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Report Number: AC20112 – 09 – R5

New Dunedin Hospital – Outpatients Building

Assessment of Environmental Noise Effects

Prepared for:
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Association of Australasian Acoustical Consultants

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Document Acceptance

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1.0 BACKGROUND

Acoustic Engineering Services Ltd (AES) have been engaged to provide acoustic engineering advice relating to a Resource Consent application for construction and operation of the Outpatients Building at New Dunedin Hospital (NDH).

The Applicant requires an Assessment of Environmental Noise Effects for the activity with regard to schedule 6 clause 10 of the COVID-19 Recovery (Fast-track Consenting) Act 2020 (Fast Track Act) and section 104 (1) of the Resource Management Act (RMA), which requires the actual and potential effects of the activity to be considered.

We have based our analysis on the following documentation:

- Resource Consent architectural report titled, *Whakatuputupu, New Dunedin Hospital Outpatient Building Resource Consent Design Report, Rev H,* as prepared by Warren and Mahoney HDR, and dated the 12th of April 2022.
- Integrated transport assessment titled *Ministry of Health New Dunedin Hospital, Dunedin* as prepared by Novo Group Limited and dated April 2022.
- Developed Design Building Services drawings titled *NDH Outpatient Building, and Equipment Schedule Appendix C19A* as prepared by Beca and dated the 26th of July 2021.
- 75% Detailed Design Acoustic Report titled *New Dunedin Hospital - Outpatients Detailed Design – Acoustic Report (75 % Issue)*, as prepared by Acoustic Engineering Services and dated the 25th of February 2022.

Please find our analysis below.

1.1 Site and surrounds

The Outpatient Building is to be located on the part of the site that is north of St Andrew Street, between Castle and Cumberland Streets. This building will comprise of four occupied levels (Levels 00 to 03) a dedicated plant level including a large back-up generator (Level 04) and a rooftop plant level (Level 05). There is also a ground level extension to the north, housing engineering and gas storage. This part of the building extends into the carpark area and separates the main visitor carpark from the loading bay and rubbish area. The carpark is accessed from Cumberland Street and the loading bay from Castle Street. There are VIE tanks located at the northern end of the engineering extension and they are accessed from Cumberland Street via a one way-access through to Castle Street.

The site extends some 75 metres to the north of the main part of the Outpatient Building and is 45 metres from the end of the engineering wing. The site contains the former Lighting Direct and Anytime Fitness buildings which are to remain and be repurposed for cycle storage and end-of-trip facilities. The balance of the site has been cleared of all buildings.

Several sites surrounding the Outpatients site are owned by the Southern District Health Board (SDHB) including the site of the future Inpatients Building that is to be constructed to the south of St Andrew Street on the old Cadbury building site. To the southeast of the Outpatient site is the 'Bow Lane site' where the future Logistics Building is to be located. These buildings are not part of this Application and the sites are currently empty. The site and surrounds are shown in figure 1.1 below.

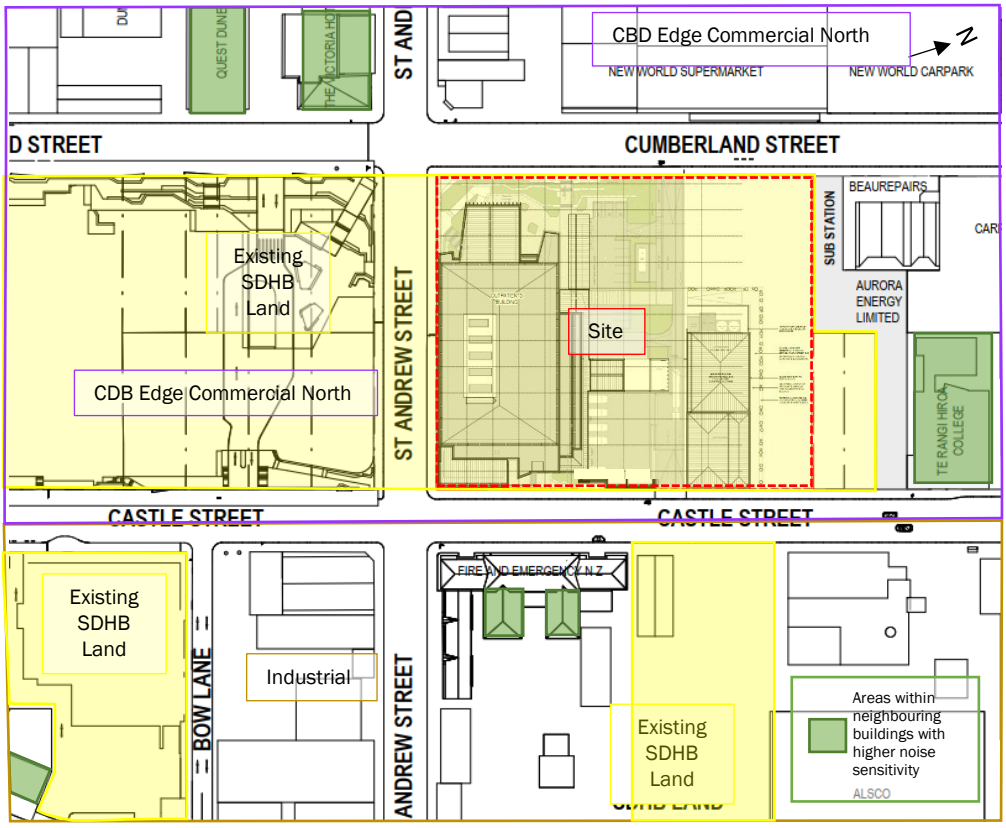

Figure 1.1 – Site and locality

The Outpatients Building is within the CBD Edge Commercial North zone (CEC North) under the operative Dunedin City Council Second Generation District Plan (2GP) as are properties immediately to the north and west and south where the future Inpatient Building will be located. Properties to the east across Castle Street are in the Industrial zone.

While the surrounding zones are Commercial, Mixed-use and Industrial, it was observed when we visited the site that there are several buildings in the vicinity containing residential activities or visitor accommodation that have a higher noise sensitivity. These are highlighted in green in figure 1.1.

1.2 Proposal

The proposal has been described in detail in the application and we have not reproduced it here. However, in summary the application is for the construction and operation of the New Dunedin Hospital Outpatient Building.

This report relates to all anticipated adverse noise and vibration effects from construction of the building and includes earthworks required to form the finished levels around the building. The construction includes erection of steel work, pouring concrete floors and stairs, façade construction and full fitout. This Application does not include inground enabling works which have been authorised under a separate consent. That Consent included removal of existing building slabs, bulk earthworks, trenching for civil services, dewatering, initial auguring of piling holes, pile driving and PDA testing.

