MARSHALL DAY Acoustics

CORNER GEELONG-BALLAN ROAD & OLD MELBOURNE ROAD, BALLAN NOISE IMPACT ASSESSMENT

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Project: **CORNER GEELONG-BALLAN ROAD & OLD MELBOURNE ROAD, BALLAN**

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SUMMARY

Wel.Co are proposing to develop vacant land located at the intersection of Geelong-Ballan Road and Old Melbourne Road, Ballan for residential purposes, which requires a planning scheme amendment. The site is subject to road traffic noise from adjoining roads to the north and west of the site.

The recommendations presented in this report are preliminary and intended for planning purposes to inform feasibility. Recommendations are to be reviewed at the design development stage of the project to verify the measures required to address noise.

This assessment has been completed to indicate the extent and possible design solutions for traffic noise attenuation at the site.

The assessment has been based on:

- Concept development plans intended as part of the planning scheme amendment
- External and internal criteria determined in accordance with VicRoads policy document *Requirement of Developers – Noise Sensitive Uses* and other relevant guidelines and legislation
- Noise measurements of 2022 traffic noise conditions undertaken at the subject site
- Noise modelling undertaken to predict traffic noise levels across the site at the ground floor level for the design year 2034.

The assessment has shown that without any screening, noise from the Western Freeway and Geelong-Ballan Road would exceed the VicRoads criteria across multiple future housing lots within the development site.

Noise modelling demonstrated that noise levels on the subject site can be mitigated in accordance with VicRoads' requirements. Preliminary noise barrier and/or earth bund configurations have been outlined showing the following:

- Noise barriers or bunds along the north and west road reserves adjacent to the development site varying in height between 1.8 m and 7.0 m above natural ground level
- An indication of lots where facade treatments may be required to achieve internal noise levels consistent with the recommendations of AS 3671 and AS 2107. Nomination of appropriate facade treatments can be confirmed once dwelling plans are further developed.

The noise barrier/earth bund may require review during subsequent design stages to account for specific lot layouts, any significant earthworks and changes to the site terrain, opportunities to minimise traffic noise as far as reasonably practical as per the general environmental duty as well as revisions to address Council and VicRoads feedback.

The results for the monitoring at locations assessable to the investigation thresholds provided in the VPRINP deemed that attention measures are not required at this site to satisfy rail noise objectives. Therefore, further assessment of rail noise has not been undertaken.

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1.0 INTRODUCTION

Wel.Co Pty Ltd (Wel.Co) are proposing to develop land located at the intersection of Geelong-Ballan Road and Old Melbourne Road, Ballan. The site is subject to significant road traffic noise from adjoining roads to the north and west of the site as well as potential railway noise from the south.

For a residential development to take place, the land will need to be rezoned. The purpose of this high-level noise impact assessment is to inform the land use and development response for the proposed subject site.

The recommendations presented in this report are preliminary and intended for planning purposes to inform feasibility. Recommendations are to be reviewed at the design development stage of the project to verify the measures required to address noise.

A glossary of acoustic terminology used throughout this report is included in Appendix A.

2.0 SITE DETAILS

The site is located on vacant land west of the Ballan township. The subject site is bounded by the following:

- Western Freeway to the north
- Geelong-Ballan Road to the west
- Old Melbourne Road to the south
- Werribee River to the east with residential dwellings beyond.

The site is currently undeveloped and is highlighted in Figure 1.

Figure 1: Subject site location

The subject site is currently located with a rural living zone. It is understood that an applicant led planning scheme amendment may be sought to rezone the land to potentially a general residential zone and low density residential zone. The currently proposed concept plans for the site indicate a mixture of residential land as well as large open public areas. The concept plans are understood to be generally in accordance with Clause 21.08 Ballan of the Moorabool Planning Scheme and the Ballan Framework plan.

The concept masterplan used to assess the feasibility of the site are provided in Appendix B.

3.0 RELEVANT LEGISLATION AND GUIDELINES

3.1 Moorabool Planning Scheme

Key extracts of ordinance from the Moorabool planning scheme relating to noise impacts relevant to the site are provided below.

21.05 DEVELOPMENT AND COMMUNITY INFRASTRUCTURE

Under clause 21.05-3, one of the strategies supporting the Objectives for Integrated transport is to *require that land use and development does not prejudice levels of service, safety, and amenity of the Western Freeway and minimise any adverse effects of noise from traffic.*

32.08 GENERAL RESIDENTIAL ZONE

32.08-11 Application requirements

An application must be accompanied by the following information, as appropriate:

…

- *The likely effects, if any, on adjoining land, including noise levels, traffic, the hours of delivery and despatch of good and materials, hours of operation and light spill, solar access and glare. …*

It could be argued that an assessment of traffic noise impacts from the Western Freeway should accompany an application.

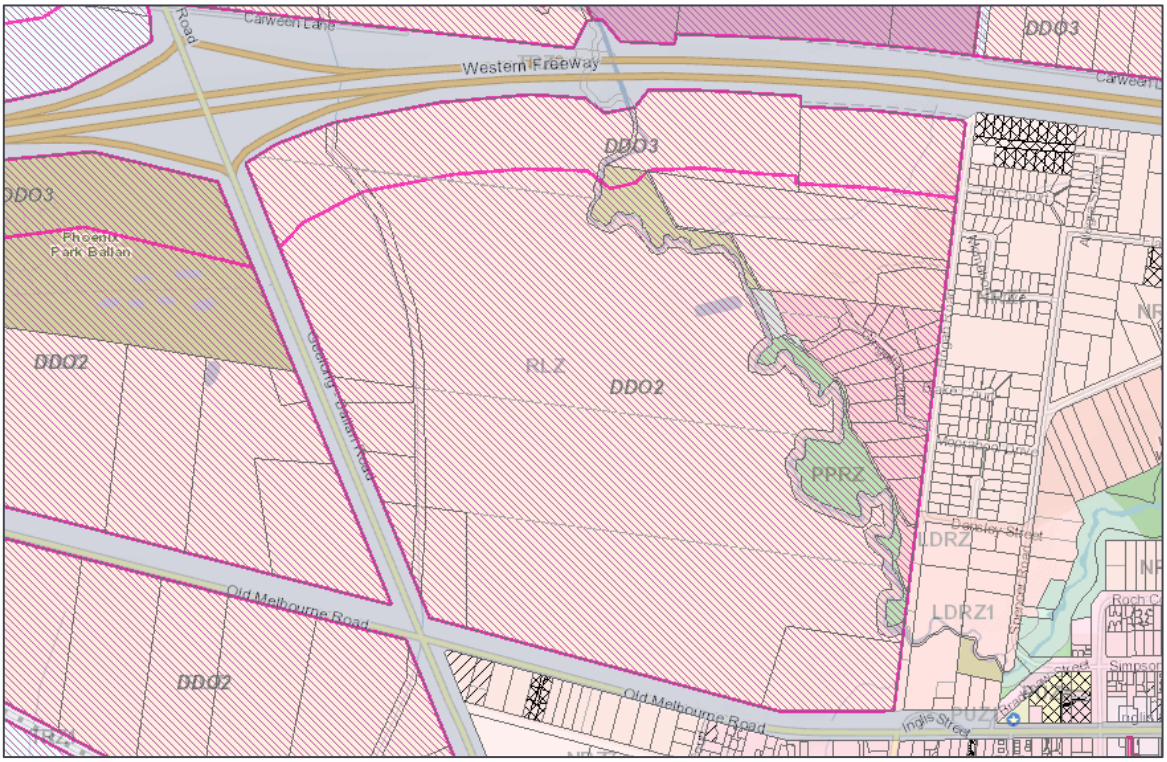
32.03 LOW DENSITY RESIDENTIAL ZONE

There are no clauses related to acoustic amenity for this zone type.

43.02 DESIGN AND DEVELOPMENT OVERLAY

The site is subject to two Design and Development Overlays, namely DDO3 which extends approximately 160 m into the north end of the site, and DDO2 which covers the remaining are of the site, as shown in Figure 2.

Figure 2: Design and Development Overlays



One of the two stated purposes of the overlays is *to identify areas which are affected by specific requirements relating to the design and built form of new development.*

There are no clauses related to acoustic amenity for DDO2.

DDO3 does include clauses relating to traffic noise impacts from the Western Highway, as reproduced below.

> *SCHEDULE 3 TO CLAUSE 43.02 DESIGN AND DEVELOPMENT OVERLAY*
>
> *Shown on the planning scheme map as DDO3.*
>
> *NATIONAL ROUTE 8 (WESTERN FREEWAY/HIGHWAY) ENVIRONS*
>
> 18.2 *Design objectives*
>
> *To ensure that the development of land or the display of signs near the alignment of the Western Freeway does not prejudice the levels of service, safety and amenity of the Western Freeway/Highway.*
>
> *To minimise any adverse effects of noise on noise sensitive uses from traffic using the Western Freeway/Highway.*
>
> *…*
>
> *5.0 Application requirements*
>
> *Building and works*
>
> *An application to construct a building or to carry out or construct works must be accompanied by plans and a report that show how the proposal responds to the decision guidelines detailed in this schedule and by information that demonstrates that the development would be constructed or carried out in accordance with the following requirements:*

- *Any new dwelling must be:*
  - *Sited where the noise level does not exceed 70dB(A).*
  - *Designed and constructed to acoustic standards as set out in AS3671-1989 "Acoustic – Roads Traffic Noise Intrusion – Building Siting and Construction" where noise level is in excess of 60dB(A). (Noise levels quoted are free field L,[1.8hr]* [sic[1]]*)*
- *Any other building providing for a noise sensitive use listed below must be designed and constructed to acoustic standards with interior noise levels not greater than those set out in any appropriate Australian Standard in relation to road traffic noise intrusion.*
  - *Accommodation (other than a dwelling).*
  - *Art and craft centre.*
  - *Brothel.*
  - *Child care centre.*
  - *Display home.*
  - *Education centre.*
  - *Funeral parlour.*
  - *Hospital.*
  - *Indoor recreation facility.*
  - *Office.*
  - *Place of assembly.*
  - *Retail premises.*
  - *Research centre.*
  - *Veterinary centre.*
  - *Warehouse.*
  - *Winery.*
- *Any buildings must be set back from the Western Freeway/Highway in order to create a visual and acoustic buffer, ensuring that future works within the Freeway/Highway reserve to minimise any adverse effects are not necessary.*

Landscaping must be provided around any buildings or works to suitably screen the development from the Western Freeway/Highway.

…

7.0 Decision guidelines

The following decision guidelines apply to an application for a permit under Clause 43.02, in addition to those specified in Clause 43.02 and elsewhere in the scheme which must be considered by the responsible authority:

[1] The reference to the noise metric L,[1.8hr] is believed to be a typographical error. The $L_{A10,18h}$ noise metric is used in both Australian Standard 3671 and the VicRoads *Traffic Noise Reduction Policy* and *Requirements of Developers – Noise Sensitive Uses* guidelines when quantifying external traffic noise. It has therefore been assumed that the noise levels quoted in this clause are intended to be free field $L_{A10(18h)}$ levels.

- *Whether the proposal will enhance the environs of the Western Freeway/Highway.*
- *Whether the proposal will prejudice the levels of service, safety and amenity of the Western Freeway/Highway.*
- *Whether proposed landscaping will suitably screen the proposal from the Western Freeway/Highway.*
- *Whether the proposed development adversely affects skyline and landscape values.*
- *The effect of the proposed development or sign on the amenity of surrounding properties.*
- *Comments of the Roads Corporation.*

Moorabool Planning Scheme Amendment C88 Panel Report

We note the following comments in the *Moorabool Planning Scheme Amendment C88, Ballan Strategic Directions Panel Report* dated 4 July 2019 concerning visual amenity considerations of traffic noise barriers:

> *It is also unknown whether the current views over land from the freeway will be maintained. Residential land adjoining a highway may be affected by traffic noise and a noise wall may be required. This could restrict views to the land and call into question the logic of providing larger lots.*
>
> *The interface with the arterial road network could be treated a number of ways to create a non-urban edge condition at this location. The Panel considers that the best approach is to investigate interface land to determine its treatment as part of the rezoning for the subject land.*

Moorabool planning scheme summary

In summary, to minimise any adverse effects of Western Freeway traffic noise on noise sensitive uses (i.e. proposed dwellings):

- Dwellings should not be located where Western Freeway traffic noise levels exceed 70 dB $L_{A10(18h)}$.
- Dwellings exposed to free field Western Freeway traffic noise levels exceeding 60 dB $L_{A10(18h)}$ must be designed and constructed to the acoustic standards in AS 3671-1989 *Acoustic – Roads Traffic Noise Intrusion – Building Siting and Construction.* We note this criterion is almost identical to the 63 dB $L_{A10(18h)}$ VicRoads criterion discussed in the next section of this report, as the VicRoads criterion includes a +2.5 dB facade correction to free field noise levels to account for any noise reflected off facade dwellings that may increase traffic noise exposure.
- Dwelling setbacks from the Western Freeway are identified as a means of minimising adverse effects from traffic noise. Landscaping is also required to 'screen' dwellings from the Western Freeway, but it is unclear if this in relation to visual screening only, or if it extends to acoustic screening by means of noise barriers. Note that noise barriers would be subject to visual amenity considerations which may limit the extent, height and appearance of any barriers.
- The Roads Corporation (VicRoads) are likely to refer to their guideline document *Requirements of Developers – Noise Sensitive Uses* (refer below) when making comments to assist a decision for the proposed development.

