# 31 Day Street

## Building Alterations and Additions

## Auckland Central

# CNVA

## Construction Noise and Vibrations Assessment

Date: 23rd March 2021

Prepared for: The Avoka Apartments – Body Corporate 183777

Prepared by: Earcon Acoustics Limited

Reference: J004345

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# Document Control

## 31 Day Street, Auckland Central

## Building Alterations and Additions

## J004345

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# Executive Summary

The proposed works are on behalf of the occupants of the subject building. It is our understanding that approval for the works and waiver of effects can readily be provided by any occupants of apartments within the subject building occupied during the works. As such, the effects on apartments within the same building are excluded from this assessment

With regards to noise, due to the proximity of the neighbouring dwellings adjacent the boundary, and in particular during drilling and chipping, noise levels will likely be higher at these façades. We note that in the absence of a confirmed methodology, the following two options are proposed:

- If the selected methodology includes scaffolding that allows for shielding to be established with acoustic blankets on scaffolds, then noise levels are expected to be at or within the Mon – Fri compliance limit of 75dB $LA_{eq}$ and 90dB $LA_{max}$ at all receivers
- If, on the other hand, the methodology does not include scaffolding (i.e. cranes only); we recommend applying the following limit exceedance for approximately 2-3 weeks at any one receiver:
    - Mon-Fri 80dB $LA_{eq}$ and 95dB $LA_{max}$ at the westernmost 12m of the southern façade of 22-28 Beresford Square, and the easternmost 12m of the northern façade of the building at 25 Day Street. Noise levels would also exceed on the concrete façade of 25 Day Street, but would be compliant internally.

With regards to vibrations, and considering the proposed works do not involve foundations, the adjacent buildings are not structurally connected to the subject building, and restrictions on work hours preclude night time works,

- Vibrations are expected to be compliant with the AUP requirements and standards whereby vibrations will be managed within the heritage structural protection DIN4150-3 criteria limits at all receivers and within the daytime amenity level of 2mm/s at all receivers.

In addition to shielding if scaffolding is used, the following mitigation measures are proposed:

- Concrete Floor grinding to occur after the façade is established, or with acoustic shielding on the façade extending no less than 1 floor above and below where grinding occurs.
- Noise generating works proposed to be limited to the hours of Monday – Saturday 7:00am to 7:00pm.

# 1 Introduction

This report has been prepared to assess the construction noise and vibrations effects of the works associated with the proposed building alterations and additions at 31 Day Street, in Auckland Central for an existing 12 level apartment building.

The proposed development comprises the recladding of the full facades, the enclosure of existing balconies, in addition to new joinery and changes to the ground and rooftop levels. The proposed works are likely to require varying degrees of concrete and steel works on the façade. The works are also likely to require scaffolding and crane operations, in addition to material delivery and carting.

This report:

- Identifies noise and vibrations generating activities associated with the site establishment, demolition works of existing elements, and construction of the proposed alterations and additions.
- Assesses the noise and vibrations from these activities against the established standards for construction, and
- Proposes mitigation measures and strategies that can reduce the impact on potential receivers.

The overall works are anticipated to take more than 20 weeks and are therefore considered "long-term duration". This report is based on information provided by:

- Architectural plans by Morrison Architects dated 22/10/2020

# 2 Site

## 2.1 Identification

The works are proposed to occur on the established apartment building on the Southern side of Day Street in Auckland CBD. For ease of reference in this report, directional references are noted in the figure below. The subject building footprint is approximately 28m on its North-South axis and 15m on its East-West axis with a façade height excluding the rooftop structure approximately 35m above ground level at the northern end adjacent Day Street, and circa 27m above ground level at the southern end.


*Figure 1 - Site Location*

The Building covers the following land parcel, as shown in the figure below:

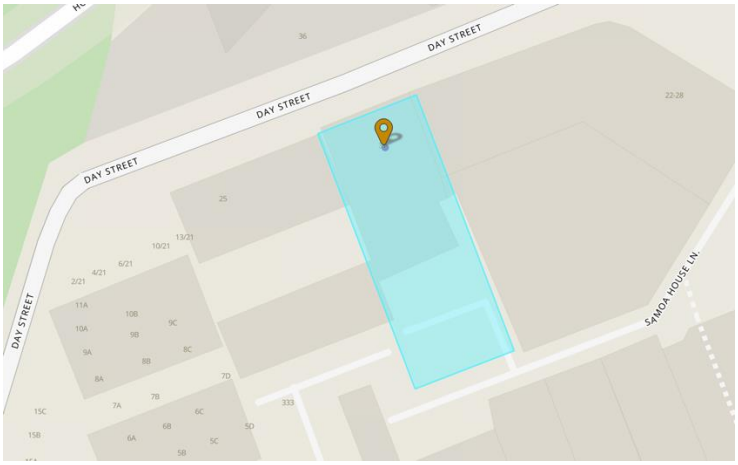



*Figure 2 - Site Boundaries*

Lot 1 DP 48490

## 2.2 Zoning

In accordance with the Auckland Unitary Plan – Operative Version, the subject site and the surrounding area are zoned *Business - City Centre Zone*.


*Figure 3 - Site Zoning*

## 2.3 Heritage Sites

As per the figure below, the site and its surrounding sites are within the Historic Heritage Overlay. Sensitivity of heritage structures to vibrations is taken into account in the assessments and mitigation measures detailed in this report.

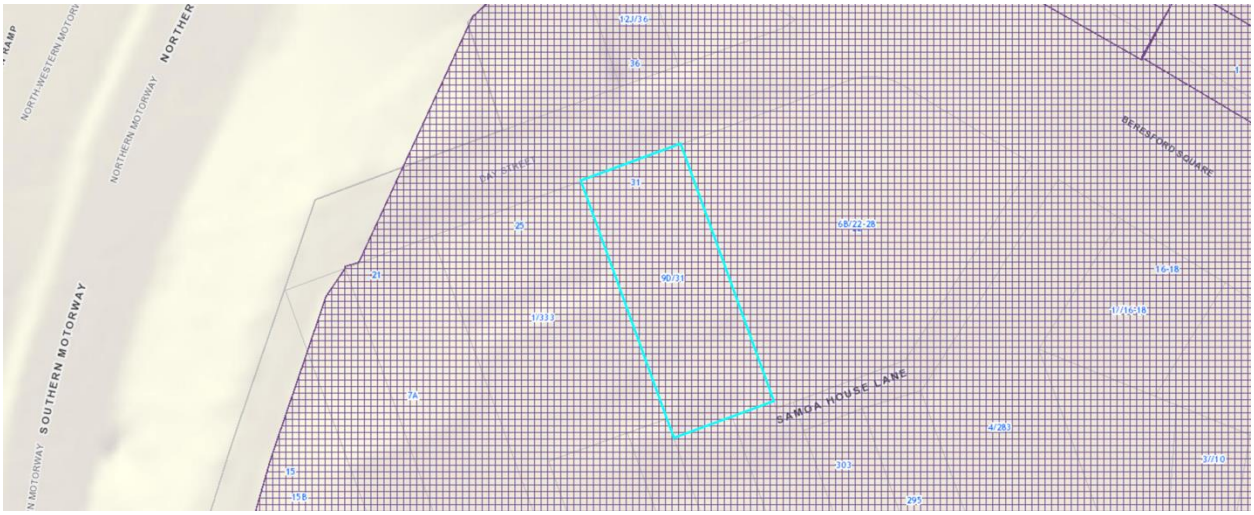



*Figure 4 – Heritage Overlay*

## 2.4 Vicinity

The neighbouring area adjacent to the subject site is predominantly residential, with commercial properties to the South. In context of noise and vibrations, the following receiver sites are in the vicinity of the proposed development, as shown in the figure below.

- **North:** Multi-storey apartment building (C-VU Apartments) at 36 Day Street. Southern façade of receiver building facing subject building is mostly concrete with minimal glazing, and at closest is circa 17-20m from subject.
- **West:** Multi-storey apartment building (The Beresford) at 22-28 Beresford Square. The western façade of the building is abutting albeit not connected to the eastern façade of the subject building. The closest areas to the subject building are the balconies at the north-western corner of the receiver, and the glazing at the southern façade circa 7m from the subject building. We note the 6-7m of the southern façade closest to 31 Day Street is solid concrete.
- **East:** Residential building AT 25 Day Street with a 3 storey block on the northern end and a 4 storey block on the southern end. The eastern façade of the building is abutting albeit not connected to the western façade of the subject building.
- **South:** A mix of commercial and residential 2 storey to 6 storey buildings between 295 and 339 Karangahape Road, at more than 27m from the façade of the subject building at


*Figure 5 – Site Vicinity - Google Earth - facing general N*

The following images are representative of the interface between the subject building and adjacent building to the East

*Figure 6 - NE Corner*

# 3 Proposed Development

## 3.1 Proposed Buildings

The proposed works comprise the full recladding of the building facades in addition to the enclosure of the balcony areas within the new northern and southern façades. The works also include new joinery and glazing, and the addition of balconies on the northern corner of the eastern façade. The following elevations are representative of the proposed façade changed compared to existing structure (shown in more detail in Appendix VII.)


*Figure 7 – North Elevation (Existing and Proposed) - [Morrison Architects]*


*Figure 8 – South Elevation – [Morrison Architects]]*

The following figure is representative of the areas work associated with the enclosure of balconies, likely to require concrete and steel works for the extension of the floorplan.

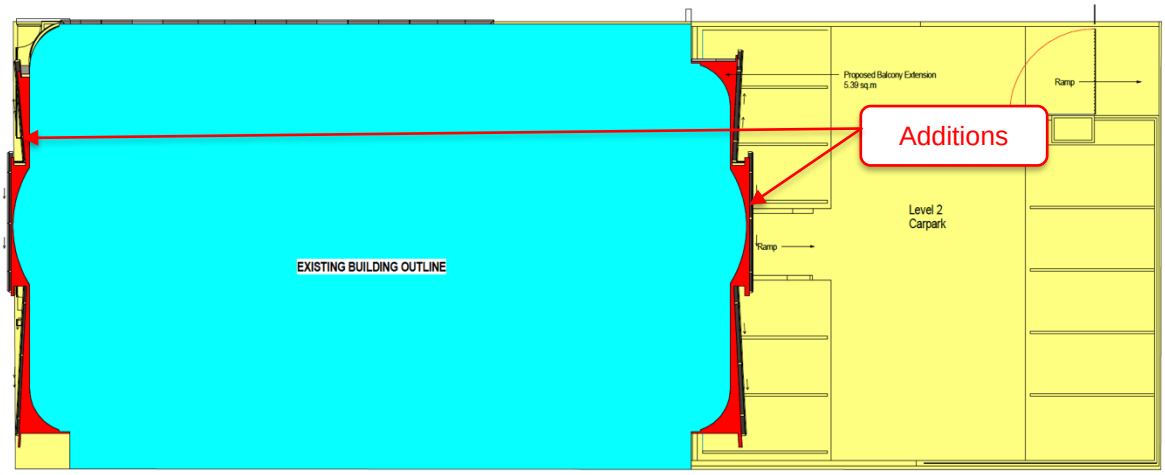



*Figure 9 – Building Additions - Balcony Enclosure - [Morrison Architects]*

The following site plan is representative of the proposed alterations and addition to the floor plans above Level 2:

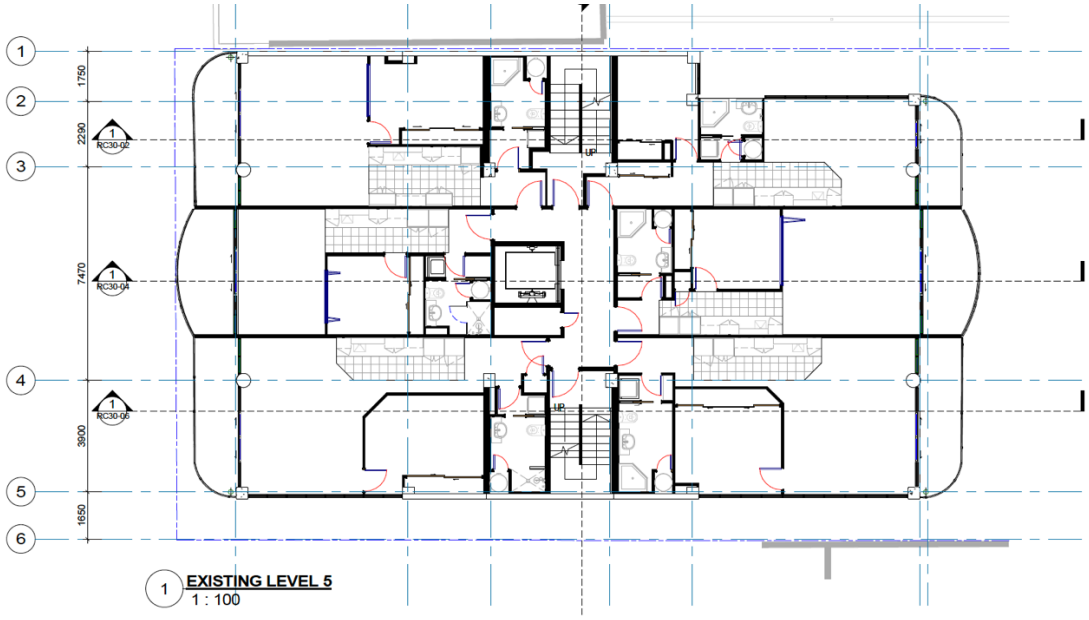



*Figure 10 - Existing Floor Plan – [Morrison Architects]*

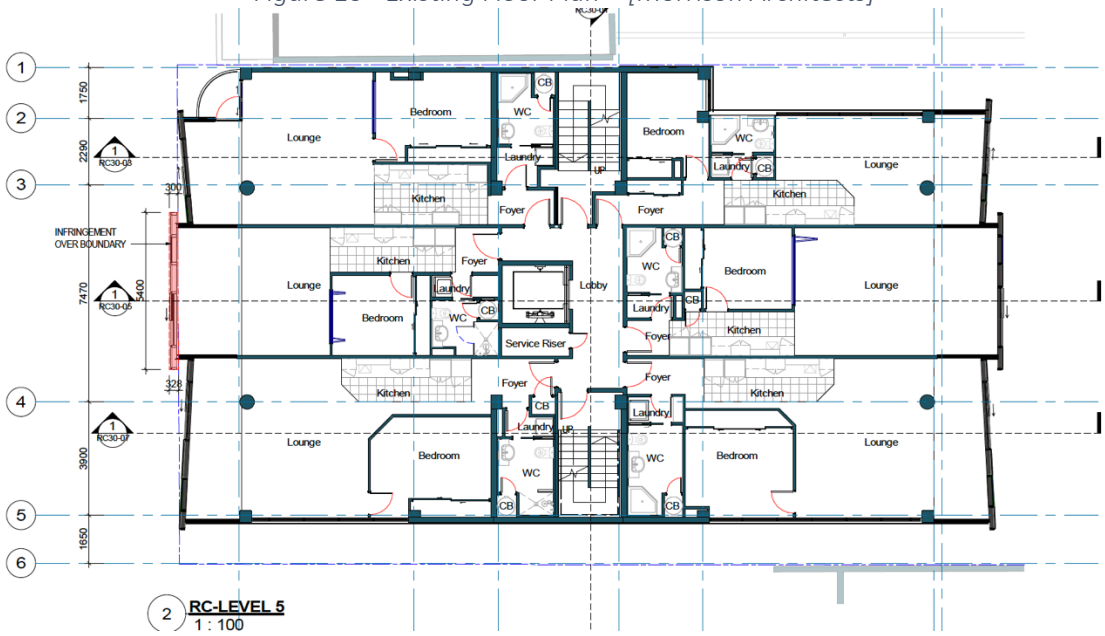



*Figure 11 - Proposed Floor Plan - [Morrison Architects]*

## 3.2 Proposed Works

The overall works are anticipated to take more than 20 weeks and are therefore considered "long-term duration". The following is a general description of the works, with the caveat that this is indicative, and details of the works may vary based on contractor methodology:

- Delivery and Installation of scaffolding.
- Installation and setup of Crane and Hoist.
- Dismantling and removal of current façade.
- Construction of building additions for enclosure of balconies
- Installation of new façade, joinery and glazing.
- Installation of new roofing and roof structures
- Dismantling and removal of scaffolding and Crane and Hoist.

We note that, depending on contractor methodology, the above may be staged for different areas and floors, in consideration of the fact the building is occupied.

### 3.2.1 Site Establishment

With the caveat that this will depend on contractor methodology, site establishment would involve first the installation of cranes/hoists atop the building, and the delivery and installation of scaffolding to the areas where works occur. A potential methodology may involve the establishment a crane atop capable of rotating to cover all facades. As a conservative measure for the purposes of this assessment, four diesel hoists are assumed required, one on each of the facades, and assumed operating simultaneously. Deliveries including loading/unloading of scaffolding are assumed to occur at the southern parking area of the building itself, with the potential for deliveries at Day street taken into account.

