HEGGIES

REPORT 10-5184R1

Revision 0

South West Rail Link
Supplementary Noise and Vibration Assessment
Stage A - Glenfield Junction Works

PREPARED FOR

Transport Infrastructure Development Corporation
Locked Bag 6501
ST LEONARDS NSW 2065

2 MAY 2007

South West Rail Link

Supplementary Noise and Vibration Assessment

Stage A - Glenfield Junction Works

PREPARED BY:

Heggies Pty Ltd
ABN 29 001 584 612
2 Lincoln Street Lane Cove NSW 2066 Australia
(PO Box 176 Lane Cove NSW 1595 Australia)
Telephone 61 2 9427 8100 Facsimile 61 2 9427 8200
Email sydney@heggies.com Web www.heggies.com

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EXECUTIVE SUMMARY

General

Transport Infrastructure Development Corporation (TIDC) has requested that a supplementary noise assessment to the South West Rail Link (SWRL) Environmental Assessment (EA) be undertaken for the Glenfield Junction (Stage A) works. This assessment has been undertaken to enable, if necessary, the early commencement of the Glenfield Junction (Stage A) works. This assessment will be included in the Submissions Report for the SWRL.

The conclusions of this report may differ from those in the SWRL EA due to the availability of updated data and noise assessment guidelines. Specifically, the application of the *"Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects"* (IGANRIP) (NSW Government - February 2007) has led to new conclusions (which supersede the previous advice) regarding the consideration of operational noise barriers.

The Glenfield Junction (Stage A) works are a component of the SWRL, which is a new line to Leppington from Glenfield Station. Construction of the SWRL is planned to begin in 2009, with the line operational by 2012. It is anticipated that the Glenfield Junction (Stage A) works could be completed by mid 2011 or earlier if necessary.

The SWRL consists of a dual track, electrified passenger railway line, approximately 13 km long, from the existing junction of the East Hills Line and the Main South Line near Glenfield out to Leppington. The SWRL also incorporates an upgraded station at Glenfield, two new stations at Edmondson Park and Leppington, and a stabling facility west of the planned Leppington town centre.

The Glenfield Junction (Stage A) construction works comprise; safety fences, services investigation and relocation, track and crossover works, earthworks and drainage for the Southern Sydney Freight Line (SSFL), and flyover works (piling, pile caps, substructure and precast superstructure).

The operational noise and vibration assessment for the Glenfield Junction (Stage A) works is restricted to the component of the works between chainage 30.500 km and 32.900 km (measured along the East Hills Line). The remaining changes to rail operations (adjacent to and south of Glenfield Station) will be assessed separately as part of future assessments.

Operational Rail Noise

Guidance in relation to operational noise goals for the proposal is provided in the IGANRIP. The interim guideline provides "noise trigger" levels that trigger the need for a project to conduct an assessment of the potential noise and vibration impacts from the project and examine what mitigation measures would be feasible and reasonable to apply to ameliorate the project's impacts.

For airborne noise created by the operation of surface track, trigger levels are provided for rail infrastructure projects including a "new railway line" or "redevelopment on an existing railway line". In the vicinity of Glenfield, the "redevelopment" trigger levels apply, and consist of two components; absolute L_{Aeq} and L_{Amax} noise level triggers and triggers based on the increase in L_{Aeq} and L_{Amax} noise levels.

The IGANRIP requires that the operational noise assessment determine both the individual and combined change in noise levels due to passenger and freight rail traffic. Further assessment of potential mitigation measures is only required where there is a noticeable increase in noise levels due to the project (defined as 2 dBA or more in L_{Aeq} or 3 dBA or more in L_{Amax}). This project is responsible for the slewing of the SSFL but not any additional freight traffic in Year 2017, consequently, the project increases (compared to the Year 2007 scenario) will be based on:

- The combined (freight and passenger rail traffic) noise level in Year 2011 (after opening); and
- The passenger rail traffic noise level (ie not including freight) in Year 2017.

The combined freight and passenger rail traffic noise levels in Year 2017 are provided for discussion purposes but are not assessed against the IGANRIP trigger levels.

For the Year 2011 and Year 2017 noise modelling scenarios, the increase in "electric passenger train" noise levels is less than the noise trigger levels of 2 dBA and 3 dBA (for L_{Aeq} and L_{Amax} respectively) at existing and planned sensitive receiver locations, during all assessment periods.

For the Year 2011 noise modelling scenario, the increase in "all train" noise levels is less than the noise trigger levels of 2 dBA and 3 dBA (for L_{Aeq} and L_{Amax} respectively) at sensitive receiver locations, during all assessment periods.

The development must increase the existing noise levels **and** exceed the L_{Amax} 85 dBA, $L_{Aeq(9hour)}$ 60 dBA noise trigger levels in order for the project to trigger an assessment of mitigation measures. On this basis, the consideration of noise mitigation measures is not warranted at this locality.

Note that for the Year 2017 noise modelling scenario, the increase in noise levels due to the combination of electric passenger and freight trains is greater than the IGNARIP noise trigger levels, however as discussed above, this increase is not the result of the project. The impact of this increase is addressed in the SSFL Environmental Assessment.

Operational Rail Vibration

The effects of vibration in buildings can be divided into three main categories; those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be prejudiced. The levels of vibration required to cause damage to buildings tend to be at least an order of magnitude (10 times) higher than those at which people consider the vibration acceptable. Hence, the controlling criterion would be the human comfort criterion, and it is therefore not necessary to set separate criteria for this proposal in relation to building damage from railway vibration.

The proposed human comfort criterion is based on the vibration dose values nominated in BS 6472, and the DEC's *"Assessing vibration: a technical guideline"* and is 109 dB, recognising that vibration levels above the continuous vibration levels nominated in AS 2670 (106 dB day, 103 dB night) would be perceptible and may result in adverse comment from sensitive receivers.

None of the existing or planned sensitive dwellings lie inside the 109 dB criterion contour.

The 106 dB (daytime "perceptible" zone) and 103 dB (night-time "perceptible" zone) contours extend out to a maximum distance of 21 m and 31 m (from the nearest track centreline) respectively. No existing or planned sensitive receivers lie within the daytime "perceptible" zone. Vibration levels may be approaching perceptibility at some of the existing residential locations during the night-time period however the levels would be well below the 109 dB criterion.

In the SSFL Environmental Assessment, vibration emissions from the freight trains were predicted to comply with the human comfort and building damage criteria at all locations, and hence no mitigation measures were proposed. The slewing of the SSFL to allow for the construction of the Glenfield North Junction does not move any part of the SSFL tracks to within 10 m of any sensitive receiver (the closest is at least 40 m away), and as such the vibration levels from the SSFL are still expected to comply with the criteria.

EXECUTIVE SUMMARY

Operational Carpark Noise

The existing carparking area on the western side of Glenfield Station is proposed to be upgraded and expanded to provide up to 295 additional spaces.

The upgraded and expanded carpark is anticipated to be used primarily during the am and pm peak periods. Noise emissions are predicted to comply with the relevant noise goals at all locations.

Construction Noise and Vibration

At the majority of locations, the construction noise modelling indicates exceedances of the noise goals when plant and equipment are located in close proximity to residential and commercial receiver locations. This results primarily from the small distances involved between construction plant and the nearest receivers; especially at construction sites near Glenfield.

Particular effort would need to be directed towards the implementation of all feasible and reasonable noise mitigation and best practice management strategies. TIDC's Construction Noise Strategy requires the preparation of a Construction Noise and Vibration Management Plan (CNVMP) at a later stage in the assessment process when more detailed information is available. Whilst this report provides an indication of the likely mitigation measures that may be required during construction, specific measures will be provided in the CNVMP.

The fact that noise criteria exceedances have been identified does not necessarily indicate that the works should not proceed, but rather, highlights the importance of managing the works to minimise both the noise levels and duration of the predicted exceedances.

Vibration monitoring and buffer zones are proposed in order to minimise disruptions to the local community and prevent damage to nearby buildings during vibration-generating construction activities (such as vibratory rolling).

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1 INTRODUCTION

1.1 Objective

Transport Infrastructure Development Corporation (TIDC) has requested that a supplementary noise assessment to the South West Rail Link (SWRL) Environmental Assessment (EA) be undertaken for the Glenfield Junction (Stage A) works. This assessment has been undertaken to enable, if necessary, the early commencement of the Glenfield Junction (Stage A) works. This assessment will be included in the Submissions Report for the SWRL.

TIDC is the proponent of the proposal, and the Submissions Report is being prepared by Parsons Brinckerhoff (PB), in accordance with the requirements of Part 3A of the *Environmental Planning and Assessment Act 1979*.

This assessment addresses the potential impacts of noise and vibration emissions during construction and operation, including a feasible and reasonable assessment of potential noise and vibration mitigation measures.

