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File Ref: AC22032 – 02 – R1

21 March 2022

UWC Limited
C/ - Ms D. Donaldson
Davis Olgilvie & Partners Ltd
PO Box 589
CHRISTCHURCH 8140

Email: damienne@do.nz

Dear Damienne,

Re: The Clearing Subdivision, Stages 3 – 6, Carters Rd, Amberley, Hurunui
State Highway noise and vibration review

Acoustic Engineering Services (AES) has been engaged by UWC Limited (the Applicant) to provide acoustic advice relating for a new subdivision (being stages 3 - 6, The Clearing), in Amberley, Hurunui. This development will contain residential lots located close to a Waka Kotahi New Zealand Transport Agency (NZTA) road designation (Carters Road, State Highway 1). Our review is with regard to reverse sensitivity effects from traffic for the new noise sensitive receivers to be established within the proposed subdivision.

Our analysis is based on our correspondence to date with Davis Olgilvie (on behalf of UWC Limited), as well as the following documentation:

- Amended Master Plan Layout, drawing MP1 titled *Proposed Subdivision of Lots 2 and 3 DP 559093, The Clearing – Stages 3 – 6 Proposed Development,* file number 41793, Revision H, as prepared for UWC Limited by Davis Ogilvie & Partners Limited, dated February 2022.

Please find our analysis below.

1.0 BACKGROUND

The proposed subdivision, known as The Clearing, is located in Amberley, Hurunui. State Highway 1 (SH1) being Carters Road, is to the west of the site. There are six stages for the subdivision development in total, and this review is limited to Stages 3 to 6 (in the order of 250 lots), where SH1 is immediately adjacent to several proposed residential sections as part of Stages 4 and 5.

We note that where properties are adjacent with SH1, a vegetation buffer is included within the allotment providing further setback between any potential building platform and the cadastral boundary with SH1 further beyond. Some adjacent lots are also set back further from the SH1 due to additional parcels of land identified as NZTA Designation 86 under the Hurunui District Plan. We understand that this land may be used in the future for realignment of the state highway.

Figure 1.1 below indicates the subdivision layout associated with Stages 3 to 6, relative to State Highway 1 in Amberley.