We understand that construction activity is expected Monday to Friday 0730 to 1800 hours and should it be required, 0730 to 1400 hours on a Saturday. Staff arrival and departure, site briefings, and other activities not using machinery may occur outside these hours.

When the building is complete, we expect operation primarily in the daytime hours with minimal activity at night-time. Primary noise sources are expected to be mechanical plant and vehicle movements. In the carpark there are twelve pick-up / drop-off spaces, six mobility spaces, an emergency service space plus a mini-bus / ambulance space. The majority of staff and visitors are expected to park off-site.

2.0 ACOUSTIC CRITERIA

The Fast Track Act requires consideration of the actual and potential effects associated with the proposal on the environment. Guidance as to the significance of any adverse noise effects may be obtained from several sources.

2.1 Construction noise and vibration

2.1.1 Dunedin City Council Second Generation District Plan

2.1.1.1 Construction noise limits

The Dunedin City Council Second Generation District Plan (2GP) states that construction noise is a temporary activity and is exempt from the zone noise rules. Construction noise must instead be measured and assessed in accordance with NZS 6803:1999 *Acoustics – Construction Noise* and the noise received at buildings housing any noise sensitive activities in any zone must not exceed the limits given in table 2.1 below. Noise sensitive activities include residential activities, visitor accommodation; hospitals, registered health practitioners and activities that involve the provision of care for babies and pre-school children. NZS 6803:1999 states the limits apply at 1 metre from the façade of buildings.

Table 2.1 – Noise limits outlined in section 4.5.4 of 2GP (excerpt from NZS 6803:1999)

Time of week	Time period (hours)	Duration of work					
		Typical duration (dB)		Short-term duration (dB)		Long-term duration (dB)	
		L_{Aeq}	L_{max}	L_{Aeq}	L_{max}	L_{Aeq}	L_{max}
Weekdays	0630 – 0730	60	75	65	75	55	75
	0730 – 1800	75	90	80	95	70	85
	1800 – 2000	70	85	75	90	65	80
	2000 – 0630	45	75	45	75	45	75
Saturdays	0730 – 1800	75	90	80	95	70	85
	1800 – 0730	45	75	45	75	45	75
Sundays and public holidays	0730 – 1800	55	85	55	85	55	85
	1800 – 2000	45	75	45	75	45	75

Construction noise received in Industrial, Port and Commercial and mixed-use zones (when not used for noise sensitive activities) for all days of the year must not exceed the limits shown in table 2.2 below.

Table 2.2 – Noise limits outlined in in section 4.5.4 of 2GP (excerpt from NZS 6803:1999)

Time period (hours)	Duration of work		
	Typical duration (dB)	Short-term duration (dB)	Long-term duration (dB)
	L_{Aeq}	L_{Aeq}	L_{Aeq}
0730 – 1800	75	80	70
1800 – 0730	80	85	75

NZS 6803:1999 *Acoustics – Construction Noise* provides different noise limits for construction activities depending on the duration of the works. This is because higher noise levels are tolerable for short term activities as opposed to those of a more permanent nature. The duration of work is for the total construction activity on the site as opposed to a specific activity, therefore for this activity we would expect the 'long-term duration' (more than 20 weeks) to apply. NZS 6803:1999 standard also provides a framework and mitigation strategies to ensure that any adverse effects are minimised.

2.1.1.2 Construction vibration limits

Rule 4.5.4.1.b of the 2GP states that *Vibration from construction must not exceed a maximum particle velocity measured on any foundation of an adjacent building on another site, or the same site if different ownership, of 25 mm/s for commercial buildings or 10 mm/s for buildings housing noise sensitive activities.*

2.1.2 NZS 6803:1999

The construction noise limits outlined in the 2GP and table 2.1 are taken from NZS 6803:1999 *Acoustics – Construction Noise*. The standard contains guidelines for the setting of construction noise limits and managing construction noise effects. The Standard states that best practicable options for noise avoidance or mitigation should be applied to construction activities on the site; however, if the best practicable options are applied and the noise limits are still not met, discretion is able to be applied.

Section C7.1.1 of the Standard notes: *"The acceptability of construction noise in any community is likely to depend on the potential for interfering with activities, the expected duration of the noise and the existing background sound level at the places affected…"*. Section 8.3 provides guidance for community relations and states *"Consultation and co-operation between the contractor and the neighbours before commencement of work, and the removal of uncertainty, can help reduce adverse reactions to noise."*

2.1.3 DIN 4150-3 Structural Vibration – Part 3: Effects of vibration on structures,

Additional guidance on acceptable vibration levels for various types of buildings is provided in table 1 of DIN 4150-3 *Structural Vibration – Part 3: Effects of vibration on structures,* as outlined in table 2.3 below. We expect that compliance with these criteria will ensure that there will not be an adverse effect on the serviceability of a structure.

Table 2.3 – Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on structures (reproduced from DIN 4150-3:1999)

Type of Structure	Guideline values for velocity, in mm/s			
	Vibration at the foundation at the frequency of			Vibration at horizontal plan of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz*)	
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

*At frequencies above 100 Hz, the values given in this column may be used as minimum values.

2.2 Operational noise limits

2.2.1 Dunedin City Council Second Generation District Plan

As stated above, the site and those surrounding it are located within the CBD and CBD Edge Commercial North (CEC North) zones. These zones are both Commercial and mixed-use zones as defined in the 2GP. Sites to the east are in the Industrial Zone.

The noise emission limits that apply at the boundary of the receiving property are those given in *Section C – City-wide provisions, 9 Public Health and Safety, 9.3 Performance Standards 9.3.6 Noise*, *points 5 and 6* and are as follows:

Commercial and mixed-use -

- 0700 to 1900 hours 60 dB $L_{Aeq\ (15\ min)}$
- 1900 to 2200 hours 60 dB $L_{Aeq\ (15\ min)}$
- 2200 to 0700 hours 60 dB $L_{Aeq\ (15\ min)}$ 85 dB L_{AFmax}

Industrial, Industrial Port, Dunedin International Airport, Taieri Aerodrome, Edgar Centre, Port and Stadium Zones -

- 0700 to 1900 hours 65 dB $L_{Aeq\ (15\ min)}$
- 1900 to 2200 hours 60 dB $L_{Aeq\ (15\ min)}$
- 2200 to 0700 hours 60 dB $L_{Aeq\ (15\ min)}$ 85 dB L_{AFmax}

Noise levels are to be measured at the boundary of the receiving property. If it is not possible to measure noise levels at the boundary, noise levels are to be measured at the closest practical point within the boundary. Unless stated otherwise noise must be measured in accordance with NZS 6801:2008 *Acoustics*

– *Measurement of environmental sound*, and assessed in accordance with NZS 6802:2008 *Acoustics – Environmental noise*

2.2.1.1 Exemptions

The above limits do not apply to construction noise or noise generated by emergency services, including helicopters for emergency services and any warning device used by emergency services for emergency purposes.

