walls on both sides of highway.	o Maintains engagement with rolling rural landscape.	- - 2m walls on both sides will confine views to a hard-edged 'tunnel' with reduced engagement with rolling rural terrain. Walls will be relatively dominant because of their length, the curving nature of the alignment, and presence of walls on both sides. Negative score increased for these combination of factors.	- - - Effects for 3m walls will be similar to 2m but amplified. Will confine views to a hard-edged 'tunnel'. Walls will be dominant because of their length, the curving nature of the alignment, and enclosure on both sides. Negative score increased for these combination of factors.	- - - Same as Option 3

NZS 6806 – Assessment matrix

Project	Assessment area	
Ōtaki to north Levin	E2 - E2	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	2x Cat B PPFs and 4 Cat A PPFs	+ 1x Cat B remains	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects	– – – 5 PPFs remain > 50 dB	– – – 6 PPFs remain > 50 dB	– – 4 PPFs remain > 50 dB	– 3 PPFs remain > 50 dB
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 2 dB reduction applies to all PPFs	+ + A 3–5 dB reduction applies to the 2 most affected PPFs	+ + + A 5–7 dB reduction applies to the 2 most affected PPFs, with several other PFPs getting a 1–2 dB benefit	+ + + An additional 2 dB benefit occurs
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	– Door and windows may need to be closed to achieve reasonable internal sound levels	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	– Low BCR (0.4)	– – – Poor BCR (<0.1)	– – – Poor BCR (0.1)	– – – Poor BCR (0.2)
Mitigation allows for integration of ecological treatment	Ecology	There is noise level risk to birds within E2 and flight paths between properties with indigenous forest fragments and open pasture. ** This area is not far from the Ōhau River, including mixed indigenous–exotic forest fragments on properties #209 and #212. Please refer to notes under D1.	+ + The EPA7 roading surface will reduce vehicle noise affecting indigenous forest birds. Extensive planting of native trees and shrubs will form a buffer to noise and form a flight corridor between sites for birds. Tree height should encourage birds to move between forests above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	+ The 1.1 m concrete safety barrier will not reduce any vehicle noise affecting indigenous forest birds. However, extensive planting of native trees and shrubs will create a buffer zone for noise and produce a flight corridor along the eastern boundary of the road for birds. Tree height should encourage birds to move between forest fragments above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	+ + The 2 m noise wall will reduce some of the vehicle noise that could potentially affect indigenous forest birds. Planting native trees and shrubs will form a buffer to noise and form a flight corridor between sites. Tree height should encourage birds to move between forests above the proposed roading.	+ + The 3 m noise wall will reduce vehicle noise from affecting indigenous forest birds. Planting native trees and shrubs will form an additional noise buffer and will create a flight corridor between sites. Tree height and the roadside wall will encourage birds to fly at height between forest fragments and above the proposed roading.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimium standards	+ + All dwellings Cat A/B – compatible noise levels achieved; no visual effects from noise mitigation; effects on amenity managed	o All dwellings Cat A/B – compatible noise levels acheived; medium visual effects of 2m wall; effects on amenity managed	– – All dwellings Cat A/B – compatible noise levels achieved; higher visual effects from 3m wall; minimised effects on amenity	– All dwellings Cat A/B – compatible noise levels achieved; high visual effects from 3m wall; less effects on amenity through EPA7
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading	Western side of highway. Question – any option for low noise surfacing with 1.1m concrete safety barrier?	+ High cost of surfacing but lower cost than walls	+ Similar costs to surfacing, concrete barrier required for bridge abutments to extend	– – High cost	– – High cost
Effects on earthworks	Roading	Bunds option?	o	o	o	o

Draft for discussion

Project	Assessment area
Ōtaki to north Levin	E2 - E2

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
			No effect	No effect, spoil sites in this location	Located behind swale, spoil sites in this lcoation	Located behind swale, spoil sites in this lcoation
Stormwater treatment and/or potential flooding effects	Roading		o	o	-	-
			No effect	No effect	walls could limit access to swales	walls could limit access to swales
Social effects of mitigation	Social	This flat area is on the outskirts of Ohau. Residents value the rural village feel of the community, the sense of serentiy, and connections to the natural environment (including being between the coast and the Tararua Ranges). A key issue here will be reducing noise to sufficient levels to retain the quiet, rural feel of the area, without compromising the views and connections to the natural environment (particularly to the west) that also contribute to the character of Ohau.	o	-	o	+
			This option benefits the largest number of properties but to a small extent in terms of sound reduction; residents (particularly those closest to the road) would likely still experience impacts to their way of life (i.e spending less time outdoors) and the quiet rural character of the area would be impacted. No visual impacts.	Provides some sound reduction to 3 properties (less than other options) and also creates a visual barrier which may limit people's feeling of connectivity to the natural environment.	Same as option 4.	Provides a reasonable level of sound reduction to the majority of properties in this area; this may help to retain the quiet character of the area and allow residents to continue their normal routines (i.e working from home or spending time outside) without disturbance. However, the 3m noise wall may create a feeling of severance between these residents and the rural/natural environment to the west, and could block views of this environment. This could adversely impact on community cohesion and character.
Effects on visual aspects of amenity values from dwellings	Visual and landscape	Small cluster of houses, generally oriented to the north away from highway, and reasonable separation distance. Issues include the effects of highway and traffic on visual amenity, and the potential for noise mitigation walls themselves to detract from visual amenity.	o	+	- -	
			Will maintain open outlook. Traffic and highway will be visible 'behind' houses. Will not affect views to rolling countryside and picturesque stands of tōtara bush in the opposite direction. Reasonable separation distance.	2m wall will screen moving traffic immediately to the south – although it will be visible in longer views along the highway to the north and south. Wall be 'behind' houses, reasonably separated from most houses in cluster. Wall will be relatively prominent because of their presence on both sides of the highway and overall distance of roughly 1.4km. Positive score reduced because wall is comparitively more prominent and benefits less pronounced.	The effects of the 3m wall will be similar to the 2m but amplified. While the wall will screen traffic immediately to the south, the overlapping walls will be a dominant feature given their height, presence on both sides of highway, overlapping nature, and combined length of roughly 1.4km. Will be a somewhat incongruous element in this rural setting.	Option 4 is same as Option 3 except for road surface.
Effects on experience for travelling public	Visual and landscape	Experience from the road will be the same as for E1. An issue is whether the 626m wall is necessary as its removal would avoid enclosing a section of highway on both sides.	o	- -	- - -	- - -
			Same as E1	Same as E1. Foregoing the 626m wall on the north side of the road would improve the experience for travelling public by eliminating the section confined by walls on both sides. This would improve the score for Option 2.	Same as E1	Same as E1 (same as Option 3)

NZS 6806 – Assessment matrix

Project	Assessment area	
Ōtaki to north Levin	F1 - F1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	9x Cat A PPFs	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects 7 PPFs > 50 dB	– – 5 PPFs remain > 50 dB	– – – All 7 PPFs remain > 50 dB	– – – All 7 PPFs remain > 50 dB	– – – 6 PPFs remain > 50 dB
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 2 dB reduction applies to all PPFs	– Negligible benefit	+ + + 4 PPFs benefit 1–2 dB	+ + + 4 dB beenfit for single PPFs, and 1–2 dB reduction for 4 other PPFs
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only				
Mitigation allows for integration of ecological treatment	Ecology	Noise level risk to birds within F1 and flight paths between properties with indigenous forest fragments and mixed forest, including #307, #311, and #326.	+ + The EPA7 roading surface will reduce vehicle noise affecting indigenous forest birds. Extensive planting of native trees and shrubs will form a buffer to noise and form a flight corridor between sites for birds. Tree height should encourage birds to move between forests above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading. The swale needs to be fast draining with no remaining standing water, situated as far from the roading as practicable and planted with native vegetation.	+ The 1.1 m concrete safety barrier will not reduce any vehicle noise affecting indigenous forest birds. Planting native trees and shrubs can produce a flight corridor and habitat for birds on the western side of the road. Tree height should encourage birds to move between forests above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading. The swale needs to be fast draining with no remaining standing water, situated as far from the roading as practicable and planted with native vegetation.	+ + The 2 m noise wall will reduce some of the vehicle noise, which could potentially affect indigenous forest birds. Planting native trees and shrubs can produce a flight corridor and habitat for birds on the western side of the road. Tree height should encourage birds to move between forests above the proposed roading. The swale needs to be fast draining with no remaining standing water, situated as far from the roading as practicable and planted with native vegetation.	+ + The 3 m noise wall will reduce vehicle noise from affecting indigenous forest birds. Planting native trees and shrubs can produce a flight corridor and habitat for birds on the western side of the road. Tree height and the roadside wall will encourage birds to fly at height between forest fragments and above the proposed roading. The swale needs to be fast draining with no remaining standing water, situated as far from the roading as practicable and planted with native vegetation.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimium standards	+ + All dwellings Cat A/B – compatible noise levels achieved; no visual effects from noise mitigation; minimised effects on amenity	+ All dwellings Cat A/B – compatible noise levels acheived; minor visual effects of concrete barrier; effects on amenity managed	– All dwellings Cat A/B – compatible noise levels acheived; medium visual effects of 2m wall ouside of swale; effects on amenity managed	– – All dwellings Cat A/B – compatible noise levels achieved; higher visual effects from 3m wall outside of swale; minimised effects on amenity
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading		+ High cost of surfacing but lower cost than walls	o Plan shows edge of 1631m of concrete safety barrier – is this is NOT included here.	– high cost	– – Higher costs
Effects on earthworks	Roading	Outside / back of swale	o No effect	o No effect	o Outside of swale no impact	o Outside of swale no impact
Stormwater treatment and/or potential flooding effects	Roading		o No effect	– No effect	– Limits access to swale	– Limits access to swale

Project	Assessment area	
Ōtaki to north Levin	F1 - F1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Social effects of mitigation	Social	This area is between Ohau and Levin; residents would typically consider themselves as part of the Levin community but still value the rural feel of this particular part of the Levin community.	o		-	o
			This option benefits the largest number of properties but to a small extent in terms of sound reduction; residents (particularly those closest to the road) would likely still experience impacts to their way of life (i.e spending less time outdoors) and the quiet rural character of the area would be impacted. No visual impacts.	Sound reduction not shown on graph - have not scored.	Low levels of sound reduction are provided by this option (to few properties) - likely to have little benefit for residents. In addition, noise wall will somewhat block views to the west which could dimish the community's feeling of connectivity to the rural/natural environment.	Low levels of sound reduction are provided by this option (to few properties) - likely to have little benefit for residents albeit somewhat higher than option 3. In addition, noise wall will somewhat block views to the west which could dimish the community's feeling of connectivity to the rural/natural environment.
Effects on visual aspects of amenity values from dwellings	Visual and landscape	Houses are NW of the highway, typically oriented away or parallel to the highway, and with relatively high level of screening by trees. Comparitively few visual issues. Potential issues restricted to effects of highway and traffic on visual amenity for the closest houses, and the potential for noise mitigation walls themselves to detract from visual amenity for those	o	o	+ +	-
			Traffic and highway will be visible 'behind' houses, typically with reasonable separation distance and trees in intervening area. Will not affect views across flat, open landscape in opposite direction, or to backdrop Tararuas beyond highway.	1.1m safety barrier will be relatively unobtrusive given the flat terrain and extent of other screening. Therefore neutral score.	2m wall will likewise be unobtrusvie given the context. Best balance between screening highway and traffic while avoiding adverse effect of the wall itself.	3m wall will be less obtrusive given context than such a wall would be in other locations. Negative score reduced for that reason. The 3m height will nevetheless mean it is reasonably prominent
Effects on experience for travelling public	Visual and landscape	The views potentially affected are short and not special - the more important views are to the Tararuas in the opposite direction. Potential issues include the general aesthetic qualities of the highway (clean lines, avoiding clutter, appearance of walls).	o	-	o	-
			Will maintain engagement with the landscape. The most important views are to the east towards the Tarauras. Will maintain clean lines of unbroken wire-rope barrier.	1.1m barrier will add to the hard edged character for 1.1km of the highway, and add to the clutter of transitions with wire-rope barriers.	2m wall would have little effect on experience from the road given the straight alignment, off-set from the road, and opportunity to use the space to soften the wall. Would retain the clean lines of unbrokcen wire-rope barrier. Neutral score given for these reasons.	3m wall will have less effect on views from road than it would in other locations given the straight alignment, offset, and reasonably short length. Negative score reduced for these reasons. It would nevertheless be more prominent than the 2m wall.

NZS 6806 - Assessment matrix

Project	Assessment area
Ōtaki to north Levin	F2 - F2

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	Single Cat B PPF	+ + + PPF achieves Cat A with mitigation	+ + + PPF achieves Cat A with mitigation	+ + + PPF achieves Cat A with mitigation	
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects	- - - Remains above 50 dB	- - - Remains above 50 dB	- - - Remains above 50 dB	
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	o 3 dB reduction predicted, although ramp likely to be a different surface (SMA) for strength reasons.	+ + 4 dB reduction	+ + + 7 dB reduction	
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	- - - Poor BCR ().1)	- - - Poor BCR ().1)	- - - Poor BCR ().1)	
Mitigation allows for integration of ecological treatment	Ecology	Noise level risk to birds within F2 and flight paths. There appears to be minimal habitat for birds except for open-pasture areas. However, birds will fly between forests, wetlands, rivers and areas with open water.	+ The EPA7 roading surface will reduce vehicle noise for birds. Planting native trees and shrubs set back from the roading will encourage birds to gain altitude before crossing the road. Low shrubs and ground cover should be planted around the on/off ramps to dissuade larger birds from alighting within this area. Small passerines may use this habitat.	+ + The 2 m noise wall will reduce some of the vehicle noise and provide a barrier for birds to fly over before crossing the roading. However, planting native trees and shrubs set back from the roading will encourage birds to gain altitude before crossing the road. Low shrubs and ground cover should be planted around the on/off ramps to dissuade larger birds from alighting within this area. Small passerines may use this habitat.	+ + The 3 m noise wall will reduce vehicle noise and provide a larger barrier to birds flying over the roading. Planting native trees and shrubs set back from the roading will encourage birds to gain altitude before crossing the road. Low shrubs and ground cover should be planted around the on/off ramps to dissuade larger birds from alighting within this area. Small passerines may use this habitat.	
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimium standards	+ + All dwellings Cat A/B - compatible noise levels achieved; no visual effects from noise mitigation; effects on amenity managed	- All dwellings Cat A/B - compatible noise levels acheived; medium visual effects of 2m wall on property boundary; minimised effects on amenity	- - All dwellings Cat A/B - compatible noise levels achieved; higher visual effects from 3m wall on property boundary; minimised effects on amenity	
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading	Note OGPA not suitable for ramps - what has been modelled?	+ Not clear who low noise surface is benefiting ?	- High cost for one property and how would access be provided? (break needed in wall / compromises continuity) This proeprty 403 will be removed ?	- - High cost for one proeprty and how would access be provdie? This proeprty 403 will be removed ?	
Effects on earthworks	Roading	Proeprty ref 403 almost certainly will be removed?	o No effect	o No effect	o No effect	
Stormwater treatment and/or potential flooding effects	Roading	Siphones shown here but could be managed	o No effect	o No effect	o No effect	
Social effects of mitigation	Social	For this area impacts are at an individual property				

Project	Assessment area	
Ōtaki to north Levin	F2 - F2	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
		level (only two properties are included in area F2) rather than at a community level - as such it is recommended that noise mitigation is selected in consultation with the individual property owner rather than considering community impacts.				
Effects on visual aspects of amenity values from dwellings	Visual and landscape	Tararua Road Interchange. The proposed wall measures appear designed for a single house, the amenity of which would be compromised by its proximity to the interchange. Potential issues are the proximity of noise walls to the house and their location on two sides of house.	o The 'baseline' Tararua Road interchange will have significant adverse effects on visual amenity of houses in close proximity (although visual effects will diminish relatively quickly with distance given the flat topography, and houses on the west side (i.e. the far side) of Arapaepae Road are typically oriented in the opposite direction).	o The 2m wall along the off-ramp and Tararua Road appears for the benefit a single house in the angle of the interchange. The wall might screen the interchange (depending on the elevation of the Tararua Road overbridge) but would be close to the house and enclose it on two sides. Therefore it has been adjusted to a neutral rather than positive score.	- - - While a 3m wall would screen the interchange, the wall itself would have adverse effects. It would be close to the house, enclose it on two sides, and be a dominant structure given its height and length. Its alignment would express the form of the interchange. The negative score is therefore increased.	
Effects on experience for travelling public	Visual and landscape	The Tararua Interchange will be the entrance to Levin from the south. Issues include the effect of noise control walls on the identity and character of this 'gateway'.	o The traffic infrastructure will dominate experience of the 'baseline' Tararua Road interchange, although it will be landmarked by views to the backdrop Tararuas.	- - The 2m curving wall following the form of the off-ramp will add to the hard-edged character and clutter of the interchange. It will detract from the 'gateway' to Levin. The negative score is therefore increased.	- - - A 3m wall will have similar adverse effects to that of a 2m wall, but the effects will be amplified. Such a wall will be an unattractive entrance to Levin. It will draw attention to the adverse effects of the interchange and may limit the opportunities to otherwise mark this location.	