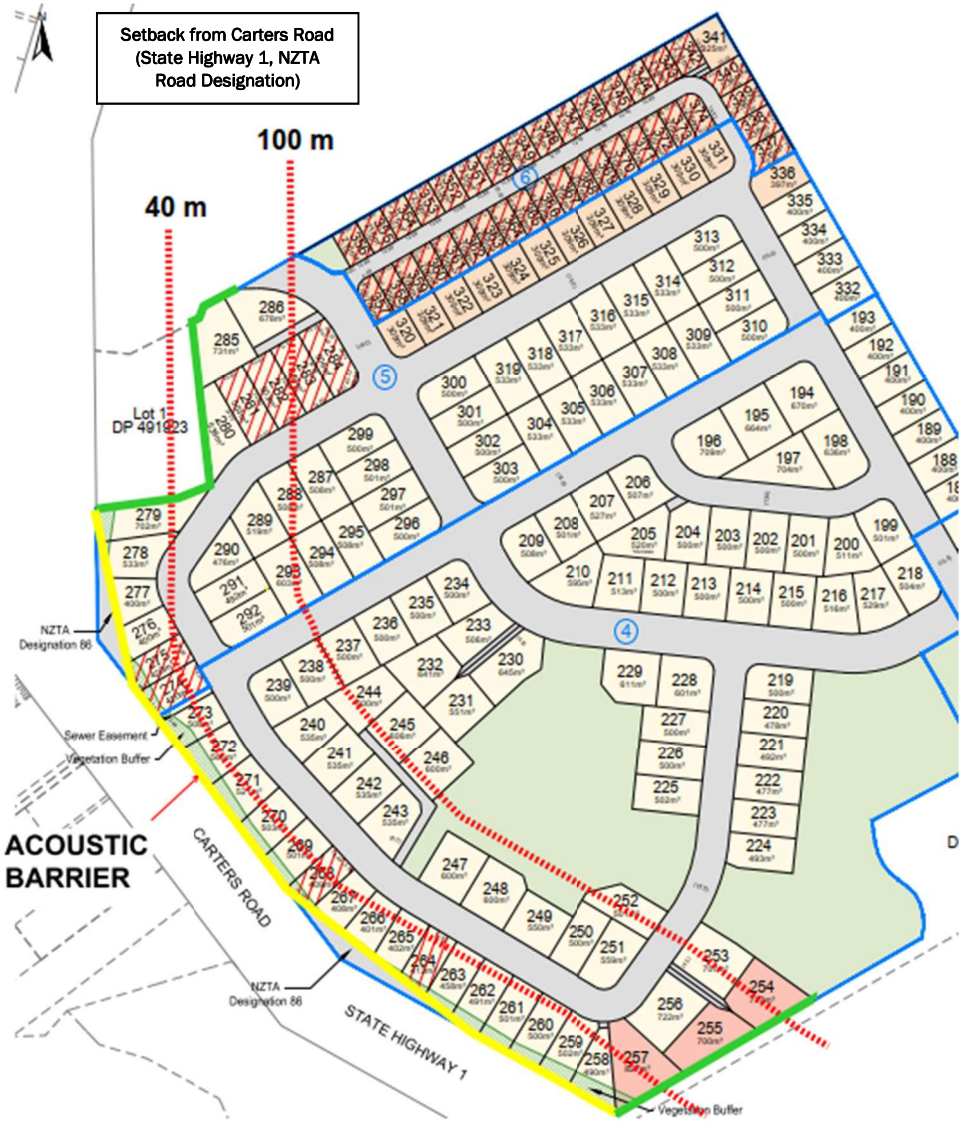

Figure 1.1 – Stage 3 – 6 The Clearing, Amberley, Hurunui

2.0 ACOUSTIC CRITERIA

Road traffic noise and vibration can cause annoyance sleep disturbance and other adverse health effects. In order to ensure that occupants of dwellings and other noise sensitive activities are not adversely affected Waka Kotahi New Zealand Transport Agency (NZTA) has prepared a guide to avoid or manage adverse effects of road traffic noise and vibration, for sensitive receivers located near to state highways. The NZTA document *Guide to the management of effects on noise sensitive land use near to the state highway network* (Version 1.0, dated September 2015), provides criteria for ensuring noise levels and vibrations are acceptable, and is consistent with criteria outlined in NZS 6806:2010 *Acoustics – Road traffic noise – new and altered roads*.

The guidance provides a stepped approach by way of calculation of setback distances for dwellings where additional controls are required – a buffer area for consideration of both noise and vibration, and an effects area where buildings should be designed and constructed to achieve reasonable indoor acoustic amenity from road traffic noise.

Based on the NZTA road and traffic information, we have determined the effects area extends some 100 metres from the nearest marked traffic lane of Carters Road (SH1) into the subdivision. Recommended internal noise levels are provide in Table 1 of the NZTA guidance. A noise level of 40 dB $L_{Aeq(24hr)}$ is recommended for both living and sleeping spaces within residential dwellings. The NZTA guidance states that "*no differentiation has been made between living and sleeping spaces as the 40 dB design noise level is measured over a 24-hour period and is broadly equivalent to 35 dB during the night period combined with 40 dB during the day*." The guidance also states that the setbacks it discusses are based on achieving 64 dB $L_{Aeq\ (24hr)}$ and above for the buffer area and between 57 and 64 dB $L_{Aeq\ (24hr)}$ in the effects area. No additional controls are recommended outside the effects area and therefore it is assumed that where noise levels are below 57 dB $L_{Aeq\ (24hr)}$ the noise levels would be appropriate for residential use without further consideration.

The NZTA guidance also states that if windows must be closed to achieve the design internal noise levels, the building must be designed, constructed and maintained with a ventilation and cooling system. The ventilation system must meet Clause G.04 of the New Zealand Building Code for habitable spaces.

The NZTA guidance also states that 3 dB should be added to existing measured or predicted noise levels, to take into account the future permitted use of the state highway.

With regard to vibration, the NZTA guidance states that the new buildings in or partly in the state highway buffer area must be designed, constructed and maintained to achieve road-traffic vibration levels complying with class C of NZ 8176E:2005. This is relevant for the lots within the buffer area, which has been determined to be 40 meters from the nearest marked traffic lane of Carters Road SH1, using relevant road and traffic information.