### 3.2.2 Demolition of Existing Elements

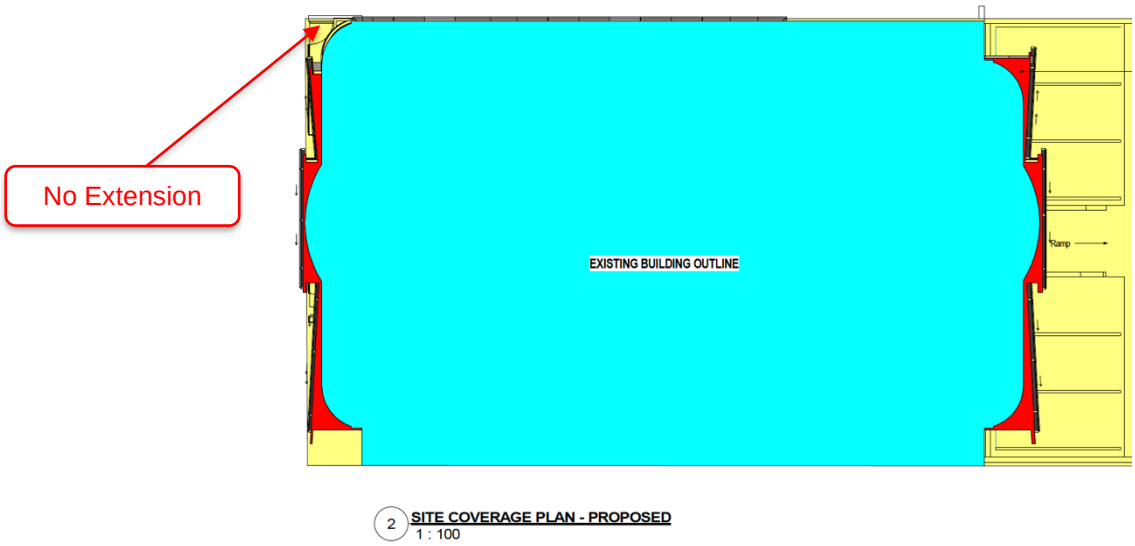
Demolition will consist of soft stripping of removable elements and cutting of structural elements requiring removal. Demolition works will mostly involve the use of hand held tools for cutting, drilling and grinding. Clearance work will occur in conjunction with the demolition works. Removal of waste materials would require the use of the diesel hoists. We note that limitations are proposed further in this report on the use of chutes.

### 3.2.3 Construction

The majority of the façade refit would require grinding and drilling of concrete, for affixing of façade elements. Based on the proposed plan, we note that no new glazing penetrations are proposed, and as such, concrete cutting is unlikely to be required and the majority of concrete alterations to existing structure would be undertaken with chipping tools.

In context of façade works proximity to the adjacent neighbours and space available for shielding mitigation measures, the following figure is indicative of the areas where extension works are proposed with the likelihood of high noise and vibration generating concrete and steel works.

Works at the NE corner do not involve extension of floors, as this area would be retained as a balcony, and as such would require minimal concrete and steel works. Furthermore, this provides space for shielding of adjacent neighbours where required.




For the proposed additions, works are likely to require drilling, grinding and steel works for the floor extensions. For the purposes of this assessment, works assumed to require pneumatic chipping hammers (14kg), Electric Percussion Drills (10kg), concrete grinders, and concurrently running vacuums for grinding.

## 3.3 Acoustic Shielding

Based on the proximity of the adjacent neighbouring receivers to the works, it is reasonable to assume that acoustic shielding is likely to be needed for noise levels to be minimised at the facades of the adjacent properties during highest noise generating activities; these being drilling, chipping and grinding

- For works at Levels 2 and above it is proposed that Acoustic blankets 2.1m wide to be affixed to scaffolding or structure to shield the North-Eastern corner of the building adjacent the neighbouring balconies at 22-28 Beresford Square as per the figure below. Acoustic blankets to be installed with no gaps between blankets and extending the height of any floor, and 1 floor above and below where works are occurring on the Northern façade.
- If works at any level require the use of high noise generating equipment such as concrete grinders or cutters, prior to the establishment of the new façade (i.e. unshielded) the floor where works occur is proposed to be shielded on the exterior of the scaffolding using acoustic blankets extending 5m either side of where the works occur to the height of the floor where works occur.
- For the Eastern and Western facades, if the construction methodology allows for shielding (i.e. using scaffolding) then high noise generating works within 10m of the adjacent properties are proposed to occur within a shielded area using acoustic blankets affixed to the scaffolding extending 1 floor above and below the floor where works occur.

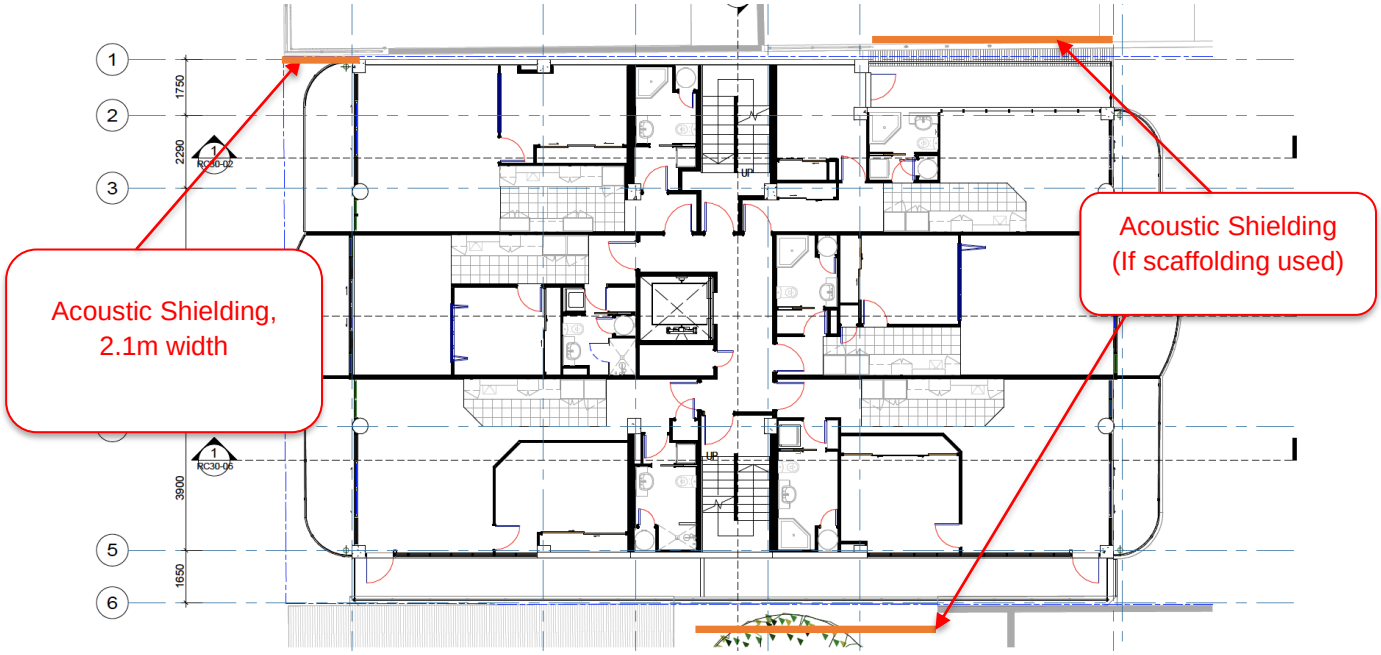



*Figure 12 - Proposed Shielding*

## 3.4 Equipment and Activities

### 3.4.1 Noise

The following table lists relevant noise generating equipment and mechanical plant expected to be used at different stages during the demolition, excavation and construction works on the subject site. Noise data is quoted below in accordance with NZS 6803:1999, and BS 5228: Part 1:1997.

| Equipment | Sound Power | Sound Pressure |
|---|---|---|
| | $L_{WA}$ [dB] | $LA_{eq}$ at 10m [dB] |
| Scaffolding – Loading Poles | 100 | 72 |
| Scaffolding – Loading Frames and Clips | 96 | 68 |
| Compressor – 3.7$m^3$/min | 106 | 78 |
| Petrol Driven Generator – 2kVA | 105 | 77 |
| Hand-held circular saw – Bench mounted | 106 | 78 |
| Pneumatic Chipping Hammer (14kg) | 106 | 78 |
| Diesel Hoist | 105 | 77 |
| Electric Percussion Drill (10kg) | 105 | 78 |
| Grinding Concrete* (225mm Blade) | 115 | 87 |
| Crane | 104 | 76 |
| Water Pump | 100 | 72 |

** Usually occurs internally within the building envelope.*

*Table 1 – Equipment noise levels*

### 3.4.2 Vibrations

The proposed works do not include the use of any equipment with potential to generate ground, or structural vibration levels of significance in context of protection of structures (DIN4150-3) or in context of AUP amenity vibration limits. We note for reference in this context, the following:

- The works proposed are on behalf of the occupants of the subject building, and it is our understanding that approval for the works can readily be provided for any apartments occupied during stages of the works.
- It is our understanding that the adjacent buildings, as per the visual references in the sections above, are not structurally connected to the subject building. Structure borne vibrations would generally be limited to propagation within the subject building.

# 4 Assessment Standards

This section details the regulatory and standards-based criteria for noise and vibrations for the demolition and construction activities on the subject site. The next section summarises the assessment criteria used in this report based on the standards in this section.

## 4.1 Noise Regulations and Standards

The following rules apply to the site and to surrounding sites:

***E25.6.28. Construction noise levels in the Business – City Centre Zone and the Business – Metropolitan Centre Zone***

*(1) Construction activities in the Business – City Centre Zone and the Business – Metropolitan Centre Zone must comply with Standard E25.6.27(1) above for any receiver not in a Business – City Centre Zone or a Business – Metropolitan Centre Zone and must not exceed the levels in Table E25.6.28.1 Construction noise levels for construction less than 15 consecutive calendar days duration in the Business – City Centre Zone and the Business – Metropolitan Centre Zone and Table E25.6.28.2 Construction noise levels for construction of 15 consecutive calendar days or more duration in the Business – City Centre Zone and the Business – Metropolitan Centre Zone when measured for any 30 minute period 1m from the façade of any building in the Business – City Centre Zone or the Business – Metropolitan Centre Zone that is occupied during the work.*

| Construction of 15 consecutive calendar days or more (total duration of works) | | |
|---|---|---|
| **Time** | **$L_{Aeq(30\ min)}$** | **$L_{AFmax}$** |
| Monday to Friday 6.30am-10.30pm | 75 dB | 90 dB |
| Saturday 7am-11pm | 80 dB | 90 dB |
| Sunday 9am-7pm | 65 dB | 85 dB |
| All other times (night time) | 60 dB | 75 dB |
| All other times in the City Centre Residential Precinct and the Learning Precinct | 55 dB | 75dB |

*Table 2 - Referencing Table E25.6.28.2 Construction noise levels for construction of 15 consecutive calendar days or more duration in the Business – City Centre Zone and the Business – Metropolitan Centre Zone*

*Where external measurement of construction noise is impractical or inappropriate, the upper limits for the noise measured inside the building will be 20dB less than the relevant levels in Table E25.6.28.1 Construction noise levels for construction less than 15 consecutive calendar days duration in the Business – City Centre Zone and the Business – Metropolitan Centre Zone and Table E25.6.28.2 Construction noise levels for construction of 15 consecutive calendar days or more duration in the Business – City Centre Zone and the Business – Metropolitan Centre Zone above.*

## 4.2 Vibrations Regulations and Standards

The effects of Vibrations should be assessed against their effects on both humans and buildings. The following sections reference the criteria pertaining to each, in context of regulatory requirements and international standards. In accordance with the Auckland Unitary Plan, pertaining to construction vibrations:

***E25.6.30 Vibration***

*(1) Construction and demolition activities must be controlled to ensure any resulting vibration does not exceed:*

- *a) the limits set out in German Industrial Standard DIN 4150-3 (1999): Structural vibration – Part 3 Effects of vibration on structures when measured in accordance with that Standard on any structure not on the same site; and*
- *b) the limits in Table E25.6.30.1 Vibration limits in buildings in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500mm of ground level at the foundation of a single storey building.*

| *Receiver* | *Period* | *Peak Particle Velocity Limit* |
|---|---|---|
| *Occupied activity sensitive to noise* | *Night – time 10pm to 7am* | *0.3 mm/s* |
| | *Daytime 7 am to 10pm* | *2 mm/s* |
| *Other occupied buildings* | *At all times* | *2 mm/s* |

*Table 3 - Referencing Table E25.6.30.1 of the AUP*

*Works generating vibration for three days or less between the hours of 7am to 6pm may exceed the limits in Table E25.6.30.1 Vibration limits in buildings above, but must comply with a limit of 5mm/s peak particle velocity in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500mm of ground level at the foundation of a single storey building, where:*

- *i. all occupied buildings within 50m of the extent of the works generating vibration are advised in writing no less than three days prior to the vibration-generating works commencing; and*
- *ii. the written advice must include details of the location of the works, the duration of the works, a phone number for complaints and the name of the site manager.*

### 4.2.1 Human Response

In accordance with Standard BS5228.2, Annex B.2, the threshold of human perception of vibrations is in the range of 0.14mm/s to 0.3mm/s. Vibrations above 0.3mm/s are noted to be perceptible, and above 1.0mm/s are noted to likely cause complaint, albeit be tolerable if below

10 mm/s. As per guidelines of BS5228.2, the following are vibration levels and the associated human response:

| Vibration level | Effect |
|---|---|
| 0.14 mm/s | Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration. |
| 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. |

*Table 4 - Reference Table B.1 of BS5528.2 Guidance on effects of vibration levels*

### 4.2.2 Effects on Buildings

In accordance with the *DIN 4150-3:1999 "Structural Vibration – Part 3: Effects of Vibration on Structures"* standard additional factors apply to limit the effects of vibrations at different frequencies on different types of buildings. The DIN 4150-3:1999 guidelines are summarised in the table below:

| Structure Type | Peak Particle Velocity - PPV (mm/s) at the foundation at a frequency of | | |
|---|---|---|---|
| | 1 Hz to 10 Hz | 10 Hz to 50 Hz | 50 Hz to 100Hz* |
| Industrial | 20 | 20-40 | 40-50 |
| Residential | 5 | 5-15 | 15-20 |
| Sensitive Structures | 3 | 3-8 | 8-10 |
| **At Frequencies above 100Hz, the values in this column can be used as minimum values* | | | |

*Table 5 - DIN4150-3:1999 - Guideline values of vibration velocity, for evaluating the effects of short-term vibrations*

The DIN 4150-3:1999 standard provides a higher level of protection for residential buildings, especially, and takes into account the effects of vibrations at different frequencies.

## 4.3 Criteria

### 4.3.1 Metrics

In accordance with the Auckland Unitary Plan and NZ standards NZS6801, NZS6802, and NZS6803, the following metrics are used to quantify noise:

- $L_{WA}$ [dB]: A-Frequency Weighted sound power level. This metric is primarily used to describe the power output from a sound source for the purposes of modelling.
- $LA_{eq}$ [dB] or $L_{eq}$ [dBA]: A-Frequency Weighted time average sound level. This metric represents the full audio range weighted against the response of the human ear. This is the primary descriptor of noise for receivers.
- $LA_{max}$ [dB] or $L_{max}$ [dBA]: Maximum sound pressure level.

In accordance with BS 5228-2:2009 the following metrics are used to quantify vibrations:

- PPV [mm/s]: Peak Particle Velocity is the instantaneous maximum velocity reached by a vibrating element, represented in mm/s
- Frequency [Hz]: Frequency of vibrations.

### 4.3.2 Noise Levels

In consideration of the following:

- The proposed works are anticipated as long duration.
- Works on-site will be restricted to the hours of 6:30am to 10:30pm Monday – Friday and 7:00am to 11:00pm Saturdays.
- More restrictive night time and Sunday noise limits are not applicable.

In accordance with the Auckland Unitary Plan requirements for the subject site zoning, the noise limits are:

Monday – Friday 6:30am to 10:30pm

- $L_{eq}$ 75 dBA
- $L_{max}$ 90 dBA

Saturdays - 7:00am to 11:00pm

- $L_{eq}$ 80 dBA
- $L_{max}$ 90 dBA

### 4.3.3 Vibration Levels

Vibrations emanating from construction activities must be considered against two criteria; Effects on Buildings and Structures, and Effects on Humans. Taking the following into account:

- The subject site is in proximity to occupied buildings, and the proposed works are anticipated to take longer than 20 weeks. Human response to vibrations should be considered.
- Works on-site will be restricted to daytime hours. More restrictive human response considerations for the avoidance of sleep disturbance during night time are not applicable.
- The DIN-4150-3 standard provides a high level of protection for buildings, and is frequently used in New Zealand, in addition to being referenced in Auckland Unitary Plan. Based on this standard for non-industrial buildings, at the most sensitive frequency, the limit is 5mm/s. For sensitive structures the limit is lower at 3mm/s
- The Auckland Unitary Plan requires a lower limit during daytime works for occupied structures of 2mm/s.
- The BS 5228-2 standard as it pertains to human response, identifies a threshold of 1mm/s where lower levels of vibrations unlikely to cause annoyance.

In consideration of the above, the following assessment criteria will be adopted in this report, where all Vibration limits in mm/s reference the maximum absolute unweighted PPV (peak Particle Velocity) in any axis.

- **Occupied Buildings:** This is in accordance with E25.6.30.(1).(b) of the Auckland Unitary Plan, which takes into account the human response factors of continuous vibrations:
  - Daytime: **2mm/s**
  - Night Time (10:00pm to 7:00am)**: 0.3mm/s**
- **Heritage Buildings**. The following limits are in accordance with DIN 4150-3:1999 as referenced in 25.6.30.(1).(a) of the Auckland Unitary Plan, and based on the sensitive heritage structures:
  - **3mm/s** @ 1-10 Hz, **3mm/s-8mm/s** @ 10-50Hz, **8mm/s-10mm/s** @ 50-100Hz, **10mm/s** @ more than 100Hz
- **Unoccupied Buildings / Structures - Residential**. The following limits are in accordance with DIN 4150-3:1999 as referenced in 25.6.30.(1).(a) of the Auckland Unitary Plan, and based on the residential structures:
  - **5mm/s** @ 1-10 Hz, **5mm/s-15mm/s** @ 10-50Hz, **15mm/s-20mm/s** @ 50-100Hz, **20mm/s** @ more than 100Hz

# 5 Noise Assessment

This section details the assessment of noise levels on the site including models for prediction of noise from the proposed works. Noise prediction models for surrounding receivers are shown in Appendix VIII.

