13 Acoustic environment

Chapter 13 provides a summary of the noise and vibration assessment undertaken for the Environmental Assessment. It involved the division of the Project area into noise sub-catchments with a distinction made between the Down side and the Up side of the rail corridor. The purpose of the study was to assess potential noise and vibration emissions during construction and operation of the Proposal and identify locations where further assessment of mitigation measures is required. More details of the noise and vibration impact assessment are provided in Technical Paper 1 in Volume Two.

13.1 Local characteristics

13.1.1 Noise sub-catchment areas and sensitive receiver locations

The existing acoustic environment in the Project area can be described as suburban. Adjacent to the railway corridor, residential and other sensitive receiver locations are currently exposed to noise emissions from the existing rail operations. Existing noise levels exceed the operational noise trigger levels at many locations as a result of the limited offset distance between the railway line and adjacent receivers. A number of roads also run parallel to and/or intersect the railway corridor. Noise emissions from these roads contribute to increased ambient levels at nearby residential and other sensitive receiver locations. Ambient noise levels within the Project area are summarised in **Section 13.1.2**.

The project area has been divided into noise sub-catchment areas. The sub-catchments are typically 200 metres to 400 metres long, encompassing sensitive receiver locations with similar geographic environments and exposure to railway noise emissions. A total of 44 sub-catchments have been defined, 22 on each side of the railway corridor. These are labelled Dn-A to Dn-V on the Down side of the railway corridor and Up-A to Up-V on the Up side. Several sub-catchments have been further divided in order to optimise the height and extent of potential noise barriers and for this reason, sub-catchments Dn-B, Dn-H and Dn-N have been further divided into two smaller sub-catchments. The location of the noise sub-catchments is defined in **Table 13.10**.

Sensitive noise receivers comprise single-level and multi-storey residential buildings and educational buildings located along the railway corridor, including St Josephs Primary School, Narwee Primary School, Beverly Hills Girls High School, the Intensive English School, Revesby Pre-School and the Southside Montessori School. The location of these receivers is shown on **Figures 16.1a** to **16.1g.**

13.1.2 Ambient noise levels

The existing noise environment varies along the corridor from Kingsgrove to Revesby, as would be expected from the range of suburban and commercial land uses within the Project area and the proximity of each location to adjacent major roads and the rail corridor. Ambient noise surveys were undertaken at 15 representative locations (BG1-15) for unattended noise monitoring and 30 locations (N1-30) for attended noise measurements. The locations of unattended and attended noise monitoring are shown on **Figures 13.1a** to **13.1g**.

Figure 13.1a **Location of noise and vibration monitoring points**

Proposal work

2008 Revesby turnback work

19600 • Metres from Central

BG2 Unattended noise monitoring location

N1 Attended noise monitoring location

V1 Attended vibration monitoring location

Indicative and subject to detailed design

Figure 13.1b **Location of noise and vibration monitoring points**

Proposal work

2008 Revesby turnback work

19600 • Metres from Central

BG2 Unattended noise monitoring location

N1 Attended noise monitoring location

V1 Attended vibration monitoring location

Indicative and subject to detailed design

Figure 13.1c **Location of noise and vibration monitoring points**

Proposal work

2008 Revesby turnback work

19600 • Metres from Central

BG2 Unattended noise monitoring location

N1 Attended noise monitoring location

V1 Attended vibration monitoring location

Indicative and subject to detailed design

Figure 13.1d **Location of noise and vibration monitoring points**

- Proposal work
- 2008 Revesby turnback work
- 19600 • Metres from Central
- BG2 Unattended noise monitoring location
- N1 Attended noise monitoring location
- V1 Attended vibration monitoring location

Indicative and subject to detailed design

Figure 13.1e **Location of noise and vibration monitoring points**

Proposal work
2008 Revesby turnback work
19600 • Metres from Central

BG2 Unattended noise monitoring location
N1 Attended noise monitoring location
V1 Attended vibration monitoring location

Indicative and subject to detailed design

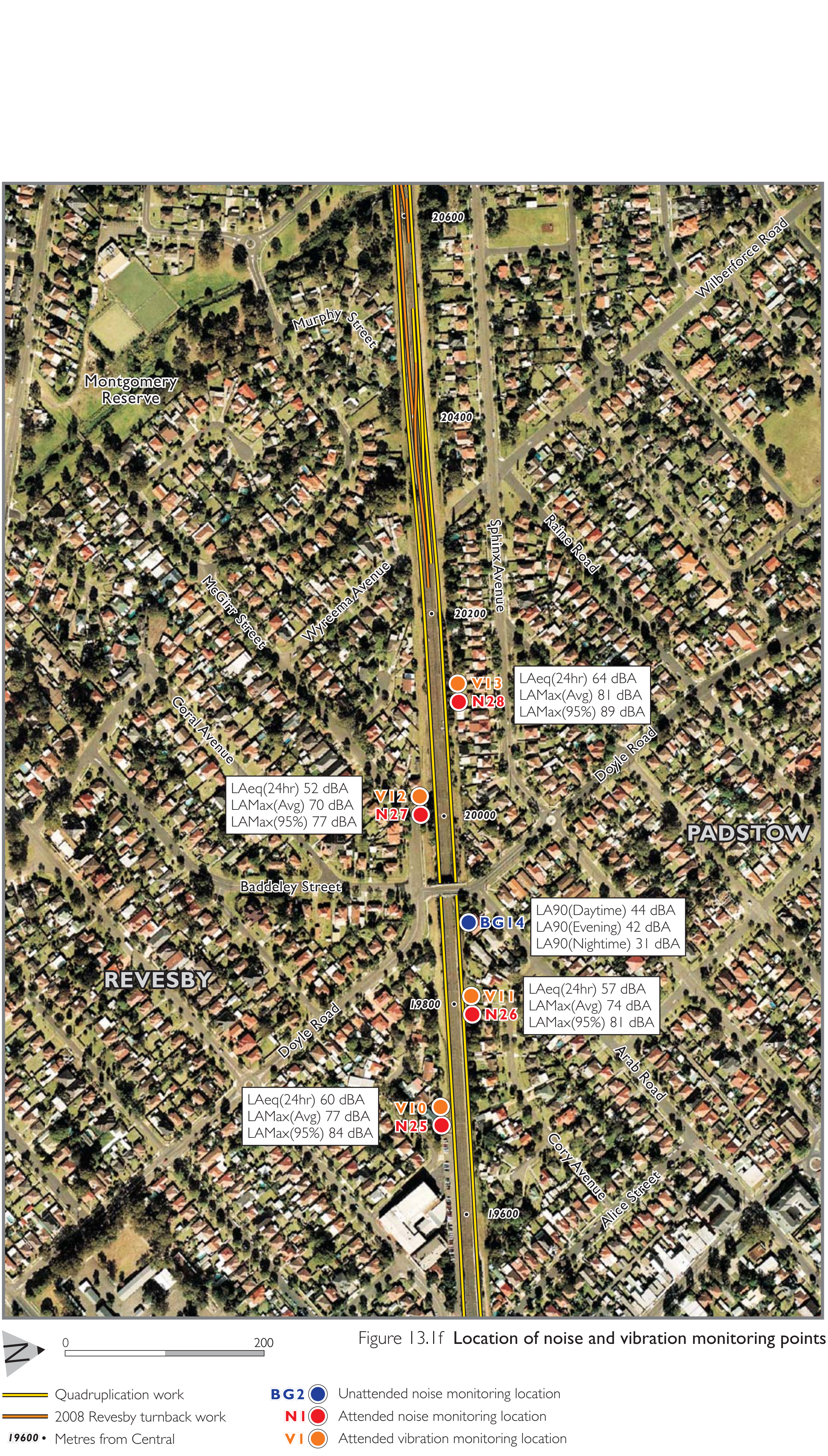


Figure 13.1f **Location of noise and vibration monitoring points**

Indicative and subject to detailed design

Figure 13.1g **Location of noise and vibration monitoring points**

Proposal work

2008 Revesby turnback work

19600 • Metres fron Central

BG2 Unattended noise monitoring location

N1 Attended noise monitoring location

V1 Attended vibration monitoring location

Indicative and subject to detailed design

The unattended noise monitoring established L_{A90} background noise levels and existing LAeq noise levels for daytime, evening and night-time. L_{A90} refers to the background noise level (or Rating Background Level) in absence of construction activities and represents the repeatable long-term minimum noise level during the daytime, evening and night-time. The LAeq is the A-weighted equivalent noise level, when filtering is applied to match normal human hearing characteristics. A summary of the processed noise levels is presented in **Table 13.1.** The definition of daytime, evening and night-time hours complies with that used by the DECC, where daytime is from 07.00 to 18.00 hours, Monday to Friday and 07.00 to 13.00 hours on Saturdays, evening from 18.00 to 22.00 hours and night-time from 22.00 to 07.00 hours.

