Appendix B
Noise and vibration assessment

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Transportation Noise & Vibration Assessment

Meltham Structure Plan

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Prepared for:
Pindan

Report: 16093715-01.docx

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Table of Contents

List of Tables

List of Figures

Appendices

1 INTRODUCTION

A structure plan is being prepared for land in close proximity to the Meltham Train Station to facilitate re-zoning of the land. The area of interest is shown in *Figure 1-1*. The proposal is to allow lots within the subject area to be redeveloped to a higher density, with those closest to the train station to be of the highest density.

Figure 1-1 Locality Plan

The subject area has the potential to be affected by transportation noise and vibration including:

- Noise and vibration from passenger trains using the Perth to Midland railway;
- Road traffic noise from Whatley Crescent;
- Road traffic noise from Railway Parade; and
- Road traffic noise from Grand Promenade.

This report has been prepared to support the structure plan by identifying the noise and vibration impacts and providing recommendations to manage these impacts.

Appendix D contains a description of some of the terminology used throughout this report.

2 CRITERIA

2.1 Noise Criteria

Appropriate criteria in relation to noise are provided in *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning* (hereafter referred to as SPP 5.4) produced by the Western Australian Planning Commission (WAPC). The objectives in SPP 5.4 are to:

- Protect people from unreasonable levels of transport noise by establishing a standardised set of criteria to be used in the assessment of proposals;
- Protect major transport corridors and freight operations from incompatible urban encroachment;
- Encourage best practice design and construction standards for new development proposals and new or redevelopment transport infrastructure proposals;
- Facilitate the development and operation of an efficient freight network; and
- Facilitate the strategic co-location of freight handling facilities.

The outdoor noise criteria in SPP 5.4 are shown below in *Table 2-1*. These criteria apply at any point 1-metre from a habitable façade of a noise sensitive premises and in one outdoor living area.

Table 2-1 Outdoor Noise Criteria

Period	Target	Limit
Day (6am to 10pm)	55 dB $L_{Aeq(Day)}$	60 dB $L_{Aeq(Day)}$
Night (10pm to 6am)	50 dB $L_{Aeq(Night)}$	55 dB $L_{Aeq(Night)}$

Note: The 5 dB difference between the target and limit is referred to as the margin.

In the application of these outdoor noise criteria to new noise sensitive developments, the objectives of SPP 5.4 is to achieve -

- acceptable indoor noise levels in noise-sensitive areas (e.g. bedrooms and living rooms); and
- a 'reasonable' degree of acoustic amenity in at least one outdoor living area on each lot.

If a noise sensitive development takes place in an area where outdoor noise levels will meet the *target*, no further measures are required.

In areas where the *target* is exceeded, customised noise mitigation measures should be implemented with a view to achieving the *target* in at least one outdoor living area on each residential lot, or if this is not practicable, within the *margin*. Where the development is multi-storey apartment type, it is inevitable that some balcony areas will face the transportation corridor. For these it is recommended a common outdoor space be provided where noise levels are no more than the *limit*.

For residential buildings, "acceptable indoor noise levels" are taken to be 40 dB $L_{Aeq(Day)}$ in living areas and 35 dB $L_{Aeq(Night)}$ in bedrooms. These levels fall within the range of the "Recommended Design Sound Levels" for houses and apartments near major roads, as given in Australian Standard AS 2107:2000 *Acoustics – Recommended design sound levels and reverberation times for building interiors*.[1]

The Guidelines to SPP 5.4 provide deemed to comply architectural treatment packages based on external noise levels as follows:

- Package A – Applied where external noise levels are 55-60 dB $L_{Aeq(Day)}$ or 50-55 dB $L_{Aeq(Night)}$;
- Package B – Applied where external noise levels are 60-63 dB $L_{Aeq(Day)}$ or 55-58 dB $L_{Aeq(Night)}$;
- Package C – Applied where external noise levels are 63-65 dB $L_{Aeq(Day)}$ or 58-60 dB $L_{Aeq(Night)}$.

2.2 Vibration Criteria

Exposure limits for vibration are normally defined in terms of a multiplying factor that is applied to the base curves defined in AS 2670.2:1990 *Evaluation of Human Exposure to Whole Body Vibration, Part 2: Continuous and Shock Induced Vibration in Buildings (1 to 80 Hz)*. The base curve is the point at which adverse comment is considered rare. The Standard also states that at levels above the base curve, vibration may or may not give rise to adverse comment depending on circumstances. The measure of human annoyance within this Report is a velocity (mm/s) root mean squared (rms). The multiplying factors are given in Appendix A of AS 2670.2-1990 as follows for a residential premises:

- Night-time continuous or intermittent vibration – Curve 1.4;
- Daytime continuous or intermittent vibration – Curve 2 to Curve 4;
- Night-time transient vibration with several occurrences per day – Curve 1.4 to Curve 20;
- Daytime transient vibration with several occurrences per day – Curve 30 to 90

It is noted that within residential areas there are wide variations in vibration tolerance. Specific values are dependent upon social and cultural factors, psychological attitudes and expected interference with privacy.

Previous projects have adopted the use of Curve 2. The Curve vibration levels vary with direction (radial, transverse, vertical) and frequency. For the Curve 2 vertical direction, the vibration level is consistent at 0.199mm/s from 8 to 80Hz.

There are no Australian Standards that provide criteria in relation to structural damage to buildings. Structural damage measurements are normally undertaken as peak component particle velocity (PCPV). For instance, for road construction projects Main Roads Western Australia (MRWA) generally adopts a limit of 5mm/s PCPV for structurally sound dwellings. The Curves of AS2670.2 are not relevant for structural damage.

It should be noted that structural damage occurs at significantly higher vibration levels than human perception, so a person will perceive vibration (and potentially be annoyed by it) well before any structural damage is likely to occur.

[1] The "acceptable indoor noise levels" for residential buildings are exactly midway between the "satisfactory" and "maximum" recommended design sound levels for houses and apartments near major roads.

3 METHODOLOGY

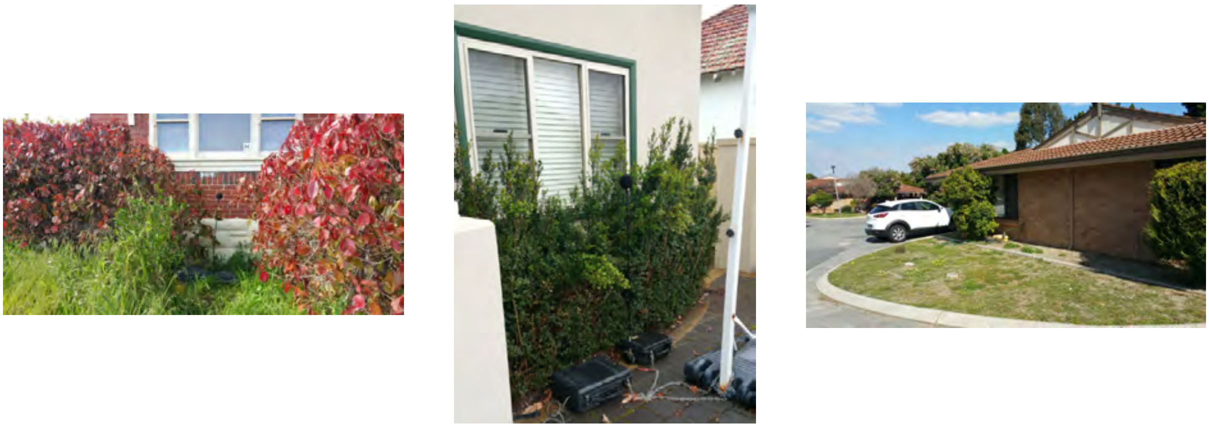
Noise and vibration measurements along with modelling have been undertaken in accordance with the requirements of SPP 5.4 as described below in *Sections 3.1* to *3.3*.

3.1 Noise Monitoring

Noise monitoring was undertaken at three locations in order to:

- Quantify the existing noise levels;
- Determine the differences between different acoustic parameters ($L_{A10,18hour}$, $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$); and
- Calibrate the noise model for existing conditions.

The instruments used were ARL Type 316 noise data loggers (refer *Figure 3-1*), located at the addresses shown in *Figure 3-2*. The microphone for each logger is 1.4 metres above ground level and was located 1-metre from the building facade. The logger was programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. The instruments comply with the requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The loggers were field calibrated before and after the measurement session and found to be accurate to within +/- 1 dB. Lloyd George Acoustics also holds current laboratory calibration certificate for the loggers.



2 Grand Promenade | 226 Railway Parade | 308 Whatley Crescent

Figure 3-1 Photographs of Noise Data Loggers

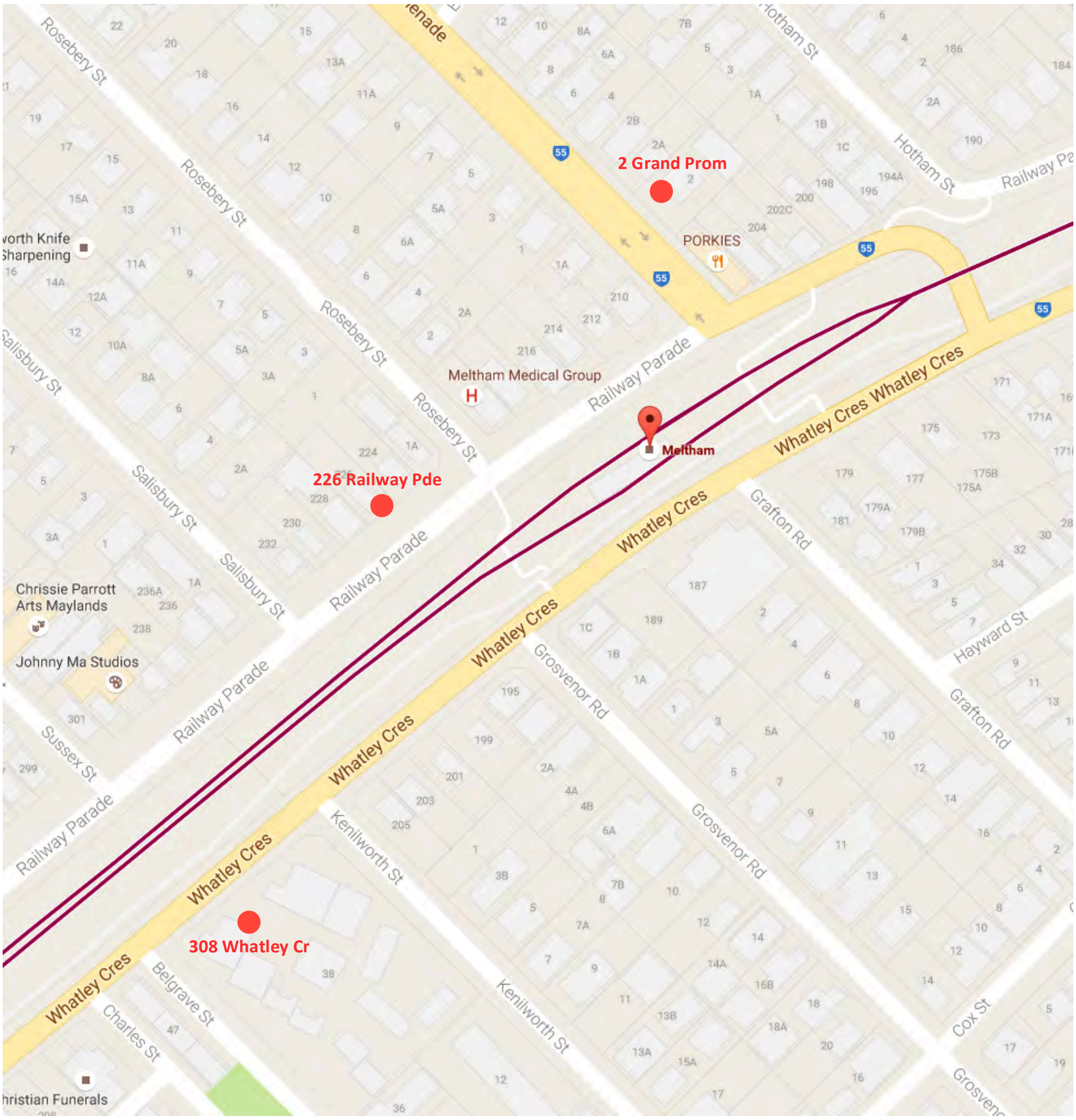


Figure 3-2 Noise Logger Locations

The noise data collected was verified by inspection and professional judgement. Where hourly data was considered atypical, an estimated value was inserted and highlighted by bold italic lettering.

3.2 Vibration Monitoring

Vibration measurements were carried out at the same locations as the noise monitoring described in *Section 3.1*.

The vibration levels were recorded using Texcel GTM vibration loggers, connected to a geophone, where spikes penetrate the ground. The meter was set to record data at 5-minute intervals and consisted of peak vibration and rms vibration.

3.3 Road Noise Modelling

The computer programme *SoundPLAN 7.4* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms.

In line with the requirements of SPP 5.4 Guidelines, each road was separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Classes 1 & 2) vehicles. Non-heavy vehicles have a source height of 0.5 metres above road level and heavy vehicles have two sources, at heights of 1.5 metres and 3.6 metres above road level, to represent the engine and exhaust respectively. By splitting the noise source into three, allows for less barrier attenuation for high level sources. Note that corrections are applied to the exhaust of –8.0 dB (based on Transportation Noise Reference Book, Paul Nelson, 1987) and to the engine source of –0.8 dB, so as to provide consistent results with the CoRTN algorithms for the no barrier scenario.

Predictions are made at heights of 1.4 metres above floor level and at 1.0 metre from an assumed building façade (resulting in a + 2.5 dB correction due to reflected noise).

Various input data are included in the modelling such as ground topography, road design, traffic volumes etc. These model inputs are discussed below.

3.3.1 Ground Topography

Topographical data was based on that provided by Landgate via Planning Solutions. The data is provided as 3-dimensional contours in AutoCAD digital format for incorporation into the noise model. Landgate data also provided cadastral information as well as existing building outlines.

All existing buildings are assumed to have a height of 3.5 metres, typical of single storey residences. Future buildings are modelled on the basis of 3 metres per floor, with buildings up to 6 storeys high considered.

3.3.2 Traffic Data

All three roads (Grand Promenade, Railway Parade & Whatley Crescent) are assumed to have dense graded asphalt road surface and posted speeds of 60km/hr. These assumptions are applied for both the existing and future scenarios.

Traffic volumes were requested from Main Roads Western Australia (MRWA) and included a 2011 calibration plot, 2011 traffic volumes and percentage heavy vehicles and 2031 traffic volumes and percentage heavy vehicles. These were provided on 21 September 2016 by Clare Yu (Traffic Modelling Analyst).

Reviewing the calibration plot, the MRWA model is considered reasonably accurate so that no adjustments have been applied to the provided 2031 modelled traffic volumes (refer *Figure 3-3*).

Reviewing historical data (2009/10 to 2014/15), the roads in question have not shown a consistent traffic growth, with some years increasing and others decreasing (refer *Table 3-1*). As such, no adjustment has been made to the 2011 traffic volumes to represent the 2016 volumes, being those present during the noise monitoring.

Table 3-1 Traffic Counts for Major Roads in Meltham Study Area

Road	Section	Year					
		2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Grand Promenade	West of Railway	-	16,930	-	17,460	17,550	-
Railway Parade	East of Central	-	11,200	-	11,590	-	-
	South of Grand Prom	13,210	13,590	-	14,860	13,010	-
Whatley Crescent	East of Garrett	-	17,650	-	18,670	17,770	-
	North of Grafton	-	11,480	-	12,580	10,940	-
	East of Central	-	-	-		12,760	-

"-" indicates no count available.

Figure 3-3 shows the existing traffic volumes and percentage heavy vehicles used in the noise modelling and *Figure 3-4* shows the forecast traffic volumes.

3.3.3 Ground Attenuation

The ground attenuation has been assumed to be 0.1 (10%) for roads and 0.8 (80%) elsewhere. Note 0.0 represents hard reflective surfaces such as water and 1.00 represents absorptive surfaces such as grass.

3.4 Passenger Railway Noise Modelling

Much of that discussed in *Section 3.3* is also relevant to train modelling with the following changes:

- Nordic Rail Prediction Method (Kilde Rep. 130) algorithms selected;
- Maximum noise level from a passing train calibrated to align with existing file data, being 87 dB(A) for a speed of 130km/hr;
- A train travelling at 80km/hr is estimated to be around 6 dB quieter and one at 60km/hr around 10 dB quieter;
- From the current timetable, there are 68 movements from Perth to Midland, with 57 of these assumed to be 3 car sets (75m long) at 60km/hr and 11 assumed to be 6 car sets (150m long) at 80km/hr.
- From the current timetable, there are 71 movements from Midland to Perth, with 57 of these assumed to be 3 car sets (75m long) at 60km/hr and 14 assumed to be 6 car sets (150m long) at 80km/hr.
- The speed is relatively slow in the area due to trains either stopping at Meltham Station (assumed to be all 3 car sets) or express trains travelling through Meltham Station (assumed to be all 6 car sets) but still at a reduced speed.

