- Further consultation with the GCC and RailCorp would be undertaken to determine the future plans for the Schofields village centre and the plans for rehabilitation of the existing station site.
- Further discussion with the MoT would be undertaken regarding the provision of a bus service between the existing and new Schofield stations (refer Section 8.2).

While not part of the Project, the rehabilitation of the Schofields village is part of the GCC plans for revitalisation of the Schofields village centre. Plans for the village centre have not yet been released; however, it is likely that these plans would focus on the following outcomes:

- encouraging further commercial development within the village centre to complement and support the existing small businesses
- encouraging the revitalisation of Schofields as a village centre to differentiate it from the new Schofields town centre (at the new station location)
- retaining the existing community feel within Schofields village by promoting development that is consistent with a village community.

8.4 Noise and vibration

This section summarises the potential noise and vibration impacts of the Project based on the findings of Technical Paper 2 — *Noise and Vibration Assessment* (Volume 2). The existing noise environment in the Project area is described in Section 3.4.

8.4.1 Assessment approach

Airborne construction noise

Unattended background noise monitoring was undertaken during February and March 2007 at nine locations in the vicinity of the proposed construction works between Quakers Hill and Vineyard (refer Figure 3-17). Results of the unattended noise monitoring are described in Section 3.4.2.

Construction noise modelling scenarios were developed for the Project construction phases considered to have the highest potential for noise impacts (refer Section 9.7 of Technical Paper 2). Predicted noise levels were calculated for both 'typical' and 'worst case' construction activities, assuming plant would be operating in the area closest to the respective receivers.

The main noise metrics used to describe construction noise emissions in the modelling and assessments are:

- $L_{A1(60\ second)}$ — the typical maximum noise level for an event, used in the assessment of potential sleep disturbance during night-time periods
- $L_{A10(15\ minute)}$ — the average maximum noise level during construction activities, used to assess the construction noise impacts

- L_{A90} — the background noise level in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods, $L_{A10(15\ minute)}$ construction noise goals are based on the L_{A90} background noise levels
- A-weighted sound measured in decibels (dBA) — A-weighted noise measurements are those that have been scaled to account for the differential response of the human ear to different sound frequencies (i.e. noises with frequencies within the human ear's most sensitive range are scaled to be louder than noises with frequencies outside of this range).

Airborne construction noise trigger levels

Construction noise impacts were assessed in accordance with the *Environmental Noise Control Manual* (ENCM, Environment Protection Authority 1994). The ENCM provides guidelines for assessing noise generated during construction works. Noise level restrictions applicable to construction are based on the duration of construction works as follows:

- For a construction period of up to 4 weeks duration, the L_{A10} noise level, when measured over a period of not less than 15 minutes, should not exceed the L_{A90} background noise level by more than 20 dBA.
- For a construction period of between 4 and 26 weeks, the L_{A10} noise level should not exceed the L_{A90} background noise level by more than 10 dBA.
- For a construction period of greater than 26 weeks, the L_{A10} noise level should not exceed the L_{A90} background noise level by more than 5 dBA.

As the overall duration of the proposed construction program for the Project is greater than 26 weeks, the L_{A90} background + 5 dBA noise goal is applicable to residential and other noise sensitive receivers (e.g. schools, hospitals, nursing homes) along the rail corridor. The $L_{A10(15\ minute)}$ construction noise goal is based on the local L_{A90} background noise level during the relevant time period (daytime, evening or night-time). For retail and commercial buildings, it is generally accepted that receivers are 5–10 dBA less sensitive to noise emissions than residential receivers. For these receivers, an L_{A10} noise objective of L_{A90} background + 10 dBA was conservatively applied. The noise objectives for each of the nearby receiver groups along the rail corridor are detailed in Table 8-10.

Table 8-10 Summary of L_{A10} noise objectives for nearby receiver groups

Work area	Work area location and chainage	Nearest receiver locations	L_{A10} construction noise objective (dBA)[1] RBL + 5 dBA		
			Daytime	Evening	Night-time
Stage 1					
1	Quakers Hill Station (40.2 kilometres)	Quakers Hill Preschool	50	n/a[2]	n/a[2]
		Quakers Hill Child Care Centre			
		The Quakers Inn (Commercial)	55	55	47
2	Manorhouse Boulevard (40.9 kilometres)	25 Manorhouse Boulevard	38	41	37
		27D Manorhouse Boulevard			
		33 Manorhouse Boulevard			

Work area	Work area location and chainage	Nearest receiver locations	L_{A10} construction noise objective (dBA)[1] RBL + 5 dBA		
			Daytime	Evening	Night-time
3	Manorhouse Boulevard (41.1 kilometres)	47 Manorhouse Boulevard	38	41	37
		55 Manorhouse Boulevard			
		63 Manorhouse Boulevard			
4	New Schofields Station (42.9 kilometres)	217 Railway Terrace	41	41	38
		209 Railway Terrace			
		159 Railway Terrace			
5	Existing Schofields Station (43.8 kilometres)	123 Railway Terrace	49	45	43
		82 Bridge Street			
		93 Bridge Street			
Stage 2					
6	Westminster Street overbridge (44.25 kilometres)	2A + 2B Westminster Street	41	41	38
		21 Railway Terrace			
		44 Bridge Street			
7	Riverstone Station (45.96 kilometres)	1 Richards Avenue	46	42	36
		4 West Parade			
		17 Richards Avenue			
8	Riverstone Meatworks (46.5 kilometres)	2 Bourke Street	43	39	35
		80 Riverstone Parade			
		76 Riverstone Parade			
9	New Vineyard Station (48.86 kilometres)	6 Ashford Road	45	39	35
		21 Norwood Road			
		22 Ashford Road			
10	Existing Vineyard Station (49.23 kilometres)	8 Dulwich Road	45	39	35
		12 Dulwich Road			
		2 St James Road			

Notes: 1: The L_{A10} construction noise goals are applicable at the nearest and/or most affected residential receiver, or other noise sensitive receiver location.