3.2 Legislation and guidelines

Various guidelines and standards are used in Victoria to assess and control road traffic noise for new residential developments. A summary of the key guidelines and policies for this assessment is presented in Table 1. Further details of the guidelines and policies are provided in Appendix C.

Table 1: Legislation and guidelines relevant to the proposal

Document	Overview
Environment Protection Act 2017 (the EP Act)	The EP Act provides the overarching legislative framework for the protection of the environment in Victoria. It establishes a general environmental duty to minimise the risks of harm to human health or the environment from pollution or waste, including noise, so far as reasonably practicable. The EP Act does not specify noise limit values, but prohibits the emission of unreasonable or aggravated noise from non-residential premises. Section 93 of the EP Act provides for the creation of an environmental reference standard to be used to assess and report on environmental conditions in the whole or any part of Victoria (see below).
Environment Reference Standard dated 25 May 2021 (ERS)	The ERS is made under section 93 of the EP Act. The ERS sets out environmental values for ambient sound that are sought to be achieved and maintained in Victoria and standards to support those values. The indicators and objectives within the standard provide a benchmark for comparing desired outcomes to the actual state of the environment and a basis for assessing actual and potential risks to the environmental values. The ERS is not a compliance standard, and the values listed within the ERS for different land uses are explicitly not noise limits nor design criteria. The primary function of the ERS is to provide assessment and reporting benchmarks for environmental values. Section 60(1A) of the Planning and Environment Act 1987 states the responsible authority (i.e. local council), if the circumstances appear to so require, may consider the ERS before deciding on a planning application.
General environmental duty (GED)	The general environmental duty (GED) is outlined in Part 3.2 of the EP Act which came into effect 1 July 2021. The GED requires anyone engaging in an activity posing a risk of harm to human health and/or the environment from pollution (including noise) and waste, to minimise those risks to prevent harm as far as reasonably practicable. The GED applies wherever there is a risk of harm, regardless of whether the noise emitted has caused complaints or caused harm to people or the environment. The GED is applied first to eliminate or reduce the risk of harm to human health and the environment from noise so far as reasonably practicable. Satisfying noise limits or design criteria should be a secondary consideration once the risk of harm has been minimised. The development of vacant land that is subject to traffic noise for residential or other noise sensitive uses may be considered to be an activity that poses a risk of harm to human health. Therefore, the developer should take reasonably practicable steps to reduce the risk of harm.

Document	Overview
VicRoads' *Requirements of Developers – Noise Sensitive Uses*	VicRoads has developed guidelines for noise mitigation at new residential developments near freeways. These guidelines include the following acoustic criteria: • Erect traffic noise barriers/bunds of sufficient height and suitable construction in order to reduce external noise levels to 63 dB $L_{A10(18h)}$ or less at the lowest habitable floor of exposed dwellings • Provide sound insulation treatment to residential dwellings sufficient to satisfy the recommended internal noise levels specified in Australian Standard 2107-2016 *Acoustics - Recommended design sound levels and reverberation times for building interiors.* Further information is provided in Appendix C1 for reference.
Australian/New Zealand Standard AS/NZS 2107:2016 *Acoustics - Recommended design sound levels and reverberation times for building interiors* (AS 2107)	AS 2107 is referred to in VicRoads' *Requirements of Developers – Noise Sensitive Uses* and provides recommendations for acceptable internal noise levels. It provides recommendations for acceptable internal noise levels. Table 1 of AS 2107 presents the recommended design sound levels for "houses and apartments in inner city areas or entertainment districts or near major roads", which is considered to be applicable to the development site. Further information is provided in Appendix C2.
Australian Standard *3671-1989 Acoustics - Road traffic noise intrusion - Building siting and construction* (AS 3671)	AS 3671 is primarily concerned with the reduction of traffic noise intrusion in buildings within areas exposed to roads carrying more than 2,000 vehicles per day. It provides guidance on the design and construction of buildings necessary to achieve acceptable internal noise levels, as recommended in AS 2107.
Victorian Passenger Rail Infrastructure Noise Policy dated April 2013 (VPRINP)	Section 5 of the VPRINP sets out the conditions under which transport bodies must apply the policy. The policy sets 'investigation thresholds' for the assessment of noise. These are noise levels, which if exceeded, indicate that noise mitigation should be considered. Refer to Appendix C4 for further detail.

4.0 GENERAL ENVIRONMENTAL DUTY (GED)

Under the GED, a person (including individuals and body corporates) who is conducting a business or an undertaking and engaging in an activity that involves the design, manufacture, installation or supply of a structure must minimise the risk of harm.

When a person is conducting a business or an undertaking, they must:

- use and maintain plant, equipment, processes, and systems in a manner to minimise risks
- use and maintain systems for identification, assessment and control of risks, and for the evaluation of the effectiveness of controls
- implement systems to minimise the harmful effects if the risk eventuates
- ensure that all substances are handled, used or transported in a manner that minimises risks
- provide information, instruction, supervision and training to any person engaging in an activity.

Where they fail to do so, they will not satisfy the GED.

There is a primary risk of harm to future residents of the development in relation to noise from the Western Freeway and other roads interfering with the enjoyment of outdoor private and public spaces (backyards, parks, etc. The definition of "harm" in the Environment Protection Act 2017 means an adverse effect on human health and includes adverse effects on amenity that unreasonably interferes with enjoyment of the place or premises.

4.1 Measures to reduce noise to future residents of the development

4.1.1 Noise screening of Western Freeway by way of noise barriers and/or bunds

This report contains an assessment of traffic noise from the Western Freeway in accordance with the VicRoads' document *Requirement of Developers – Noise Sensitive Uses* which seeks to impose requirements on developers of residential land, including adjacent the Western Freeway.

The requirements include the design and construction of noise barriers and other noise amelioration measures to achieve the VicRoads target of 63 dB $L_{A10(18hr)}$ or less outside dwellings proposed throughout the development.

EPA Victoria have questioned whether the 63 dB $L_{A10(18hr)}$ criterion represents the latest state of knowledge on appropriate outdoor traffic noise criteria. A review of outdoor criteria for other Australian states and territories and prominent studies on health impact thresholds due to environmental noise is presented in Appendix C3.

Criteria from state and territory policies are similar, ranging between 55 – 60 dB L_{Aeq} during the day and 50 – 55 dB L_{Aeq} during the night, which is typically equivalent to 58 – 63 dB $L_{A10(18h)}$. The VicRoads criterion is at the upper end of the range.

For the ranges noted above, we consider the upper value to be the minimum requirement to be achieved, and the lower value to be the aspirational goal and weighed against the reasonableness and practicalities of the measures required to meet the lower value.

Section 7.2 of this report provides indicative minimum extents and heights of barriers and/or earth bunds to achieve the target criteria at the ground floor of future dwellings within the development.

Section 8.1 details appropriate construction materials and methods for noise barriers.

4.1.2 Design of dwellings

Designing noise barriers to reduce noise at the ground floor of dwellings and in private open space is broadly considered reasonable and practical for a new residential development adjacent to a freeway. Noise barriers are not considered to be a practical mitigation option to reduce noise to upper levels of dwellings as the significant barrier height required would be incompatible with visual amenity outcomes for residents, and would also result in impractical engineering controls to manage wind loading and structural support.

As such, noise from traffic can be reduced at upper levels of affected dwellings by designing building envelopes (facade, glazing, doors, roofs and ventilation paths) so that internal noise levels support the ERS environmental values (specifically sleep during the night, domestic and recreational activities and normal conversation indoors).

Section 8.2 includes preliminary specifications for dwelling facades to achieve internal amenity consistent with the recommended levels contained in AS 2107.

While dwelling plans are not yet available at this stage in the planning process, the VicRoads' document *Guidelines for Developers* recommends the following measures to be implemented where practical in addition to screening provided by a barrier:

> *The noise sensitive buildings adjacent to the Freeway should also be designed and constructed to protect internal noise sensitive areas. That is, the building layout should have the service areas (laundry, bathroom, garage, etc,) facing the freeway whilst the noise sensitive uses (bedrooms, living areas, etc,) are located away from the freeway side of the building. Furthermore, for the exposed facade, window and door openings should be of a minimum size.*

4.1.3 Commissioning measurements/Evaluation of the effectiveness of controls

The above measures (noise barrier/bund, facade specifications, and building siting and layout considerations) should be confirmed during the detailed design stages of the development (i.e. prior to construction).

Once construction of the noise barrier/bund has been completed, commissioning noise measurements could be undertaken to confirm that noise levels outside dwellings achieve the target criteria contained in the VicRoads' document *Requirement of Developers – Noise Sensitive Uses*.

Furthermore, once dwellings have been constructed, commissioning measurements could be undertaken to confirm that internal noise levels are consistent with the recommended levels contained in AS 2107.

4.2 Reducing risk as far as reasonably practicable

The proposed noise control measures will not eliminate the risk of harm completely, because sensitivity to noise is variable and some people can experience annoyance or loss of amenity from noise at levels that achieve the external (VicRoads) and internal (AS 2107) noise criteria.

The developer is therefore required to reduce the risk of harm as far as reasonably practicable. Section 6 of the EP Act notes regard is to be given to the following factors:

> *(a) the likelihood of those risks eventuating;*
>
> *(b) the degree of harm that would result if those risks eventuated;*
>
> *(c) what the person concerned knows, or ought reasonably to know, about the harm or risks of harm and any ways of eliminating or reducing those risks;*
>
> *(d) the availability and suitability of ways to eliminate or reduce those risks;*
>
> *(e) the cost of eliminating or reducing those risks.*

EPA Guideline 1856 further outlines how to consider whether proposed controls are 'reasonably practicable'. The guideline states the following:

> *Controls that eliminate or substitute the source of the risk are the most effective, followed by engineering or building controls, and finally training and site practices. Often a combination of all these controls will be needed.*

Referencing the considerations in EPA Publication 1856 *Reasonably Practicable*, the noise control measures described in Section 4.1 are considered reasonably practicable on the following basis:

- While traffic noise cannot be completely eliminated at the subject site, both the likelihood and consequence of risks would reduce with noise-control measures implemented.
- The degree of knowledge of the risks and noise-control measures is considered extensive, as the proposed controls are effective, are considered accepted industry standards, and are set out in reputable guidelines (for example, VicRoads' *Requirements of Developers,* AS 2107).
- The proposed noise-control measures are well understood and developed, considered available and suitable, on the basis that the recommended measures demonstrably lower the risk of harm, and raw materials/land are readily available for the construction of the recommended measures.
- The height and length extents of the indicative noise barriers/bunds and the indicative facade treatments are to balance the mitigation of risks from traffic noise while not introducing other significant risks. For example:
  - Reduced visual amenity associated with lack of sunlight and other urban design considerations from much higher noise barriers
  - Provision of blank facades to allow for higher sound insulation of dwelling walls
  - Safety of motorists, construction workers and maintenance crews
  - Topographical issues relating to soil types, stormwater flow, erosion and underground utilities
  - Prohibitive traffic noise barrier costs and disproportionate upfront dwelling construction/purchase price and ongoing maintenance costs.

Section 7.2 of this report provides indicative extents and heights of barriers and/or earth bunds to achieve the VicRoads external design criterion. However, consideration is to be given to extending barriers/bunds where reasonable and practicable to minimize traffic noise exposure and the associated risk of harm if a perceptible reduction below 63 dB $L_{A10(18hr)}$ can be achieved.

The EP Act notes that regard is to be given to the cost of reducing risks when evaluating reasonably practicable ways of reducing risk.

In the case of traffic noise control via barriers, it is often the case that the cost associated with increasing the height of the barriers only provides minimal additional decibel reductions. For context (and without any other change in characteristics), a reduction in noise level of:

- 5 dB is often described as a clearly noticeable change
- 3 dB is often described as being a just perceptible change
- 1 to 2 dB is often described as being an imperceivable change.

Hence the proposed strategy is to design barriers/bunds such that the external noise environment to meet the VicRoads criteria as minimum and giving consideration to increasing barrier extents where practical that result in a further perceivable reduction in traffic noise, while also designing future dwellings to enable an appropriate internal residential amenity to be achieved.