Table 13.1 Summary of ambient noise levels at unattended noise monitoring locations

Monitoring Location	Noise Level (dBA)					
	Daytime		Evening		Night-time	
	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
BG1: 141 Morgan Street, Beverly Hills	53	62	51	60	44	57
BG2: Beverly Hills Girls High School	48	59	50	58	38	55
BG3: Wiruna Crescent, Narwee	43	61	43	59	35	55
BG4: 20 Kardella Crescent, Narwee	58	70	52	68	40	64
BG5: 4 Ventura Avenue, Narwee	39	57	43	55	35	51
BG6: 6 Fullerton Crescent, Riverwood	40	61	41	51	39	50
BG7: 216A Bonds Road, Riverwood	51	68	47	66	39	62
BG8: 4A William Street, Riverwood	39	55	38	46	35	46
BG9: 18 Webb Street, Riverwood	42	57	38	54	34	51
BG10: 95 Webb Street, Riverwood	40	78	42	61	38	57
BG11: 4 Bridge Street, Padstow	45	61	46	58	38	55
BG12: 19 Parmal Avenue, Padstow	41	55	43	52	39	51
BG13: 32 Alice Street, Padstow	45	58	42	55	33	51
BG14: 153A Arab Road, Padstow	44	58	42	56	31	51
BG15: 24 Henry Avenue, Panania	41	62	41	53	35	56

Attended noise monitoring determined the average Sound Exposure Level (L_{AE}), 95th Percentile Maximum Noise Level (LAmax) and Equivalent Continuous Noise Level (LAeq(24 hour)) noise levels for each of the 30 locations. Each measurement set included a minimum of 20 train passby events, split approximately equally between the two existing tracks. The Sound Exposure Level is used to indicate the total acoustic energy of an individual noise event. The Equivalent Continuous Noise Level represents the cumulative effects of all the train noise events occurring in one day. The LAmax is the Maximum Noise Level occurring during a train passby event. A summary of the attended noise measurements is shown in **Table 13.2.**

Table 13.2 Summary of attended noise measurement results

Monitoring Location	Number of Trains	Average Speed (km/h)	Noise Level (dBA)		
			Average L_{AE}	Calculated $L_{Aeq(24hour)}$	Average Maximum L_{Amax}
N1: 80 Tooronga Terrace, Beverly Hills	20	65	82	57	75
N2: 109A Morgan Street, Beverly Hills	21	64	83	58	76
N3: Beverly Hills Girls High School	20	59	77	52	70
N4: 2 Gregory Crescent, Beverly Hills	21	65	82	57	75
N5: 6 Wiruna Crescent, Beverly Hills	22	64	82	57	75
N6: 19 Bryant Street, Narwee	21	56	82	57	75
N7: 13 Narwee Avenue, Narwee	21	58	85	60	77
N8: 4 Ventura Avenue, Narwee	20	71	85	60	77
N9: 12 Yardley Avenue, Narwee	22	72	81	56	74
N10: 2 Karne Street, Narwee	20	75	81	56	74
N11: 68 Josephine Street, Riverwood	24	67	85	60	79
N12: 216A Bonds Road, Riverwood	20	73	93	68	88
N13: 25 Romilly Street, Riverwood	20	60	80	55	71
N14: 1A Coleridge Street, Riverwood	20	52	77	52	70
N15: Webb Street car park, Riverwood	22	60	82	57	76
N16: 3 Bennett Road, Riverwood	20	69	82	57	74
N17: 49 Webb Street, Riverwood	21	70	79	54	71
N18: William Street car park, Riverwood	20	47	81	56	69

Monitoring Location	Number of Trains	Average Speed (km/h)	Noise Level (dBA)		
			Average L_{AE}	Calculated $L_{Aeq(24hour)}$	Average Maximum L_{Amax}
N19: 95 Webb Street, Riverwood	22	82	86	58	75
N20: 89 Davies Road, Padstow	20	77	87	62	81
N21: 4 Bridge Street, Padstow	21	76	84	59	76
N22: 68 Davies Road, Padstow	21	63	81	56	75
N23: Banks Street car park, Padstow	22	48	85	60	78
N24: 32 Alice Street, Padstow	20	43	79	54	71
N25: 2 Crusade Avenue, Padstow	20	56	85	60	77
N26: 15 Cory Avenue, Padstow	21	68	82	57	74
N27: 2 McGirr Street, Padstow	20	64	77	52	70
N28: 55 Sphinx Avenue, Revesby	20	69	89	64	81
N29: 24 Hendy Avenue, Revesby	27	66	78	53	71
N30: Tooronga Terrace car park, Beverly Hills	20	47	78	53	77

Note 1 The calculated LAeq(24hour) noise levels are based on the measured L_{AE} noise levels and 280 train passby events in a 24 hour period (based on the current CityRail timetable – dated 28 May 2006).

13.1.3 Ambient vibration levels

Attended vibration measurements were undertaken adjacent to the railway corridor at 15 locations to establish vibration levels from train operations at representative receiver locations. At each location, measurements were undertaken at two locations approximately 10 metres apart to determine the change in vibration levels with increasing distance from the track. Each measurement set includes a minimum of 20 train passby events. A summary of the measured vibration levels at each location is presented in **Table 13.3.** The measured average vibration level is expressed in terms of decibels (dB re 10^{-9} m/s).

The locations of vibration monitoring (V1-15) are shown on **Figures 13.1a** to **13.1g**.

Table 13.3 Summary of attended vibration measurement results

Measurement location	Number of passby events	Average speed (km/h)	Distance to track (metres)	Average vibration level[1] (dB re 10^{-9} m/s)
V1: 2 Gregory Crescent, Beverly Hills	21	65	13	96
			23	94
V2: 13 Narwee Avenue, Narwee	21	58	24[2]	92
			34[2]	85
V3: 4 Ventura Avenue, Narwee	20	71	21	98
			31	92
V4: 2 Karne Street, Narwee	20	75	17	96
			26	90
V5: 216A Bonds Road, Riverwood	20	73	3	103
			13[4]	86
V6: Webb Street car park, Riverwood	22	60	12	87
			22[2]	81
V7: William Street car park, Riverwood	20	47	17	87
			26[2]	79
V8: 4 Bridge Street, Padstow	21	76	24	90
			30[2]	86
V9: 32 Alice Street, Padstow	20	43	27	95
			25	91
V10: 2 Crusade Avenue, Padstow	20	56	8	97
			14	88
V11: 15 Cory Avenue, Padstow	21	68	12	101
			22	90
V12: 2 McGirr Street, Padstow	20	64	18	89
			28[2]	90
V13: 55 Sphinx Avenue, Revesby	20	69	17	90
			27[3]	88
V14: 24 Hendy Avenue, Panania	27	66	19[2]	92
			29	82
V15: Tooronga Terrace car park, Beverly Hills	20	47	14[2]	90
			23	84

Note 1 Vibration levels are the maximum 1-second RMS vibration levels measures for individual train events.
Note 2 The vibration levels at frequencies below 20 Hz were omitted from these results due to contamination from other, unidentified vibration sources.
Note 3 The vibration levels at frequencies below 25 Hz were omitted from these results due to contamination from other, unidentified vibration sources.
Note 4 The vibration levels at frequencies below 31.5 Hz were omitted from these results due to contamination from other, unidentified vibration sources.

13.2 Changes to the acoustic environment

13.2.1 Construction noise

The *Environmental Noise Control Manual* (Department of Environment and Conservation, 1994) provides guidelines for assessing the noise impact from construction sites. The guideline outlines the following noise emission objectives:

- For a construction period of up to four weeks' duration, the LA10 noise level when measured over a period of not less than 15 minutes should not exceed the LA90 background noise level by more than 20dBA.
- For a construction period of between 4 and 26 weeks, the LA10 noise level should not exceed the LA90 background noise level by more than 10dBA.
- For a construction period of greater than 26 weeks, the LA10 noise level should not exceed the LA90 background noise level by more than 5dBA.

As the overall duration of the proposed construction program is greater than 26 weeks, the LA90 background plus 5dBA noise goal is applicable to residential and other noise-sensitive receiver locations, such as schools, hospitals and nursing homes. It is generally acceptable that retail and commercial building receivers are 5dBA to 10dBA less sensitive to noise emissions than residential receivers. Therefore, an LA10 noise objective of LA90 plus 10dBA has been conservatively applied for the receivers in commercial and retail areas without adjacent residential dwellings. Otherwise, the more stringent residential criteria would apply.

The general approach of the DECC to the control of construction noise is to use silenced equipment and limit the hours of operation for noisy construction work to between 07.00 and 18.00 hours from Monday to Friday, 08.00 to 13.00 hours on Saturdays with no work on Sundays or public holidays. Daytime construction noise objectives are applied as most of the works would occur during this time period. However, some activities would need to be undertaken outside normal hours for safety reasons as required by the police or RTA or to avoid significant traffic or service disruptions. Construction noise levels will inevitably depend on the number of plant items and equipment operating at any one time and their precise location relative to the receiver of interest. Details of the typical plant and equipment required for different work areas along the corridor and there associated sound pressure levels are outlined in the in **Table 13.4**.

Table 13.4 Sound pressure levels for plant items

Plant Item	Noise level at seven metres (dBA)	
	Typical maximum level	Noise level for modelling (L_{A10})
Heavy rock breaker On excavator KATO 750	103	98
Excavator KATO	86	83
Boring Rig (diesel)	85	82
Bulldozer Caterpillar D9	88	83
Skidsteer	85	82
Crane 60t crawler or truck mounted	85	80
Backhoe/FE loader wheeled	86	82
Semi trailer 25-28 tonne	87	82
Dump truck 15 tonne	83	82
Product truck 12-15 tonne	83	82
Vibratory pile driver	96	90
Impact piling rig	109	105
Diesel generator	79	78
Concrete saw	95	92
Jackhammer - hand held	88	84
Lighting tower/ Lunar lighting tower	55	55
Flood lights - daymaker	75	75
Concrete truck	88	85
Concrete pump	84	82
Concrete agitator	80	78
Ballast regulator	96	93
Ballast tamper	96	93
Franna crane	85	80
400t crane	85	80
100t crane	85	80
Road profiler	83	82
Asphalter	83	82
Auger piling rig	85	82

Indicative daytime construction noise levels at sensitive receiver locations in the vicinity of the bridge and station works are shown in **Table 13.5**. The predicted L_{A10} daytime construction noise levels at the nearest locations exceed the construction noise goals by clear margins, at some locations by more than 40dBA. However, these exceedances do not suggest that the works should not proceed but rather highlight the importance of managing the works to minimise both the noise levels and duration of the predicted exceedances. Mitigation measures are discussed in **Section 13.3.1.**