The conclusions of this report may differ from those in the SWRL EA due to the availability of updated data and noise assessment guidelines. Specifically, the application of the *"Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects"* (IGANRIP) (NSW Government - February 2007) has led to new conclusions (which supersede the previous advice) regarding the consideration of operational noise barriers.

1.2 Background

The Glenfield Junction (Stage A) works are component of the SWRL, which is a new line to Leppington from Glenfield. The SWRL itself is part of the Metropolitan Rail Expansion Program (MREP), which also includes:

- CBD Rail Link (CBDRL) - A new tunnel between Central and the North Shore Line at St Leonards including new stations in the CBD and in the lower North Shore, and extra tracks between St Leonards and Chatswood; and
- North West Rail Link (NWRL) - A new line to Rouse Hill from Epping via Castle Hill.

Construction of the SWRL is planned to begin in 2009, with the line operational by 2012. It is anticipated that the Glenfield Junction (Stage A) works could be completed by mid 2011 or earlier if necessary.

1.3 Proposal Outline

The SWRL consists of a dual track, electrified passenger railway line, approximately 13 km long, from the existing junction of the East Hills Line and the Main South Line near Glenfield out to Leppington. The SWRL also incorporates an upgraded station at Glenfield, two new stations at Edmondson Park and Leppington, and a stabling facility west of the planned Leppington town centre.

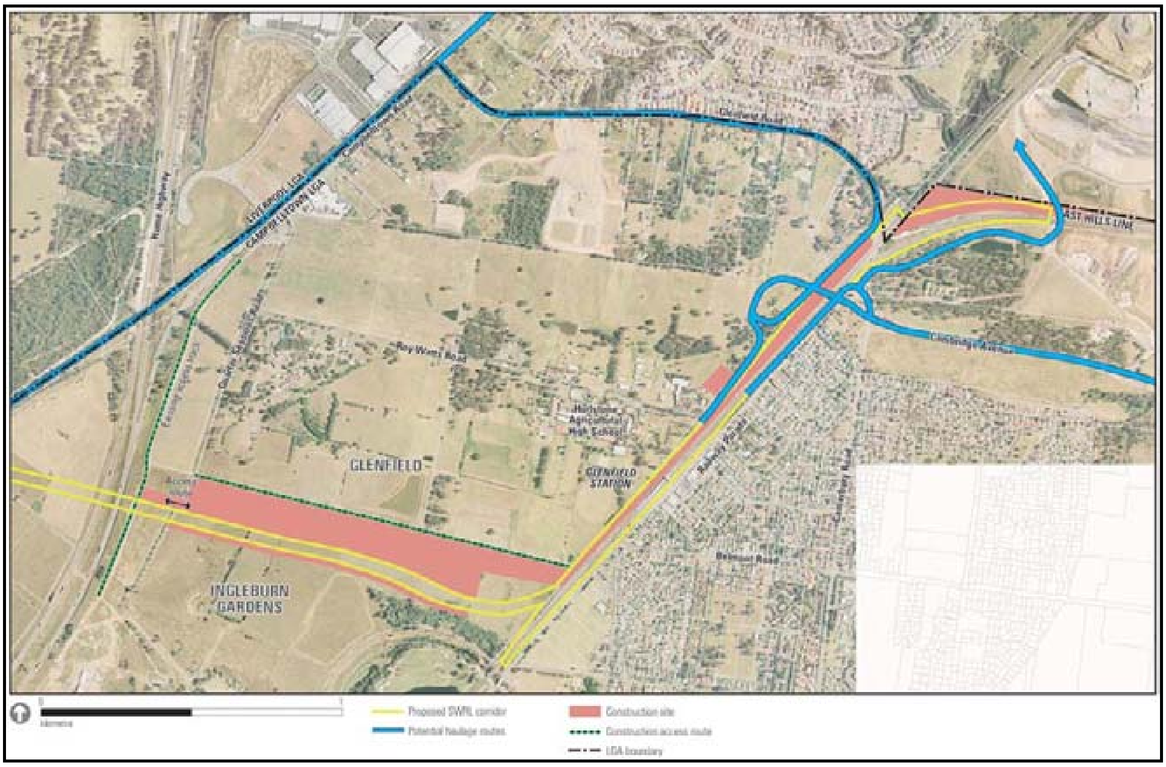
The Glenfield Junction (Stage A) construction works comprise:

- Safety fences, services investigations and relocations.
- Glenfield North Junction flyover works: piling, pile caps, substructure and precast superstructure.
- Glenfield South Junction flyover preliminary works: piling, pile caps and substructure.
- Track and crossover works.
- Service investigation and relocation.
- Earthworks and drainage for the future Southern Sydney Freight Line (SSFL) track.

The operational noise and vibration assessment for the Glenfield Junction (Stage A) works is restricted to the component of the works between chainage 30.500 km and 32.900 km (measured along the East Hills Line). Stage A works do not involve works to the station. Works at Glenfield Station are part of the remainder of the project which is subject to further assessment.

The location of the proposal is shown in **Figure 1**.

Figure 1 Location of the Proposal



1.4 Terminology

Specific acoustic terminology is used within this preliminary assessment. An explanation of common terms is included as **Appendix A**.

Consistent with normal rail terminology, track chainages are referenced to 0 km at Sydney Terminal Station. Up and Down directions refer to trains travelling to Sydney and from Sydney, respectively. The Up and Down sides of the corridor are the left-hand and right-hand sides, respectively, when facing towards Sydney (i.e. facing in the direction of decreasing chainage).

2 PROPOSAL DESCRIPTION

2.1 General

A single track, grade-separated reinforced concrete flyover is proposed at Glenfield Junction North to facilitate the passage of trains between the East Hills Line and Main South Line. The proposed flyover would extend from the Up East Hills Line (EHL) and pass over the Main South Line (MSL). The flyover structure also needs to pass under the Glenfield Road/Cambridge Avenue overpass of the MSL.

A crossover would also be constructed to the south of the flyover to connect the Up EHL with the MSL Up track. Preliminary work would be undertaken at the site of the future Glenfield South Junction flyover.

The Glenfield Junction (Stage A) works are split into four stages, which are discussed below. A site map is provided in **Appendix B** and the staging drawings are provided in **Appendix G**.

Stage 1

- Pre-SWRL works by ARTC including the addition of a new freight track on part of the Up (western) Side of the corridor.
- The installation of a turnout near chainage 41.500 km MSL, and the removal of a turnout near chainage 40.700 km MSL.
- The construction of a car parking area on the Up (western) side of the corridor.

Stage 2

- The erection of safety fencing.
- Upgrading of site access road near EHL.
- Extension of culvert near chainage 31.500 km EHL.
- Service investigations and relocations to the south of Glenfield Station.
- Earthworks, foundation and track works between (approximately) chainage 41.400 km and chainage 40.800 km MSL for additional freight track on the Up (western) Side of the track installed in Stage 1.
- Construction of footings and walls on Down (eastern) Side of MSL for the overpass structure.

Stage 3

- The erection of safety fencing.
- Construction of a temporary level crossing over SSFL.
- Slewing of portion of existing SSFL, and removal of another portion.
- Installation of a second turnout near chainage 41.500 km MSL.
- Construction of embankment between EHL and 40.800 km MSL.
- Construction of foundation and walls for western side of overpass near chainage 40.800 km MSL.

Stage 4

- Removal of a section of existing SSFL and a turnout at chainage 41.300 km MSL.
- Erection of overpass deck and associated modifications to MSL Over Head Wiring (OHW).
- Installation of new turnouts near chainage 41.400 km and 41.600 km MSL.
- Construction of ramp on Up (western) Side of overpass.
- Construction of track, OHW and signalling for new Up EHL.
- Track cutting, connecting and slewing to make new Up EHL operational.
- Construction of piles, pile caps and substructure for Glenfield Junction South Flyover.

Note that the Glenfield Junction (Stage A) works include the preparation of the James Meehan Estate worksite. It is assumed however, that the establishment of worksites involves minimal construction work, and is unlikely to result in a significant noise impact. This assumption will be reviewed when the CNVMP is compiled (at which stage more information concerning worksite preparation will be known).

3 EXISTING AND FUTURE ENVIRONMENT

3.1 Locality Descriptions

3.1.1 East of Main South Line (Seddon Park to Cambridge Avenue)

The corridor is primarily bounded by residential land and a village retail and commercial precinct adjacent to Glenfield Station. Glenfield Public (Primary) School and Angels Garden Children's Services are also located in this area.

Adjacent to the existing railway corridor, residential and other sensitive receiver locations are currently exposed to noise and vibration emissions from the current rail operations.

The developed areas are unlikely to change in the short term.

The Glenfield Waste Facility is located on the eastern side of the line to the north of the Glenfield Road Overbridge, and is not considered noise-sensitive.

3.1.2 West of Main South Line (Glenfield Road Overbridge to Slessor Road)

North of Glenfield Road, the corridor is bounded by residential land (offset by 160 m of parkland).