2: L_{A10} construction noise objectives for the evening and night-time periods are not applicable for the Quakers Hill Preschool and Child Care Centre as these facilities are not in operation during these periods.

Ground-borne construction noise

Ground-borne or regenerated noise in buildings is caused by the transmission of ground-borne vibration rather than the direct transmission of noise through air. Vibration may be generated by construction equipment (such as rock-breakers) and transmitted through the ground into the adjacent building structures. After entering a building, this vibration causes the walls and floors to faintly vibrate, and hence, to radiate noise.

TIDC's *Construction Noise Strategy (Rail Projects)* (TIDC 2007) provides an acceptable target objective during the night-time period of $L_{Aeq(15minute)}$ 35 dBA in residences with a maximum permissible level of 40 dBA applicable, providing that the proponent or contractor is able to demonstrate that best available technology and best management practices are being employed to minimise emission levels.

Construction vibration

The standards normally used as a basis for assessing the risk of vibration damage to structures are:

- German Standard DIN 4150 *Part 3* (1999) — *Structural Vibration – Effects of Vibration on structures*
- British Standard BS 7385 *Part 2* (1993) — *Evaluation and measurement for vibration in buildings, guide to damage groundborne vibration*.

The 'safe limits' for short-term building vibration are summarised in Section 11.2 of Technical Paper 2. Safe limits are those up to which no damage due to vibration effects would be observed for a particular class of building.

Human comfort is normally assessed with reference to *Assessing Vibration: a technical guideline* (DEC 2006), 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 (human comfort) at residential or commercial receivers is a V_{rms} (root mean squared vibration velocity) of 0.4 millimetres per second (mm/s).

Indicative safe working distances for typical items of vibration intensive plant are listed in Table 45 of Technical Paper 2. The safe working distances apply to structural damage of typical buildings and with typical geotechnical conditions. They do not address heritage structures. Vibration monitoring would be undertaken prior to construction to confirm safe working distances at specific vibration sensitive sites.

Operational rail noise

Noise emissions from suburban electric passenger trains were modelled for the Project under the following three scenarios:

- Existing situation (year 2007) — incorporating existing ground terrain, buildings, passenger rail traffic and tracks.
- After opening situation (year 2013) — incorporating future ground terrain following the construction of the Project and passenger train movements on the new track.
  The number of train movements for this scenario is expected to increase during the morning (AM)/afternoon (PM) peaks, while remaining services are expected to be the same as the existing situation (year 2007).
- Long-term situation (year 2023) — incorporating the proposed future rail traffic on the new tracks (i.e. four trains per hour in both directions, and up to eight trains per hour in both directions during the AM and PM peaks) at an indicative period into the future.

As described in Chapter 6, the Project would be constructed in two stages:

- Stage 1 — Project works between Quakers Hill and new Schofields Station
- Stage 2 — Project works between new Schofields Station and Vineyard.

While the timing of Stage 2 has yet to be determined, the noise assessment has assumed that Stages 1 and 2 would be commissioned by 2013 (i.e. the 'after opening' noise modelling scenario). This assumption represents a conservative estimate of the earliest time that the second stage would be constructed and commissioned.

The primary noise metrics that were used to describe the predicted rail noise in the modelling and assessment for the Project included:

- L_{Amax} — the maximum noise level not exceeded for 95% of train pass-by events
- $L_{Aeq(15\ hour)}$ — the daytime equivalent continuous noise level, which represents the cumulative effects of all the train noise events occurring in the daytime period between 7 am and 10 pm
- $L_{Aeq(9\ hour)}$ — the night-time equivalent continuous noise level, which represents the cumulative effects of all the train noise events occurring during the night-time period between 10 pm and 7 am.

The operational noise modelling used for the assessment was validated against attenuated noise monitoring undertaken at nine locations adjacent to the Richmond Branch Line between Quakers Hill and Vineyard (refer Figure 3-17 and Section 3.4.2).

Operational rail noise trigger levels

For airborne noise created by the operation of surface track, the NSW Government's *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects 2007* (IGANRIP) provides trigger levels for the redevelopment on an existing railway line (refer Tables 8 and 9 of Technical Paper 2). The daytime noise trigger levels for residential receivers that apply to the Project are:

- L_{Amax} 85 dBA with an increase of 3 dBA or more in L_{Amax}
- $L_{Aeq(15\ hour)}$ 65 dBA with an increase of 2 dBA or more in $L_{Aeq(15\ hour)}$
- $L_{Aeq(9\ hour)}$ 60 dBA with an increase of 2 dBA or more in $L_{Aeq(9\ hour)}$.

The noise trigger levels for non-residential sensitive receivers that apply to the Project are based on the $L_{Aeq(1\ hour)}$ internal noise levels. Internal noise levels relate to the noise level at the centre of the habitable room (with windows open to provide adequate ventilation) that is most exposed to the noise source. The noise trigger levels for non-residential sensitive receivers that apply to the Project are:

- Schools/educational institutions – $L_{Aeq(1\ hour)}$ 45 dBA with an increase of 2 dBA or more in $L_{Aeq(1\ hour)}$
- External playground areas for educational receivers – $L_{Aeq(15\ hour)}$ 65 dBA with an increase of 2 dBA or more in $L_{Aeq(15\ hour)}$.