5.0 NOISE MEASUREMENTS

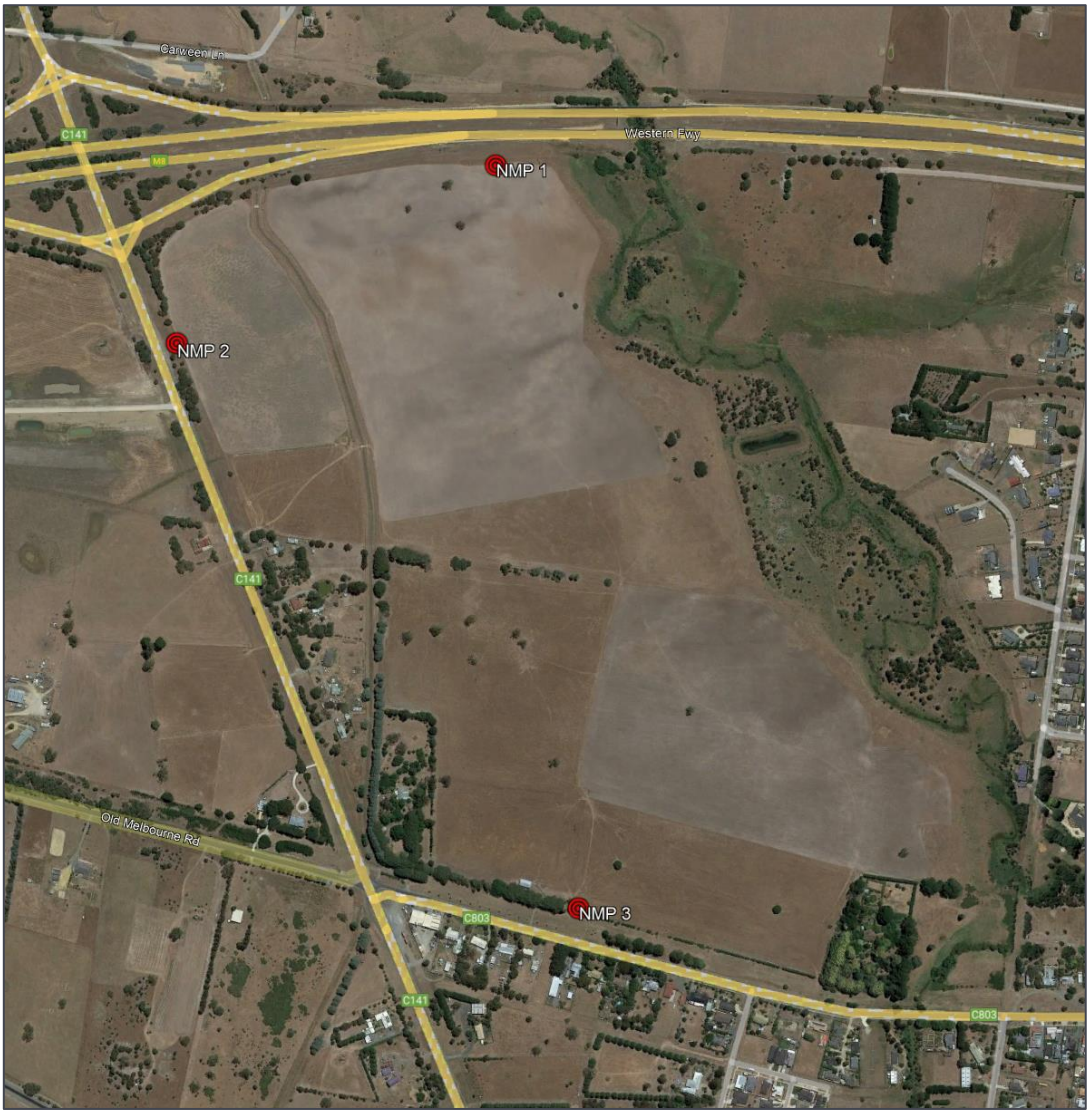
5.1 Measurement locations

Noise monitoring was conducted to measure existing traffic noise levels between 10 – 23 March 2022. Three (3) noise monitors were deployed to measure traffic noise from Western Freeway, Geelong-Ballan Road and Old Melbourne Road respectively. The noise monitor locations are shown in Figure 3.

Noise levels were continuously measured in general accordance with Appendix C of VicRoads Road Design Note RDN 06-01 *Interpretation and Application of VicRoads Traffic Noise Reduction Policy 2005*.

Further details regarding the noise measurements are contained in Appendix D.

Figure 3: Noise monitoring positions, NMP (Source: Google)



5.2 Average noise levels

Table 2 presents a summary of equivalent (average) noise levels at each measurement location averaged over the days with acceptable or marginal weather conditions as per VicRoads Road Design Note DN 06-01.

Table 2: Measured noise levels during acceptable or marginal weather conditions

Parameter	Measured noise level, dB		
	NMP 1	NMP 2	NMP 3
$L_{A10(18h)}$ (6am-midnight)	68	63	54
Day $L_{Aeq(16h)}$ (7am-10pm)	65	62	54
Night $L_{Aeq(8h)}$ (10pm-7am)	63	56	45

5.3 Rail noise investigation threshold

The noise monitoring results from the logger installed at NMP 3 was analysed and compared with the investigation thresholds provided in the VPRINP. The noise monitoring at this location included any contributions from the Ballarat-Melbourne Railway Line, which is located approximately 500 m south from the nearest point of the development site.

Due to the large separation distance from the railway, only train horns could be clearly audible at the southern site boundary, i.e. noise from the locomotives and carriages were not clearly audible over other ambient noise sources. Further, maximum noise levels from the use of the horn were broadly comparable to maximum noise levels from vehicle pass by events on Old Melbourne Road.

For simplicity, average and maximum noise levels from all noise sources (trains, vehicles and any other sources) were compared to the VPRINP investigation thresholds.

This is considered to be a conservative approach given:

- Based on observations on site, the contribution of train noise to the total day and night average noise levels is likely to be negligible.
- Train maximum noise level events during the NMP 3 noise monitor deployment and retrieval were observed to be less than 70 dB L_{Amax}.

The noise monitoring results for the monitoring location closest to the railway line are summarised in Table 3 and are compared to the VPRINP investigation thresholds.

Table 3: Maximum and average rail noise levels, dB

Location	Daytime ambient noise level, $L_{Aeq(16h)}$	Night-time ambient noise level, $L_{Aeq(8h)}$	95th percentile maximum of all events, L_{Amax}
NMP 3 (approx. 500 m from railway)	54	45	82
VPRINP investigation thresholds	65	60	85

From Table 3 it is evident that the measured average and maximum noise levels are below the VPRINP investigation threshold.

As all measured noise levels at NMP 3 are below the VPRINP investigation threshold, therefore no mitigation treatment is expected to be required to address train noise at the subject site. Therefore, further assessment of rail noise has not been undertaken in this report.

6.0 NOISE MODELLING METHODOLOGY

To predict noise levels due to traffic at the development site for the design year 2034, noise modelling was undertaken in accordance with the *Calculation of Road Traffic Noise* (CoRTN) method implemented in SoundPLAN v8.2 noise modelling software.

Noise modelling enables the prediction of traffic noise across the development site, accounting for local terrain, atmospheric and ground conditions, road surface and gradient, traffic flow, and reflective or screening elements such as barriers or buildings.

6.1 Assumptions

6.1.1 Propagation conditions

The following assumptions were made:

- 50% soft ground was assumed for ground effect attenuation as the surrounding areas of the site and intervening ground between the freeway and site is primarily vegetated.
- When comparing to VicRoads criteria, a facade correction of +2.5 dB was applied to the predicted future free field external noise levels to account for any noise reflected off future dwelling facades.
- No dwellings or other structures were entered into the model and therefore shielding by proposed intervening buildings has not been accounted for. The actual noise levels at dwellings located behind the first row of dwellings adjacent to a road are likely to be lower than the predicted noise levels once construction of the first row of houses is completed. The omission of shielding by future dwellings therefore accounts for any progression of construction that may result in new dwellings being constructed and occupied prior to the construction of any other dwellings that may provide beneficial shielding of traffic noise, thereby resulting in a conservative assessment.
- Digital terrain data was sourced from publicly available data for existing and future site scenarios. For the purpose of this preliminary study, existing site levels been used, as future site levels have not yet been finalised at this early stage of the project. Refer to Section 7.2 for further discussion on terrain.

6.1.2 Traffic and road conditions

Table 4 provides a summary of the VicRoads traffic data[2] for the roads adjacent to the site as at March 2022 when the noise measurements were undertaken.

Table 4: Existing traffic data

Road	Annual Average Daily Traffic 24 hour (AADT)	Percentage heavy vehicles	Annual AADT growth rate	Vehicle speed
Western Freeway (westbound)	Before ramp: 12,000 After ramp: 11,000	Before ramp: 17 % After ramp: 19 %	Before ramp: 2.7 % After ramp: 2.5 %	110 km/h
Western Freeway (eastbound)	Before ramp: 11,000 After ramp: 13,000	Before ramp: 19 % After ramp: 18 %	Before ramp: 2.5 % After ramp: 3.2 %	110 km/h
Western Freeway westbound offramp	1,000	12 %	2.6%	80 km/h assumed
Western Freeway eastbound onramp	2,000	12 %	2.85 %	80 km/h assumed
Geelong-Ballan Road	Two-way: 4,100	12 %	2.4 %	80 km/h
Old Melbourne Road	Two-way: 4,500	8 %	2.0 %	80 km/h

VicRoads typically require noise levels to be predicted based on the traffic volumes expected 10 years after finalisation of the development. For feasibility purposes It is assumed that the development would be finalised once civil works are completed, which is anticipated to be in 2024. As such, the relevant horizon year for the traffic noise assessment is 2034. Table 5 provides a summary of the estimated future traffic volume data for the Western Freeway for the design year 2034, based on the VicRoad's growth rate for the roads.

Should the design year change as the project progresses, the resultant noise mitigation requirements may change proportionally. However, from experience on similar projects, any increases in predicted traffic noise levels due to increases in traffic volumes are typically negligible. There is typically a 1 dB increase in traffic noise for every 25 % increase in traffic volumes, all else being equal.

Table 5: Assumed future traffic volumes

Road	Annual Average Daily Traffic 24 hour (AADT)
Western Freeway (westbound)	Before ramp: 16,521 After ramp: 14,794
Western Freeway (eastbound)	Before ramp: 14,794 After ramp: 18,791
Western Freeway westbound offramp	1,361
Western Freeway eastbound onramp	2,802
Geelong-Ballan Road	Two-way: 5,450
Old Melbourne Road	Two-way: 5,677

The 18-hour volumes used in the model were set to 95 % of the daily volumes.

[2] *Traffic Volume*, Department of Transport, https://vicroadsopendata-vicroadsmaps.opendata.arcgis.com/datasets/traffic-volume/explore accessed March 2022

6.2 Noise model calibration

The noise monitor locations shown in Figure 3 were entered into the noise model and the existing noise levels modelled based on the existing traffic data shown in Table 4. The modelled noise levels were compared to the measured noise levels to assess the accuracy of the model. Table 6 shows a comparison of the measured and modelled noise levels.

Table 6: Measured and modelled free field noise levels (existing traffic volumes), dB $L_{A10(18h)}$

Description	NMP 1	NMP 2	NMP 3
Measured	68	63	54
Modelled	69	64	57
Difference	+1	+1	+3

Note: modelled values shown do not include facade correction

The predicted noise levels were above the measured noise level at all locations but generally in reasonable correlation to one another. A calibration factor of -3 dB was used to adjust the noise model predictions for Old Melbourne Road to account for local conditions at NMP 3.

6.3 Noise modelling scenarios

To inform the potential mitigation requirements on site, the following future scenarios were modelled:

- No noise barriers
- Indicative noise barriers and/or earth bunds and local fencing to achieve the VicRoads criterion of 63 dB $L_{A10(18h)}$ (and comparable DDO3 free field criterion of 60 dB $L_{A10(18h)}$ triggering the need to review dwelling sound insulation performance) at lowest-habitable floor of future dwellings.

Further mitigation requirements for individual dwelling constructions may be required for the upper levels of multi-storey dwellings, as discussed in Section 8.2.

7.0 PREDICTED NOISE LEVELS

7.1 Results with no noise barriers/bunds

Appendix E1 presents a noise level contour map showing predicted traffic noise levels for the year 2034 with no additional noise barriers and/or bunds in place.

The VicRoads target noise criterion of 63 dB $L_{A10(18h)}$ (comparable to the DDO3 free field criterion of 60 dB $L_{A10(18h)}$ triggering the need to review dwelling sound insulation performance) is shown as a dashed line.