## 5.1 Noise Modelling

### 5.1.1 Software

To predict noise propagation at the subject site from the proposed works, an environmental model was constructed for the works using the CadnaA version 2019 computer modelling program. The following applies to the modelling software CadnaA:

- The modelling method for noise propagation over distance is based on the international standard ISO 9613: "Acoustics – Attenuation of sound during propagation outdoors" methodology.
- The model allows importing digital ground elevation contours and data to define the topography and data for each of the noise sources, and the locations, geometry and elevations of the noise receivers.
- The modelling also takes into account a multitude of additional absorption and reflection effects including ground and façade reflections.
- The program then calculates the $LA_{eq}$ dB level, without time averaging, as the metric for the noise levels at the receivers for the purposes of this assessment.
- Locations of predicted $LA_{eq}$ Levels, as per the figures in Appendix IX, are positioned at approximately 1m from the relevant facades of the receivers at the elevation for the model.

### 5.1.2 Work Phases

The works on the site were modelled for the worst case combined scenario taking into account

- Multiple activities expected to generate highest noise levels occurring simultaneously
- Worst case elevations of the work.
- Representative locations of noise generating activities.

As per the above, and considering the proposed works as detailed in the previous sections, noise modelling was designed with the following Activities occurring simultaneously on each of the facades:

- Diesel hoist running on the current roof level.
- Pneumatic Chipping Hammer (14kg) and
- Electric Percussion Drill (10kg)

This would create a model with multiple machines running at full capacity, simultaneously. The noise source elevations were selected to model the highest incident noise on the most sensitive and exposed receivers at each façade, at 1.5m above the floor at each respective level.

- Northern Façade: Level 5 - 16.5m above ground level, Level 1: 4.5m above ground level
- Western Façade: Level 3 - 10.5m above ground level
- Southern Façade: Level 3 - 10.5m above ground level
- Eastern Façade: Level 5 - 16.5m above ground level

Example as per the figure below shows works modelled at the Northern and Western Facades:

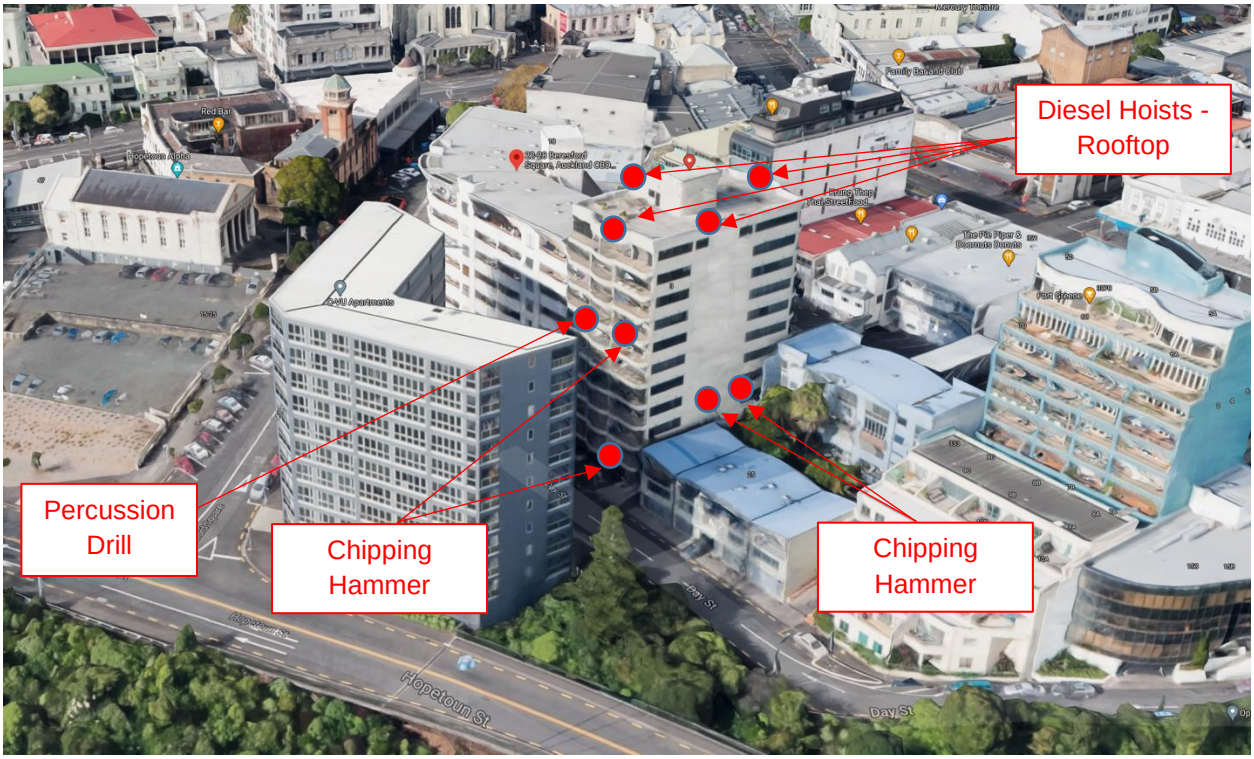



*Figure 13 - Activity Locations – Modelling – [Google Earth]*

### 5.1.3 Modelled Mitigation Measures

Modelling was done with the proposed NE corner shielding for the adjacent receivers. Modelling was also done with localised shielding affixed to exterior of scaffolding if requirement arises for high noise generating works such as concrete grinding prior to the shielding effect of the proposed façade being installed.

### 5.1.4 Modelled Scenarios:

Activities were modelled at the locations noted below, and modelling was repeated for different receiver elevations to assess the effects on different receiver storeys.

| Equipment | Sound Power Level (dBA) |
|---|---|
| Pneumatic Chipping Hammer (14kg) | 106 |
| Electric Percussion Drill (10kg) | 105 |
| Diesel Hoist | 105 |

*Table 6 - Modelling Scenarios*

## 5.2 Modelling Analysis

Demolition and construction are dynamic activities that have to respond to localised effects that can be impractical to predict. To accommodate for this, models are designed with conservative assumptions, and cover key activities, to represent the higher end of the noise levels expected.

The following conservative assumptions were inherent in the noise models for the subject site in this report.

- Simultaneity: In each modelled scenario, all machinery was assumed running at full capacity simultaneously. This does not usually occur, as sequential dependencies may require one or more machines to idle while others complete their tasks.
- Time Averaging: In all modelled scenarios, machinery was assumed to run continuously regardless of sample time period. In reality, construction works are usually highly variable with machines cycling from off (setting up), to idling (preparation) to on (operating.) Taking time averaging into account, either as a result of operational processes, or as an enforced process, would usually reduce the noise level for the compliance criteria $L_{Aeq}$.

## 5.3 Receiver Analysis

The example predictive models in the Appendix represent the noise levels while all machinery in a scenario is running continuously. Noise predictions are shown in the predictive models in Appendix IX of this report, where the noise levels depicted in the figures are noted to be at 1m from the associated facades and calculated in the figures without any time averaging effects. Provided the mitigation measures detailed in the following section, and in the CNVMP are adhered to, the predicted noise levels can be maintained as low as practicably possible.

Notwithstanding that, due to proximity, and if the selected methodology is not conducive to shielding, noise levels may exceed the compliance limits at some directly adjacent receivers for short durations while works are in proximity.

### 5.3.1 East – 22-28 Beresford Square

- Work on Northern Façade: During works on the northern façade of the subject building, and provided acoustic shielding is established on the Northeast corner to shield the balconies of the receiver, noise levels are predicted to be compliant with the Mon-Fri limits of 75dB $LA_{eq}$ and 90dB $LA_{max}$ as per the predictive model below (Shown in more detail in Appendix VIII)

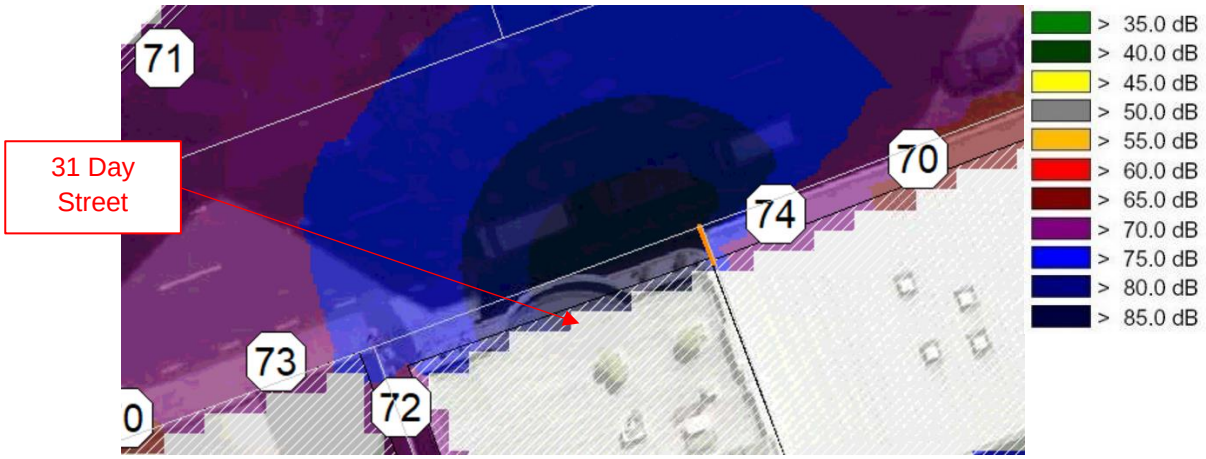
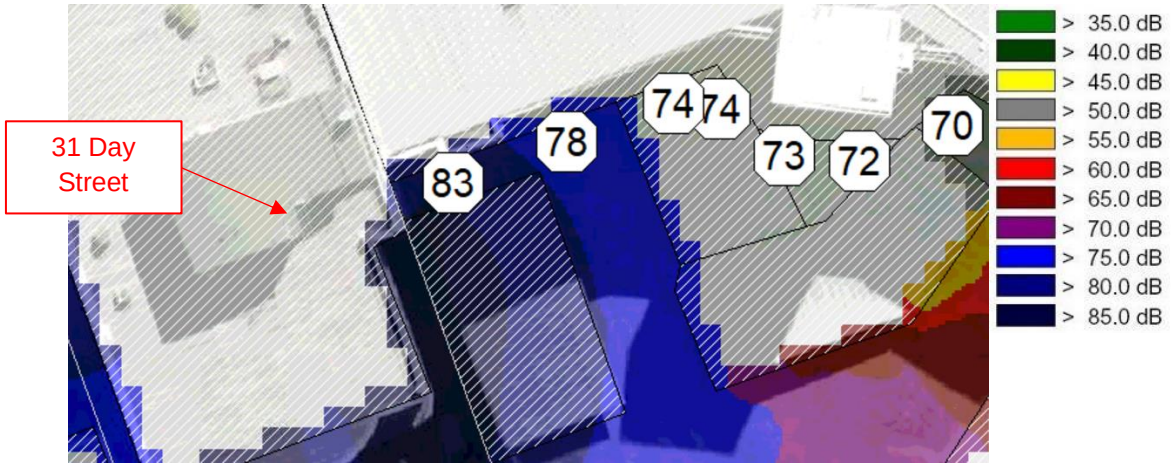



*Figure 14 - Noise Levels at NE Corner*

- Work on Eastern Façade – With Shielding: During works at the eastern façade, noise levels at this receiver will be dependent on the methodology selected pertaining to practicability of shielding. If scaffolding is established for the works on the eastern façade, then use of acoustic blankets on the scaffolding would be readily achievable extending 1 floor above and below where works occur. If shielding is practicable, noise levels would be within the Mon-Fri limits of 75dB $LA_{eq}$ and 90dB $LA_{max}$.

- Work on Eastern Façade– Without Shielding: If works are undertaken with cranes, without the use of scaffolding, shielding would not be practicable. In this case, noise levels at the concrete part of the southern façade (circa 7m closest to subject building) would reach up to $L_{eq}$ 85dBA while works are in proximity. We note the effects of this noise exceedance at the concrete part of the façade would be readily attenuated to within the internal compliance limits as per Section 5.4 below. At the closest glazing of the southern façade of the receiver building, noise levels would reach circa $L_{eq}$ 80dBA during works in proximity, this being an exceedance of 5dBA above the $L_{eq}$ 75dBA limit.

The following figure is representative of noise levels on the southern façade of the eastern receiver 22-28 Beresford Square, if the methodology selected makes it impractical to establish shielding. Shown in more detail in Appendix VIII.




The following image is representative of the construction of the southern façade of the receiver:


*Figure 15 - Southern facade of 22-28 Beresford Square – Facing NW [Open Street Maps – Apple]*

### 5.3.2 North – 36 Day Street

The building across Day Street, at its closest, is circa 17m-20m from the closest façade of the subject building. Provided concrete floor grinding on the northern end of the subject site is undertaken after the façade is established (for shielding,) noise levels at 36 Day Street are predicted to be within the Mon-Fri limits of 75dB $LA_{eq}$ and 90dB $LA_{max.}$ Furthermore, we note that the southern façade of 36 Day Street is mostly concrete, within minimal glazing. External noise levels on this façade would be effectively attenuated internally. The following figure is representative of noise levels to the North, and the section below is representative of noise propagation from multiple sources to the receiver:

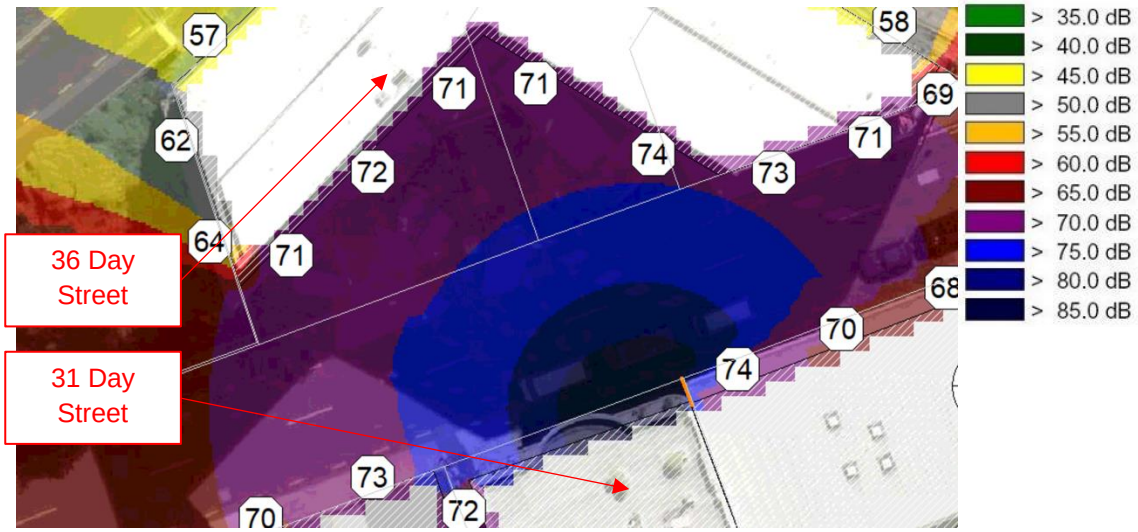



*Figure 16 - Noise Levels at 36 Day Street*

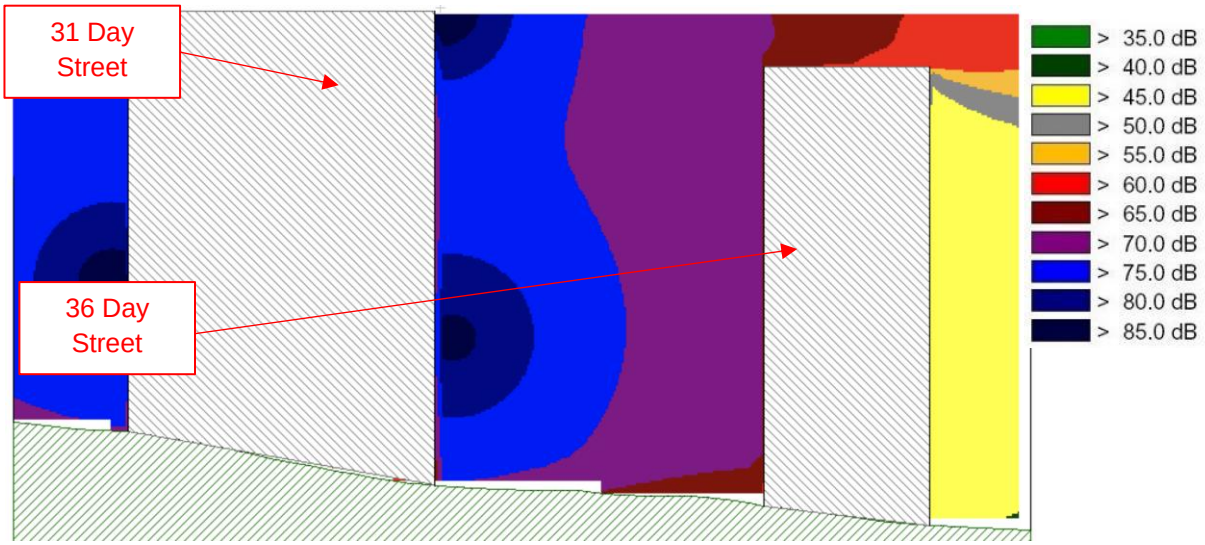



*Figure 17 - Section - Noise Propagation to 36 Day Street*

### 5.3.3 West – Southern Building of 25 Day Street

- Work on Western Façade – With Shielding: During works at the eastern façade, noise levels at this receiver will be dependent on the methodology selected pertaining to practicability of shielding. If scaffolding is established for the works on the eastern façade, then use of acoustic blankets on the scaffolding would be readily achievable extending 1 floor above and below where works occur. If shielding is practicable, noise levels would be within the Mon-Fri limits of 75dB $LA_{eq}$ and 90dB $LA_{max.}$
- Work on Western Façade– Without Shielding: If works are undertaken with cranes, without the use of scaffolding, shielding would not be practicable. In this case, noise levels at the closest part of the northern façade of the southern building would reach up to $L_{eq}$ 80dBA while works are in proximity, this being an exceedance of 5dBA above the $L_{eq}$ 75dBA limit.
- Work on Southern Façade: If works are undertaken with cranes, without the use of scaffolding, shielding would not be practicable. In this case, noise levels at the solid concrete façade of 25 Day Street would reach up to $L_{eq}$ 85dBA while works are in proximity. We note the effects of this noise exceedance at the concrete part of the façade would be readily attenuated to within the internal compliance limits as per Section 5.4 below.