Operational road traffic noise

The existing and future road traffic volumes in the vicinity of each new bus interchange and commuter car park were calculated for the busiest 1 hour period ($L_{Aeq(1\ hour)}$) during the daytime and night-time periods (refer Section 8.3 of Technical Paper 2). The L_{Aeq} calculation method was based on the increase in road traffic as a result of the Project.

Noise from the bus, kiss-and-ride and taxi rank operations at the proposed interchange was predicted at the potentially worst-affected receiver locations. Representative L_{Amax} noise levels of 84 dBA and 74 dBA within 7 metres of the noise source were used for these calculations for buses and cars respectively. These noise levels were based on measurement data for bus and light vehicle operations. The assumed number of vehicle movements used for these calculations are provided in Table 33 of Technical Paper 2.

Operational road traffic criteria

The *Environmental Criteria for Road Traffic Noise* (ECRTN; EPA 1999) presents criteria that would apply to noise from all bus movements and other road traffic associated with the Project; however, it is noted that these noise criteria are guidelines only, and as such, are not mandatory. The ECRTN criteria are presented in tables 31 and 32 of Technical Paper 2. Table 8-11 summarises the noise criteria levels that would be applicable to the Project.

Table 8-11 Road criteria levels applicable to the Project

Road type	$L_{Aeq(1\ hour)}$ noise criteria (dBA)	
	Daytime	Night-time
Collector road	60	55
Local road	55	50

Ground-borne noise from rail operations

The operational ground-borne noise trigger levels used for the assessment are based on the Department of Environment and Climate Change's (DECC) (2007e) IGANRIP. A summary of the IGANRIP trigger levels used for the assessment of potential ground-borne noise impact of the Project is provided in Table 8-12.

Table 8-12 Ground-borne (internal) noise trigger levels

Receiver	Time of day	Noise trigger levels (dBA)[1]
Development increases existing rail noise levels by 3 dBA or more AND the resulting rail noise levels exceed:		
Residential	Daytime (7 am-10 pm)	40 L_{Amax} (slow)
	Night-time (10 pm-7 am)	35 L_{Amax} (slow)
Schools, Educational Institutions, Places of Worship	When in use	40-45 L_{Amax} (slow)

Note 1: The trigger levels are relevant only where ground-borne noise levels are audible, and of a higher level than airborne noise levels from rail operations.

The ground-borne noise trigger levels listed in Table 8-12 are only considered to be exceeded if all of the following conditions are met:

- *Overall noise trigger level* — Ground-borne noise levels at residential receiver locations are required to exceed an overall trigger as shown in Table 8-12. Other noise sensitive receivers are required to exceed an overall trigger level of 40 dBA to 45 dBA when in use.
- *Noise level increase* — The $L_{Amax(internal,\ slow\ response)}$ ground-borne noise level is required to increase by 3 dBA or more as a result of the Project.
- *Audibility* — For surface track, the internal ground-borne noise levels should be audible and be higher in level than the internal airborne noise from rail operations.

Operational vibration

The operational vibration trigger levels used for the assessment are based on the vibration dose values for human comfort nominated in BS 6472, and *Assessing Vibration: a technical guideline* (DEC 2006). For both the 2013 (after opening) and 2023 (long-term) scenarios, this equates to a pass-by level of 113 dB reference level (re) 10^{-9} metres per second (m/s).

The vibration guideline indicates that the threshold of perception for most people is a Vrms of approximately 0.14 mm/s (or 103 dB). Any exceedance of this threshold could result in an adverse impact on sensitive receivers. Therefore, based on the modelling, any such exceedance expected has been included in the vibration assessment (refer Appendix F of Technical Paper 2).

For intermittent vibration at residential receiver locations, vibration trigger levels are expressed in terms of the vibration dose value (VDV) during the daytime (7 am to 10 pm) and night-time (10 pm to 7 am) periods. The VDV is a measure that takes into account the overall magnitude of the vibration levels during a train pass-by, as well as the total number of train pass-bys during the daytime and night-time periods.

The vibration trigger levels that have been applied to the Project are summarised in Table 8-13.

Table 8-13 Trigger levels for intermitted vibration applicable to the Project

Receiver type	Vibration Dose Value ($m/s^{1.75}$)[1]	
	Daytime[2]	Night-time[2]
Residential properties	0.2	0.13
Offices, schools, educational institutions and places of worship	0.4	0.4

Notes: 1: VDVs are based on the 'preferred' values in the DEC (2006) guideline *Assessing vibration: a technical guideline.*

2: Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am.

8.4.2 Airborne construction noise impacts

Bridge and station construction

Indicative construction noise levels at representative sensitive receivers in the vicinity of bridge and station work sites are summarised in Table 8-14. As discussed in Section 8.4.1, these works are considered to have the highest potential for construction noise impacts (refer Section 9.7 of Technical Paper 2).

At all sensitive receiver locations, the predicted L_{A10} noise levels would exceed the construction noise goals, some by as much as 40 dBA (Manorhouse Boulevard). The exceedance of noise goals would primarily be due to the small offset between construction sites and residential/commercial receivers. The greatest noise impacts are predicted to occur during piling works. This is due to the operation of noisier items, such as the rock breaker and vibratory piling rig.

The predicted exceedance of noise trigger levels during bridge and station construction works does not necessarily indicate that the works should not proceed. Rather, the findings of the noise assessment highlight the importance of managing the works to limit both the noise levels and the duration of predicted exceedances. Measures proposed to manage the noise impacts during bridge and station construction are described in Section 8.4.9.