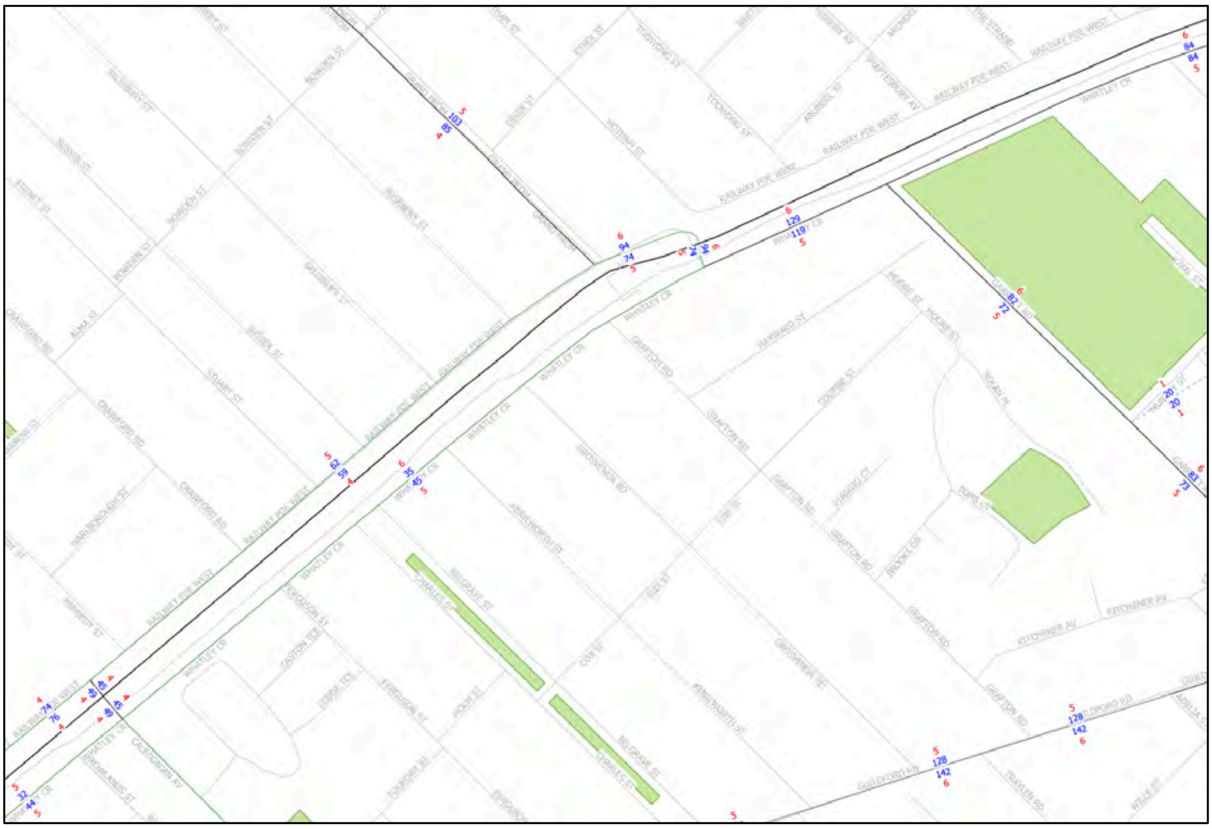


Figure 3-3 Existing Traffic Volumes Used in Noise Model

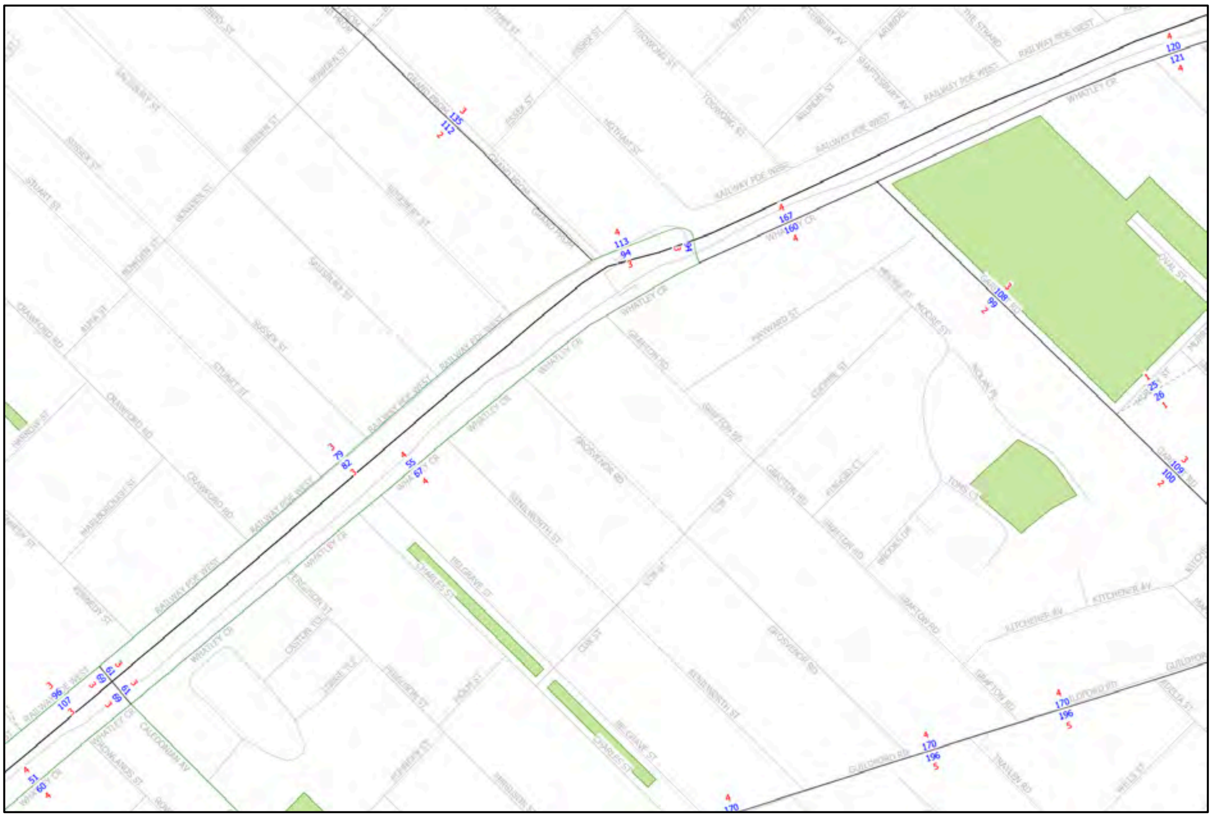


Figure 3-4 Forecast 2031 Traffic Volumes Used in Noise Model

3.5 Parameter Relationships

The CoRTN algorithms used in the *SoundPlan* modelling package were originally developed to calculate the $L_{A10,18hour}$ noise level. SPP 5.4 however uses $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$. The relationship between the parameters varies depending on the composition of traffic on the road (volumes in each period and percentage heavy vehicles). As noise monitoring was undertaken, it would be normal practice to simply use the difference between the measured parameters and apply this within the model. In this instance, the measured values (refer *Section 4.1*) are influenced by both car and train noise.

For road traffic, it is expected that the hourly L_{Aeq} value will be 3 dB less than the hourly L_{A10} value. Hourly traffic volumes were then reviewed for relevant sections of road and a log relationship applied. For example:

- Let's say the traffic count for Whatley Crescent, between 4pm and 5pm is 1039 vehicles and this has an assumed noise level of 63.0 dB $L_{A10,hour}$ and 60 dB $L_{Aeq,1hour}$ from road traffic alone.
- From 5pm to 6pm, the volume is 987 vehicles. This can be related to the previous noise by:
  - $L_{A10,18hour(5pm\ to\ 6pm)} = L_{A10,18hour(4pm\ to\ 5pm)} - 10 \times Log(Volume_{(4pm\ to\ 5pm)}/Volume_{(5pm\ to\ 6pm)})$
  - $L_{A10,18hour(5pm\ to\ 6pm)} = 63.0 - 10 \times Log(1039/987)$
  - $L_{A10,18hour(5pm\ to\ 6pm)} = 62.8$ dB
- The above calculation is repeated for each hour allowing the $L_{A10,18hour}$ and $L_{Aeq(Day)}$ to be calculated.
- For the Railway Parade counts, the relationship was calculated to be a 2.1 to 2.5 dB differential between $L_{A10,18hour}$ and $L_{Aeq(Day)}$. With reference to *Section 4.1*, the measured differential was 1.6 dB, suggesting the trains do affect the measured $L_{Aeq(Day)}$ noise level.
- For the Whatley Crescent counts, the relationship was calculated to be a 2.1 to 2.4 dB differential between $L_{A10,18hour}$ and $L_{Aeq(Day)}$. With reference to *Section 4.1*, the measured differential was 2.3 dB, suggesting the trains do not significantly affect the measured $L_{Aeq(Day)}$ noise level.
- The measured $L_{Aeq(Day)}$ noise level on Railway Parade was 57.9 dB with an $L_{A10,18hour}$ noise level of 59.5 dB. Had there been no trains, it is expected the measured $L_{Aeq(Day)}$ would have been 57.0 dB. With this in mind, it is calculated the noise from trains is 50.7 dB $L_{Aeq(Day)}$ since 57.0 combined with 50.7 results in 57.9 dB. This train noise level then allows train noise only to be calibrated within the model.

4 RESULTS

4.1 Noise Monitoring

The results of the noise monitoring are summarised below in *Tables 4-1 to 4-3* and shown graphically in *Appendix B*.

Table 4-1 Measured Average Noise Levels – 2 Grand Promenade

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
15 September 2016	62.8	59.6	61.0	53.0
16 September 2016	62.8	59.4	60.7	53.8
19 September 2016	62.3	59.6	61.0	53.9
20 September 2016	61.4	58.4	59.8	52.8
21 September 2016	61.4	58.8	60.2	52.8
Weekday Average	**62.1**	**59.2**	**60.5**	**53.3**

The average differences between the weekday $L_{A10,18hour}$ and $L_{Aeq(Day)}$ is 1.5 dB and this conversion has been used in the modelling. The average differences between the weekday $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is 7.4 dB. As such, compliance with the daytime criteria of *Section 2.1* will result in compliance with the night-time criteria so that only daytime noise levels will be considered.

Table 4-2 Measured Average Noise Levels – 226 Railway Parade

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
15 September 2016	60.2	56.9	58.3	50.5
16 September 2016	59.8	57.0	58.2	52.4
19 September 2016	59.9	57.1	58.4	51.7
20 September 2016	58.8	55.8	57.2	50.0
21 September 2016	58.7	56.1	57.5	50.2
Weekday Average	**59.5**	**56.6**	**57.9**	**51.0**

The average differences between the weekday $L_{A10,18hour}$ and $L_{Aeq(Day)}$ is 1.6 dB and this conversion has been used in the modelling. The average differences between the weekday $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is 6.9 dB. As such, compliance with the daytime criteria of *Section 2.1* will result in compliance with the night-time criteria so that only daytime noise levels will be considered.

Table 4-3 Measured Average Noise Levels – 308 Whatley Parade

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq (Day)}$	$L_{Aeq (Night)}$
15 September 2016	66.1	61.8	63.3	55.0
16 September 2016	65.7	61.9	63.2	56.2
19 September 2016	64.9	62.0	63.4	54.9
20 September 2016	64.7	61.2	62.6	54.7
21 September 2016	64.8	60.8	62.2	54.2
Weekday Average	**65.2**	**61.5**	**63.0**	**55.0**

The average differences between the weekday $L_{A10,18hour}$ and $L_{Aeq(Day)}$ is 2.3 dB and this conversion has been used in the modelling. The average differences between the weekday $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is 7.9 dB. As such, compliance with the daytime criteria of *Section 2.1* will result in compliance with the night-time criteria so that only daytime noise levels will be considered.

4.2 Vibration Monitoring

The results of the vibration monitoring are provided in *Appendix C* and summarised below:

- The vibration logger at Grand Promenade suffered a power failure during monitoring. This location is set-back from the railway and given the results of the other two loggers, is not considered critical. Also, as train movements are frequent, the logger would have recorded train events, even if for only a short period.
- Peak component vibration levels at all three locations are below 5mm/s and therefore structural damage to buildings from passing freight trains is considered unlikely;
- RMS component vibration levels at all three locations are below 0.199mm/s and therefore are below Curve 2 of AS2670.2.

4.3 Noise Modelling

4.3.1 Existing Scenario

The noise contours of the existing road and rail scenarios are provided in *Figures 4-1 and 4-2*. Given the extent of the contours, it can be seen that noise from road traffic will dictate the compliance status for new development in the area.

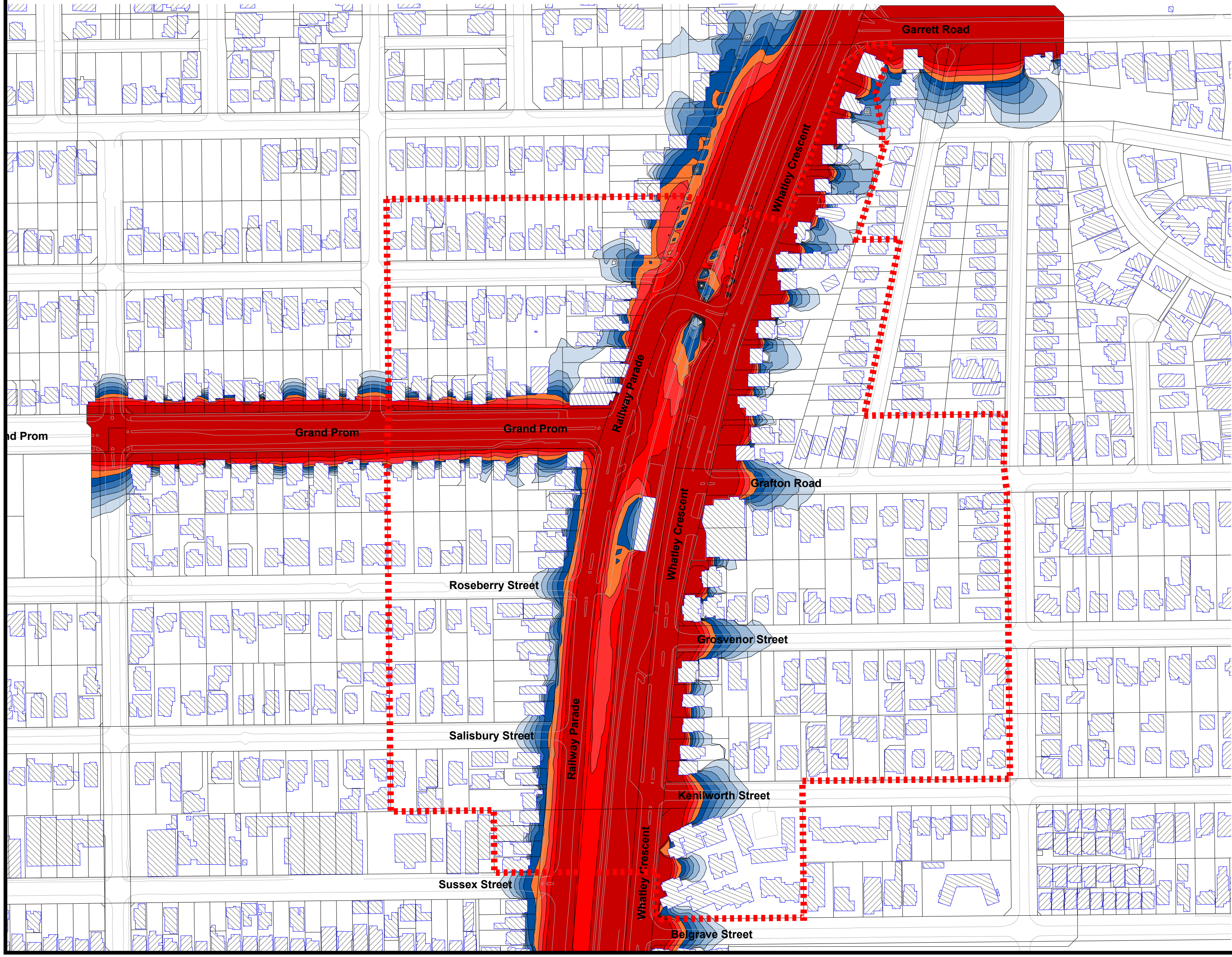
4.3.2 Future Scenario

The road noise model was changed to incorporate the future traffic volumes. Existing buildings remained in the model with the results for various floor heights shown in the noise contour plots of *Figures 4-3 to 4-8*.

Meltham Structure Plan

LAeq(Day) Noise Level Contours - Existing Road Traffic

Figure 4-1



Noise levels
LAeq,Day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	

Signs and symbols

Existing Buildings

Elevation line

Subject Area

28 October 2016

Length Scale 1:4500

0 25 50 100 150 m

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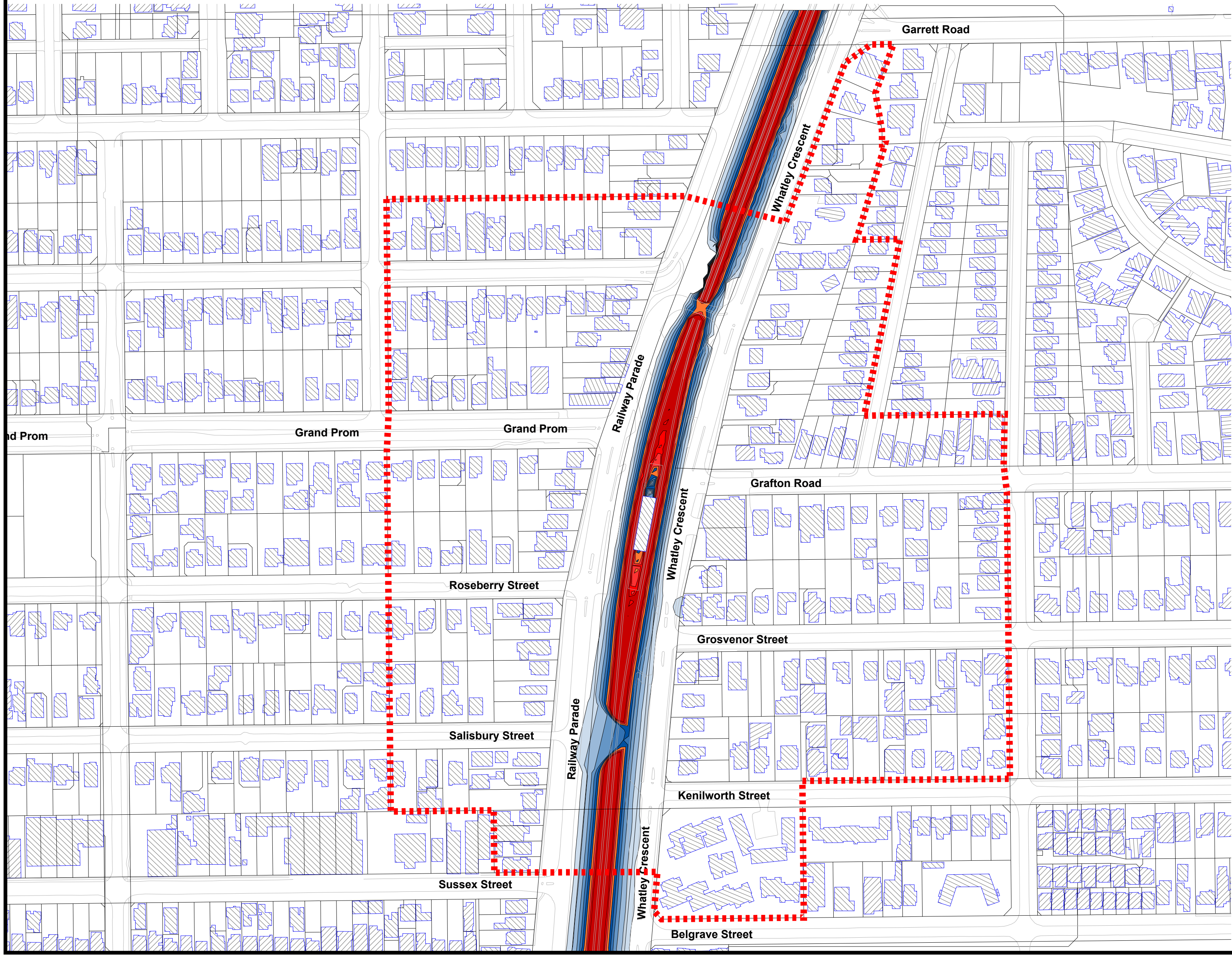
Meltham Structure Plan