The following figure is representative of noise levels at the southern building of 25 Day Street:

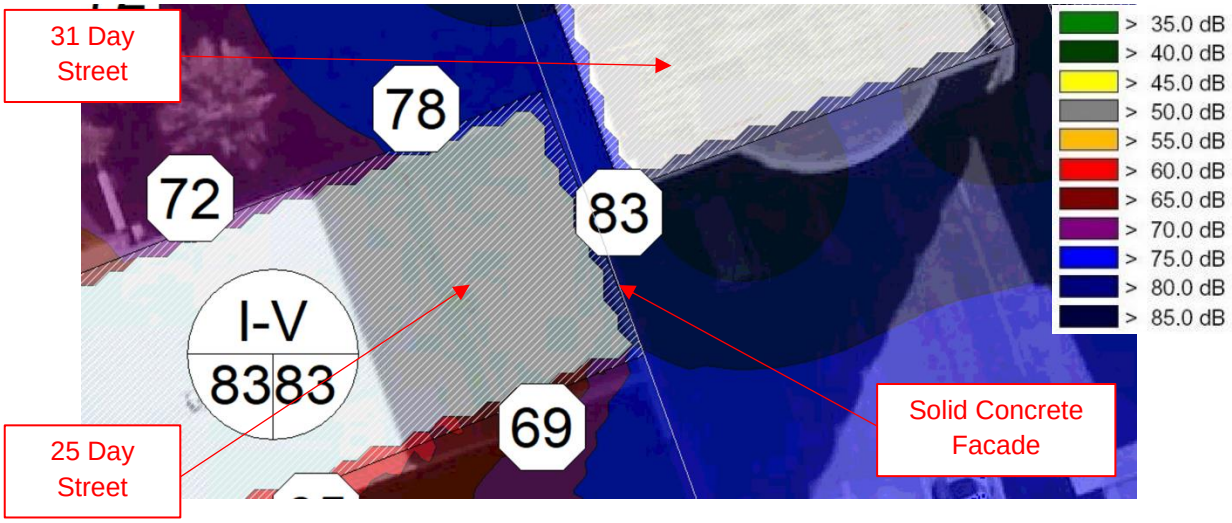



*Figure 18 - Noise Levels at 25 Day Street*

The following figure is representative of the eastern solid concrete façade of 25 Day Street

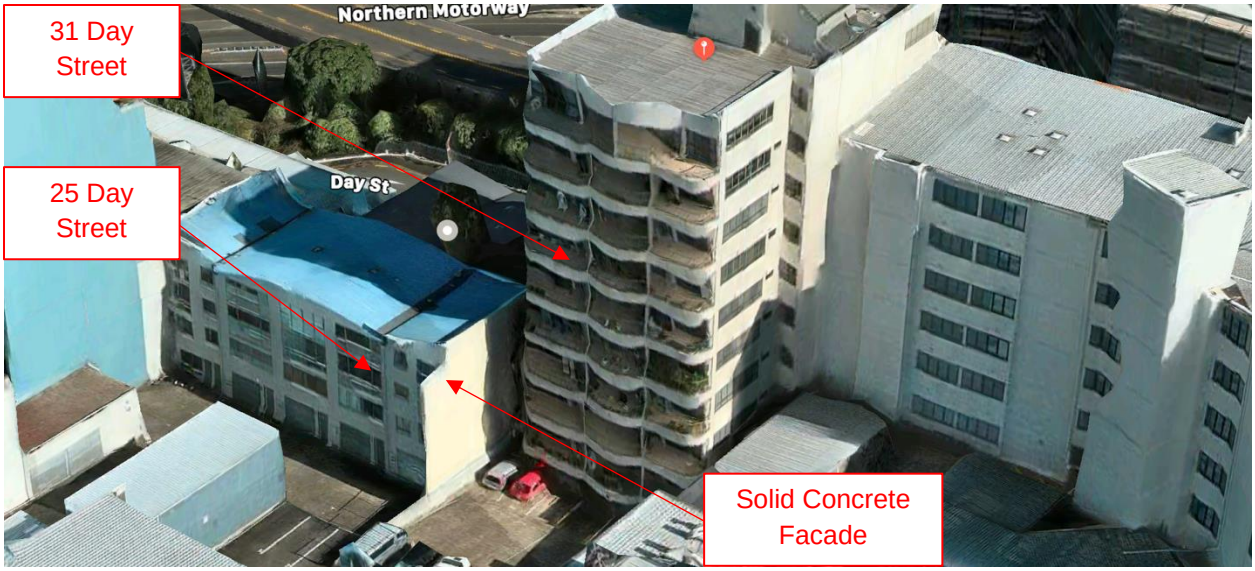



*Figure 19 - Solid Concrete Facade of 25 Day Street – Facing General NW - [Open Street Maps - Apple]*

### 5.3.4 South – 295 – 327 Karangahape Road

The buildings to the South are more than 27m from the closest façade of the subject building. Provided concrete floor grinding on the southern end of the subject site is undertaken after the façade is established (for shielding,) noise levels at the receivers to the South are predicted to be within the Mon-Fri limits of 75dB $LA_{eq}$ and 90dB $LA_{max.}$

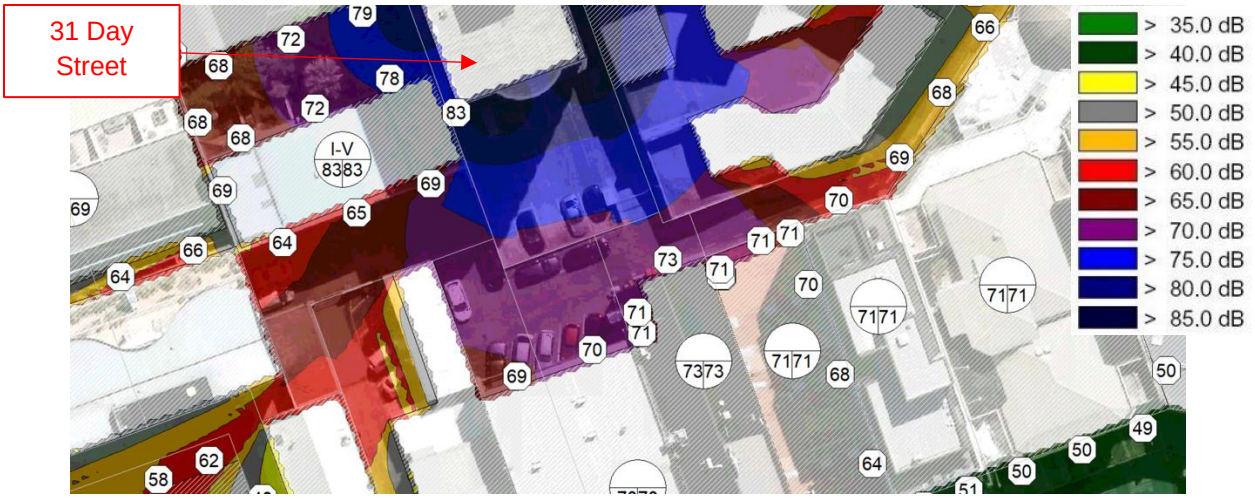



*Figure 20 - Noise Levels at Southern Receivers*

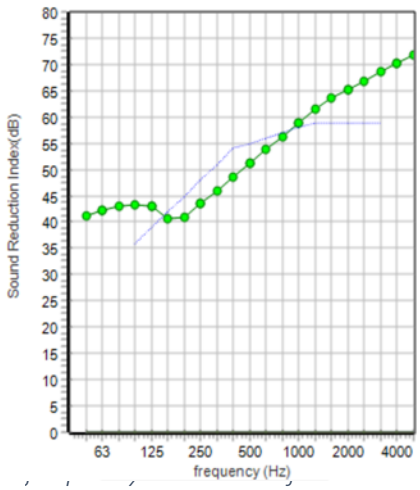
### 5.3.5 Other receivers

Taking into account the proposed equipment restrictions and mitigation measures, noise levels are expected to be at or within the Mon – Fri compliance limit of 75dB $LA_{eq}$ and 90dB $LA_{max}$ at all other receivers during all works

## 5.4 Adjacent Solid Concrete Façades

A number of facades, including the east facing facade of the adjacent building at 8/25 Day Street, is noted to be a concrete structure, with no glazing, egresses, or penetrations. Noise levels incident on this solid facade along the boundary of the subject site, are expected to be excessive due to their proximity to works. Notwithstanding that, the effects of these noise levels on the interior of the building would be minimal due to the attenuating effect of the solid facades. As such, a better indicator of effects would be the internal noise levels within these buildings.

The structure of the façade, as noted from external visual assessment, is concrete block. Notwithstanding internal linings and thermal insulation, the concrete alone would attenuate noise levels as per the Sound Reduction Index figure to the right. (Software: Insul Version 8.0.7)




Based on this, even if noise levels at the facade reach up to $LA_{eq}$ 90dB, and calculated for the façade area and regular room sizes, a solid concrete façade would be expected to attenuate noise levels down to an internal level of $LA_{eq}$ 42-45dB.

We note this would be lower than the criteria limit when considered internally. In accordance with the AUP and associated NZS 6801: 2008; when external measurements are not possible, a 20dB reduction on the stated external limit ($LA_{eq}$ 75dB in this case) is required for internal measurements.

Based on the above, we would predict noise incident on the solid concrete facades adjacent the building would have effects compliant internally with the requirements of the AUP.

# 6 Structure Borne Noise

Structure borne noise occurs when vibrations are transmitted through structures and radiated as sound through building elements, where wall vibrations generate a radiated noise farther away from the source when assessed for airborne propagation. This noise usually occurs when vibrations are predominantly in the frequency range of 30Hz -200Hz. Concrete and steel buildings are particularly prone to propagation of structure borne high frequency vibrations.

The proposed tools are likely to generate vibrations within this range, and notwithstanding detailed structural analysis being out of this scope, it is likely that during works some apartments within the subject building would experience varying levels of structure borne noise. We note this is limited to the building itself as adjacent building are generally structurally separate in context of vibration propagation.

# 7 Vibrations Assessment

Prediction and modelling of vibration propagation is impractical in context of construction due to the number of variables involved. Vibration prediction in construction is usually impractical and highly caveated.

Focus is made in this assessment on vibration levels that can be expected in a well-managed and supervised site. Emphasis is made on appropriate management procedures established from pre-activity assessments on-site

The vibration levels quoted in the following sections come under two categories:

- Standard BS 5228: Levels quoted in this standard pertain to different ground strata that may not be applicable to specific sites. Vibration levels from BS5228 are referenced as indicative of the range and scale that can be expected in order to identify affected neighbours, and not as accurate predictors of levels in any specific location.
- Earcon Measurement: Vibration levels quoted from Earcon measurements pertain to actively monitored and supervised sites, comparative with the subject site, operating with effective management procedures. These quoted measurements represent vibration levels achieved while maintaining reasonable work pace and intensity.

This assessment considers examples and measurements noted in standards or taken for similar activities at different distances, assesses these against the criteria, and identifies activities at specific locations that have the potential to exceed the criteria limits

Excessive vibrations are sometimes the result of unusual activities or incidents such as dropping of large objects. These should be minimised and controlled through training, management controls and supervision. This analysis pertains to vibrations resulting from normal activities expected at the subject site. Taking into account:

- Elevations of the expected works (no works on the basement or foundations)
- Types of equipment proposed
- Adjacent buildings are not structurally connected to the subject building.
- The works are undertaken on behalf of the occupancies, and as such written approval for the works can readily be obtained as a waiver for effects on occupied apartments during works.
- Restrictions on work hours in the CNVMP pertaining to night time vibration limits

It is expected that the proposed development and associated works will readily comply with the criteria limits at all neighbouring receivers.

# 8 Compliance

We note for reference that the proposed works are on behalf of the occupants of the subject building. It is our understanding that approval for the works and waiver of effects can readily be provided by any occupants of apartments within the subject building occupied during the works. As such, the effects on apartments within the same building are excluded from this assessment

## 8.1 Noise

Due to the proximity of the neighbouring dwellings adjacent the boundary, and in particular during drilling and chipping, noise levels will likely be higher at these façades. We note that in the absence of a confirmed methodology, the following two options are proposed:

1. If the selected methodology includes scaffolding that allows for shielding to be established with acoustic blankets on scaffolds, then noise levels are expected to be at or within the Mon – Fri compliance limit of 75dB $LA_{eq}$ and 90dB $LA_{max}$ at all receivers during all work
2. If, on the other hand, the methodology does not include scaffolding (i.e. cranes only); we recommend applying the following limit exceedance for approximately 2-3 weeks at any one receiver:
    - Mon-Fri 80dB $LA_{eq}$ and 95dB $LA_{max}$ at the westernmost 12m of the southern façade of 22-28 Beresford Square, and the easternmost 12m of the northern façade of the building at 25 Day Street as per the figure below. We note for reference that noise levels would also exceed on the concrete façade of 25 Day Street, but would be compliant internally.

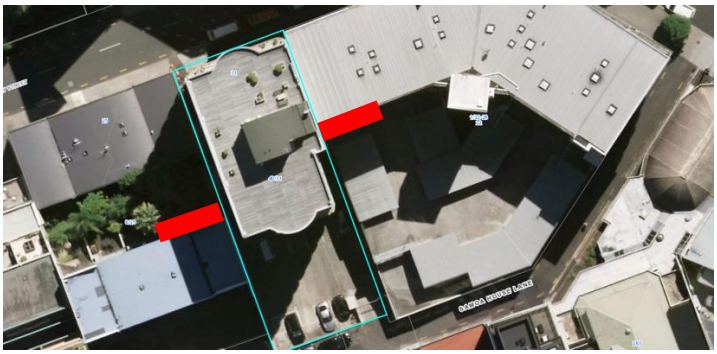


*Figure 22 - Areas of Exceedances if shielding is not possible*

## 8.2 Vibrations

Considering the proposed works, vibrations are expected to be compliant with the AUP requirements and standards whereby vibrations will be managed within the heritage structural protection DIN4150-3 criteria limits at all receivers and within the amenity level of 2mm/s at all receivers.

# 9 Mitigation Measures

This section details the proposed mitigation measures to reduce, insofar as practicable, noise and vibrations at the surrounding sites.

## 9.1 Fencing

- For works at Levels 2 and above it is proposed that Acoustic blankets 2.1m wide to be affixed to scaffolding or structure to shield the North-Eastern corner of the building adjacent the neighbouring balconies at 22-28 Beresford Square as per the figure below. Acoustic blankets to be installed with no gaps between blankets and extending the height of any floor, and 1 floor above and below where works are occurring on the Northern façade.
- If works at any level require the use of high noise generating equipment such as concrete grinders or cutters, prior to the establishment of the new façade (i.e. unshielded) the floor where works occur is proposed to be shielded on the exterior of the scaffolding using acoustic blankets extending 5m either side of where the works occur to the height of the floor where works occur.
- For the Eastern and Western facades, if the construction methodology allows for shielding (i.e. using scaffolding) then high noise generating works within 10m of the adjacent properties are proposed to occur within a shielded area using acoustic blankets affixed to the scaffolding extending 1 floor above and below the floor where works occur.

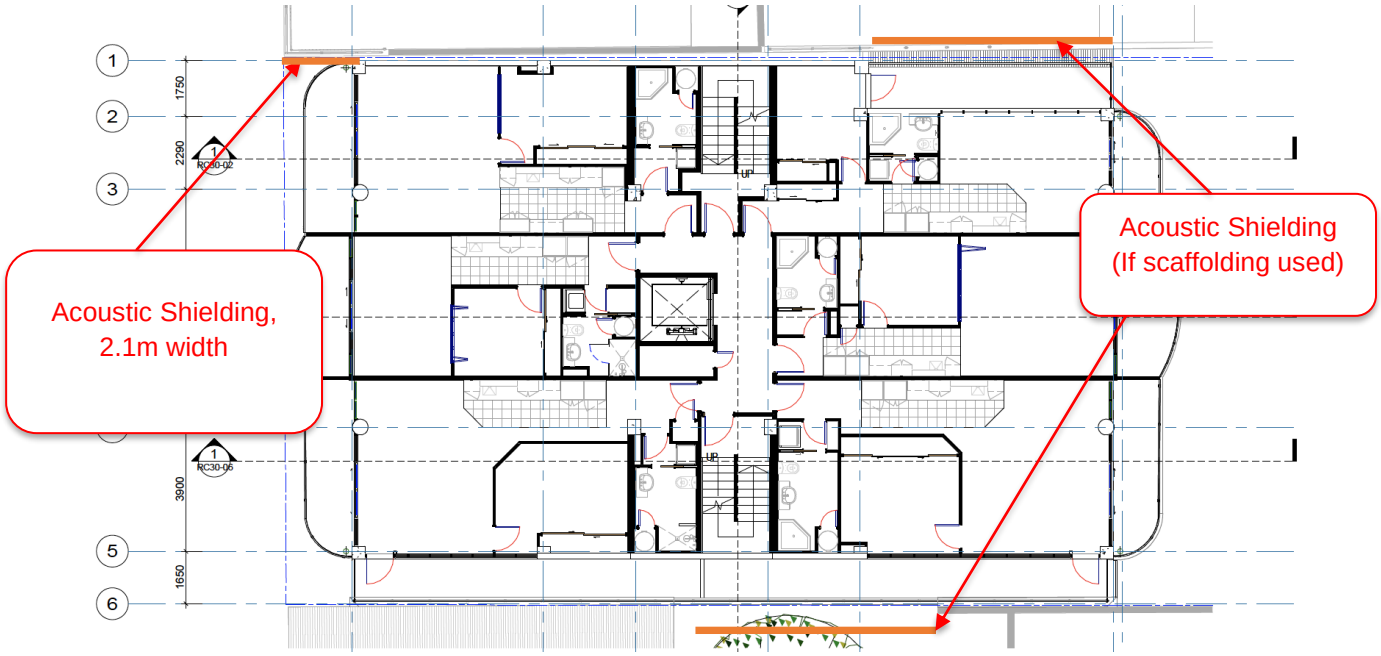



*Figure 23 - Proposed Shielding*

## 9.2 Equipment Restrictions

The following restrictions are proposed

- Concrete Floor grinding to occur after the façade is established, or with acoustic shielding on the façade extending no less than 1 floor above and below where grinding occurs.