As shown by the contour map, the VicRoads target noise criterion (and comparable DDO3 criterion) is predicted to be exceeded in the parts of the subject site that are closer to the Western Freeway, particularly at the north-eastern corner of the development site, and for some residential lots adjacent to the Geelong-Ballan Road.

Predicted noise levels across a significant portion of the development are lower than the VicRoads target criterion (and comparable DDO3 free field criterion), including proposed lots facing Old Melbourne Road. This portion could be developed prior to noise barrier/bund construction.

Noise barriers/bunds will be required at the northern site boundary of the development site to satisfy the external traffic noise criteria. While not strictly necessary in all instances, dwellings on the western boundary would also benefit from solid boundary fences to reduce traffic noise from Geelong-Ballan Road in outdoor areas.

7.2 Indicative noise barrier/bund design

The northwest of the subject site currently benefits from screening from the Western Freeway on the westbound offramp by the topography of sections of the north-western site boundary (existing earth bund adjacent to the westbound off ramp) as shown in Figure 4 overleaf.

Conversely, the terrain at the northeast of the site falls away relative to the road as shown in Figure 5.

A preliminary traffic noise barrier/bund configuration has been developed that is predicted to satisfy the VicRoads target noise objective of 63 dB $L_{A10(18h)}$ (and comparable DDO3 free field criterion) at all ground floor locations within the development.

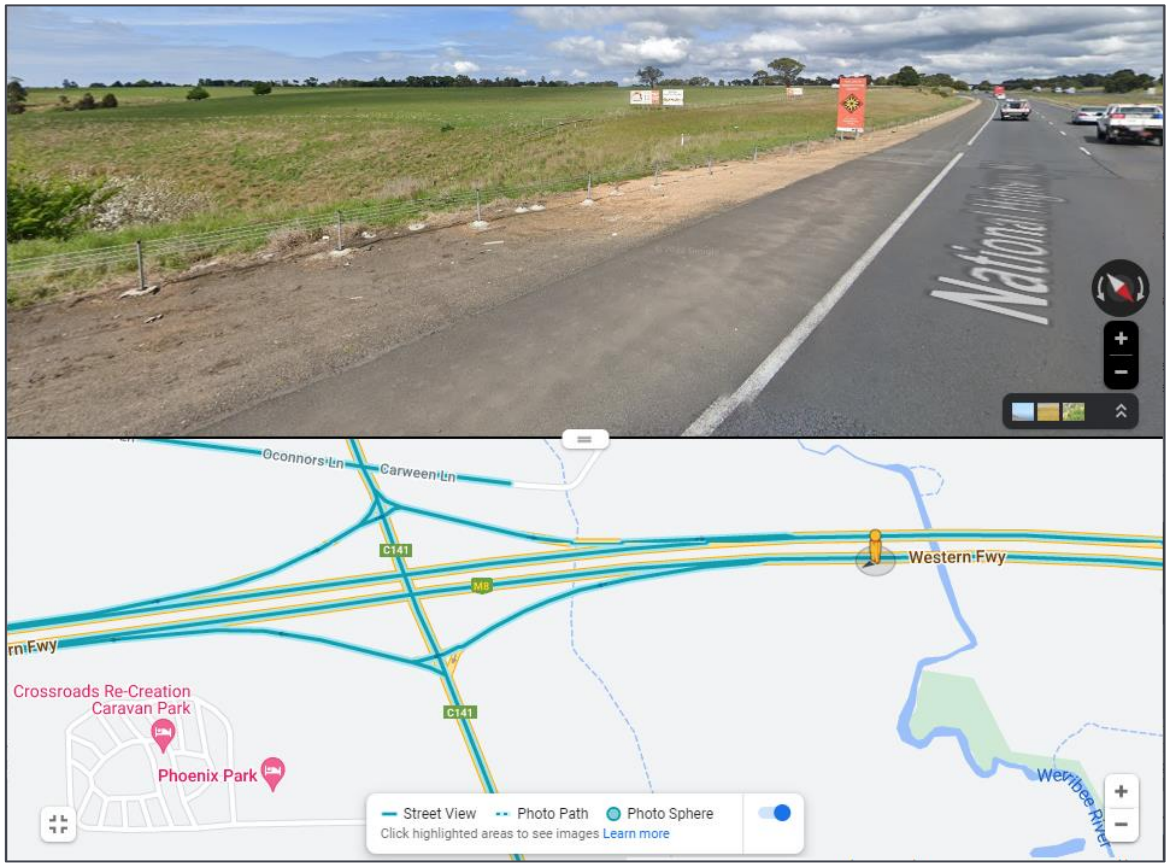
Indicative minimum effective barrier/bund heights and a description of their locations are shown in Table 7.

Table 7: Indicative minimum height and lateral extent of barriers and/or earth bunds

Screening reference	Location	Minimum height above natural ground
Northern site barrier/bund	Indicative location between the proposed residential lots and Western Highway.	4.5 m – 7.0 m
North-eastern barrier/bund	Adjacent to the proposed local park and wetland retention basin. This barrier avoids unfeasibly high barriers adjacent to the Western Freeway that would need to continue past the Werribee River bridge, well beyond the subject site.	5.5 m
Western boundary fences	On the Geelong-Ballan Road boundary and/or proposed residential lot boundaries to provide screening of external areas at the rear of residential lots.	2.4 – 1.8 m

Figure 4: Existing earth bund adjacent to Western Freeway off ramp (source: Google Maps)

Figure 5: Fall of land at the northeast of the site (source: Google Maps)



The indicative design of additional noise barriers and/or earth bunds has been based on publicly available existing site elevation levels.

The effective height of the freeway barrier/bund required to satisfy traffic noise criteria is heavily dependent on the relative elevations of the freeway, proposed residential areas and intervening land. The location of the Western Freeway barrier/bund was arbitrarily selected between residential lot boundaries and the freeway rope barrier.

Therefore, the minimum barrier/bund height required to satisfy traffic noise criteria is heavily subject to the following considerations:

- Proposed future elevation levels in residential areas
- VicRoads requirements for minimum setback distances from the freeway and access requirements for routine maintenance
- Setbacks (if any) from residential areas to achieve appropriate urban design principles regarding visual amenity and overshadowing caused by the barrier, in addition to other engineering concerns such as soil quality, erosion, stormwater management, underground utilities, wind loading and other structural requirements
- Addressing the GED by minimising traffic noise exposure in residential areas, as discussed in Section 4.0, potentially by providing higher barriers that minimise traffic noise as far as reasonably practicable.

The 1.8 m high fences on the western boundary to Geelong-Ballan Road are also an indicative measure to allow traffic noise criteria to be achieved at proposed residential lots in proximity to the road. We note that the VicRoads and DDO3 traffic noise criteria would not strictly apply to the majority of the proposed residential lots on Geelong-Ballan Road.

The barrier/bund and fence heights and locations presented in this report are therefore indicative only for the purposes of demonstrating that external traffic noise criteria can be satisfied. and are expected to require further review during subsequent design stages.

7.3 Results with noise barriers/bunds

Appendix E2 presents a noise level contour map showing the predicted noise levels at ground level with the preliminary barrier/bund configuration in place. The VicRoads target noise criterion of 63 dB $L_{A10(18h)}$ (comparable to the DDO3 free field criterion of 60 dB $L_{A10(18h)}$) is shown as a dashed line.

The noise contour map indicates that the VicRoads criterion (and comparable DDO3 criterion triggering the need to review dwelling sound insulation performance) will be satisfied at ground level at all residential lots with the implementation of indicative screening as described above.

Appendix E3 presents a noise level contour map showing the predicted noise levels at first floor level (approximately 4.5m above ground) with the preliminary barrier/bund configuration in place. Note that free field noise levels (without a +2.5 dB facade reflection correction) is depicted by the contours, and the DDO3 free field criterion of 60 dB $L_{A10(18h)}$ is shown as a dashed line.

The noise contour map indicates that the DDO3 criterion triggering the need to review dwelling sound insulation performance will still be exceeded at first floor level for some lots at the north and west of the site. The sound insulation performance of dwellings may need to be considered, subject to the performance of the final noise barrier/berm design.

Traffic noise levels at ground and first floor level of proposed residential lots would not exceed 70 dB $L_{A10(18h)}$, satisfying the requirement in Section 5.0 of DDO3 of not locating dwellings in areas exposed to traffic noise above such a level.

8.0 TRAFFIC NOISE CONTROL OPTIONS

8.1 Noise barrier construction

In accordance with VicRoads' Bridge Technical Note BTN 007 V1.1 *Code of Practice Noise Attenuation Walls* dated June 2018[3] (BTN 007), the noise barrier must be of a non-porous construction with no gaps and a surface density of at least 20 kg/m^2 at its thinnest point; or a construction that has a sound insulation rating value of $R_w + C_{tr}$ of at least 25 dB.

Suitable materials are listed below:

- Double skin Colorbond fence either side of 90 mm timber/steel frame with insulation provided in the cavity
- 3 mm thick steel (e.g. Bluescope HW350 – Corten)
- 40 m thick timber (e.g. pine)
- 10 mm thick glass
- 18 mm thick Perspex or polycarbonate
- 75 mm brick or concrete
- Earth bunding.

It is critical that the barrier is well sealed and free of any holes or gaps. In particular, there must be no gap at the base of the barrier. It is recommended that the base of the barrier is buried to a depth of 10-20 cm.

8.2 Facade specification

As described in Section 7.2, noise barriers/bunds on the northern site interfaces are likely to be required to achieve the target criteria. With the example noise barrier designs described in Section 7.2 in place, the external target criteria could be met at the ground floor of all of the lots within the development.

The VicRoads criteria also refers to constructing dwellings such that the internal noise levels recommended by AS 2107 are achieved.

Facades of modern dwellings satisfying energy efficiency requirements that are exposed to traffic noise levels of 63 dB $L_{A10(18h)}$ or less generally do not require specific noise mitigation measures for the building envelope.

However, as per the requirement in Section 5.0 of DDO3, dwellings with facades exposed to free field traffic noise levels above 60 dB $L_{A10(18h)}$ should be designed and constructed to acoustic standards as set out in AS 3671 (i.e. designed to achieve the internal design levels of AS 2107).

An indication of the lots which DDO3 deems to require a review for building envelope sound insulation performance is indicated on the first floor noise contour map in Appendix E3. Note that it is not expected that ground level spaces will require a review of specific noise mitigation measures given free field noise levels are not predicted to exceed 60 dB $L_{A10(18h)}$.

Typical facade constructions can be developed as the design progresses and a mitigation design is formalised.

[3] It is noted that the May 2023 revision to BTN 007 transferred acoustic design requirements to Department of Transport and *Planning's Standard Specifications Section 765 Noise Attenuation Walls*. At the time of writing however, this Standard Specification had not been updated accordingly.

For preliminary information purposes, Table 8 presents example facade treatments that have been prepared based on the predicted external noise levels of less than 60 dB $L_{A10(18h)}$. The noise contours in Appendix E indicate this noise level (corresponding to approximately 57 dB L_{Aeq} during the day and 53 dB L_{Aeq} during the night) is unlikely to be exceeded for a typical two-storey dwelling.

The example constructions consider commonly available residential building materials, and are not generally considered onerous for a residential estate adjacent to a freeway.

Table 8: Typical constructions – indicative only

External walls	Roof/ceiling	Glazing		External doors
		Ground	First	
$R_w > 40$ Example construction: - 9 mm fibre cement sheet - 90 mm timber stud framing - Minimum R2.0 fibrous cavity insulation - 10 mm thick plasterboard (7 kg/m^2) internal wall lining.	$R_w > 40$ Example construction: - Metal deck roofing (minimum BMT 0.48 mm) or roof tiles with sarking - Minimum R3.6 fibrous roof insulation - 10 mm thick plasterboard (7 kg/m^2) internal ceiling lining. Eaves to be sealed and treated to minimise noise break in via the roof space.	$R_w > 33$ Example construction: 6.76 mm laminated glass(1) All windows and sliding glass doors shall incorporate full perimeter acoustic seals which form an airtight seal on closure. Evaporative cooling (which requires windows to remain open) not recommended(2).	$R_w > 37$ Example construction: 10.76 mm laminated glass(1)	$R_w > 30$ Example construction: Minimum 40 mm solid core with good-quality full perimeter acoustic grade seals which form an airtight seal on door closure.

Notes:

(1) Should the builders select alternative windows for thermal insulation, care shall be taken such that the acoustic performance of such system meets the minimum sound transmission loss requirements. The final glazing selection will be dependent on size, function, and relevant Australian Design Standards. This assessment considers a typical of room size with total glazing areas of up to 4 m^2 per room at ground level and 3 m^2 at first floor level.