NZS 6806 – Assessment matrix

Project	Assessment area	
Ōtaki to north Levin	G1 - G1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	10x Cat A PPFs in area, plus undeveloped potential Tara-Ika site	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects 2x PPFs exceed 50 dB	o 1 PPF remains > 50 dB	- Both PPFs remain > 50 dB	- Both PPFs remain > 50 dB	-
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 2 dB reduction applies to all PPFs	- - 3 PPFs receive 1 dB of benefit, which is not significant	+ Most affected PPFs receive 2 dB benefit, and other PPFs 1 dB	+ Bund performs similarly to 3m high wall
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	+ Good BCR (1.2) due to PPF density.	- - - Poor BCR (0.1)	- - - Poor BCR (0.1)	- - - Poor BCR (0.1)
Mitigation allows for integration of ecological treatment	Ecology	Noise level risk to birds within G1, surrounding area and flight paths between properties with indigenous forest fragments, including #463 and #479.	+ The EPA7 roading surface will reduce vehicle noise affecting indigenous forest birds. Extensive planting of native trees and shrubs will form a buffer to noise and form a flight corridor between sites for birds. Tree height should encourage birds to move between forests above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	+ The 2 m noise wall on top of cut will reduce some of the vehicle noise, which could potentially affect indigenous forest birds. Ground cover and shrubs should be planted along the cut. Planting native trees and shrubs will form a buffer to noise and form a flight corridor between sites. Tree height should encourage birds to move between forests above the proposed roading.	+ + The 3 m noise wall on top of cut will reduce vehicle noise from affecting indigenous forest birds. Ground cover and shrubs should be planted along the cut. Planting native trees and shrubs will form an additional noise buffer and will create a flight corridor between sites. Tree height and the roadside wall will encourage birds to fly at height between forest fragments and above the proposed roading.	+ + + The 3 m noise bund on top of a cut will reduce vehicle noise. Planting of shrub and groundcover on the bund will provide a connection between the existing forest areas and will allow a corridor for birds to fly between the two indigenous forest areas. Tree height and the bund will encourage birds to fly higher and above the proposed roading.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	Disrupting the existing ambience of the house and property with construction noise. The whole site is a cultural landscape with many structures, equipment and implements that relate to the history of the Prouse family timber	- - Currently the house has a quiet rural ambience. Construction noise will likely impact this quality	- - Currently the house has a quiet rural ambience. Construction noise will likely impact this quality	- - Currently the house has a quiet rural ambience. Construction noise will likely impact this quality	
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an important site)	Heritage	Potential visual effects from entry gates and through the grounds to walls/bund While there are large trees surrounding the property which should hide most visual intrusions, there will be areas where any bund and/or wall will be visible. The entry gate and drive to the house also have significance and any wall or bund should stop short of the crossing with Queen Street to avoid visual impacts.	+ No visual impacts likely with a high performance surface. The dB rating will be reduced for the house from 52 to 49.	- A wall is likely to be visible from the boundary through gaps in trees, particularly from the stables, which could be intrusive, although the house itself is surrounded by trees. The dB rating would not change from the existing.	- A taller wall than for option 2 is clearly going to be more visually intrusive particularly for the stables, albeit through the existing trees. As with other options where the trees are removed because of age, disease, fire or high winds, the wall will be more visible. The dB rating reduces from 52 to 51.	- I am presuming your option 2 below option 3 is actually option 4. There are the same visual issues as with the wall, but the potential for planting which would reduce the visual impact. The dB rating remains the same as existing.
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimum standards [NOTE – 2 dwellings not witih G1 with 69 dBleg(24) readings?]	+ + All dwellings Cat A/B – compatible noise levels achieved; no visual effects from noise mitigation; minimised effects on amenity	- All dwellings Cat A/B – compatible noise levels acheived; medium visual effects of 2m wall on top of cut; effects on amenity managed	- - All dwellings Cat A/B – compatible noise levels achieved; higher visual effects from 3m wall on top of cut; minimised effects on amenity	- All dwellings Cat A/B – compatible noise levels achieved; lower visual effects from 3m noise bund on top of cut; effects on amenity managed
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading	Would low noise surface be full extent or only in location where nopsie walls shown?	+ High cost of surfacing but lower cost than walls – assume only needed for the 584m section??	- High cost, plus challenges with break needed for Queen?	- - High cost, plus challenges with break needed for Queen?	o Opportunity to lose spoil and low cost, challenges with break needed for Queen?

Project	Assessment area
Ōtaki to north Levin	G1 - G1

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Effects on earthworks	Roading	Noise bund extended full length for future Tara-Ika??	o	o	o	+
			No effect	fence to top of cut no effect	fence to top of cut no effect	Opportunity to dispose of unsuitable mateials
Stormwater treatment and/or potential flooding effects	Roading		o	o	o	o
			No effect	No effect	No effect	No effect
Social effects of mitigation	Social	This area is anticipated to be developed into a more urban area in future. As such, higher levels of noise and structures such as noise walls will be a more anticipated part of the environment than in the more rural areas such as Ohau and Manakau. As the future character of the area will likely be different to the existing environment, it is recommended that noise mitigation is developed in collaboration with the developers. It is also noted that the proposed road is located within a cut, so will not be visible from the development (presumably) - so a noise wall on top of the cut would significantly increase the road's visual presence in the landscape - would need to work with developers/residents to determine whether this would adversely impact on community character or not.	+	- -	-	+
			This option is preferred as it will benefit the highest number of properties, both existing and future, and would not have a visual impact.	This option is not preferable - it provides a low level of sound reduction to only 3 properties and does not benefit the remainder.	Some benefit will be experienced by those properties closest to the road (which may make spending time outdoors less difficult) however for most properties there will be no benefit.In addition, the wall on top of the cut could be perceived as a barrier/wall between this community and the rest of Levin which could adversely impact on community cohesion.	Same as option 3 - however the bund provides a more natural barrier which could be expected to minimise the adverse impacts of a 'wall' on community cohesion (again it is recommended that the community are consulted to determine how they would perceive a noise wall)
Effects on visual aspects of amenity values from dwellings	Visual and landscape	It is assumed the highway will be in trench through Area G although understand this is yet to be confirmed. Such trenching would be the single most visual benefit for current and future residents (in terms of both the highway and the overpasses on Tararua Road and Queen Street East). The proposed additional noise mitigation measures are adjacent to the bush at the Prouse homestead. Issues include detracting from views of the bush (for instance from Queen Street East) and from within the bush, and also any physical effects on the bush.	+ +	+ + +	+	+
			The location of the highway in a trench would already provide significant visual and urban design mitigation. A high performance surface would form a consistent package of measures. A positive score is therefore assigned compared to a 'baseline' surface alignment.	2m wall is limited to 500m south of Queen Street East. Given the location of the highway in a trench, the 2m wall for 500m south of Queen Street East would have little additional benefit in terms of visual amenity for residents, although it would help to maintain a tranquil character in the bush adjacent to the Prouse homestead. Revegetation could soften the wall (and provide an edge buffer). The positive score for the trenching is therefore increased.	A 3m wall would likewise provide no additional benefits, but would be more dominant (for instance in views from Queen Street East and from the opposite side of the highway) and would create a dark shadow on the western side of the stand of bush. The positive score assigned the trenching is therefore reduced for Option 3.	A 3m bund in this confined location and flat landscape would be difficult to contour in way that would appear natural. The bund could be planted to merge with the adjacent bush, but the same outcome could be achieved more convincingly by revegating at natural ground level (either side of a wall).
Effects on experience for travelling public	Visual and landscape	The trench will be distinctive part of the highway and is the baseline against which these effects are assessed. The proposed additional noise measures are not a significant issue. Potential incidental issues include effects on views of the bush at Prouse homestead, appearance of walls or bund.	+ +	+ +	+	+
			The experience of travelling through the trench section will be determined by the treatment of the cut batters, the overbridges (i.e. Tararua Road and Queen Street East), and features close to the top of the trench such as the bush adjacent to the Prouse homestead at Queen Street East. The confined views through this section should be considered in the context of adjacent sections of the highway which will afford open views to Levin and the Tararua Ranges backdrop. The trench section has the potential to be distinctive and attractive.	A 2m wall at the top of the cut could potentially reduce views of the bush at Queen Street East. This would be avoided by a small offset from the top of the cut, and planting both sides of the wall.	A 3m wall at the top of the cut would be more dominant compared to a 2m wall. However, it could be softened by a combination of offset from the edge of the cut and planting on both sides of the wall as an edge buffer for the stand of bush.	As discussed, a 3m bund in would be difficult to contour in this context so as to be natural. it is likely to appear heavy and out of place even if successfully planted. A more convincing approach would be to plant on natural ground either side of a wall.

Draft for discussion

NZS 6806 – Assessment matrix

Project	Assessment area	
Ōtaki to north Levin	H1 - H1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	3x Cat B PPFs and 8x Cat A PPFs in cluster	+ All Cat A	 2 Cat B PPFs remain	 1 Cat B PPF remains (although this could be treated by extending the barrier)	 1 Cat B PPF remains (although this could be treated by extending the barrier)
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects	- 5 PPFs remain > 50 dB	- - 9 PPFs remain > 50 dB	- 7 PPFs remain > 50 dB	- - 8 PPFs remain > 50 dB
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 2 dB reduction applies to all PPFs	+ + Effective (3–4 dB) reduction for those direectly behind and 1–2 dB for several others	+ + + Effective (4–5 dB) reduction for those direectly behind and 1–3 dB for several others	+ + + Slightly less effective than noise wall
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	o Reasonable levels achievable with doors and windows ajar	- Door and windows may need to be closed to achieve reasonable internal sound levels	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	- Low BCR (0.5)	- - - Poor BCR (0.1)	- - - Poor BCR (0.1)	- - Low BCR (0.3)
Mitigation allows for integration of ecological treatment	Ecology	Noise level risk to birds within H1, surrounding area and flight paths between properties with wetlands, including #570 and #586. *** Feedback has not been requested for A1; however, properties #19, #20, and #21 contain wetland areas and mitigation of these wetlands is also required. Refer to L1 and L2.	+ The EPA7 roading surface will reduce vehicle noise affecting wetland birds. Extensive planting of native trees and shrubs will form a buffer to noise for birds. Tree height should encourage birds to move between sites and above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading. Replacement wetland areas should be established on one side of the road to reduce birds overflying the proposed roading.	+ + The 2 m noise wall on top of cut will reduce some of the vehicle noise, which could potentially affect wetland birds. Ground cover and shrubs should be planted along the cut. Planting native trees and shrubs will form a buffer to noise, and tree height should encourage birds to move at height over the proposed roading. Replacement wetland areas should be established on one side of the road to reduce birds overflying the proposed roading.	+ + The 3 m noise wall on top of cut will reduce vehicle noise from affecting wetland birds. Ground cover and shrubs should be planted along the cut. Planting native trees and shrubs will form an additional noise buffer. Tree height and the roadside wall will encourage birds to fly at height between wetlands and above the proposed roading. Replacement wetland areas should be established on one side of the road to reduce birds overflying the proposed roading.	+ + + The 3 m noise bund on top of a cut will reduce vehicle noise. Tree height and the roadside wall will encourage birds to fly at height between wetlands and above the proposed roading. Replacement wetland areas should areas should be established on one side of the road to reduce birds overflying the proposed roading.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimium standards	+ + All dwellings Cat A/B – compatible noise levels achieved; no visual effects from noise mitigation; minimised effects on amenity	- All dwellings Cat A/B – compatible noise levels acheived; medium visual effects of 2m wall on top of cut; effects on amenity managed	- - All dwellings Cat A/B – compatible noise levels achieved; higher visual effects from 3m wall on top of cut; effects on amenity managed	- All dwellings Cat A/B – compatible noise levels achieved; lower visual effects from 3m noise bund on top of cut; effects on amenity managed
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading	Pinch point near northern extent of Waihou	+ High cost of surfacing but lower cost than walls	- High cost	- - Very high cost	+ + Use waste material andqdequate space between cut and Waihou Road, lowest cost option
Effects on earthworks	Roading	Based on DBC drawings and road in cut through Waihou area	o No effect	o Small incraese in footprint but no additional EW	o Small incraese in footprint but no additional EW	+ Good opportunity to use unsuitable materials for bund

Project	Assessment area	
Ōtaki to north Levin	H1 - H1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Stormwater treatment and/or potential flooding effects	Roading		o No effect	o No effect	o No effect	o No effect
Social effects of mitigation	Social	This is a largely rural area. Although this community is part of Levin, the local environment is quiet and rural currently. Key issues for this area will be retaining this quiet rural feel as much as possible (noting that the road will affect this community character regardless). The road is proposed to be located within a cut, so a noise wall would have the potential to disrupt existing views of the rural environment and adversely impact on community character - however consultation with existing residents is recommended to determine whether this is something of high value to the community or whether installing a noise wall to minimise noise for several properties is seen as a worthwhile trade-off.	+ This option is preferred as it will benefit the highest number of properties, both existing and future, and would not have a visual impact.	o This option provides sound reduction to 6 properties, however the remainder will still experience significant noise impacts; this may adversely impact their way of life and the quiet character of the area.	o Some benefit will be experienced by those properties closest to the road (approx 5 properties) however for other properties there will be no benefit. In addition, the wall on top of the cut could be perceived as a barrier/wall between this community and the rest of Levin which could adversely impact on community cohesion.	+ Same as option 3 - however the bund provides a more natural barrier which could be expected to minimise the adverse impacts of a 'wall' on community cohesion (again it is recommended that the community are consulted to determine how they would perceive a noise wall)
Effects on visual aspects of amenity values from dwellings	Visual and landscape	Houses in H1 are slightly elevated and typically oriented in the direction of the new highway. They currently enjoy a rural outlook, although the views are relatively short because of rural residential subdivision, shelter planting, and the chicken facility. Issues include the effects of highway and traffic on visual amenity, and the potential for noise mitigation walls themselves to detract from visual amenity.	o The 'baseline' highway will be a prominent foreground - replacing houses and shelter belts on the opposite side of Waihou Road. The alignment in shallow cut will help reduce potential prominence.	+ + A 2m wall will be the best balance between screening the highway and traffic and avoiding creating new adverse effects from walls. There is enough separation to maintain views over the wall (including of the sky). Opportunities to soften the wall with street trees on the far side (western side) of Waihou Road.	- - While the wall will screen the highway and traffic, it will be a dominant feature itself given the 3m height and 1.1km length. It will 'wall off' the area to a greater extent than the 2m wall.	- While it will similarly screen the highway and traffic, a bund in this flat location will appear dominant and artificial, despite being planted. There may be room to contour the bund in a naturalistic way, but there is little topography to anchor it. A planted 3m bund will be softer than a 3m wall, but the same footprint might be better used by planting either side of a wall.
Effects on experience for travelling public	Visual and landscape	While the landscape in this area does not have special quality (it is a mixed landscape on Levin's rural fringes) it contributes to overall quality of the route. Issues are maintaining (i) clean lines, (ii) experience of rural setting, and (iii) avoiding incongruous high wall or bund (depending on design).	o Will retain engagement with surrounding landscape, although outlook is relatively confined and mixed through this area. Will retain clean lines and continous wire-rope barrier.	- Wall will be unobtrusive from highway given its straight alignment, offset from the carriageway (beyond top of cut), and relatively low height. Could be softened further by planting both sides. Will retain clean lines and continous wire-rope barrier within the carriageway.	- - The wall will be comparatively more obtrusive (desptie offset and straight alignment) given its 3m height and 1.1km length. As with 2m wall, could be softened by planting both sides.	- A 3m high planted bund at top of cut batter will appear softer than the 3m wall (the negative score is therefore reduced) but will nevertheless appear artificial and heavy in this location (by comparison, a 2m wall with planting both sides is likely to be lighter and less obtrusive).

NZS 6806 – Assessment matrix

Project	Assessment area	
Ōtaki to north Levin	L1 - L1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	1x Cat B PPF and 8x Cat A PPFs	+ + The single Cat B remains	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects	– – 4 PPFs remain > 50 dB	– – – 5 PPFs remain > 50 dB	– – 4 PPFs remain > 50 dB	– 2 PPFs remain > 50 dB
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 1 dB reduction applies to all PPFs	+ + Up to 5 dB at most affected PPF	+ + + Up to 6 dB at most affected PPF	+ + + Up to 8 dB at most affected PPF
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	– Door and windows may need to be closed to achieve reasonable internal sound levels	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	– – Low BCR (0.4)	– – – Poor BCR (0.2)	– – – Poor BCR (0.2)	– – – Poor BCR (0.2)
Mitigation allows for integration of ecological treatment	Ecology	Noise level risk to birds within L1, surrounding area and flight paths between properties with wetlands (#493), openwater (#493), indigenous scrub (#472, #495) and mixed forest (#493). Bird movements will occur between L1 and L2 with birds flying over the proposed road.	+ + The EPA7 roading surface will reduce vehicle noise affecting wetland, forest and open water birds. Planting native trees and shrubs will form a buffer to noise for birds. Tree height should encourage birds to move between sites above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading. Replacement wetland areas should be established at a distance from the road and preferably only on one side of the road to reduce birds overflying the proposed roading. However, there are numerous wetland and open water sites that bird movement will be unavoidable.	+ The 1.1 m concrete safety barrier will not reduce any vehicle noise affecting forest or wetland birds. However, extensive planting of native trees, shrubs and wetland vegetation will create a buffer zone for noise for birds. Tree height should encourage birds to move between sites above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	+ + The 2 m noise wall will reduce some of the vehicle noise that could potentially affect wetland birds. Planting native trees, shrubs and wetland vegetation will form a buffer to noise and form habitat at each site. Tree height should encourage birds to move between forests above the proposed roading. Replacement wetland areas should be established at a distance from the road and preferably only on one side of the road to reduce birds overflying the proposed roading. However, there are numerous wetland and open water sites that bird movement will be unavoidable.	+ + The 3 m noise wall will reduce vehicle noise from affecting indigenous forest birds. Planting native trees, shrubs and wetland vegetation will form a buffer to noise and form habitat at each site. Tree height and the roadside wall will encourage birds to fly at height between forest fragments and above the proposed roading. Replacement wetland areas should be established at a distance from the road and preferably only on one side of the road to reduce birds overflying the proposed roading. However, there are numerous wetland and open water sites that bird movement will be unavoidable.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimium standards	+ + All dwellings Cat A/B – compatible noise levels achieved; no visual effects from noise mitigation; effects on amenity managed	+ All dwellings Cat A/B – compatible noise levels acheived; minor visual effects of concrete barrier; minimised effects on amenity	– All dwellings Cat A/B – compatible noise levels acheived; medium visual effects of 2m wall; minimised effects on amenity	– – All dwellings Cat A/B – compatible noise levels achieved; higher visual effects from 3m wall; minimised effects on amenity
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading	Check use of OGPA on grade over rail is acceptable OGPA and concrete safety barrier combiend option?	+ High cost of surfacing but lower cost than walls	+ Cost effective method and tie into bridge barriers to avoid multiple transistions	– High cost / possible sight distance issues inside of curve? Larger fill needed	– – High cost / possible sight distance issues inside of curve? Larger fill needed
Effects on earthworks	Roading		o No effect	o No effect	– – Larger fill embankment needed	– – Larger fill embankment needed
Stormwater treatment and/or potential	Roading		o	o	–	–