The land on the western side of the Main South Line to the north of the Liverpool District office of the Department of Education and Training is currently undeveloped, but is undergoing residential subdivision and development. Development of this residential estate (est. 1000 dwellings) is expected to occur from 2006 to 2013.

Adjacent to the existing railway corridor, residential and other sensitive receiver locations are currently exposed to noise and vibration emissions from the current rail operations.

Glenfield Road has considerable road traffic volumes, and vehicles travel at reasonably high speeds. In these areas, road traffic noise is a significant component of the existing acoustic environment

3.1.3 West of Main South Line (Canal to Glenfield Road Overbridge)

The corridor is bounded by rural land, with Hurlstone Agricultural College and Glenfield Special School to the south. The Liverpool District office of the Department of Education and Training are also in this area.

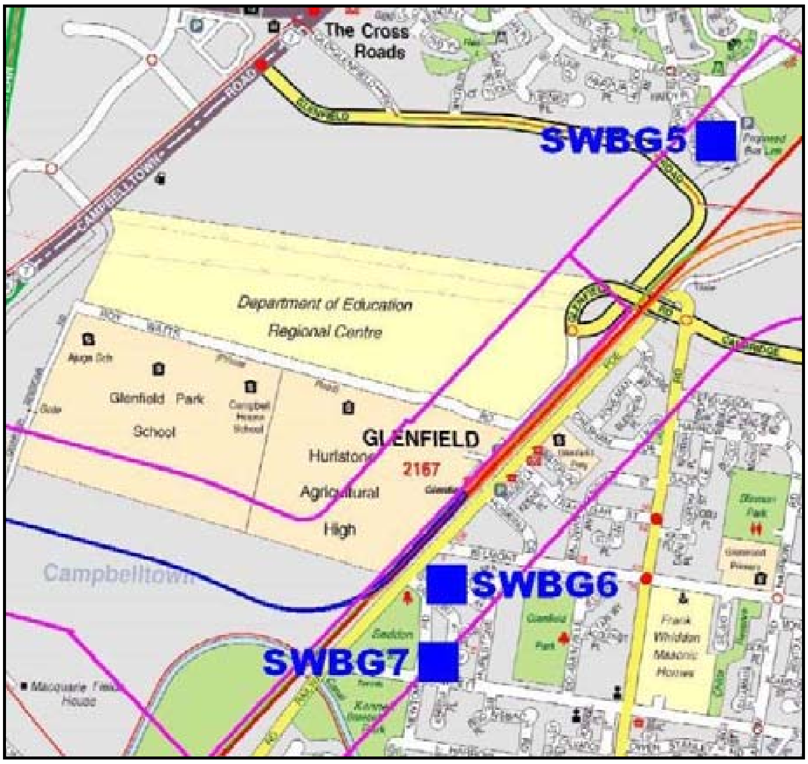
Adjacent to the existing railway corridor, these receivers are currently exposed to noise and vibration emissions from the current rail operations. The Main South Railway would be the dominant noise sources in this area.

3.2 Noise Measurements

3.2.1 Ambient Noise Measurements

Ambient noise surveys have been undertaken at a total of seven representative locations between Casula (north of Glenfield) and Rossmore (west of Leppington) as part of the SWRL EA. The monitoring locations adjacent to the Glenfield Junction (Stage A) works (SWBG5, SWBG6 and SWBG7) are identified in **Figure 2**. The results from the loggers adjacent the Glenfield Junction (Stage A) works are still valid and will be reused for this assessment.

Figure 2 Site Map - Ambient Noise Measurement Locations



Source : UBD

Methodology

The purpose of the ambient noise monitoring is to determine the existing background noise levels, which are used as a basis for assessing the impact of noise emissions during the construction phase of the proposal.

Noise logging was undertaken in April and July 2006 using ARL noise loggers, type EL215 and EL316, positioned at each of the monitoring locations for a period of at least one week. These loggers continuously monitored noise levels and stored the results as statistical noise levels every 15 minutes.

All equipment used for the surveys carries current manufacturer's calibration certification. Calibration was checked before and after each measurement and at the downloading of data from the noise loggers. In all cases, the calibration drift was less than the acceptable limit of 0.5 dBA.

Weather details for the period of noise logging were obtained from the Bureau of Meteorology. The wind speed and direction information was sourced from the weather station located at Holsworthy.

Noise Monitoring Results

The noise loggers were set to record ambient noise levels continuously in consecutive 15 minute intervals. These loggers store statistical descriptors which reflect the range of noise levels in the preceding interval.

The full results from the unattended noise monitoring are presented graphically in **Appendix C**. The weather records obtained from the Bureau of Meteorology for the monitoring period are overlaid on the daily noise plots.

In order to determine the Rating Background Level (RBL) during the daytime, evening and night-time periods, the L_{A90} background noise levels were processed in accordance with the procedure in the Department of Environment and Conservation's (DEC's) Industrial Noise Policy (INP). The RBL is the overall single figure background level representing quiet ambient conditions in each assessment period (daytime, evening and night-time).

The existing L_{Aeq} noise levels for the daytime, evening and night-time periods were also processed in accordance with the procedure in the INP. These values represent the typical "energy-averaged" noise levels during each assessment period.

A summary of the processed noise levels is presented in **Table 1**.

Table 1 Summary of Ambient Noise Levels at Unattended Noise Monitoring Locations

Monitoring Location		Daytime Noise Level* (dBA)		Evening Noise Level* (dBA)		Night-time Noise Level* (dBA)	
		L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
SWBG 5	15 Slessor Road, Casula	41	52	41	54	35	52
SWBG 6	6 Newtown Road, Glenfield	47	59	46	58	39	57
SWBG 7	18 Newtown Road, Glenfield	41	61	42	59	37	56

Note * DEC's preferred definition of daytime, evening and night-time hours. Daytime refers to standard daytime construction hours, namely 7.00 am to 6.00 pm Monday to Friday and 8.00 am to 1.00 pm on Saturday. Evening refers to the period 6.00 pm to 10.00 pm. Night-time refers to the period 10.00 pm to 7.00 am.

The summary results in **Table 1** are derived from the entire week of the noise logging. The data has been segregated into the relevant time of day (daytime, evening and night-time) to assist in setting noise criteria for construction and train stabling operations.

3.2.2 Attended Noise Measurements

Attended noise measurements were undertaken adjacent to the existing railway corridor to validate the computer noise modelling for the existing and future rail operations.

The measurements were carried out near to the Hurlstone Agricultural School access road, on the Up (western) Side of the corridor, approximately 30 m from the nearest track (the unwired freight line), and approximately 41 m from the Up Main. The microphone was positioned at a height of 1.5 m above ground, and at this location the track was on slight embankment. The measurement location is indicated in **Figure 3**.

Figure 3 Site Map - Attended Noise Measurement Location

The measurement set included 17 passenger train passby events and 3 freight train passby events.

Measurement Methodology

Attended noise measurements were undertaken using a Brüel & Kjær Type 2260 precision Sound Level Meter. The measurements were A-weighted, fast response L_{Amax} and L_{AE} (sound exposure level).

One-third octave L_{max} measurements were also obtained for each train passby event. These L_{max} values are the maximum levels occurring in each 1/3 octave band during the train passby. Individual bands are therefore not necessarily time coincident.

The L_{AE} measurements were commenced as the train noise rose significantly above the background level and were terminated as the train noise approached the background level. In the event that noise from passing vehicles or other sources significantly affected the measurement results, the measurement was discarded.

During the attended measurements, an observer noted the direction of each train passby event, as well as the number of carriages, train type and train speed.

Calibration of the sound level meter was carried out before and after each series of measurements. In all cases, the calibration drift was less than the acceptable limit of 0.5 dBA.

Attended Noise Measurement Results

A summary of the overall L_{Amax}, L_{AE} and L_{Aeq} noise levels is presented in **Table 2**.

"L_{Amax}" refers to the maximum noise level registered during the train passby with the sound level meter set to fast response. "L_{AE}" refers to the sound exposure level, which is a measurement integrated over time, reflecting both the noise level and the duration of the event. L_{AE} values may be summed logarithmically and used to calculate the L_{Aeq} noise exposure for each assessment period (eg $L_{Aeq(24hour)}$, $L_{Aeq(15hour)}$, $L_{Aeq(9hour)}$ and $L_{Aeq(1hour)}$).

Table 2 Summary of Attended Noise Measurement Results

Train Type	No of Trains	Ave Speed (km/h)	Ave L_{AE} Noise Level (dBA)	Calculated L_{Aeq} Noise Level (dBA)[1]				L_{Amax} Noise Level (dBA)	
				24hr L_{Aeq}	15hr Day	9hr Night	1hr Peak	Average Maximum	95th Percentile
Electric Passenger Sets	17	72	79	49	50	48	52	65	69
Freight Loco Sets	3	65	75	41	41	41	46	69	72
Freight Wagon Sets			77	43	43	43	47	66	67
Total	20	-	-	51	51	50	54	-	72

Note 1: The calculated L_{Aeq} noise levels are based on the measured L_{AE} noise levels and the number of train passby events in each assessment period - determined from the current CityRail timetable (March 2007) and the SSFL Environmental Assessment Report.