LAeq(Day) Noise Level Contours - Existing Rail Traffic

Figure 4-2



Noise levels
LAeq,Day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	

Signs and symbols

- Existing Buildings
- Elevation line
- Subject Area

28 October 2016

Length Scale 1:4500

0 25 50 100 150 m

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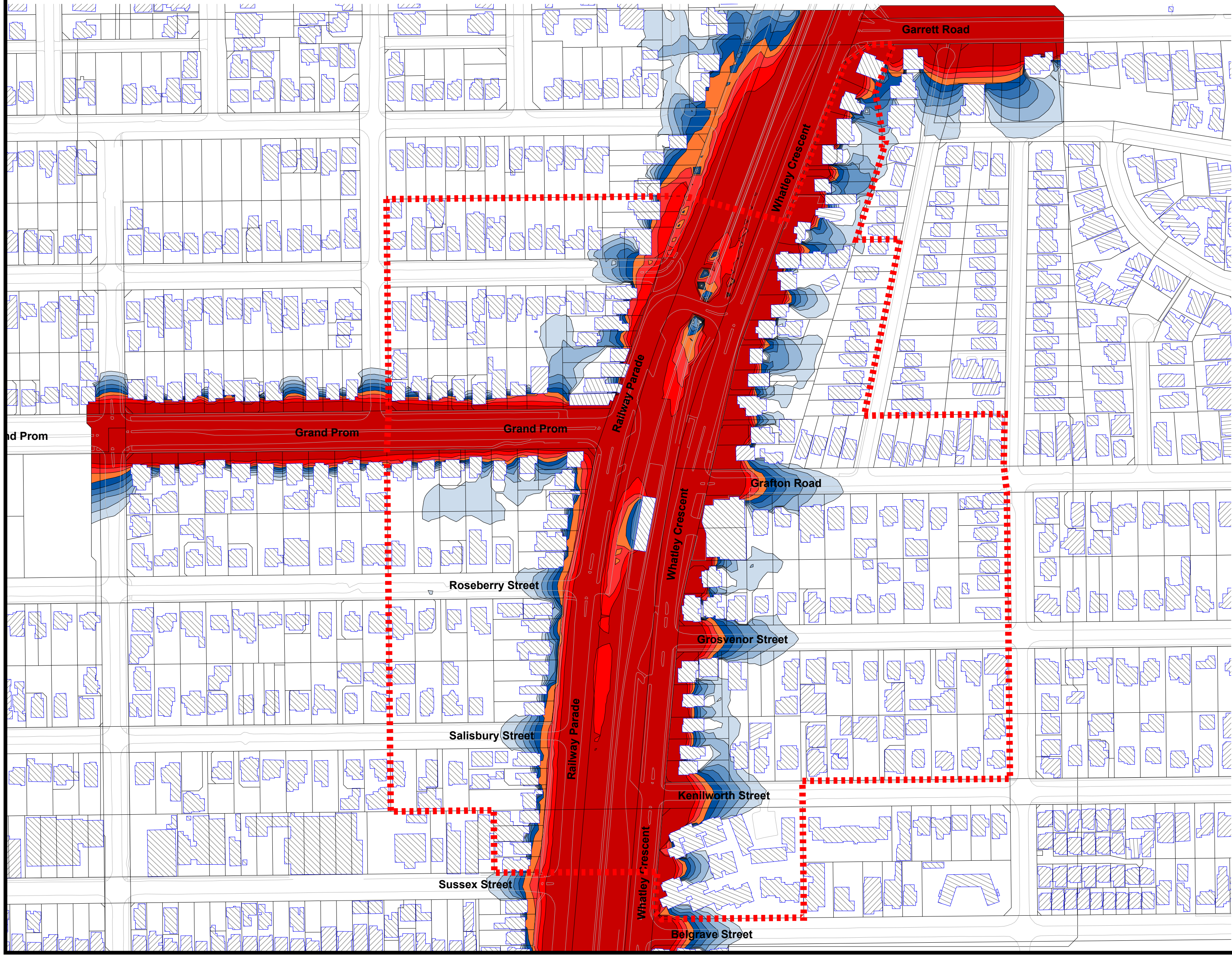
Meltham Structure Plan

LAeq(Day) Noise Level Contours - Future Road Traffic (Ground Level)

Figure 4-3



Noise levels
LAeq,Day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	

Signs and symbols

- Existing Buildings
- Elevation line
- Subject Area

28 October 2016

Length Scale 1:4500

0 25 50 100 150 m

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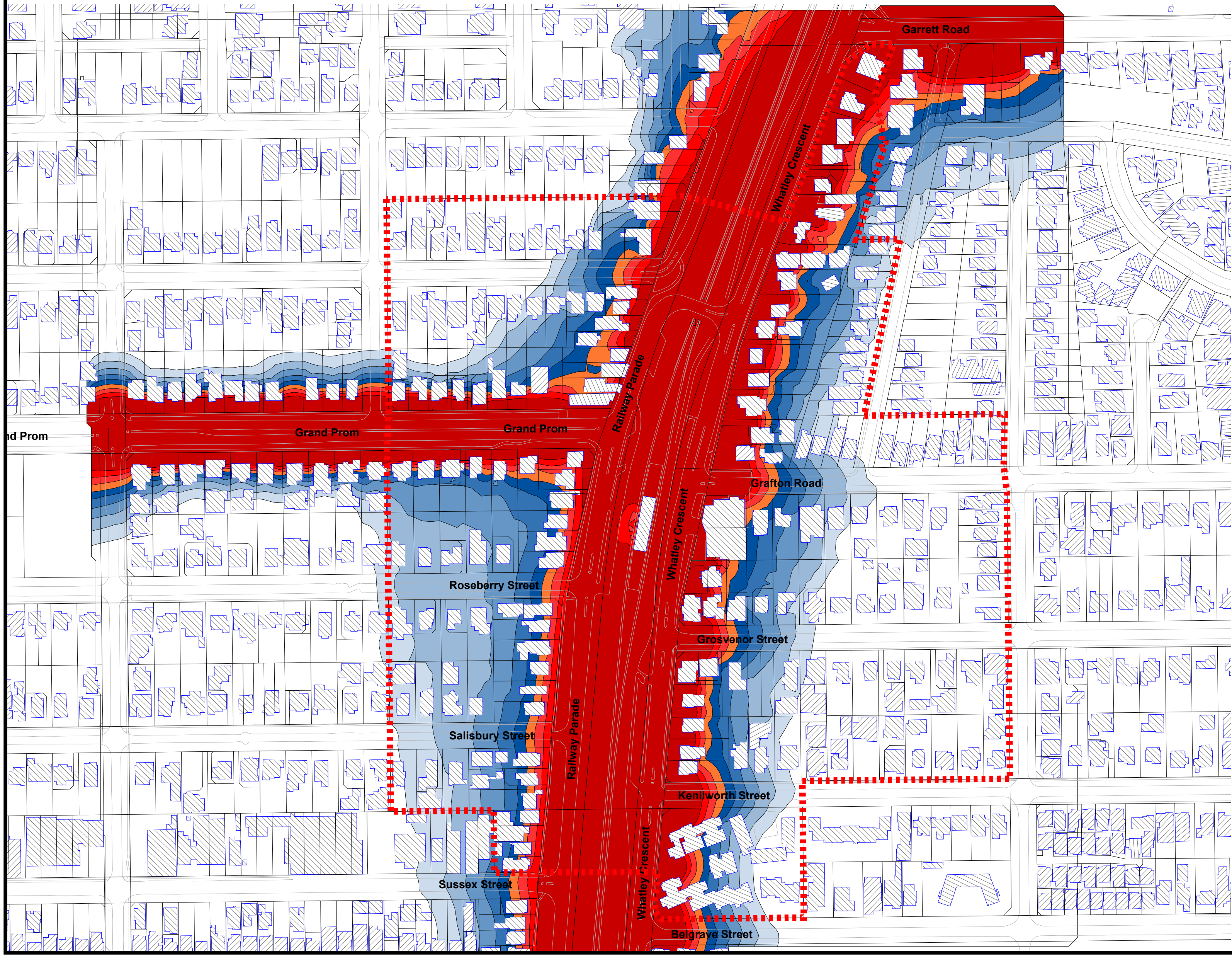
Meltham Structure Plan

LAeq(Day) Noise Level Contours - Future Road Traffic (Level 1)

Figure 4-4



Noise levels
LAeq,Day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	

Signs and symbols

- Existing Buildings
- Elevation line
- Subject Area

28 October 2016

Length Scale 1:4500

0 25 50 100 150 m

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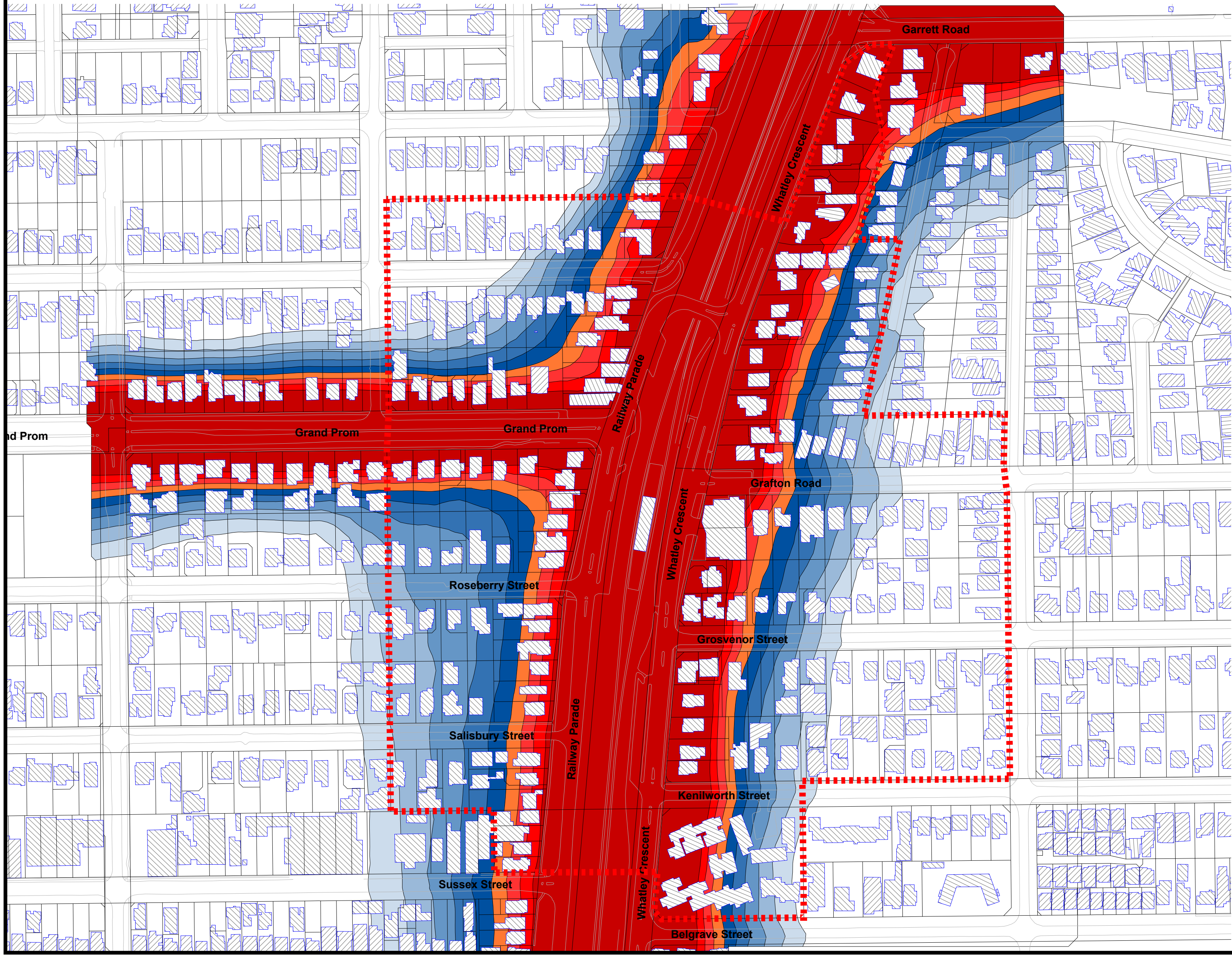
Meltham Structure Plan

LAeq(Day) Noise Level Contours - Future Road Traffic (Level 2)

Figure 4-5



Noise levels
LAeq,Day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	

Signs and symbols

- Existing Buildings
- Elevation line
- Subject Area

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Length Scale 1:4500

0 25 50 100 150 m

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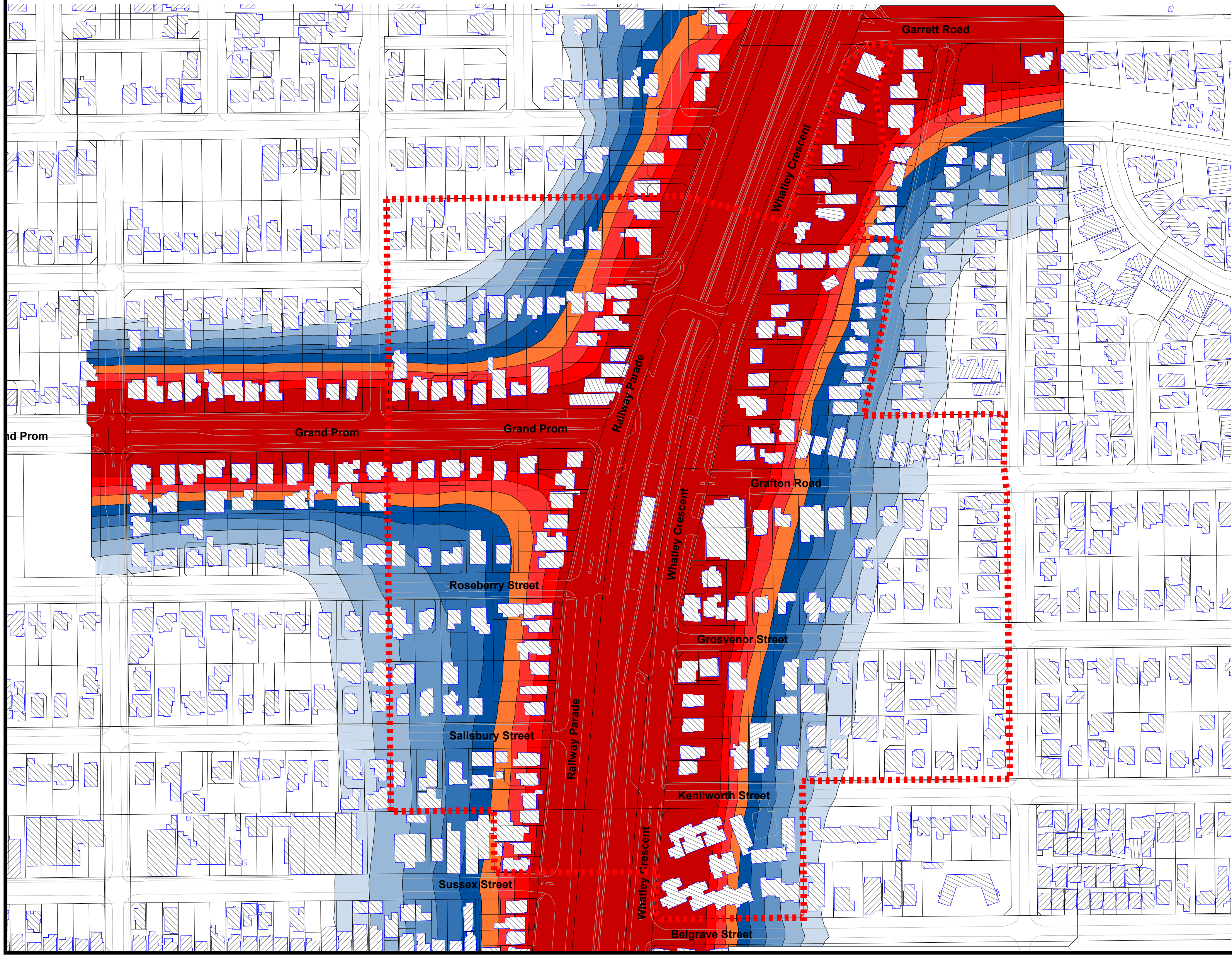
Meltham Structure Plan

LAeq(Day) Noise Level Contours - Future Road Traffic (Level 3)