Project	Assessment area
Ōtaki to north Levin	L1 - L1

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
flooding effects			No effect	No effect	Drainage challenges from road super through wall	Drainage challenges from road super through wall
Social effects of mitigation	Social	This area is located to the north of Levin. While the community would typically consider themselves part of Levin, the area itself is characterised by a quiet rural character which the community value.	+	-	o	+
			This option benefits the largest number of properties but to a small extent in terms of sound reduction; residents (particularly those closest to the road) would likely still experience impacts to their way of life (i.e spending less time outdoors) and the quiet rural character of the area would be impacted. No visual impacts.	Provides less benefit than options 3 and 4(in terms of both sound reduction levels and number of properties benefitting). No noise mitigation is provided to properties along the Avenue that are very close to the road; daily life could be affected for these residents (in terms of spending time outdoors or working from home no longer being viable).	This option provides noise mitigation to those properties closest to the main road. However no noise mitigation is provided to properties along the Avenue that are very close to the road; daily life could be affected for these residents (in terms of spending time outdoors or working from home no longer being viable). Additionally properties set further back from the road will not receive benefit from the noise walls, and their daily life could also be affected.	Same as option 3, but slightly higher benefits in terms of number of properties benefited and level of sound reduction at some properties.
Effects on visual aspects of amenity values from dwellings	Visual and landscape	The highway bisects the rural residential enclave at the end of Sorenson Road, and the NIMT overpass will be a dominant structure. Dwellings on the north side of the alignment (Area L1) are typically oriented in the opposite direction so that the highway is 'behind' these houses. The area has a rural outlook although views are typically short because of the pattern of subdivision, trees, and the existing NIMT corridor. Noise effects will be in conjunction with visual effects.	o	o	-	- - -
			The high performance surface will avoid adding to the visual effects that will already occur from the NIMT flyover.	1.1m safety barriers will add to the hard-edged character of the highway while only have a small effect in screening traffic. However, it is anticipated that such safety barriers will be required in any event for the NIMT overpass, so that extending the barriers a little further east beyond the overpass approaches would have little additional visual effect. A neutral score is therefore assigned in this instance.	2m walls would have greater adverse effects in this context compared to other locations. While they will screen traffic on the eastern approaches, they will stop short of the crest of the NIMT overpass. Such an configuration will appear an arbitary after-thought than integral to the overpass. At the same time the walls will acentuate the prominence of the eastern ramps. The configuration will appear cluttered. The elevation of the ramps reduces the opportunities to soften the walls with planting. For these reasons a slightly adverse score score is assigned rather than positive score.	The visual effects of 3m walls will have similar in type but amplified compared to 2m walls. They will be dominant elements given the combination of height, length (700m), and elevation on structure. For these reasons an increased negative score has been assigned.
Effects on experience for travelling public	Visual and landscape	The area does not have special landscape values. However, the views anticipated from elevated structures such as the NIMT are important to legibility of the route given the location on the outskirts of Levin. Issues include (i) enclosure on an elevated structure, (ii) frustration of anticipated views.	o	o	- -	- - -
			Will maximise the views anticipated from an elevated overpass. While such views are not special (they are of Levin's rural fringes) they will contribute to legibility of the nearby urban area and distant views of the Tararua Ranges and Koputaroa valley.	While safety barriers restrict foreground views (such as into rivers) they will maintain wide views anticipated from an elevated overpass. Such safety barriers will be necessary in any event. For these reasons a neutral score is assigned.	2m walls on both sides will frustrate views anticipated from an elevated overpass. They will create a chute (or tunnel) at odds with such an overpass. It will create clutter because the noise walls are likely to be in addition to (and sit just outside) the safety barriers. For these reasons a more negative score is assigned.	The effects of 3m walls on both sides will be similar but amplified compared to 2m walls. The 3m walls will be more dominant, and will create a more pronounced chute (or tunnel). Similarly, a more negative score is assigned.

NZS 6806 – Assessment matrix

Project	Assessment area
Ōtaki to north Levin	L2 - L2

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Compliance with NZS 6806 criteria	Acoustics	3x Cat B PPFs	+ + 1x Cat B remains	+ + + All PPFs Cat A	+ + + All PPFs Cat A	+ + + All PPFs Cat A
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects	– – – All PPFs remain > 50 dB	– – – All PPFs remain > 50 dB	– – – All PPFs remain > 50 dB	– – – All PPFs remain > 50 dB
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 1 dB reduction applies to all PPFs	+ + Up to 4 dB at most affected PPF	+ + + Up to 6 dB at most affected PPF	+ + + Up to 8 dB at most affected PPF
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	– Door and windows may need to be closed to achieve reasonable internal sound levels	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar	o Reasonable levels achievable with doors and windows ajar
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	Poor BCR (0.1)	Poor BCR (<0.1)	Poor BCR (0.1)	Poor BCR (0.1)
Mitigation allows for integration of ecological treatment	Ecology	Noise level risk to birds within L2, surrounding area and flight paths between properties with wetlands (#461, #493, #501, #519), openwater (#470, #485), indigenous scrub (#493) and mixed forest (#484, #488). Bird movements will occur between L1 and L2 with birds flying over the proposed road.	+ + The EPA7 roading surface will reduce vehicle noise affecting wetland, forest and open water birds. Planting native trees and shrubs will form a buffer to noise for birds. Tree height should encourage birds to move between sites above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading. Replacement wetland areas should be established at a distance from the road and preferably only on one side of the road to reduce birds overflying the proposed roading. However, there are numerous wetland and open water sites that bird movement will be unavoidable.	+ The 1.1 m concrete safety barrier will not reduce any vehicle noise affecting forest or wetland birds. However, extensive planting of native trees, shrubs and wetland vegetation will create a buffer zone for noise for birds. Tree height should encourage birds to move between sites above the proposed roading. Trees should be set back from the roading to allow birds further distance to gain altitude before crossing the roading.	+ + The 2 m noise wall will reduce some of the vehicle noise that could potentially affect wetland birds. Planting native trees, shrubs and wetland vegetation will form a buffer to noise and form habitat at each site. Tree height should encourage birds to move between forests above the proposed roading. Replacement wetland areas should be established at a distance from the road and preferably only on one side of the road to reduce birds overflying the proposed roading. However, there are numerous wetland and open water sites that bird movement will be unavoidable.	+ + The 3 m noise wall will reduce vehicle noise from affecting indigenous forest birds. Planting native trees, shrubs and wetland vegetation will form a buffer to noise and form habitat at each site. Tree height and the roadside wall will encourage birds to fly at height between forest fragments and above the proposed roading. Replacement wetland areas should be established at a distance from the road and preferably only on one side of the road to reduce birds overflying the proposed roading. However, there are numerous wetland and open water sites that bird movement will be unavoidable.
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No issues				
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an	Heritage	No issues				
Alignment with District Plan objectives and policies	Planning	HDC Objs & policies require: maintaining overall day/night noise conditions at compatible levels (assume meeting NZS 6806 respresents compatible level); minimise/manage amenity effects and meet at least minimium standards	+ + All dwellings Cat A/B – compatible noise levels achieved; no visual effects from noise mitigation; effects on amenity managed	+ All dwellings Cat A/B – compatible noise levels acheived; minor visual effects of concrete barrier; minimised effects on amenity	– All dwellings Cat A/B – compatible noise levels acheived; medium visual effects of 2m wall; minimised effects on amenity	– – All dwellings Cat A/B – compatible noise levels achieved; higher visual effects from 3m wall; minimised effects on amenity
Planning authorisations required	Planning					
Engineering degree of difficulty with cost	Roading		+ High cost of surfacing but lower cost than walls	+ Cost effective method and tie into bridge barriers to avoid multiple transistions	– High cost and larger fill needed?	– – High cost and larger fill needed?
Effects on earthworks	Roading		o No effect	o No effect	– – Larger fill embankment needed	– – Larger fill embankment needed
Stormwater treatment and/or potential flooding effects	Roading		o No effect	o No effect	o No effect	o No effect

Draft for discussion

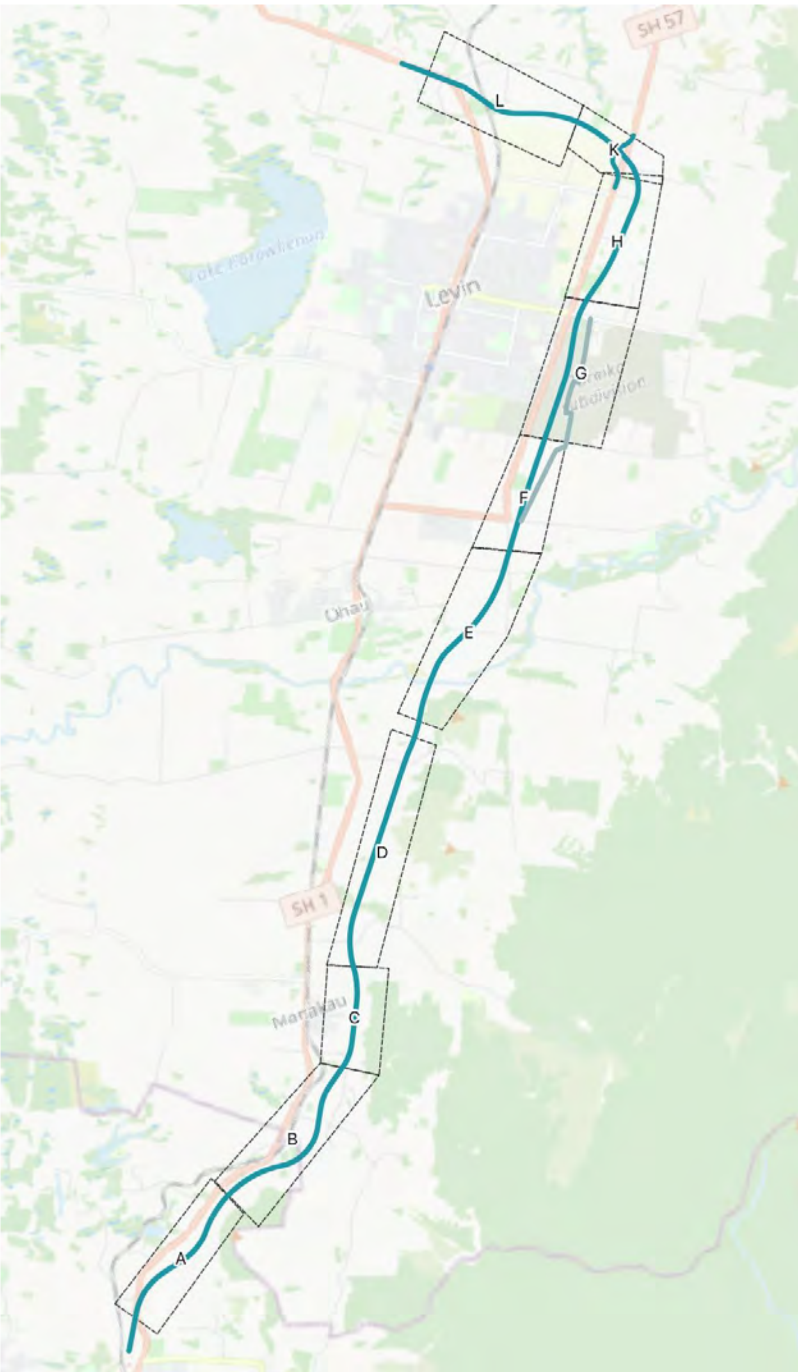
Project	Assessment area
Ōtaki to north Levin	L2 - L2

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4
Social effects of mitigation	Social	This area is located to the north of Levin. While the community would typically consider themselves part of Levin, the area itself is characterised by a quiet rural character which the community value.	o This option benefits the most properties but to a lesser extent than other options.	- This option only benefits one property; for all others, noise will still impact on their way of life (i.e by limiting time they are able to spend outside or working from home).	- - This option only benefits one property; for all others, noise will still impact on their way of life (i.e by limiting time they are able to spend outside or working from home) and the noise wall will provide a visual barrier between properties and the surrounding rural environment which may somewhat affect the rural character of the area that residents value (noting that the existence of the road will already be impacting on this).	+ Provides a significant level of sound reduction to 3 properties, likely enough to allow them to go about their daily lives (i.e spending time outside) without significant disruption from noise. For other properties, however, there will be no benefit. The 3m wall will create a visual barrier which will somewhat restrict views of the surrounding environment, however views will still be maintained in the other direction so little impact on community character expected (beyond what the road itself is already impacting on).
Effects on visual aspects of amenity values from dwellings	Visual and landscape	The relevant houses comprise three 'orphaned' from the Sorenson Road cul de sac, and three on The Avenue. The houses are typically oriented to the north toward the highway including (for some dwellings) the NIMT overpass. Issues include (i) views of the highway and traffic in the northerly outlook, and (ii) adverse visual effects of noise walls.	o The high performance surface will avoid adding to the visual effects that will already occur from highway, especially the NIMT flyover.	o 1.1m safety barriers will add to the hard-edged character of the highway while only have a small effect in screening traffic. However, it is anticipated that such safety barriers will be required in any event for the NIMT overpass, so that extending the barriers a little further east beyond the overpass approaches would have little additional visual effect. There is potential to use planting to soften the barriers and screen traffic. A neutral score is therefore assigned in this instance.	+ 2m walls would screen traffic. The walls will not advance as far up the approaches as proposed on the northern side of the highway, and the incongrous configuration of the northern side will be less apparent from the southern side. Nevertheless, the walls will extend up the lower part of the overpass rampe, and traffic will be visible passing the crest of the overpass. For these reasons a slightly postive score is assigned.	- - - 3m walls will screen traffic (except for oblique views to the crest of the overpass) but the wall itself will be a dominant structure in the outlook from the group of three houses, given the 3m height, 600m length, location in the northerly outlook, and that they advance part way up the overpass approach.
Effects on experience for travelling public	Visual and landscape	As for L1 above.	o Same as L1	o Same as L1	- - Same as L1	- - - Same as L1

Appendix D

Noise mitigation options
for Workshop N4

Index map

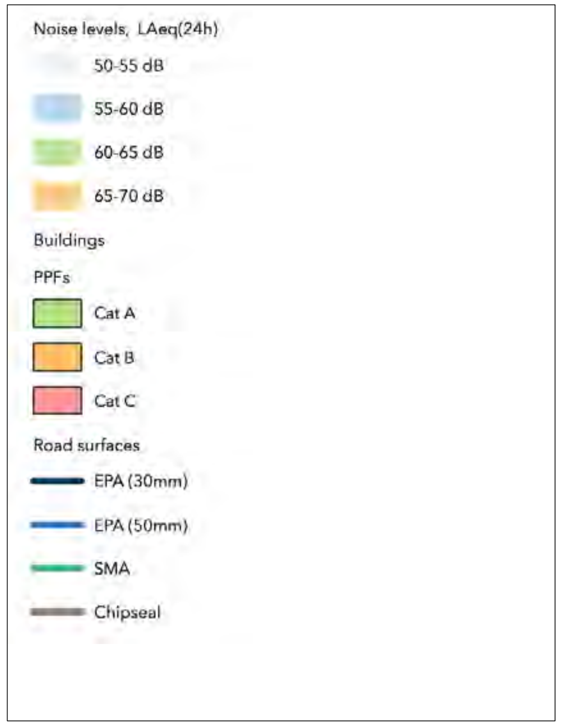


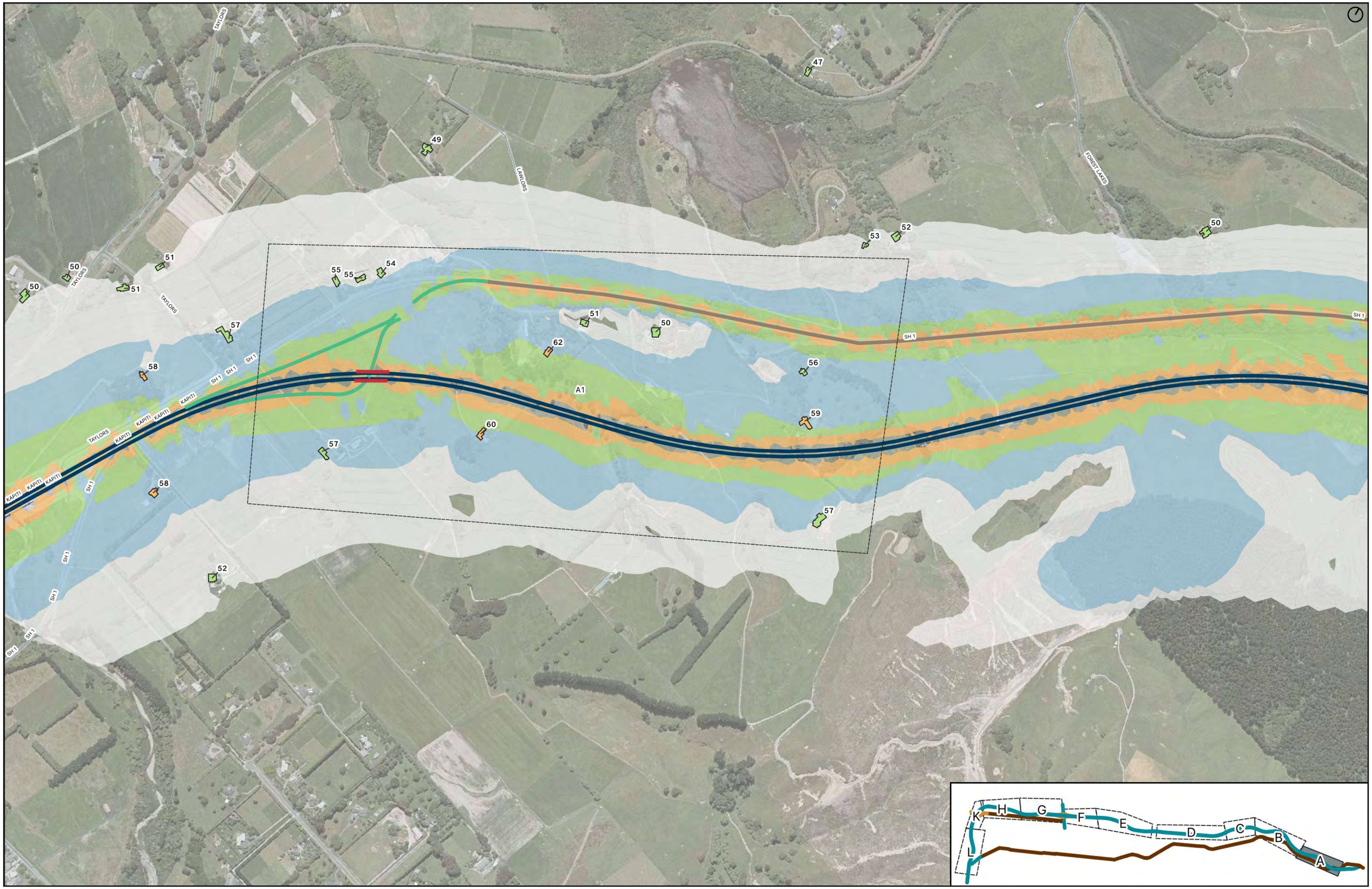
Introduction

This drawing set provides an update of noise mitigation options for Areas A and G where there have been material changes to the design.