4 IDENTIFICATION OF SENSITIVE RECEIVERS

In order to assess the potential noise and vibration impacts from the proposal, it was first necessary to identify potentially affected receivers in the vicinity of the area.

Building occupancy (residential, commercial, industrial, education, hospital, worship, etc) information was obtained by visiting the site and sighting each building within a distance of approximately 300 m from the railway corridor.

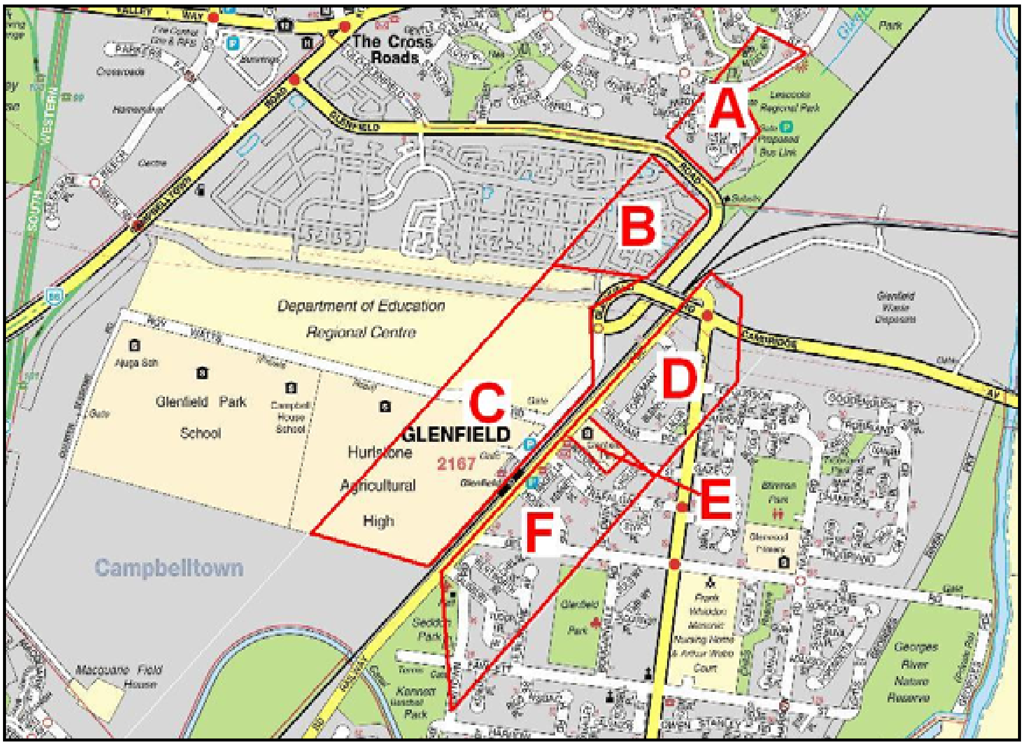
Within some of the proposal area, land uses are likely to substantially change. Some of this change will have occurred by the time the proposal is scheduled to open, and these proposed land uses are indicated in site map. Proposed land uses were determined from the Campbelltown City Council (2002), *Campbelltown (Urban Area) Local Environmental Plan 2002*.

The existing and anticipated future noise environments along the route are summarised in **Section 3**. The identified sensitive receivers are shown in **Table 3** and **Figure 4**.

Table 3 Sensitive Receivers

Type	Receiver Group	Description
Residential	A	Casula Residential
	B	Future Glenfield Road Residential
	D	Railway Parade (North) Residential
	F	Railway Parade (South) Residential
Educational	C	Hurlstone Agricultural High School and Liverpool District office of DET
	E	Glenfield Public Primary School

Figure 4 Site Map - Sensitive Receiver Groups



5 OPERATIONAL RAIL NOISE

5.1 Operational Noise Metrics

The primary noise metrics used to describe railway noise emissions in the modelling and assessments are:

L_{Amax}	The "Maximum Noise Level" occurring during a train passby noise event.
$L_{Aeq(24hour)}$	The "Equivalent Continuous Noise Level", sometimes also described as the "energy-averaged noise level". The $L_{Aeq(24hour)}$ may be likened to a "noise dose", representing the cumulative effects of all the train noise events occurring in one day.
$L_{Aeq(15hour)}$	The Daytime "Equivalent Continuous Noise Level". The $L_{Aeq(15hour)}$ represents the cumulative effects of all the train noise events occurring in the daytime period from 7.00 am to 10.00 pm.
$L_{Aeq(9hour)}$	The Night-time "Equivalent Continuous Noise Level". The $L_{Aeq(9hour)}$ represents the cumulative effects of all the train noise events occurring in the night-time period from 10.00 pm to 7.00 am.
$L_{Aeq(1hour)}$	The busiest 1-hour "Equivalent Continuous Noise Level" The $L_{Aeq(1hour)}$ represents the typical L_{Aeq} noise level from all the train noise events during the busiest 1-hour of the assessment period.
L_{AE}	The "Sound Exposure Level", which is used to indicate the total acoustic energy of an individual noise event. This parameter is used in the calculation of L_{Aeq} values from individual noise events.

The subscript "A" indicates that the noise levels are filtered to match normal human hearing characteristics (ie A-weighted).

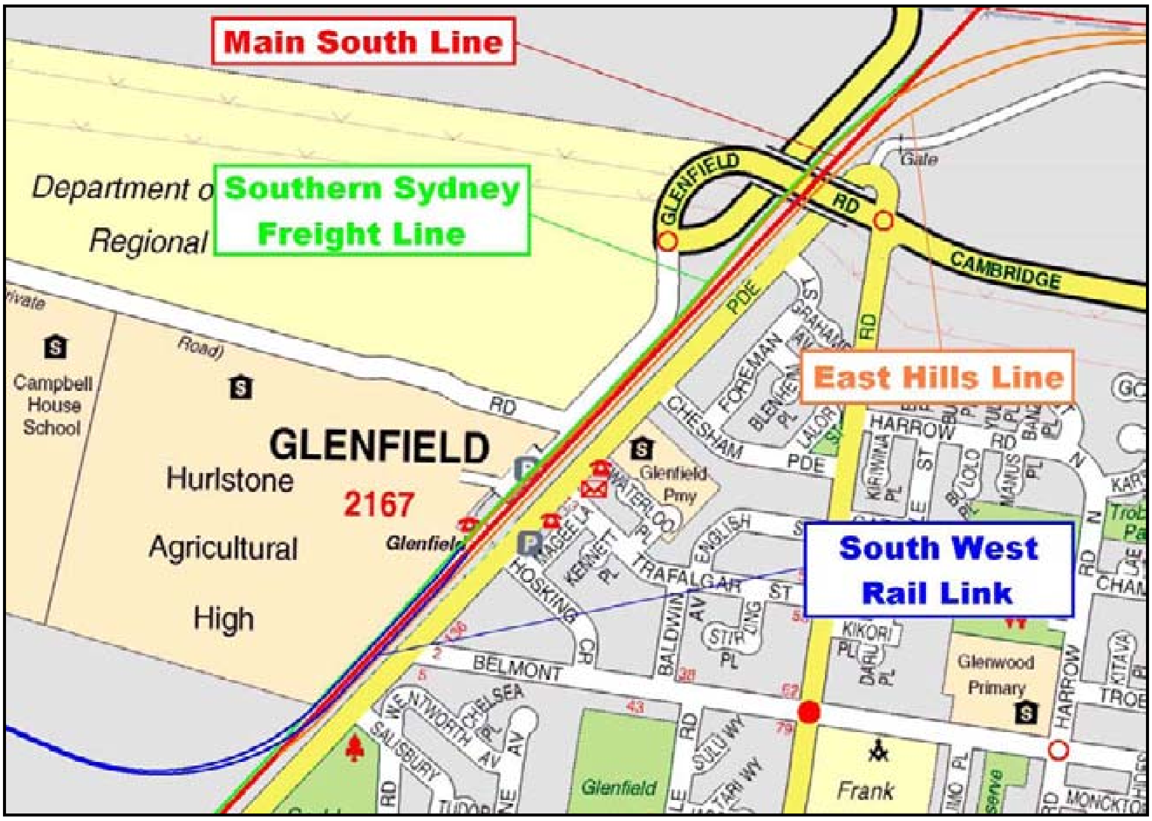
5.2 Operational Noise Goals

Guidance in relation to operational noise goals for the proposal is provided in the *"Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects"* (IGANRIP) (NSW Government - February 2007). The main purpose of the guideline is to assist the ongoing expansion of rail transport 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 trigger the need for a project to conduct an assessment of the potential noise and vibration impacts from the project and examine what mitigation measures would be feasible and reasonable to apply to ameliorate the project's impacts. Importantly, the noise trigger levels are not intended to be applied automatically in any mandatory sense as conditions in statutory approvals or licences.