Table 13.5 Predicted LA10 noise objectives and levels for nearby receiver groups

Work area and scenario	Nearest receiver locations to the proposed construction sites	Distance from site (metres)	LA10 construction noise			
			Objective[1] (dBA)			Predicted level[2] (dBA)
			1	2	3	
Beverly Hills Station (City Side) (Bridge Construction)	49 Cahill Street, Beverly Hills	35	58	56	49	73
	64 Cahill Street, Beverly Hills	40				71
	78 Tooronga Terrace, Beverly Hills	50				69
King Georges Road Overbridge, Beverly Hills (Bridge Construction)	141 Morgan Street, Beverly Hills	70	58	56	49	69
	4-6 Edgbaston Road, Beverly Hills	70				73
	Beverly Hills Girls High School	70				73
King Georges Road Overbridge, Beverly Hills (Piling Works)	141 Morgan Street, Beverly Hills	120	58	56	49	60
	4-6 Edgbaston Road, Beverly Hills	70				67
	Beverly Hills Girls High School	60				67
Broad Arrow Road, Narwee (Road) (Bridge Construction)	20 Kardella Crescent, Narwee	40	63	59	45	75
	23 Bryant Street, Narwee	45				72
	39 Broad Arrow Road, Narwee	60				71
Broad Arrow Road, Narwee (Bridge Construction)	140 Hannans Road, Narwee	70	63	57	45	72
	39 Kardella Crescent, Narwee	80				69
	42 Broad Arrow Road, Narwee	90				68
Karne Street, Narwee (Piling Works)	1 Karne Street, Narwee	25	44	48	39	**74**
	12 Huntingdale Avenue	30				**73**
	2 Ventura Avenue, Narwee	10				**81**
Bonds Road, Riverwood (Bridge Construction)	216A Bonds Road, Riverwood	15	56	52	44	**86**
	2A Bonds Road, Riverwood	15				**84**
	68 Josephine Street, Riverwood	35				70
Belmore Road, Riverwood (Bridge Construction)	1 Morotai Avenue, Riverwood	70	44	43	40	**70**
	3 Phillip Street, Riverwood	50				**76**
	54 Thurlow Street, Riverwood	40				**78**
Belmore Road, Riverwood (Piling Works)	1 Morotai Avenue, Riverwood	70	44	43	40	**67**
	3 Phillip Street, Riverwood	80				**65**
	54 Thurlow Street, Riverwood	70				**67**
Webb Street, Riverwood (Road) (Bridge Construction)	40 Lillian Road, Riverwood	50	45	47	43	**74**
	91 Webb Street, Riverwood	40				**76**
	95 Webb Street, Riverwood	30				**77**

Work area and scenario	Nearest receiver locations to the proposed construction sites	Distance from site (metres)	LA10 construction noise			
			Objective[1] (dBA)			Predicted level[2] (dBA)
			1	2	3	
Webb Street, Riverwood (Creek) (Bridge Construction)	2 Meager Avenue, Padstow	185	45	47	43	56
	40 Lillian Road, Riverwood	80				63
	95 Webb Street, Riverwood	45				**70**
Webb Street, Riverwood (Creek) (Piling Works)	2 Meager Avenue, Padstow	175	45	47	43	**75**
	40 Lillian Road, Riverwood	90				**66**
	95 Webb Street, Riverwood	70				**85**
Davies Road, Padstow (Bridge Construction)	68 Davies Road, Padstow	15	50	51	43	**88**
	70 Davies Road, Padstow	30				**76**
	89 Davies Road, Padstow	15				**87**
Davies Road, Padstow (Piling Works)	68 Davies Road, Padstow	15	50	51	43	**82**
	70 Davies Road, Padstow	55				**71**
	89 Davies Road, Padstow	60				**71**
Padstow Station (Bridge Construction)	32 Alice Street, Padstow	75	50	47	38	**72**
	49 Cahors Road, Padstow	65				**71**
	59 Howard Road, Padstow	45				**74**
Padstow Station (Piling Works)	32 Alice Street, Padstow	110	50	47	38	63
	49 Cahors Road, Padstow	70				69
	59 Howard Road, Padstow	35				**74**
Doyle Road, Padstow (Bridge Construction)	1 Bradley Street, Padstow	30	49	47	36	**77**
	153A Arab Road, Padstow	30				**79**
	93 Doyle Road, Revesby	25				**75**
Doyle Road, Padstow (Piling Works)	1 Bradley Street, Padstow	55	49	47	36	67
	153A Arab Road, Padstow	40				**74**
	93 Doyle Road, Revesby	20				**77**
Revesby Station (Station construction)	143 The River Road, Revesby	190	46	46	40	59
	48 Simmons Street, Revesby	65				**71**
	7 Macarthur Avenue, Revesby	150				63

Note 1 Objective 1 is Daytime
Objective 2 is Evening
Objective 3 is Night-time
Out-of-hours works are discussed further in Section 7.4.

Note 2 Shaded cells indicate a significant exceedance of 20 dBA or more above the daytime LA10 construction noise goal, for receivers surrounding each work site.

While construction vehicles associated with the Proposal would need to travel short distances on local roads, most would use major roads including King Georges Road, Belmore Road, Davies Road, The River Road and Canterbury Road to minimise noise impacts where possible. The number of truck movements is normally most intensive during the earthworks stage.

Access to work areas would be provided by the existing vehicle gates along the rail corridor. Some additional access gates may be added where streets or reserves adjoin the rail corridor or some existing gates could be relocated. Access is proposed via appropriate easements and other suitable locations along the corridor, resulting in many access points. Construction traffic will be dependent on the active work areas, minimising the number of days of heavy vehicle traffic at each access point.

Where possible, construction vehicles would use major roads, including King Georges Road, Belmore Road, Davies Road, The River Road and Canterbury Road, although they would need to travel short distances on local roads to access most of the worksites.

Table 12.5 presents an approximate range of truck movements per day at each of the proposed access points. The number of trucks per day at each access point ranges between 1 and 40. Each access point would be subject to construction-related traffic for between 6 and 17 months.

The predictions show that off-site truck noise levels would comply with the relevant road traffic noise criteria at offset distances greater than 20 metres. The following mitigation measures would be implemented in order to minimise the risk of exceeding the criteria at residential receiver locations, particularly where the offset distance is 20 metres or less:

- All trucks would have mufflers and any other noise control equipment maintained in good working order.
- Truck drivers would be instructed to avoid heavy acceleration and braking as far as practicable.
- Truck drivers would be instructed to avoid compression braking as far as practicable.
- Speeds would be minimised as far as practicable.
- Truck movements would be restricted to the daytime period to the greatest possible extent.

Noise from idling trucks near construction sites can also affect amenity in some instances. For this reason, it is recommended that any queuing of trucks awaiting entry to the site outside normal construction hours would be restricted to locations away from residences as far as possible. If trucks are required to queue in such locations during construction hours, engines would be shut down. The finalised construction traffic arrangements will be reviewed during the CNVMP assessment.

13.2.2 Operational noise

Operational noise emissions from suburban electric passenger trains are predominantly caused by the rolling contact of steel wheels on steel rails. Other noise sources on these trains, such as air-conditioning plant and air compressors, are generally insignificant compared with the wheel-rail interaction, unless the train is travelling at a very slow speed or is stationary.

In order to assess the operational noise emissions for the Proposal, three noise modelling scenarios have been considered:

- **Scenario 1** – Existing Situation (2006). This model incorporates the existing ground terrain, rail traffic and tracks. The 2006 model also includes the existing 2.5 metre noise barriers located at the eastern end of the Project area at the following locations:
  - Down side barrier up to chainage 14.18 kilometres
  - Up side barrier to chainage 14.10 kilometres
- **Scenario 2** – 2021 without mitigation (approximately 10 years after opening). This model incorporates the new Up and Down Main tracks, additional turnouts, new underbridges and rail traffic increase due to the proposed Clearways timetable. The model includes the Down Main barrier being constructed as part of the 2008 Revesby Turnback Project between chainages 20.25 kilometres and 20.76 kilometres.
- **Scenario 3** – 2021 with proposed mitigation. This model incorporates the proposed mitigation measures alongside the new Up and Down Main tracks in areas where these are considered to be feasible and reasonable.

The traffic data for the 2006 noise model were based on the current CityRail timetable (dated May 2006) and the data for the future modelling scenarios (2021) uses estimates of future train numbers, derived for the Revesby Turnback Project, based on eight trains per hour in each direction and up to 16 trains per hour in the peak direction on the Main Lines. There is a total of 254 train movements per day in the current timetable, compared with 596 per day for the future modelling scenario (2021).

The reference noise levels used for the noise modelling were based on the attended noise measurements undertaken adjacent to the railway corridor between Kingsgrove and Revesby.

Operational noise trigger levels

The trigger levels used for the noise modelling are derived from the *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects* (Department of Environment and Climate Change 2007). The main purpose of the guideline is to assist the ongoing expansion of the rail transport network by ensuring that potential noise impacts associated with rail developments are assessed in a consistent and transparent manner. The interim guideline provides noise trigger levels that initiate the need for an assessment of potential noise and vibration impacts of the operation of the Proposal and an examination of the mitigation measures that would be feasible and reasonable for the amelioration of the resulting impacts. The noise trigger levels are not intended to be applied automatically in any mandatory sense as conditions in statutory approvals or licences.

Trigger levels are provided for rail infrastructure projects including new railway lines or the redevelopment of an existing railway line for airborne noise created by the operation of surface track. The trigger levels for residential and other noise-sensitive receiver locations are listed in **Tables 13.6** and **13.7**.

Noise levels for residential locations are assessed one metre in front of the most affected building façade. Noise trigger levels are considered both immediately after operations commence for new and redeveloped rail projects and for projected traffic volumes at an indicative period into the future to represent the expected typical level of rail traffic usage. Trigger levels for the redevelopment of an existing rail line are applicable where residential or other sensitive receivers are subject to existing rail noise at or above the noise trigger levels in **Table 13.6** for new rail line development.

Table 13.6 Rail traffic noise trigger levels for residential development

Type of development	Residential noise trigger levels (dBA)	
	Day (07.00 to 22.00)	Night (22.00 to 07.00)
Redevelopment of existing rail line Where development increases existing rail noise levels AND resulting rail noise levels exceeds	65 LAeq (15 hours) 85 LAmax	60 LAeq (9 hours) 85 LAmax

Note - These numbers represent levels of noise that trigger the need for a rail infrastructure project to conduct an assessment of potential noise impacts. An increase in existing rail noise levels is taken to be an increase of 2.0 dB or more in LAeq in any hour or an increase of 3.0 dB or more in L*Amax*.