For all other areas, the Selected Options have been maintained.

Legend

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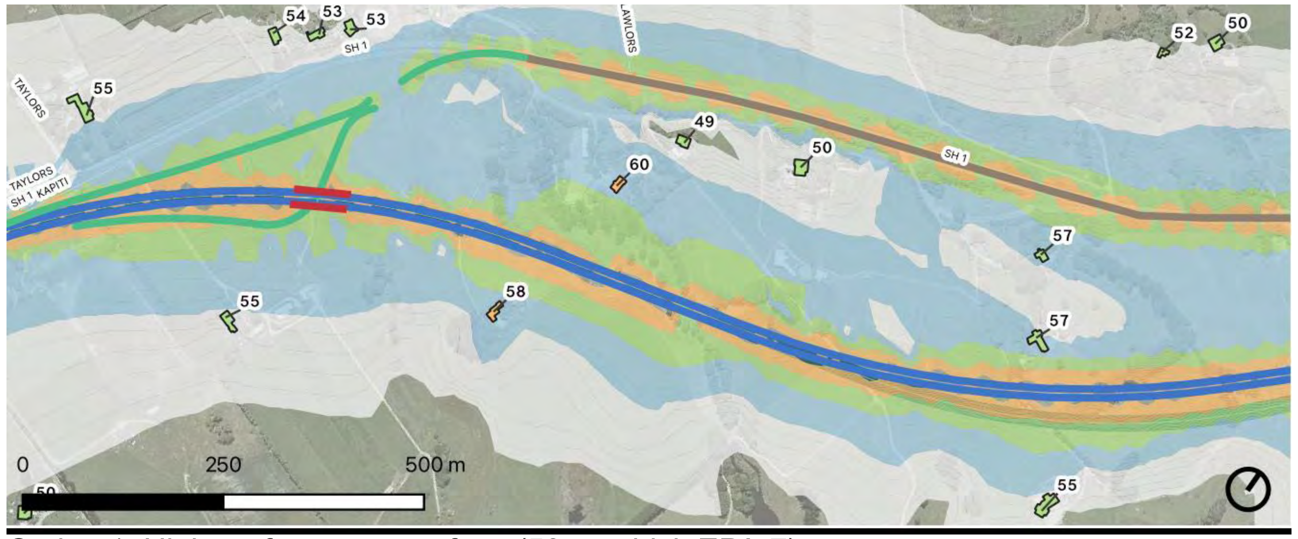
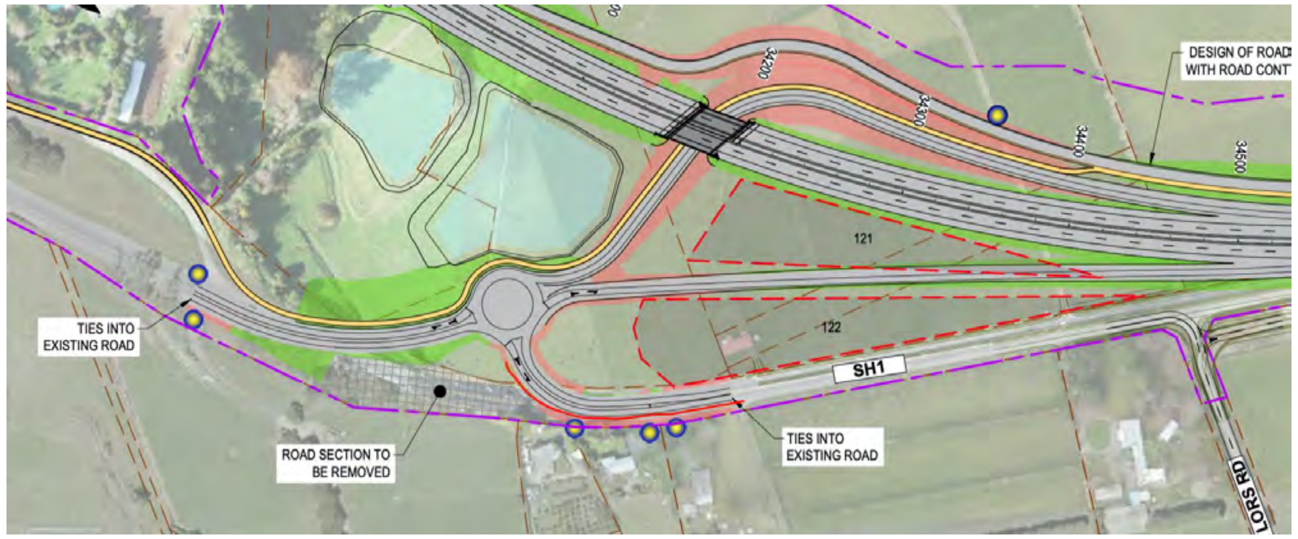
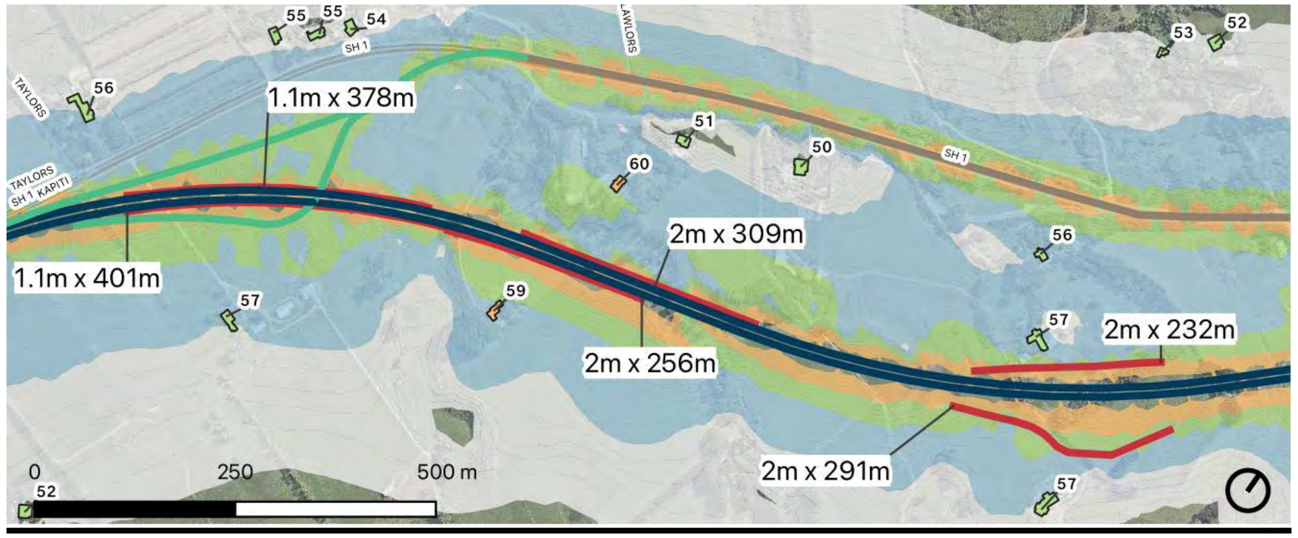


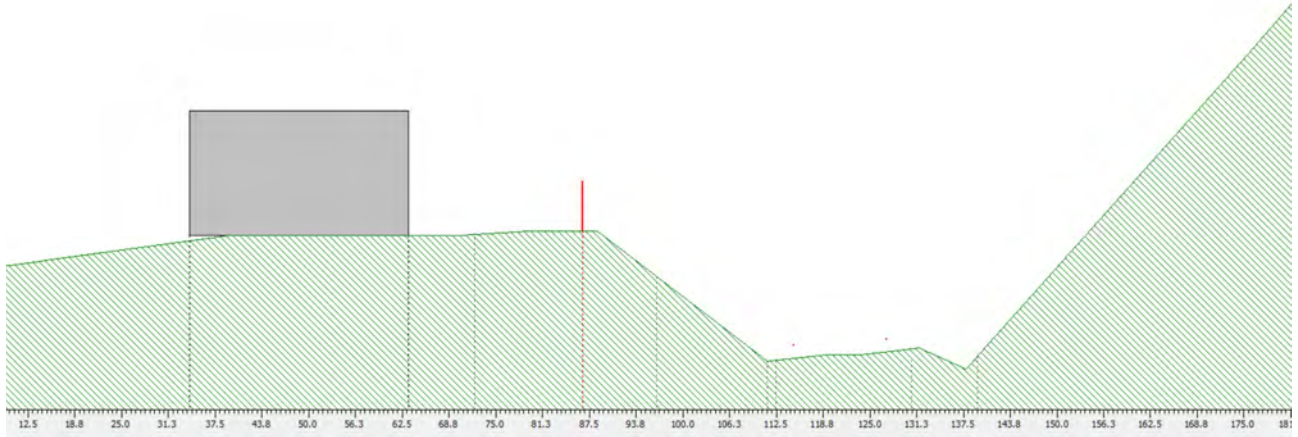
Option 1: High performance surface (50mm thick EPA-7)

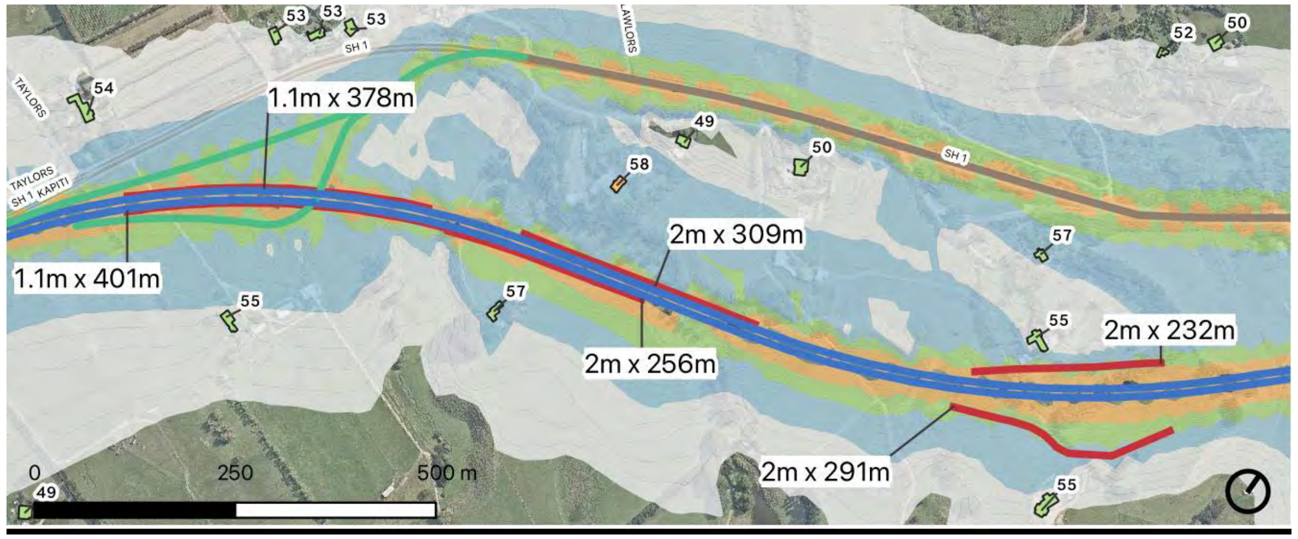


Consider upgraded property boundary fences on existing SH1 to screen offramp

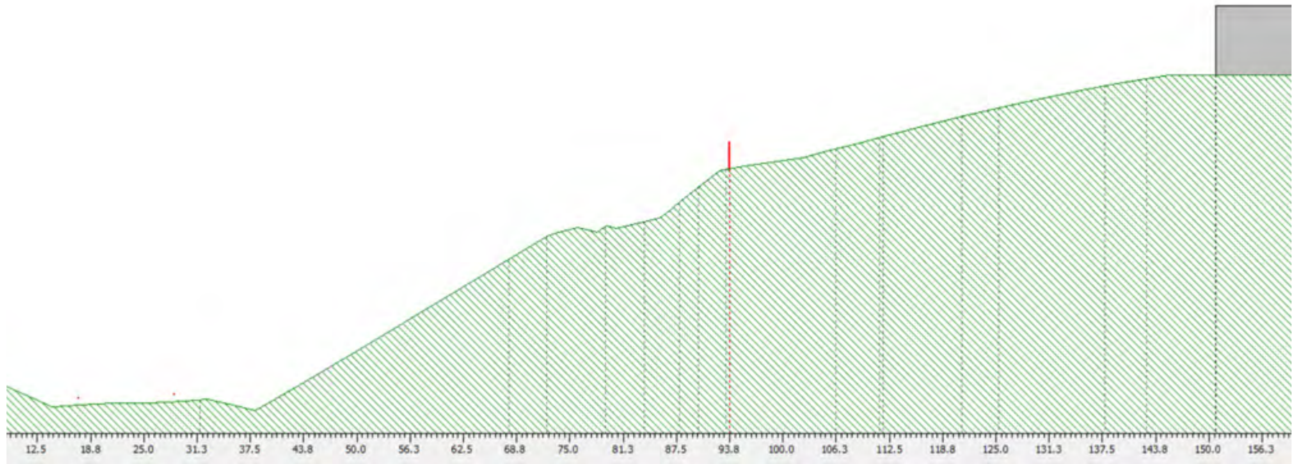


Option 2: 2m high noise wall (with do minimum surface)