(2) Any ventilation systems for the dwellings would need to be assessed during the detailed design phase to determine suitable performance and construction requirements that do not compromise the sound insulation performance provided by the overall building envelope.

8.3 Detailed design

Several design elements will require refinement as the project progresses.

As discussed in Section 7.2, it is expected that the alignment and design of the noise barriers/bunds and fences may need to be refined in order to accommodate feedback from VicRoads and Council, the effect of any changes to the horizon year, and any civil engineering considerations. In addition, there may be changes in terrain height on the site to represent final finished levels, accommodate drainage or other considerations.

Once any terrain changes have been determined and the final noise barrier and/or bund alignment have been agreed, detailed noise modelling will be required to optimise the height requirements.

Once the barrier/bund design has been finalised, typical facade construction specifications can be determined for the potentially affected dwellings.

9.0 ENVIRONMENTAL REFERENCE STANDARD

The Environmental Reference Standard (ERS) is an environmental benchmark. It includes environmental values, indicators and objectives that describe environmental and human health outcomes to be achieved or maintained in the whole or in parts of Victoria. These values, indicators and objectives are used to assess and report on changing environmental conditions by providing a reference point for decision makers to consider whether a proposal or activity is consistent with the environmental values identified in the ERS. The ERS also allows decision makers to evaluate potential impacts on human health and the environment that may result from a proposal or activity. It is important to note the objectives contained in the ERS are not to be used as criteria or limits to be achieved.

The 63 dB $L_{A10(18h)}$ criterion in the VicRoads publication *Requirement of Developers* is approximately equivalent to the objectives for ambient sound for category I land use defined in the ERS. The relevant categories for the development site are categories II and III (including residential, mixed-use and open space land uses), which reference objectives lower than those for category I.

Following implementation of traffic noise barriers/bunds measures, the modelling indicates noise levels at ground level will range from 63 dB $L_{A10(18h)}$ (approximately 60 dB L_{Aeq} during the day and 56 dB L_{Aeq} at night) at some locations immediately adjacent to the site boundary, down to approximately 57 dB $L_{A10(18h)}$ (approximately 54 dB L_{Aeq} during the day and 50 dB L_{Aeq} at night) for the majority of the subject site. These predicted noise levels do not take into account screening that would be provided by the built form of dwellings. Once dwellings are constructed on site, it is anticipated that noise levels due to traffic across the majority of the site would be significantly lower than shown in the noise contour maps at this stage, and for the most part, consistent with the objectives for category III land uses.

Given the most-affected dwellings on the project boundary would be exposed to noise levels higher than the objectives for their relevant land use categories, consideration should be given to building siting, orientation and internal layout (see Section 4.1.2).

EPA Publication 1992 *Guide to the Environment Reference Standard* provides information primarily for decision makers about how the ERS should be applied to support decision making, and how the environmental values, indicators and objectives for each element of the environment should be interpreted.

Section 5.4.1 b) of the guideline describes the derivation of the ERS objective noise levels being based on generally achieving internal noise levels recommended by AS 2107, and making assumptions regarding the typical noise reduction provided by the building envelope within the corresponding land use setting.

VicRoads publications and AS 3671 (as referenced by DD03 ordinance) also recommend AS 2107 design levels be achieved within dwellings.

The AS 2107 design criteria for the acoustic environment within building interiors are set to ensure a healthy, comfortable and productive environment for the occupants and the users, as per Section 1.0 *Scope* of the Standard.

Therefore, dwellings where the AS 2107 internal criteria are satisfied would generally satisfy the values for ambient sound nominated by the ERS within the dwelling.

Refer to Appendix B4 for further details on the ERS.

10.0 SUMMARY

Wel.Co are proposing to develop vacant land located at the intersection of Geelong-Ballan Road and Old Melbourne Road, Ballan for residential purposes, which requires a planning scheme amendment. The site is subject to road traffic noise from adjoining roads to the north and west of the site.

The recommendations presented in this report are preliminary and intended for planning purposes to inform feasibility. Recommendations are to be reviewed at the design development stage of the project to verify the measures required to address traffic noise.

This assessment has been completed to indicate the extent and possible design solutions for traffic noise attenuation at the site.

The assessment has been based on:

- Concept development plans intended as part of the planning scheme amendment
- External and internal criteria determined in accordance with VicRoads policy document *Requirement of Developers – Noise Sensitive Uses* and other relevant guidelines and legislation
- Noise measurements of 2022 traffic conditions undertaken at the subject site
- Noise modelling undertaken to predict traffic noise levels across the site at the ground and first floor levels for the design year 2034.

The assessment has shown that without any screening, noise from the Western Freeway and Geelong-Ballan Road would exceed the criteria outlined in VicRoads guidelines across multiple future housing lots within the development site.

Noise modelling demonstrated that noise levels on the subject site can be mitigated in accordance with VicRoads' requirements. An indicative noise barrier and/or earth bund configuration has been outlined showing the following:

- Noise barriers or bunds along the north and west road reserves adjacent to the development site varying in minimum height between 1.8 m and 7.0 m
- An indication of lots where facade treatments may be required to achieve internal noise levels consistent with the recommendations of AS 3671 and AS 2107. Nomination of appropriate facade treatments can be confirmed once dwelling plans are further developed.

The noise barrier/earth bund may require review during subsequent design stages to account for specific lot layouts, any significant earthworks and changes to the site terrain, opportunities to minimise traffic noise as far as reasonably practical as per the general environmental duty as well as revisions to address Council and VicRoads feedback.

The results for the monitoring at locations assessable to the investigation thresholds provided in the VPRINP deemed that attention measures are not required at this site to satisfy rail noise objectives. Therefore, further assessment of rail noise has not been undertaken.

APPENDIX A GLOSSARY OF TERMINOLOGY

dB	Decibel. The unit of sound level.
C_{tr}	Ctr is a sound insulation adjustment, commonly used with Rw and $D_{nT,w}$. C_{tr} adjusts for low frequency noise, like noise from trucks and subwoofers. C_{tr} values typically range from about -4 to about -12.
L_{A10}	The noise level exceeded for 10% of the measurement period. This is commonly referred to as the average maximum noise level. The 'A' indicates that the sound has been filter in a manner that approximates the average human hearing response.
$L_{A10\ (18h)}$	The arithmetic average of the 18 one-hour L_{A10} measurements (or predictions) between 6am and midnight. This is the primary descriptor used in Victoria for road traffic noise.
L_{Aeq}	The equivalent continuous sound level. This is referred to as the equivalent noise level and can be considered to be an average over the measurement interval. The 'A' indicates that the sound has been filter in a manner that approximates the average human hearing response.
$L_{Aeq,8h}$	The L_{Aeq} noise level measured over an 8-hour period. For road traffic noise measurements in Victoria, the 8-hour period is 10pm the previous day to 6am on the given day. The 'A' indicates that the sound has been filter in a manner that approximates the average human hearing response.
$L_{Aeq,16h}$	The L_{Aeq} noise level measured over a 16-hour period. For road traffic noise measurements, the 16-hour period is 6am-10pm in Victoria. The 'A' indicates that the sound has been filter in a manner that approximates the average human hearing response.
L_{Amax}	The A-weighted maximum sound level. The highest sound level which occurs during the measurement period.
R_w	Weighted Sound Reduction Index, a single number rating of the sound insulation performance of a specific building element. Rw is measured in a laboratory. R_w is commonly used by manufacturers to describe the sound insulation performance of building elements such as plasterboard and concrete.

APPENDIX B CONCEPT DEVELOPMENT MASTERPLAN

APPENDIX C NOISE POLICY, GUIDELINES AND BENCHMARKS

C1 Traffic noise – VicRoads requirements

VicRoads has an internal policy which is used to determine entitlement to noise barriers in situations where VicRoads takes responsibility for noise mitigation. Since October 1997, this policy has been known as the *Traffic Noise Reduction Policy*. The Policy recommends design objectives for traffic noise in Victoria.

VicRoads' *Traffic Noise Reduction Policy* recommends traffic noise level objectives that are used by VicRoads when building new roads or upgrading existing roads. Where new noise sensitive developments are planned close to existing major traffic routes, the developer must take responsibility for noise mitigation. VicRoads is a referral authority, and so has the right to seek to impose requirements on residential developers seeking planning approvals for land adjacent to VicRoads-controlled roads.

In addition, VicRoads has developed guidelines for noise mitigation at new residential developments near major roads, including *Requirements of Developers – Noise Sensitive Uses*. These guidelines recommend developers undertake some combination of the following:

- Erect traffic noise barriers of sufficient height and suitable construction in order to reduce external noise levels to 63 dB $L_{A10(18h)}$ or less at the ground floor level of the worst-affected dwellings.
- The noise sensitive buildings should also be designed and constructed to protect internal noise sensitive areas. That is, the building layout should have non-habitable areas (e.g. laundry, bathroom, garage, etc.) facing the freeway whilst noise sensitive spaces (bedrooms, living areas, studies etc.) are located away from the freeway side of the building. Furthermore, for the exposed facade, window and door openings should be of a minimum size.
- Where the developer decides, in consultation with VicRoads and Council that it is not desirable to erect high noise barriers, then provide sound insulation treatment to residential dwellings sufficient to achieve the recommended internal noise levels specified in Australian Standard 2107-2016 *Acoustics - Recommended design sound levels and reverberation times for building interiors.*
- Indoor and outdoor measurements prior to dwelling occupancy to demonstrate traffic noise barriers and building envelopes perform as expected and satisfy the indoor and outdoor design criteria.

C2 Traffic noise – Internal noise levels

Australian Standard 2107-2016 Acoustics - Recommended design sound levels and reverberation times for building interiors provides recommendations for acceptable internal noise levels. Table 9 shows the recommended internal design sound levels stated in AS2107 for *houses and apartments in inner city areas or entertainment districts or near major roads*, which is considered to be applicable to the proposed development.

Table 9: AS 2107 recommended internal noise levels

Area	Recommended design sound level range, dB L_{Aeq}
Living areas	35-45
Sleeping areas at night	35-40
Work areas	35-45

Achieving the lower level is preferred, but achieving with the maximum noise level is considered to be satisfactory.

AS 2107 does not specify the measurement procedure to determine whether compliance has been achieved but does state the following:

> *In situations where traffic (or other) noise levels may vary widely over a 24-hour period, measurements to assess compliance with this Standard should be taken at the relevant time according to the area of occupancy or activity in the building.*

Given the above, it could be argued that measurements for bedrooms should be made during the period between 2200-0700 hrs (commonly referred to as the night period), although this does not allow for those occupants who may be shift workers or such like that may have a requirement to sleep during the day. For living and dining rooms, the measurement should be made during the period between 0700-2200 hrs (commonly referred to as the day/evening period).

However, VicRoads' document *Requirement of Developers – Noise Sensitive Uses* notes that AS 2107 does not adequately consider peak noise levels, i.e. designing a dwelling to achieve the upper range of the criteria due to averaged day and night period traffic noise levels will result in times during peak traffic periods where the criteria are exceeded.

To address these points, it is proposed to design dwelling envelopes such that internal traffic noise levels achieve the average and peak period levels in Table 10.

Table 10: Nominal indoor design targets

Space	Period average	Peak traffic
Bedrooms during the night	35 dB $L_{Aeq(2200\text{-}0700\ hrs)}$	40 dB $L_{Aeq(1h)}$
Living areas during the day	40 dB $L_{Aeq(0700\text{-}2200\ hrs)}$	45 dB $L_{Aeq(1h)}$

C3 Traffic noise criteria review

The Victorian EPA has provided the following feedback in regard to the VicRoads external traffic noise criterion of 63 dB $L_{A10(18h)}$ nominated in the *Traffic Noise Reduction Policy* and *Requirement of Developers* guidelines:

> *When considering the risk of harm, it is important to have regard to the current state of knowledge. The state of knowledge relating to road traffic noise and its impact on human health and the environment has evolved significantly since 1989 when the criterion of 63 dB LA10 (18 hours) was first given effect. There are also more up-to-date guidelines, such as for example, the World Health Organisation Environmental Noise Guidelines for the European Region 2018 and the supporting systematic reviews of scientific evidence.*

MDA have reviewed state government traffic noise policies for external traffic noise criteria for new residential development adjacent to major roads. Criteria for new or redeveloped roads near existing residences have also been noted.

The review also considered the recommended noise levels in the 2018 WHO *Environmental Noise Guideline* referenced by the EPA, and an Australian Government led study by enHealth.

Regardless of who is responsible for meeting the noise targets, the nominated objective levels within the documents provide an indication of the upper limit of each body's generally acceptable traffic noise levels.

A summary of the criteria is presented in Table 11.

Criteria from state and territory policies are similar, ranging between 55 – 60 dB L_{Aeq} during the day and 50 – 55 dB L_{Aeq} during the night, which is typically equivalent to 58 – 63 dB $L_{A10(18h)}$.