Based on the amended Master Plan, we have identified the lots associated with the subdivision which will be located within 100 metres of Carters Road (SH1) as shown in table 2.1 below.

Table 2.1 – Lots located within 100 metres of Carters Road (SH1)

Distance between lots and Carters Road	Lots
Within 40 metres	257 – 279
40 to 100 metres	238 – 244, 247 – 256, 280 – 283, 285, 286, 288 - 293

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3.0 ACOUSTIC BARRIER

Based on correspondence, we understand that the Applicant has proposed an acoustic barrier to be constructed at the following locations in figure 1.1 above:

- Along the cadastral boundary between the lots 258 – 279 and adjacent state highway
- For internal boundaries of lots 254, 255, 257, 279, 280, 285 & 286 to adjacent lots not part of the subdivision (Lot 1 DP 28365, and Lot 1 DP 491923)

The acoustic barrier should meet the following minimum standards:

- Surface mass – at least 10 kg/m^2
- The fence must be continuous and maintained with no gaps or cracks. For timber fences, this will require palings to be well overlapped (25 mm minimum) or a "board and batten" system, and a sleeper rail connecting the base of the palings to the ground. We also recommend a paling thickness of at least 25 mm to help resist warping.
- Suitable fencing materials which are commonly used include 25 mm timber, 9 mm fibre cement, 21 mm plywood, masonry, and concrete.

The required height of the barrier is discussed in section 4.0 below.

4.0 TRAFFIC NOISE ANALYSIS

The expected noise levels due to vehicles travelling past the subdivision on SH1 with an acoustic barrier has been calculated using the Calculation of Road Traffic Noise (CoRTN) algorithm applied with the SoundPLAN (v8.2) 3D noise modelling software.

The modelling was based on data inputs for the local terrain and ground conditions, worst-case traffic conditions based on an Average Annual Daily Traffic (AADT) volume of 12,237 with 14.4% of the flow composition being heavy vehicles[1], with road surface type of two-layer road chip seal grade 2/4[2] and designated speed limit of 80 km/hr.

We have considered the following acoustic barrier design:

- A 2.0 metre high acoustic barrier along the internal site boundaries of the subdivision as shown by the green lines in figure 1.1 above.
- A 3.0-metre-high acoustic barrier along the boundaries of the NZTA Designation and sites as shown by the yellow line in figure 1.1 above.

The resulting predicted road traffic noise contours are shown in figure 4.1 below when received at 1.5 metres above ground level. 3 dB has been added to the predicted noise levels to account for future permitted use, as required by NZTA. Based on this modelling, the following noise levels are expected to be received in Stage 4 and 5 of the subdivision:

- Up to 64 dB $L_{Aeq\ (24hr)}$ at lots 257 - 279
- Up to 60 dB $L_{Aeq\ (24hr)}$ at lots 237 – 255, 280 – 295, 298, 299, 320, 353 – 356, 367 – 360

[1] Data sourced from NZTA State Highway traffic volumes – 2015 to 2019 for State Highway 1
[2] Data sourced from Mobile Road database https://mobileroad.org/desktop.html