Table 8-14 Predicted L_{A10} construction noise levels – piling, bridge and station works

Construction site	Typical sensitive receiver location	Distance from site (m)	L_{A10} daytime[1] construction noise goal (dBA)	Predicted L_{A10} daytime construction noise levels (dBA)
Stage 1				
Quakers Hill Station (pedestrian footbridge construction)	Quakers Hill Preschool	37	50	66 - 80
	Quakers Hill Child Care Centre	80		61 - 74
	The Quakers Inn (Commercial)	115		57 - 70
Quakers Hill Station (removal of level crossing)	Quakers Hill Preschool	37	50	67-80
	Quakers Hill Child Care Centre	80		61-74
	The Quakers Inn (Commercial)	115		58-70
Manorhouse Boulevard (culvert replacement)	25 Manorhouse Boulevard	50	38	70-76
	27D Manorhouse Boulevard	20		83-88
	33 Manorhouse Boulevard	60		65-72
Manorhouse Boulevard (retaining wall construction)	47 Manorhouse Boulevard	35	38	67-72
	55 Manorhouse Boulevard	10		83-85
	63 Manorhouse Boulevard	40		74-75
New Schofields Station (platform construction)	217 Railway Terrace	80	41	65-71
	209 Railway Terrace	70		60-67
	159 Bridge Street	210		43–47
Existing Schofields Station (demolition)	123 Railway Terrace	50	49	65-75
	82 Bridge Street	30		70-76
	93 Bridge Street	10		81-84
Stage 2				
Riverstone Station (overbridge platform construction)	1 Richards Avenue	20	46	70-75
	4 West Parade	70		64-70
	17 Richards Avenue	25		55-57
Riverstone Meatworks (removal of level crossing)	2 Bourke Street	100	43	61-69
	80 Riverstone Parade	25		68-78
	76 Riverstone Parade	50		65-74
New Vineyard Station (platform construction)	6 Ashford Road	90	45	58-67
	21 Norwood Road	160		51–55
	22 Ashford Road	190		49-52

Construction site	Typical sensitive receiver location	Distance from site (m)	L_{A10} daytime[1] construction noise goal (dBA)	Predicted L_{A10} daytime construction noise levels (dBA)
Existing Vineyard Station (demolition)	8 Dulwich Road	110	45	55-62
	12 Dulwich Road	130		53-58
	2 St James Road	120		45-53

Note: 1: Daytime construction noise goals are presented in this table as most works will occur during this time period. Night-time noise goals are typically 10 dBA lower.

Corridor earthworks and track works

Noise emissions from the proposed track works, including earthworks, overhead wiring, signalling and track-laying, would move progressively along the rail corridor in stages, such that most residential receivers would not be exposed to high levels of construction noise for periods longer than approximately one month at a time. As such, the L_{A90} background + 5 dBA criterion that applies to construction projects of greater than 26 weeks may be overly conservative for many locations of the Project. Notwithstanding this, construction traffic may continue to pass individual receivers for a longer duration, depending on the locations of vehicle access points.

Table 8-15 summarises the predicted noise levels during corridor earthworks and track works.

For short periods of time, criterion exceedances of over 20 dBA, and up to 40 dBA, are likely at the nearest receivers, with track-laying likely to cause the greatest exceedances. Noise levels during other activities are predicted to be 5–10 dBA lower; however, they may occur over a longer period of time than the track works. In all cases, the noise levels during corridor earthworks and track works would not be sustained. Lower noise levels would occur when the plant is located away from receivers or operating on less noise-intensive tasks.

Measures proposed to manage the noise impacts during corridor earthworks and track works are described in Section 8.4.9.

Table 8-15 Noise levels during corridor earthworks and track construction

Offset distance to receiver (m)	L_{A10} track construction noise level (dBA)		
	Earthworks[1] (excavation and compaction)	Overhead wiring, signals and cable duct installation	Track installation
10	82	80	90
20	79	77	84
30	76	74	81
40	74	72	79
100	66	64	73

Note: 1: Rock breakers would generally not be required for excavation works, as the cuttings are predominantly in clay and shale. If required, noise from a rock breaker would be 10–15 dBA higher than predicted for earthworks (although this may be reduced by shielding if the works are undertaken at the base of a cutting).

Construction traffic noise

The community may associate truck movements on local roads immediately adjacent to construction sites with the construction works for the Project. Once the trucks move onto collector and arterial roads, truck noise is likely to be perceived as part of the general road traffic. On this basis, construction traffic impacts have been assessed on close proximity to the Project. Noise from idling trucks near construction sites could also affect the amenity of the area.

Access to work areas would be provided via the existing vehicle gates along the rail corridor. Some additional access gates may be added where streets or reserves adjoin the rail corridor or where some existing gates could be relocated.

The maximum (L_{Amax}) noise emission from a typical truck in good condition and high engine load is in the order of 83 dBA at receivers within 7 metres of the noise source; however, the $L_{A10(15\ minute)}$ (average maximum noise levels) would be lower than this. Depending on the number of trucks operating on site, their position and general intensity of movements, the $L_{A10(15\ minute)}$ noise levels would be at least approximately 5 dBA lower than the L_{Amax}.

Table 8-16 summarises the predicted off-site truck noise during the construction of the Project. Predicted noise levels for off-site construction traffic fall within the levels set out in the ECRTN (EPA 1999), which range between 55 and 60 dBA.

Predictions indicate that off-site truck noise levels would comply with the relevant road traffic noise criteria at offset distances greater than 20 metres. While individual truck noise events would be clearly perceptible, the L_{Aeq} assessment indicates that they would not have a major impact on the acoustic amenity of the area.