Noise from vehicles operating on public roads or trains on rail lines is also exempt from this standard.

2.2.1.2 Sound insulation

Rule 9.3.1 *Performance Standards – Acoustic Insulation* of the 2GP, requires all rooms, in the locations specified below, that are to be used for noise sensitive activities to have acoustic insulation that achieves a minimum design standard of $D_{nt,w} + C_{tr} > 30$.

The rule applies to the following locations relevant to the Outpatient Building:

- within 20 metres of an Industrial zone,
- within 40 metres from a State Highway
- CEC – North zone

The entire Outpatient Building contains noise sensitive activities and is in the CBD Edge Commercial North zone (CEC North zone) it is also within 40 metres of Cumberland Street (SH 1 North), Castle Street (SH 1 South) and St Andrew Street (SH 88).

The rule states *the following rooms are not required to have acoustic insulation: bathrooms, laundries, toilets, pantries, walk-in wardrobes, corridors, hallways, lobbies, clothes drying rooms, or other spaces of a specialised nature occupied neither frequently nor for extended periods.*

2.2.2 NZS 6802:2008

NZS 6802:2008 *Acoustics – Environmental noise* outlines a guideline daytime limit of 55 dB $L_{Aeq\ (15\ min)}$ and a night-time noise limit of 45 dB $L_{Aeq\ (15\ min)}$ for "the reasonable protection of health and amenity associated with the use of land for residential purposes". The Standard also recommends a night-time L_{max} noise limit of 75 dB L_{AFmax} to prevent sleep disturbance.

For town centres and mixed-use areas NZS 6802:2008 offers a guideline day and night-time limit of 60 dB L_{Aeq} for non-residential receivers.

For heavy industrial zones NZS 6802:2008 offers a guideline intra-zonal limit of 75 dB $L_{Aeq\ (15\ min)}$ for compatible activities. However, if residential accommodation is permitted separate rules should apply to the residential accommodation to achieve adequate isolation of habitable rooms.

This standard recommends a 15-minute measurement interval for fluctuating continuous sound.

The Standard also describes how a -3 dB adjustment may be applied to sound received for less than 50 % of the daytime period, and a -5 dB adjustment may be applied to sound received for less than 30 % of the daytime period. It goes on to describe how a - 5 dB adjustment of the representative sound level may be applied when the level of sound reduces significantly for large periods of time but does not switch off completely. In these cases, the energy average of the sound being investigated should be calculated over

the entire time frame to determine the magnitude of the adjustment. No such adjustment is permitted for the night-time period.

The Standard explicitly states that an L_{max} noise limit should be set where sleep protection is required and should only be set for night-time hours.

2.2.3 World Health Organisation

Guidelines for Community Noise[1], a document produced by the World Health Organisation (WHO) based on extensive international research recommends a guideline limit of 70 dB $L_{Aeq\ (24\ hour)}$ for industrial commercial, shopping, and traffic areas.

For residential situations a guideline night-time limit of 45 dB L_{Aeq} and 60 dB L_{Amax} is recommended to allow occupants to sleep with windows open. The document also offers a guideline limit of 30 dB L_{Aeq} within bedrooms to avoid sleep disturbance.

These guidelines are measured at the façade of dwellings and other noise sensitive locations and apply for 16 hours in the daytime, and 8 hours for the night-time.

2.3 Existing noise environment

To determine the noise levels already present in the area, Rewa Satory of AES visited the site to observe and measure the existing ambient noise environment. During her visit between 1400 hours on Monday the 22nd of June 2020 and 1100 hours on Tuesday the 23rd of June 2020 noise sources audible in the area included:

- Traffic on Castle, Cumberland, Stuart and St Andrew Streets
- Noise from pedestrians and vehicles in nearby carparks
- Noise from the St. Pauls Cathedral bell
- Rail noise from the Main South Line
- Noise associated with the Pioneer Energy Centre
- Noise from industrial activity to the east, including panel-beaters and automotive repair garages
- Intermittent helicopter noise
- Emergency sirens associated with both the Police and Fire Stations in close proximity to the site

Other noise sources audible in the area from time to time are likely to include:

- Noise from several automotive repair garages, including panel-beaters
- Mechanical plant noise (heat pumps) from neighbouring sites

Measurements were carried out in several locations on the edge of Cumberland and Castle Streets surrounding the site in proximity to the proposed buildings. The noise measured was dominated by traffic on these roads, even during the night-time period. At 1700 hours the ambient noise level was 72 dB L_{Aeq} / 93 dB L_{AFmax} with approximately 20 vehicles passing per minute (including 3 % heavy vehicles). Even at 0130 hours when less than 1 vehicle passed per minute (including 10 % heavy vehicles) noise levels remained

[1] Edited by Berglund, B et al. *Guidelines for community noise.* World Health Organization 1999.

high at 57 dB L_{Aeq} / 89 dB L_{AFmax}. During periods where no traffic was passing the 'background' or L_{A90} noise level was measured to be 62 dB L_{A90} at 1700 hours and 47 dB L_{A90} at 0130 hours.

We have also considered traffic count data as collected by NZTA for adjacent roads. Based on this traffic data, expected traffic noise levels have been calculated using the CoRTN model to estimate the expected worst-case noise levels incident on the façade of neighbouring buildings due to traffic on Cumberland and Castle Streets. Our analysis indicates that traffic noise levels in the order of 66 dB $L_{Aeq\ (24\ hour)}$ would be expected at the boundary of properties on Castle and Cumberland Streets. This modelling aligns with the measured noise levels as we would expect noise from traffic to be lower than the 24-hour average at night and higher during the day. We also expect that noise sources such as traffic in the wider area, train noise and mechanical noise also contribute to the noise levels in the area.

Overall, it is concluded that the existing ambient noise in the area is elevated. The measured noise levels exceed the 2GP daytime limits by some margin, and also approach the 2GP limit during the night-time (3 dB lower). The noise level measured in the daytime also exceeded the daytime construction noise limit. During the night-time the noise measured in the area exceeded the construction noise limit for sensitive activities by some margin (12 dB).