- Up to 57 dB $L_{Aeq\ (24hr)}$ at all remaining lots

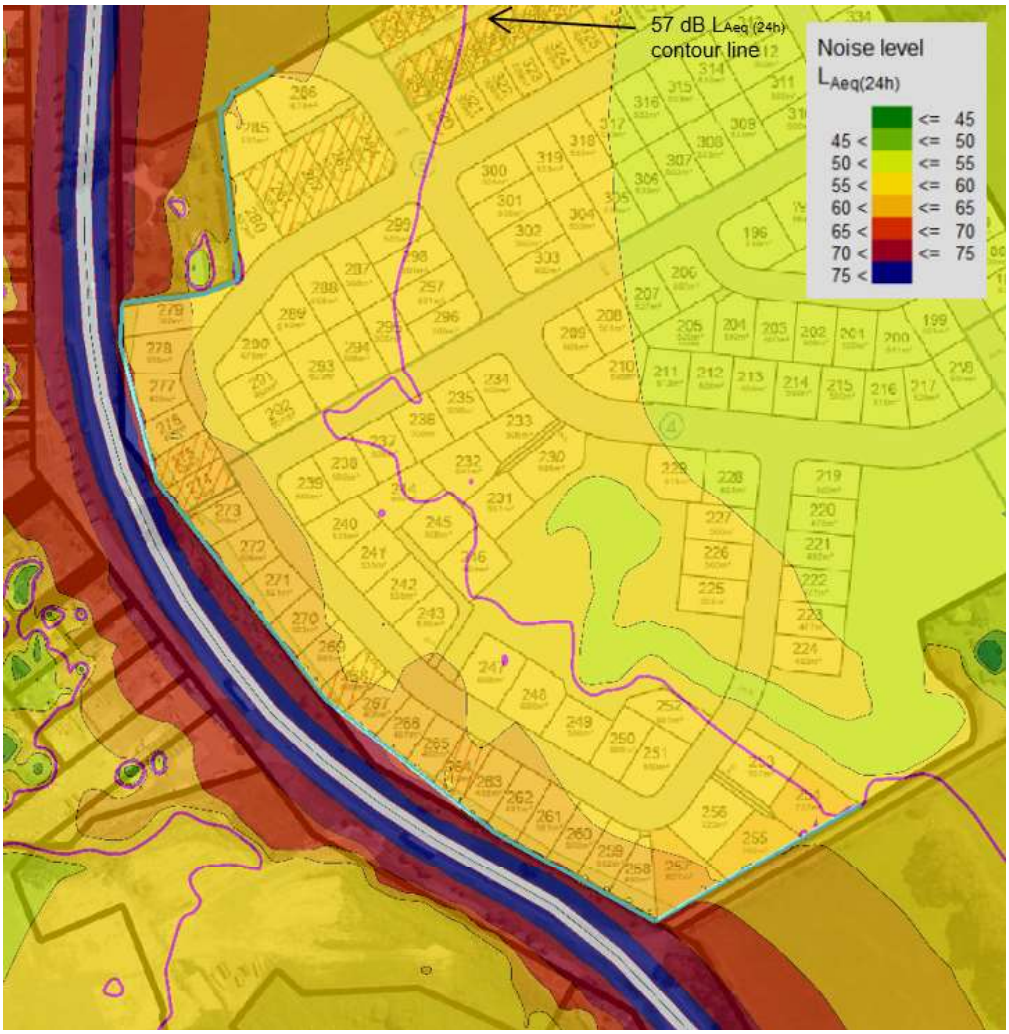

Figure 4.1 – Expected noise levels received across The Clearing subdivision (at 1.5 m above ground level)

As discussed above, where noise levels are no more than 57 dB $L_{Aeq\ (24hr)}$, upgrades to the building envelope or alternative ventilation systems are not expected to be required. We have discussed the lots where noise levels exceed 57 dB $L_{Aeq\ (24\ hr)}$ further below.

We note that if a lower barrier was installed (say 1.8 metres in height), then the majority of sites within 40 metres of the nearest marked traffic lane (buffer zone) of Carters Road (SH1) would exceed 64 dB L_{Aeq} by some margin, and would not be suitable for development.

4.1 Indicative construction upgrades - Lots 257 - 279

Based on noise levels of up to 64 dB $L_{Aeq\ (24hr)}$ at lots 257 – 279, from road traffic noise on SH1, in order to comply with the NZTA internal noise level requirement of 40 dB $L_{Aeq\ (24hr)}$, acoustic upgrades to a typical residential building envelope are expected to be required.

Some examples of the typical building envelope build-ups which will be required for sleeping and living areas orientated towards SH1 are given in table 4.1 below, with upgrades over 'standard' construction shown in bold.