Cross section of 2m noise wall to west of highway



Option 3: High performance surface (50mm thick EPA-7) + 2m high noise wall


Cross section of 2m noise wall to east of highway


PC4 Proposed Zoning
Residential
Low Density Area
Medium Density Area
Open Space
Greenbelt
Commercial
Industrial
ARAPAEPAE SOUTH
ARAPAEPAE
QUEEN
TARARUA
GARTH
STRATHMORE
STIRLING
BRAEMAR
ROSS
CARGILL
LIVERPOOL
BLEDISLOE
NORRIE
MEADOWVALE
HADFIELD
SELWYN
PARSONS
SOLWAY
PERTH
HEATHER
FEATHERSTON
FULLER
TAINUI
VOGEL
FOX
GREY
WELD
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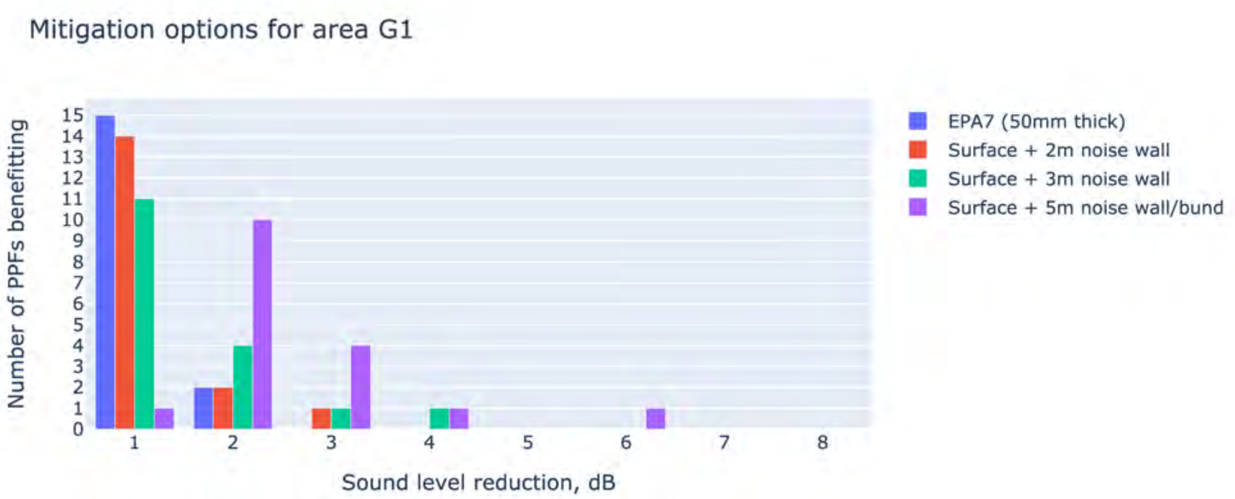
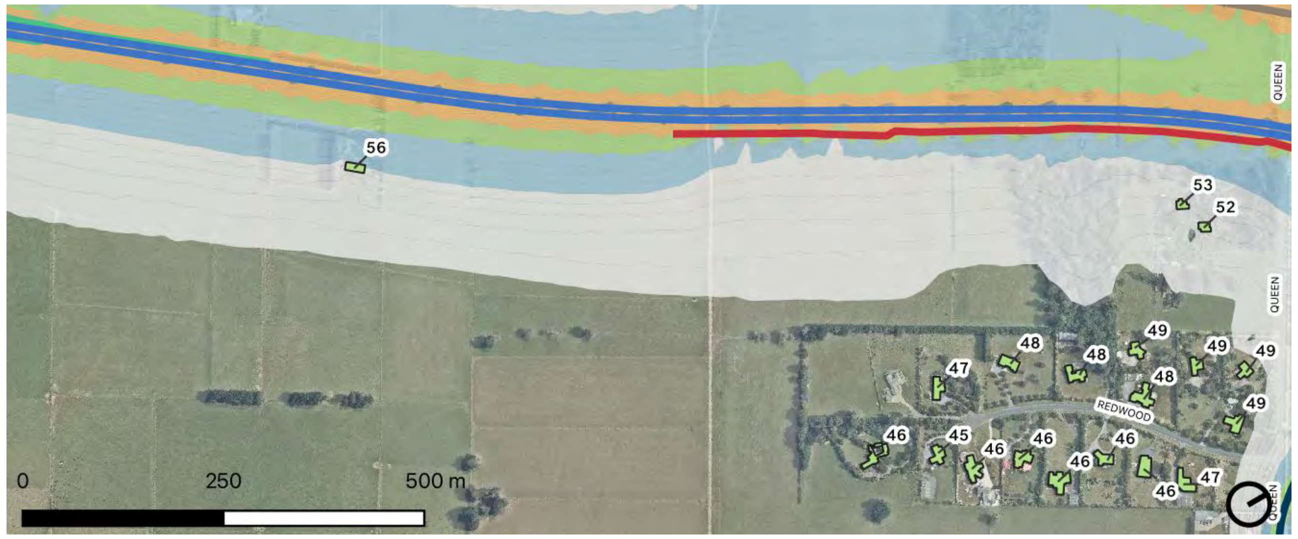
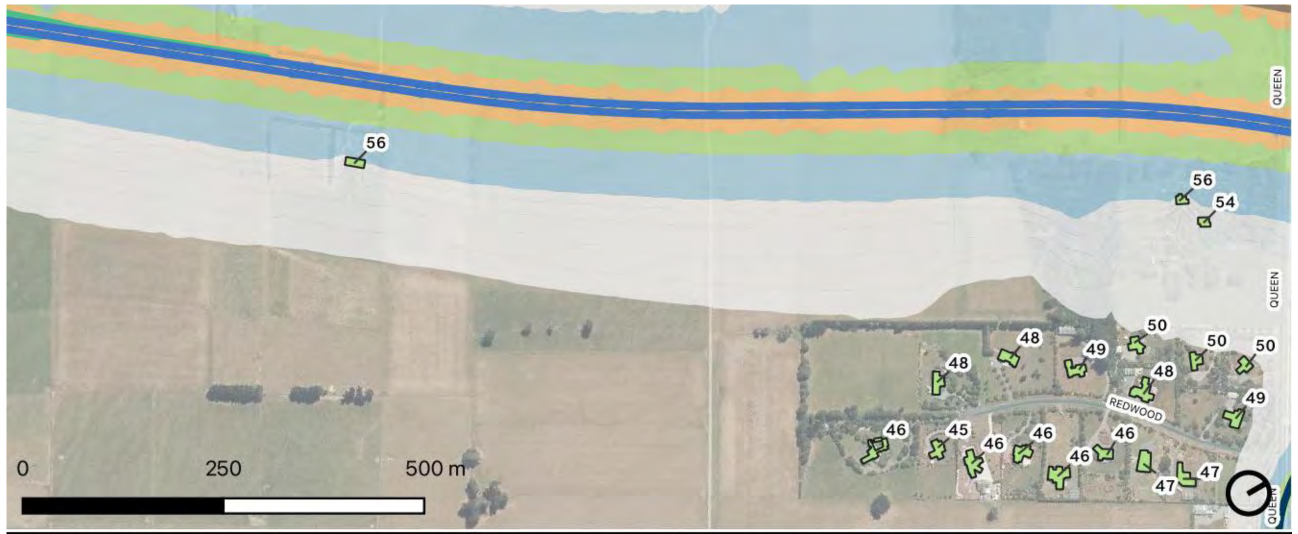


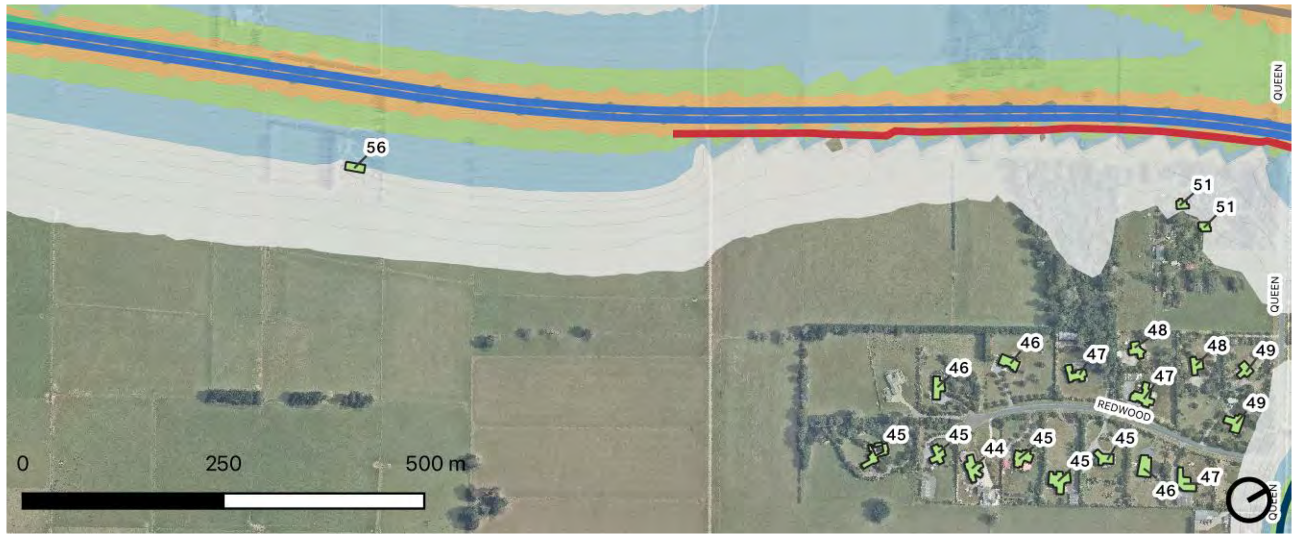
Noise reduction provided by different mitigation options



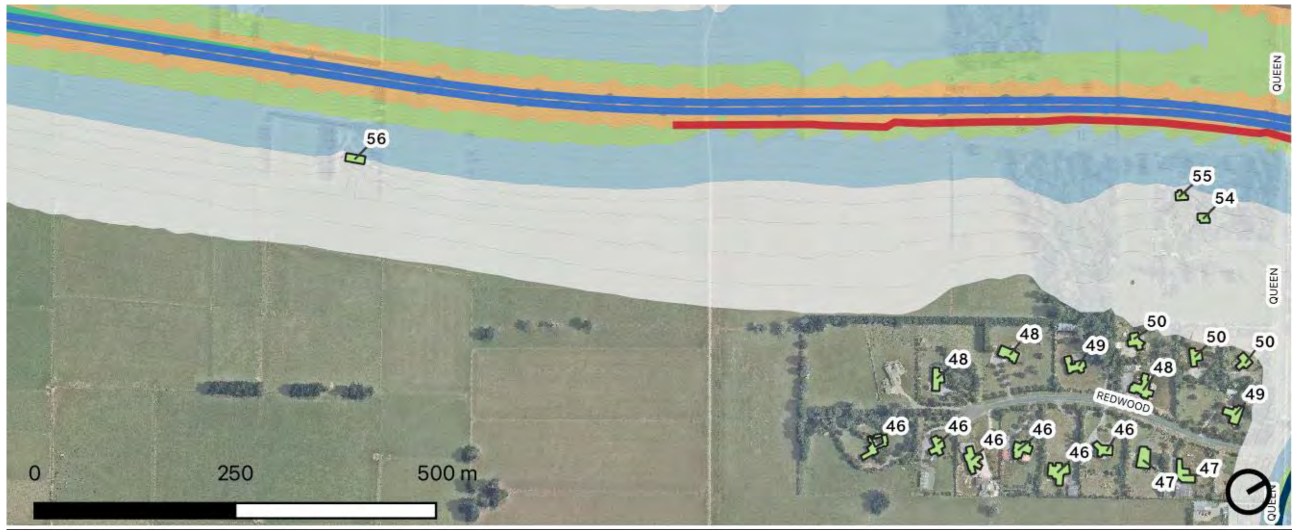
Option 3: High performance surface (50mm thick EPA-7) + 3m high noise wall



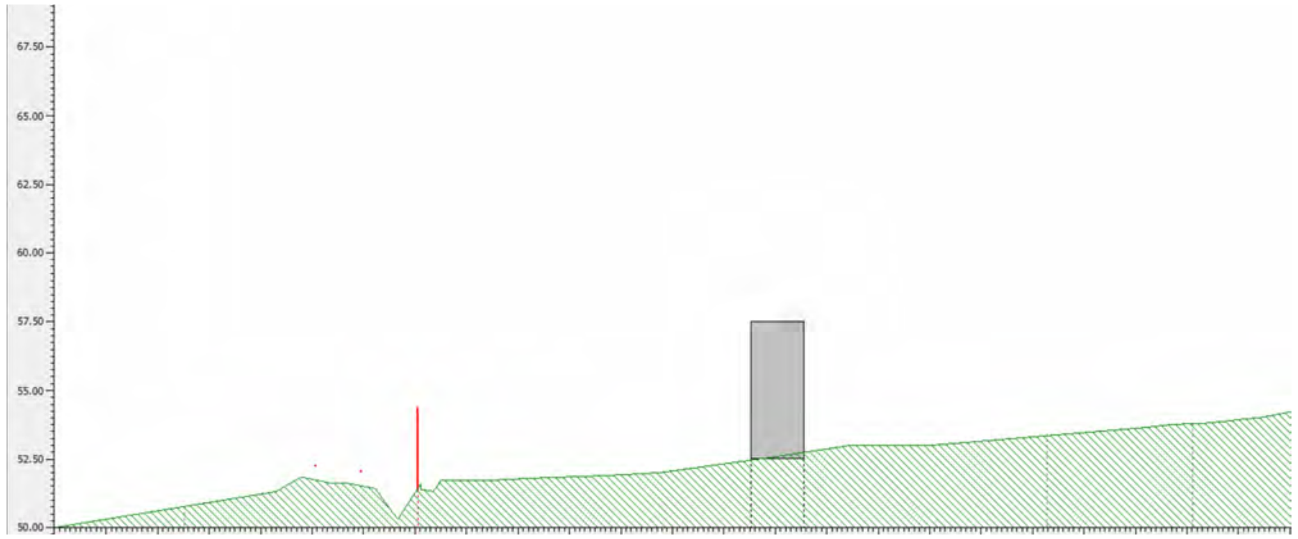
Option 1: High performance surface (50mm thick EPA-7)



Option 4: High performance surface (50mm thick EPA-7) + 5m high noise bund / wall



Option 2: High performance surface (50mm thick EPA-7) + 2m high noise wall


Cross section to east of highway with 3m high noise wall

Appendix E

Collated evaluations for Workshop N4

NZS 6806 - Assessment matrix

DRAFT FOR DISCUSSION

Project	Assessment area
Ōtaki to North of Levin	A1 - A1

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Compliance with NZS 6806 criteria	Acoustics	3x PPFs in area are Category B (New Road). 82 SH1 is outside of the project area	+ One Cat B PPF changes to Cat A	+ One Cat B PPF changes to Cat A	+ + Two Cat B PPF changes to Cat A			
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	Noise levels > 50 dB LAeq(24h) have increased risk of adverse health effects All PPFs > 50 dB	- - - All PPFs remain > 50 dB	- - - All PPFs remain > 50 dB	- - - All PPFs remain > 50 dB			
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 2 dB reduction applies to all PPFs (subject to rounding)	o Noise walls to west of highway on top of cut provide 2 dB benefit. Walls on east are less effecttive	+ + Combined effectiveness of two solutions			
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	- Door and windows may need to be closed to achieve reasonable internal sound levels	- Door and windows may need to be closed to achieve reasonable internal sound levels	- Door and windows may need to be closed to achieve reasonable internal sound levels			
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	- - - Poor BCR due to low housing density. Surface likely to extend beyond area	- - - Poor BCR due to low housing density	- - - Poor BCR due to low housing density			
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	No impacts on heritage buildings	o	o	o			
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an important site)	Heritage	No impacts on heritage buildings	o	o	o			
Engineering degree of difficulty with cost	Roading	M&O Challenges of maintianing walls offset from road in this section, top of cuts etc with difficult access	- Additional cost than standard requirement but less than other options	- - High cost option $1.6M for noise walls 2m, plus cost of 1.1m barriers, access challenges Brooker	- - - Highest cost option for nosie walls plus extra OGPA, access challenges Brooker.			
Effects on earthworks	Roading		o No impact	- - Complex section significant EW, walls change footprint and transistion from C2F	- - Complex section significant EW, walls change footprint and transistion from C2F			
Stormwater treatment and/or potential flooding effects	Roading		o No impact	o Grey infrastructure / piped through section limited effect	o Grey infrastructure / piped through section limited effect			

Project	Assessment area	
Ōtaki to North of Levin	A1 - A1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Social effects of mitigation	Social	Potenital negative social impacts on way of life and quality of living environment for those in particular living between SH1 and new highway.	o	o	o			
			Improvement of noise will benefit experience and use of outdoor space and quality of living environment however does not significantly change social impacts nor generate additional social impacts	As previous	As previous			
Impacts on the visual amenity of surrounding residents, in particular ONLs	Visual and landscape		o	+ +	+ +			
			The baseline is the effects of the naked highway. Scored '0' on the basis of no difference from baseline (accepting that the highway will have adverse effects)	2m walls will screen highway traffic and carriageway without being overly dominant.	Same as Option 2 visually			
Road users' views to the surrounding landscape	Visual and landscape		o	- -	- -			
			As above, no change from the baseline. Open views to Pukehou.	Sections of wall will add to the highway's hard character. Will affect foreground of views to Pukehou.	Same as Option 2 from a visually			

NZS 6806 – Assessment matrix

Project	Assessment area	
Ōtaki to North of Levin	G1 - G1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Compliance with NZS 6806 criteria	Acoustics	There are 2x Cat B PPFs (131 Arapaepae Rd) and the western building of the Prouse Homestead which strictly is not a PPF	+ + + All PPFs become Cat A	+ + + All PPFs become Cat A	+ + + All PPFs become Cat A	+ + + All PPFs become Cat A		
Comparison with Environmental Noise Guidelines (WHO 2018)	Acoustics	3 PPFs on Redwood Grove, plus the closer PPFs exceed 50 dB	o All Redwood Grove PPFs now achieve health criteria	o No additional PPFs achieve health criteria	o No additional PPFs achieve health criteria	o No additional PPFs achieve health criteria		
Effectiveness of noise mitigation	Acoustics	What level of reduction is achieved, and how does this vary throughout cluster	+ A 2 dB reduction applies to all PPFs (subject to rounding)	o Noise wall provides neglible benefit	+ + Achieves 2-4 dB reduction in the outdoor areas of the Prouse homestead and ground floor facades	+ + + Achieves 4-6 dB reduction in the outdoor areas of the Prouse homestead and ground floor facades		
Requirement for building modification mitigation	Acoustics	Building modification may be required where doors and windows are required to be closed to achieve 40 dB inside.	- Door and windows may need to be closed to achieve reasonable internal sound levels at closest PPFs. Does not apply at Redwood Grove PPFs	- Door and windows may need to be closed to achieve reasonable internal sound levels at closest PPFs. Does not apply at Redwood Grove PPFs	- Door and windows may need to be closed to achieve reasonable internal sound levels at closest PPFs. Does not apply at Redwood Grove PPFs	- Door and windows may need to be closed to achieve reasonable internal sound levels at closest PPFs. Does not apply at Redwood Grove PPFs		
Value for money	Acoustics	Calculation of indicative Benefit Cost Ratio for comparison purposes only	- - - Poor BCR due to low housing density	- - - Poor BCR due to low housing density	- - - Poor BCR due to low housing density	- - - Poor BCR due to low housing density		
Potential effects of operational noise from the Project on heritage buildings and sites	Heritage	Impact on amenity values of the garden and house	- 6-8 dB increase in nloise levels from the existing	- 6-8 dB increase in nloise levels from the existing	o 3-4 dB increase in nloise levels	o Little increase in noise levels		
Effects of mitigation structures on cultural values (eg. bund or barrier traverses an important site)	Heritage	Visible impact of bunds and/or sound barriers	o No visible intrusion	o Viewshafts of the 2 metre high noise may be visible from the stables, the orchard, vegetable garden through breaks in the trees but will not be visible from the house	- Viewshafts of the 3 metre high noise will will be visible from the stables, orchard and vegetable garden through breaks in the trees but will not be visible from the house	- Viewshafts of the 5 metre high noise will be visible from the stables, orchard and vegetable garden through breaks in the trees but will not be visible from the house		
Engineering degree of difficulty with cost	Roading	Option 4 is likely challenging wth fill requirement when already in defecit plus constrained corridor near prouse	o Some extra cost, but minor compared to other options so scored zero to differentiate	- Additional cost ~$1M for 640m of wall (plus 50mm OGPA)	- - Additional cost ~$1.5M for 640m of wall (plus 50mm OGPA)	- - - Addítiional $1.2M for wall and C2F, hwoever note lack of fill material in this zone plus extra footprint		
Effects on earthworks	Roading		o No impact	o Little impact on EW	o Little impact on EW	- - - Significant extra fill required to achieve		
Stormwater treatment and/or potential flooding effects	Roading		o No impact	o No impact	o No impact	- - High risk flood location and large bund will complciate flow paths		