2.4 Discussion of limits and adverse effects

2.4.1 Construction noise effects

Based on the above, compliance with the long-term construction noise limits of 70 dB L_{Aeq} and 85 dB L_{AFmax} outlined in the 2GP and NZS6803:1999 will ensure noise effects are acceptable during the daytime.

As outlined above, we understand that there are noise sensitive receivers (apartments, hotel rooms and firemen's sleeping quarters) in the locations shown in green in figure 1.1. Therefore, at these buildings the more stringent night-time construction noise limits apply under the 2GP (45 dB L_{Aeq} between 2000 and 0630 hours as outlined in table 2.1).

However, as outlined above noise levels in the area are already elevated and exceed the 2GP daytime construction limit of 70 dB L_{Aeq} at times during the day and the 45 dB L_{Aeq} night-time limit by considerable margin. We also note that the 2GP 'noise sensitive receiver' night-time construction noise limit of 45 dB L_{Aeq} is considerably lower than the 2GP Commercial and mixed-use and Industrial zone operational noise night-time limit of 60 dB L_{Aeq}. This creates an unusual situation where limited-term construction noise at night-time must be much lower than the limit for continuous noise emissions and noise levels currently experienced in the area.

Therefore, based on the above discussion we consider it conservative to conclude that where construction noise levels comply with the 2GP construction day and night- limits, the noise effects would be acceptable.

2.4.2 Construction vibration effects

Based on the guidance of DIN 4150-3, the vibration limits given in the 2GP are more conservative than what would typically be required for commercial or industrial buildings; however, the limits are more relaxed than would typically be allowed to protect historic buildings.

The 2GP limits would allow for vibration levels almost two orders of magnitude higher than the limits of perception which are around 0.2 mm/s. Therefore, even when construction vibration levels comply with the 2GP limits which provide protection from cosmetic damage for typical buildings there can be effects on occupants of buildings. We recommend that monitoring and consultation are included in the Construction Noise and Vibration Management Plan for more sensitive spaces such as the Fire Station (described in section 3.0), to mitigate adverse effects as far as practicable.

2.4.3 Operational noise effects

The 2GP noise limits which apply in the CBD and CEC North and Industrial zones are consistent or more conservative than generic national and international guidance.

As above, there are some apartments, traveller's accommodation and sleeping quarters surrounding the site. While residential receivers in residential zones would typically be protected from high noise levels by lower noise limits, sensitive activities in industrial and/or mixed-use zones generally do not receive the same level of sleep protection. For any new noise sensitive activities in these zones, the building needs to be designed to provide a minimum façade reduction of $D_{nt,w} + C_{tr} > 30$. Where external noise levels are in the order of 60 – 65 dB L_{Aeq}, this would result in internal noise levels of 30 – 35 dB L_{Aeq} which is appropriate.

We note that the existing noise sensitive activities may have been constructed before this requirement was mandatory and, as outlined above, these properties are already subject to high levels of uncontrolled noise from traffic on the surrounding road network and the main south railway line. Noise from these sources is expected to already be higher than the 2GP 60 dB L_{Aeq} night-time limit for much of the night-time period and so these noise sensitive activities are likely to already have measures in place to manage elevated night-time noise, at the levels permitted by the 2GP.

Similarly noise from emergency services is already experienced in the area due to police, fire engine and ambulance sirens and if there is not expected to be a significant change in noise level from the existing environment, we would not expect a significant additional adverse effect.

Based on the above, we consider that noise from the Outpatient building which complies with the 2GP noise limits would be expected to have a minimal adverse effect.

3.0 CONSTRUCTION NOISE AND VIBRATION

We have calculated the expected noise levels arising from all anticipated and known noise generating activities associated with the construction of the Outpatient building and supporting earthworks.

3.1 Construction noise

3.1.1 Mitigation

Typical noise mitigation strategies for construction noise are as follows:

- Site hoarding established surrounding the site that is 2.0 metres high with a minimum surface mass of 10 kg/m^2 and is continuous and maintained with no gaps or cracks. This is largely already in place to the east, west and south of the site with gate access on the northern side for construction vehicles. Any openings currently provided as view ports for the public will be temporarily covered when work is underway in these areas.
- Selecting low noise machinery.
- Limiting the hours of higher noise activities to 0730 – 1800 hours Monday to Friday and 0730 to 1400 hours on Saturday.
- Adopting a Construction Noise and Vibration Management Plan (CNVMP) which outlines the measures which will be employed to ensure that noise and vibration impacts on neighbouring properties are minimised as far as practical. The CNVMP would be expected to include:
    - Restrictions on the operational hours of construction works on site.
    - Machinery and equipment to be used.
    - Duration of work.
    - The requirement for specific equipment to be tested prior to being used on site and the physical mitigation required to result in complying levels.
    - Limitations on the arrival and departure times of heavy vehicles, and operating recommendations.
    - Details of complaints procedures and the need for and responsibilities of a Noise Liaison Officer for the community.
    - Requirements for liaison with the neighbouring properties prior to higher noise/vibration activities being undertaken.

We expect that these mitigation steps will be adopted as standard best construction practice and we have included them in our assessment below.

3.1.2 Distances to nearest buildings

The construction noise limit criteria apply at the façade of buildings housing noise sensitive activities. In figure 3.1 below we have shown occupied buildings in pink, with buildings used for sleeping / residential activity in green. Buildings that are used for storage or that are not noise sensitive such as the Castle Street power plant have not been highlighted as these are not noise sensitive. The distances from the nearest façades to locations on the site have also been shown as various setback distances are referred to in the following sections.