Table 4.1 – Indicative building envelope build-ups for Lots 257 – 279 to achieve the NZTA requirements

Building envelope	Indicative construction details
External Walls	20 mm timber weatherboard / 20 mm air cavity / **4.5 mm (6.5 kg/m²) fibre cement RAB** (e.g. James Hardie HomeRAB pre-cladding board) / min 90 mm timber framing with fibrous insulation to the cavity / **2 layers** of 10 mm Standard Gib plasterboard
	0.55 mm colorsteel / 20 mm air cavity / **4.5 mm (6.5 kg/m²) fibre cement RAB** (e.g. James Hardie HomeRAB pre-cladding board) / min 90 mm timber framing with fibrous insulation to the cavity / **2 layers** of 10 mm Standard Gib plasterboard
	70 mm brick over cavity / min 90 mm timber framing with fibrous insulation to the cavity / 10 mm Standard Gib plasterboard
	Plaster system on 50 mm Integra light weight concrete panels / 20 mm air cavity /min 90 mm timber framing with fibrous insulation to the cavity / 10 mm Standard Gib plasterboard
Glazing	**10 mm float glass** / 12 mm air gap / 4 mm float glass
	7 mm PMMA laminated glass (e.g. Hush or Soundstop) / 10 mm air space / 4 mm float glass
Roof/ceiling	0.55 mm profiled metal pitched roof system (such as Long-run Steel) / minimum 300 mm ceiling cavity with fibrous insulation / 13 mm Standard Gib plasterboard

Lower noise levels are expected to be incident on the side walls and rear wall which face away from SH1. Therefore, the build-ups for these walls are likely to be able to be downgraded.

As discussed above, the NZTA guidance states that if windows must be closed to achieve the design noise levels of 40 dB $L_{Aeq\ (24hr)}$, the building must be designed, constructed and maintained with a ventilation and cooling system. The ventilation system must meet Clause G.04 of the New Zealand Building Code for habitable spaces. Based on the report titled *NANR116: 'Open/closed window research', sound insulation through ventilated domestic windows*, as prepared by Napier University in UK and dated April 2007, windows which have been cracked open for ventilation are expected to provide an outside to inside traffic noise reduction of 17 dB. Based on this research, dwellings where noise levels are higher than 57 dB $L_{Aeq\ (24hr)}$ will require a ventilation and cooling system to meet the internal noise limit of 40 dB $L_{Aeq\ (24hr)}$.

Therefore, a ventilation and cooling system is expected to be required for the dwellings on Lots 257 – 279.

We note that New Zealand Transport Agency's (NZTA) *Guide to the management of effects on noise sensitive land use near to the state highway network* (Version 1.0, and dated September 2015) recommends the following specification for the ventilation and cooling system:

- *Ventilation must be provided to meet Clause G.04 of the New Zealand Building Code. At the same time the sound of the system must not exceed 30 dB $L_{Aeq(30s)}$ when measured 1.0 metre away from any grille or diffuser.*

- *The occupant must be able to control the ventilation rate in increments up to a high air flow setting that provides at least 6 air changes per hour (more than is specified in clause G.04). At the same time the sound of the system must not exceed 35 dB $L_{Aeq(30s)}$ when measured 1.0 metre away from any grille or diffuser.*

- *The system must provide cooling that is controllable by the occupant and can maintain the temperature at no greater than 25°C. At the same time, the sound of the system must not exceed 35 dB $L_{Aeq(30s)}$ when measured 1.0 metre away from any grille or diffuser.*

4.1.1 Two-storey buildings

The above analysis is for single storey buildings. If two-storey buildings are proposed at the residential lots adjacent to Carters Road SH1 (lots 257 – 279), noise levels of up to 69 dBA $L_{eq\ (24h)}$ would be expected on the upper façades of these buildings where there is line of sight from the upper level of the building to the road, and therefore no attenuation from the acoustic barrier is achieved. It could therefore be beneficial to restrict the residential dwellings built on these lots to single storey only.

The NZTA guidelines can still be achieved if two-storey buildings were preferred but will require significant upgrades to the upper-level façades of the habitable spaces of the dwellings. Outdoor balconies which overlook the State Highway should not be permitted.

4.1.2 Outdoor living areas

We have considered noise levels when indicative dwellings have been constructed on the sites to illustrate where outdoor living areas may be able to be located. We have modelled a rectangular shaped house (of approximate size of 170 m^2) on each of the sites. The resulting expected level of noise is shown on the contours in figure 4.2.

This analysis shows that the noise levels on the parts of the site that are orientated to the east will be reduced to less than 57 dB $L_{Aeq\ (24hr)}$. Therefore, if primary outdoor living areas are screened from the State Highway by the dwelling (or a neighbouring dwelling) it is realistic to expect that noise levels of less than 57 dB $L_{Aeq\ (24hr)}$ could be achieved.