Figure 4-6



Noise levels
LAeq,Day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	

Signs and symbols

- Existing Buildings
- Elevation line
- Subject Area

28 October 2016

Length Scale 1:4500

0 25 50 100 150 m

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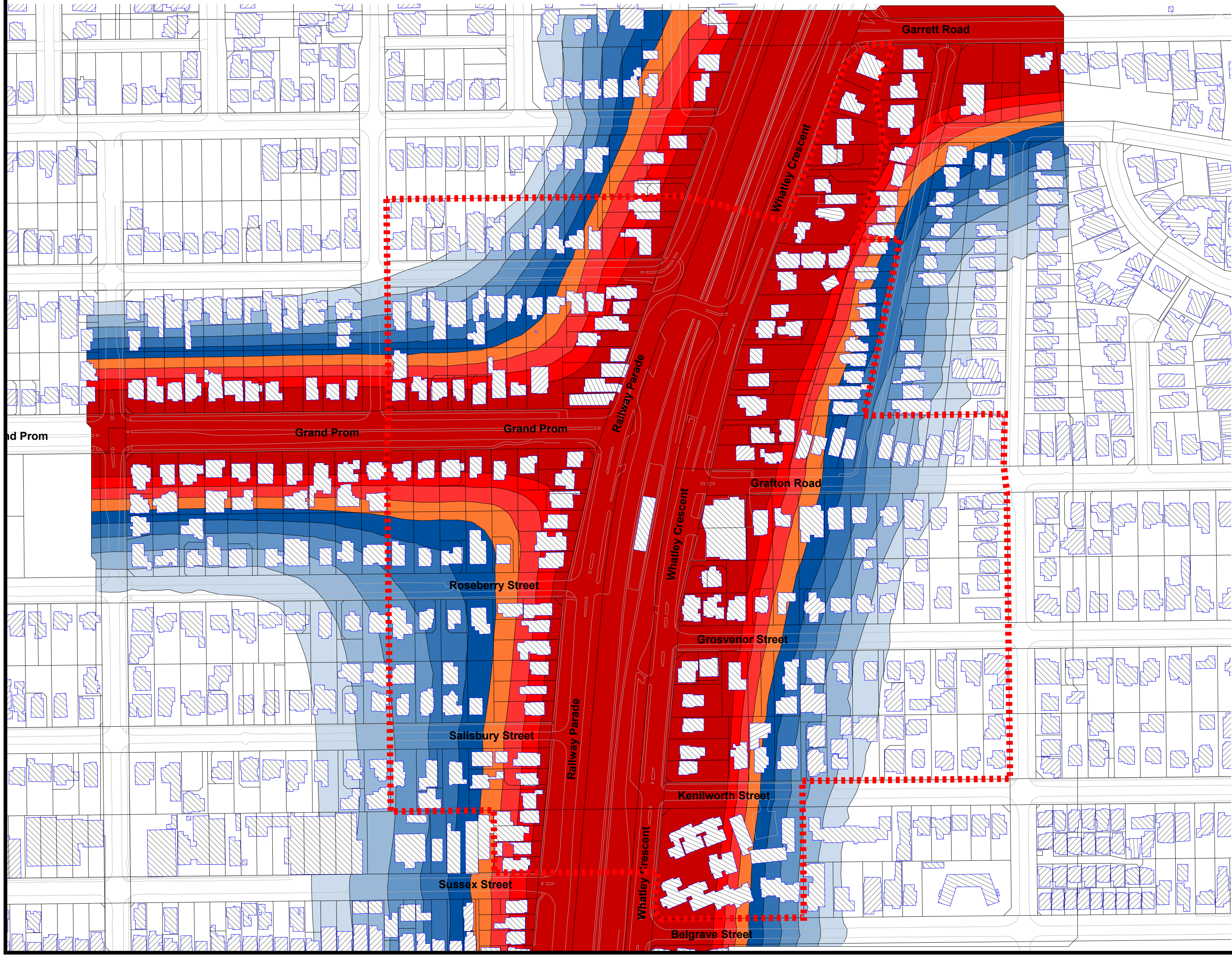
Meltham Structure Plan

LAeq(Day) Noise Level Contours - Future Road Traffic (Level 4)

Figure 4-7



Noise levels
LAeq,Day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	

Signs and symbols

- Existing Buildings
- Elevation line
- Subject Area

28 October 2016

Length Scale 1:4500

0 25 50 100 150 m

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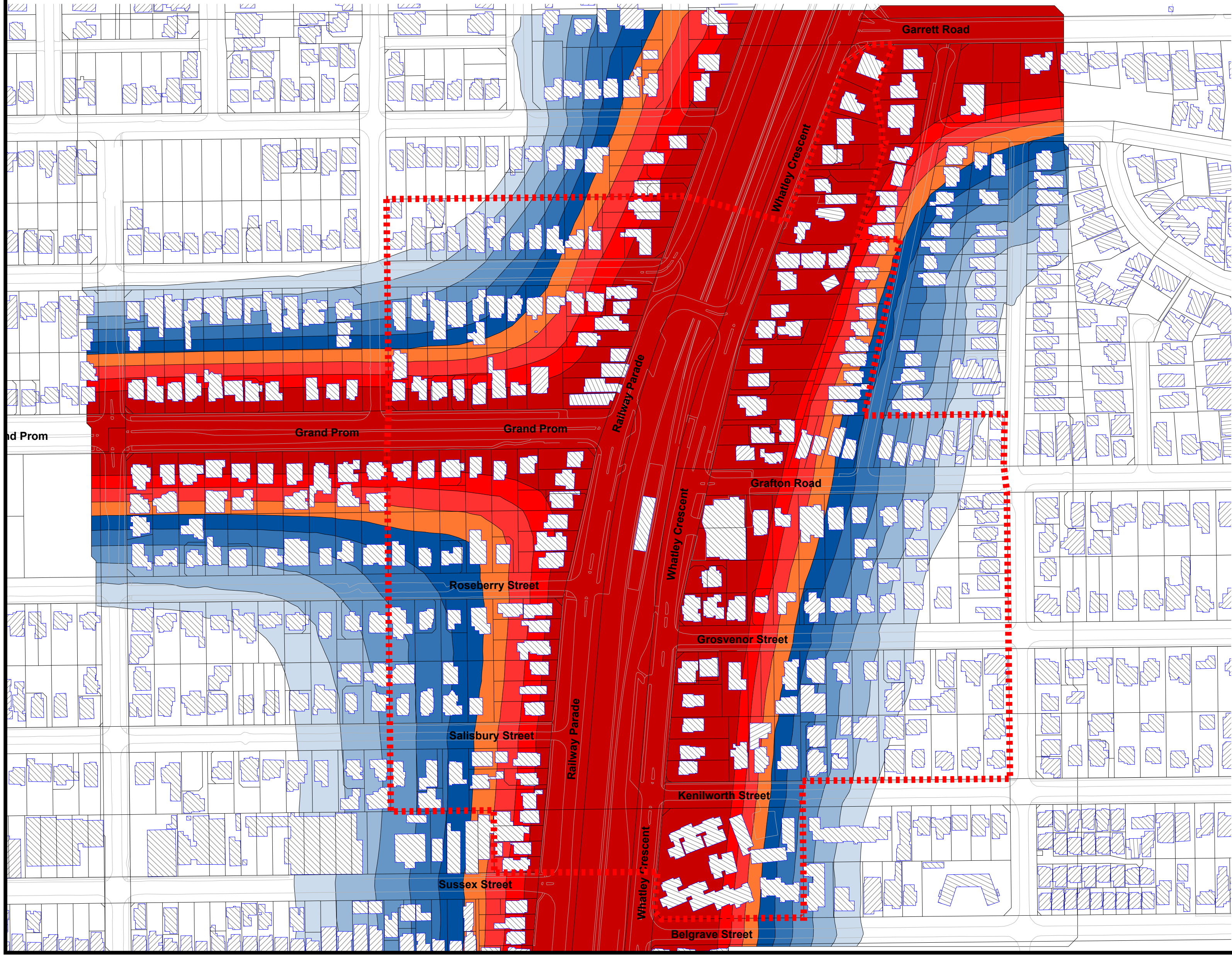
Meltham Structure Plan

LAeq(Day) Noise Level Contours - Future Road Traffic (Level 5)

Figure 4-8



Noise levels
LAeq,Day dB

< 55
55 <= < 56
56 <= < 57
57 <= < 58
58 <= < 59
59 <= < 60
60 <= < 61
61 <= < 62
62 <= < 63
63 <=

Signs and symbols

- Existing Buildings
- Elevation line
- Subject Area

28 October 2016

Length Scale 1:4500

0 25 50 100 150 m

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The contours are a worst-case scenario in that, say for modelling to the third floor, there is limited barrier attenuation since all existing buildings are assumed to be single storey. This is considered appropriate for an area where the ultimate development will occur over a long period of time. To show the difference, between contours with the existing buildings and ultimate development, the third level contours were calculated with an indicative ultimate development based on *Figure 4-9* (shown in *Figure 4-10* as the image from the 3D noise model), with the contours provided in *Figure 4-11*. The difference in the extent of the contours is evident behind the first row of buildings along Railway Parade and Whatley Crescent, where development will be at its highest.

Figure 4-9 Potential Building Heights

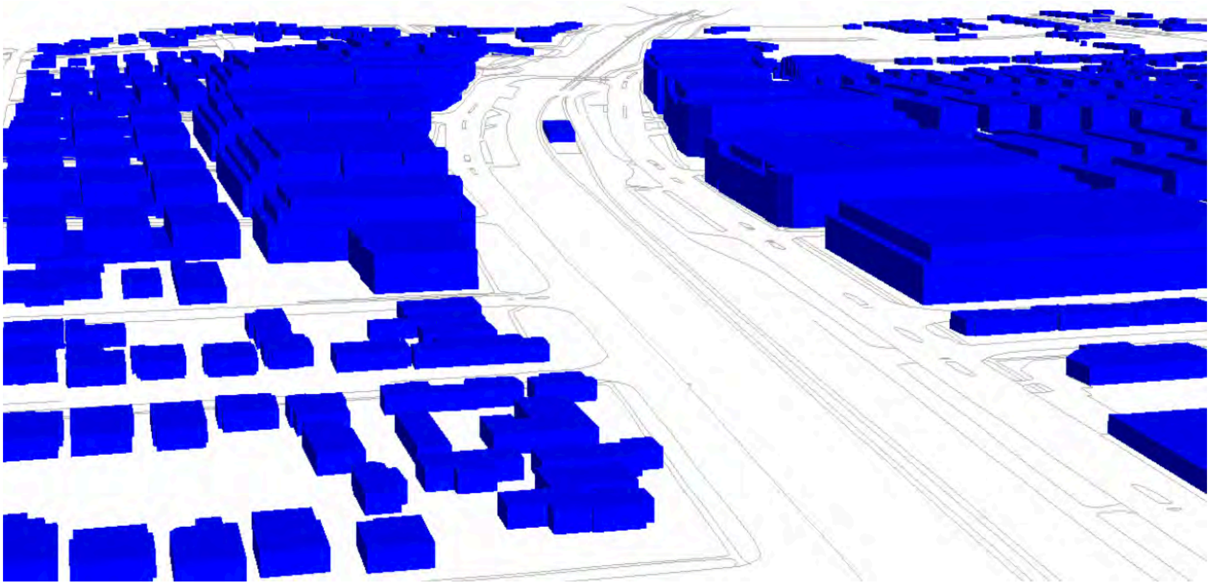
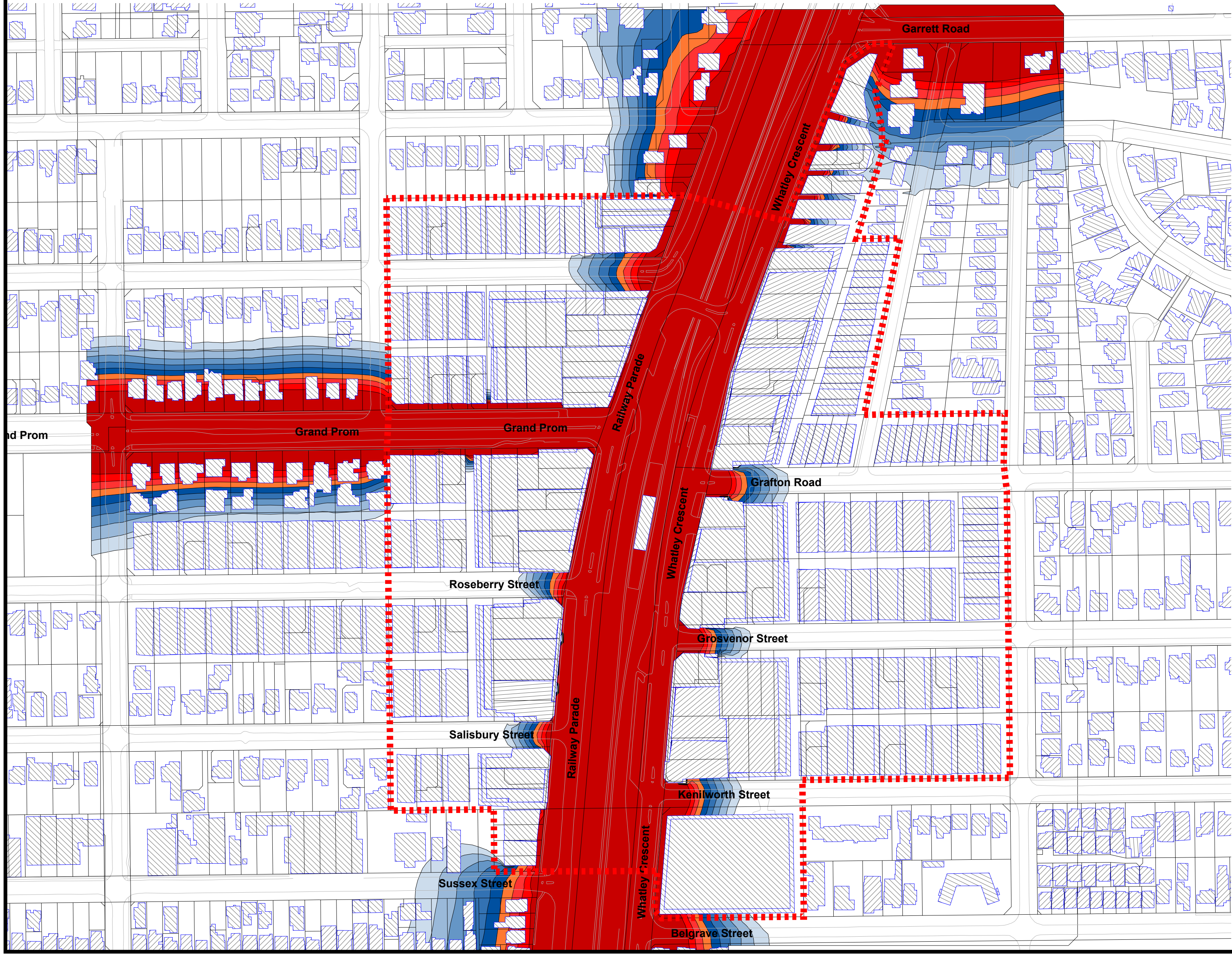


Figure 4-10 Potential Building Heights Shown as 3D Noise Model

Meltham Structure Plan

LAeq(Day) Noise Level Contours - Future Road Traffic (Level 3) With Potential Ultimate Building Development

Figure 4-11



Noise levels
LAeq,Day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	

Signs and symbols

Existing Buildings

Elevation line

Subject Area

31 October 2016

Length Scale 1:4500

0 25 50 100 150 m

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5 ASSESSMENT

There is negligible vibration in the area and therefore this does not require any further detailed assessment.

Whilst individual train passbys will be audible, the average over a day or night period is negligible compared to that of road traffic noise, which is the dominant noise source in the area.

The objectives of the *Section 2.1* criteria are for noise at all noise sensitive developments to be no more than the *limit* and preferably no more than the *target*. Where the *target* is achieved, no further controls are required. Where the ***target*** is exceeded, further controls are necessary. With no noise control, road traffic noise levels for some future dwellings will be above the ***target***. Given the multi-storey nature of the proposal, construction of noise walls is not considered to be an appropriate noise mitigation technique. As such, noise mitigation will need to be in the form of upgraded façade treatments.

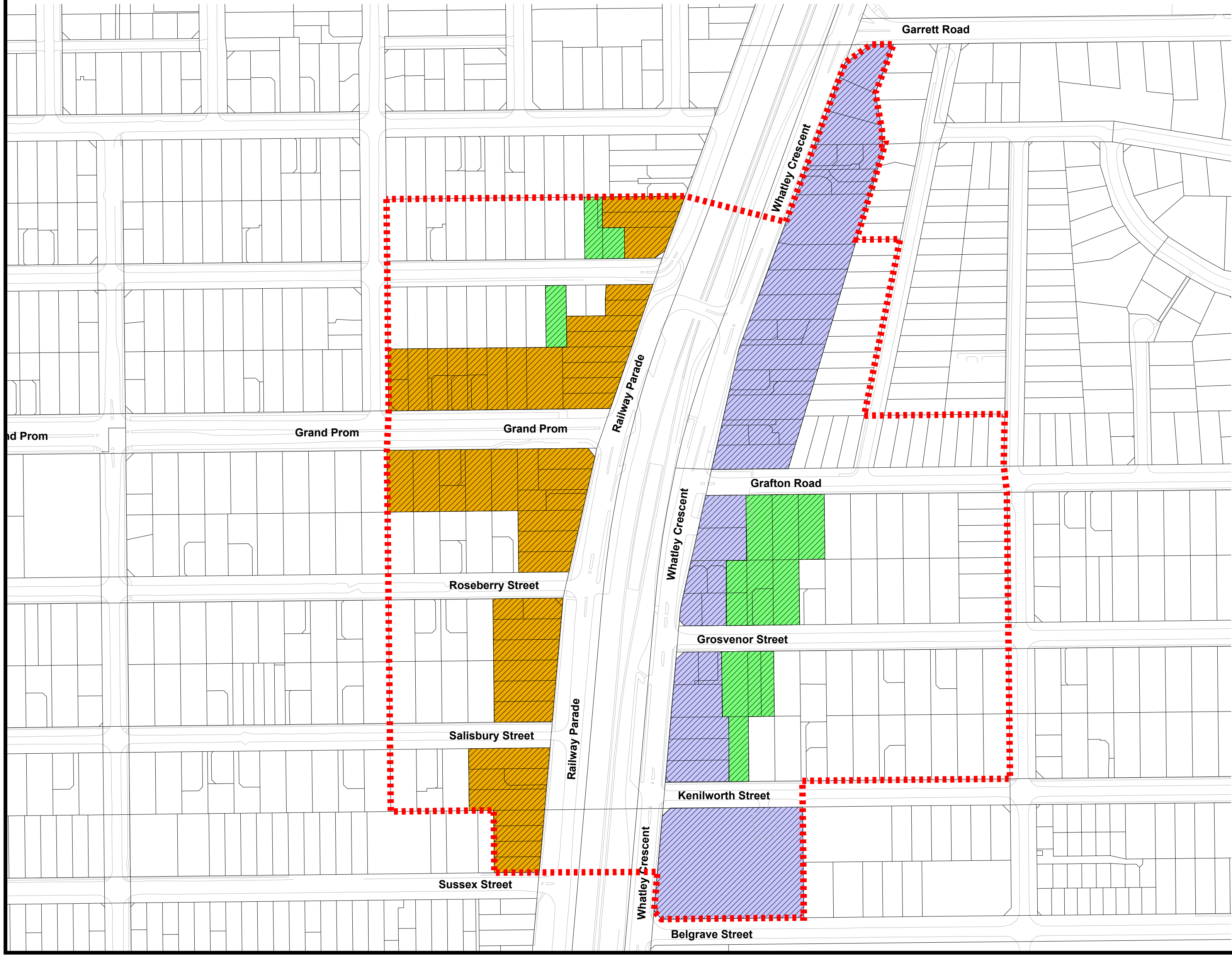
The results of *Figures 4-3 to 4-8* have been used to identify those lots that may be affected by noise depending on the height of the development. Whilst *Figure 4-9* provides the indicative building heights, this has not been taken into account since this may change. The recommendations are shown in *Figures 5-1 to 5-6* and described below:

- Where a floor of a building is identified as being Package A, the requirements of the SPP Guidelines (refer *Appendix A*) are to be incorporated within the development. This is a deemed to satisfy approach so that alternatives can be implemented provided these are justified by a report analysing the specific building plans prepared by an appropriately qualified acoustical consultant (member firm of the Association of Australian Acoustical Consultants).
- Where a floor of a building is identified as being Package B, the requirements of the SPP Guidelines (refer *Appendix A*) are to be incorporated within the development. This is a deemed to satisfy approach so that alternatives can be implemented provided these are justified by a report analysing the specific building plans prepared by an appropriately qualified acoustical consultant (member firm of the Association of Australian Acoustical Consultants). As opposed to Package A, a specific report is considered good practice in this instance, since Package B can increase costs significantly. It should also be noted that in this case, a shared outdoor common area shielded from the road traffic, is recommended to be provided as it is likely some person's balcony's will be facing the road.
- Where a floor of a building is identified as being Specialist Advice, a report must be undertaken by a suitably qualified acoustical consultant (member firm of the Association of Australian Acoustical Consultants) taking into account the proposed plans of the development.