Project	Assessment area	
Ōtaki to North of Levin	G1 - G1	

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Social effects of mitigation	Social	Potenital negative social impacts on way of life and quality of living environment for those in particular living between SH1 and new highway. Mitigation has potential to create increased visual severance of community connection.	o	o	o	-		
			Improvement of noise will benefit experience and use of outdoor space and quality of living environment however does not significantly change social impacts nor generate additional social impacts	Improvement of living environment and although visual buffer is provided this benefits the east but could further visually seprate the sliver of land between SH57 and new corridor, as many properties already have trees bordering property this could be mitigated, social effects or benefits are insignificant	Improvement of living environment and although visual buffer is provided this benefits the east but could further visually seprate the sliver of land between SH57 and new corridor, as many properties already have trees bordering property this could be mitigated, social effects or benefits are insignificant	The extent of this wall could change sense of place and create a visual severance of community.		
Impacts on the visual amenity of surrounding residents, in particular ONLs	Visual and landscape		o	+ +	-	- - -		
			The baseline is the effects of the naked highway. Scored '0' on the basis of no difference from baseline (accepting that the highway will have adverse effects)	2m walls will screen moving highway traffic and carriageway without being overly dominant. However, there will be specific adverse effects in blocking view along Queen Street toward ranges.	While 3m walls will screen moving traffic and carriageway, the walls will also start to be dominant in the context of adjacent urban streets and houses.	2m high walls on top of 3m bund will be a major backdrop feature to planned urban area, and will dominate adjacent street and houses.		
Road users' views to the surrounding landscape	Visual and landscape		o	o	-	- -		
			As above, no change from the baseline. Views will be limited by planned urban development.	2m walls will add to highway's hard character, but in the context of a planned urban development that would enclose highway in any event.	3m walls will add to highway's hard character, but in the context of a planned urban development that would enclose highway in any event. However, more dominant than 2m walls.	2m walls will add to the highway's hard character, and the 2m wall and 3m bund would enclose highway but in context on planned urban development that would enlose highway anyway.		

APPENDIX B.6: NOISE SURVEY REPORT (NV2)

Ōtaki to North of Levin Project

Noise survey report

Client: Waka Kotahi / NZ Transport Agency
Date: 7 October 2022
Ref: NV2/B

Prepared for (the Client)
Stantec for Waka Kotahi / NZ Transport Agency

Prepared by the Consultant)
Altissimo Consulting Ltd

Project	Ōtaki to North of Levin
Report	Noise survey report
Reference	NV2/B

Prepared by

Michael Smith
Principal Acoustics Engineer

Reviewed by

Robin Wareing
Principal Acoustic Engineer

Version history:

Version	Date	Comment
A	4/07/2022	Issued to client for comment
B	7/10/2022	Issued for lodgement

Report disclaimer and limitations:

This report has been prepared in accordance with the usual care and thoroughness of the consulting profession for the use of the Client. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

1 Introduction

Waka Kotahi is proposing to construct an highway from Ōtaki to North of Levin. Altissimo Consulting has been engaged to perform sound monitoring at number of locations along the length of the proposed expressway. The data gathered will assist in quantifying and qualifying the existing environment. The monitoring locations were selected to cover a range of environments.

Three different types of measurements were used to develop a comprehensive understanding of the existing noise environment. The measurement types were:

- Short term (15min) attended measurements with detailed site observations,
- Medium term (10 days) unattended noise logging (10 days) to capture the diurnal variations at 4-6 locations,
- Long term (3 month) unattended noise logging to better understand how sound varies seasonally and with different weather conditions.

Logging results have been presented in terms of different noise metrics ($L_{Aeq(24h)}$, L_{day}, L_{night}) and in a number of graphical representations so that trends and variations can be observed.

The different noise metrics used to describe road-traffic noise are listed and defined in Table 1.

Table 1 Noise metric definitions

Metric	Definition
$L_{Aeq(24h)}$	Time-average sound level over a 24h period. This is the primary noise metric used to describe road-traffic noise
$L_{Aeq(15min)}$	Time-average sound level over a 15-minute period. This is the metric gathered during short term attended measurements.
$L_{A90(15min)}$	Statistical descriptor of noise levels that are exceeded for 90% of a 15-minute evaluation time. This is representative of the background or steady state noise.
$L_{A10(15min)}$	Statistical descriptor of noise levels that are exceeded for 10% of a 15 minute evaluation time. This takes into account peaks in the measured level.
$L_{A10(18h)}$	Arithmetic average of the 18x $L_{A10(1h)}$ values between 0600h-midnight
L_{den}	Time-average sound level, over a 24-hour period, after the addition of 10 decibels to sound levels at night, and the addition of 5 decibels to sound levels in the evening L_d is the $L_{Aeq(12h)}$ over the 12-hour daytime period 0700-1900h L_e is the $L_{Aeq(3h)}$ over the 3-hour evening period 1900-2200h L_n is the $L_{Aeq(9h)}$ over the 9-hour night-time period 2200-0700 h the following day
L_{night}	Time-average sound level between 2300-0700h. Note that this is a different time period than the L_n term from the L_{den} metric.
Background sound	Sound which is heard continuously or frequently enough to form part of a background which other sounds are perceived (ISO 12913-1)

2 Methodology

Sound monitoring has been performed in general accordance with the Waka Kotahi noise monitoring guide[1]. This guide is written primarily for quantifying road-traffic noise rather than ambient noise measurements, and as such is not entirely appropriate for measurements in locations without existing road-traffic noise.

All measurements were performed using high resolution (100ms or 125ms) samples. These high-resolution samples have been post-processed to determine the 15-minute and 24-hour average levels.

Weather conditions were obtained from a weather station installed at one of the noise monitoring locations (see Section 4). Periods with rainfall or a measured wind speed of greater than 5 m/s were identified and excluded from the summary data in accordance with NZS 6801.

The exclusion of windy periods is necessary as wind on microphones can cause erroneous readings. However, the increased noise from vegetation moving in the wind, and whistling resulting from turbulent air, is a real part of the existing environment that people experience. Whilst common for most environmental noise assessments, the exclusion of windy periods means the data presented in this report does not show higher sound levels that would be experienced at times.

2.1 Short term attended measurements

Attended measurements were performed by Altissimo between April-September 2022. 27 locations were measured along the length of the project. At each location a 15-minute daytime measurement was performed and at six locations measurements were repeated during the night.

These attended measurements provide a snapshot of the existing noise environment. The short duration of the measurements mean they are strongly influenced by ambient conditions. The conditions at the time of measurement may not be typical to the existing noise environment. The equipment used for these measurements is presented below:

Table 2 Sound Level Meter for attended measurements

Item	Detail
Sound Level Meter	NTi XL2-TA A2A-17220-E0
Calibration Date	24/01/2020

Detailed site observations were made by an acoustic specialist in the context of an active listener. The nature of the of the listener means these observations may note environmental noise contributions that a casual listener may not notice. Observations were standardised based on the qualitative levels:

- Not at all
- A little
- Moderately
- A lot
- Dominates completely

[1] NZ Transport Agency (2012), Noise monitoring requirements, v1.0

2.2 Medium term unattended logging

Four sites along the length of the expressway were selected for medium-term noise logging. At each location a sound level meter was installed for 10 days. No attended observations were made at these sites. The locations and associated measurement equipment is described in the following table:

Table 3 Medium-term logging measurement details

Address	246 Tararua Road	70 Waihou Road	459 Arapaepae Road South
Sound level meter	ARL Ngara SN: 8781F	ARL Ngara SN: 8781D0	NTi XL2-TA A2A-17220-E0
Last calibration date	12/11/2019	18/09/2020	24/01/2020
NZTM coordinates	1794168E 5497735S	1796491E 5500728S	1834522E 5537088S
Measurement conditions	Free-field	Free-field	Free-field

Each logger records 100ms samples, these were combined into daily average levels in post-processing. Diurnal patterns were also calculated for each site.

2.3 Long term unattended logging

Four sites were selected for long term longing over a five-month period. The locations were selected due to the presence of existing traffic infrastructure. This logging was performed using lower cost sound level meters[2], which allowed for much longer logging than is typically performed.

The equipment and measurement locations are described in the following table:

Table 4 Long-term logging measurement details

Location	46 Sorenson Road	190 Arapaepae Road	10 Nikau Lane	378 Arapaepae South Road
Sound level meter	Noise Sentry mk3	Noise Sentry mk3	Noise Sentry mk3	Noise Sentry mk3
Serial number	Alh8DHWycV8dghNSz6hRtD	AFjehvUa8VWfgDHi52jZND	AlHWjt26212VqBlAxoLZnD	CFDUr3Wao38doLlAS8JxlD

This Long-term logging allows for seasonal variability, and wider statistics to be evaluated. Daily levels and diurnal patterns have been evaluated.

[2] These sound level meters use a micro-electro-mechanical systems (MEMS) microphone rather than the traditional diaphragm microphone. The manufacturer states that the sound level meter meets the Type 1 requirements for accuracy, but does not have a formal type approval. In addition, the sound level meters have noise floor of approximately 30dB. These sound level meters do not have an IANZ calibration certificate, although they have been field calibrated. Altissimo Consulting consider that these are fit for the purpose used.

3 Monitoring locations

The three following figures show the locations selected for sound monitoring. These sites were selected to give an adequate representation of the current environment along the length of the expressway.

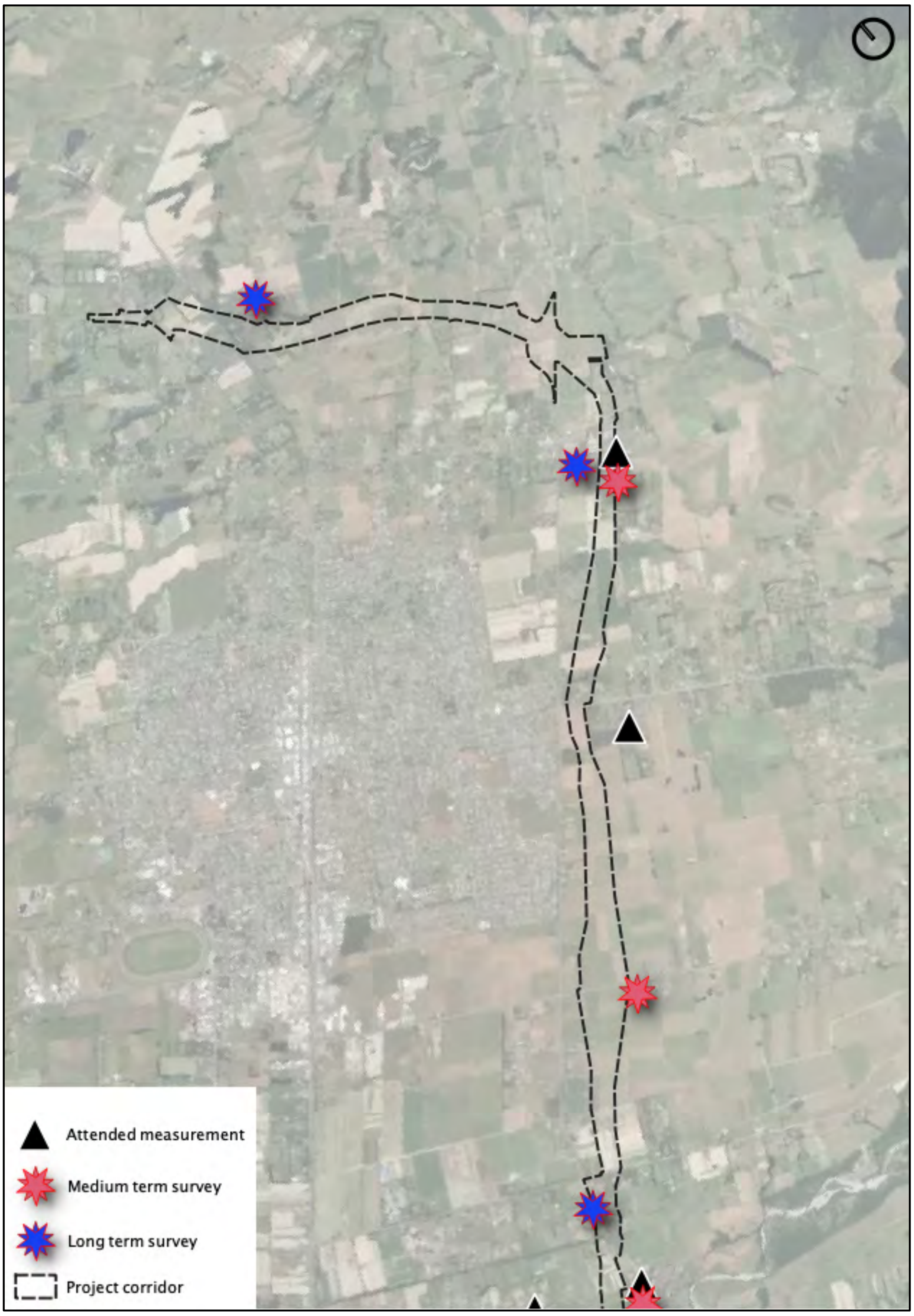


Figure 1 Noise monitoring locations (north)

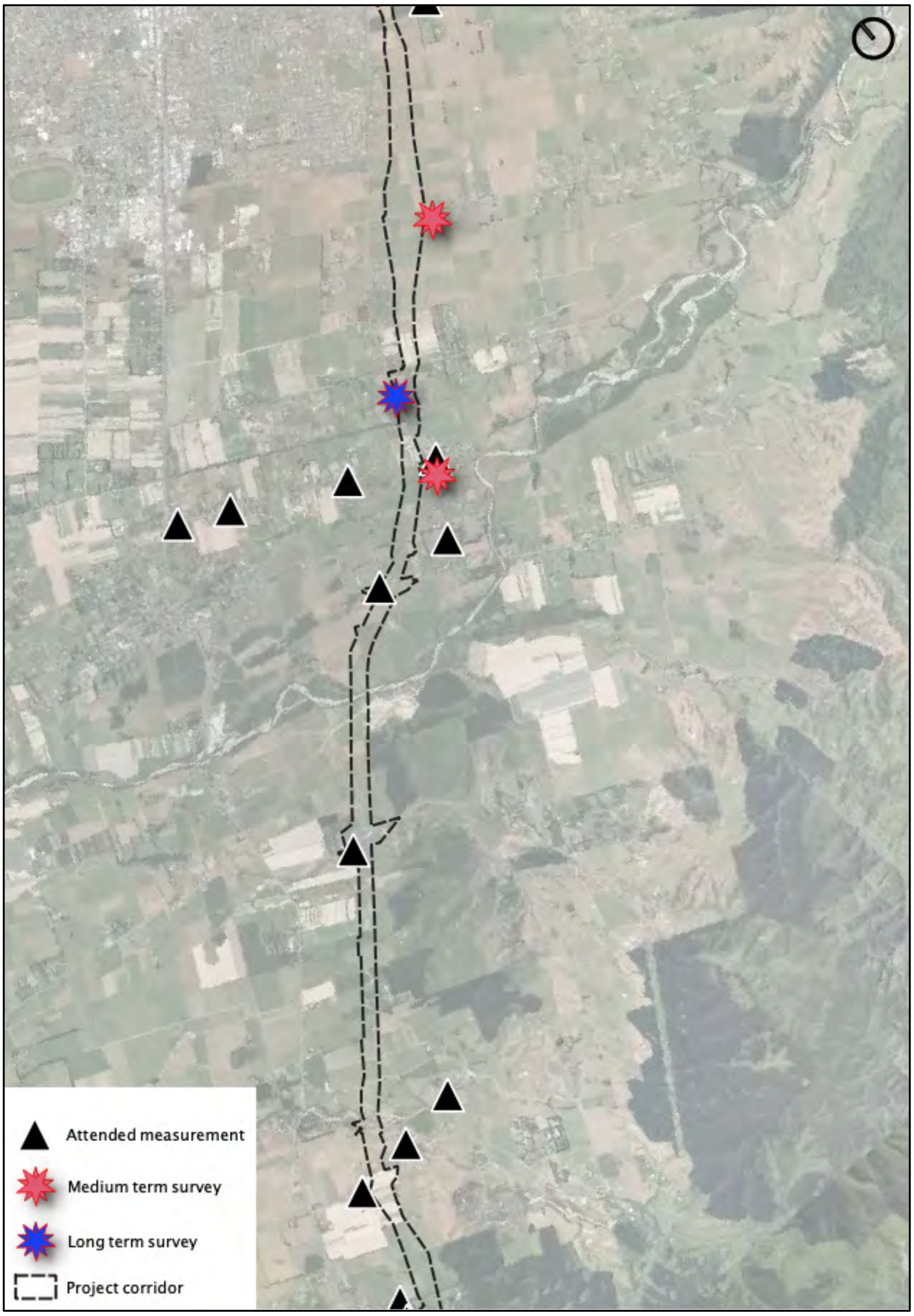


Figure 2 Noise monitoring locations (central)

Figure 3 Noise monitoring locations (south)

4 Weather conditions

Wind speed, direction and rainfall data was obtained from a Davis VantageVue weather that I installed at 10 Nikau Lane in Manakau, co-located with a long-term noise logger.