For airborne noise created by the operation of surface track, trigger levels are provided for rail infrastructure projects including a "new railway line" or "redevelopment on an existing railway line". The different tracks In the vicinity of Glenfield are shown in **Figure 5**. The *East Hills Line* and *Main South Line* are existing passenger tracks, the *Southern Sydney Freight Line* will be an existing freight track at the time of opening, and the *South West Rail Link* would represent new track.

Figure 5 Site Map - Track Categories



Source : UBD

The noise trigger levels for residential and other sensitive receiver locations are provided in **Table 4** and **Table 5**. For projects involving a shared rail corridor (ie electric passenger and freight trains), the interim guideline specifies that noise levels be reported separately, however all noise from the rail corridor needs to be considered in the assessment process (refer **Section 5.7.1**).

Table 4 Airborne Noise Trigger Levels for Surface Track - Residential

Type of Development	Residential Noise Trigger Levels (dBA)		
	Day (7 am to 10 pm)	**Night (10 pm to 7 am)**	**Commentary**
New rail line development	Development increases existing rail noise levels AND Resulting rail noise levels exceed:		These numbers represent levels of noise that trigger the need for a rail infrastructure project to conduct an assessment of its 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 LAmax.
	60 LAeq(15hour) 80 LAmax	55 LAeq(9hour) 80 LAmax	
Redevelopment of existing rail line	Development increases existing rail noise levels AND Resulting rail noise levels exceed:		
	65 LAeq(15hour) 85 LAmax	60 LAeq(9hour) 85 LAmax	

Table 5 Airborne Noise Trigger Levels for Surface Track - Other Sensitive Land Uses

Sensitive Land Use	Noise Trigger Levels (dBA)	
	New Rail Line Development	Redevelopment of Existing Rail Line
	Development increases existing rail noise levels by 2.0 dBA or more in LAeq in any hour AND Resulting rail noise levels exceed:	
Schools, educational institutions - internal	40 LAeq(1hour)	45 LAeq(1hour)
Places of worship - internal	40 LAeq(1hour)	45 LAeq(1hour)
Hospitals - internal	35 LAeq(1hour)	35 LAeq(1hour)
Hospitals - external	60 LAeq(1hour)	60 LAeq(1hour)
Passive recreation	LAeq as per residential noise level values in **Table 4** (does not include maximum noise level component)	
Active recreation (eg golf course)	65 LAeq(24hour)	65 LAeq(24hour)

The LAeq noise level increase discussed in **Table 4** refers to an increase "in any hour"; in practice this is very difficult to predict as the exact future hourly timing of trains is not currently known. For the purposes of this assessment, Heggies have assessed the increase "in any assessment period", where the assessment periods are the 15 hour daytime period, the 9 hour night-time period and the 1 hour peak period.

In assessing noise levels at residential receiver locations, the noise level is to be assessed at 1 m in front of the most affected building façade. Internal noise level refer to the noise level at the centre of the habitable room that is most exposed to the noise source and are to apply with windows open sufficiently to provide adequate ventilation.

For new and redeveloped rail projects, the noise trigger levels apply both immediately after operations commence and for projected traffic volumes at an indicative period into the future to represent the expected typical level of rail traffic usage (ten years or similar period into the future).

The "redevelopment of an existing rail line" trigger levels are applicable where residential or other sensitive receivers are subject to existing rail noise at or above the noise trigger levels in **Table 4** for a "new rail line" development. For this project, the "redevelopment of an existing rail line" trigger levels are appropriate.

5.3 Operational Noise Sources

5.3.1 Passenger Rail Services

Noise emissions from suburban electric passenger trains are predominantly caused by the rolling contact of steel wheels on steel rails. Even under ideal conditions, noise would occur as a result of the rolling contact and the finite roughness of typical wheel and rail running surfaces. Other noise sources on electric passenger trains, (such as air-conditioning plant and air compressors) are generally insignificant when compared with the wheel-rail interaction, unless the train is travelling at very low speed or is stationary.

Impact noise from rail discontinuities such as turnouts and mechanical joints or uneven welded joints also has an effect on the level of wheel-rail noise emission, as impulsive noise is emitted as each wheel of the train impacts the discontinuity. Some types of rail bridges may also increase the level of noise emission.

In areas where there are tight radius curves, flanging noise or curve squeal may also increase the level of noise emission.

The SoundPLAN input data used in the modelling for this proposal were adapted to ensure that the calculated noise levels accurately reflect local conditions (ie CityRail trains, etc). The reference noise levels used for the noise modelling (**Table 6**) were based on measurements undertaken by Heggies on recent projects, including the Cronulla Line Upgrade and Duplication Project and measurements undertaken adjacent to the Main North Line.

Table 6 Reference Noise Levels used for Electric Passenger Train Modelling

Train Types	Reference Conditions	LAmax	LAE
Tangara / Millennium	15 m, 80 km/h	87	89
Double Deck Suburban	15 m, 80 km/h	89	92
Intercity	15 m, 80 km/h	92	93

5.3.2 Freight Rail Services

The only trains operating on the SWRL will be electric passenger services. There will be, however, diesel/electric freight train operations on the Ingleburn to Glenfield Passing Loop, SSFL and Main South Lines within the assessment area.

The dominant noise sources on diesel-electric locomotives are usually the diesel engine exhaust, dynamic brake fans and the wheel-rail interaction.

The noise emission from the diesel engine is dependent on power requirements (notch setting) and may be at a maximum at any speed. Noise levels also vary significantly between classes of locomotive. Maximum engine noise levels (for a single locomotive) are typically 85 dBA at 15 m for modern locomotives (e.g. 82 Class and NR Class), but may be over 90 dBA for some older locomotives.

The reference noise levels used for the noise modelling (**Table 7**) are based on the *Rail Noise Database*.

Table 7 Reference Noise Levels for Freight Rail Modelling

Type	Train Types	Reference Conditions	LAmax	LAE
Wheel / Rail	Diesel Electric Loco	15 m, 80 km/h	87	89
	Wagons	15 m, 80 km/h	93	100
Diesel Exhaust	Diesel Engine	15 m, 80 km/h, Medium Notch	85	82
	XPT	15 m, 80 km/h, Medium Notch	84	81

Southern Sydney Freight Line (SSFL)

The Australian Rail Track Corporation (ARTC) is planning to build a new bi-directional, non electrified, dedicated freight line from Macarthur to Sefton. The existing Ingleburn to Glenfield Passing loop will be modified as part of these works, and connected to new tracks to the north and south to form part of the dedicated freight line.

The proposed 30 km SSFL commences south of Macarthur, (where the electrified RailCorp passenger network finishes) and runs through to Sefton Park Junction, were it connects to the existing Metropolitan Goods Line via an underpass. In the vicinity of the proposal, the SSFL will run on the western (Up) side of the corridor (on the existing freight passing loop) before crossing from the western to the eastern side of the corridor on a grade separated flyover north of the Glenfield Road overbridge.

As the SSFL is expected to be completed by 2009, it has been included in this assessment. All data concerning the SSFL has been drawn from the *Southern Sydney Freight Line Environmental Assessment* (April 2006) (SSFL EA).

The "Existing Situation" (Year 2007) modelling incorporates the Year 2008 forecast freight operations in the SSFL EA, as this accurately represents the freight operations that residents will be subjected to prior to the Glenfield Junction (Stage A) works. After the Glenfield Junction (Stage A) works have been completed, most of the freight operations will shift to the SSFL tracks, however the SSFL EA indicates that there will be no step-change in freight train numbers immediately after opening. Consequently, for the "After Opening" (Year 2011) modelling, the freight data again incorporates the Year 2008 forecast in the SSFL EA.

5.3.3 Track Features

Bridges and Flyovers

When trains operate on elevated structures, including bridges and viaducts, vibration from the rails is transmitted into the structure, resulting in noise radiation from the surfaces of the bridge or viaduct.

Noise emissions from elevated structures are partially dependent on the damping properties and resonant behaviour of the structural elements. Unballasted steel bridges typically generate the highest noise emissions, whereas noise emissions from concrete bridges with ballasted or resiliently fixed track may be almost as low as "at grade" noise emission levels. Some bridge designs incorporating parapets may actually reduce noise emissions to below "at grade" levels by virtue of the noise barrier effect, however even these bridges may produce some annoying low frequency noise.

For this assessment, it has been assumed the grade-separated flyovers will be fixed-track concrete with low side screens (approximately 1 m above Top Of Rail). For these types of structures, the source noise levels are marginally lower than equivalent at-grade ballasted track. If ballast track is used in lieu of fixed-track, the overall noise levels would be lowered by a further marginal amount.

Rail Surface Discontinuities

Discontinuities in the rail running surface occur at turnouts, crossings, track defects, etc. For an eight-car train, a single rail discontinuity would result in 32 impulsive noise emissions. For this assessment, the modelled location of turnouts and crossovers was based on the information discussed and summarised in **Section 2.1**.