Meltham Structure Plan

Noise Mitigation Requirements (Ground Level)

Figure 5-1



Signs and symbols

- Subject Area
- Package A
- Package B
- Specialist Advice

31 October 2016

Length Scale 1:4500

0 25 50 100 150 m

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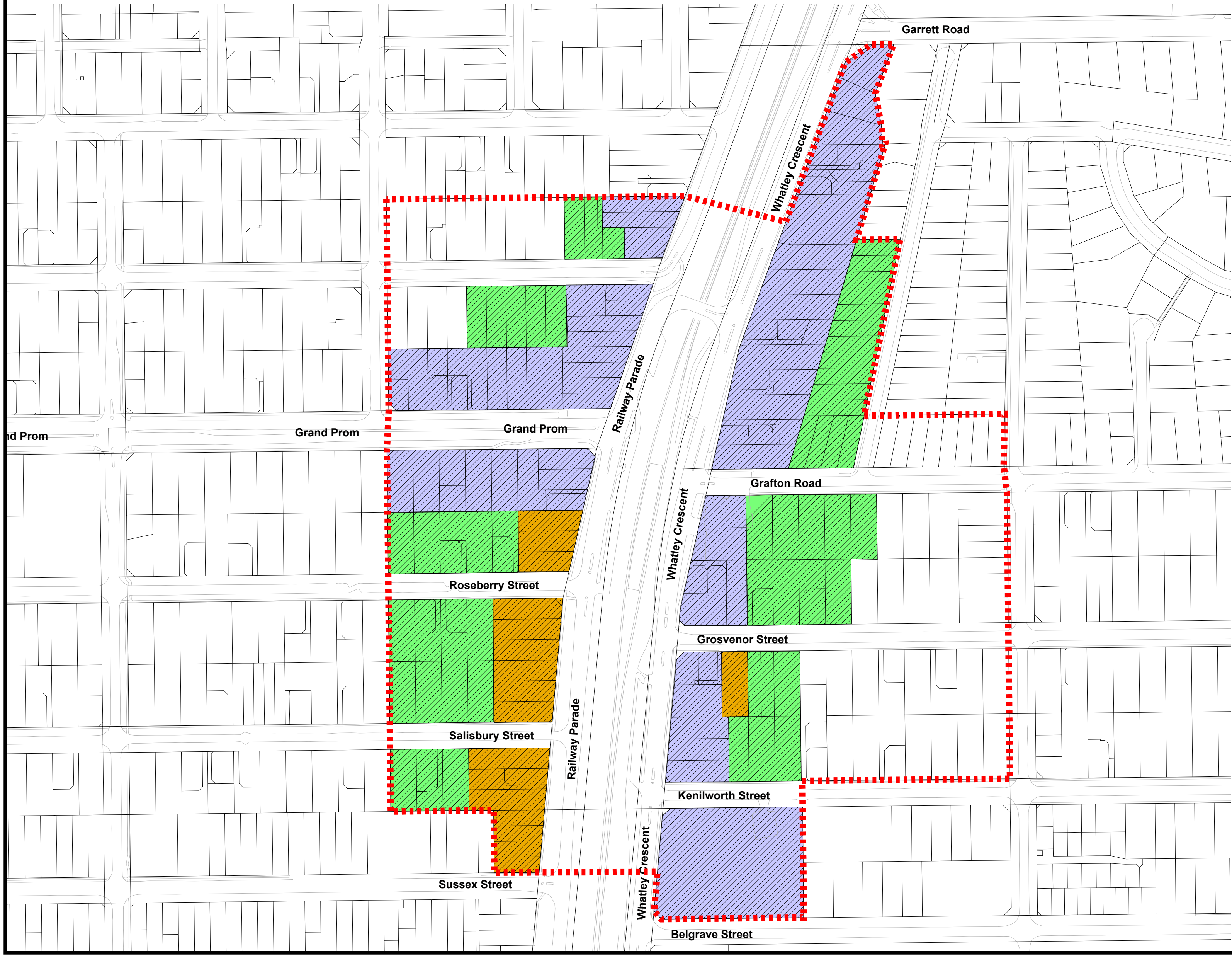
Figure 5-2

Meltham Structure Plan

Noise Mitigation Requirements (First Level)



Signs and symbols

- Subject Area
- Package A
- Package B
- Specialist Advice

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Length Scale 1:4500

0 25 50 100 150 m

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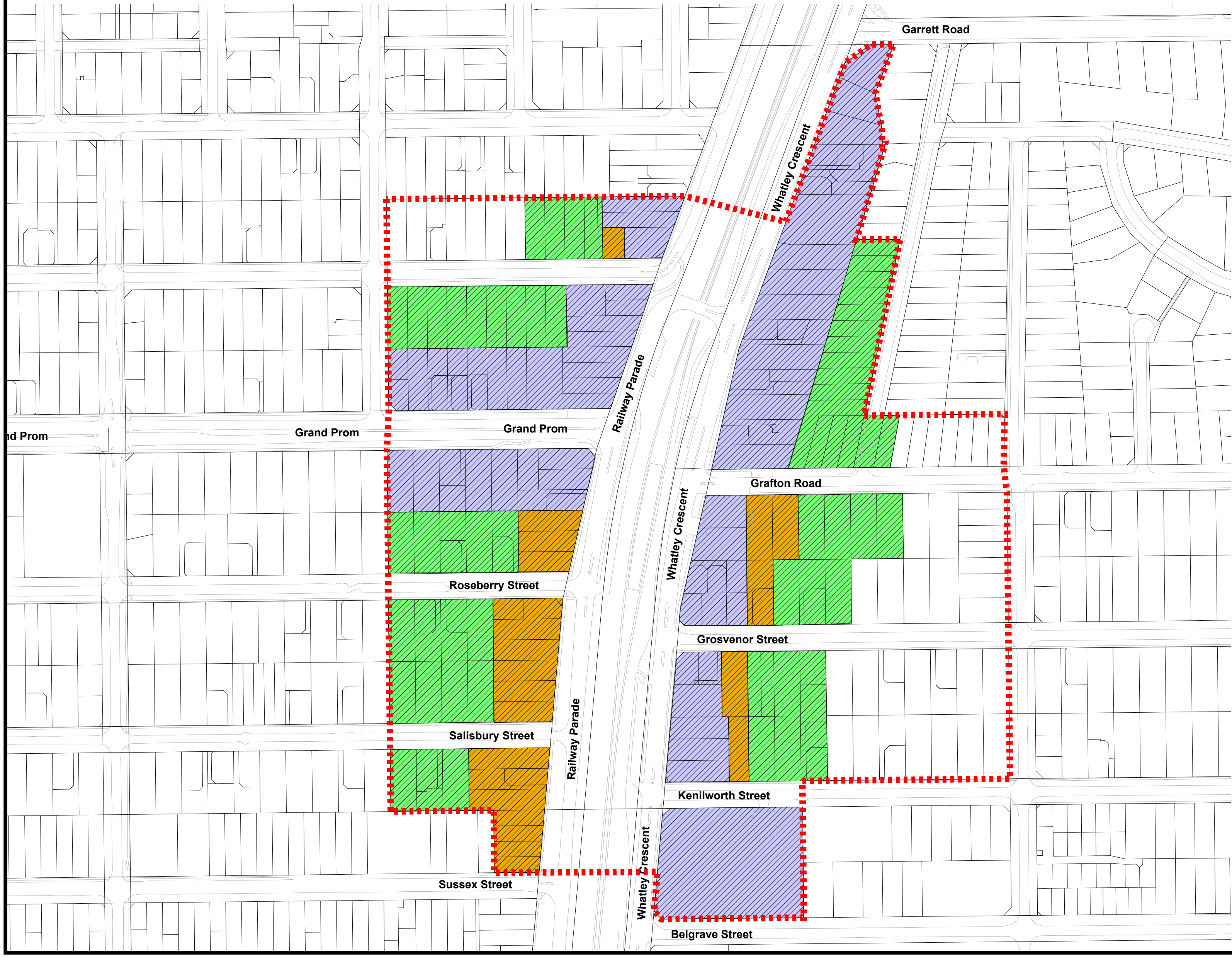
Noise Mitigation Requirements (Second Level)

Figure 5-3



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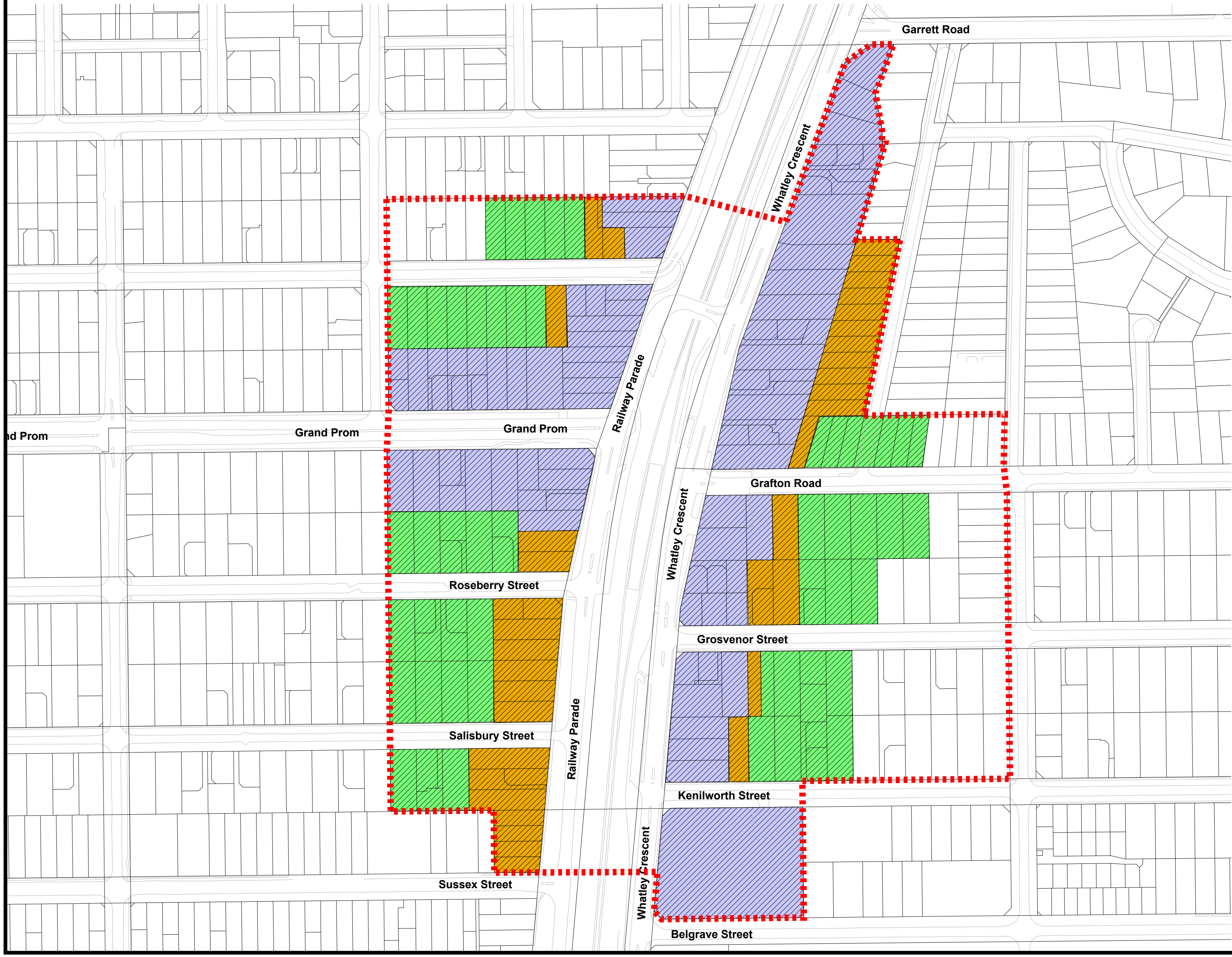
Noise Mitigation Requirements (Third Level)

Figure 5-4



Signs and symbols

- Subject Area
- Package A
- Package B
- Specialist Advice

31 October 2016

Length Scale 1:4500

0 25 50 100 150 m

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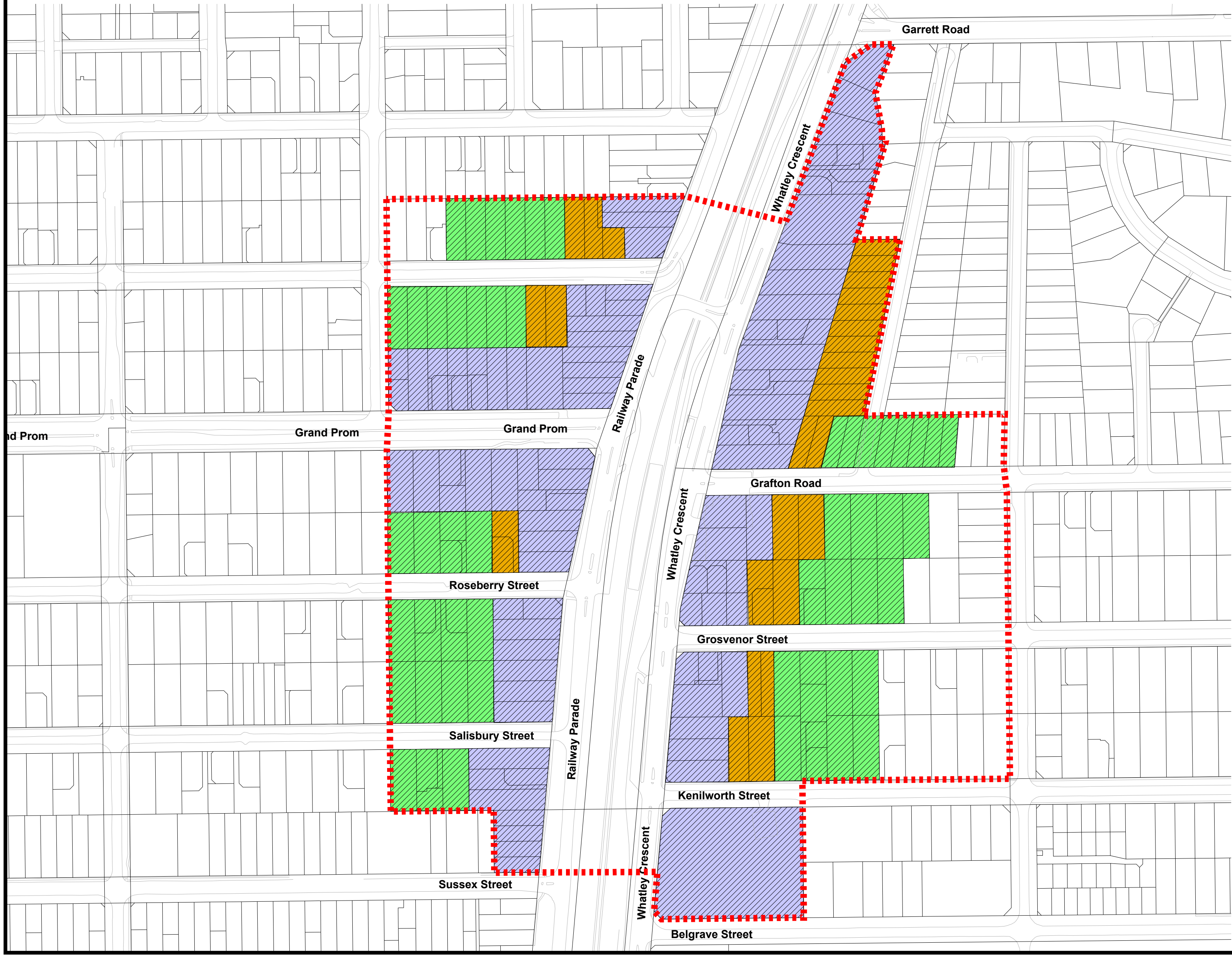
Meltham Structure Plan

Noise Mitigation Requirements (Fourth Level)