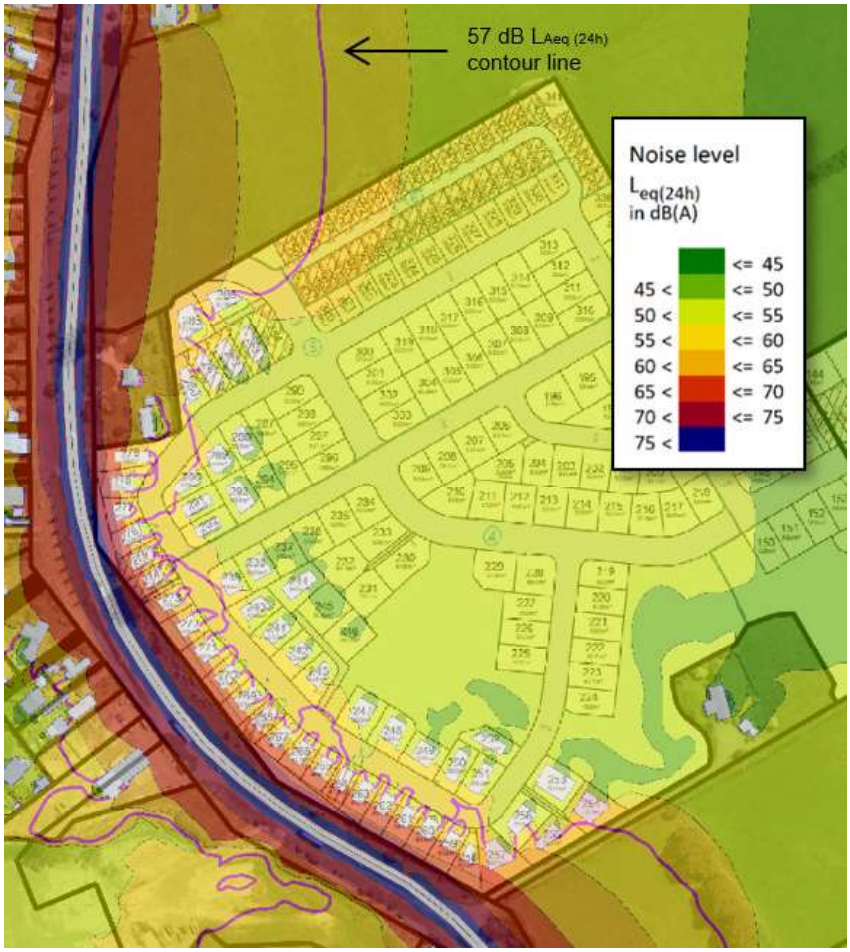

Figure 4.2 – Expected noise levels received across The Clearing subdivision with dwellings (shown at 1.5 metres above ground level)

A requirement may therefore be appropriate for lots 254 – 281, 285, 286 and 290 for a primary outdoor area to be located on northeast sides of buildings, or an acoustic report for each dwelling stating that the building has been designed so that there is space for the primary outdoor living area to be located in a position where the noise level is below the NZTA guideline level of 57 dB $L_{Aeq\ (24hr)}$.

4.2 Indicative constructions - Lots 237 – 256, 280 – 295, 298, 299, 320, and 353 – 360

Based on noise levels of 57 to 60 dB $L_{Aeq\ (24h)}$ being received at lots 237 – 256, 280 – 295, 298, 299, 320, and 353– 360 from traffic on SH1, upgrades to the typical building envelope build-ups are unlikely to be required, unless significant areas of light-weight constructions (such as large areas of glazing) are adopted. Therefore, the typical build-ups outlined in table 4.2 below provide an indication of likely adequate construction for dwellings on these lots.