## 9.3 Time Restrictions

In consideration of the residential nature of the surrounding area, and the night-time vibration limits for protection of sleep (E25.6.30):

- All **noise or vibrations generating works** shall be limited to the hours of
    - Monday – Saturday 7:00am to 7:00pm.

Noise or Vibration generating work shall **not** occur on Sundays.

## 9.4 Equipment Recommendations

- **Rattling Guns:** the use of rattle guns on steel or concrete structures can generate high and potentially tonal noise levels especially when occurring at elevation. The impulsiveness, sudden onset, and tonality of the events makes them particularly annoying especially considering the presence of retirement facilities, a childcare facility, and a hospice all in proximity. We would recommend consideration of the following alternatives:
    - Shear snap off bolts.
    - Hydraulic torque wrenches.
- **Stud Shots:** The noise levels generated from stud shots on steel structures is highly tonal, loud, and impulsive, and can be cause for disruption and significant annoyance to neighbouring receivers. We would recommend consideration screw fixing as a best practicable option to minimise noise.

# 10 Assessment of Effects

## 10.1 AUP OP Assessment

As the Permitted Activity Standards stipulated under the AUP OP for construction noise - E25.6.27 cannot be met due to the proximity and elevation of the adjacent receivers with line of sight into the works, and no practicable options to shield them, consent is required for a Restricted Discretionary Activity pursuant to E25.4.1(A2) and assessment against the criteria below is provided.

*E25.8. Assessment – restricted discretionary activities E25.8.1. Matters of discretion The Council will restrict its discretion to all of the following matters when assessing a restricted discretionary resource consent application: (1) for noise and vibration: (a) the effects on adjacent land uses particularly activities sensitive to noise; and (b) measures to avoid, remedy or mitigate the adverse effects of noise. (2) for internal noise levels of noise sensitive spaces in the Business – City Centre Zone, Business – Metropolitan Centre Zone, Business – Town Centre Zone, Business – Local Centre Zone, Business – Neighbourhood Centre Zone or the Business – Mixed Use Zone: (a) reverse sensitivity effects; and (b) alternative temperature control solutions.*

*E25.8.2. Assessment criteria The Council will consider the relevant assessment criteria for restricted discretionary activities from the list below:*

*(1) for noise and vibration:*

*(a) whether activities can be managed so that they do not generate unreasonable noise and vibration levels on adjacent land uses particularly activities sensitive to noise;*

As detailed in Section 8 of this report, a number of mitigation measures are proposed, including:

- Shielding, where practicable
- Restrictions on equipment use

With the above measures in place, it is our opinion that noise and vibration levels can be maintained at levels commensurate with the type of works and proximity of the adjacent neighbours.

*(b) the extent to which the noise or vibration generated by the activity: (i) will occur at times when disturbance to sleep can be avoided or minimised; and (ii) will be compatible with activities occurring or allowed to occur in the surrounding area; and (iii) will be limited in duration, or frequency or by hours of operation; and (iv) will exceed the existing background noise and vibration levels in that environment and the reasonableness of the cumulative levels; and (v) can be carried out during daylight hours, such as road works and works on public footpaths.*

As detailed in Section 8 of this report, and in consideration of the residential nature of the adjacent receivers:

- The highest noise and vibration generating activities are restricted to the hours of Mon-Sat 7:00am to 7:00pm. This is for protection from sleep disturbance to residential occupancis in the vicinity
- The exceedance of the AUP criteria would only occur during the limited period of works in proximity.

Based on the above, it is our opinion that the works, with the mitigation measures implemented, would minimise the effects on neighbours.

*(c) the extent to which the effects on amenity generated by vibration from construction activity: (i) will be mitigated by written advice of the activity to adjacent land uses prior to the activity commencing; and (ii) can be mitigated by monitoring of structures to determine risk of damage to reduce occupant concern; and (iii) can be shown to have been minimised by the appropriate assessment of alternative options; and (iv) are reasonable taking into account the level of vibration and the duration of the activity (where levels of 10mm/s peak particle velocity may be tolerated only for very brief periods).*

As detailed in Section 8 of this report, a number of measures are implemented to manage and maintain vibration levels within the compliance limits at occupied receivers, including:

- Restrictions on operational times to avoid sleep disturbance associated with night time vibrations.

Based on the above, it is our opinion that the works, with the mitigation measures implemented, would control vibration levels at neighbouring receivers to within compliance levels as per the requirements of the Auckland Unitary Plan.

*(d) whether the measures to minimise the noise or vibration generated by the activity represent the best practicable option.*

The decision to recommend an increase of the allowed noise and vibration limit at the adjacent receivers was not taken lightly. A number of considerations and options were taken in account and assessed for practicability. These include assessment of reducing the noise from the source, and shielding the receivers from the noise source. The following details some of the assessed considerations:

### Reducing noise from the source

Due to the proximity of the receivers, little more can be done to reduce noise from works while allowing reasonable progress, and as such the measures proposed are the best practicable options for control of noise and vibrations.

### Shielding Receivers

The main consideration here is the practicability of shielding receivers. If the methodology allows for scaffolding, then shielding would be practicable and noise levels would be maintained compliance at all receivers. If on the other hand the only practicable methodology involves cranes with no scaffolding, then shielding would not be practicable, and noise levels would exceed the limits for the short durations noted.

Based on the above, it is our opinion that the measures proposed for the works are the best practicable options available.

## 10.2 Assessment of Noise Effects

Construction works inevitably result in undesirable noise effects in the surrounding environment. To quote from the national standard NZS6803:1999, pertaining to construction noise:

> *"Although this may mean that the noise is undesirable, it is not necessarily unreasonable when all the relevant factors are taken into consideration. Construction noise is an inherent part of the progress of society. 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."*

Based on this, it is reasonable to assume that for appropriate hours of the day, works that maintain noise levels within the compliance limits are deemed to have reasonable effects, provided no affected neighbours have specific sensitivities to noise. Examples of these would be schools, early childhood centres, retirement villages, or recording studios.

Where special sensitivity receivers are identified, specific assessments are usually required even if noise levels are compliant with the regulatory limits. As such consideration must be given to the occupancies in proximity to a construction site.

Noise levels within buildings should be considered when the main use of the surrounding environment during the works is indoors. For reference in this context, the sound insulation levels of old villa type dwellings in New Zealand is generally expected to provide attenuation of 20-25dB with doors and windows closed. As a conservative measures, an attenuation level of 20dB is assumed between external and internal noise levels.

A number of other considerations are required when assessing the effects of noise on the surrounding environment, including the site itself, the dynamics of the work (where it occurs within the site), and how the effected receiver occupancies are used (indoors vs outdoors.) The following subsections provide a high level summary of the considerations pertaining to the subject site

### 10.2.1 Effects at Compliance Level

For the subject development, we note that the neighbourhood is predominantly residential. As such, assessment against normal domestic activities is appropriate

Based on the absence of specific noise sensitivities in the immediate surroundings, and with this being a long term duration project, the compliance limit for noise in accordance with the AUP is Leq 75dBA and Lmax 90dBA measured at 1m from the façade of a building, and is considered reasonable.

We note this level relates to outdoor noise. Subjectively, this is generally higher than noise levels adjacent an active state highway during busy hours of the day including heavy vehicle traffic flowing.

An external noise level of Leq 75dBA would limit outdoor activities, as conversations would require raised voices and the majority of people would only be comfortable for short periods. Taking into account the times of day allowed for this compliance noise level, it is likely to overlap with outdoor recreational activities, potentially during Saturdays (when noise levels are allowed to reach 80dBA). Notwithstanding that, this level would still be compliant.

Assessed internally, this noise level would conservatively result in an internal noise level of Leq 55dBA. For subjective comparison, this noise level is analogous with the interior of an noisier active home, or noise within an active open plan office.

We note for reference that conversational speech at 1m separation is approximately 60dBA. As such, this noise level would not interfere with normal conversations, albeit would require elevated voice.

### 10.2.2 Effects at Exceedance Level 80dBA

Regarding the exceedance at $L_{eq}$ 80dBA, when assessed internally, noise levels in rooms would conservatively be expected to reach approximately Leq 60dBA depending on the building envelope. For the subject area, we would expect newer building to attenuate noise at the frequencies involved by at least 25dBA. This would result in internal noise levels of 55dBA which would be in-line with the internal compliance limits, where internal measurements are required.

For subjective assessment in a residential occupancy, this noise level is where most people would have to raise their voices in conversations, and those watching TV need to increase the volume to hear clearly. Construction noises at this level also become disruptive in phone conversations.

Based on the above, the 5dBA difference is considered louder, albeit not unusual for the proposed activities, and not excessive in terms of subjective perception especially considering the proximity of the adjacent building to the boundary. The effects of the exceedance is considered in context of the following:

- Restricted Work Hours: In accordance with the CNVMP; excavation works have more stringent work hour restrictions than other works. These are proposed to only be undertaken between 7:00am and 7:00pm Mon-Sat in consideration of the occupancy nature of the affected properties being residential dwellings.
- Monitoring: The contractor is also required to implement pre-activity monitoring during test runs of excavation. The monitoring is intended specifically to establish procedures that sufficiently mitigate noise and vibration levels. This includes management of on/off

cycle times, setting up proper operational intensity, and installation of additional shielding where required.

- Occupancy: In accordance with the CNVMP, the works shall be, insofar as practicable coordinated with neighbours to occur during times of least occupancy.
- Noise Level: The maximum level of exceedance is predicted to be approximately 5dBA ($L_{eq}$) which is not unusual for the type of works, and subjectively not considered excessive.
- Equipment Limitations are proposed to maintain noise levels as low as practicably possible while allowing works to proceed at a reasonable pace
- Duration: Noise exceedances would reasonably be expected to occur for no more than 3 weeks for any one receiver, caveated by possible weather disruptions or delays.

# 11 Summary

The proposed works are on behalf of the occupants of the subject building. It is our understanding that approval for the works and waiver of effects can readily be provided by any occupants of apartments within the subject building occupied during the works. As such, the effects on apartments within the same building are excluded from this assessment

## 11.1 Noise

Due to the proximity of the neighbouring dwellings adjacent the boundary, and in particular during drilling and chipping, noise levels will likely be higher at these façades. We note that in the absence of a confirmed methodology, the following two options are proposed:

3. If the selected methodology includes scaffolding that allows for shielding to be established with acoustic blankets on scaffolds, then noise levels are expected to be at or within the Mon – Fri compliance limit of 75dB $LA_{eq}$ and 90dB $LA_{max}$ at all receivers
4. If, on the other hand, the methodology does not include scaffolding (i.e. cranes only); we recommend applying the following limit exceedance for approximately 2-3 weeks at any one receiver:
    - Mon-Fri 80dB $LA_{eq}$ and 95dB $LA_{max}$ at the westernmost 12m of the southern façade of 22-28 Beresford Square, and the easternmost 12m of the northern façade of the building at 25 Day Street. Noise levels would also exceed on the concrete façade of 25 Day Street, but would be compliant internally.

## 11.2 Vibrations

Considering the proposed works do not involve foundations, the adjacent buildings are not structurally connected to the subject building, and restrictions on work hours preclude night time works,

- Vibrations are expected to be compliant with the AUP requirements and standards whereby vibrations will be managed within the heritage structural protection DIN4150-3 criteria limits at all receivers and within the amenity level of 2mm/s at all receivers.

## 11.3 Mitigation

In addition to shielding if scaffolding is used, the following mitigation measures are proposed:

- Concrete Floor grinding to occur after the façade is established, or with acoustic shielding on the façade extending no less than 1 floor above and below where grinding occurs.
- All noise or vibrations generating works shall be limited to the hours of Monday – Saturday 7:00am to 7:00pm.

# Appendix I- CNVMP

## Construction Noise and Vibrations Management Plan

*Pending Methodology - Management Plan to be attached here*

# Appendix II- Site Contact Details

## Construction Noise and Vibrations Management Plan

# Noise and Vibrations Management Plan

# Contact Details

## Project Contacts

Company Name

Company Business Address

Company Contact Number

### Onsite person responsible for compliance with this Construction Management Plan

Name Project Manager:

Contact Number

### Contact person in control of the site

Name Onsite Manager:

Contact Number

### Health Safety & Environmental Manager

Name HS&E Manager:

Contact Number

### Construction Works

### Is construction in stages? Yes/No

If Yes give details. ……

Demolition ☐

Excavations ☐

Construction ☐

Is your Company in control of the site during this stage of work? Yes/No

If you answered **NO** only the Company in control of the site may complete and sign for responsibility of the Construction Management Plan.

I……. have due authorisation and delegation to sign this Construction Management Plan on behalf of the Company listed above and take responsibility for ensuring compliance with our commitment specified herein, the resource consent conditions, district plan and any other relevant legislation.

Signed …… Dated ……

# Appendix III – Resource Consent Conditions

## Construction Noise and Vibrations Management Plan

*Resource Consent Conditions to be attached here*

# Appendix IV – Project Timeline

## Construction Noise and Vibrations Management Plan

*Summary of project timeline to be attached here*

# Appendix V – Standards

## Regulatory

### *Auckland Unitary Plan – Operative*

The Auckland Unitary Plan provides, inter alia, a regulatory framework defining the noise and vibration limits on construction sites within the jurisdiction of the Auckland City Council. These limits are references in this report and assessed against for compliance analysis.

## Noise

### *NZS 6801: 2008 – Acoustics – Measurement of Environmental Sound*

This standard defines the parameters, quantities and metrics to describe noise in community environments, in addition to the procedures and methodologies of measuring and acquiring these quantities.

### *NZS 6802: 2008 – Acoustics – Environmental Noise*

This standard defines procedures for the assessment of noise against compliance criteria.

### *NZS 6803:1999 - Acoustics – Construction Noise*

This standard covers the specifics of measurement and assessment of noise from construction, maintenance and demolition. This standard also provides, for the purposes of noise level predictions, guideline noise levels expected from different machinery associated with construction and demolition activities. NZS 6803:1999 includes reproduced annexes from the British Standard BS 5228: Part 1: 1997. These are cited in this report as "pertaining to BS5228 as referenced in NZS6803".

## Vibrations

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

This standard provides guideline vibration levels for different construction activities, and recommended methods for vibration control on construction and open sites where operations are expected to generate significant vibration levels.

### *AS 2670.1: 2001 - Evaluation of human exposure to whole-body vibration - General*

This standard provides methods for the measurement and assessment of vibrations as they pertain to human health, comfort and perception.

### *DIN 4150-3:1999-02 – Structural Vibrations – Part 3: Effects of Vibration on Structures*

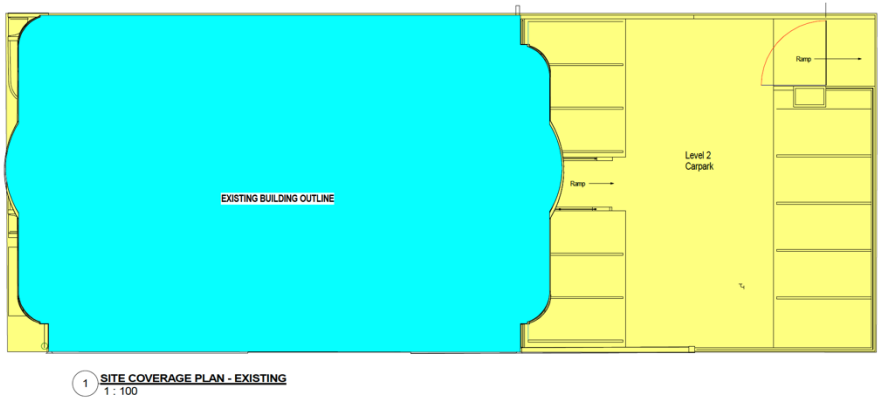
This standard provides methodology for measuring and assessing the effects of vibrations on buildings and structures designed for static loading.