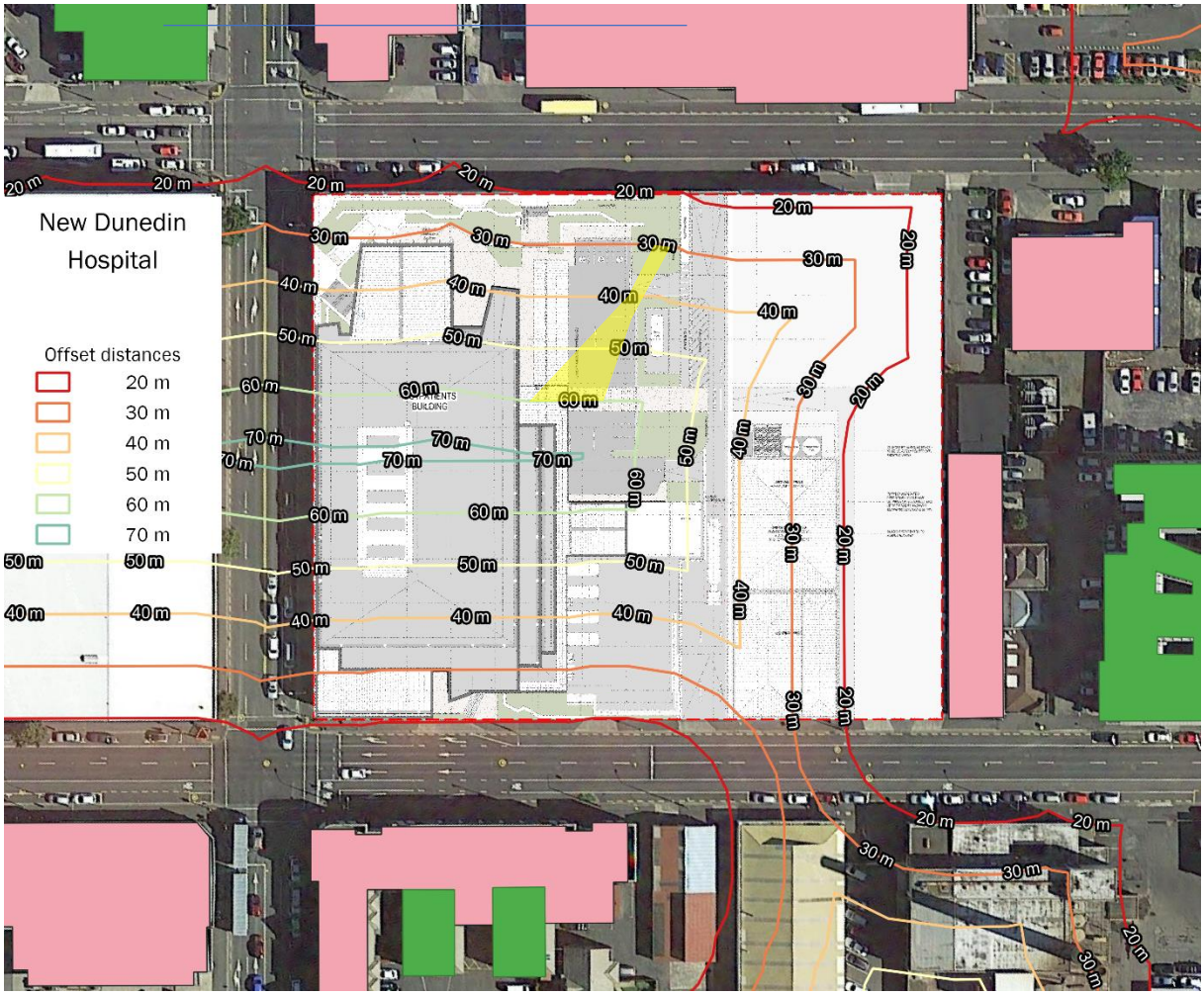

Figure 3.1 – Distances from occupied buildings

3.1.3 Noise generating activities

Based on our experience and discussions with the project team we expect the higher noise generating activities will be those discussed below. We note that it is unlikely that these activities will occur in their worst-case locations concurrently; however, in some instances we have also indicated separation distances to achieve 67 dB L_{Aeq} at nearby buildings to indicate that it will be practicable to achieve compliance even if two high-noise activities were to occur at the same time in the worst-case locations.

3.1.3.1 Generators

Generators may be used on site during construction. The noise emissions from a generator can vary significantly depending on the type, the size, and whether it is within an enclosure. The sound power of temporary generators can range between 80 – 115 dB L_{wA}. We have considered whether it would be practical to mitigate noise from the largest types of generator to meet a noise level of 67 dB L_{Aeq} as it is likely the generator may be operating for extended periods.

Based on a generator with a sound power of 115 dB L_{wA} and the acoustic site fencing described above, noise levels of 67 dB L_{Aeq} or less would be expected at ground floor neighbouring properties if the generator is a minimum of 30 metres from the nearest receiver. However, a generator of this size should be located at least 80 metres from the façade of two storey buildings and 100 metres from the façade of multi storey

buildings if no additional mitigation is in place. We expect it will be practicable to locate the generator in the location indicated in yellow in figure 3.1 above so that it is 30 metres from New World, 80 metres from the Fire Station and 100 metres from the upper levels of Victoria Hotel and Te Rangi Hiroa College, or provide additional mitigation in the form of an enclosure.

This setback could be reduced if a lower noise model was selected. It would need to be increased or additional localised physical mitigation introduced if a higher noise model were selected, or if the generators were needed outside the daytime period.

3.1.3.2 Site ground works

While the majority of site works are covered under the ground enabling works Consent, there will some groundworks undertaken under this consent for the formation of carparks, loading dock and landscaping.

BS 5228-1:2009 – Code of practice for noise and vibration control on construction and open sites – Part 1: Noise provides noise level information for excavators up to 40T. Based on the range of values presented in this standard we have assumed a worst-case sound power of 108 dB L_{wA}.

An excavator of this size will not exceed the noise limits if working more than 30 metres from any noise sensitive façade without any additional shielding. For buildings that are over two levels there is no shielding from the site fencing; however, the multi-level Quest Apartments, Victoria Hotel and Te Rangi Hiroa College buildings are all more than 30 metres from the site boundary and therefore we do not expect any exceedances from site ground works at these buildings.

With the 2.0 metre site hoarding the noise level at ground floor and first floor receivers on the opposite side of the road would not exceed 62 and 69 dB L_{Aeq} respectively. Therefore, we expect even large excavators to be able to operate on the majority of the Outpatients site without exceeding the 2GP limits.

The gates and the site entrance and exit will not be as effective in providing acoustic screening and where excavators and other ground works are required within 10 metres of the entrance and exit to the site (where there is no site hoarding) a smaller excavator will be required.

3.1.3.3 Concreting activities

We expect that the main noise generating activities associated with concrete activities on site will be the pumping and pouring of concrete, and the use of power floats on the slabs.

Concrete pumping and pouring

Noise data has been sourced from BS 5228-1:2009, which states that typical concrete trucks and pumps have a sound power of up to 105 dB L_{wA}. It is expected that the truck will be easily able to be operated at least 30 metres from the nearest sensitive receivers. The noise level without any site fencing and 30 metres separation will be 67 dB L_{Aeq}.

For concrete pumped to higher levels the sound power of the pump will be louder. For example, for concrete pumped to the 5th floor the sound power is expected to be 110 dB L_{wA} and in this situation the concrete truck will need to be located 40 metres from the façade of multi storey buildings to ensure noise is less than 70 dB L_{Aeq}. To achieve 67 dB L_{Aeq} the pump needs to be 55 metres from multi storey buildings and at least 20 metres from single level buildings where there is site hoarding. Therefore, we expect it will be practicable to ensure noise from concrete pumping complies with the 2GP limits.