Within SoundPLAN, these are modelled over a track length of 10 m. The correction is applied to both the L_{Amax} and L_{AE}.

Conventional Turnout = +6 dBA (L_{Amax} and L_{AE})

Where turnouts have been removed the noise source correction is deleted.

5.3.4 Assumptions for SWRL Noise Modelling Assessment

For this assessment, a series of assumptions have been made.

Passenger Services

- Train speed profiles obtained from TIDC (for the SWRL rail traffic) were used as the basis for the modelled train speed. This is a slightly conservative measure as trains not using the maximum acceleration would have slower speeds and hence marginally lower noise levels.
- The number of modelled "stopping" train services on the SWRL lines was based on the peak and core hourly frequencies supplied by RailCorp and the assumption that the line would have similar operating hours to current services on other lines in the CityRail network.
- The number of "non stopping" train services (stabled at the Leppington Train Stabling Yard and travelling non-stop to the Glenfield Junctions) was assumed to be 12 in each direction per day.
- Of the trains travelling to and from Leppington, 50% operate on the East Hills Line, and 50% operate on the Main South Line.
- The electric passenger services on all lines were assumed to consist of 75% Tangara/Millennium car sets, and 25% Suburban car sets.

Freight Services

- Train speeds are assumed to be typically 80 km/h in the assessment area.
- Specific notch settings are currently unknown. Consequently, medium notch setting has been adopted for this assessment.
- Rail traffic is assumed to have two locomotives and a trailing length of 800 m.
- The specific details of signalling locations are not yet know, so potential noise sources such as "bunching" and "stretching" (due to coupling slack) of wagons, and "idling" of locomotives have not been included in this assessment.

5.4 Noise Modelling Inputs

Ground Terrain

The ground terrain data for the current modelling was provided by TIDC in the form of 3D contours in AutoCAD format.

Track Alignment Strings and Ground Terrain within Railway Corridor

The track alignments for the proposed lines were provided by TIDC in the form of separate 2D horizontal and vertical alignments in AutoCAD format. These two files were combined by Heggies to form the required 3D track strings.

Rail Traffic Data

Year 2007 train numbers were based on the current CityRail timetable (as at March 2007) and the *Southern Sydney Freight Line – Environmental Assessment* (Parsons Brinckerhoff, April 2006). **Table 8** provides a summary of the total passenger train numbers adopted for the modelling scenarios.

The "1 hour peak" data is for the hour with the highest number of trains passing through Glenfield. It is a different and non-concurrent period for passenger and freight trains, and in the case of passenger trains, is not necessarily the same as RailCorp's standard definition of "peak hour" (trains arriving at Town Hall between 7.30 am and 8:30 am).

Freight train numbers vary each day and diesel passengers services operate at different times on different days. The data presented below therefore represents train numbers on a ”typical” weekday.

Table 8 Summary of Train Movements for Modelling Scenarios - Year 2007

Rail Line	Train Type	Trains per period					
		Day 7am - 10pm		Night 10pm - 7am		1 Hour Peak[1]	
		Down	Up	Down	Up	Down	Up
MSL	Electric Passenger	60	62	24	20	3	8
MSL	Diesel Passenger	5	4	1	0	0	0
EHL	Electric Passenger	52	41	15	25	5	8
Freight Loop	Freight	9	11	8	5	2[2]	2[2]

Note 1: Passenger and Freight ”1 Hour peaks” are not concurrent. Passenger peak is 7 am to 8 am

Note 2: Estimated

The IGANRIP specifies that the noise trigger levels apply both immediately after operations commence (Year 2011) and for projected traffic volumes at an indicative period into the future to represent the expected typical level of train usage (ten years or a similar period into the future).

For this project, Year 2017 has been selected for the future scenario as all components of the Metropolitan Rail Expansion Program (SWRL, NWRL, CBD Link) are expected to be operational. The MREP documentation provides Year 2017 traffic figures, and the SSFL documentation provides Year 2018 freight traffic figures (which been assumed to be similar to Year 2107). Train numbers for the Year 2022 scenario (ten years after opening) were not available, however the Year 2017 train numbers are considered to be adequate on the basis that the increase in train numbers between 2017 and 2022 would be negligible in terms of the change in noise levels.

Year 2011 and Year 2017 train numbers were based on the information supplied by RailCorp and the *Southern Sydney Freight Line - Environmental Assessment* (Parsons Brinckerhoff, April 2006).

The train numbers used in the future modelling scenarios (Year 2011 and Year 2017) are summarised in **Table 9** and **Table 10**.

Table 9 Summary of Train Movements for Modelling Scenarios - Year 2011

Rail Line	Train Type	Trains per period					
		Day 7am - 10pm		Night 10pm - 7am		1 Hour Peak[1]	
		Down	Up	Down	Up	Down	Up
MSL	Electric Passenger	60	62	24	20	3	8
MSL	Diesel Passenger	5	4	1	0	0	0
EHL	Electric Passenger	54	43	15	25	5	10
SSFL	Freight	9	11	8	5	2[2]	2[2]

Note 1: Passenger and Freight ”1 Hour peaks” are not concurrent. Passenger peak is 7 am to 8 am

Note 2: Estimated

Table 10 Summary of Train Movements for Modelling Scenarios – Year 2017

Rail Line	Train Type	Trains per period					
		Day 7am - 10pm		Night 10pm - 7am		1 Hour Peak[1]	
		Down	Up	Down	Up	Down	Up
MSL	Electric Passenger	92	96	34	32	2[2]	8
MSL	Diesel Passenger	5	4	1	0	0	0
EHL	Electric Passenger	70	65	15	18	8	12
SSFL	Freight	18	18	13	13	2[2]	2[2]

Note 1: Passenger and Freight "1 Hour peaks" are not concurrent. Passenger peak is 7 am to 8 am

Note 2: Estimated

5.5 Validation of the Computer Model

As discussed in **Section 3.2.2**, noise measurements were undertaken adjacent to the rail corridor in order to validate the operational computer noise model. The measurements were carried out near to the Hurlstone Agricultural School access road, on the Up (western) Side of the corridor, approximately 30 m from the nearest track (the unwired freight line), and approximately 41 m from the Up Main.

A summary of the measured noise levels, together with the modelling results for the same location is provided in **Table 11**. The noise model validation for the L_{Aeq} assessment parameter has been compared with the $L_{Aeq(9hour)}$, representing the equivalent continuous noise level of all trains during a typical 9 hour night-time period (10 pm to 7 am).

Table 11 Measured and Modelled Noise Levels - Up Side Location

Train Type	Number of Meas. Train Events	Measured Noise Levels (dBA)			Modelled Noise Levels (dBA)[1]		Difference - Modelled minus Measured (dBA)	
		Highest LAmax	95th Percentile LAmax	LAeq (9hour)[2]	95th Percentile LAmax	LAeq (9hour)	LAmax [3]	LAeq (9hour)
Up Side Passenger	17	72	69	49	82	54	+13	+5
Up Side Freight	3	73	72	45	87	54	+15	+9

Note 1 Modelled noise levels based on reference levels presented in **Section 5.3**.

Note 2 The calculated $L_{Aeq(9hour)}$ noise levels are based on the measured L_{AE} noise levels and 85 passenger train, and 13 freight train passby events during a typical 9 hour night-time period.

Note 3 Representing the notional 95th percentile of L_{Amax} train noise levels.

For the existing electric passenger and freight train movements on the existing lines, the modelled L_{Amax} and $L_{Aeq(9hour)}$ noise levels are significantly higher than the measured noise levels.

Reasons why the modelled noise levels are higher than the measured levels could be a result of the following:

- The reference L_{Amax} noise levels (in **Table 6** and **Table 7**) are necessarily based on the typical "worse case" maximum levels which may not have been observed during the attended measurements.
- The noise model predictions are based on a typical train speed of 80 km/h compared with measured average speeds of approximately 65 km/h to 70 km/h.
- The attended measurements did not include any Intercity passenger trains which typically have higher L_{Amax} and L_{Aeq} noise levels.

On the basis of the above and the fact that the reference noise levels have been successfully employed on many other recent rail projects, the noise modelling results will be used in preference to the measured levels. Given that the predicted noise levels are potentially higher than the actual noise levels, the noise modelling represents a conservative assessment.

A previous assessment was carried out by Heggies at this location in relation to the series of turnouts at the existing Glenfield North Junction. A noise logger was deployed next to the rail corridor for 8 days in December 2005. A comparison of the measured and modelled noise levels at this location is provided in **Table 12**.