# Appendix VI – Methodology

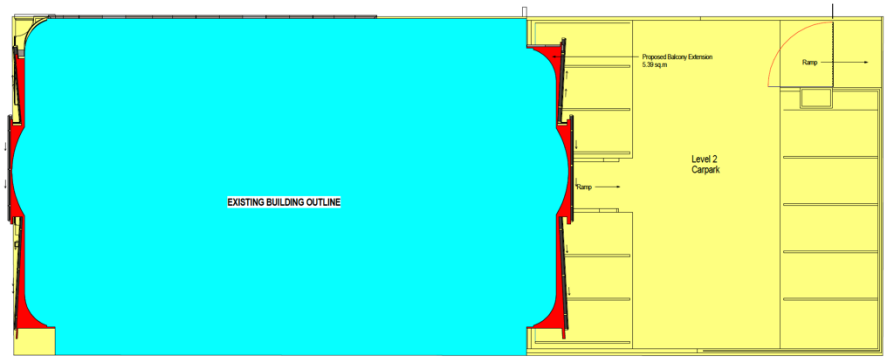
The analysis of noise and vibrations effects in this report will follow the following process:

- Site: Identification of subject site location, structures currently on the site and structures and activities in proximity to site.
- Proximity: Assessment of the location, nature, and sensitivity of noise and vibrations receivers in proximity to the subject site.
- Stratigraphy: Identification of the stratigraphy of the site especially pertaining to areas with strata likely to require noise and/or vibration intensive works to excavate.
- Works: Identification of the proposed works for the site. This includes:
    - Structures assigned for demolition, if any.
    - Depths of excavations
    - Retention methodology
    - Types of foundations
    - Construction process
- Equipment: Identification of required equipment and mechanical plant most likely to generate noise and vibrations:
    - Combinations of equipment operating during each phase
    - Locations of equipment based on stratigraphy and proposed works.
- Modelling of noise propagation at site including:
    - Site and surrounding topography
    - Built environment surrounding site, including heights and elevations
    - Equipment locations and associated noise power levels
    - Elevation / depth of equipment during different phases of works.
    - Inclusion of mitigation measures.
- Vibrations: Analysis of activities likely to generate significant vibrations:
    - Frequency and level of vibrations expected from activities at representative distances.
    - Proximity of vibrations generating activities to surrounding structures.
- Assessment: Analysis of the modelled noise propagation and vibrations levels against defined criteria based on:
    - Regulatory framework, in this case the Auckland Unitary Plan
    - New Zealand & International standards where appropriate pertaining to Noise and Vibration in the environment generally and from construction works specifically.
- Mitigation: Consideration of Best Practicable Options for the mitigation of noise or vibrations from equipment or activities

# Appendix VII – Proposed Development




1 SITE COVERAGE PLAN - EXISTING
1 : 100




2 SITE COVERAGE PLAN - PROPOSED
1 : 100

**EXISTING SITE COVERAGE LEGEND**

| | | |
|---|---|---|
| BUILDING COVERAGE | 455.81 sqm | 60.05% |
| PAVED IMPERMEABLE | 303.22 sqm | 39.95% |
| **TOTAL SITE AREA:** | **759.03sqm** | **100.00%** |

**PROPOSED SITE COVERAGE LEGEND**

| | | |
|---|---|---|
| BUILDING COVERAGE | 455.81 sqm | 33.27% |
| ADDITIONAL BUILDING | 10.08 sqm | 2.17% |
| PAVED IMPERMEABLE | 293.76 sqm | 54.44% |
| **TOTAL SITE AREA:** | **759.65sqm** | **100.00%** |

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Project Status

PROJECT TITLE:
Avoka Apartments
Reclad / Remedial

PROJECT ADDRESS:
31 Day St, Auckland

SHEET TITLE:
DEVELOPMENT CONTROL & SITE COVERAGE

North

Scale Bar
0 1000 2000 5000
SCALE: 1:100

PROJECT ISSUE DATE
Issue Date

SCALES:
1 : 100 at A1

| DESIGNER | DRAWN BY | CHECKER |
|---|---|---|
| Designer | Author | Checker |

| PROJECT NO. | SHEET NO. | REV NO. |
|---|---|---|
| | RC01-03 | |

*Figure 24 - Proposed Work Plan – Site Coverage*

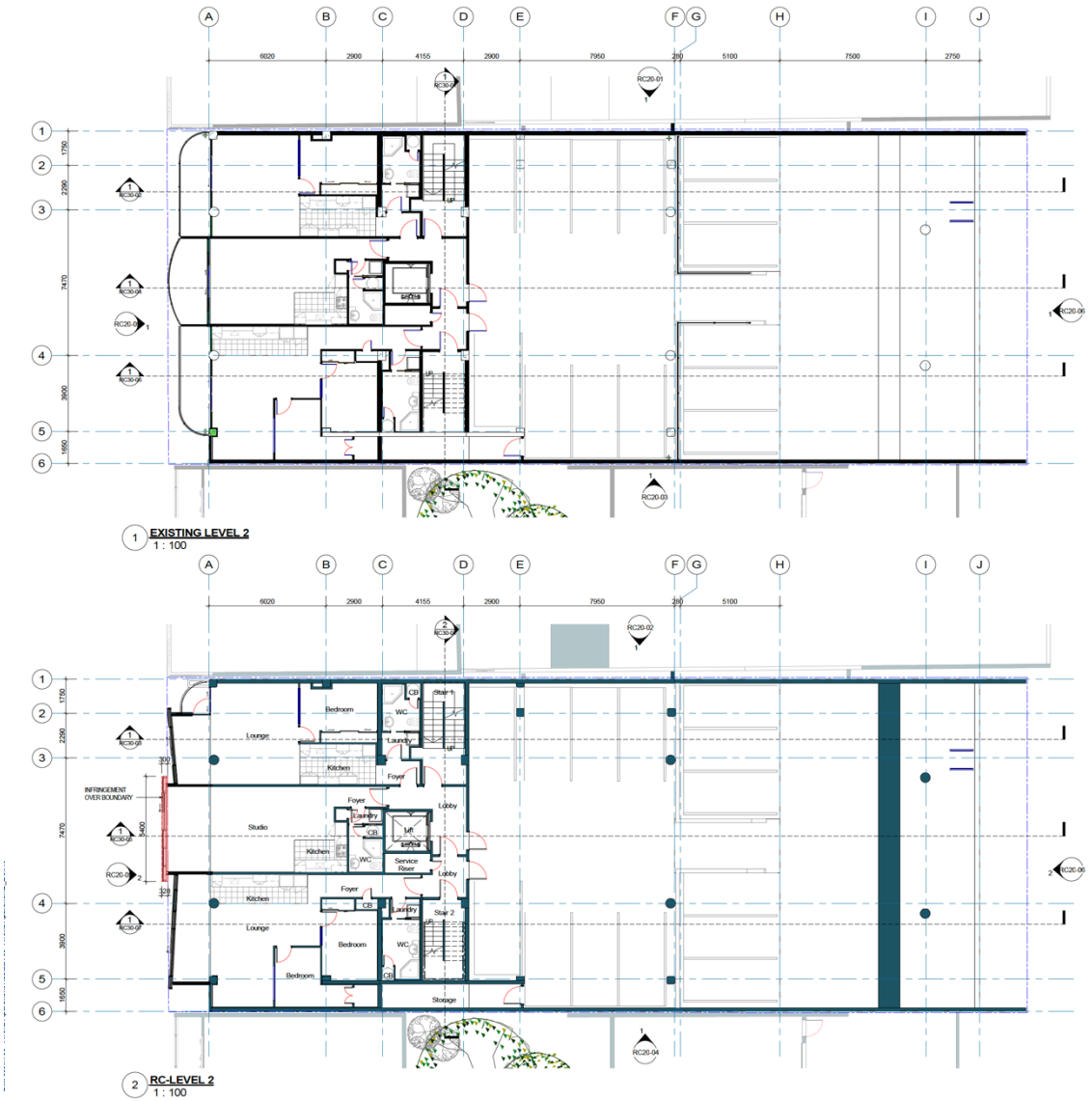
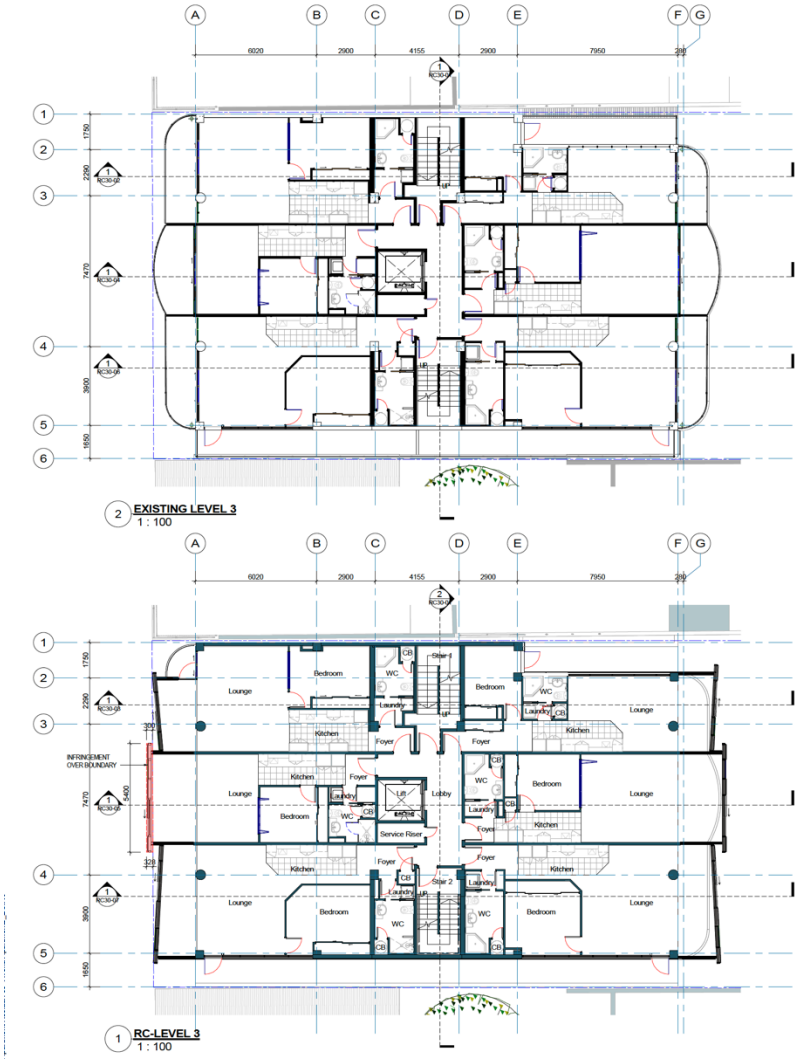



*Figure 25 – Level 2 proposed works*

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Project Status

PROJECT TITLE:
Avoka Apartments
Reclad / Remedial

PROJECT ADDRESS:
31 Day St, Auckland

SHEET TITLE:
EXISTING AND
PROPOSED LEVEL 3

North

Scale Bar
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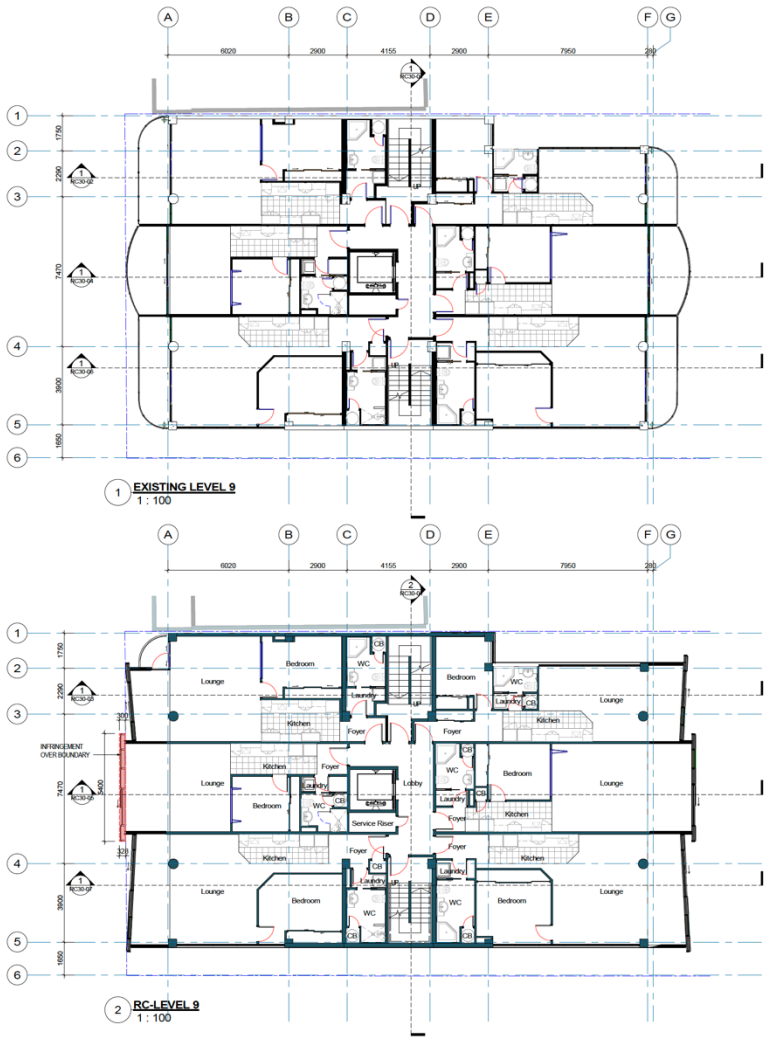
| Designer | Author | Checker |

| PROJECT NO. | SHEET NO. | REV NO. |
|---|---|---|
| | RC01-06 | |

*Figure 26 – Level 3 Proposed works*

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Project Status

PROJECT TITLE:
Avoka Apartments
Reclad / Remedial

PROJECT ADDRESS:
31 Day St, Auckland

SHEET TITLE:
EXISTING AND
PROPOSED LEVEL 9

North

Scale Bar
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SCALE: 1:100

PROJECT ISSUE DATE
Issue Date

SCALES:
1 : 100 at A1

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|---|---|---|
| Designer | Author | Checker |

| PROJECT NO. | SHEET NO. | REV NO. |
|---|---|---|
| | RC01-12 | |

*Figure 27 – Level 9 Proposed Works*


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Project Status

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Avoka Apartments
Reclad / Remedial

PROJECT ADDRESS:
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SHEET TITLE:
EXISTING AND
PROPOSED LEVEL 12

North

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SCALE: 1:100

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| Designer | Author | Checker |

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|---|---|---|
| RC01-15 | | |

*Figure 28 – Level 12 Proposed Works*


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Project Status

PROJECT TITLE:
Avoka Apartments
Reclad / Remedial

PROJECT ADDRESS:
31 Day St, Auckland

SHEET TITLE:
EXISTING AND
PROPOSED ROOF

North

Scale Bar
0 1000 2000 5000
SCALE: 1:100

PROJECT ISSUE DATE
Issue Date

SCALES:
1 : 100 at A1

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|---|---|---|
| Designer | Author | Checker |