Table 8-16 Predicted off-site truck noise

Distance (m)	$L_{Aeq(1\ hour)}$ sound pressure level (dBA)			
	Daytime		Night-time	
	Predicted	Criteria	Predicted	Criteria
10	**57**	55	**51**	50
20	54	55	48	50
30	52	55	46	50
40	50	55	44	50
50	49	55	43	50

Notes: 1: DECC's *Environmental Criteria for Road Traffic Noise 1999*. Exceedances are shown in bold.

2: Assumed two trucks per hour for the night-time scenario and eight trucks per hour for the daytime scenario.

Increase in road traffic noise due to traffic diversions during construction

Traffic diversions during construction would result in a localised increase in noise levels; however, these increases are likely to be small. An 80% increase in local traffic volume corresponds to a noise increase of approximately 2.5 dBA for a given receiver, assuming other factors such as speed and percentage of heavy vehicles remains unchanged. As such, noise impacts associated with the traffic diversions are not likely to be significant.

The ECRTN recommends that developments creating additional traffic on existing roads should be designed in such a way as to not increase the existing road noise by more than 2 dBA. This objective would be considered further during the development of traffic management plans for the Project (refer Section 8.2).

8.4.3 Ground-borne construction noise

The major source of ground-borne noise during the construction phase of the Project would result from excavation using rock breakers and soil compaction using vibratory rollers. Typical regenerated noise levels within a building from heavy, medium and light rock breakers, operating in hard sandstone, are presented in Table 8-17. The levels in Table 8-17 have conservatively been used to predict the $L_{Aeq(15minute)}$ regenerated (ground floor) noise levels.

Table 8-17 Regenerated noise levels versus distance

Distance (m)	L_{Amax} regenerated noise level (dBA)		
	Heavy rock breaker (1,600 kg)	Medium rock breaker (900 kg)	Light rock breaker (300 kg)
10	75	72	69
20	62	59	56
30	55	52	49
40	50	47	44
50	45	42	39
65	40	37	34
85	35	32	29
110	30	27	24

Note: These ground-borne noise levels (inside buildings) are indicative only. Actual levels are dependent on factors such as geotechnical conditions, building construction, machinery intensity and other factors.

The nearest receivers to any site activity are generally no closer than 10–20 metres. At these locations, the predicted regenerated noise levels are expected to be approximately 56-69 dBA (for a light 300 kilogram rock breaker) and 62–75 dBA (for a heavy 1,600 kilogram rock breaker). This represents a potential exceedance of up to 35 dBA of the 40 dBA $L_{Aeq(15minute)}$ regenerated noise criterion.

8.4.4 Construction vibration impacts

It is reasonable to assume that construction activities would be managed so as to avoid structural damage due to vibration. In order to achieve this, the recommended safe working distances provided in Table 45 of Technical Paper 2 would be observed. If work within these zones is necessary, vibration monitoring would be undertaken to confirm these safe working distances. This monitoring would be particularly required for vibration-intensive activities adjacent to the heritage-listed Riverstone Station and Yard Group (refer Section 3.5).

The potential vibration impact during construction would primarily be in relation to human response. Several plant items have the potential to result in adverse human responses at receivers close to construction sites (the closest of which would be typically 10–15 metres from these activities). Ground vibration levels for vibratory sheet piling are likely to comply with the human comfort criteria at distances exceeding 20 metres from a building; however, vibratory piles could be used at closer distances where suitable ground conditions exist and should be assessed on a case-by-case basis.

Construction vibration levels at residential receivers are predicted to comply with building damage criteria but may be perceptible during vibratory rolling. Vibration monitoring would be required to establish appropriate buffer distances, particularly in relation to heritage structures (refer Section 3.5).

8.4.5 Operational rail noise impacts

The following provides a summary of the operational rail noise predicted during the existing, after opening and long-term situations (years 2007, 2013 and 2023, respectively).

Existing situation (Year 2007)

The predicted L_{Amax}, $L_{Aeq(15\ hour)}$ daytime and $L_{Aeq(9\ hour)}$ night-time noise levels for the existing situation (Year 2007) are presented in the form of noise contour plots in Appendix G of Technical Paper 2. A summary of the predicted exceedances of the IGANRIP trigger levels (overall component only) for the existing situation (Year 2007) is provided in Table 8-18.

Table 8-18 Summary of IGANRIP trigger level exceedances – Year 2007

Noise level descriptor	Exceedance zone (Chainage – km)	Side of track	Predicted Noise Level (dBA)[1]	Overall noise trigger level (dBA)	Number of exceedances within zone
$L_{Aeq(15\ hour)}$	Manorhouse Boulevard (40.940 km – 41.310 km)	Up[2]	61	65	0
	Reycroft Avenue (41.670 km – 41.760 km)	Up[2]	60		0
	Bridge Street (43.530 km – 43.720 km)	Down[3]	54		0
$L_{Aeq(9\ hour)}$	Manorhouse Boulevard (40.940 km – 41.310 km)	Up[2]	58	60	0
	Reycroft Avenue (41.670 km – 41.760 km)	Up[2]	57		0
	Bridge Street (43.530 km – 43.720 km)	Down[3]	51		0
L_{Amax}	Manorhouse Boulevard (40.940 km – 41.310 km)	Up[2]	89	85	32
	Reycroft Avenue (41.670 km – 41.760 km)	Up[2]	88		4
	Bridge Street (43.530 km – 43.720 km)	Down[3]	80		0

Note 1: The predicted noise levels are representative of the highest levels within the exceedance zone.