Table 12 Measured and Modelled Noise Levels – Down Side Location

Train Type	Number of Meas. Train Events	Measured Noise Levels (dBA)		Modelled Noise Levels (dBA)[1]		Difference - Modelled minus Measured (dBA)	
		95th Percentile LAmax	LAeq (9hour)[2]	95th Percentile LAmax	LAeq (9hour)	LAmax [3]	LAeq (9hour)
Down Side, All Trains	8 days	93	69	93	64	0	- 5

Note 1 Modelled noise levels based on reference levels presented in **Section 5.3**.

Note 2 It is noted that the measured $L_{Aeq(9hour)}$ noise level was assessed as having a significant component of road traffic noise from Railway Parade.

Note 3 Representing the notional 95th percentile of L_{Amax} train noise levels.

The model provides a better prediction of noise levels at this Down Side location, especially considering that part of the difference in the $L_{Aeq(9hour)}$ levels is due to road traffic noise.

5.6 Noise Modelling Scenarios

In order to assess the operational noise emissions for the proposed Glenfield Junction (Stage A) works, three noise modelling scenarios have been considered:

- **Scenario 1** - Existing Situation (Year 2007). This model incorporates the existing ground terrain, rail traffic (passenger and freight) and tracks. This scenario was used in order to determine the existing noise levels and to perform a validation of the computer noise model.
- **Scenario 2** - After Opening Situation (Year 2011). This model incorporates the revised track alignments and proposed freight operations on the SSFL. As discussed in **Section 5.4**, some passenger trains run on new or revised lines but the train volumes are the same as Year 2007.
- **Scenario 3** - Long-term Situation (Year 2017). This model incorporates the proposed future electric passenger and freight rail traffic (including SWRL) on the new tracks at an indicative period into the future to represent the expected typical level of train usage.

Noise Trigger Levels and Assessment Parameters

In order to undertake an assessment of the future rail operations, **Table 4** provides noise trigger levels for both the daytime and night-time assessment periods. In terms of the L_{Amax} assessment parameter, the noise trigger levels at residential receiver locations are the same during the daytime and night-time periods, however the L_{Aeq} noise levels during the night-time period are 5 dBA lower (ie more stringent) than the daytime period.

Table 8, **Table 9** and **Table 10** provide a summary of the total train movements during the daytime and night-time periods. On the basis of the existing and proposed train movements during the daytime and night-time periods, the calculated $L_{Aeq(15hour)}$ daytime noise levels would be approximately 2 dBA to 3 dBA higher than the $L_{Aeq(9hour)}$ night-time levels for electric passenger trains. The calculated $L_{Aeq(9hour)}$ night-time noise levels would be 0 dBA to 1 dBA higher than the $L_{Aeq(15hour)}$ daytime noise levels for freight trains (as the average number of movements per hour is higher during the night-time period).

Predicted night-time noise levels are therefore closer to the noise trigger levels than daytime noise levels. If predicted night-time noise levels are less than or equal to the night-time noise trigger levels, then the daytime noise levels will also be below the noise trigger levels. Consequently, for all of the noise modelling scenarios, noise calculations have been performed for the night-time period only.

For each noise modelling scenario, calculations of the L_{Amax} and $L_{Aeq(9hour)}$ night-time noise levels have been undertaken separately for the electric passenger trains and freight trains. This enables the potential noise impacts from the two sources to be reported separately.

Noise Trigger Levels for other Sensitive Receiver Locations

Within the project area, Glenfield Public Primary School, Angels Garden Children's Services and Hurlstone Agricultural High School are located in close proximity to the railway corridor. For these receivers, noise trigger levels for the typical highest 1 hour period (when in use) are provided in **Table 5**. For these schools, the $L_{Aeq(1hour)}$ noise trigger level is 45 dBA (internal) and the increase in L_{Aeq} noise levels must be 2 dBA or more in order to trigger further assessment of potential mitigation measures.

5.7 Prediction of Operational Noise Emissions

5.7.1 General

The IGANRIP requires that the operational noise assessment determine both the individual and combined change in noise levels due to passenger and freight rail traffic. Further assessment of potential mitigation measures is only required where there is a noticeable increase in noise levels due to the project (defined as an increase of 2 dBA or more in L_{Aeq} or 3 dBA or more in L_{Amax}).

This project is responsible for the slewing of the SSFL but not the additional freight traffic in Year 2017, consequently, the project increases (compared to the Year 2007 scenario) will be based on:

- the combined (freight and passenger rail traffic) noise level in Year 2011 (after opening), and
- the passenger rail traffic noise level (i.e not including freight) in Year 2017.

The combined freight and passenger rail traffic noise levels in Year 2017 are provided for discussion purposes but are not assessed against the IGANRIP trigger levels.

The conclusions of the operation rail noise assessment differ from those in the SWRL EA due to the application of the since published *"Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects"* (IGANRIP) (NSW Government - February 2007).

5.7.2 Increase in L_{Aeq} noise levels

On the basis of the existing and proposed train movements in **Table 8**, **Table 9** and **Table 10**, the following increases in L_{Aeq} noise levels would be expected due to the increase in train movements alone:

- Compared with the existing situation, the $L_{Aeq(15hour)}$ daytime noise levels from passenger trains would increase by 1.7 dBA as a result of the additional train movements in Year 2017. During the night-time period, the increase in $L_{Aeq(9hour)}$ noise levels would be 0.7 dBA.
- Compared with the existing situation, the $L_{Aeq(15hour)}$ daytime noise levels from freight trains would increase by 2.5 dBA as a result of the additional train movements in Year 2017. During the night-time period, the increase in $L_{Aeq(9hour)}$ noise levels would be 3.0 dBA.
- Compared with the existing situation, the $L_{Aeq(15hour)}$ daytime noise levels from all trains (passenger plus freight) would increase by 2.1 dBA as a result of the additional train movements in Year 2017. During the night-time period, the increase in $L_{Aeq(9hour)}$ noise levels would be 2.0 dBA. (Note that the increase in noise from all trains is additive on a logarithmic basis, assuming an equal overall noise contribution from passenger and freight trains.)

Note that these increases do not take into account the changes in noise levels that will occur due to the modifications to the track alignments, the location of turnouts, and the changes to the vertical alignment and track type on the Up EHL flyover.

5.7.3 Existing Situation (Year 2007)

The predicted L_{Amax} and $L_{Aeq(9hour)}$ night-time noise levels for the existing situation (Year 2007) are presented in the form of noise contours in **Appendix D**, evaluated at a calculation height of 2.0 m above ground level (representative of the first occupied level at the nearest receiver locations).

For the existing situation (Year 2007), the predicted L_{Amax} and $L_{Aeq(9hour)}$ night-time noise levels from electric passenger trains and freight trains exceed the L_{Amax} 85 dBA and $L_{Aeq(9hour)}$ 60 dBA noise trigger levels at many residential locations. The predicted noise levels from electric passenger and freight trains also exceed the $L_{Aeq(1hour)}$ noise trigger levels at the schools.

5.7.4 After Opening Situation (2011)

The predicted change in L_{Amax} and $L_{Aeq(9hour)}$ night-time noise levels for the “after opening” situation (Year 2011) compared to the current situation (Year 2007) are presented in the form of noise contours in **Appendix E**, evaluated at a calculation height of 2.0 m above ground level.

For this situation, the majority of freight train movements will be on the new bi-directional SSFL track, located on the Up Side of the railway corridor. Four freight trains in each direction will continue to operate on the existing main lines, two each in the daytime and night-time periods.

The SSFL Environmental Assessment indicates that freight trains will operate at a maximum speed of approximately 70 km/h to 80 km/h on the new track, which is similar to current freight operations in the vicinity of Glenfield North Junction. The proposed changes in track alignment are expected to result in marginally higher freight L_{Aeq} and L_{Amax} noise levels along the Up side of the corridor.

As Up side receivers are setback at least 40 m and 150 m near the greatest changes in track alignment, the predicted increase at sensitive locations would be less than 0.5 dBA in both cases.

Some of the electric passenger trains travelling in the Up direction would run on the new Up East Hills Line, which is situated closer to receivers on the Up Side of the railway corridor and incorporates a new grade separated flyover. The location of several turnouts has also been modified.

Compared with the existing situation (Year 2007), the predicted L_{Amax} noise levels from electric passenger trains would remain generally unchanged on both sides of the railway corridor. The predicted $L_{Aeq(9hour)}$ night-time noise levels would decrease slightly due to the removal of several turnouts and the use of low concrete parapets on the Up East Hills Line flyover.

Compared with the existing situation (Year 2007), the predicted increase in L_{Amax} and L_{Aeq} noise levels at all existing and planned sensitive receivers will be less than the noise trigger levels (of L_{Aeq} 2 dBA and L_{Amax} 3 dBA) on both sides of the corridor, in terms of both electric passenger noise, and total rail noise.

5.7.5 Long-term Situation (2017)

The change in predicted L_{Amax} and $L_{Aeq(9hour)}$ night-time noise levels for the long-term situation (Year 2017) compared to the current situation (Year 2007) are presented in the form of noise contours in **Appendix F**, evaluated at a calculation height of 2.0 m above ground level.