Table 13.7 Rail traffic noise trigger levels for sensitive land uses other than residential

Sensitive land use	Noise level values	
	Redevelopment of existing line	New rail line development
	Development increases existing rail noise levels by 2 dB or more in LAeq in any hour AND resulting rail noise levels exceed:	
Schools, educational institutions – internal	45 LAeq(1 hour)	40 LAeq(1 hour)
Places of worship – internal	45 LAeq(1 hour)	40 LAeq(1 hour)
Hospitals – internal	35 LAeq(1 hour)	35 LAeq(1 hour)
Hospitals – external	60 LAeq(1 hour)	60 LAeq(1 hour)
Active recreation (such as a golf course)	65 LAeq(24 hours)	65 LAeq(24 hour)
Passive recreation	LAeq as per residential noise level values shown in Table 12.5 (does not include maximum noise level component)	

The typical noise impact assessment process for a rail proposal is outlined in the guidelines. This commences with the determination of the necessary trigger levels and the locations where the environmental noise values are applicable. These are derived through discussion with the relevant agencies during a Planning Focus meeting and reference to the guidelines. Assessment of whether the selected trigger levels are exceeded as a result of the proposed development is carried out as part of the environmental assessment process. It is determined whether the exceedances would result in environmental harm or community concern and, if so, a cost-benefit analysis of feasible and reasonable noise mitigation measures would be undertaken, aimed at achieving the maximum protection of the acoustic environment. Community consultation would follow to review the noise levels achievable for the Project.

Feasibility relates to the engineering considerations and the practicality of building the proposed measures given the constraints of a particular site. Reasonableness relates to the application of judgement, taking into account potential noise reduction, cost, aesthetic impacts and community wishes, potential change in noise levels and the benefits arising from the development. Community consultation is an important process in determining the reasonableness of the proposed noise mitigation measures.

Noise Modelling Results

The results of the computer noise modelling for all three scenarios are summarised in the following section. Details of the modelling and its results are included in **Technical Paper 1** in Volume Two.

Scenario 1 – Existing situation (2006)

The number of locations exceeding overall noise trigger levels, based on the calculated noise levels, is:

- 46 on the Down side of the railway corridor where existing noise levels exceed the LAmax 85dBA and/or LAeq(15hr) 65dBA trigger levels.
- 46 on the Up side of the corridor where existing noise levels exceed the LAmax 85dBA and/or LAeq(15hr) 65dBA trigger levels.

Scenario 2 – Future situation (2021) without noise mitigation

The number of locations exceeding the overall noise trigger levels, based on calculated future noise levels without mitigation measures, is:

- 215 on the Down side of the railway corridor where predicted noise levels exceed the LAmax 85dBA and/or LAeq(15hr) 65dBA trigger levels.
- 179 on the Up side of the corridor where predicted noise levels exceed LAmax 85dBA and/or LAeq(15hr) 65dBA trigger levels.

Compared with the existing situation, the number of locations exceeding the overall noise trigger levels is predicted to increase from 46 to 215 on the Down side of the corridor and from 46 to 179 on the Up side of the corridor.

The predicted increase in LAeq noise levels at the nearest receivers as a result of the Proposal (without mitigation) would typically be approximately 5dBA in every hour. Similarly, at most locations, the predicted increase in LAmax noise levels as a result of the Proposal would be approximately 4dBA. The increase in LAeq and LAmax noise levels results from the proposed increase in train speeds on the new lines and reduced offset distances between the new tracks and receiver locations.

Scenario 3 – Future situation (2021) with noise mitigation

The number of locations exceeding the noise trigger levels, based on the calculated future noise levels with the proposed noise mitigation measures in place, is:

- 57 on the Down side of the railway corridor where predicted noise levels exceed the LAmax 85dBA and/or LAeq(15hr) 65dBA trigger levels.
- 56 on the Up side of the corridor where predicted noise levels exceed LAmax 85dBA and/or LAeq(15hr) 65dBA trigger levels.

Compared with the existing situation, the number of locations exceeding the overall noise trigger levels is predicted to increase from 46 to 57 on the Down side of the corridor and from 46 to 56 on the Up side of the corridor. Compared with the 2021 situation without noise mitigation measures, the number of locations exceeding the overall noise trigger levels is predicted to be reduced from 215 to 57 on the Down side of the track and from 179 to 56 on the Up side of the track.

13.2.3 Construction vibration

Assessing Vibration: a technical guideline (Department of Environment and Climate Change) is based on the guidelines contained in British Standard BS 6472-1992. BS 6472. These guidelines refer only to the human comfort criteria for vibration. Vibration resulting from construction has therefore been assessed in accordance with the German Standard DIN 4150 Part 3-1999 and British Standard BS 7385 Part 2-1993. These are the standards normally used for assessing the risk of vibration damage to structures.

The recommended safe working distance for vibration intensive plant is outlined in **Table 13.8.** These distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions. Safe working distances apply to structural damage of typical buildings and geotechnical conditions but they do not address heritage structures. Vibration monitoring is recommended to confirm safe working distances at specific sites.

Exceedances of structural damage criteria may occur if a 13 tonne (or larger) roller or a heavy hydraulic hammer is operated within 20 metres to 25 metres of a residential building. Monitoring at the commencement of vibratory compaction or hydraulic hammering within 30 metres of residential buildings would be undertaken to determine compliance or non-compliance and in the event of non-compliance, immediate corrective action would be taken in accordance with the mitigation measures outlined in **Section 13.3.2.**

Construction activities would be managed to avoid structural damage due to vibration by observing the recommended safe working distances outlined for cosmetic damage in **Table 13.8**. If it is necessary to work within these distances, vibration monitoring would be undertaken. Potential impacts would therefore be primarily in relation to human response.

Table 13.8 Recommended safe working distances for vibration intensive plant

Plant item	Rating/description	Safe working distance (metres)	
		Cosmetic damage (DIN 4150)	Human response (BS 6472)
Vibratory Roller	< 50 kN (typically 1-2 tonnes)	5	15 to 20
	< 100 kN (typically 2-4 tonnes)	6	20
	< 200 kN (typically 4-6 tonnes)	12	40
	< 300 kN (typically 7-13 tonnes)	15	100
	> 300 kN (typically 13-18 tonnes)	20	100
	> 300 kN (typically > 18 tonnes)	25	100
Vibratory Pile Driver	Sheet piles	2 to 20	20
Pile Boring	≤ 800 mm	2 (nominal)	N/A
Jackhammer	Hand held	1 (nominal)	Avoid contact with structure

Human comfort is normally assessed with reference to the NSW Department of Environment and Conservation document *Assessing vibration: a technical guideline* which is based on British Standard BS 6472-1992 Evaluation of human exposure to vibration in buildings (1–80 Hz). For daytime activities, the limiting objective for continuous vibration at residential or commercial receivers is Vrms 0.4 mm/s.

13.2.4 Operational vibration

Railway vibration is generated by dynamic forces at the wheel-rail interface and will occur to some degree, even with continuously welded rail and smooth wheel and rail surfaces. This vibration propagates through the sleepers or rail mounts into the ground or track support structure. It can then propagate through the ground or structure and may sometimes be felt as tactile vibration by the occupants of buildings.

The effects of vibration in buildings can be divided into three main categories:

- where occupants or users of the building are inconvenienced or possibly disturbed;
- where building contents may be affected; and
- where the integrity of the building or the structure itself may be prejudiced.

Although people are able to perceive relatively low vibration levels, it is not appropriate to set vibration emission limits to require no vibration as that is unrealistic. Instead, there is a need to set realistic design criteria which minimises disturbance and adverse impacts on amenity and human comfort. Floor vibration levels perceptible to individuals are well below vibration that affects building contents and structural integrity and therefore the human comfort criterion would be an acceptable criterion to control vibration effects on all three categories.

Assessing Vibration: a technical guideline (Department of Environment and Climate Change, 2006) also applies to the assessment of vibration during operation of the Proposal The guideline classifies vibration levels for train passby events as being intermittent.

For intermittent vibration at residential receiver locations, vibration trigger levels are expressed in terms of the Vibration Dose Value (VDV) during the daytime (07.00 to 22.00 hours) and night-time (22.00 to 07.00 hours) periods. The VDV is a measure that takes into account the overall magnitude of the vibration levels during a train passby, as well as the total number of train passbys during the daytime and night-time periods.

The guideline nominates *preferred* vibration dose values of 0.2 $m/s^{1.75}$ (daytime) and 0.13 $m/s^{1.75}$ (night-time) and *maximum* vibration dose values of 0.4 $m/s^{1.75}$ (daytime) and 0.26 $m/s^{1.75}$ (night-time) for residential receivers. The more stringent *preferred* vibration dose values have been applied in this assessment. For offices, schools, educational institutions and places of worship, the guideline nominates VDVs twice the residential daytime levels (0.4 $m/s^{1.75}$ during the daytime and night-time periods).

The vibration trigger levels of 0.2 $m/s^{1.75}$ daytime and 0.13 $m/s^{1.75}$ night-time would permit vibration levels of up to 112 dB during the day or night at residential properties. For offices, schools, educational institutions and places of worship, the vibration trigger levels would permit Vrms vibration levels 6 dB higher than residential properties.

The criteria for intermittent vibration for residences and other sensitive receiver locations is based on DECC guidelines and is summarised in **Table 13.9**.

Table 13.9 Trigger levels for intermittent vibration

Sensitive receiver	Vibration dose value ($m/s^{1.75}$)	
	Day	Night
Residential properties	0.2	0.13
Offices, schools, educational institutions and places of worship	0.4	0.4

The Vrms vibration levels are predicted to exceed the 112 dB vibration trigger level (corresponding to a VDV of 0.2 $m/s^{1.75}$) at the following residential locations:

- 48 Vanessa Street, Beverly Hills - At this location, the predicted Vrms vibration level is 115 dB and exceeds the vibration trigger level by a margin of 3 dB. Future vibration levels are predicted to increase by 3 dB as a result of the Proposal when compared with the existing situation.