Figure 5-5



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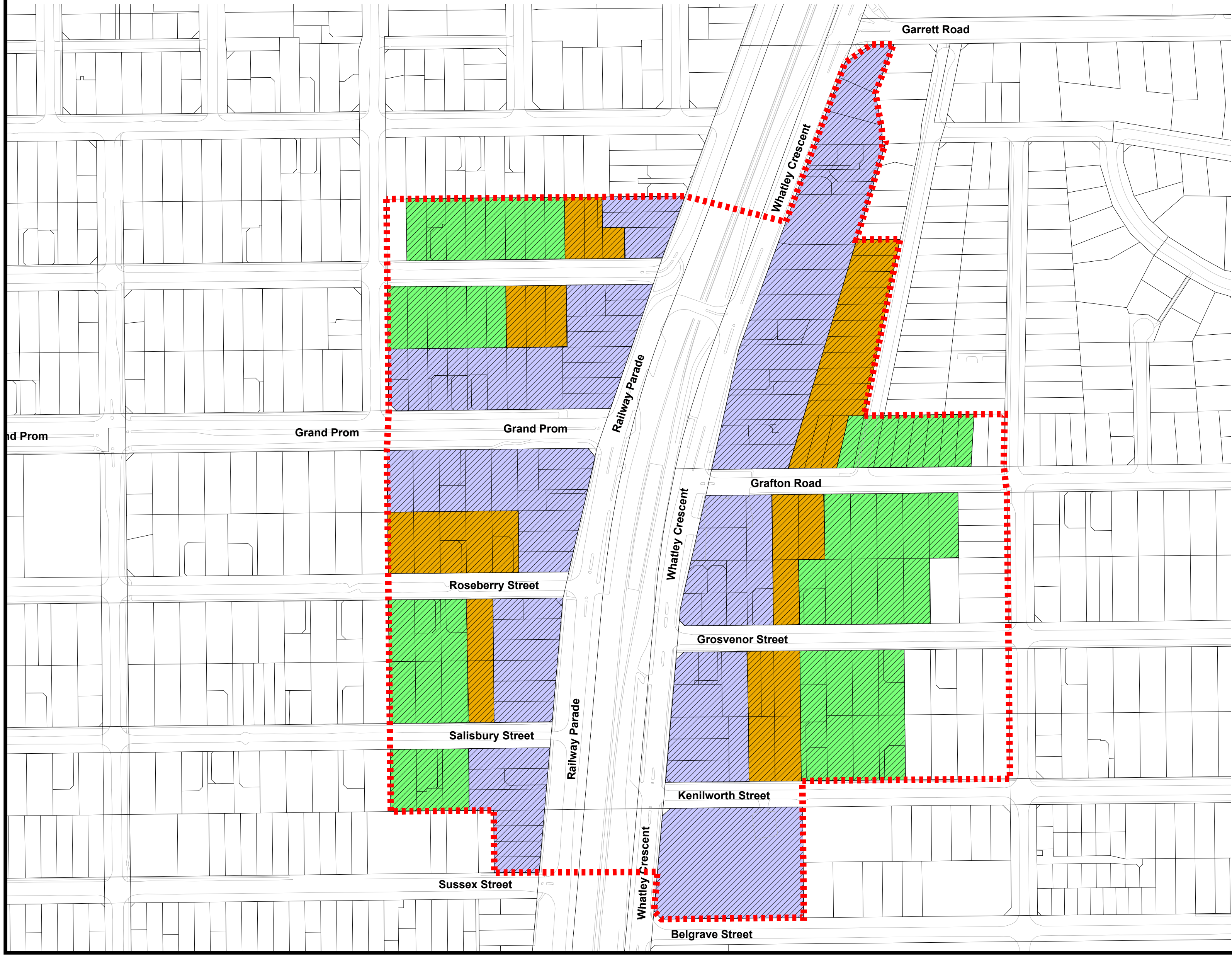
Meltham Structure Plan

Noise Mitigation Requirements (Fifth Level)

Figure 5-6



Signs and symbols

- Subject Area
- Package A
- Package B
- Specialist Advice

31 October 2016

Length Scale 1:4500

0 25 50 100 150 m

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The recommended approach is based on existing buildings rather than the ultimate development. This is considered reasonably conservative in that for a development that will ultimately be located behind a larger building, it may be forced to incorporate noise control, which may be unnecessary once the larger building has been constructed. If plans for the larger building are available, then this can be taken into account but if these aren't available, the benefits of the larger building are to be ignored, as it may be many years before it is developed.

6 CONCLUSION

Vibration from trains in the area is negligible and therefore no detailed analysis for vibration isolation or the like is required. Train noise is also a minor issue in terms of compliance with criteria, which deals with average noise levels. This does not mean that trains will be inaudible, with individual train passbys likely to be audible.

Road traffic noise is the dominant noise source in that area. To comply with the appropriate criteria, noise affected areas have been identified in *Figures 5-1 to 5-6* and summarised below.

- Where a floor of a building is identified as being Package A, the requirements of the SPP Guidelines (refer *Appendix A*) are to be incorporated within the development. This is a deemed to satisfy approach so that alternatives can be implemented provided these are justified by a report analysing the specific building plans prepared by an appropriately qualified acoustical consultant (member firm of the Association of Australian Acoustical Consultants). Part of Package A requires a notification on title.
- Where a floor of a building is identified as being Package B, the requirements of the SPP Guidelines (refer *Appendix A*) are to be incorporated within the development. This is a deemed to satisfy approach so that alternatives can be implemented provided these are justified by a report analysing the specific building plans prepared by an appropriately qualified acoustical consultant (member firm of the Association of Australian Acoustical Consultants). As opposed to Package A, a specific report is considered good practice in this instance, since Package B can increase costs significantly. It should also be noted that in this case, a shared outdoor common area shielded from the road traffic, is recommended to be provided as it is likely some person's balcony's will be facing the road. A notification on title is also required.
- Where a floor of a building is identified as being Specialist Advice, a report must be undertaken by a suitably qualified acoustical consultant (member firm of the Association of Australian Acoustical Consultants) taking into account the proposed plans of the development. A notification on title is also required.

Appendix A

ACCEPTABLE TREATMENT PACKAGES

The packages and information provided on the following pages are taken from *Implementation Guidelines for State Planning Policy 5.4 Road and Rail Transport Noise and freight Considerations in Land Use Planning*; December 2014.

Where outdoor noise levels are above the ***target*** level, excluding the effect of any boundary fences, the Guidelines propose acceptable treatment packages that may be implemented without requiring detailed review. The packages are also intended for residential development only. At higher noise levels or for other building usages, specialist acoustic advice will be needed.

The acceptable treatment packages are intended to simplify compliance with the noise criteria, and the relevant package should be required as a condition of development in lieu of a detailed assessment.

Transition between each package should be made on the basis of the highest incident $L_{Aeq(Day)}$ or $L_{Aeq(Night)}$ value to the nearest whole number determined for the building development under assessment.

Any departures from the acceptable treatment specifications need to be supported by professional advice from a competent person that the proposal will achieve the requirements of the Policy.

With regards to the packages, the following definitions are provided:

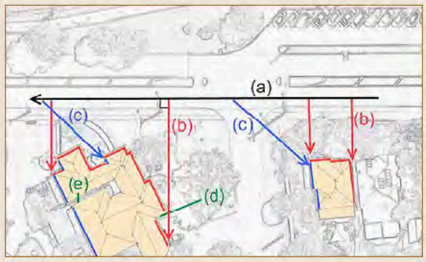
- **Facing** the transport corridor: Any part of a building façade is 'facing' the transport corridor if any straight line drawn perpendicular to its nearest road lane or railway line intersects that part of the façade without obstruction (ignoring any fence).

- **Side-on** to transport corridor: Any part of a building façade that is not 'facing' is 'side-on' to the transport corridor if any straight line can be drawn from it to intersect the nearest road lane or railway line without obstruction (ignoring any fence).

- **Opposite** to transport corridor: Neither 'side on' nor 'facing', as defined above.

Determining building face orientation

The following sketch shows two residences in proximity to a road.



'Facing' façades are identified by drawing straight lines (b) perpendicular (at a 90 degree angle) to the road (a). Where these lines intersect a façade – without obstruction – the façades are shown in red as 'facing' the road.

Façades shown in blue are not 'facing' but have clear lines (c) that intersect the road at any angle, and are therefore classed as 'side on' to the road.

The remaining façades are 'opposite' to the road.

Package A

Area	Orientation to Road or Rail Corridor	Package A (up to 60 dB $L_{Aeq(Day)}$ and 55 dB $L_{Aeq(Night)}$)
Bedrooms	Facing	• Windows systems: Glazing up to 40% of floor area (minimum R_w + C_{tr} 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
	Side	• Windows systems: As above.
	Opposite	No requirements
Other Habitable Rooms Including Kitchens	Facing	• Windows and external door systems: Glazing up to 60% of floor area (minimum R_w + C_{tr} 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to be same performance including brush seals.
	Side	• Windows and external door systems: As above.
	Opposite	No requirements
General	Any	• Walls (minimum R_w + C_{tr} 45) – Two leaves of 90mm thick brick with minimum 50mm cavity • Roof and ceiling (minimum R_w + C_{tr} 35) – Standard roof construction with 10mm plasterboard ceiling and minimum R2.5 insulation between ceiling joists. • Eaves to be closed using 4mm compressed fibre cement sheet. • Mechanical ventilation – Refer following pages.

Note: Any penetrations in a part of the building envelope must be acoustically treated so as to not downgrade the performance of the building elements affected. Most penetrations in external walls such as pipes, cables or ducts can be sealed through caulking gaps with non-hardening mastic or suitable mortar.

Package B

Area	Orientation to Road or Rail Corridor	Package B (up to 63 dB $L_{Aeq(Day)}$ and 58 dB $L_{Aeq(Night)}$)
Bedrooms	Facing	• Windows systems: Glazing up to 40% of floor area (minimum R_w + C_{tr} 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
	Side	• Windows systems: As above.
	Opposite	• Windows systems: Glazing up to 40% of floor area (minimum R_w + C_{tr} 25) – 4mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Alternatively, 6mm thick glass (monolithic, toughened or laminated) in sliding frame.
Other Habitable Rooms Including Kitchens	Facing	• Windows and external door systems: Glazing up to 60% of floor area (minimum R_w + C_{tr} 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to have laboratory certificate confirming R_w + C_{tr} 31 performance. Alternative, change to hinged door with perimeter acoustic seals and 10mm thick glass.
	Side	• Windows and external door systems: Glazing up to 60% of floor area (minimum R_w + C_{tr} 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Glass doors to be same performance (R_w + C_{tr} 28) including brush seals.
	Opposite	No requirements
General	Any	• Walls (minimum R_w + C_{tr} 50) – Two leaves of 90mm thick brick with minimum 50mm cavity. Cavity to include 25mm thick, 24kg/m^3 insulation and where wall ties are required, these are to be anti-vibration/resilient type. • Roof and ceiling (minimum R_w + C_{tr} 35) – Standard roof construction with 10mm plasterboard ceiling and minimum R2.5 insulation between ceiling joists. • Eaves to be closed using 4mm thick compressed fibre cement sheet. • Mechanical ventilation – Refer following pages.
Outdoor Living Area		• Locate on the side of the building that is opposite to the corridor where practicable; or • Provide a shared common area that is opposite to the corridor.

Note: Any penetrations in a part of the building envelope must be acoustically treated so as to not downgrade the performance of the building elements affected. Most penetrations in external walls such as pipes, cables or ducts can be sealed through caulking gaps with non-hardening mastic or suitable mortar.

Mechanical Ventilation requirements

It is noted that natural ventilation must be provided in accordance with F4.6 and F4.7 of Volume One and 3.8.5.2 of Volume Two of the National Construction Code. Where the noise *limit* is likely to be exceeded, a mechanical ventilation system is usually required. Mechanical ventilation systems will need to comply with AS 1668.2 – *The use of mechanical ventilation and air-conditioning in buildings*.

In implementing the acceptable treatment packages, the following must be observed:

- Evaporative air conditioning systems will meet the requirements for Packages A and B provided attenuated air vents are provided in the ceiling space and designed so that windows do not need to be opened.
- Refrigerant based air conditioning systems need to be designed to achieve fresh air ventilation requirements.
- External openings (e.g. air inlets, vents) need to be positioned facing away from the transport corridor where practicable.
- Ductwork needs to be provided with adequate silencing to prevent noise intrusion.

Notification

Notifications on certificates of title and advice to prospective purchasers warning of the potential for noise impacts from major transport corridors help with managing expectations.

The area of land for which notification is required should be identified in the noise management plan and contain a description of major noise sources nearby (e.g. 24-hour freight rail).

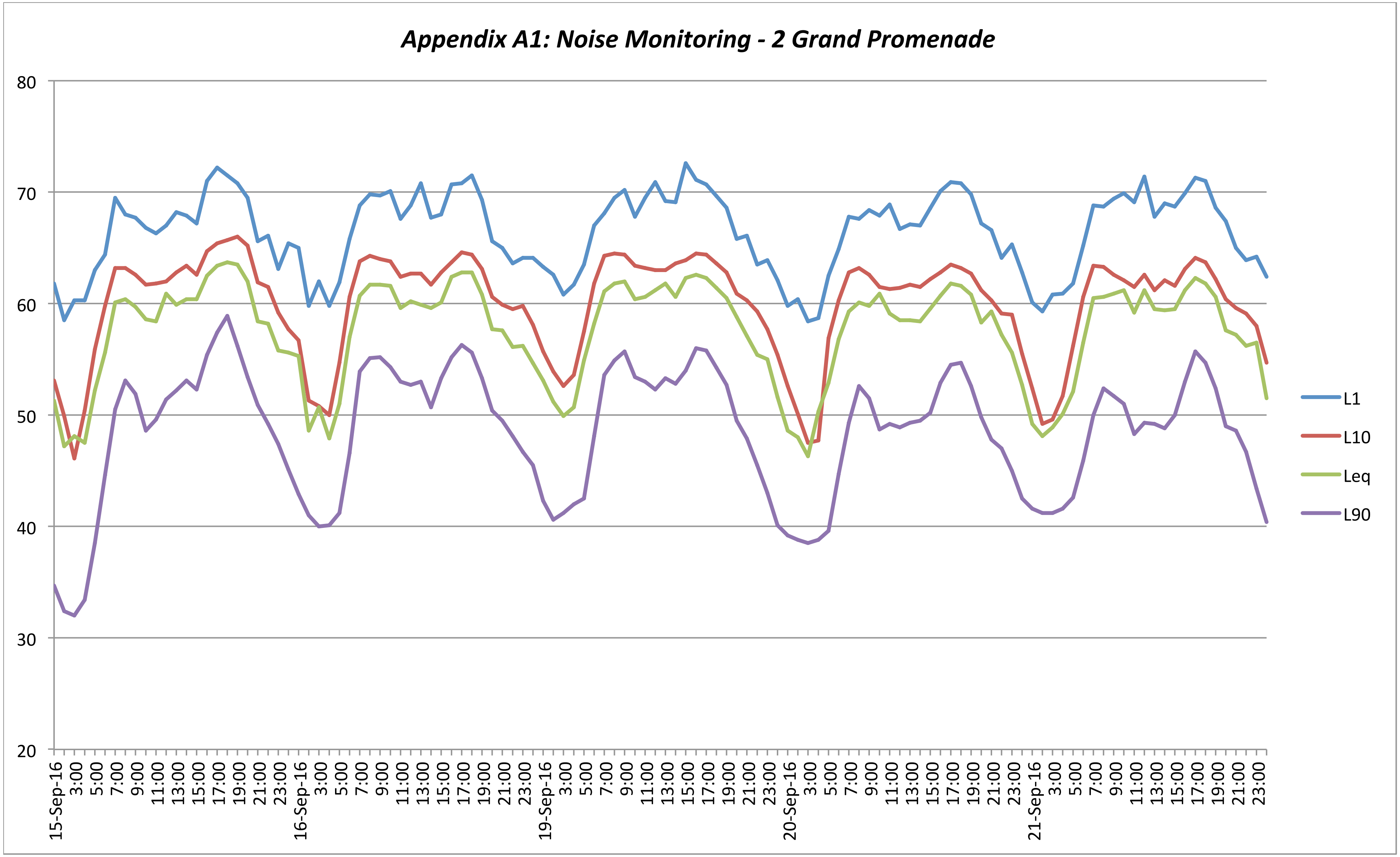
Notification should be provided to prospective purchasers, and required as a condition of subdivision (including strata subdivision) for the purposes of noise sensitive development or planning approval involving noise sensitive development, where external noise levels are forecast or estimated to exceed the 'target' criteria as defined by the Policy.

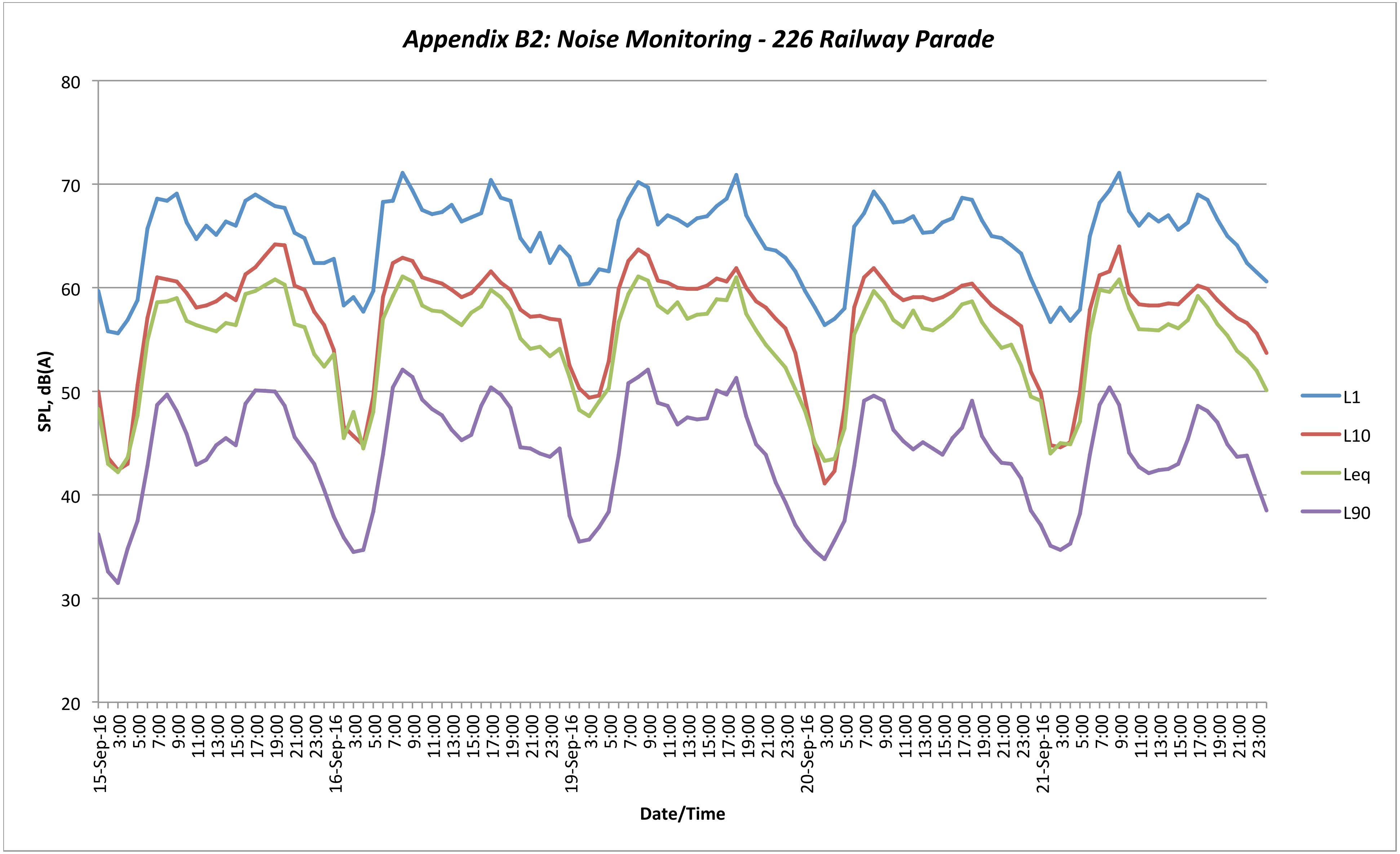
In the case of subdivision and development, conditions of approval should include a requirement for registration of a notice on title, which is provided for under Section 165 of the Planning and Development Act 2005 and Section 70A of the Transfer of Land Act 1893. An example of a suitable notice is:

Notice: This lot is situated in the vicinity of a transport corridor and is currently affected, or may in the future be affected, by transport noise and vibration. Further information is available on request from the relevant local government offices.