Concrete floating

Once the slabs have been poured, a concrete float is used on the setting slab. While the overall noise levels of the specific equipment on site will vary (due to a wide variation in noise of the concrete floats available), we have based our analysis on a handheld power float, with a sound power of 100 dB L_{wA}. We have

considered a scenario where the power float is operated on the closest part of the foundation slab to a sensitive receiver, the stairwell tower near the boundary with Castle Street. Based on this scenario the worst-case noise level at the Fire Station would be 65 dB L_{Aeq}.

3.1.3.4 Cranes

Based on the size of the development, we expect that at least one crane will be required as part of the general site works during construction.

We understand that a 250-tonne mobile crane will be used on site. Based on the values given in BS 5228-1:2009, for a 400 tonne crane a sound power of 106 dB L_{wA} has been used. Based on this assumption, noise from a crane operating 30 metres from the façade of any building will result in a noise level of 67 dB L_{Aeq} at that façade. We expect that it will be practicable for the crane to operate in those locations. If the operates more than 25 metres from any noise sensitive buildings, the noise level will be 70 dB L_{Aeq} at that façade. We therefore expect it will be practicable to comply with the construction noise limits in the 2GP at all neighbouring buildings due to use of a crane.

3.1.3.5 Heavy vehicles

Vehicle access will be at least 20 metres from any neighbouring boundary. Based on a sound power of 108 dB $L_{wA,}$ we expect that 50 heavy vehicles travelling at 10 km/h could enter or exit the site during any 15-minute period before the 2GP daytime construction noise limit was exceeded. Therefore, we expect this source to comply with the 2GP limits.

3.1.3.6 Other higher noise activities

During construction there will be various other construction activities on site including rattle guns, grinders and other portable hand tools.

These types of equipment have varying sound powers and are typically used intermittently. For example, the sound power of an impact wrench ('rattle gun') varies considerably, and for construction sized models a sound power between 94 and 113 dB L_{wA} can be expected. Smaller models and those with pneumatic operation can produce as low as 75 dB L_{wA}. Other tools such as metal grinders may have a sound power in the order of 108 dB L_{wA}.

The location where compliance may be most challenging during the use of handheld tools is when they are used for extended periods opposite the Fire Station. The noise level due to typical use of a construction sized impact wrench (assumed to be generating noise for 3 minutes out of a 15-minute period) used at the closest point to these receivers would be 50 - 69 dB L_{Aeq} at the Fire Station. Handheld grinders being used on steelwork at the closest point to the Fire Station may generate a noise level of 70 dB L_{Aeq} during typical use (assumed to be generating noise for 7.5 minutes out of a 15-minute period).

Based on the above, with suitable tool selection, we expect it will be possible to achieve compliance at all locations. At the critical locations there may need to be limitations around simultaneous use of tools and/or the use of temporary screening.

As part of the Construction Noise Management Plan, the noise level of the actual hand tools used should be measured and specific mitigation measures developed based on these measurements, to ensure the noise limits are not exceeded.

3.1.4 Cumulative noise levels

We note that the 2GP noise limits apply to the cumulative noise levels from all activity on the site. In most cases the activities assessed above will not occur at the same time or when they occur at the same time, they will be located far enough apart so that the cumulative noise level does not approach the 2GP limits.

The more critical sources with regard to cumulative noise, are those that are expected to produce noise for extended periods of time – for example, generators. For these types of sources, it may be prudent to select lower noise models / consider location on site / introduce screening to ensure noise levels are significantly below the 2GP limits (for example, 10 dB below), so no accumulation occurs. This will be best managed via the Construction Noise and Vibration Management Plan.

3.2 Construction vibration

There are many factors which will influence the vibration level experienced in the foundation of any adjacent buildings, such as ground type, foundation type, distance, machine selection, and the like. Vibration levels are therefore difficult to accurately predict; however, there is the potential for construction activities to produce moderate levels of vibration with a project of this size.

As stated above the 2GP states that vibration from construction must not exceed a maximum particle velocity measured on any foundation of an adjacent building on another site, of 25 mm/s for commercial buildings or 10 mm/s for buildings housing noise sensitive activities.

Approximate vibration levels generated by a range of construction activities are as follows:

- A vibratory roller could generate up to 5 – 6 mm/s at distance of 5 metres, reducing to 1.5 mm/s at 20 metres.

- Excavators and trucks travelling over irregular surfaces could generate 1 – 2 mm/s at distances of 5 metres, reducing to less than 0.1 mm/s at 20 metres.

All nearby buildings are more than 20 metres from the site and we therefore expect that the 2GP limits would be complied with by some margin.

As described above a Construction Noise and Vibration Management Plan is recommended to ensure adverse effects are managed appropriately. The CNVMP would include methods of reducing vibration effects including selection of low-vibration construction methods, community engagement, timing high vibration activities for less sensitive times, and may include vibration monitoring at more sensitive and/or historic sites such as Dunedin Central Fire Station.

4.0 OPERATIONAL NOISE

Once the Outpatients building is operational, the most significant ongoing noise sources are expected to be mechanical plant, and heavy vehicle movements. We have discussed these sources below.

4.1 Mechanical plant

The main internal plant rooms are on Level 04 of the Outpatient Building and there is also an external plant deck on the rooftop - Level 05.

The dominant noise emitting plant is expected to include heat pump chillers, a generator, back up diesel boilers, AHU plant, vacuum plant, extract fans and HW heat pumps. Based on the mechanical drawings we understand mechanical plant will be located both externally and within louvered plant rooms.

It is standard practice to ensure that cumulative noise from mechanical plant is designed to comply with the relevant noise limits, and that is part of our current Building Design scope, which is well progressed. This can typically be achieved through the selection of low noise models, shielding, attenuators, acoustic louvres, or wrapping or boxing out external ducting. Noise from mechanical plant will also need to be managed to ensure that noise break-in back into the NDH buildings is not problematic – and based on our analysis to date for the Outpatient Building that will be more constraining than the 2GP noise limits.

In some locations the building layout also provides significant shielding for noise from mechanical plant received at the site boundaries - such as on Level 05 where the majority of the outdoor plant is set back from the façade.

The mechanical design is in the detailed design stage and specific models have been selected for many items of plant. Where the specific models have been selected, we have used manufacturer's data to determine noise levels. We understand that these models could change at procurement stage and therefore, our preliminary analysis has included some additional conservatisms. The following worst-case locations/sources have been assessed:

- Level 04 Generator
- Rooftop plant
- Level 04 louvres and exhaust grilles.