- Gregory Crescent, Beverly Hills - At this location, the predicted Vrms vibration level is 113 dB and exceeds the vibration trigger level by a margin of 1 dB. Future vibration levels are predicted to increase by 7 dB as a result of the Proposal when compared with the existing situation.

The feasibility of installing ballast mat on the near track at these locations would be investigated as part of the detailed design process for the purpose of mitigating the future vibration levels. Ballast mats comprise a soft resilient layer, usually made from rubber or other synthetic compounds (typically 40 mm thick). These are usually placed beneath the ballast to reduce the vibration transmitted into the surrounding ground. This could be expected to mitigate vibration levels by up to 5dB and provide a corresponding reduction in ground-borne noise levels of 5dBA to 10dBA.

At offices, schools, educational institutions and places of worship, the Vrms vibration levels are predicted to comply with the 118 dB vibration trigger level (corresponding to a VDV of 0.4 $m/s^{1.75}$) at all locations.

13.3 Management measures

13.3.1 Management of construction noise

The following mitigation measures are proposed to minimise construction noise:

- Noise intensive construction works would be carried out during normal construction hours wherever practicable. Where works close to the live line need to be carried out during track possessions, noise intensive activities would be scheduled to occur during the daytime, where possible. No more than four consecutive nights of high noise and/or vibration generating works would be undertaken over a seven day period, unless otherwise approved by the relevant authority.

- Quietest available plant suitable for the relevant tasks would be used.

- The duration of noise intensive activities would be minimised insofar as possible.

- Where feasible and reasonable, site hoardings or temporary noise barriers would be used to provide acoustic shielding of noise intensive activities although space restrictions may make this difficult to achieve.

- Rock breakers (if required) would be of the *Vibro-silenced* or *City* type.

- Activities resulting in highly impulsive or tonal noise emission such as rock breaking, would be limited to 08.00 hours to 12.00 hours Monday to Saturday and 14.00 hours to 17.00 hours Monday to Friday (except where essential during track possessions or as agreed with the relevant authorities). High noise activities would not be undertaken for more than three continuous hours without a minimum of one-hour respite period being provided.

- Noise awareness training would be included in inductions for site staff and sub-contractors. This would include advising of behavioural practices such as no swearing/ unnecessary shouting or loud radios to be used on site, and no dropping of materials from height.

- Noise generating plant would be orientated away from sensitive receivers and the offset distance between noisy plant and adjacent sensitive receivers would be maximised where possible.

- Notification would be provided to stakeholders and sensitive receivers via letterbox drops, advising of the nature and timing of works, and a 24 hour contact number for enquiries and complaints.

- Periodic noise monitoring would be carried out to confirm that noise levels do not significantly exceed the predictions and that noise levels of individual plant items do not significantly exceed the levels shown in **Table 13.4**.

- Minimise disturbance arising from delivery of goods to work areas. Deliveries would be carried out within standard construction hours, except as directed by the police or RTA.

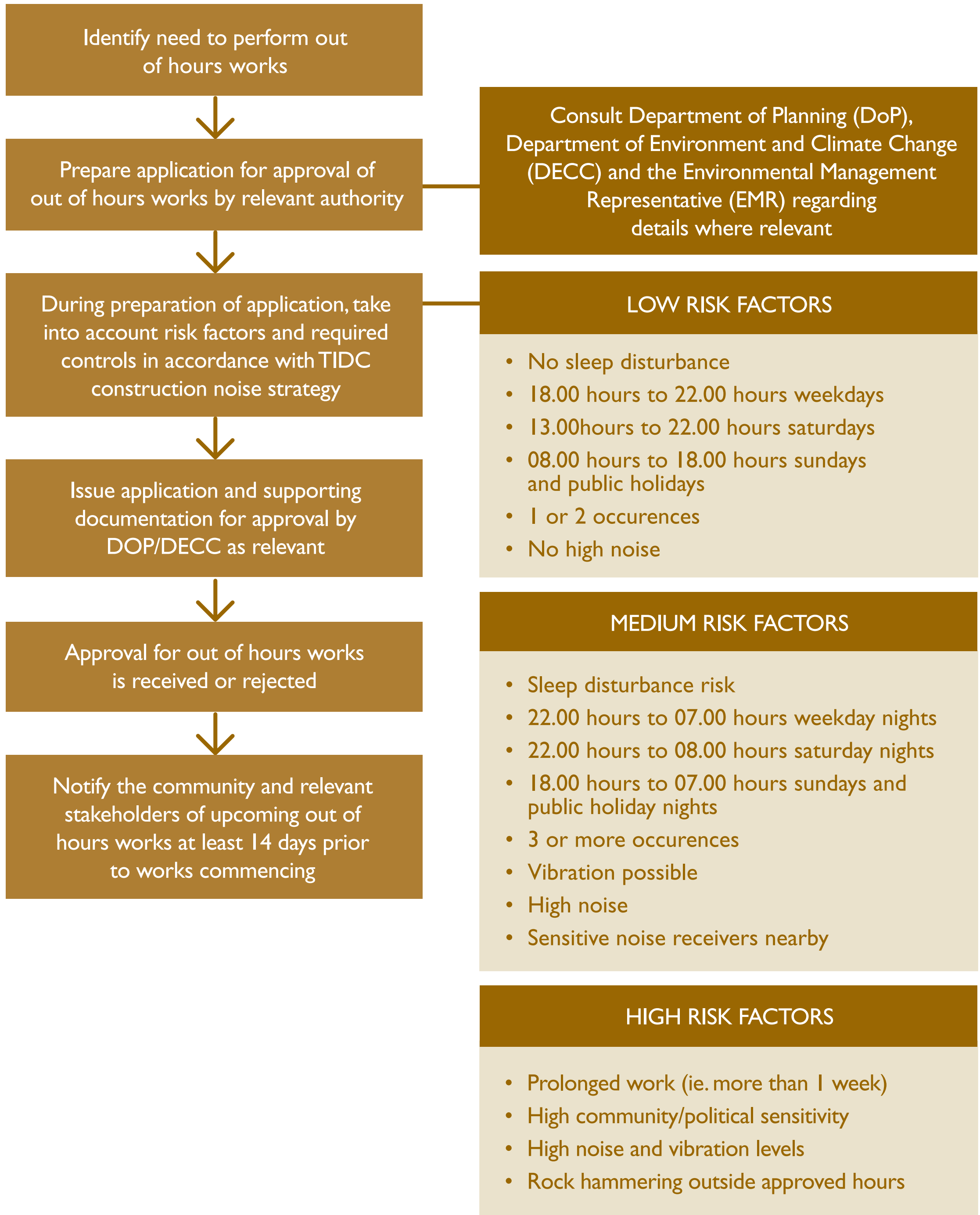
- Non-tonal reversing beepers or equivalent would be fitted and used on all construction vehicles and mobile plant regularly used on site and other vehicles.

- Trucking routes to be via major roads, where possible.

- Trucks would not be permitted to queue near residential dwellings with engines running.

In circumstances where, following application of the standard mitigation measures (outlined above), construction noise levels are still predicted to exceed the noise goals, the relevant additional mitigation measures identified in the TIDC Construction Noise Strategy would be implemented. A copy of the Construction Noise Strategy is available on the TIDC web site.

Figure 13.2 provides an outline of the out-of-hours assessment procedure that would be implemented for any work required outside the standard hours. This procedure is adopted from the Construction Noise Strategy. In addition, the following additional mitigation measures are proposed to minimise construction noise for work outside of normal construction hours:



Note: For medium and high risk factors, acoustic assessments are required

Figure 13.2 **Out of hours work assessment**

- Where noise intensive construction works are required, a detailed construction noise impact assessment would be prepared detailing the specifics of work, sites and timing.
- All relevant stakeholders including council would be provided with appropriate notice (14 days in advance) of all out-of-hours work.
- The noisiest construction activities would take place before 22:00 hours, with as much preparation work as possible undertaken in day-time hours.
- Where possible, noise intensive construction works during the weekend possessions would be undertaken during the daytime periods, with noise emissions during the night-time period being kept to a minimum, except where activities are critical to the completion of possession works and restoring rail services

13.3.2 Management of construction vibration

The following management measures are proposed to limit construction vibration:

- Preparation and implementation of site-specific Construction Noise and Vibration Management Plan.
- Establishment of buffer zones limited to activities assessed as safe or to activities undertaken in conjunction with strict vibration monitoring.
- Selection of the smallest suitable size of vibratory roller when working close to occupied and heritage buildings to minimise vibration impact.

13.3.3 Management of operational noise

The noise modelling results discussed in **Section 13.2.2** identified a number of locations where future noise levels and increases in noise levels as a result of the Proposal have triggered the need to undertake a further assessment of feasible and reasonable mitigation measures in accordance with the guidelines. In order to initiate an assessment of rail noise impacts and investigate mitigation measures, both the increase in rail noise levels as a result of the Proposal and the overall level of rail noise must exceed the trigger levels identified in the guidelines. The hierarchy of noise control is to give first preference to source control measures such as route selection to maximise offset distances and regular track maintenance, then physical mitigation measures between the source and receiver such as noise barriers and land use planning measures and a final preference for receiver controls whereby specific acoustical measures are incorporated in the design of the individual dwellings including building treatments of windows and doors.

There are three approaches available to minimise the operational noise of the Proposal. These are summarised in the following section in order of preference.

Source control measures

The design of the Proposal includes the following measures to reduce noise levels generated at source, the wheel and rail interface:

- Continuously welded track to reduce noise associated with train wheels running over joints in the rails.
- Fully ballasted tracks.
- Ballast top bridge designs used for the new track underbridges which are inherently quieter than the old design where the track is directly connected to the structure below.
- Track lubrication provided on sharp curves to reduce wheel squeal.

Other source controls that would improve operational noise levels are regular track maintenance, improved wheel condition, speed restrictions and the introduction of quieter rolling stock. These controls are more long-term operational strategies that will further improve noise mitigation but are outside the scope of the Proposal.