For the day and night criteria ranges noted above, we consider the upper value to be the minimum requirement to be achieved, and the lower value to be the aspirational goal and weighed against the

reasonableness and practicalities of the measures required to meet the lower value, as per discussion in Section 4.0.

The WHO criteria are approximately 1 to 2 dB more conservative than the lower end of these ranges, but is noted to be based on long term averages and considers noise levels where there is sufficient evidence where a degree of adverse health impacts begin to emerge. As individual responses to noise can vary significantly, there will inevitably be a small proportion of the population with relatively high sensitivity to noise that the noise level ranges noted above will not cater for.

Table 11: Summary of external traffic noise criteria from state and territory policies and prominent health studies

Source document	External criteria summary [1]	Comment
VicRoads *Traffic noise reduction policy* (2005) *Requirements of Developers – Noise sensitive uses* (2005)	63 dB $L_{A10(18h)}$	Generally equivalent[2] to 60 dB $L_{Aeq,15h}$ (day) and 56 dB $L_{Aeq,9h}$ (night). Same criterion recommended for new residential development adjacent to existing roads and for existing residences adjacent to new or redeveloped roads. Relative increase criterion may also apply.
NSW *Road Noise Policy* (2011)	55/60 dB $L_{Aeq(15h)}$ (day) 50/55 dB $L_{Aeq(9h)}$ (night)	Applies to existing residential areas subject to change in noise due to new (more stringent criterion) or redeveloped freeways/arterial/sub-arterial roads or roads with increased traffic volumes (less stringent criterion). Relative increase criterion may also apply. The Policy references Australian state/territory and international road noise policies in addition to numerous other studies available at the time of publication. No external criteria for new development adjacent to major roads. Appendix C10 discusses new residential development near existing roads and notes interim guidelines that nominate internal criteria only. However, some NSW councils have differing policies on external noise levels at new residential developments. See Camden Council example below.
Camden Council *Environmental Noise Policy* (2018)	55/57 dB $L_{Aeq,15h}$ (day)	Applies to the principle private open space or an equivalent area of useable open space of a new dwelling, and an area of communal open space in residential flat building developments. The more stringent criterion applies to dwellings outside of new release areas.
SA DIT *Road Traffic Noise Guidelines EHTM Attachment 7A* (2021)	55 – 60 dB $L_{Aeq(15h)}$ (day) 50 – 55 dB $L_{Aeq(9h)}$ (night)	Applies to existing residential areas subject to change in noise due to new (more stringent criterion) or redeveloped (less stringent criterion) roads. Relative increase criterion may also apply. No external criteria for new development adjacent to major roads. Refer to MBS 010 below.
SA Ministerial Building Standard MBS 010 *Construction requirements for the control of external sound* (2023)	-	Contains provisions for reducing the intrusion of unacceptable levels of sound into habitable rooms of residential buildings. Presents internal criteria for habitable rooms. No external criteria for new development adjacent to major roads.

Source document	External criteria summary [1]	Comment
QLD Department of Transport and Main Roads *Development Affected by Environmental Emissions from Transport Policy* (2017)	60/63 dB $L_{A10(18h)}$ at facades 57/60 dB $L_{A10(18h)}$ (free field) in private and communal open spaces 63 dB $L_{A10(12h)}$ (free field) in public open spaces	External noise criteria for new 'accommodation' developments near state-controlled road. More stringent criteria apply where night-time background noise levels are below certain thresholds. Broadly considered 3 dB more stringent than/comparable to VicRoads' 63 dB $L_{A10(18h)}$ facade-corrected criterion respectively. Generally equivalent[2] to 57 – 60 dB $L_{Aeq,15h}$ (day) and 53 – 56 dB $L_{Aeq,9h}$ (night). Less stringent criteria apply for multi-modal corridors including a railway.
Roads ACT *Noise Management Guidelines* (2018)	60 dB $L_{Aeq(16h)}$ (day) 55 dB $L_{Aeq(8h)}$ (night)	New noise sensitive developments located adjacent to existing roads.
WA Planning Commission *State Planning Policy 5.4 Road and Rail Noise* (2019)	55 dB $L_{Aeq(16h)}$ 50 dB $L_{Aeq(8h)}$	New noise-sensitive land-use and/or development within a trigger distance (200 – 300 m) of strategic or significant freight/traffic routes. Also includes noise targets of 55/60 dB $L_{Aeq(15h)}$ (day) and 50/55 dB $L_{Aeq(9h)}$ (night) for new/upgraded roads respectively.
Tasmanian State Road Traffic Noise Management Guidelines v1 (2015)	63 dB $L_{A10(18h)}$ Alternative: 52 dB $L_{A10(18h)}$ in outdoor living areas on the sheltered side of a building	Applies to existing residential areas subject to change in noise due to new or redeveloped roads. Generally equivalent[2] to 60 dB $L_{Aeq,15h}$ (day) and 56 dB $L_{Aeq,9h}$ (night). The alternative criterion can be considered if the above criterion is not reasonable or practical to achieve. No external criteria for new development adjacent to major roads.
NT Department of Transport *Road traffic noise on NT government controlled roads* (2014)	58/63 dB $L_{A10(18h)}$	Noise targets that only apply to future unplanned roads (as at 2014) adjacent to existing noise sensitive/residential land use respectively. Generally equivalent[2] to 55/60 dB $L_{Aeq,15h}$ (day) and 51/56 dB $L_{Aeq,9h}$ (night). Noise sensitive land use includes aged care facilities, hospices and nursing homes and may include schools, libraries and hospitals. No external criteria for new development adjacent to major roads, but refers developers to AS 2107 for internal noise criteria.

Source document	External criteria summary [1]	Comment
World Health Organisation *Environmental noise guidelines for the European Region* (2018)	53 dB L_{den} (free field) 45 dB L_{night} (free field)	Health based review. L_{den} and L_{night} are long term averages over a year. Traffic noise above these levels are associated with adverse health impacts and effects on sleep. The criteria are free field levels in the absence of facade reflections. A facade correction[1] should be considered to allow for equivalent comparison with other L_{Aeq} or L_{A10} criteria in this table. 53 dB L_{den} (free field) has been estimated[3] to be broadly comparable to facade corrected equivalent noise levels of 53 dB L_{Aeq} during the day and 49 dB L_{Aeq} during the night. This approximation will vary from site to site depending on changes in noise levels during the day, evening and night periods due to changes in factors such as traffic volume, speed and percentage heavy vehicles.
Environmental Health Standing Committee (enHealth), Department of Health and Aged Care *The health effects of environmental noise* (2018)	60 dB $L_{Aeq,16h}$ (day) 55 dB $L_{Aeq,8h}$ (night)	Health based review. *There is sufficient evidence of a causal relationship between environmental noise and both sleep disturbance and cardiovascular disease to warrant the suggested health-based limits for residential land uses.* It is not clear whether the criteria are free field or facade corrected levels.

Notes:

[1] Values quoted are facade corrected levels. The facade correction – generally +2.5 dB – is an allowance for noise reflected from a building facade to a measurement or observation point that results in a higher noise level than if there were no reflective surfaces nearby.

[2] This approximation is based on a review of traffic noise data collected at 70 sites across Southeast Queensland. The approximation will vary from site to site depending on changes in noise levels during the day and night periods due to changes in factors such as traffic volume, speed and percentage heavy vehicles. Source: R. Brown, H. Brown, Acoustics RB Pty Ltd, *A re-examination of the relationship between the $L_{10(18hour)}$ noise level parameter and other road traffic noise level parameters*, Acoustics 2016, 2016. https://acoustics.asn.au/conference_proceedings/AASNZ2016/papers/p130.pdf accessed 9 June 2023.

[3] This approximation is based on a review of traffic noise data collected at 121 sites across NSW. The approximation will vary from site to site depending on changes in noise levels during the day and night periods due to changes in factors such as traffic volume, speed and percentage heavy vehicles. Source: J. Parnell, J. Peng, *The Relevance of the 2018 WHO Noise Guidelines to Australasian Road Traffic Noise Objectives*, Acoustics 2019, 2019. https://www.acoustics.asn.au/conference_proceedings/AAS2019/papers/p34.pdf accessed 9 June 2023.

It is noted that where state and territory policies nominated internal noise level criteria, that most policies were aligned with nominating 35 dB L_{Aeq} at night within sleeping areas and 40 dB L_{Aeq} during the day within other habitable rooms.

C4 Passenger rail noise

The *Victorian Passenger Rail Infrastructure Noise Policy* (VPRINP) was released in April 2013 and states that transport bodies and planning authorities must refer to the policy when the following is proposed:

- New passenger rail infrastructure,
- Redevelopment of existing passenger rail infrastructure; or
- A planning scheme amendment for land near an existing or planned rail corridor.

The policy sets 'investigation thresholds' for the assessment of noise. These are noise levels, which if exceeded, indicate that noise mitigation should be investigated. It states that:

> *In considering changing land use near an existing passenger rail corridor, transport bodies and planning authorities should consider the receivers set out in Table B in Attachment 2. Transport bodies and planning authorities should consider whether the noise level produced at these receivers will exceed the investigation thresholds for the periods specified in Table B in Attachment 2.* [reproduced below as Table 12]
>
> *If an assessment shows the investigation thresholds are not exceeded, noise impacts should be considered a secondary matter. This means no further action need be considered under this policy.*

The investigation thresholds are defined in terms of:

- $L_{Aeq,16h}$ – equivalent continuous daytime (0600 – 2200 hrs) noise level
- $L_{Aeq,8h}$ – equivalent continuous night-time (2200 – 0600 hrs) noise level
- L_{Amax} – maximum noise level.

Table 12: Investigation thresholds for change in land use near an existing rail corridor

Time	Type of receiver	Investigation threshold(s)	
Day (0600 – 2200 hrs) External	Residential dwellings and other buildings where people sleep including aged person homes, hospitals, motels and caravan parks. Noise sensitive community buildings including schools, kindergartens, libraries.	65 L_{Aeq}	85 dB L_{Amax}
Night (2200 – 0600 hrs) External	Residential dwellings and other buildings where people sleep including aged person homes, hospitals, motels and caravan parks.	60 L_{Aeq}	85 dB L_{Amax}

It is worth noting that the VPRINP investigation thresholds are generally consistent with that used in other States, such as the NSW *Rail Infrastructure Noise Guideline* (RING) for redevelopment of an existing 'heavy rail' line.

The noise levels in the PRINP are understood to be façade levels consistent with interstate railway noise policies.

The investigation thresholds are not design criteria. Should the investigation thresholds be exceeded, then the following internal design targets are recommended by MDA based on sleep disturbance as per Section D6:

- Bedrooms: 50-55 dB L_{Amax}
- Other living areas: 60 dB L_{Amax}
- Shops/offices: 65 dB L_{Amax}

The VPRINP requires the maximum railway noise be based on the 95th percentile of the maximum for all measured events. Where practical, maximum noise levels of trains and vehicles should meet internal sleep disturbance criteria with windows of apartments closed. The assessment should consider the airborne and structure-borne components.

These limits are based on a precedent set in the Victorian Civil and Administrative Tribunal (VCAT) regarding acceptable internal noise levels for residences adjacent to tramway lines (Reference No. P2470/2003). In this case, a decision to grant a permit was made on the basis that the noise level of trains was not to exceed 55 dB L_{Amax} in bedrooms and 60 dB L_{Amax} in living areas. These levels were based on the commonly-used criteria for sleep disturbance taken from the *NSW Road Noise Policy*.

Since 2003, there have been two VCAT decisions which have recommended an internal noise limit of 50 dB L_{Amax} in bedrooms. However, there is no compelling case for the lower criterion as the decisions were not based on objective evidence presented to the Tribunal and are, in MDA's opinion, unnecessarily restrictive; 55 dB L_{Amax} is very close to the threshold of onset for noise-related sleep disturbance, and there is almost no significant difference (<1 %) in reported levels of sleep disturbance between 55 dB L_{Amax} and 50 dB L_{Amax}.

C5 Environmental Reference Standard (ERS)

EPA Publication 1992 Guide to the Environmental Reference Standard, dated June 2021, provides the following information in relation to the Environmental Reference Standard (ERS):

> *The Environment Reference Standard (ERS) is a new legislative instrument made under the Environment Protection Act 2017 (the Act). The ERS is an environmental benchmark. It brings together a collection of environmental values, indicators and objectives that describe environmental and human health outcomes to be achieved or maintained in the whole or in parts of Victoria. These values, indicators and objectives are used to assess and report on changing environmental conditions by providing a reference point for decision makers to consider whether a proposal or activity is consistent with the environmental values identified in the ERS. The ERS also allows decision makers to evaluate potential impacts on human health and the environment that may result from a proposal or activity. The ERS does not specify requirements that must be met by environmental managers or other duty holders.*
>
> *The ERS is a tool that can be used to assess the impacts on human health and the environment that may result from a proposal or activity, or from existing environmental conditions on a site. This application of the ERS must be seen within the context of preventing harm from pollution and waste as part of the broader environment protection framework under the Act. Because it is preventative in nature, this framework seeks to minimise risks of harm to human health and the environment rather than setting and authorising acceptable levels of pollution and waste. The focus on prevention allows for continual improvement in managing these risks as knowledge expands and more effective risk- reduction techniques and technologies emerge.*

The environmental values defined in the ERS are contained in Table 13.