Note 2: Up refers to the track on which trains travel in a direction towards Sydney (i.e. the eastern side of the rail corridor)

Note 3: Down refers to the track on which trains travel in a direction away from Sydney (i.e. the western side of the rail corridor)

For the existing situation, the predicted L_{Amax}, $L_{Aeq(15\ hour)}$ and $L_{Aeq(9\ hour)}$ noise levels from electric passenger trains generally comply with the L_{Amax} 85 dBA, $L_{Aeq(15\ hour)}$ 65 dBA and $L_{Aeq(9\ hour)}$ 60 dBA noise trigger levels at all residential receivers, with the exception of receivers that face directly onto the rail corridor along Manorhouse Boulevard and Reycroft Avenue in Quakers Hill, where the overall L_{Amax} trigger level is exceeded by up to 4 dBA.

After opening situation (2013)

The future environment surrounding the rail corridor will be extensively modified by the development associated with the NWGC (refer Section 3.1.3). The 16 precincts of the NWGC are at various planning stages so it is difficult to determine the exact nature and distribution of future land uses; however, it is estimated that a total of approximately 70,000 new homes will be provided, along with new infrastructure, town centres and areas of commercial development. Section 3.1.3 provides further detail of the likely development around the rail corridor.

As the exact location of future residential areas and other sensitive receivers are as yet unknown, the impact of the Project for the after opening situation (2013) has been assessed based on the existing environment and proposed rail traffic on the new tracks (i.e. increase in train services in the AM and PM peaks, with the remaining services the same as the existing situation (year 2007)).

Trigger level exceedances have been predicted at two existing residential locations within the Project area (Manorhouse Boulevard and Bridge Street/Tain Place; refer Table 8-29) for the long-term situation (Year 2023). The predicted L_{Aeq} and L_{Amax} noise levels at these locations for the after opening (Year 2013) situation are discussed below. Importantly, the modelling assumed that both Stage 1 and Stage 2 would be completed by 2013. As such, the modelling represents a worst-case scenario. These exceedances are discussed below.

Manorhouse Boulevard, Quakers Hill

Residential receivers are located between approximately 15 and 20 metres from the future Up track (i.e. the existing single line track). The new track would be constructed on the western (Down) side of the existing track at a nominal track centre of 6.4 metres (i.e. the new track would be located further away from the existing residential dwellings located on Manorhouse Boulevard than the existing track).

A summary of the predicted exceedances of the IGANRIP trigger levels for the after opening situation (Year 2013) is provided in Table 8-19.

Table 8-19 Summary of IGANRIP trigger level exceedances – Manorhouse Boulevard during Year 2013 (track chainage 40.940 km – 41.310 km)

Noise level descriptor	Predicted noise Level (dBA) (Year 2007)[1]	Overall noise trigger level (dBA)	Predicted noise level increase (dBA)	Noise level increase trigger (dBA)	Number of IGANRIP exceedances within zone
$L_{Aeq(15\ hour)}$	62 (61)	65	1	2 or more	0
$L_{Aeq(9\ hour)}$	58 (58)	60	0	2 or more	0
L_{Amax}	89 (89)	85	0	3 or more	0

Note 1: The predicted noise levels are representative of the highest levels within the exceedance zone.

The after opening $L_{Aeq(15\ hour)}$ and $L_{Aeq(9\ hour)}$ noise levels are predicted to increase by up to 1 dBA at the nearest receiver locations on Manorhouse Boulevard; they would comply with the noise trigger levels of $L_{Aeq(15\ hour)}$ and $L_{Aeq(9\ hour)}$ 65 dBA at all receivers.

The after opening L_{Amax} noise levels are predicted to exceed the overall trigger level of 85 dBA at all receivers that face directly onto the rail corridor along Manorhouse Boulevard (as is currently the case for the existing situation). However, the L_{Amax} noise levels are not predicted to increase by 3 dBA or more at this location as a result of the Project, as the new track would be located further away from the existing residences than the existing single track, and the existing train speeds on this section of the Richmond Branch Line are expected to remain unchanged.

For the Project to trigger an overall IGANRIP exceedance, the predicted noise levels must exceed either:

- 65 dBA with an increase of 2 dBA or more in $L_{Aeq(15\ hour)}$
- 60 dBA with an increase of 2 dBA or more in $L_{Aeq\ (9\ hour)}$
- 85 dBA with an increase of 3 dBA or more in L_{Amax}.

Therefore, noise levels for Manorhouse Boulevard receivers located adjacent to the rail corridor are predicted to comply with the overall IGANRIP noise trigger levels for the after opening situation in 2013. Since compliance is achieved for both the L_{Aeq} and L_{Amax} noise trigger levels, further consideration of noise mitigation measures is not required for the after opening situation (Year 2013).

Reycroft Avenue, Quakers Hill

Residential receivers are located between approximately 15 and 20 metres from the future Up track (i.e. the existing single track). The new track would be constructed on the western (Down) side of the existing track at a nominal track centre of 6.4 metres (i.e. the new track would be located further away from the existing residential dwellings located on Reycroft Avenue than the existing track).

A summary of the predicted exceedances of the IGANRIP trigger levels for the after opening situation (Year 2013) is provided in Table 8-20.

Table 8-20 Summary of IGANRIP trigger level exceedances – Reycroft Avenue during Year 2013 (track chainage 41.670 km – 41.760 km)

Noise level descriptor	Predicted noise Level (dBA) (Year 2007)[1]	Overall noise trigger level (dBA)	Predicted noise level increase (dBA)	Noise level increase trigger (dBA)	Number of IGANRIP exceedances within zone
$L_{Aeq(15\ hour)}$	61 (60)	65	1	2 or more	0
$L_{Aeq(9\ hour)}$	58 (57)	60	1	2 or more	0
L_{Amax}	88 (88)	85	0	3 or more	0

Note 1: The predicted noise levels are representative of the highest levels within the exceedance zone.