The existing RailCorp fleet would comprise existing rolling stock rather than a dedicated fleet. Tangara and Millennium trains are approximately 2dBA to 3dBA quieter than the other double-deck suburban trains and on this basis it is considered reasonable to assume that the frequency of the noisier train events would reduce over time as the older rolling stock is retired. Lowering train speeds is not desirable from an operational perspective as this would provide long-term adverse constraints on the line.

Source control measures would provide benefit to sensitive receivers in locations where no increase in the overall trigger levels and rail noise levels would occur.

Source/receiver measures

Noise barriers can provide significant noise reductions in areas where source control measures are not adequate to mitigate noise levels completely. Barriers can take a number of different forms including free-standing walls (transparent or solid), grass or earth mounds and cuttings where the track is lower than the receiver. Earth mounds are preferred as they are less visually intrusive and less likely to be vandalised but they require a larger land area. As a result, noise barriers are likely to be the only realistic option where land availability is limited.

The noise assessment for the Proposal has considered barriers to date. However, if other mitigation measures can meet the same criteria (provide a similar acoustic performance) and are reasonable and feasible, these would be considered and investigated further during detailed design.

The application of noise mitigation measures was indicatively determined by the topography in the vicinity. Where the rail line was considered to be at grade or in cutting relative to the noise-sensitive receivers, the potential barrier would be located on the existing property boundary at local ground level. Where it would be on embankment relative to the noise-sensitive receivers, the typical barrier would be located at a distance of 4.3 metres from the centre line of the nearest future main track at top-of-rail level.

A range of principles has been applied to determine the appropriate, feasible and reasonable noise mitigation measures including optimal height, cost, design goals, feasibility and reflected noise issues. These are outlined and described in **Technical Paper 1** in Volume Two**.** The following principles have been applied to determine whether noise barriers are feasible and/or reasonable:

- At locations exceeding the overall noise trigger levels, noise barrier design goals of L_{Amax} 80dBA and L_{Aeq}(15 hour) 60dBA (which are 5dBA below the overall trigger levels) have been adopted as part of the noise barrier optimisation methodology.
- Noise barriers would only be considered if they could provide a reduction in the L_{Aeq} and/or L_{Amax} noise levels at dwellings of at least 5dBA. This reduction must be achieved for at least one sensitive receiver location in the sub-catchment. This test was applied to avoid the construction of noise walls with significant visual impacts which would provide little or no acoustic benefit.
- The height of the noise barrier would be optimised to provide the most efficient barrier design and would be limited to a height of 4.0 metres above the top of the rail.
- Noise barriers would only be considered at locations where three or more receivers qualify for noise barrier consideration.

A summary of the potential noise barrier heights and locations at the 35 sub-catchments identified in the noise barrier requirements screening test resulting from the assessment of the above principles and considerations, is shown in **Table 13.10**. These are preliminary and subject to change during detail design.

It is anticipated that construction of noise barriers would be required at 30 of the sub-catchment locations, varying in height from 1.0 metres to 4.0 metres over a total length of 6,850 metres. The locations of the proposed noise barriers are shown in **Figures 13.3a** to **13.3g**. These are indicative and subject to change. Extensive community consultation would be required before the barrier locations and other noise management measures can be confirmed.

Table 13.10 indicates that there would still be some residential and educational receivers where noise levels above the trigger values are likely to be experienced even with the noise barriers in place. There would be a total of 69 noise sensitive receiver locations where the predicted noise levels in 2021 exceed the overall trigger levels. Of these, 13 are located within a recently constructed development, where development consent would have required noise emissions from the adjacent railway line to be taken into account in the building design. It is therefore reasonable to assume that further mitigation is not required for this development.

Table 13.10 Summary of proposed noise barrier heights and locations

Sub-catchment	Barrier location Chainage (km)	Assessed barrier length (m)	Target barrier height (m)[1]	Assessed barrier height (m)[1]	Trigger level exceedances			
					Without mitigation		With mitigation 2021	
					2006	2021	Target barrier	Assessed barrier
Dn - A	14.18 to 14.38	200	4.0	**1.0**	0	**3**	0	**0**
Dn - B2	14.90 to 14.97	70	>5.0	**4.0**	2	**7**	1	**1**
Dn - C	14.97 to 15.34	370	5.0	**3.0**	1	**14**	0	**1**
Dn - D	15.41 to 15.65	240	>5.0	**1.5**	0	**16**	0	**0**
Dn - E	15.78 to 15.97	190	>5.0	**3.5**	5	**5**	0	**0**
Dn - F	15.97 to 16.18	210	4.5	**2.0**	1	**5**	0	**0**
Dn - G	16.33 to 16.80	470	>5.0	**3.0**	6	**17**	0	**0**
Dn - H1	16.80 to 17.01	210	>5.0	**1.5**	3	**7**	0	**0**
Dn - H2	17.08 to 17.14	60	>5.0	**4.0**	1	**11**	3	**6**
Dn - I	17.14 to 17.31	170	>5.0	**3.0**	3	**3**	1	**1**
Dn - K	17.65 to 18.00	350	5.0	**2.5**	6	**27**	0	**1**
Dn - L	18.17 to 18.35	180	>5.0	**1.0**	2	**10**	0	**3**
Dn - M	18.60 to 18.78	180	>5.0	**N/A**[2]	1	**9**	1	**9**
Dn - N1	18.85 to 18.91	60	>5.0	**2.5**	0	**2**	0	**0**
Dn - N2	19.03 to 19.12	90	3.0	**2.5**	0	**4**	0	**0**
Dn - O	19.17 to 19.26	90	>5.0	**N/A**[3]	8	**12**	8	**12**
Dn - P	19.63 to 19.81	180	>5.0	**3.0**	4	**6**	1	**2**
Dn - Q	19.99 to 20.25	260	>5.0	**3.5**	3	**4**	0	**0**
Up - B	14.73 to 14.97	240	>5.0	**3.5**	4	**6**	3	**3**
Up - C	14.97 to 15.29	320	>5.0	**2.5**	1	**11**	0	**1**
Up - D	15.38 to 15.58	200	>5.0	**3.5**	16	**18**	2	**2**
Up - F	16.13 to 16.33	200	>5.0	**3.0**	0	**6**	0	**0**
Up - G	16.33 to 16.75	420	>5.0	**3.0**	2	**26**	0	**0**

Sub-catchment	Barrier location Chainage (km)	Assessed barrier length (m)	Target barrier height (m)[1]	Assessed barrier height (m)[1]	Trigger level exceedances			
					Without mitigation		With mitigation 2021	
					2006	2021	Target barrier	Assessed barrier
Up - H	16.93 to 17.11	180	>5.0	**3.5**	1	**5**	0	**1**
Up - I	17.29 to 17.40	110	>5.0	**4.0**	0	**6**	1	**1**
Up - J	17.50 to 17.65	150	5.0	**2.0**	0	**8**	0	**0**
Up - K	17.65 to 17.85	200	>5.0	**1.0**	1	**5**	0	**0**
Up - L	18.07 to 18.35	280	>5.0	**2.5**	2	**5**	0	**0**
Up - N	18.79 to 19.00	210	>5.0	**4.0**	12	**29**	22	**22**
Up - O	19.12 to 19.25	130	>5.0	**2.5**	1	**4**	1	**1**
Up - P	19.46 to 19.88	420	5.0	**3.0**	3	**18**	0	**1**
Up - R	20.26 to 20.47	210	>5.0	**1.5**	0	**5**	0	**0**
Totals	-	**6,850**	-	-	89	**313**	44	**65**[4]

Note 1 Barrier height is the height of the barrier above the top of the rail at embankment locations. At locations where the track is at grade or in cutting, the barrier height is the height of the barrier above local ground level.

Note 2 Noise barriers at these locations are not recommended as the required 5 dBA noise reduction would not be achieved at any receiver locations within the sub-catchment.

Note 3 Noise barriers are not cost effective in these areas as the TNBA and MBVA values within these sub-catchment areas are less than 0.2 dBA/m^2.

Note 4 The total number of residual receivers (with assessed barriers) in the Proposal area also includes those in sub-catchments (identified in Table 13 of Technical Paper 1 containing less than three residuals. These are sub-catchments Up-A (2 locations), Up-E (1 location) and Up-M (1 location). This gives a total of 69 residual receivers for Year 2021 with the assessed barriers.