Wind speeds were measured at 1.8m above ground, which is representative of the wind speed at a normal microphone location. It should be noted that the measured wind speed is expected to be lower than the reference wind speeds at 10m above ground level (AGL).

Figure 4 Weather station

5 Results

5.1 Attended monitoring and observations

Table 5 Attended measurement results and observations

Address	Start	$L_{Aeq(t)}$	$L_{A90(t)}$	$L_{Aeq(24h)}$ (est)	Contribution from state highway	Contribution from other road traffic*	Other notable sound sources
North East Levin							
15 Koputaroa Rd	28/9/21 0915h	47	42	45-50	Moderately	A little	Birds
	27/9/21 2212h	41	27		A little	A little	
47 Sorenson Road	21/4/21 1524h	47	44	45-50	A lot	Not at all	
165 Fairfield Road	28/9/21 0839h	45	40	40-50	Moderately	Not at all	Birds, aircraft
	27/9/21 2254h	38	26		A little	Not at all	Transformer

Address	Start	$L_{Aeq(t)}$	$L_{A90(t)}$	$L_{Aeq(24h)}$ (est)	Contribution from state highway	Contribution from other road traffic*	Other notable sound sources
Levin East							
32 Mcdonald Road	28/9/21 0845h	51	45	50-55	Moderately	Not at all	
	27/9/21 2236h	47	38		A little	Not at all	Flowing water in stream, birds, sheep
70 Waihou Road	20/7/21 2211h	44	36	50-55	A little	Not at all	
20 Redwood Grove	20/7/21 2136h	37	31	40-45	A little	A little	
246 Tararua Rd	27/5/21 1345h	42	33	46-49	A little	Not at all	
Ohau East							
183 McLeavey Rd	21/4/21 1503h	40	37	40-45	A little	A little	Birds, wind, insects
74 McLeavey Rd	22/4/21 0942h	54	43	53-57	Moderately	A little	Birds, wind, insects
22 McLeavey Rd	22/4/21 0919h	60	55	58-63	A lot	A little	
59 Railway Tce	28/9/21 0957h	48	44	54-50	Moderately	Not at all	Birds
17 Riveredge	21/4/21 1618h	44	37	40-50	A little	A little	Birds in trees and dogs barking.
514 Arapaepae Road South	21/4/21 1446h	42	39	40-50	Not at all	Moderately	Dogs. Cicada
205 Muhunoa Road East	21/4/21 1433h	42	39	40-50	A little	Moderately	Wind in trees, and cicadas.
	21/4/21 2155h	37	34		Not at all	Not at all	
62 Kuku East Road	20/7/21 1638h	44	40	43-50	A little	A little	Birds
Manakau							
119 North Manakau Road	21/4/21 1557h	43	39	40-48	A little	Not at all	Insects, birds, cows, wind in flaxes
37 Martins Road	21/4/21 1614h	43	39	40-48	A little	Not at all	
44 Mokena Kohere	20/7/21 1705h	48	44	45-52	A little	Not at all	Wind in trees
5 Witako St	28/9/21 1014h	54	48	40-50	Moderately	Not at all	Birds chirping in trees
Tame Porati	21/4/21 1622h	50	47	45-55	Moderately	Not at all	
29 Eastern Rise	21/4/21 1342h	48	46	45-53	A little	Not at all	
Hanawera Ridge	21/4/21 1653h	45	43	44-49	A little	Not at all	

Address	Start	$L_{Aeq(t)}$	$L_{A90(t)}$	$L_{Aeq(24h)}$ (est)	Contribution from state highway	Contribution from other road traffic*	Other notable sound sources
Mountain View	20/7/21 1341h	47	43	45-52	Moderately	Not at all	Water flowing in stream audible
North Ōtaki							
27 Taylors Road	21/4/21 1413h	44	42	42-48	A little	A little	Insects, birds, and wind in trees
108 Greenwood Rvd	28/9/21 1048h	44	40	42-48	A little	Not at all	
11 Waitohu Rd	28/9/21 1037h	53	46	50-55	A little	Not at all	

* Local traffic observed, but paused/omitted from measurement

5.2 Noise logger summary

The results of the noise logging are presented in Table 6 as range of measured levels and the median value for the following parameters:

- Time average level ($L_{Aeq(24h)}$)
- Time average level ($L_{Aeq(t)}$) over the 15-hour day period, and 9-hour night period
- Background level ($L_{A90(1h)}$) as the average of 1-hour samples in each day or night period

The following table presents the average levels at each logging location:

Table 6 Average levels at logging sites

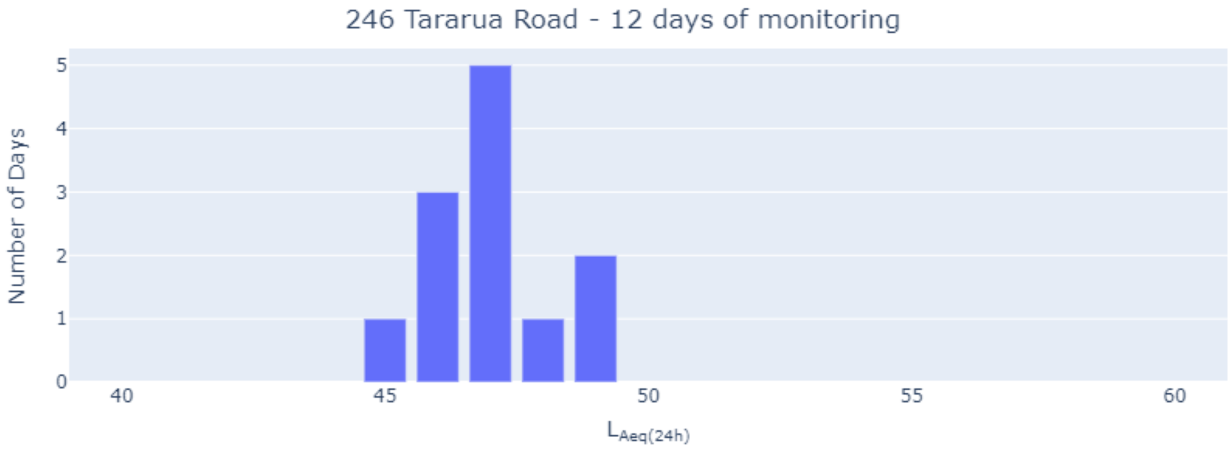
Measurement location	$L_{Aeq(24h)}$ dB	$L_{Aeq(day)}$ dB	$L_{Aeq(night)}$ dB
246 Tararua Road	47	48	43
70 Waihou Road	46	47	40
459 Arapaepae Road South	45	46	36
46 Sorenson Road	46	47	39
378 Arapaepae Road	50	51	42
190 Arapaepae Road	52	53	48
10 Nikau Lane	46	47	44

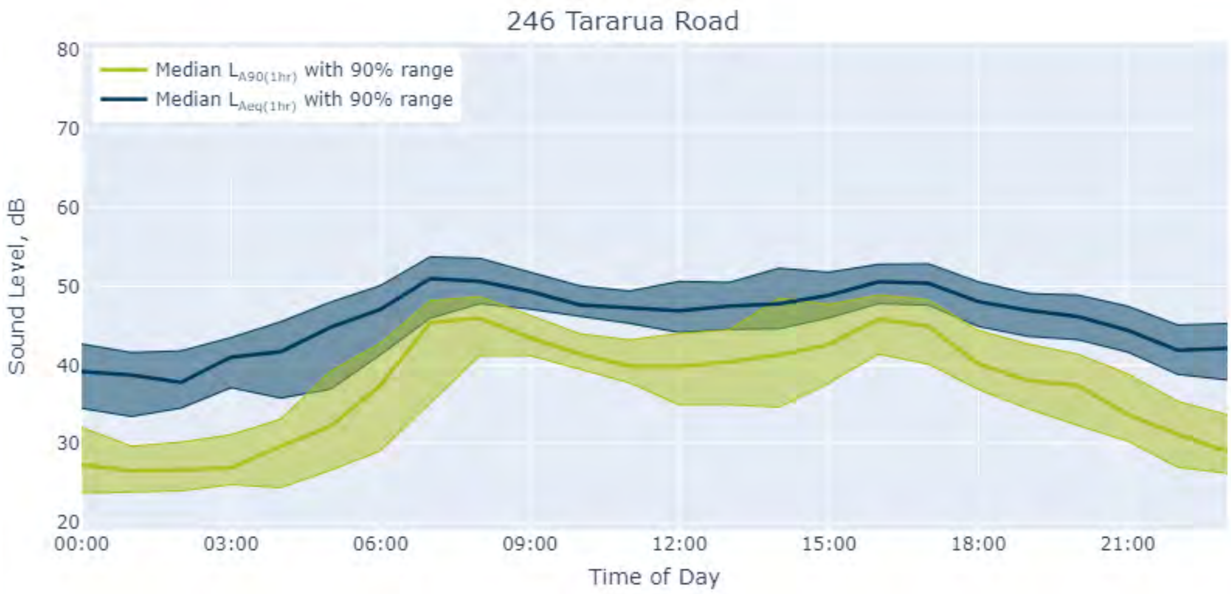
6 Variability in environmental noise levels

The diurnal variability for each measurement location has been evaluated and is presented in the following figures. At all locations an increase in noise level occurs during the day, which is expected due to increased human and animal activity. In some locations a peak occurs in the morning and evening, which is due to busy traffic periods.

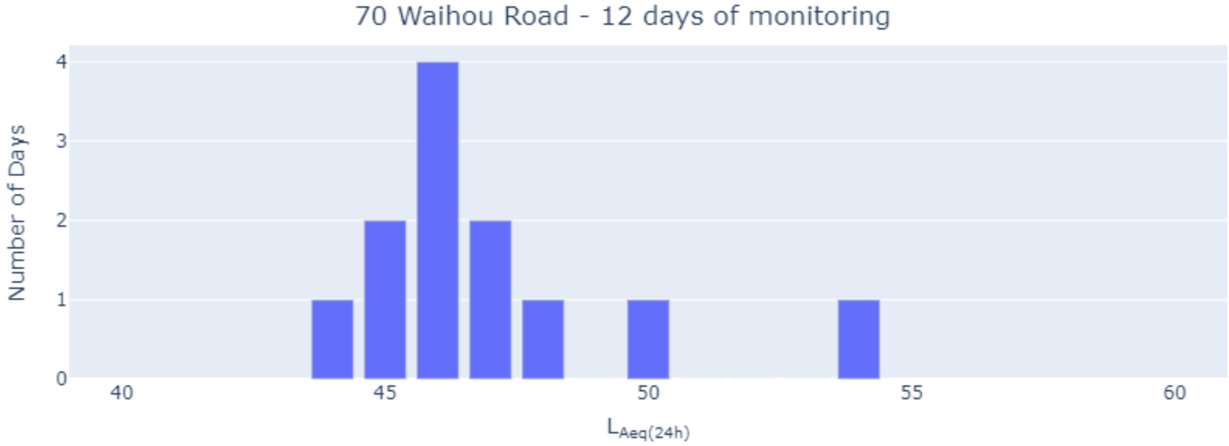
Environmental noise is subject to significant variability due to a range of factors, including weather, animals, and human activities. This variability means representing each site with a single number is unreliable. To show this variability the following histograms have been produced for the long-, and medium-term logging sites.