The table also includes discussion on how the acoustic criteria support the environmental values. Some environmental values are not applicable to the proposed development.

Table 13: Environmental values of the ambient sound environment

Environmental value	Description of environmental value	Comment
Sleep during the night	An ambient sound environment that supports sleep during the night	Provided windows are closed, the facades of modern dwellings that are exposed to traffic noise levels of 63 dB $L_{A10(18h)}$ or less generally do not require specific or relatively onerous noise mitigation measures for the building envelope to achieve internal noise levels that are appropriate for sleep during the night.
Domestic and recreational activities	An ambient sound environment that supports recreational and domestic activities in a residential setting	Traffic noise levels of 63 dB $L_{A10(18h)}$ will allow for conversation at normal voice effort indoors with a window open. When windows are closed, the facades of modern dwellings generally do not require specific or relatively onerous noise mitigation measures for the building envelope to achieve internal noise levels that are appropriate for domestic activities, including normal voice effort conversation. Traffic noise levels of 63 dB $L_{A10(18h)}$ will generally allow for conversation at normal voice effort in an outdoor area. The concept development Master Plan provides outdoor areas away from the roads that border with the subject site that will be subject to lower traffic noise levels.
Normal conversation	An ambient sound environment that allows for normal conversation indoors without the need to raise voices	
Child learning and development	An ambient sound environment that supports cognitive development and learning in children	The concept development Master Plan does not include an educational or daycare facility. Such a facility should be located away from the roads that bound the subject site to minimise traffic noise exposure where practical.
Human tranquillity and enjoyment outdoors in natural areas	An ambient sound environment that allows for the appreciation and enjoyment of the environment for its natural condition and the restorative benefits of tranquil soundscapes in natural areas	The ERS definition of 'natural areas' does not apply to the proposed development.
Musical entertainment	An ambient sound environment that recognises the community's demand for a wide range of musical entertainment.	Not relevant to the proposed development.

Table 3.2 and 3.3 of the ERS quantifies objective ambient day and night noise levels for different land uses. The two tables have been amalgamated as per Table 14.

Table 14: Land use categories, indicators and objectives for the ambient sound environment

Land use category	General description	Planning Zones	Outdoor indicators and objectives
Category I	An urban form with distinctive features or characteristics of taller buildings, high commercial and residential intensity and high site coverage.	Industrial Zone 1 (IN1Z) Industrial Zone 2 (IN2Z) Port Zone (PZ) Road 1 Zone (RDZ1) Capital City Zone (CCZ) Docklands Zone (DZ)	Day 0600 – 2200 hrs: 60 dB $L_{Aeq,16h}$ Night 2200 – 0600 hrs: 55 dB $L_{Aeq,8h}$
Category II	Medium rise building form with a strong urban or commercial character. Typically contains mixed land uses including activity centres and larger consolidated sites, and an active public realm.	Industrial Zone 3 (IN3Z) Commercial 1 Zone (C1Z) Commercial 2 Zone (C2Z) Commercial 3 Zone (C3Z) Activity Centre Zone (ACZ) Mixed Use Zone (MUZ) Road 2 Zone (RDZ2)	Day 0600 – 2200 hrs: 55 dB $L_{Aeq,16h}$ Night 2200 – 0600 hrs: 50 dB $L_{Aeq,8h}$
Category III	Lower rise building form including lower density residential development and detached housing typical of suburban residential settings or in towns of district or regional significance.	Residential Growth Zone (RGZ) General Residential Zone (GRZ) Neighbourhood Residential Zone (NRZ) Urban Floodway Zone (UFZ) Public Park and Recreation Zone (PPRZ) Urban Growth Zone* (UGZ)	Day 0600 – 2200 hrs: 50 dB $L_{Aeq,16h}$ Night 2200 – 0600 hrs: 40 dB $L_{Aeq,8h}$
Category IV	Lower density or sparse populations with settlements that include smaller hamlets, villages and small towns that are generally unsuited for further expansion. Land uses include primary industry and farming.	Low Density Residential Zone (LDRZ) Township Zone (TZ) Rural Living Zone (RLZ) Green Wedge A Zone (GWAZ) Rural Conservation Zone (RCZ) Public Conservation and Resource Zone (PCRZ) Green Wedge Zone (GWZ) Farming Zone (FZ) Rural Activity Zone (RAZ)	Day 0600 – 2200 hrs: 40 dB $L_{Aeq,16h}$ Night 2200 – 0600 hrs: 35 dB $L_{Aeq,8h}$
Category V	Unique combinations of landscape, biodiversity and geodiversity. These natural areas typically provide undisturbed species habitat and enable people to see and interact with native vegetation and wildlife.	Natural areas are classified as land within Category V irrespective of the planning zones that apply to that land.	Qualitative: A sound quality that is conducive to human tranquillity and enjoyment having regard to the ambient natural soundscape

Land use category	General description	Planning Zones	Outdoor indicators and objectives
Category I, II, III or IV depending on surrounding land uses and the intent of the specific planning zone (which may have a diversity of uses) as specified in a schedule to the planning zone		Comprehensive Development Zone (CDZ) Priority Development Zone (PDZ) Special Use Zone (SUZ) Public Use Zone (PUZ)	-

* Urban Growth Zone (UGZ) is a Category III land use until the relevant precinct structure plan is adopted, at which time the approved land uses will determine the land use category.

"Natural areas" means national parks, state parks, state forests, nature conservation reserves, wildlife reserves and environmentally significant areas and landscapes outside metropolitan Melbourne that are identified in a planning scheme.

APPENDIX D TRAFFIC NOISE MEASUREMENTS

Traffic noise levels at the site were measured using three (3) Rion NL-31 environmental noise loggers fitted with windshields. Noise monitoring was conducted to measure existing traffic noise levels between 10 – 23 March 2022.

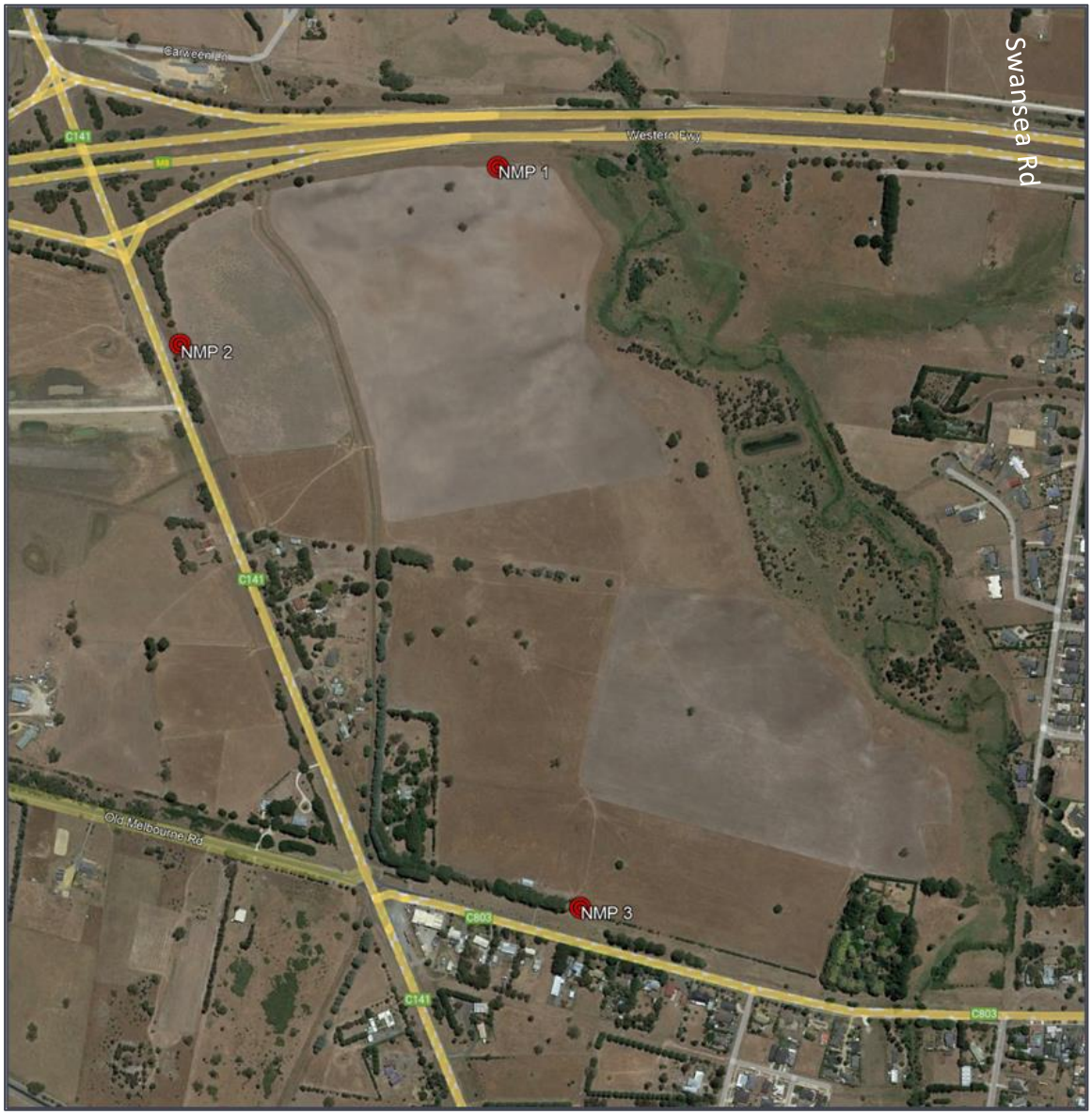
All noise loggers were mounted at a height of approximately 1.5 m above local ground level under free field conditions.

Measurements were obtained using the 'Fast' response time and A-weighting frequency network. The equipment was checked before and after the survey and no significant drifts in sensitivity were observed.

Weather data has been taken from the Bureau of Meteorology's weather station at Ballarat, with periods of high wind or significant rainfall highlighted Table 6. In accordance with VicRoads' document *Traffic Noise Measurement Requirements for Acoustic Consultants* (2011), the measurement survey period captured at least 3 days of valid data after adverse weather conditions or other reasons were discarded. 'Adverse weather conditions' are described as those where the wind speed exceeds 3 m/s and during heavy rain or continuous light rain. As such, the monitoring data is considered sufficient for this assessment.

The noise logger locations are presented in Figure 6.

Figure 6: Noise monitoring positions (Source: Google Earth)



The $L_{A10(18h)}$ noise level measurements are shown in Table 15.