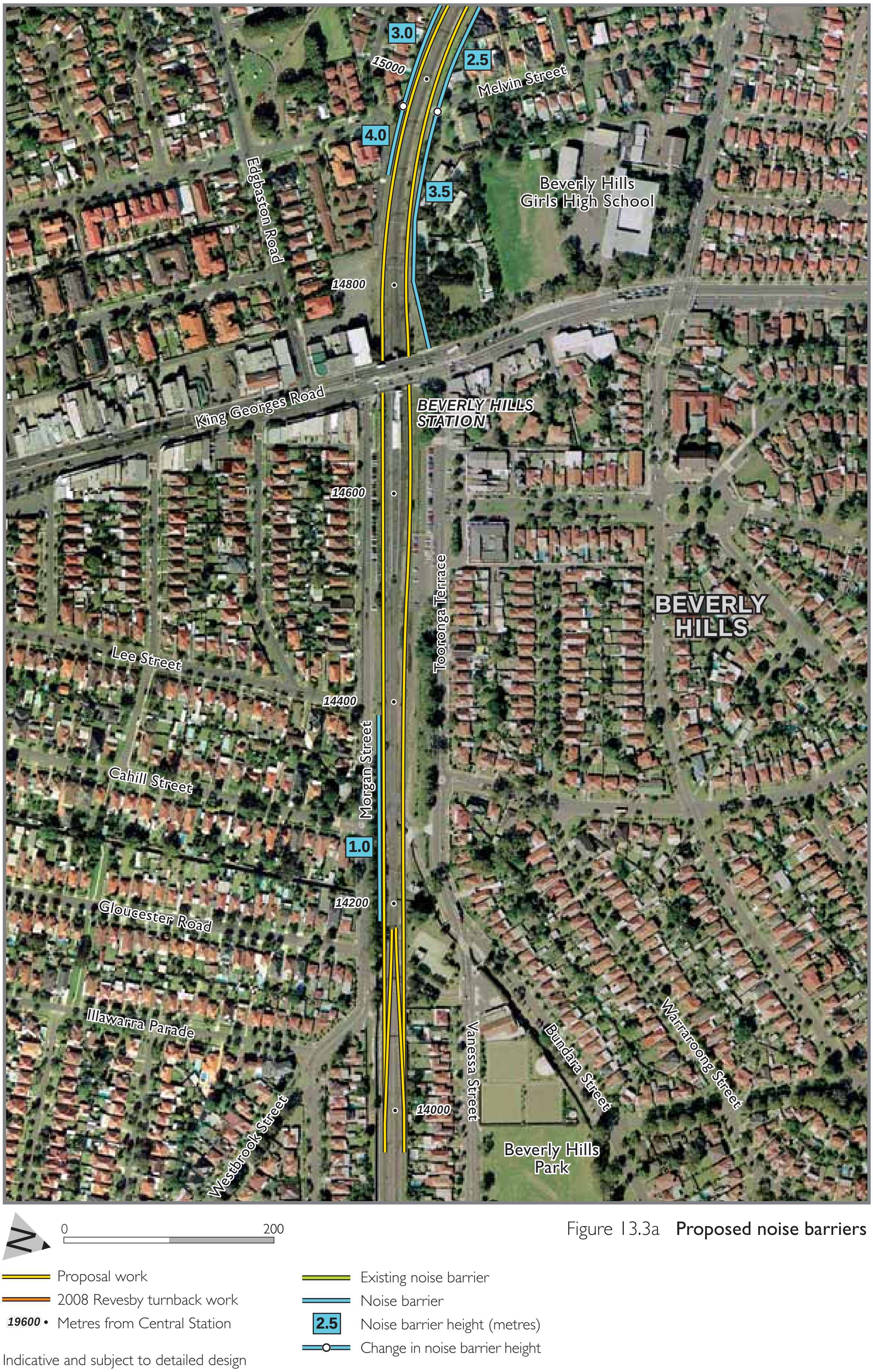


Figure 13.3a **Proposed noise barriers**

Indicative and subject to detailed design

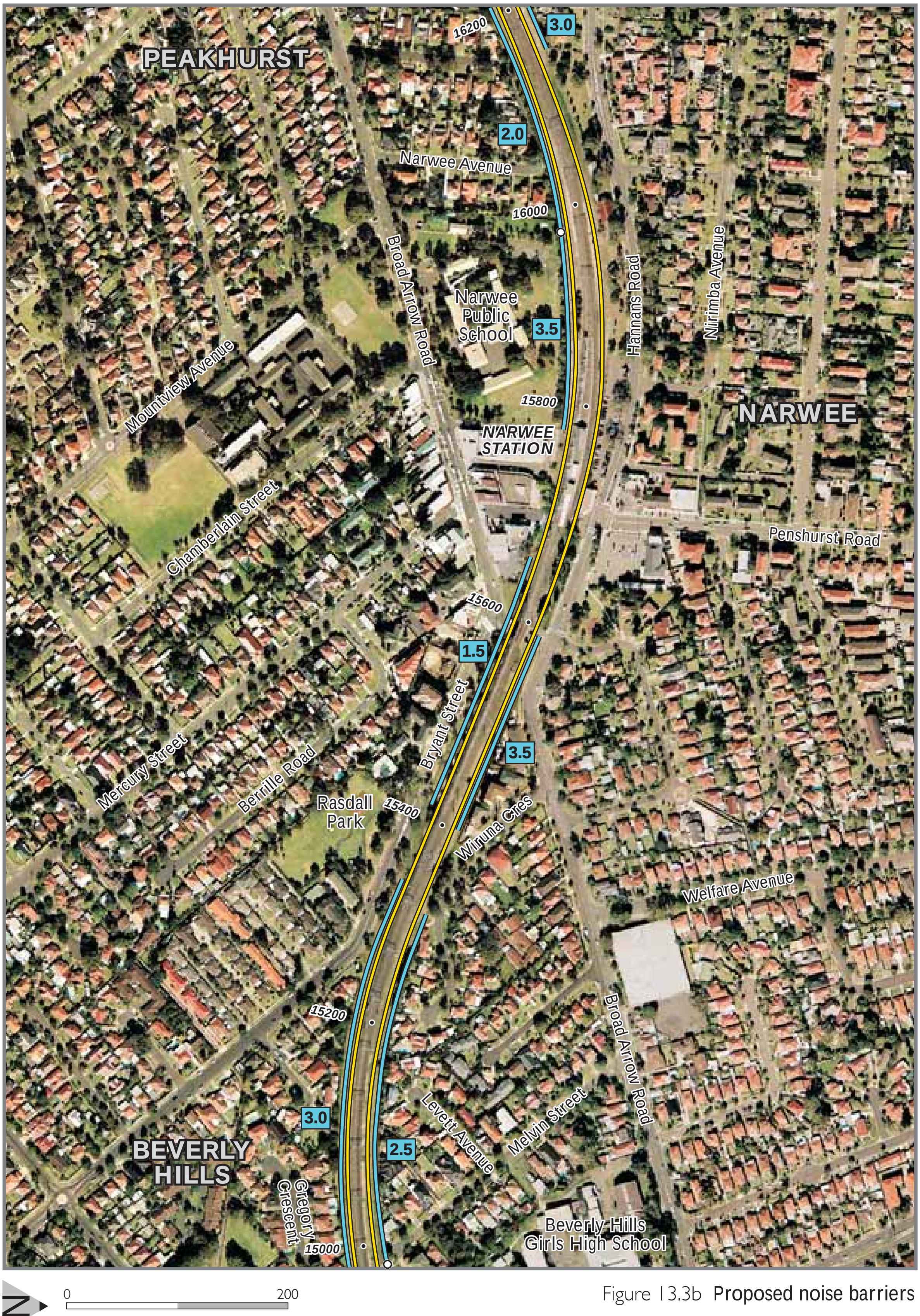


Figure 13.3b **Proposed noise barriers**

- Proposal work
- 2008 Revesby turnback work
- *19600* • Metres from Central Station
- Existing noise barrier
- Noise barrier
- **2.5** Noise barrier height (metres)
- Change in noise barrier height

Indicative and subject to detailed design

Figure 13.3c **Proposed noise barriers**

Proposal work
2008 Revesby turnback work
19600 • Metres from Central Station
Indicative and subject to detailed design

Existing noise barrier
Noise barrier
2.5 Noise barrier height (metres)
Change in noise barrier height

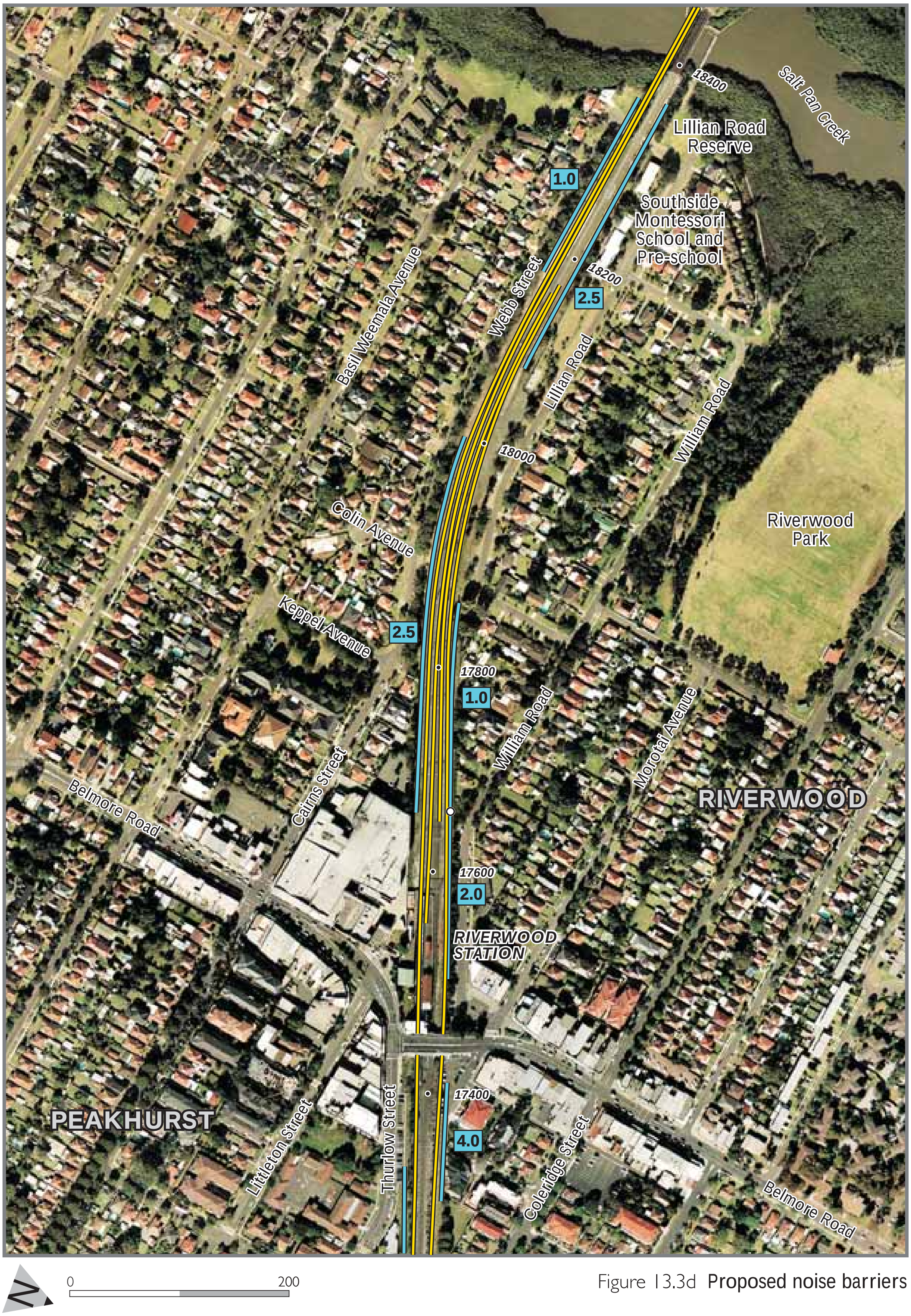


Figure 13.3d **Proposed noise barriers**

Figure 13.3e **Proposed noise barriers**

Proposal work
2008 Revesby turnback work
19600 • Metres from Central Station
Existing noise barrier
Noise barrier
2.5 Noise barrier height (metres)
Change in noise barrier height