| PROJECT NO. | SHEET NO. | REV NO. |
|---|---|---|
| RC01-16 | | |

*Figure 29 - Roof Proposed Works*

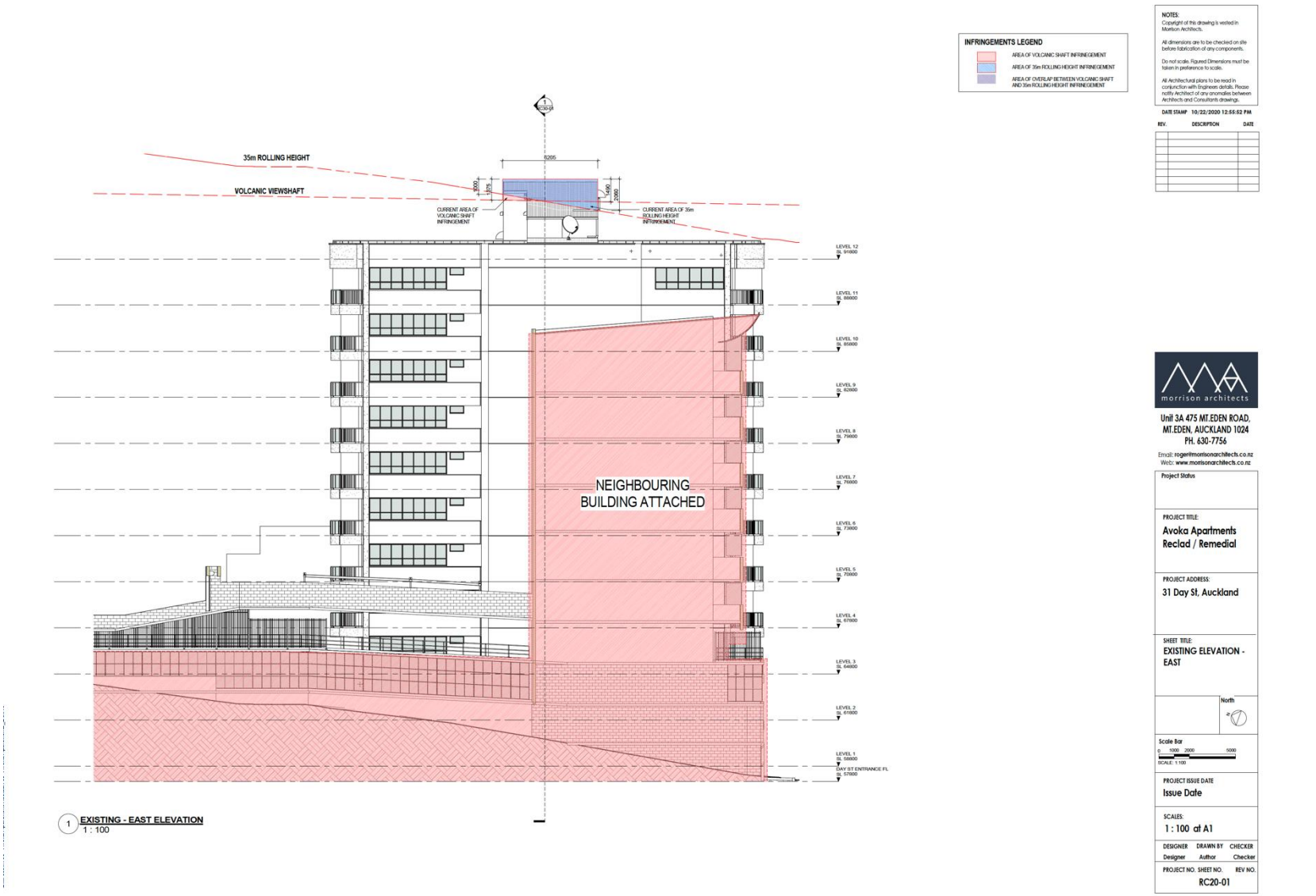



*Figure 30 - Existing East Elevation*

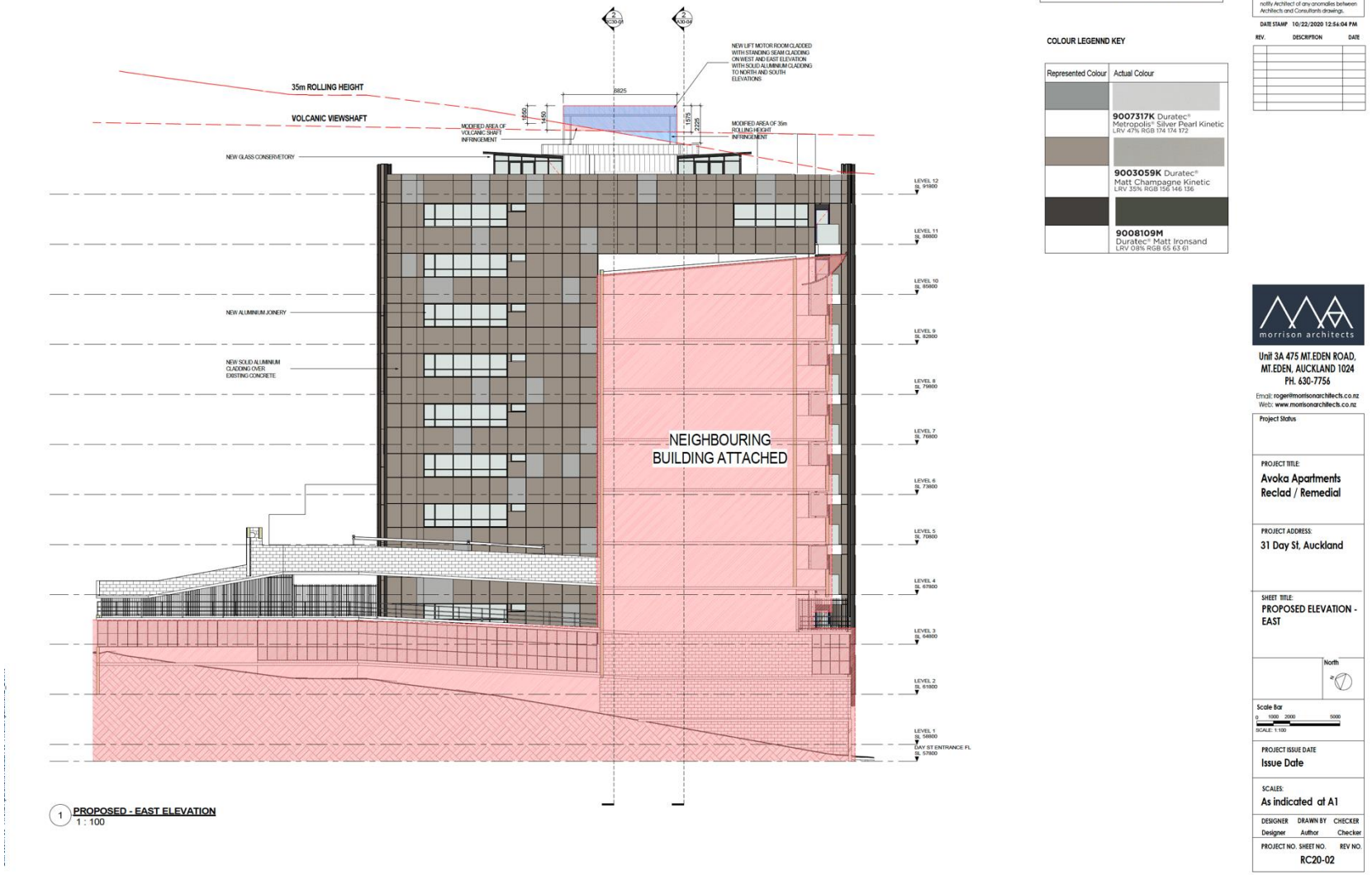



*Figure 31 - Proposed East Elevation*

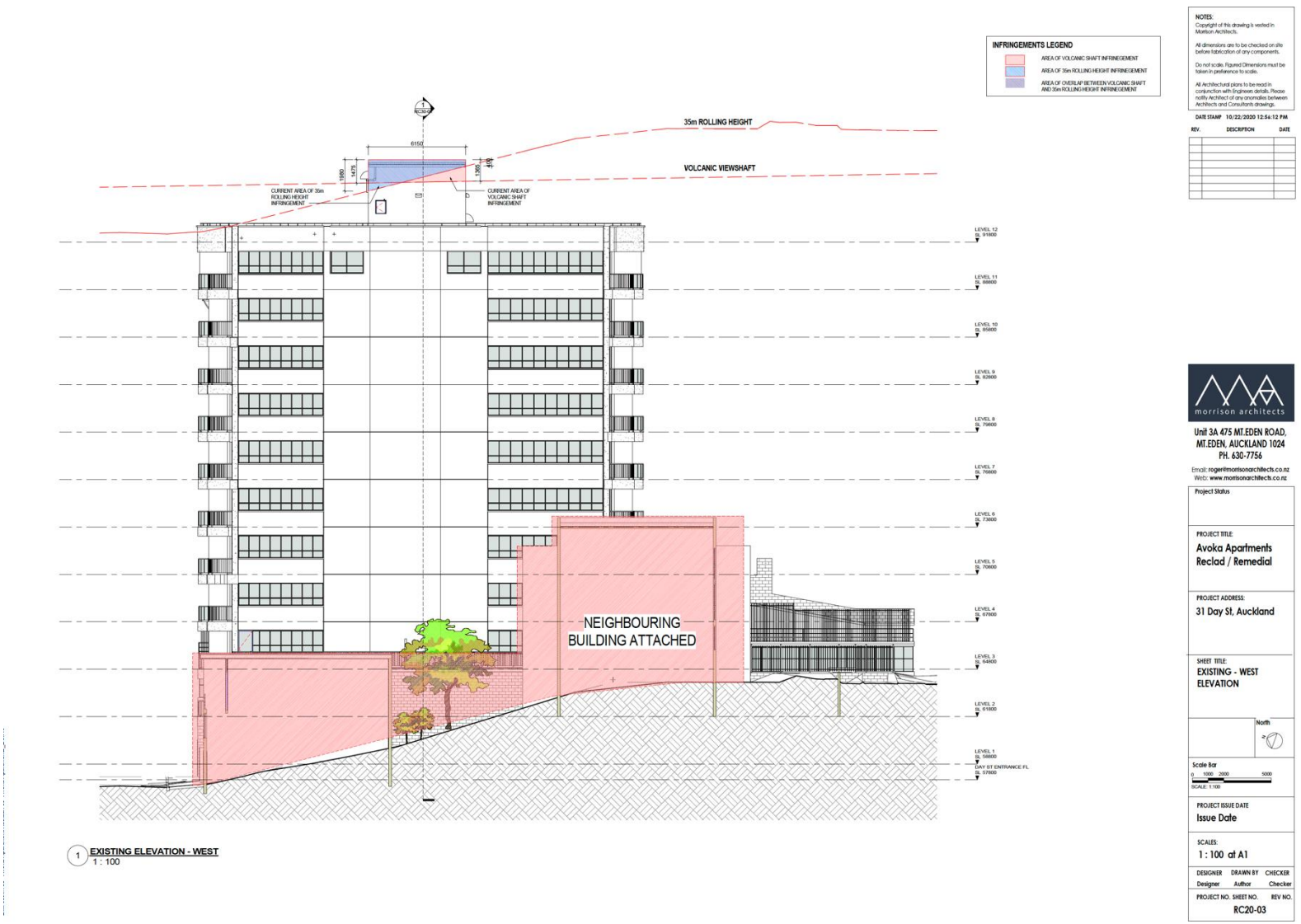



*Figure 32 - Existing West Elevation*

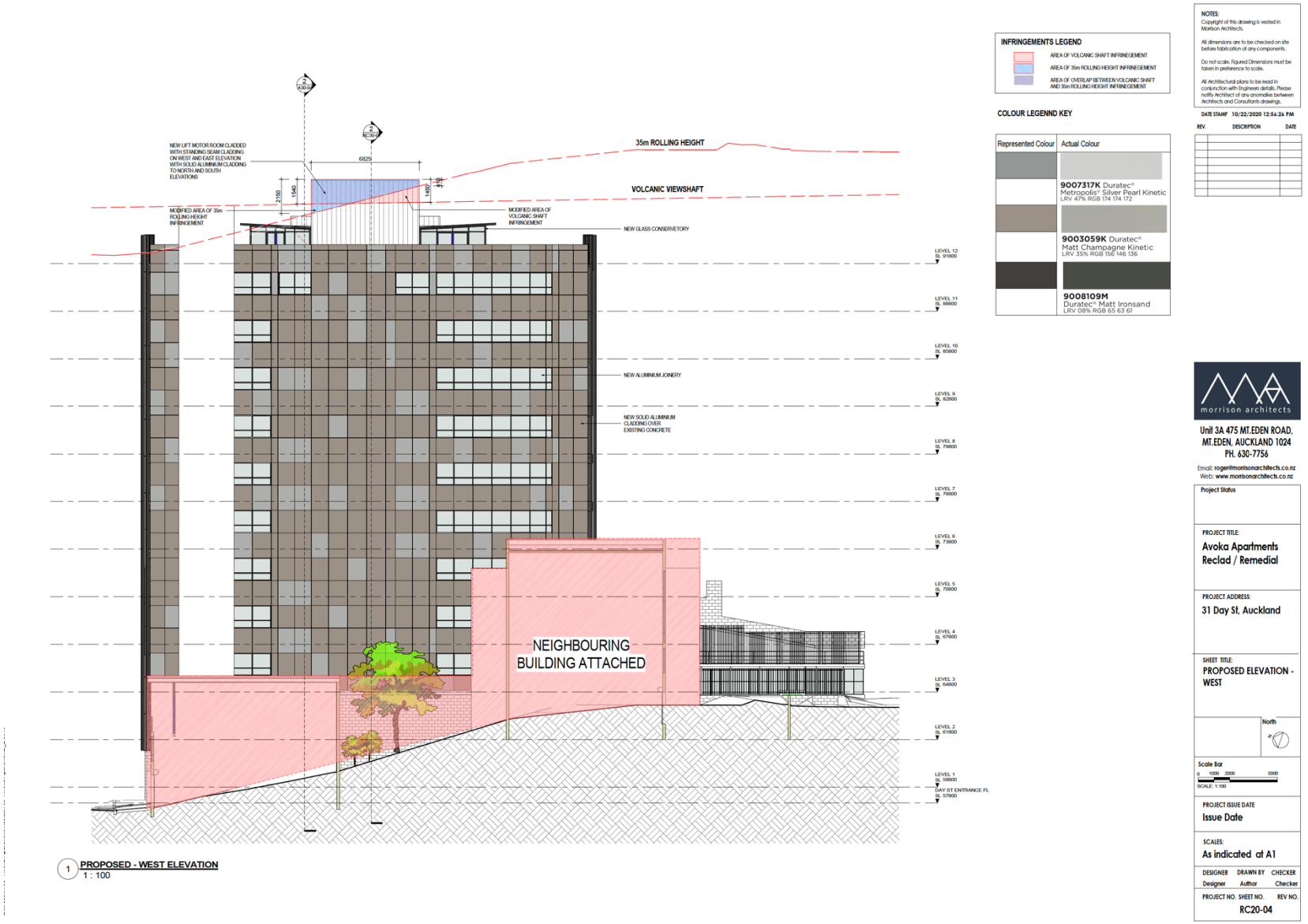



*Figure 33 - Proposed West Elevation*

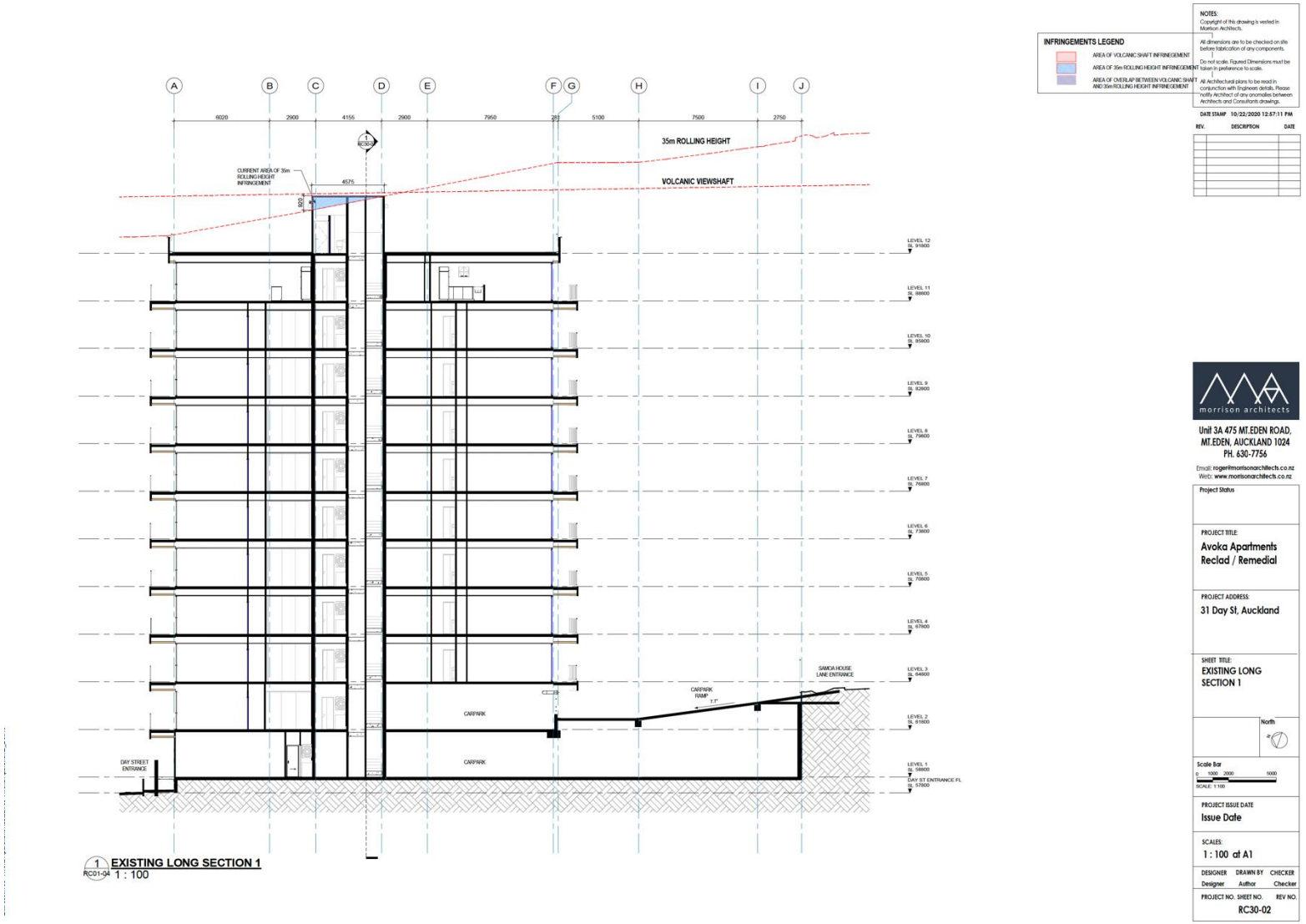



*Figure 34 - Existing Section*

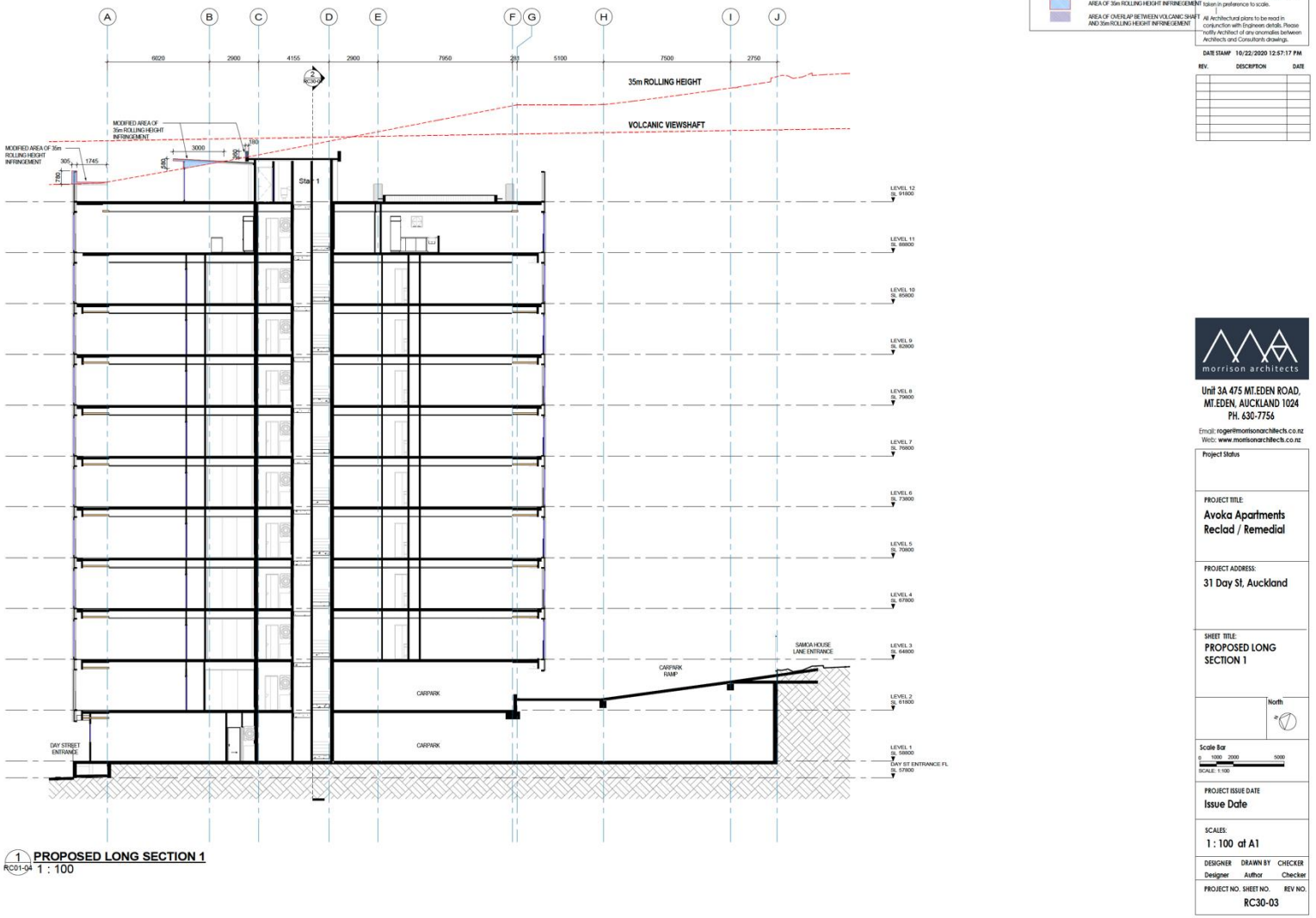


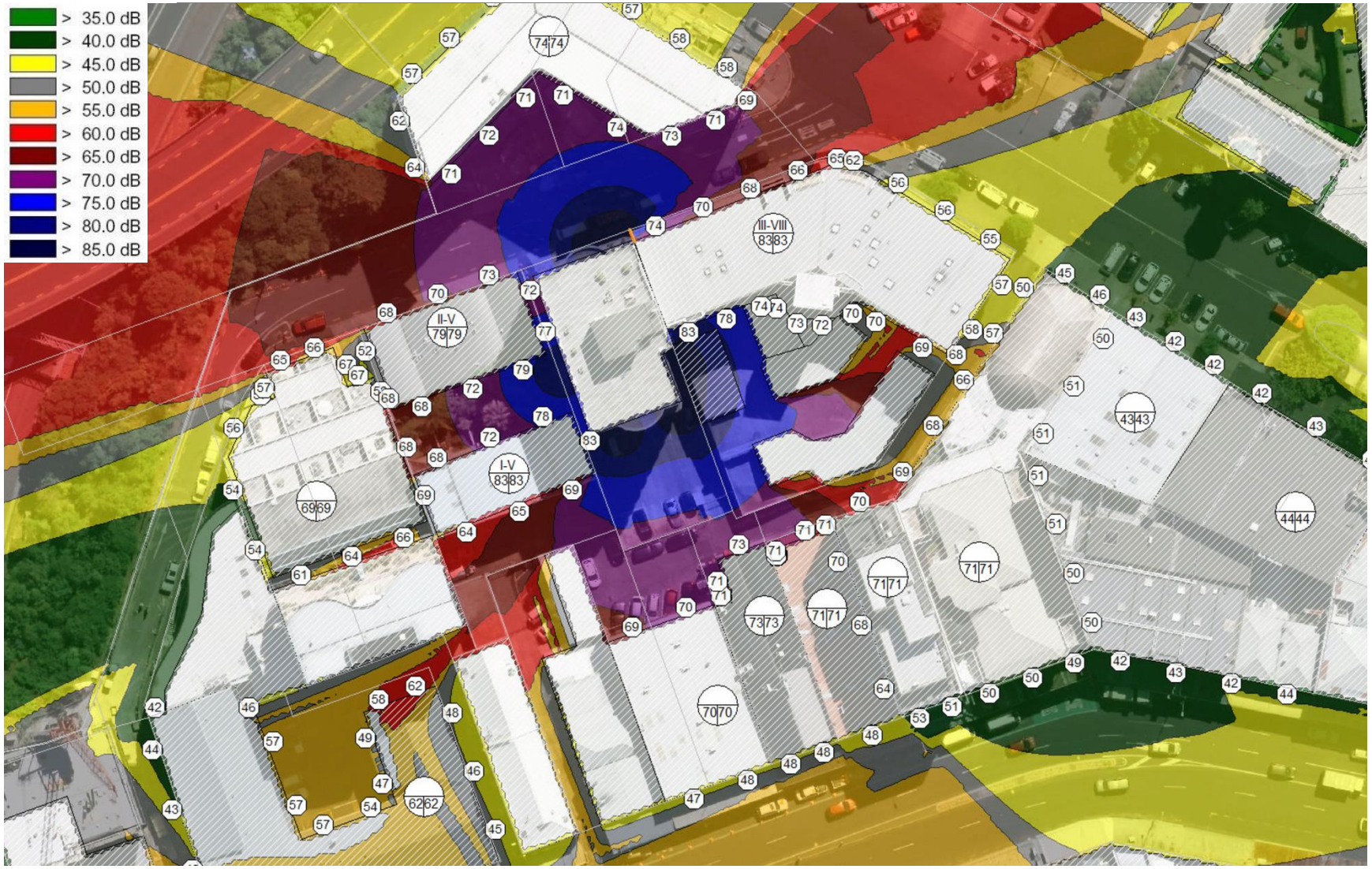

*Figure 35 - Proposed Section*

# Appendix VIII – Noise Prediction Models

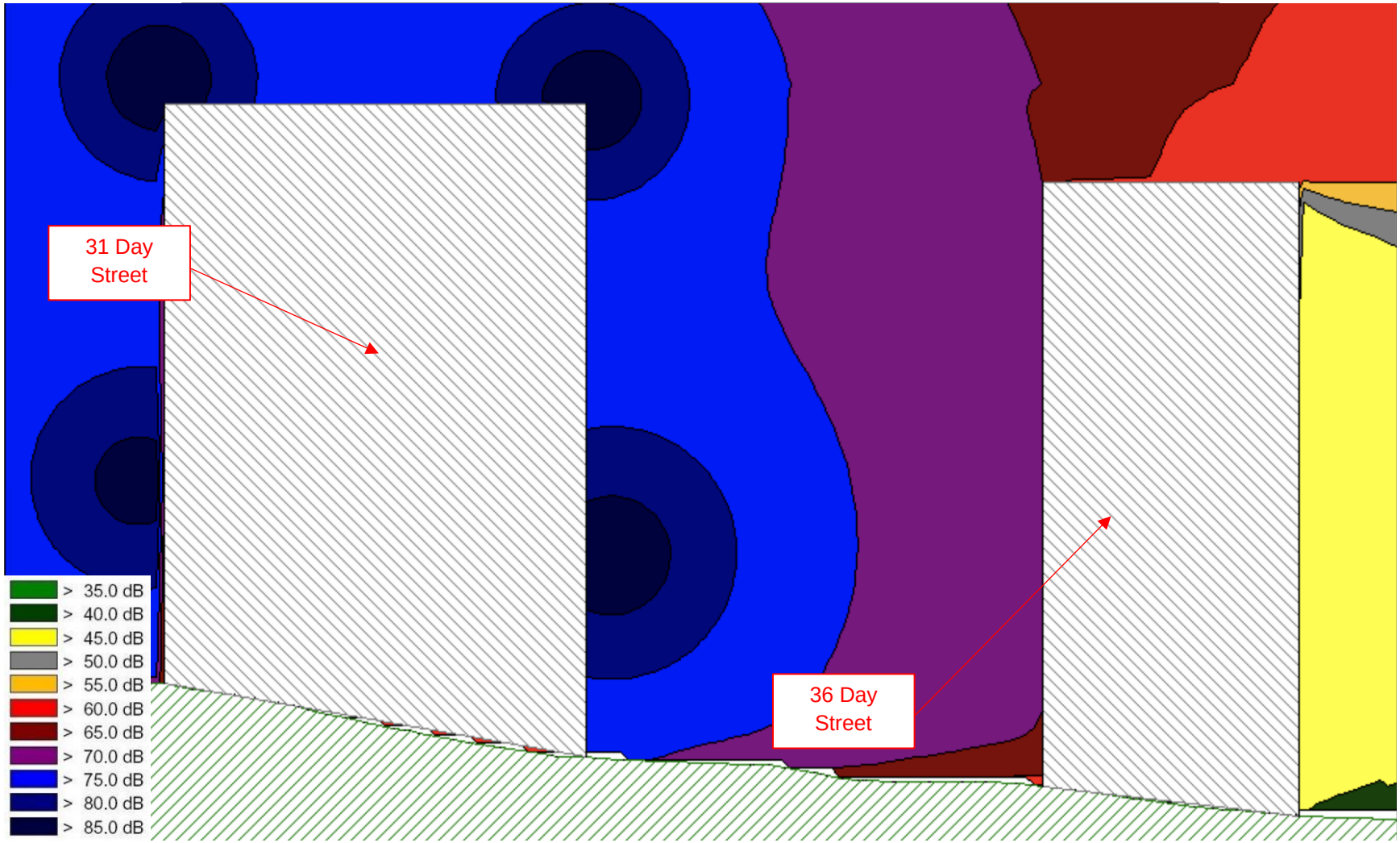
## CadnaA Version 2019

*Without Time Averaging*

| Activity | Receiver Height |
|---|---|
| Façade Works | 12m Grid (Levels in circles are maximum for full façade height) |



| Activity | Receiver Height |
|---|---|
| Façade Works | Section across Day Street |



# Glossary of Terms- Acoustics

**Ambient Noise**: the total noise, at a given place, a composite of sounds from many sources near and far.

**Asymmetric**: a waveform not identical on both sides of the mean or zero line, lacks symmetry.

**Average**: in acoustics where dB levels are extensively used, average may not mean adding up the values and then dividing by the number of samples.

**Octave**: a range of frequencies whose upper frequency limit is twice that of its lower frequency limit. For example, the 1000 Hertz octave band contains noise energy at all frequencies from 707 to 1414 Hertz.

In acoustical measurements, Sound Pressure Level is often measured in octave bands, and the centre frequencies of these bands are defined by ISO - 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, 16 kHz to divide the audio spectrum into 10 equal parts.

The sound pressure level of sound that has been passed through an octave band pass filter is termed the octave band sound pressure level.

One-third Octave Bands, there are three similar bands in each octave band.

1/1, 1/3, 1/6, 1/12, and 1/24 octaves are all used in acoustics.

**Background Noise**: the noise at a given location and time, measured in the absence of any alleged noise nuisance sources, also known as Residual Noise.

**Broadband Noise:** also called wideband noise - noise whose energy is distributed over a wide section of the audible range as opposed to Narrowband Noise.

**Class 1:** precision grade sound level meters for laboratory and field use - also known as Type 1.

**Continuous Spectrum:** sound spectrum whose components are continuously distributed over a given frequency range.

**Frequency Weighted Sound Levels**: Frequency weightings correlate objective sound measurements with the subjective human response. The human ear is frequency selective; between 500 Hz and 6 kHz our ears are very sensitive compared with lower and higher frequencies.

**A-weighting**: the A-weighting filter covers the full audio range - 20 Hz to 20 kHz and the shape is similar to the response of the human ear at the lower levels

**C-weighting**: a standard frequency weighting for sound level meters, commonly used for higher level measurements and Peak - Sound Pressure Levels.

**Z-weighting**: Z for 'Zero' frequency weighting, which implies no frequency weighting. In reality the range is 10 Hz to 20 kHz ±1.5 dB.

**dB Level**: is the Logarithm of the ratio of a given acoustic quantity to a reference quantity of the same kind. The base of the logarithm, the reference quantity, and the kind of level must be indicated.

**decibel**: dB : a relative unit of measurement widely used in acoustics, electronics and communications. The dB is a Logarithmic unit used to describe a ratio between the measured level and a reference or threshold level of 0dB. The ratio may be Sound Power, Sound Pressure, voltage or Sound Intensity, etc.

**Deltatron ®**: trade name for IEPE - Integrated Electronics Piezoelectric.

**FFT**: Fast Fourier Transform : a digital signal processing technique that converts a time record into a narrow band constant bandwidth filtered spectrum. Measurements are defined by specifying the frequency span and a number of lines (or filters).

**Frequency**: f : the number of times that a Periodic function or vibration occurs or repeats itself in a specified time, often 1 second - cycles per second. It is usually measured in Hertz (Hz).

**Frequency Analysis**: analysing an overall broadband noise to identify the different contributions in different parts of the audio spectrum. Typically the analysis in made using 1/1-Octave, 1/3-Octave or narrow band (FFT) Analysis.