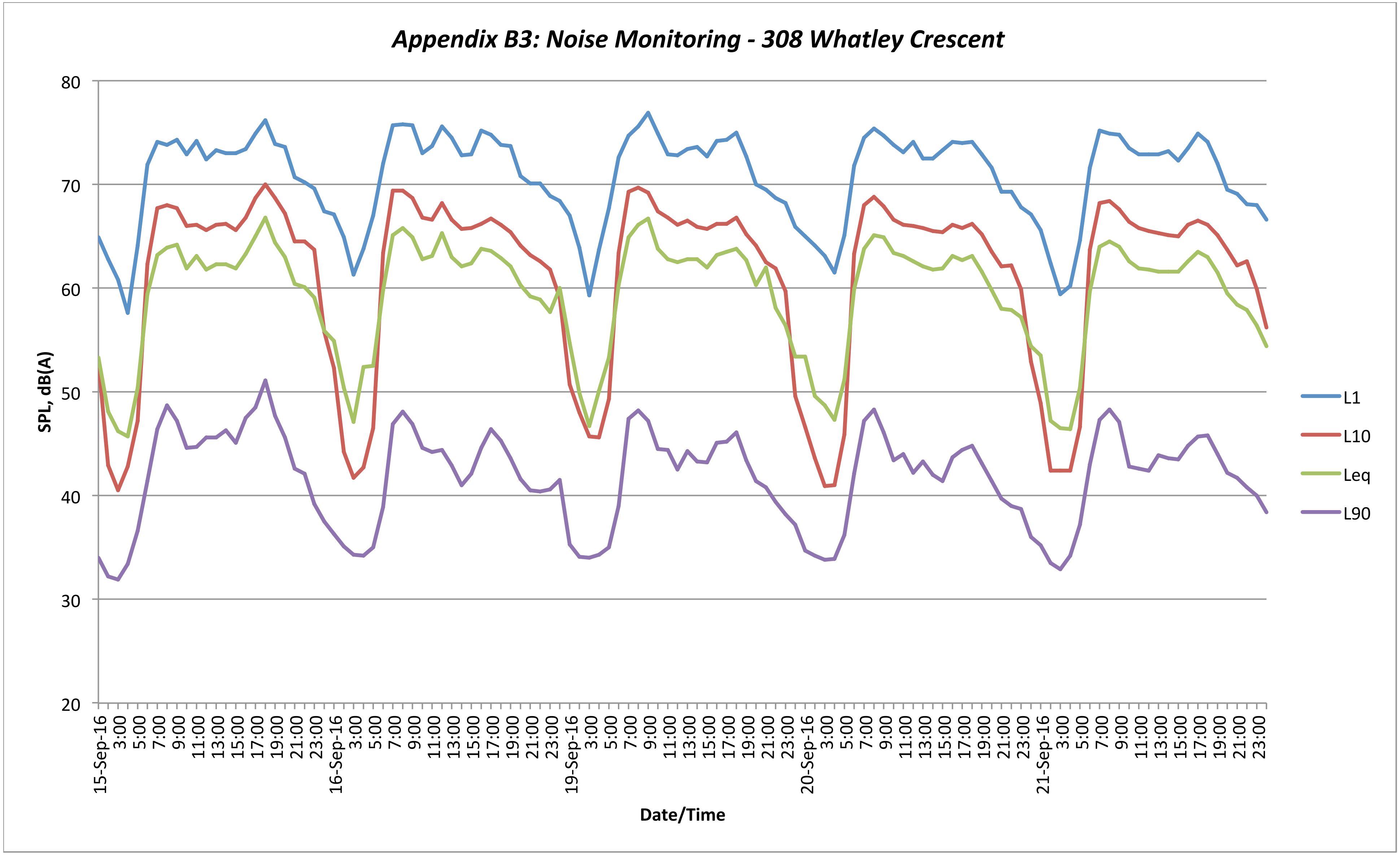
Appendix B

Noise Monitoring Results


Appendix A1: Noise Monitoring - 2 Grand Promenade
80
70
60
50
40
30
20
15-Sep-16
3:00
5:00
7:00
9:00
11:00
13:00
15:00
17:00
19:00
21:00
23:00
16-Sep-16
19-Sep-16
20-Sep-16
21-Sep-16
L1
L10
Leq
L90



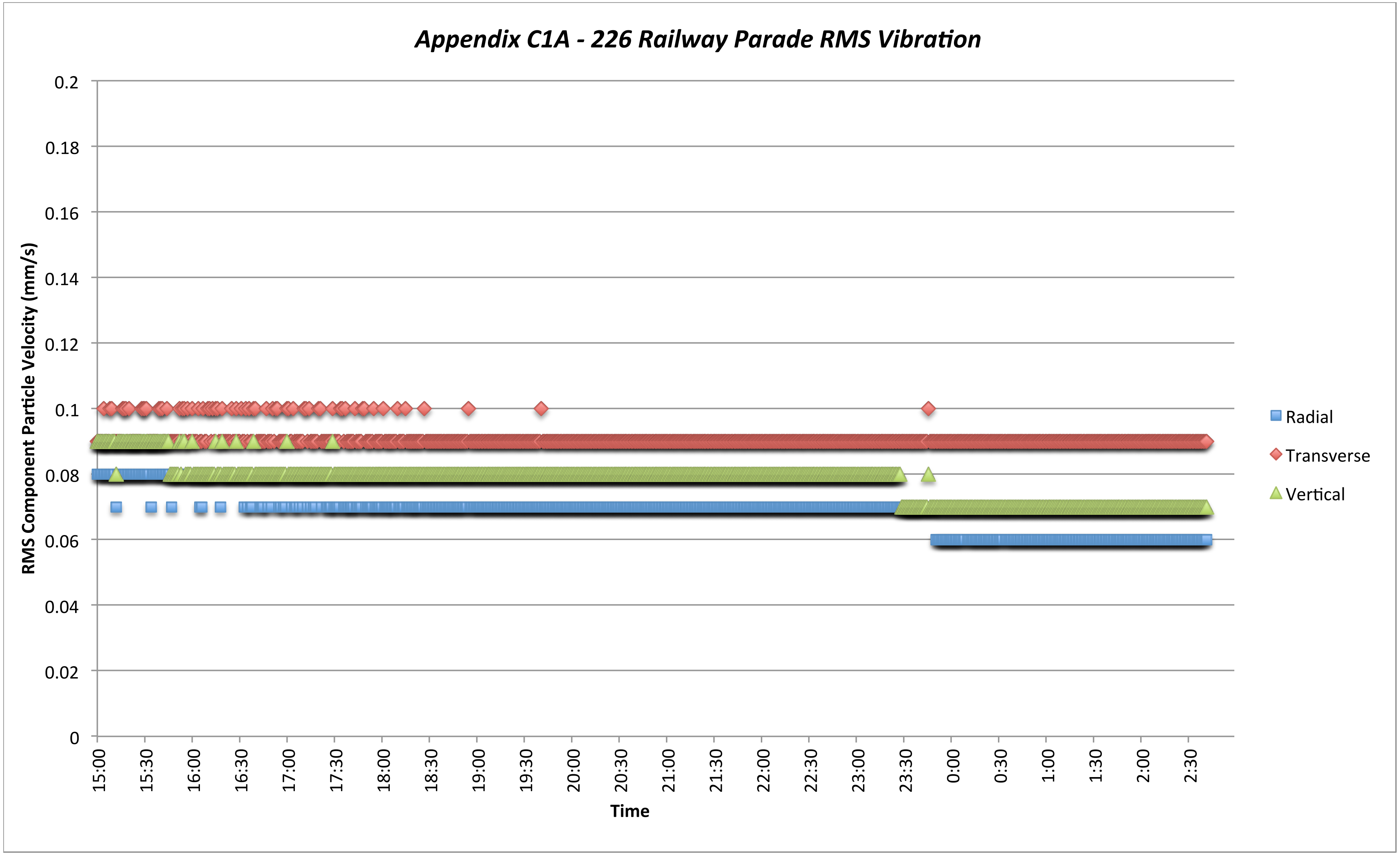
Appendix B2: Noise Monitoring - 226 Railway Parade
80
70
60
50
40
30
20
SPL, dB(A)
15-Sep-16
16-Sep-16
19-Sep-16
20-Sep-16
21-Sep-16
3:00
5:00
7:00
9:00
11:00
13:00
15:00
17:00
19:00
21:00
23:00
Date/Time
L1
L10
Leq
L90



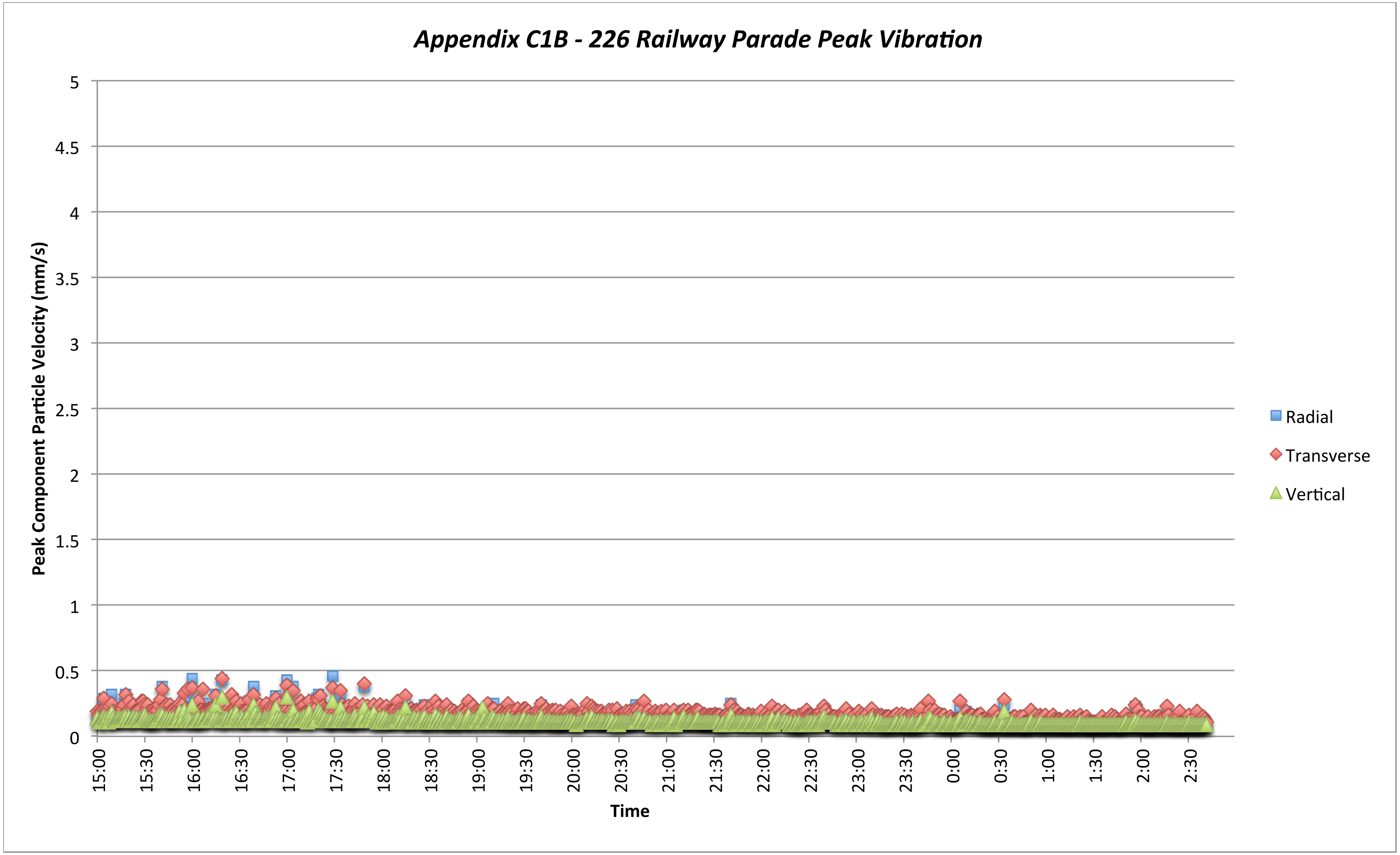
Appendix B3: Noise Monitoring - 308 Whatley Crescent
SPL, dB(A)
80
70
60
50
40
30
20
Date/Time
L1
L10
Leq
L90

Appendix C

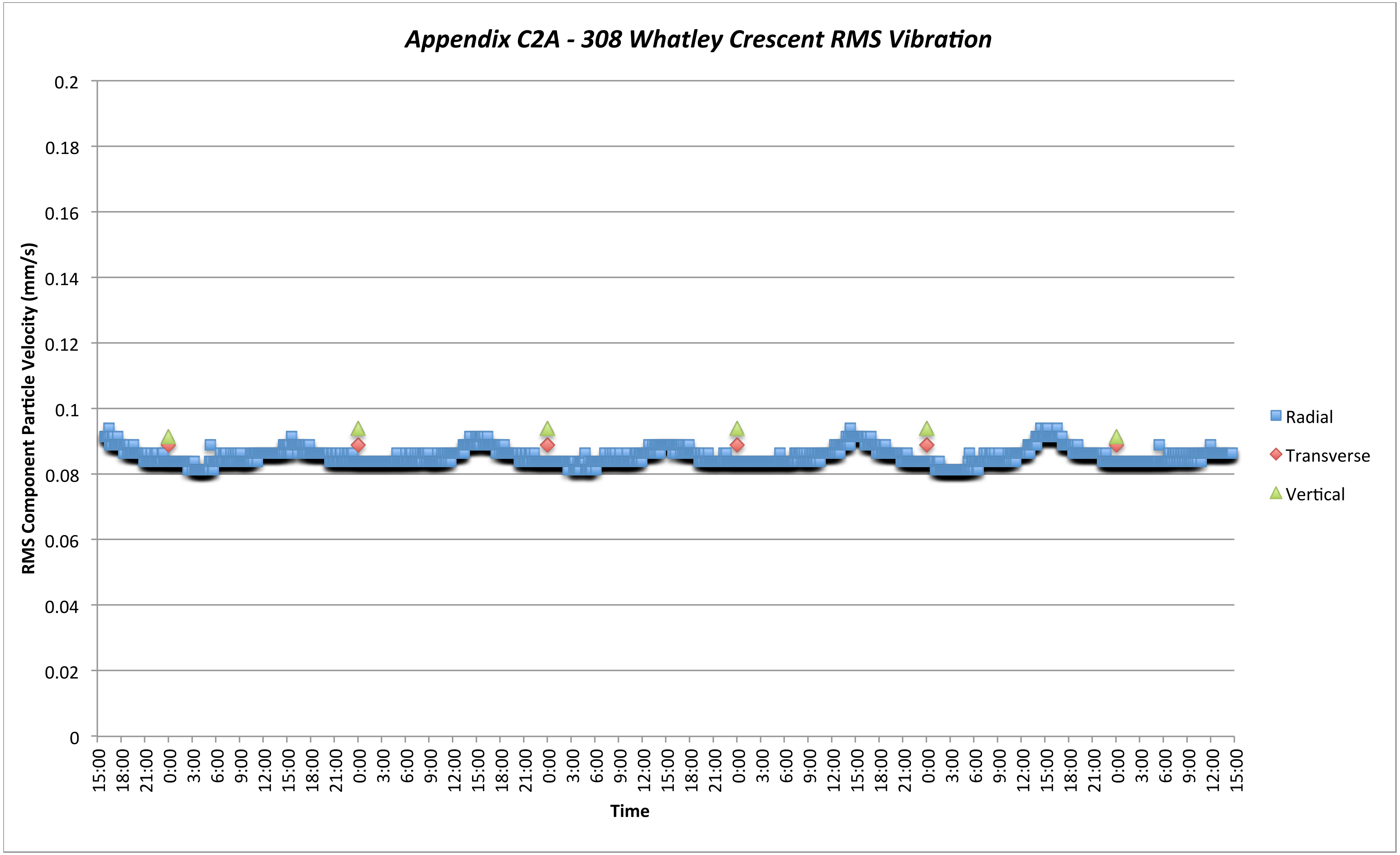
Vibration Monitoring Results

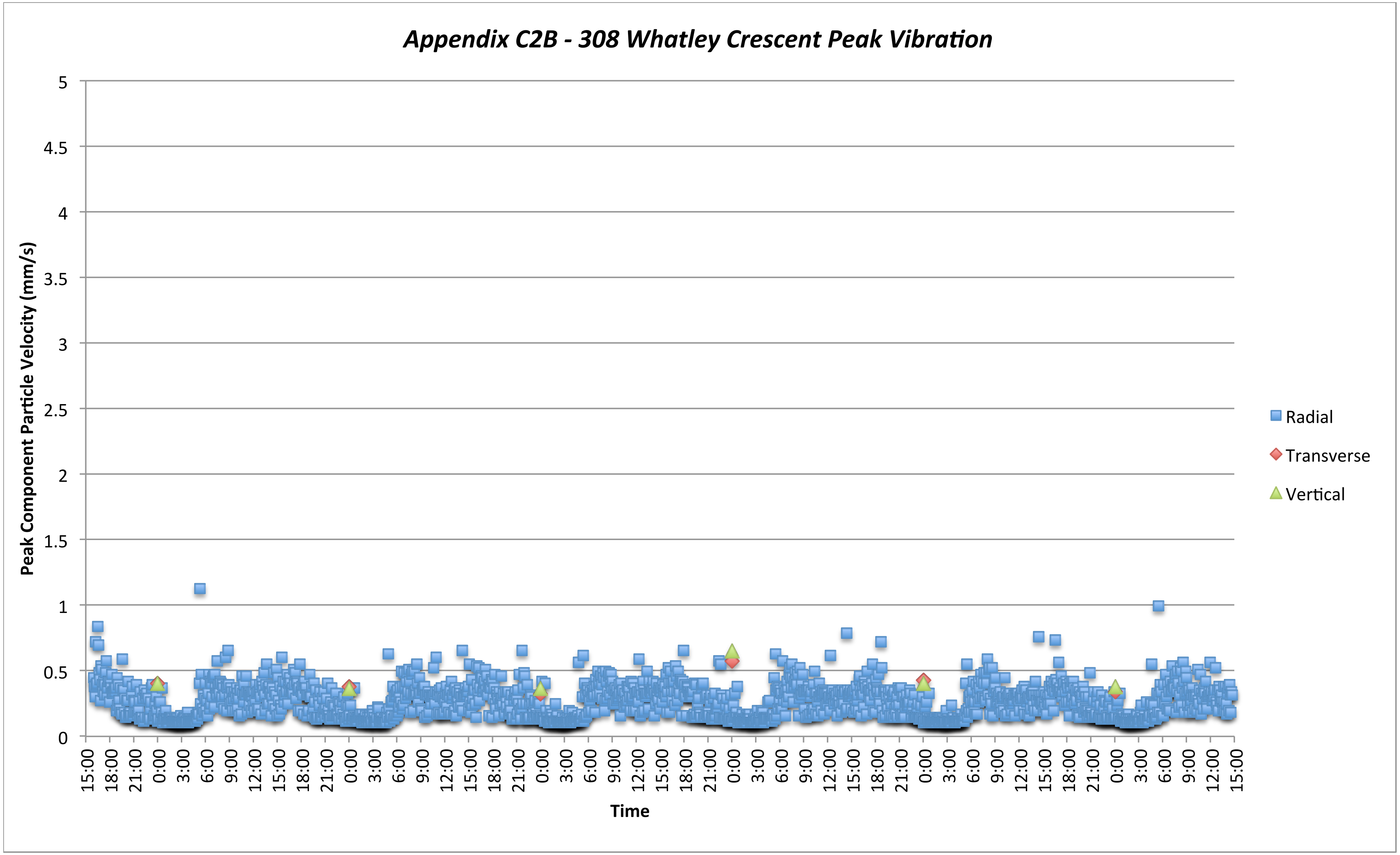


Appendix C1A - 226 Railway Parade RMS Vibration
RMS Component Particle Velocity (mm/s)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
15:00
15:30
16:00
16:30
17:00
17:30
18:00
18:30
19:00
19:30
20:00
20:30
21:00
21:30
22:00
22:30
23:00
23:30
0:00
0:30
1:00
1:30
2:00
2:30
Time
Radial
Transverse
Vertical