4.1.1 Level 04 Generator

We understand that a single CAT model 3516 diesel generator set with maximum rating of 2000 kVA, and electrical output of 1600 ekW is to be located on Level 04 in the south-western corner of the Outpatient Building. Based on Caterpillar Commercial Process Division generator performance data we expect this generator to have a sound power in the order of 123 – 124 dB L_{wA} (including 101 dB L_{wA} at 63 Hz).

Air intake is through an approximate 10 m^2 opening in the roof (at the western end adjacent to St Andrew Street) to a courtyard surrounded by the façade on the south, west and north sides and with a full-height external louvre on the east side that is ducted to a plenum and intake attenuator. The air discharge is fully ducted from the generator radiator via an attenuator, to an external louvre on the western façade. There is also a generator room run-on fan which turns on after the generator is turned off. We understand that the exhaust flue will have one internal silencer/muffler and one external muffler.

The primary challenge with this generator will be to ensure that noise break-in to sensitive spaces within lower levels of the Outpatient Building is not problematic. If this is achieved the noise level at the nearest boundaries will comply with the 2GP limits by some margin.

To confirm this, we have undertaken preliminary calculations to determine the expected noise level at the Cello Technology Hub at 359 Cumberland Street, some 30 metres from the discharge. Based on the proposed 3.6-metre-long attenuator the noise at the nearest receiver (Cello Technology Hub) due to the discharge is expected to be 47 dB $L_{Aeq.}$ The other sources including the air intake, also with 3.6 metre attenuator, noise from the exhaust and noise break-out from the generator room are expected to be lower than that from the discharge and we expect the noise due to all sources from operation of the generator would be less than 49 dB L_{Aeq} at the Cello Technology Hub thus complying with the 2GP daytime and night-time limits.

4.1.2 Rooftop plant and plantroom breakout

Five banks of 12 chiller/heat pump units are to be located on the Level 05 rooftop of the Outpatient Building. At this stage of the design there are two preliminary selections for the chillers. The Trane CXAF 180 HE XLN EC HDM FIX chiller with a sound power of 91 dB L_{wA}, and the Trane CGAF 150 SE XLN chiller with a sound power of 87 dB L_{wA}.

We have used SoundPLAN computational modelling to determine the expected noise levels from the rooftop chiller units and the Level 4 Plant Room break-out at the nearest boundaries, as follows:

- Northern boundary Midas – 47 dB L_{Aeq}
- Eastern boundary at the first-floor façade of the Dunedin Central Fire Station – 56 dB L_{Aeq}
- Western boundary 359 Cumberland Street, Cello Technology Hub– 48 dB L_{Aeq}
- Southwestern properties:
    - The Victoria Hotel – 54 dB L_{Aeq} at the level of the Level 05 rooftop plant.
    - Quest Hotel – 51 dB L_{Aeq} at the second-floor façade

Several other mechanical plant items are to be located on the Outpatient Building roof including roof cowls for Level 04 AHU units and several extract fans or extract fan outlets. The current drawings show approximately 66 rooftop items of this type for which specific models have not been selected.

Based on the distances to the nearest boundaries these items could each have a sound power in the order of 90 dB L_{Aeq} and cumulative noise would comply with the 2GP limits. The worst-case locations are where 8 extract fan outlets are to be located between gridlines A and B and gridlines 26 and 27. However even in this location each outlet could have a sound power of 90 dB L_{wA} without any additional shielding and the combined noise would comply with the 2GP limits at the nearest receiver (Dunedin Fire Station), we therefore expect it will be practicable for noise from these items to comply with the day and night-time 2GP limits.

4.1.3 Sprinkler pump

The fire protection plantroom is located in the Engineering department in the wing that extends north of the building. This space contains an electric and a diesel driven sprinkler pump along with a diesel tank and a 150,000-litre sprinkler tank. The pump room has two louvre openings on the east side. The sprinkler pumps are tested regularly (likely on a weekly basis) during the daytime and based on measurements of a similar sprinkler the sound power emitted through the louvre is likely to be in the order of 103 dB L_{wA}. The noise level at the nearest receiver, the Fire Station, is expected to be less than 58 dB L_{Aeq} thus complying with the 2GP daytime limit of 65 dB L_{Aeq} by some margin.

4.2 Vehicle movements

The expected noise sources associated with the loading bays are rubbish trucks, heavy goods vehicle deliveries, medical gas refuelling tankers, reversing alarms, stock movement and the like. We have

considered a single heavy vehicle having a sound power of 108 dB L_{wA} and a single light vehicle having a sound power of 90 dB L_{wA} travelling at 10 km/hr on site.

Based on the traffic report we understand that peak vehicle traffic is expected to occur in a 3-hour period in the morning where there will be 13 heavy vehicles using the loading bay including rubbish collection these vehicles will enter and exit via Castle Street. The VIE tanks are likely to be refuelled every 2 – 3 weeks by a vehicle entering from Cumberland Street and exiting onto Castle Street. Based on the traffic report we understand there may be up to 315 light vehicle movements in the morning peak period using the Cumberland Street entrance/exit and these are expected to primarily be visitor vehicles.

We have used SoundPLAN computational modelling to consider a peak 15-minute period including the mitigation described above. The peak 15-minute traffic volumes have been based on twice the average light traffic volume for the 3-hour peak morning period. For heavy vehicles we have assumed as a worst-case scenario the 4 heavy vehicles entered the site loaded/unloaded in a worst-case 15-minute period. We have modelled the following vehicle movements:

- 2 heavy delivery vehicles and 1 rubbish truck enter the site, load/unload and leave
- A VIE tanker arriving to fills the VIE tank
- 52 vehicle movements (26 arrivals plus 26 departures) in the Cumberland Street entrance/exit and carpark.

Based on information provided in the traffic report this situation is unlikely to occur in practice due to tracking conflicts in the loading bay and with the VIE tanker. Although similar levels to those presented below would be received when 4 heavy vehicles use the loading bay in a 15-minute period. The expected noise levels at the nearest receivers are presented in table 4.1 below.

Table 4.1 – Noise levels due to vehicles on site

Receiver	Noise level dB L_{Aeq}	
	Ground Level boundary	First Floor façade / balcony
Fire Station	58	60
DHB building on Castle Street	60	-
Midas	56	58
Te Rangi Hiroa College	48	52
Beaurepairs	57	-
New World	57	-
Cello	54	-
The Victoria Hotel	48	48

Based on this scenario, the 2GP daytime limits are therefore expected to be complied with at all neighbouring boundaries.