**Frequency Band**: a continuous range of frequencies between two limiting frequencies.

**Hertz**: Hz : the unit of Frequency or Pitch of a sound. One hertz equals one cycle per second.

**Impact Sound**: the sound produced by the collision of two solid objects. Typical sources are footsteps, dropped objects, etc., on an interior surface (wall, floor, or ceiling) of a building.

**Infrasound**: sound whose frequency is below the low-frequency limit of audible sound (about 16 Hz).

**Integrating (of an instrument)**: indicating the mean value or total sum of a measured quantity.

**kHz**: kilohertz : 1 kHz = 1000 Hz = 1000 Hertz.

**LA**: A-weighted, Sound Level.

**LA10**: is the noise level just exceeded for 10% of the measurement period, A-weighted and calculated by Statistical Analysis.

**LA90**: is the noise level exceeded for 90% of the measurement period, A-weighted and calculated by Statistical Analysis.

**LAn**: noise level exceeded for n% of the measurement period with A-weighted , calculated by Statistical Analysis - where n is between 0.01% and 99.99%.

**LAeq**: A-weighted, equivalent sound level. A widely used noise parameter describing a sound level with the same Energy content as the varying acoustic signal measured - also written as dBA Leq

**LAF**: A-weighted, Fast, Sound Level.

**LAFmax**: A-weighted, Fast, Maximum, Sound Level.

**LAFmin**: A-weighted, Fast, Minimum, Sound Level.

**LAIeq**: A-weighted, Impulse, Leq, Sound Level.

**LAmax**: A-weighted, Maximum, Sound Level

**LAS**: A-weighted, Slow, Sound Level.

**LASmax**: A-weighted, Slow, Maximum, Sound Level.

**LASmin**: A-weighted, Slow, Minimum, Sound Level.

**LC**: C-weighted, Sound Level.

**LCE**: C-weighted, Sound Exposure Level

**LCeq**: C-weighted, Leq, Sound Level

**LCF**: C-weighted, Fast, Sound Level.

**LCFmax**: C-weighted, Fast, Maximum, Sound Level.

**LCpeak**: C-weighted, Peak, Sound Level.

**Leq**: Equivalent Sound Level

**Lpeak**: Peak Sound Level

**LZ**: Z weighted, Sound Level.

**LZE**: Z-weighted, Sound Exposure Level

**LZeq**: Z-weighted, Leq, Sound Level.

**LZF**: Z-weighted, Fast, Sound Level.

**LZFmax**: Z-weighted, Fast, Maximum, Sound Level.

**LZFmin**: Z-weighted, Fast, Minimum, Sound Level.

**Multi-spectrum**: a one or two-dimensional array of spectra, consisting of two or more spectra that were recorded during the same measurement

**Narrowband Noise**: noise which has its energy distributed over a relatively small section of the audible range.

**Natural Frequency**: the frequency at which a resiliently mounted mass will vibrate when set into free vibration. The frequency of oscillation of the free vibration of a system if no Damping were present.

**Noise**: any sound that is undesired by the recipient. Any sound not occurring in the natural environment, such as sounds emanating from aircraft, highways, industrial, commercial and residential sources. Interference of an electrical or acoustical nature.

**Octave**: a range of frequencies whose upper frequency limit is twice that of its lower frequency limit. For example, the 1000 Hertz octave band contains noise energy at all frequencies from 707 to 1414 Hertz.

**Octave Band analyser**: an instrument that measures Sound Levels in octave bands.

**Peak-to-Peak**: the amplitude difference between the most positive and most negative value in a time waveform, that is, the total Amplitude.

**Piezoelectric**: PE : any material which provides a conversion between mechanical and electrical energy. Piezo is a Greek term which means 'to squeeze'. If mechanical stresses are applied to a piezoelectric crystal, then an electrical charge results. Conversely, when an electrical voltage is applied across a piezoelectric material, the material deforms.

**Pitch**: is a subjective auditory sensation and depends on the frequency, the harmonic content, and to a lesser extent on the loudness of a sound.

**Spectrum**: the description of a sound wave's resolution into its components of frequency and amplitude.

**Third Octave Band**: Octave bands sub-divided into three parts, equal to 23% of the centre frequency. Used when octave analysis is not discrete enough. Divides the audio spectrum into 33 or more equal parts with Constant Percentage Bandwidth filter.

**Tone**: sound or noise recognisable by its regularity. A simple or Pure Tone has one frequency. Complex tones have two or more simple tones, the lowest tone frequency is called the Fundamental, the others are Overtones.

**Vibration**: mechanical oscillations occur about an equilibrium point. The oscillations may be periodic such as the motion of a pendulum or random.