Table 4.2 – Typical building envelope build-ups for Lots 237 – 256, 280 – 295, 298, 299, 320, and 353 –– 360 to achieve the NZTA requirements

Building envelope	Construction details
External Walls	20 mm timber weatherboard / 20 mm air cavity / minimum 90 mm timber framing with fibrous insulation to the cavity / 10 mm Standard Gib plasterboard
	0.55 mm colorsteel / 20 mm air cavity / minimum 90 mm timber framing with fibrous insulation to the cavity / 10 mm Standard Gib plasterboard
	70 mm brick over cavity / minimum 90 mm timber framing with fibrous insulation to the cavity / 10 mm Standard Gib plasterboard
	Plaster system on 50 mm Integra light weight concrete panels / 20 mm air cavity / 90 mm timber framing with fibrous insulation to the cavity / 10 mm Standard Gib plasterboard
Glazing	6 mm float glass / 12 mm air gap / 4 mm float glass
Roof/ceiling	0.55 mm profiled metal pitched roof system (such as Long-run Steel) / minimum 300 mm ceiling cavity with fibrous insulation / 13 mm Standard Gib plasterboard

However, we note that where two-storey buildings are proposed, depending on the shielding from established dwellings closer to the State Highway, noise levels expected on the upper façades of these buildings could be elevated above 60 dB $L_{Aeq\ (24hr)}$, especially where there is direct line of sight from the upper level of the building to the road. In these circumstances, increased acoustic construction upgrades, more in line with those outlined in table 4.1 could be required.

As discussed above, as noise levels are higher than 57 dB $L_{Aeq\ (24hr)}$ incident on some elements of the building envelope, some habitable spaces may require a ventilation and cooling system to meet the internal noise limit of 40 dB $L_{Aeq\ (24hr)}$.

4.3 Remaining Lots

As shown in figure 4.1, road traffic noise levels of less than 57 dB $L_{Aeq\ (24h)}$ are expected to be received across the remaining lots. In these instances, upgrades to the typical building envelope build-ups to achieve appropriate internal noise levels are not expected to be required, and typical constructions as outlined in table 4.2 would be appropriate.

For these remaining lots, a ventilation and cooling system is also not expected to be required.

5.0 TRAFFIC VIBRATION ANALYSIS

The NZTA guidance described above states that the new buildings in or partly in the State Highway buffer area (40 metres) must be designed, constructed, and maintained to achieve road-traffic vibration levels complying with Class C of NS 8176E:2005 *Vibration and shock - Measurement of vibration in buildings from land-based transport and guidance to evaluation of effects on human beings*.

NS 8176.E:2005 recommends that vibration levels in new residential buildings comply with Class C classification of 0.3 mm/s $v_{w,95}$, outlined in NS 8176. If this is met, then it is expected that potential reverse sensitivity effects associated with road traffic vibration will be adequately mitigated.

Vibrations were taken on the site of 193 Carters Road, a stretch of road with a current speed limit of 80 km/hr. Vibration measurements were undertaken by AES Acoustic Engineer Robin Chen from 1000 to 1600 hours on the 3rd of March 2022, in general accordance with NS 8176E:2005 *Vibration and shock - Measurement of vibration in buildings from land-based transport and guidance to evaluation of effects on human beings*.

Measurements were undertaken using a Svantek 958A vibration monitor (serial number 92893), and all monitoring equipment held current calibration certification. The vibrations caused by 15 single passings of heavy road vehicles with weight greater than 3500 kg were measured at each position.

The measured surface vibration levels at various setbacks from the nearest marked traffic lane in the 80 km/hr speed limit zone on the relevant stretch of Carters Road SH1 are shown in table 5.1 below, with vibration levels which exceed the criterion highlighted.

Table 5.1 – Measured vibration levels in 80 km/hr speed limit zone of Carters Road SH1

Setback from the nearest marked traffic lane of Carters Road SH1	Mean weighted vibration level (mm/s)	Statistical maximum weighted vibration level (mm/s)	Standard deviation
14.5 metres	0.65	0.94	0.16
17.5 metres	0.47	0.62	0.08
20 metres	0.16	0.29	0.07

Compliance with vibration levels on the ground is achieved when the statistical maximum weighted vibration level is lower than 0.3 mm/s.

Based on the above measured data, the vibration levels on the ground are expected to comply with the vibration criterion of 0.3 mm/s with a setback of greater than 20 meters from the nearest marked traffic line of Carters Road SH1. As the coupling loss between the soil and the concrete foundation of a dwelling is expected to provide additional vibration reduction (in the order of 0.2 mm/s based on previous measurements), dwellings slightly closer than 20 meters from the road may also experience less than 0.3 mm/s.