Indicative and subject to detailed design

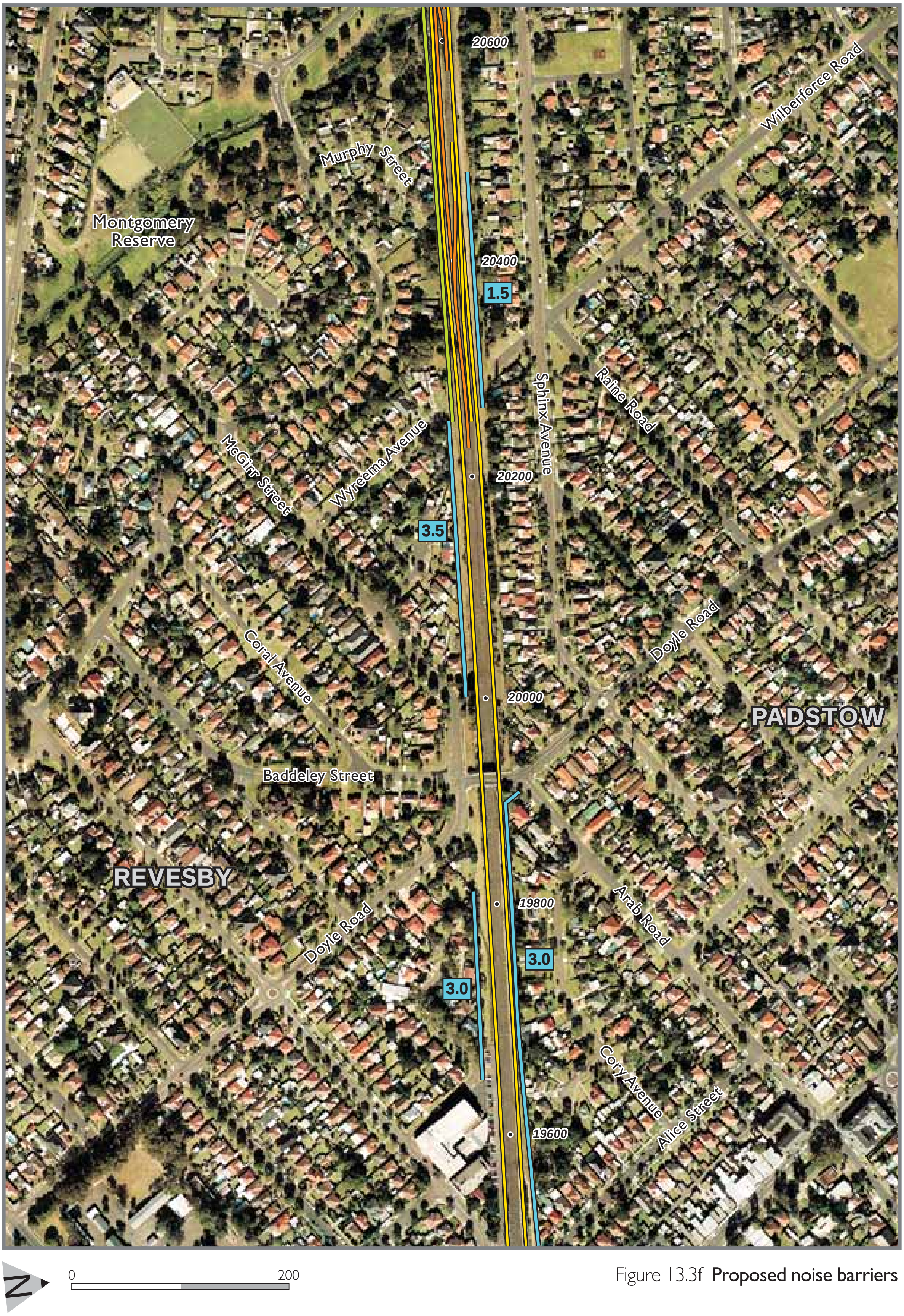


Figure 13.3f **Proposed noise barriers**

Proposal work

2008 Revesby turnback work

19600 • Metres from Central Station

Existing noise barrier

Noise barrier

2.5 Noise barrier height (metres)

Change in noise barrier height

Indicative and subject to detailed design

Figure 13.3g **Proposed noise barriers**

A further five locations are school or community centre buildings which are predicted to exceed the overall trigger level of LAeq(1hour) of 45dBA internally, on the basis of naturally ventilated conditions (windows open).

Building treatments in the form of alternative ventilation would be considered at the remaining 51 locations to allow residents to close their windows if desired to maintain a satisfactory internal noise environment.

Receiver controls

These measures generally involve the inclusion of specific acoustical treatments to buildings and individual dwellings to reduce internal noise levels. Such treatments involve higher performance windows, doors and seals. Building treatments require occupants to keep their windows and doors closed and hence alternative ventilation is usually required to maintain adequate air flow. An obvious disadvantage is that building treatments would not have any effect on the noise levels outside the dwelling, within front or back yards. Building treatments are generally more costly than other measures and are applied as a last resort after all other options have been exhausted.

Table 13.11 provides a summary of the typical noise reductions from passenger train sources achieved with open, single and double-glazed windows in light-framed and masonry buildings.

Table 13.11 Indicative building noise reduction

Building Type	Windows	Internal Noise Reduction (dBA)
All	Open	10
Light Frame	Single glazed (closed)	20
Masonry	Single glazed (closed)	25
Masonry	Double glazed (closed)	30

Subject to development of the detailed design, building treatments in the form of alternative ventilation would be considered at 75 locations to allow residents to close their windows if desired, in order to maintain a satisfactory internal noise environment. Details of specific development approval requirements for the dwellings identified as requiring building treatment would be investigated as part of the detailed design and the number of locations requiring building treatments therefore cannot be finalised until this additional information is obtained and extensive community consultation undertaken. Location specific noise measurements may also be undertaken at affected receivers prior to confirming offers of building treatment. An additional 25 locations where schools and other noise-sensitive non-residential buildings would need to be considered for building treatment to allow the windows to be closed in order to maintain a satisfactory internal noise environment.

Mitigation Measures

The requirements for noise barriers may vary as the detailed design develops. Further modelling would be carried out to consider in more detail the effects of shielding provided by railway cuttings and other features. Consideration needs to be given to balancing urban design and community impacts of the higher noise barriers, particularly where they are on embankments, with the project aim of minimising noise impacts. Extensive community consultation would be required before the barrier locations and other noise management measures can be confirmed.

The following mitigation measures would be required to minimise operational noise impacts of the Proposal. These may be amended where detailed design and further noise modelling changes the requirement for noise mitigation.

- All new bridges would be designed to incorporate reasonable measures to mitigate noise, including a preference for ballasted concrete bridges or ballasted composite bridges at all locations where such bridges are feasible.
- Construction of noise barriers at 32 sub-catchment locations, varying in height from 1.5 metres to 4.0 metres. Consultation on the colour and finish (material and surface pattern) of the noise barriers together with associated landscaping would be undertaken throughout the detailed design and construction stages of the Project with residents and stakeholders located adjacent to the rail corridor.
- Building treatments in the form of sealed glazing and forced ventilation systems would be considered at 75 locations. This number could be reduced by increasing the extent of barriers and raising their height in some locations.
- There are an additional 25 locations including schools and other noise-sensitive non-residential buildings, where building treatment would be considered.
- Implementation of the RailCorp *Whole of Network Strategy*, which is aimed at reducing train noise on the metropolitan rail network over time.
- Modelling assumes that by 2021, older rolling stock will be retired, resulting in 75 percent of the electric passenger fleet comprising either Tangara or Millennium trains, which would be approximately 2dBA to 3dBA quieter than the older double-deck suburban trains. A decrease in noise levels over time could also be expected as older rolling stock is retired.

The location and scale of proposed noise barriers at three locations along the rail corridor are shown on **Figure 13.4.**

13.3.4 Management of operational vibration

Operational vibration from the Proposal is only predicted to exceed the vibration trigger levels at two locations and as such the following mitigation measures would be required.

- At two locations (between chainages 14.04 kilometres and 14.10 kilometres on the Up side and chainages 14.94 kilometres and 15.00 kilometres on the Down side of the track), resilient ballast mat is proposed to a length of 60 metres at each location for both the Up and Down Main track in order to mitigate future vibration levels.

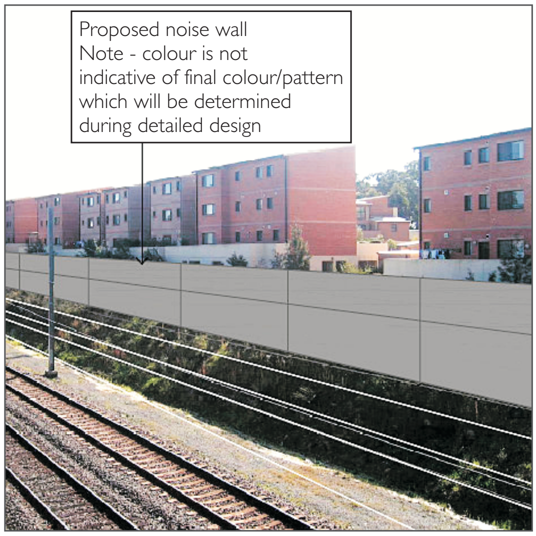
Existing view at Huntingdale Road

Proposed noise wall at Huntingdale Road

Existing view at Lillian Road

Proposed noise wall at Lillian Road

Existing view at Davies Road



Proposed noise wall at Davies Road

Figure 13.4 **Scale and location of noise barriers at three locations**