The after opening $L_{Aeq(15\ hour)}$ and $L_{Aeq(9\ hour)}$ noise levels are predicted to increase by up to 1 dBA at the nearest receiver locations on Reycroft Avenue, and would comply with the noise trigger levels of $L_{Aeq(15\ hour)}$ 65 dBA and $L_{Aeq(9\ hour)}$ 60 dBA at all receivers.

The after opening L_{Amax} noise levels are predicted to exceed the overall trigger level of 85 dBA at four receivers located directly adjacent to the rail corridor. However, the L_{Amax} noise levels are not predicted to increase by 3 dBA or more at this location as a result of the Project, as the new track would be located further away from the existing residents than the existing single track, and the existing train speeds on this section of the Richmond Branch Line are expected to remain unchanged.

As for the Manorhouse Boulevard receivers, the predicted noise levels for Reycroft Avenue receivers adjacent to the rail corridor do not trigger an overall IGANRIP exceedance for the after opening situation in 2013. As such, further consideration of noise mitigation measures is not required for the after opening situation (Year 2013).

Bridge Street and Tain Place, Schofields

Residential receivers are located between approximately 10 and 20 metres from the future Down track (i.e. the existing single track).The new track would be constructed on the eastern (Up) side of the existing track (refer Figure 6-1) at a nominal track centre of 4 metres (i.e. the new track would be located further away from the existing residential dwellings on Bridge Street and Tain Place than the existing track).

A summary of the predicted exceedances of the IGANRIP trigger levels for the after opening situation (Year 2013) is provided in Table 8-21.

Table 8-21 Summary of IGANRIP trigger level exceedances – Bridge Street/Tain Place during Year 2013 (track chainage 43.530 km – 43.720 km)

Noise level descriptor	Predicted noise Level (dBA) (Year 2007)[1]	Overall noise trigger level (dBA)	Predicted noise level increase (dBA)	Noise level increase trigger (dBA)	Number of IGANRIP exceedances within zone
$L_{Aeq(15\ hour)}$	59 (54)	65	5	2 or more	0
$L_{Aeq(9\ hour)}$	56 (51)	60	5	2 or more	0
L_{Amax}	87 (80)	85	7	3 or more	6

Note 1: The predicted noise levels are representative of the highest levels within the exceedance zone.

The after opening $L_{Aeq(15\ hour)}$ and $L_{Aeq(9\ hour)}$ noise levels are predicted to increase by up to 5 dBA at the nearest receiver locations on Bridge Street and Tain Place, and would comply with the noise trigger levels of $L_{Aeq(15\ hour)}$ 65 dBA and $L_{Aeq(9\ hour)}$ 60 dBA at all receivers.

The after opening L_{Amax} noise levels are predicted to exceed the overall trigger level of 85 dBA at six receivers located on Bridge Street and Tain Place, with noise levels expected to increase by 7 dBA at these receiver locations. This increase in the L_{Amax} noise levels is due to the increased track design speed along this section of track.

The predicted 7 dBA increase of the L_{Amax} noise level for the six receivers on Bridge Street and Tain Place exceeds the overall IGANRIP noise trigger level of a 3 dBA or more increase in L_{Amax}. As such, further assessment is warranted for the consideration of reasonable and feasible noise mitigation at this location.

Other noise sensitive receivers

Sensitive receivers included in the noise assessment are shown in Figure 3-17, and comprise:

- Quakers Hill Preschool, Quakers Hill
- Kerry Jones Child Care Centre, Quakers Hill
- Wyndham and Terra Sancta College, Quakers Hill
- Riverstone Childcare Centre
- Vineyard Early Learning Centre.

The after opening (Year 2013) noise levels are predicted to comply with the trigger level of $L_{Aeq(1\ hour\ internal)}$ 45 dBA at all sensitive receiver locations listed above.

The nearest potentially affected 'other noise sensitive receiver' is the Quakers Hill Pre-school, which is located on the coroner of Pearce and Lalor roads (refer Figure 3-1). A summary of the predicted noise levels at this location is provided in Table 8-22.

Table 8-22 Summary of IGANRIP trigger level exceedances – other sensitive receivers during Year 2013 (track chainage 40.200 km – 43.250 km)

Noise level descriptor	Predicted noise Level (dBA) (Year 2007)[1]	Overall noise trigger level (dBA)	Predicted noise level increase (dBA)	Noise level increase trigger (dBA)	Number of IGANRIP exceedances within zone
$L_{Aeq(1\ hour\ internal)}$	44 (42)	45	2	2 or more	0
$L_{Aeq(15\ hour)}$	52 (51)	65	1	2 or more	0

The noise levels during 2013 (after opening) at the Quakers Hill Pre-school are predicted increase by approximately 2 dBA. The noise levels at the Pre-school, and the active recreational area attached to the Pre-School, are predicted to comply with the trigger levels of $L_{Aeq(1\ hour\ internal)}$ 45 dBA and $L_{Aeq(15\ hour)}$ 65 dBA, respectively.

Temporary turnout — Stage 1 commissioning

As described in Section 6.2.3, a temporary turnout would be installed to the north of the new Schofields Station for the commissioning of Stage 1, which is expected in 2011. This turnout would be removed following the commissioning of Stage 2 of the Project (refer Section 6.2.3).