Based on geographical data from LINZ Data Service and the provided site plans, we have the following recommendations with regards to the lots adjacent to Carters Road SH1 within the buffer zone that may be affected by vibration levels from the road:

- For the residential lots 258 – 264, 268 - 275, and 279, no vibration treatment is required to achieve the NZTA criterion as the distance from the road and vegetation buffer on the lots provide sufficient setback (greater than 20 metres) for potential building platforms.

- For the residential lots 265 – 267 and 276 - 278 which are adjacent to Carters Road SH1 with no vegetation buffer, vibration treatment may be required if a dwelling is constructed less than 20 meters from the nearest marked traffic lane. As recommended by NZTA, a resilient vibration dampening/isolation material could be introduced between the bearing strips of the rib raft and the ground (ie, between the raft edge and rib beam and the ground). The vibration isolation material should be designed by the supplier/manufacturer and be at least 25 mm thick.

The design of any dwellings within 20 metres of the State Highway should therefore be reviewed during the Building Consent process.

6.0 CONCLUSIONS

We have reviewed potential traffic noise and vibration issues for the proposed The Clearing Subdivision Stages 3 – 6, which contains residential lots located close to Carters Road (State Highway 1).

Based on the proposed subdivision layout and traffic information from NZTA, we can confirm that the NZTA internal noise limits of 40 dB $L_{Aeq\ (24hr)}$ for the sleeping and living areas and 57 dB $L_{Aeq\ (24hr)}$ for outdoor living areas would be achievable with 3.0-metre-high acoustic fencing to State Highway 1, and 2.0 metre high for internal subdivision boundaries as shown in figure 1.1. The NZTA vibration guidance will also be achievable. The dwellings on some lots may however require acoustic upgrades and ventilation systems, and in limited cases, foundations designed to reduce vibration.

The following Conditions may be appropriate:

- A 3.0 metre high acoustic barrier should be constructed along the site boundaries between the State Highway 1 and lots 258 – 279, with a 2.0 metre high acoustic barrier for internal boundaries of the subdivision and neighbouring properties for lots 254, 255, 257, 279, 280, 285, and 286. Acoustic barrier design should conform to the following minimum specifications:
    - Surface mass – at least 10 kg/m^2
    - The fence must be continuous and maintained with no gaps or cracks. For timber fences, this will require palings to be well overlapped (25 mm minimum) or a “board and batten” system, and a sleeper rail connecting the base of the palings to the ground. We also recommend a paling thickness of at least 25 mm to help resist warping.
    - Suitable fencing materials which are commonly used include 25 mm timber, 9 mm fibre cement, 21 mm plywood, masonry, and concrete.
- For lots 257 – 279, dwellings must be single level, and the site layout design must allow for a primary outdoor living area to be located in a position where the noise level is below the NZTA guideline level of 57 dB $L_{Aeq\ (24hr)}$.
- Dwellings on lots 237 – 295, 298, 299, 320, and 353 – 360, must be designed, constructed, and maintained to achieve a design noise level of 40 dB $L_{Aeq\ (24h)}$ inside all habitable spaces. The 40 dB $L_{Aeq\ (24h)}$ must take into account the future permitted use of the State Highway 1 as well as the noise mitigation achieved through the construction of the acoustic barriers as outlined above.
- If windows must be closed to achieve the design noise level of 40 dB $L_{Aeq\ (24h)}$, the building must be designed, constructed, and maintained with a ventilation and cooling system. The ventilation and cooling system must meet Clause G.04 of the New Zealand Building Code for habitable spaces.
- For lots 257 – 279 which are adjacent to Carters Road SH1, the design of the dwellings should be reviewed by an appropriate expert if the building platform is constructed less than 20 meters from the nearest marked traffic lane, to ensure vibration levels within the dwelling do not exceed 0.3 mm/s $v_{w,95}$.

- Prior to lodging a Building Consent, or at the time of lodging a Building Consent with Council for the construction or alteration of a dwelling, a design report prepared by an appropriately qualified Acoustic Engineer shall be submitted to Council demonstrating compliance with the above conditions.

We trust that this is of some assistance. Please do not hesitate to contact us to discuss further as required.

Kind Regards,

Robin Chen
BE Hons (Mech)
Acoustic Engineer
Acoustic Engineering Services