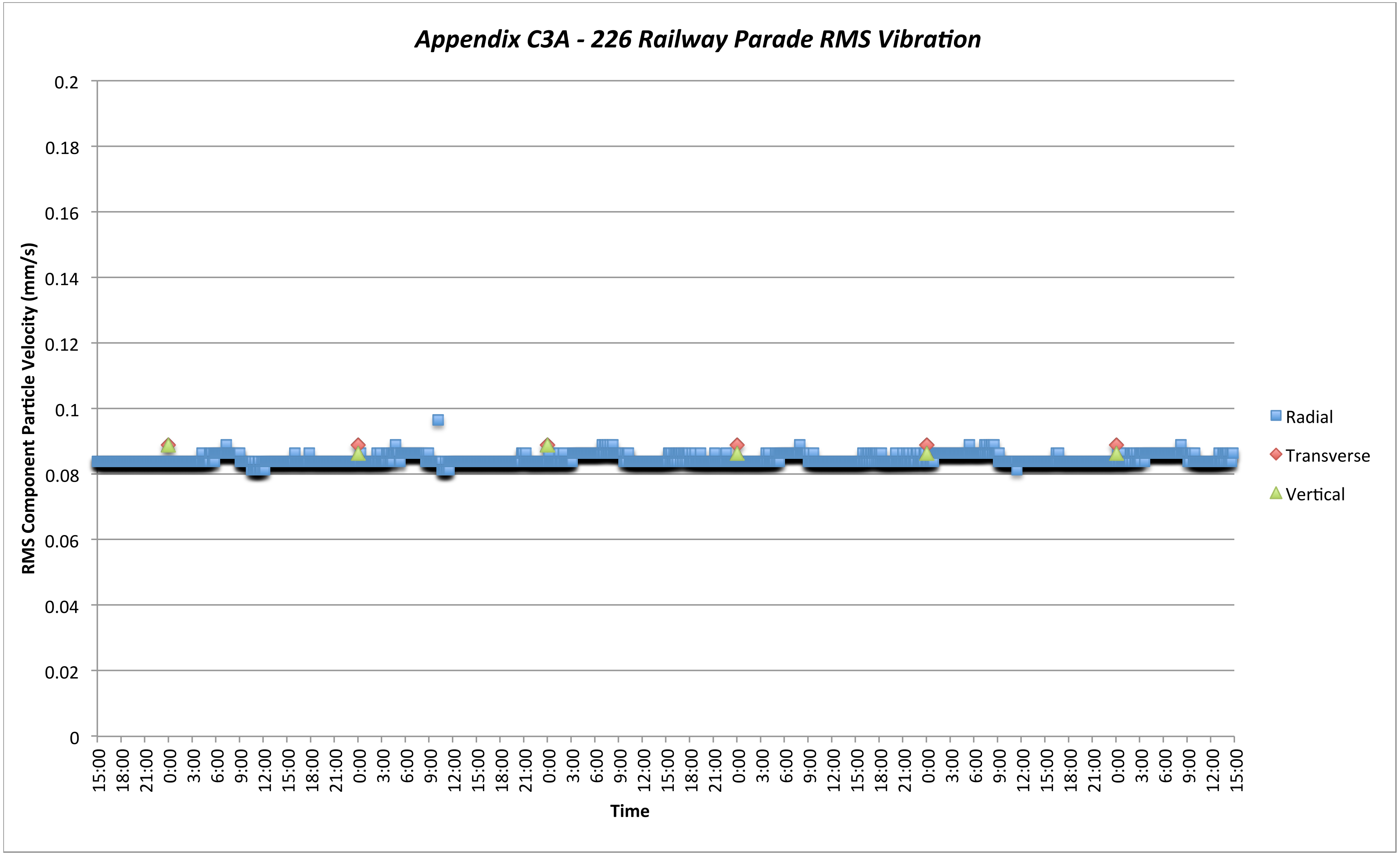


Appendix C1B - 226 Railway Parade Peak Vibration
Peak Component Particle Velocity (mm/s)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
15:00
15:30
16:00
16:30
17:00
17:30
18:00
18:30
19:00
19:30
20:00
20:30
21:00
21:30
22:00
22:30
23:00
23:30
0:00
0:30
1:00
1:30
2:00
2:30
Time
Radial
Transverse
Vertical


Appendix C2A - 308 Whatley Crescent RMS Vibration
RMS Component Particle Velocity (mm/s)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
15:00
18:00
21:00
0:00
3:00
6:00
9:00
12:00
Time
Radial
Transverse
Vertical

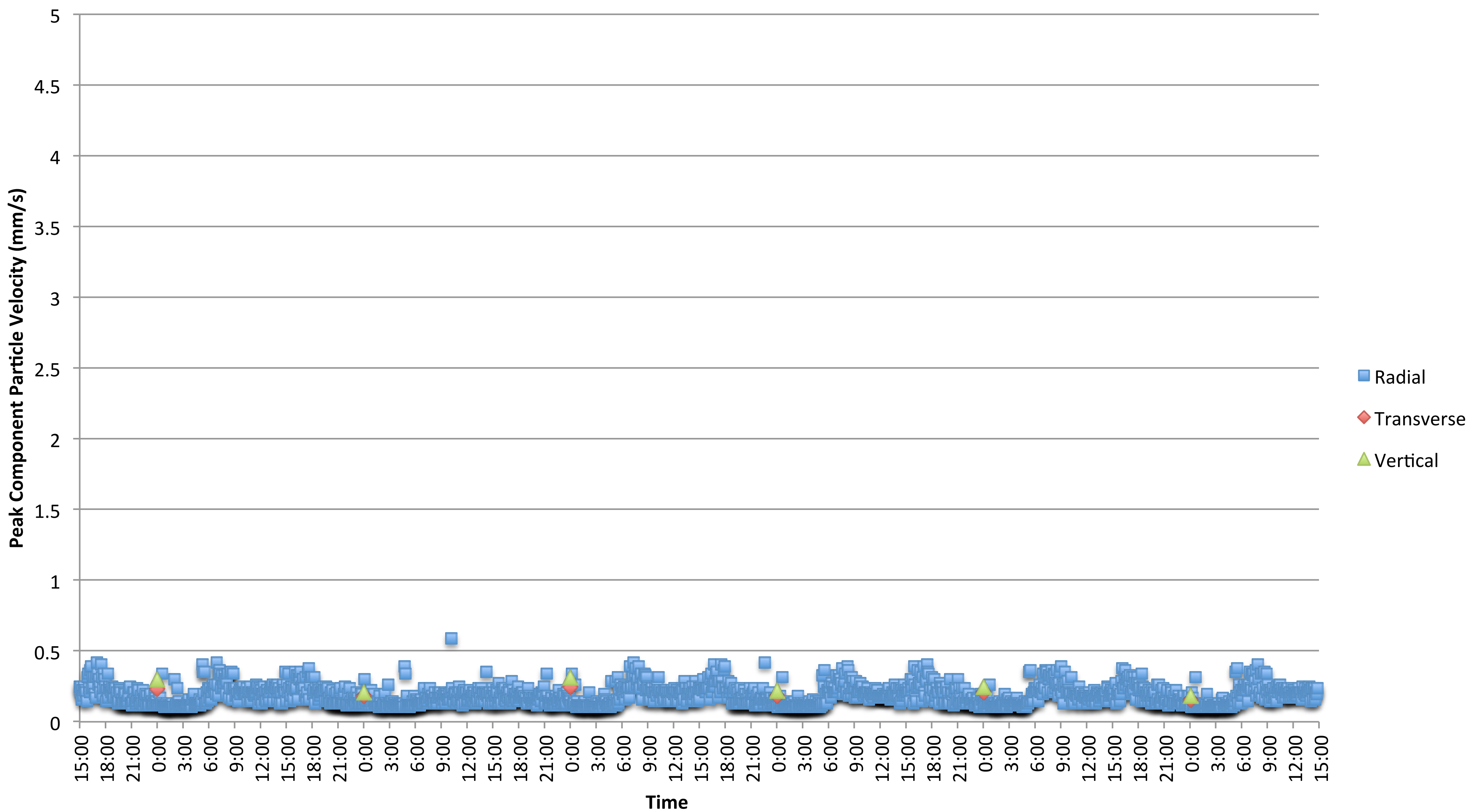


Appendix C2B - 308 Whatley Crescent Peak Vibration
Peak Component Particle Velocity (mm/s)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
15:00
18:00
21:00
0:00
3:00
6:00
9:00
12:00
Time
Radial
Transverse
Vertical



Appendix C3A - 226 Railway Parade RMS Vibration
RMS Component Particle Velocity (mm/s)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
15:00 18:00 21:00 0:00 3:00 6:00 9:00 12:00 15:00 18:00 21:00 0:00 3:00 6:00 9:00 12:00 15:00 18:00 21:00 0:00 3:00 6:00 9:00 12:00 15:00 18:00 21:00 0:00 3:00 6:00 9:00 12:00 15:00 18:00 21:00 0:00 3:00 6:00 9:00 12:00 15:00 18:00 21:00 0:00 3:00 6:00 9:00 12:00 15:00
Time
Radial
Transverse
Vertical

Appendix C3B - 226 Railway Parade Peak Vibration



Appendix D

Terminology

The following is an explanation of the terminology used throughout this report.

Decibel (dB)
The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting
An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A dB.

L_1
An L_1 level is the noise level which is exceeded for 1 per cent of the measurement period and is considered to represent the average of the maximum noise levels measured.

L_{10}
An L_{10} level is the noise level which is exceeded for 10 per cent of the measurement period and is considered to represent the "*intrusive*" noise level.

L_{90}
An L_{90} level is the noise level which is exceeded for 90 per cent of the measurement period and is considered to represent the "*background*" noise level.

L_{eq}
The L_{eq} level represents the average noise energy during a measurement period.

$L_{A10,18hour}$
The $L_{A10,18 \text{ hour}}$ level is the arithmetic average of the hourly L_{A10} levels between 6.00 am and midnight. The *CoRTN* algorithms were developed to calculate this parameter.

$L_{Aeq,24hour}$
The $L_{Aeq,24 \text{ hour}}$ level is the logarithmic average of the hourly L_{Aeq} levels for a full day (from midnight to midnight).

$L_{Aeq,8hour}$ / $L_{Aeq (Night)}$
The $L_{Aeq \text{ (Night)}}$ level is the logarithmic average of the hourly L_{Aeq} levels from 10.00 pm to 6.00 am on the same day.

$L_{Aeq,16hour}$ / $L_{Aeq (Day)}$
The $L_{Aeq \text{ (Day)}}$ level is the logarithmic average of the hourly L_{Aeq} levels from 6.00 am to 10.00 pm on the same day. This value is typically 1-3 dB less than the $L_{A10,18hour}$.

R_w

This is the weighted sound reduction index and is similar to the previously used STC (Sound Transmission Class) value. It is a single number rating determined by moving a grading curve in integral steps against the laboratory measured transmission loss until the sum of the deficiencies at each one-third-octave band, between 100 Hz and 3.15 kHz, does not exceed 32 dB. The higher the R_w value, the better the acoustic performance.

C_{tr}

This is a spectrum adaptation term for airborne noise and provides a correction to the R_w value to suit source sounds with significant low frequency content such as road traffic or home theatre systems. A wall that provides a relatively high level of low frequency attenuation (i.e. masonry) may have a value in the order of –4 dB, whilst a wall with relatively poor attenuation at low frequencies (i.e. stud wall) may have a value in the order of -14 dB.

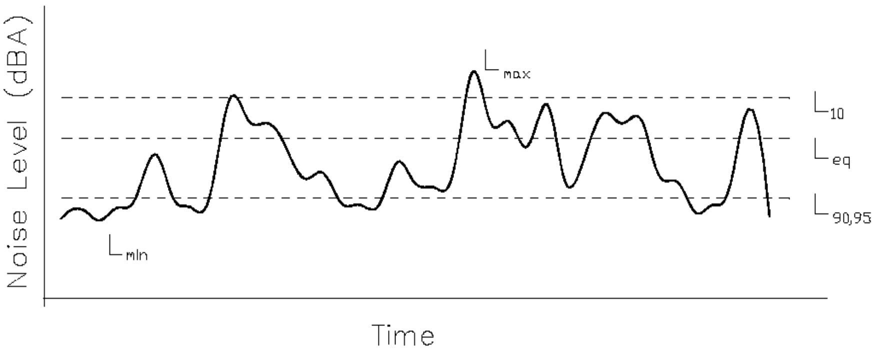
Satisfactory Design Sound Level

The level of noise that has been found to be acceptable by most people for the environment in question and also to be not intrusive.

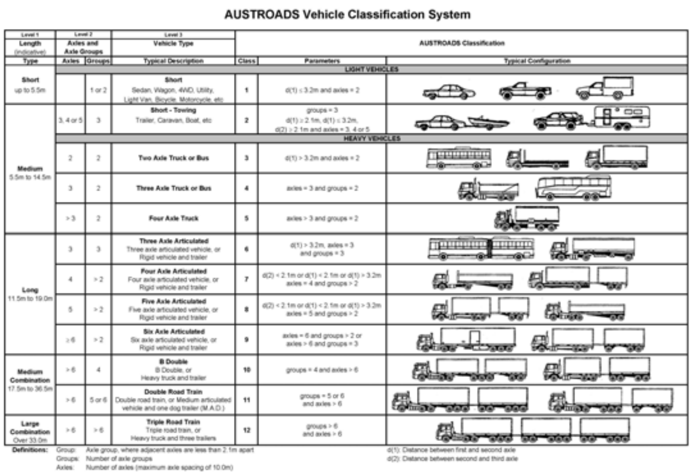
Maximum Design Sound Level

The level of noise above which most people occupying the space start to become dissatisfied with the level of noise.

Chart of Noise Level Descriptors



Austroads Vehicle Class



AUSTROADS Vehicle Classification System

Level 1 Length (indicative) Type	Level 2 Axles and Axle Groups: Axles	Level 2 Axles and Axle Groups: Groups	Level 3 Vehicle Type: Typical Description	AUSTROADS Classification: Class	Parameters	Typical Configuration
			LIGHT VEHICLES			
Short up to 5.5m		1 or 2	**Short** Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc	**1**	d(1) ≤ 3.2m and axles = 2	
Medium 5.5m to 14.5m	3, 4 or 5	3	**Short - Towing** Trailer, Caravan, Boat, etc	**2**	groups = 3 d(1) ≥ 2.1m, d(1) ≤ 3.2m, d(2) ≥ 2.1m and axles = 3, 4 or 5	
			HEAVY VEHICLES			
	2	2	**Two Axle Truck or Bus**	**3**	d(1) > 3.2m and axles = 2	
	3	2	**Three Axle Truck or Bus**	**4**	axles = 3 and groups = 2	
	> 3	2	**Four Axle Truck**	**5**	axles > 3 and groups = 2	
Long 11.5m to 19.0m	3	3	**Three Axle Articulated** Three axle articulated vehicle, or Rigid vehicle and trailer	**6**	d(1) > 3.2m, axles = 3 and groups = 3	
	4	> 2	**Four Axle Articulated** Four axle articulated vehicle, or Rigid vehicle and trailer	**7**	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 4 and groups > 2	
	5	> 2	**Five Axle Articulated** Five axle articulated vehicle, or Rigid vehicle and trailer	**8**	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 5 and groups > 2	
	≥ 6	> 2	**Six Axle Articulated** Six axle articulated vehicle, or Rigid vehicle and trailer	**9**	axles = 6 and groups > 2 or axles > 6 and groups = 3	
Medium Combination 17.5m to 36.5m	> 6	4	**B Double** B Double, or Heavy truck and trailer	**10**	groups = 4 and axles > 6	
	> 6	5 or 6	**Double Road Train** Double road train, or Medium articulated vehicle and one dog trailer (M.A.D.)	**11**	groups = 5 or 6 and axles > 6	
Large Combination Over 33.0m	> 6	> 6	**Triple Road Train** Triple road train, or Heavy truck and three trailers	**12**	groups > 6 and axles > 6	

Definitions: Group: Axle group, where adjacent axles are less than 2.1m apart
Groups: Number of axle groups
Axles: Number of axles (maximum axle spacing of 10.0m)
d(1): Distance between first and second axle
d(2): Distance between second and third axle

Typical Noise Levels