We do not expect this peak to occur during the night-time but even if it did compliance would still be achieved. In reality very little heavy vehicle traffic is expected on site between 1900 and 0700 hours. To determine the noise levels expected during the night-time we have considered a case where 1 HV movement occurs, and 12 light vehicles enter or exit the carpark in a 15-mintue period. Based on this scenario the noise levels would be at least 6 dB lower than those presented in table 4.1 above and comply with the 2GP limits by some margin.

4.2.1 Wash bay

A wash bay is to be located in the loading bay. We expect a high-pressure wash bay may generate a sound power of up to 107 dB L_{wA}. A block fence is to be constructed that is 2.1 metres in height above the level of the loading bay.

Based on a vehicle being washed for 15-minutes continuously the noise level at the first-floor façade of the Fire Station will be 65 dB L_{Aeq} which complies with the District Plan daytime limit. Typical washing is not expected to occur continuously for 15-minutes and there will also be additional shielding from the vehicle when the washing occurs on the far side of the vehicle. Therefore, we expect that the cumulative noise from vehicle washing would not exceed the 2GP daytime limits even if it occurred during a peak vehicle movement period.

4.2.2 Rubbish compactor

There are two rubbish compactors located on the eastern side of the loading bay. Noise from rubbish compactors can vary considerable and sound powers given in BS 5228-1:2009 range from 99 dB L_{wA} to 108 dB L_{wA}. A full height fin wall at the eastern end of the loading zone extends north out to approximately 1 metre from the end of the compactors and the 2.1 metre brick fence extends north from there.

Based on the compactors operating continuously for 5 minutes in a 15-minute period, the noise level from a compactor with a sound power of 108 dB L_{wA} will be 63 dB L_{Aeq} at the first-floor façade of the Fire Station which complies with the District Plan daytime limit. The compactors are only expected to operate sporadically. Therefore, we do not expect compactors to operate during a peak vehicle movement period.

4.3 Cumulative noise

In the majority of receiver locations, cumulative operational noise levels will be comfortably below the 2GP limits. The critical locations/times with regard to cumulative noise will be at the Fire Station when peak vehicle movements occur at the same time as the wash bay or rubbish compactor is being used.

We expect that the high-pressure wash bay and rubbish compactors would not be used for extended periods, and so even when including peak vehicle movements, the noise level at the first-floor of the Fire Station façade would be 65 dB L_{Aeq} which complies with the 2GP daytime limit.

5.0 REVERSE SENSITIVITY EFFECTS

The 2GP noise insulation rules require all rooms that are to be used for noise sensitive activities in high noise areas to have a minimum design standard of $D_{nt,w} + C_{tr} > 30$ to manage potential reverse sensitivity effects.

As discussed above, the dominant existing external noise source in the area is the surrounding road network. Based on our modelling and measurements we expect that the maximum noise levels that may be experienced on the façades of the Outpatient Building from typical traffic flows on the adjacent roading network may be in the order of 65 to 70 dB L_{Aeq} and 80 to 90 dB L_{AFmax}. A façade designed to $D_{nt,w} + C_{tr} > 30$ would therefore ensure break-in noise levels were reduced to approximately 35 to 40 dB L_{Aeq} and 50 to 60 dB L_{AFmax}.

Based on our involvement with the internal acoustic design of the NDH buildings to date, the design of the façade is expected to result in even lower internal noise levels within noise sensitive spaces through the arrangement of spaces and façade reductions.

At this stage we understand that the thickness of the glazing has not been finalised; however, we have considered the design requirements and undertaken some preliminary calculations for key spaces to determine whether the $D_{nt,w} + C_{tr} > 30$ design standard is expected to be met and the effects on occupants of the spaces.

We have undertaken calculations based on the proposed constructions of:

- 6 mm glazing / 16 mm cavity / 8.5 mm PMMA laminate glass
- Terracotta rainscreen cladding on metal battens / Rockwool Thermal Rock / 16 mm Densglass Gold (minimum surface mass 12 kg/m^2) / 150 mm steel framing / plasterboard lining with 140 mm fibrous insulation to the cavity.

The expected façade reduction achieved for some key spaces is shown in table 5.1 below.

Table 5.1 – Façade reduction for key noise sensitive spaces

Space	Area	Façade reduction $D_{nt,w} + C_{tr}$
Typical Consult	16 m^2	35
Collab Workspace	149 m^2	35
Pathology Collection	13 m^2	33
Open Plan collaborative Ambulatory workspace	140 m^2	32

Therefore, we expect the current design to comply with the 2GP limits and that there will be minimal reverse sensitivity effect due to locating the hospital in the CEC – North Zone.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Noise from anticipated and known sources associated with the construction and operation of the New Dunedin Hospital Outpatient Building and vibration associated with the construction has been considered.

6.1 Construction

Compliance with the long-term construction noise limits of 70 dB L_{Aeq}, 85 dB L_{AFmax} in the daytime and 45 dB L_{Aeq}, 75 dB L_{AFmax} in the night-time and vibrations limits of 10 mm/s outlined in the District Plan and NZS6803:1999 are achievable and will ensure noise effects are acceptable.

We recommend that a Construction Noise and Vibration Management Plan (CNVMP) which outlines the measures which will be employed to ensure that noise and vibration impacts on neighbouring properties are minimised as far as practical is adopted including physical and managerial mitigation measure to minimise construction noise and vibration.

Based on the analysis outlined in this report, we expect that it will be practicable for construction noise and vibration to comply with the 2GP limits and therefore the effects of construction noise and vibration will be acceptable.

6.2 Operation

Where noise from the NDH Outpatient Building complies with the 2GP noise limits at the boundary of any other site we expect there will be a minimal adverse effect.

Based on the analysis outlined in this report, we expect that it is realistic for noise associated with the operation of the Outpatient Building including mechanical plant noise, noise from vehicle movements to comply with the 2GP zone noise limits.

We are currently engaged to undertake a detailed mechanical plant acoustic review to ensure that adequate mitigation is integrated into the design of the mechanical systems, to achieve compliance. We understand that any model substitutions will be reviewed to ensure that compliance is maintained.

6.3 Reverse Sensitivity

Where the façade of the Outpatient Building is designed to comply with the 2GP requirement of $D_{nt,w} + C_{tr}$ of at least 30 we expect the occupants will be well protected from break-in noise.

The current design intent is to provide a façade with performance at or better than the 2GP requirement therefore we expect minimal adverse effects from break-in noise from the surrounding area. The design of the facade will need to be reviewed at the project progresses to ensure that adequate mitigation is integrated into the design of these systems, to ensure compliance is achieved. We have been engaged to undertake that review.