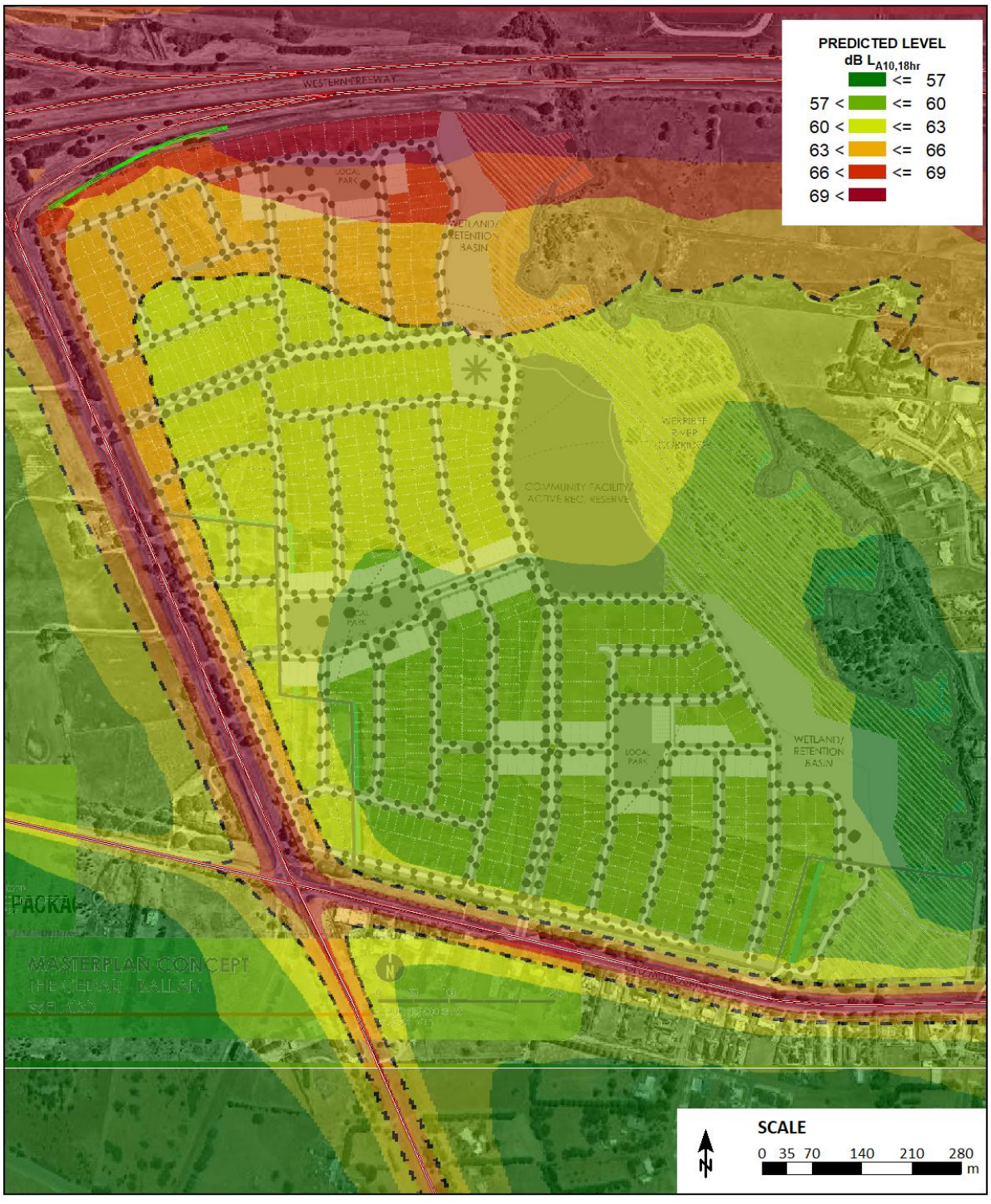
Table 15: Measured noise levels at subject site, dB $L_{A10(18hr)}$

Date	Measured noise level			Weather
	NMP 1	NMP 2	NMP 3	
Friday, 11 March 2022	68	64	54	Marginal
Saturday, 12 March 2022	68	61	54	Marginal
Sunday, 13 March 2022	70	63	54	Marginal
Monday, 14 March 2022	68	61	52	Marginal
Tuesday, 15 March 2022	71	63	54	Marginal
Wednesday, 16 March 2022	71	64	53	Too windy
Thursday, 17 March 2022	69	64	54	Marginal
Friday, 18 March 2022	67	63	54	Too windy
Saturday, 19 March 2022	69	63	53	Too windy
Sunday, 20 March 2022	66	61	52	Acceptable
Monday, 21 March 2022	67	63	53	Acceptable
Tuesday, 22 March 2022	65	63	- [1]	Acceptable
Averages				
Average on acceptable and marginal weekdays	68	63	54	
Number of acceptable and marginal weekdays	6	6	5	

Note 1: Data unavailable as the noise monitor's battery was depleted.

APPENDIX E PREDICTED NOISE LEVEL CONTOURS

E1 Predicted facade-corrected traffic levels, 2034 – ground floor (no barriers)



LEGEND

- Road
- 63 dB $L_{A10,18hr}$ criterion
- Existing berm

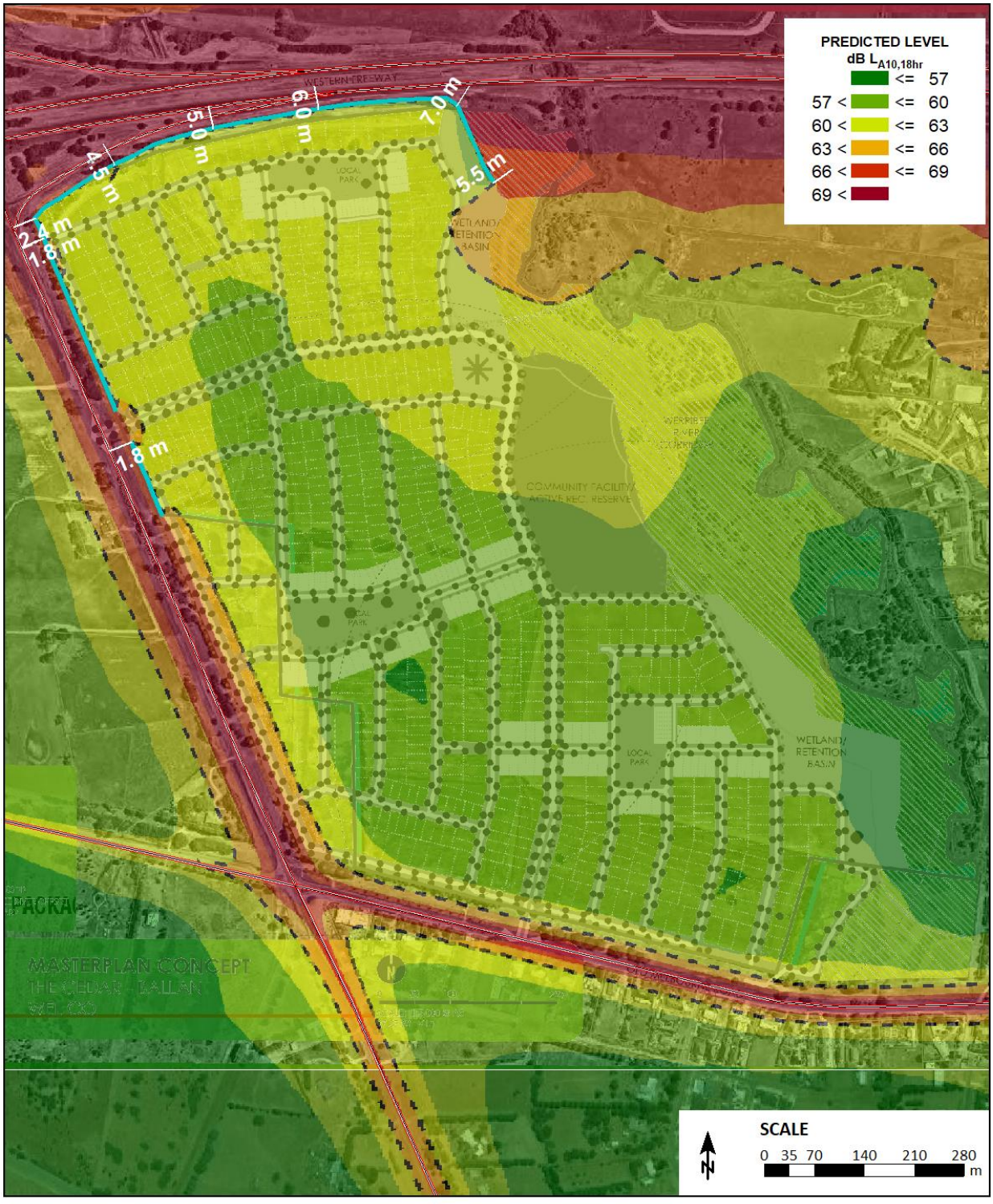
Project: Ballan Rezoning
Project number: 20220154
Client name: Wel.Co
Version: SoundPLAN 8.2
Prediction method: CoRTN (includes 2.5dB facade ref)
Model ref: 02
Run number: 1009
File: 2034 Traffic without barriers - ground floor
Prediction Height: 1.5 m

Western Freeway - Ballan

2034 traffic noise levels without barriers

MARSHALL DAY Acoustics

E2 Predicted facade-corrected traffic levels, 2034 – ground floor (with indicative barriers/bunds)



LEGEND

- Road
- Barrier/fence
- 63 dB $L_{A10,18hr}$ criterio

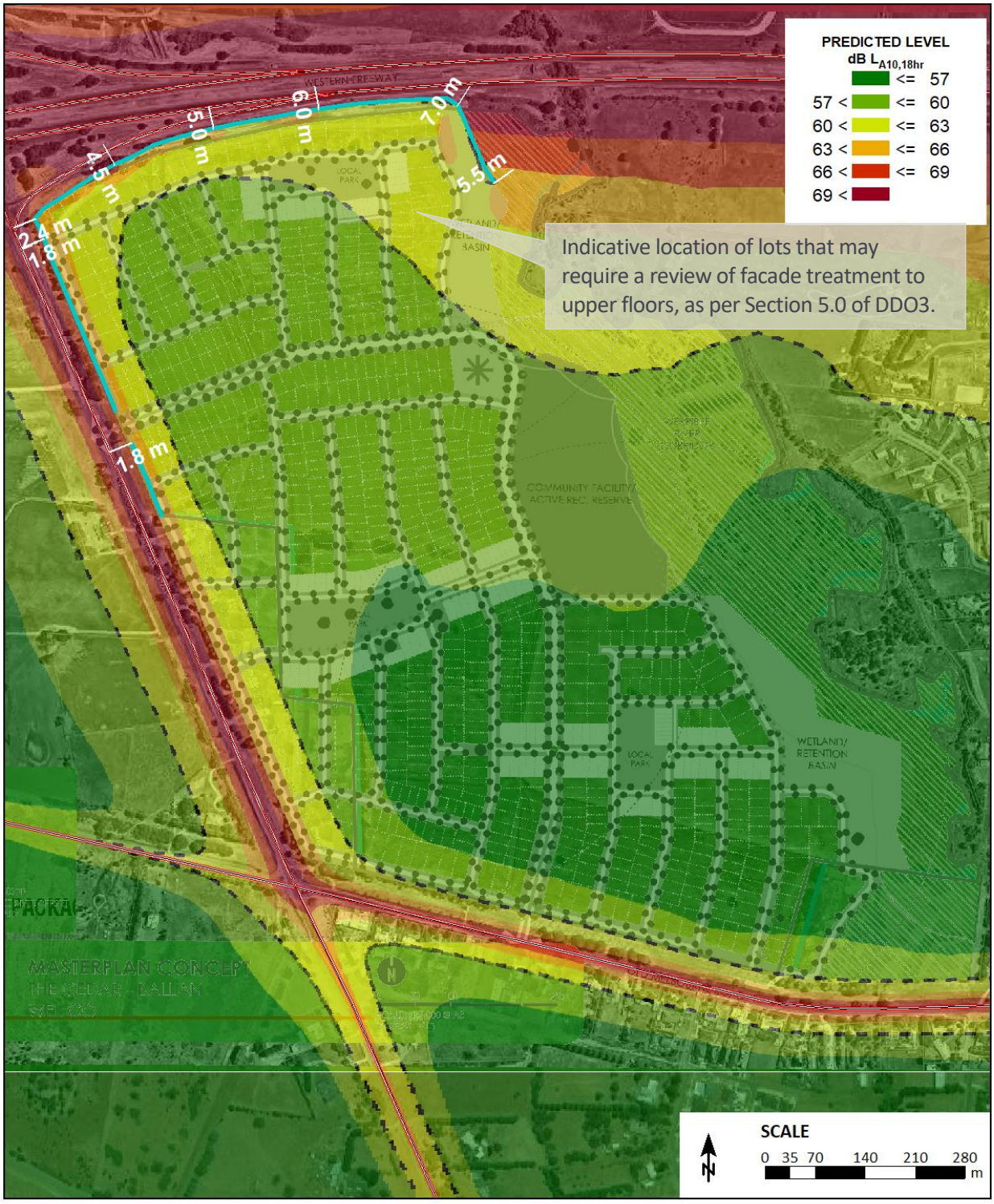
Project: Ballan Rezoning
Project number: 20220154
Client name: Wel.Co
Version: SoundPLAN 8.2
Prediction method: CoRTN (includes 2.5dB facade ref)
Model ref: 02
Run number: 1007
File: 2034 Traffic with barriers - ground floor
Prediction Height: 1.5 m

Western Freeway - Ballan

2034 traffic noise levels with indicative barriers

MARSHALL DAY Acoustics

E3 Predicted free field traffic levels, 2034 – first floor (with indicative barriers)



LEGEND

- Road
- Barrier/fence
- 60 dB $L_{A10,18h}$ criterion

Project:	Ballan Rezoning
Project number:	20220154
Client name:	Wel.Co
Version:	SoundPLAN 8.2
Prediction method:	CoRTN (free field)
Model ref:	02
Run number:	1007
File:	2034 Traffic with barriers - first floor
Prediction Height:	4.5 m

Western Freeway - Ballan

2034 traffic noise levels with indicative barriers

MARSHALL DAY Acoustics