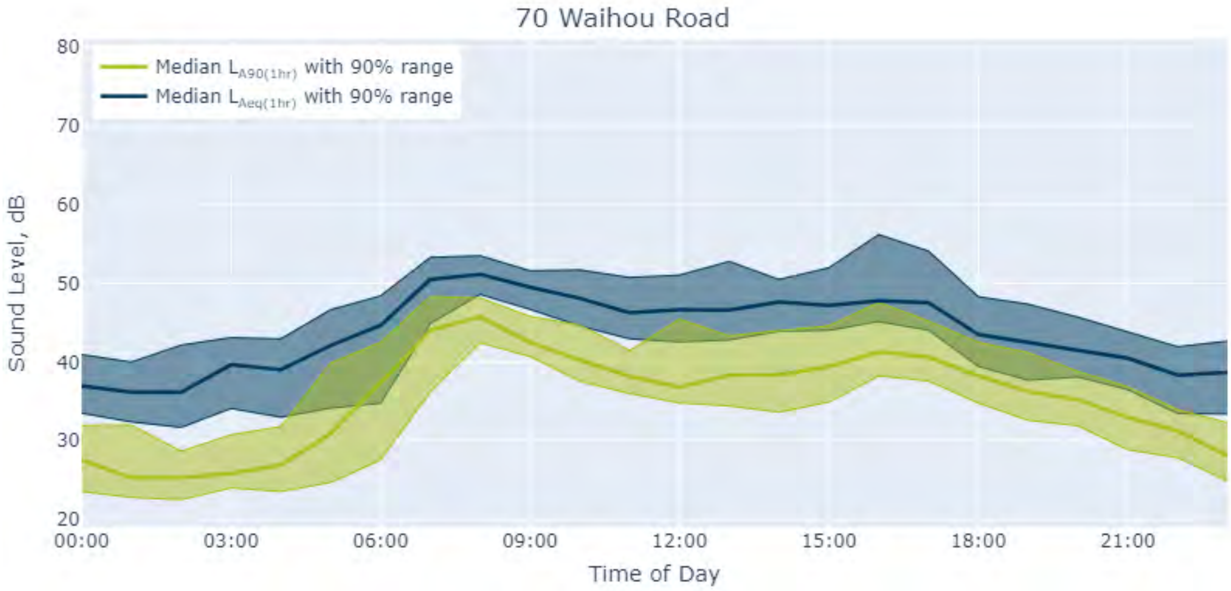
6.1 246 Tararua Road



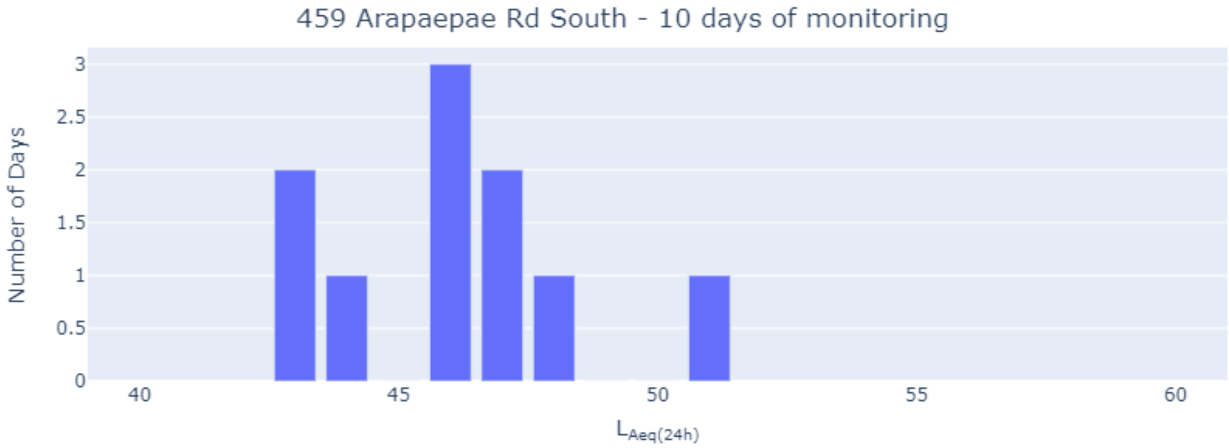


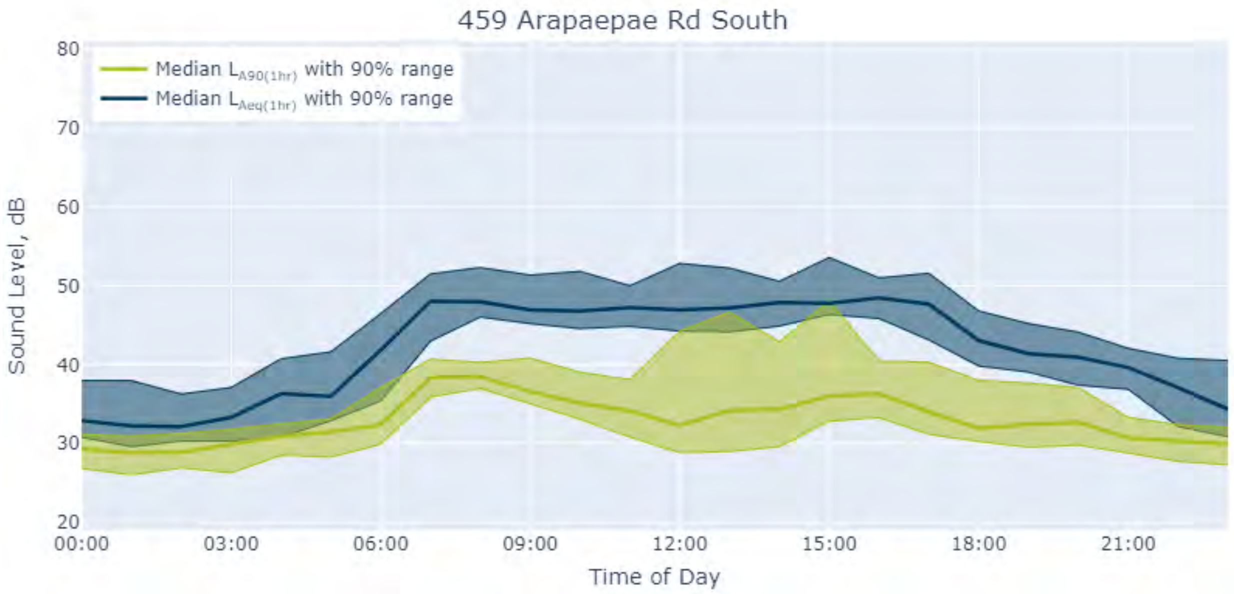
6.2 70 Waihou Road



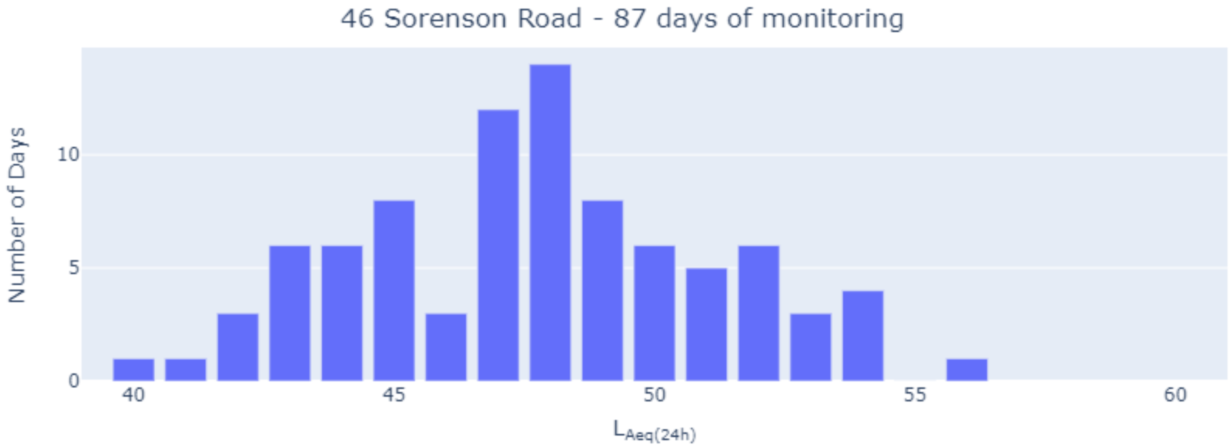


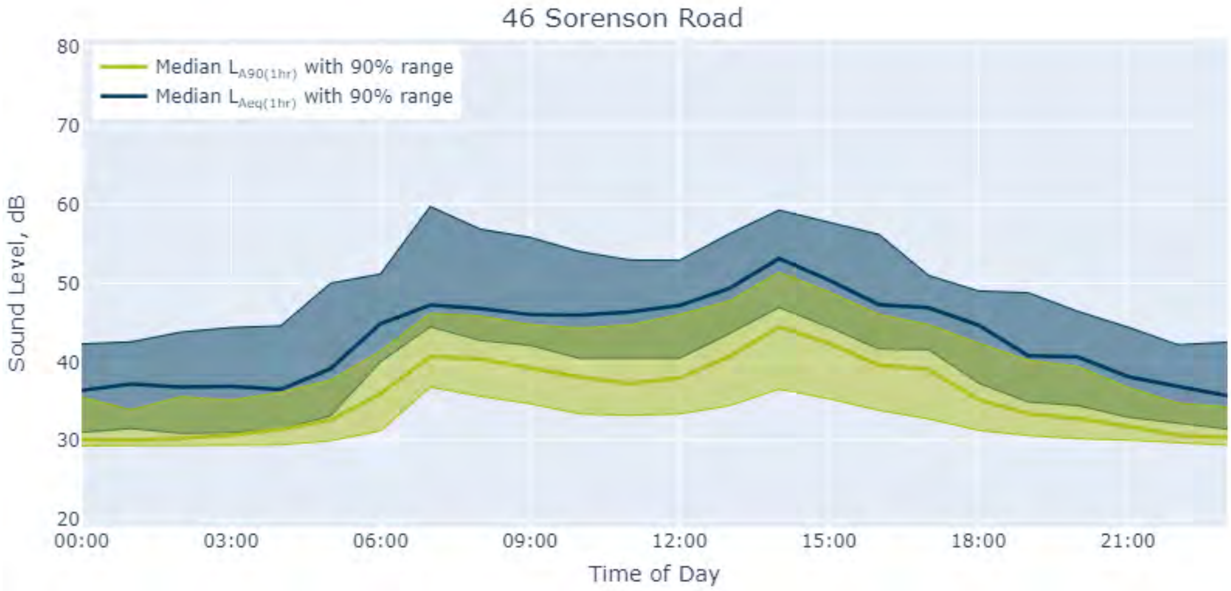
6.3 459 Arapaepae Road South



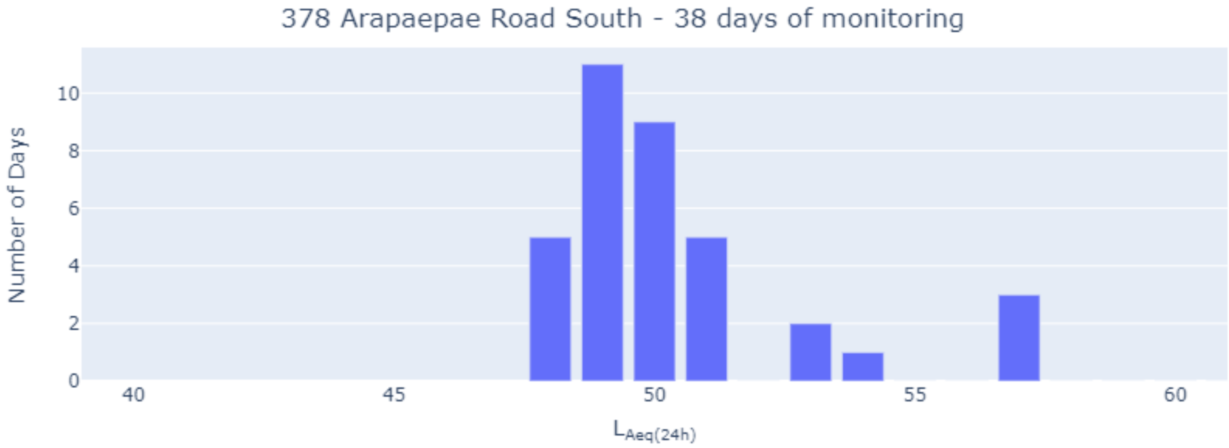


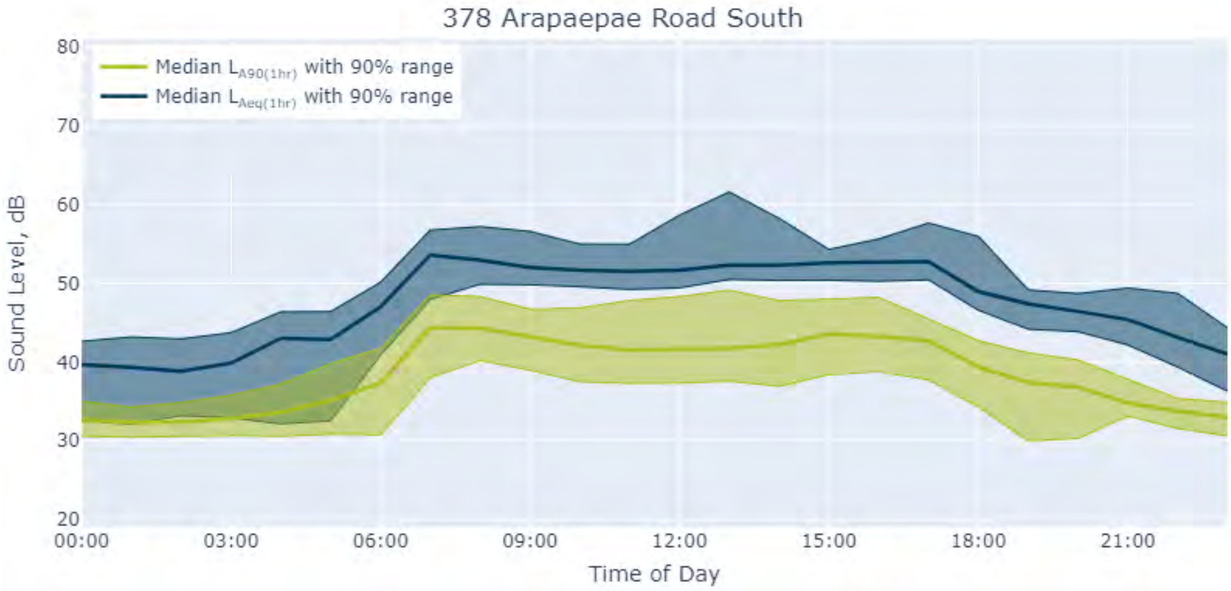
6.4 46 Sorenson Road



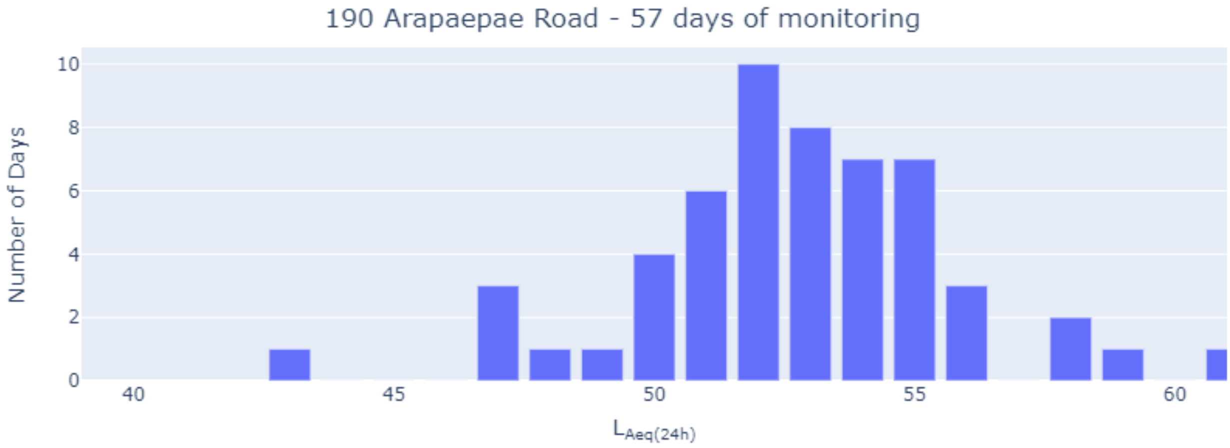


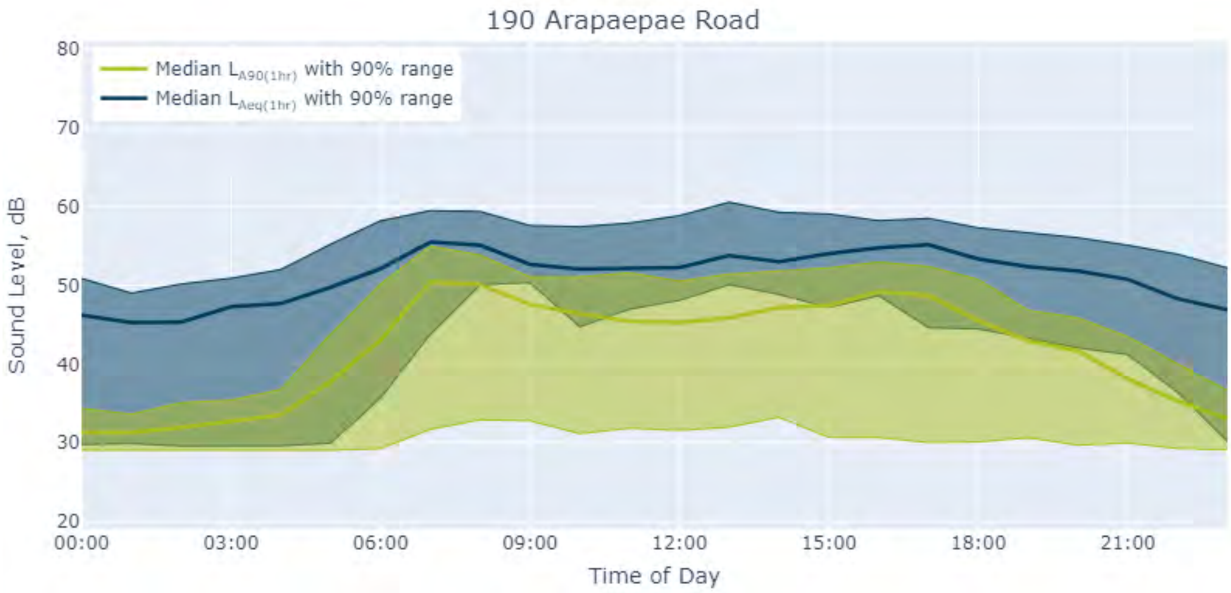
6.5 378 Arapaepae Road South



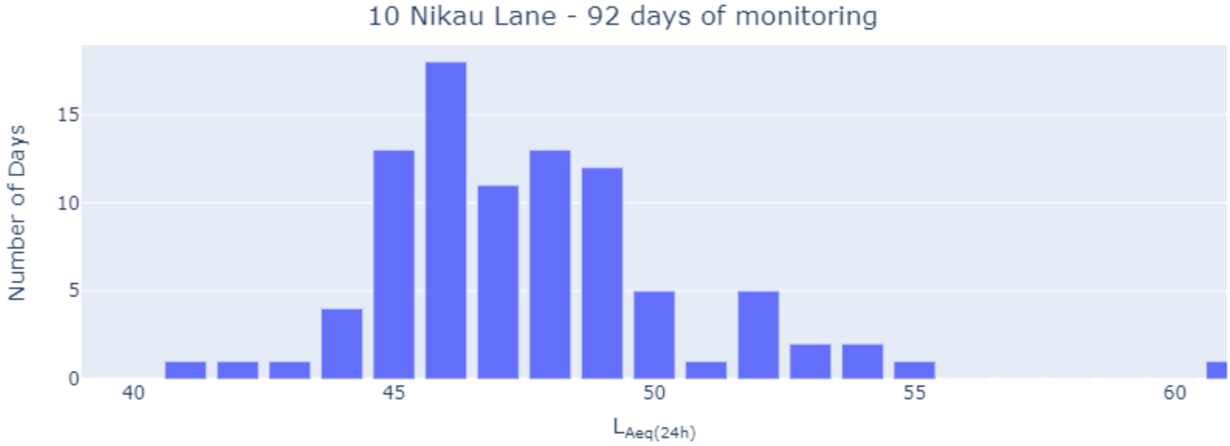


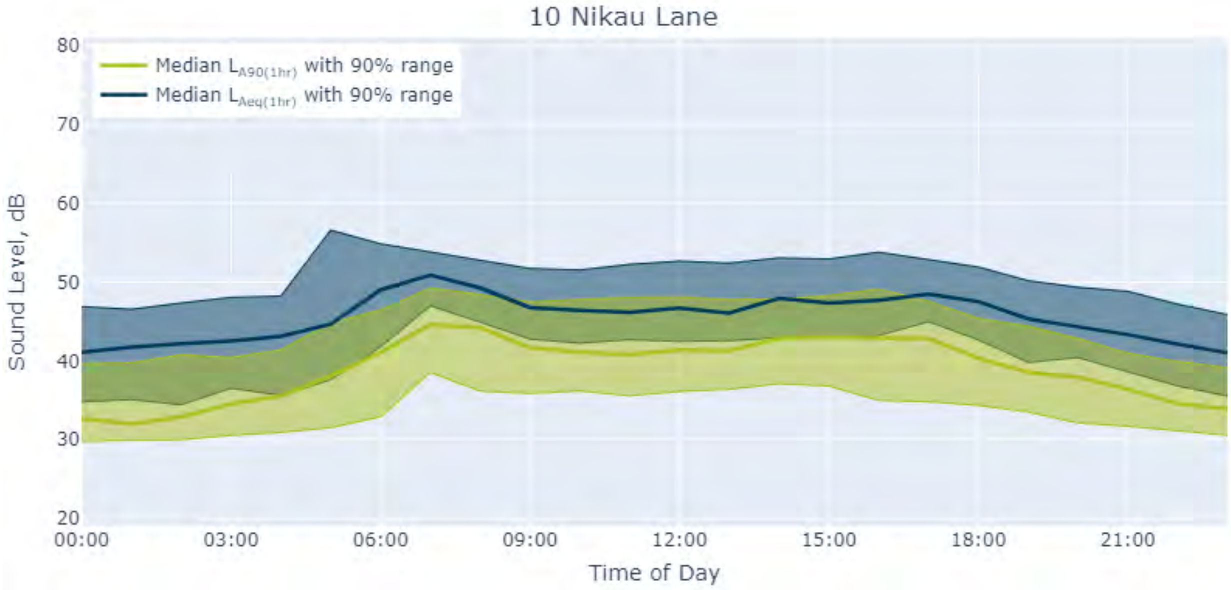
6.6 190 Arapaepae Road





6.7 10 Nikau Lane





7 Measurement sites

The following sections show the installation locations for the long- and medium-term logging.

7.1 246 Tararua Road

North view

East view

South view

West view

7.2 70 Waihou Road

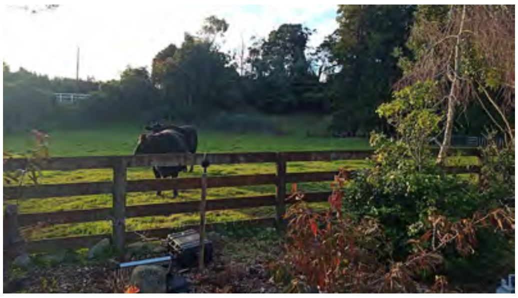
East view

North view

West view

South view

7.3 459 Arapaepae Road South



North view

East view

South view

West view

7.4 46 Sorenson Road

North view

East view

South view

West view

7.5 378 Arapaepae South Road

North view

East view

South view

West view

7.6 190 Arapaepae Road

North view

East view

South view

West view

7.7 10 Nikau Lane

North view

East view

South view

West view