Conventional turnouts result in higher noise levels than standard track as impulsive noise is emitted as each wheel of the train impacts the discontinuity in the track. In addition to the increased noise levels, the discontinuity in the rail running surface also changes that character of the noise emissions, which has the effect of increasing the perceptibility or 'loudness' of the noise. Installing a turnout into existing continuously welded rail track would, therefore, result in an increase in noise levels at adjacent receivers.

The nearest potentially affected receivers are located on Railway Terrace (Up side) and Bridge Street (Down side) between track chainages 43.3 kilometres and 43.4 kilometres. The nearest residential receivers are located approximately 30–40 metres from the proposed turnout. The noise emissions from the proposed turnout at this location have been included in the noise modelling for the 2013 after opening scenario. A summary of the predicted exceedances of the IGANRIP trigger levels for the after opening situation (Year 2013) is provided in Table 8-23.

Table 8-23 Summary of IGANRIP trigger level exceedances – temporary turnout during Year 2013 (track chainage 43.300 km – 43.500 km)

Noise level descriptor	Predicted noise Level (dBA) (Year 2007)[1]	Overall noise trigger level (dBA)	Predicted noise level increase (dBA)	Noise level increase trigger (dBA)	Number of IGANRIP exceedances within zone
$L_{Aeq(15\ hour)}$	52 (50)	65	2	2 or more	0
$L_{Aeq(9\ hour)}$	49 (46)	60	3	2 or more	0
L_{Amax}	78 (76)	85	2	3 or more	0

Note 1: The predicted noise levels are representative of the highest levels within the exceedance zone.

The after opening $L_{Aeq(15hour)}$ noise levels are predicted to comply with the trigger levels of $L_{Aeq(15\ hour)}$ 65 dBA and $L_{Aeq(9\ hour)}$ 60 dBA at all receivers located immediately adjacent to the proposed turnout. A localised increase of up to 3 dBA in the $L_{Aeq(15hour)}$ and $L_{Aeq(9\ hour)}$ noise levels is predicted at the nearest receiver locations.

The after opening L_{Amax} noise levels are predicted to comply with the trigger level of 85 dBA at all receivers located immediately adjacent to the proposed turnout. A localised increase of up to 3 dBA in the L_{Amax} noise levels is predicted at the nearest receiver locations.

Therefore, noise levels at the nearest potentially affected receivers are predicted to comply with the overall IGANRIP noise trigger levels for the after opening situation in 2013. Further consideration of noise mitigation measures is not required for the after opening (Year 2013) scenario at receiver locations adjacent to the temporary turnout.

Long-term situation (2023)

The future environment surrounding the rail corridor will be extensively modified by the development associated with the NWGC (refer Section 3.1.3). As the exact location of future residential areas and other sensitive receivers are as yet unknown, the impact of the Project for the Year 2023 situation (i.e. long-term situation) has been assessed based on the existing environment and the proposed future rail traffic on the new tracks (i.e. four trains per hour in both directions, and up to eight trains per hour in both directions during the AM and PM peaks).

Trigger level exceedances have been predicted at two existing residential locations within the project area (Manorhouse Boulevard and Bridge Street/Tain Place; refer Table 8-29) for the Year 2023 situation. These exceedances are shown in Appendix I of Technical Paper 2 (refer Volume 2), and discussed below. It should be noted that the assessment, and the identification of exceedances, has considered existing noise sensitive development only. It is assumed that for future urban development in the vicinity of the rail line, appropriate land use planning would safeguard against further noise exceedance in relation to the Project.

Manorhouse Boulevard, Quakers Hill

The predicted $L_{Aeq(15\ hour)}$, $L_{Aeq(9\ hour)}$ and L_{Amax} noise contours for Manorhouse Boulevard for the year 2023 are shown in Figures 8-5, 8-6 and 8-7. A summary of the predicted exceedances of the IGANRIP trigger levels for the long-term situation (Year 2023) is provided in Table 8-24.

Table 8-24 Summary of IGANRIP trigger level exceedances – Manorhouse Boulevard during Year 2023 (track chainage 40.940 km – 41.310 km)

Noise level descriptor	Predicted noise level (dBA) (Year 2007)[1]	Overall noise trigger level (dBA)	Predicted noise level increase (dBA)	Noise level increase trigger (dBA)	Number of IGANRIP exceedances within zone
$L_{Aeq(15\ hour)}$	65 (61)	65	4	2 or more	8
$L_{Aeq(9\ hour)}$	59 (58)	60	1	2 or more	0
L_{Amax}	89 (89)	85	0	3 or more	0

Note 1: The predicted noise levels are representative of the highest levels within the exceedance zone.

The future (Year 2023) $L_{Aeq(15\ hour)}$ noise levels are predicted to exceed the trigger level of 65 dBA at eight receivers immediately facing onto the rail corridor. The noise levels are expected to increase by up to 4 dBA at each of the affected receiver locations.

The future (Year 2023) $L_{Aeq(9\ hour)}$ noise levels are predicted to comply with the trigger level of 60 dBA for all receivers at this location. The $L_{Aeq(9\ hour)}$ noise levels are predicted to increase by up to 1 dBA.

The future (Year 2023) L_{Amax} noise levels are predicted to exceed the trigger level of 85 dBA at all receivers located on Manorhouse Boulevard that face directly onto the rail corridor. However, the L_{Amax} noise levels are not predicted to increase by 3 dBA or more as a result of the Project at this location, as the new track would be located further from the existing residents and existing train speeds on this section of the Richmond Line are expected to remain unchanged.

The predicted 4 dBA increase in the $L_{Aeq(15\ hour)}$ noise level for the eight receivers on Manorhouse Boulevard exceeds the overall IGANRIP noise trigger level. As such, further assessment is warranted for the consideration of reasonable and feasible noise mitigation at this location.