For this situation, the number of electric passenger trains and freight trains is greater than the Year 2007 and Year 2011 scenarios, as shown in **Table 10**.

Electric Passenger Trains

As for the "after opening" situation, a comparison of the "long-term situation" with the existing situation (Year 2007), indicates that L_{Amax} noise levels from electric passenger trains would remain generally unchanged on both sides of the railway corridor. This is the result of the L_{Amax} noise level from electric passenger trains being controlled by the location and speed of the trains, not the volume of trains.

Compared to the existing situation (Year 2007), the predicted $L_{Aeq(9hour)}$ noise levels from electric passenger trains would increase marginally on both sides of the rail corridor, due to the proposed increase in the number of trains operating on the network. During the night-time period, this increase is less than 1 dBA at all existing and planned sensitive receiver locations. During the daytime period, the increase is less than 2 dBA.

Compared with the existing situation (Year 2007), the predicted increase in L_{Amax} and L_{Aeq} electric passenger noise levels at all sensitive receivers (in all assessment periods) will be less than the noise trigger levels (of L_{Aeq} 2 dBA and L_{Amax} 3 dBA) on both sides of the corridor.

Freight Trains

Compared with the existing situation (Year 2007), the predicted $L_{Aeq(9hour)}$ noise levels from freight trains would increase as a result of the proposed increase in freight volumes. It is understood that the increase in freight train noise levels between Year 2007 and Year 2017 was taken into account in the determination of feasible and reasonable noise barriers for SSFL at this location.

For example, the SSFL Environmental Assessment states:

> *"Catchment GLE2 [Hurlstone Agricultural High School and the Department of Education Regional Centre] shows an increase in noise level both immediately and in 2018, but the predicted 2018 noise level is within 5dBA of the "planning" criterion, and hence under the principles described in Section 4.1, provision of mitigation measures such as barriers is not considered "feasible and reasonable". In all other cases where 2018 noise levels exceed the planning criteria and are predicted to increase, the predicted exceedance is greater than 5dBA, and hence consideration of such mitigation measures is required."*

5.8 Summary of Predicted Noise Levels

The predicted noise levels in the "electric passenger trains" and "electric passenger and freight trains" scenarios exceed the L_{Amax} 85 dBA and $L_{Aeq(9hour)}$ night-time 60 dBA noise trigger levels in Year 2007, Year 2011 and Year 2017.

For the Year 2011 and Year 2017 noise modelling scenarios, the increase in "electric passenger train" noise levels is less than the noise trigger levels in IGANRIP of 2 dBA and 3 dBA (for L_{Aeq} and L_{Amax} respectively) at existing and planned sensitive receiver locations, during all assessment periods.

For the Year 2011 noise modelling scenario, the increase in "all train" noise levels is less than the noise trigger levels of 2 dBA and 3 dBA (for L_{Aeq} and L_{Amax} respectively) at sensitive receiver locations, during all assessment periods.

As discussed in **Section 5.2**, the development must increase the existing noise levels **AND** exceed the L_{Amax} 85 dBA, $L_{Aeq(9hour)}$ 60 dBA noise trigger levels in order for the project to trigger an assessment of mitigation measures. On this basis, the consideration of noise mitigation measures **is not** warranted at this locality.

Note that for the Year 2017 noise modelling scenario, the increase in noise levels due to the combination of electric passenger and freight trains is marginally greater than the IGNARIP noise trigger levels, however as discussed in **Section 5.7.1**, this increase is largely the result of increased freight train movements and the impact of this increase is addressed in the SSFL Environmental Assessment.

5.9 Compliance Monitoring

The IGANRIP guideline recommends the selection of representative noise monitoring locations in order to later assess compliance with the predicted levels. For this project, the following representative receiver localities are proposed:

- Slessor Rd, Casula
- Railway Parade, Glenfield

A residence in each locality should be selected, and noise measurements should be undertaken prior to commencing works (Year 2007 scenario), in Year 2011 (after opening situation) and in Year 2012 (after the SWRL becomes operational). The increase in noise levels should be less than indicated in **Table 4**.

When assessing compliance with the IGANRIP, it should be recognised that noise emissions from electric passenger trains are highly variable, and both extended unattended monitoring, and detailed attended monitoring should be undertaken.

6 OPERATIONAL RAIL VIBRATION

6.1 Introduction

Overview

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 (due to the moving loads, finite roughness of the surfaces and elastic deformation). Significantly higher vibration levels can occur due to rail and wheel surface irregularities, including some irregularities that do not cause significant levels of airborne noise.

This vibration propagates via the sleepers or rail mounts into the ground or track support structure. It then propagates 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; those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be prejudiced.

Human Perception of Vibration

The actual perception of motion or vibration may not, in itself, be disturbing or annoying. An individual's response to that perception, and whether the vibration is "normal" or "abnormal", depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as "normal" in a shop, office or dwelling. Industrial environments are clearly less sensitive than say, commercial buildings, where the usual expectation is that there should be little perceptible vibration.

Although people are able to perceive relatively low vibration levels, it is not appropriate to set vibration emission limits requiring “no vibration”, since there will always be some vibration in any environment. It is necessary therefore to set realistic design criteria which minimise disturbance and adverse impacts on amenity. The recommended approach is discussed in **Section 6.3**.

Effects on Building Contents

People can perceive floor vibration at levels well below those likely to cause damage to building contents or affect the operation of typical equipment. As such, the controlling vibration criterion at most locations would be the human comfort criterion, and it is therefore not necessary to set separate criteria for this proposal in relation to the effect of railway vibration on most building contents.

Some high technology manufacturing facilities, hospitals and laboratories include equipment that is highly susceptible to vibration. Typical examples of sensitive equipment include scanning electron microscopes and microelectronic manufacturing facilities. No such facilities have currently been identified adjacent to the proposed alignment.

Effects of Vibration on Structures

The levels of vibration required to cause damage to buildings tend to be at least an order of magnitude (10 times) higher than those at which people consider the vibration acceptable. Hence, the controlling criterion would still be the human comfort criterion, and it is therefore not necessary to set separate criteria for this proposal in relation to building damage from railway vibration.

Ground-borne Noise from Rail Operations

Ground-borne noise in buildings adjacent to railway lines is most common in railway tunnel situations where there is an absence of airborne noise to mask the ground-borne noise emissions. Ground-borne noise results from the transmission of ground-borne vibration rather than the direct transmission of noise through the air. The vibration is generated by wheel/rail interaction and is transmitted from the trackbed, via the ground and into the building structure.

The vibration entering the building then causes the walls and floors to faintly vibrate and hence to radiate noise (commonly termed “ground-borne noise” or “regenerated noise”).

If of sufficient magnitude to be audible, this noise has a low frequency rumbling character, which increases and decreases in level as a train approaches and departs the site. This type of noise can be experienced in buildings adjacent to many urban underground rail systems.

For surface rail projects, the effect of ground-borne noise tends to be less of an issue than for underground rail projects. This is because the airborne noise emissions in most circumstances are much higher than the ground-borne noise levels. In some situations, however, the ground-borne noise emissions may be audible (for example, at locations where airborne noise emissions are attenuated by a noise barrier or where there are no windows facing the railway corridor).

No existing buildings have been identified as being particularly sensitive to ground-borne noise from the proposed railway. If sensitive occupancies such as residential developments, recording studios, cinemas and the like are located within approximately 40 m of the proposed alignment, an assessment would be undertaken to determine if vibration mitigation at the source (as part of the planning process) or at the building (after project opening) is required. The level of attenuation potentially required depends amongst other factors, on the distance from the track, the sensitivity of the building occupancy, train speed, etc.

6.2 Vibration Propagation

The propagation of vibration (and ground-borne noise) through the ground is a complex phenomenon. Even for a simple source, the received vibration at any point may include the arrival of several different wave types, plus other effects such as damping, reflection, and impedance mismatch caused by changes in ground conditions along the propagation path.

It is useful to note that predictions of vibration normally involve a combination of empirical and analytical methods as the various characteristics are normally not sufficiently defined to enable full analytical modelling.

6.3 Vibration Criteria

As discussed in **Section 6.1**, the human comfort criteria for vibration tend to be more stringent than other possible criteria relating to building contents or building damage.

There are several sources from which vibration criteria may be drawn. These include:

- Australian Standard AS 2670.2 1990 *“Evaluation of Human Exposure to Whole Body Vibration - Part 2: Continuous and Shock Induced Vibration in Buildings (1 Hz to 80 Hz)”*.

- The United States Department of Transportation guideline *"Transit Noise and Vibration Impact Assessment"*, 1995.
- British Standard BS 6472-1992 *"Evaluation of Human Exposure Vibration in Buildings (1 Hz to 80 Hz)"*.
- The NSW Department of Environment and Conservation document *"Assessing Vibration : a technical guideline"*, 2006

The following discussion expresses vibration levels in terms of decibels (dB re 10^{-9} m/s). A level of 100 dB corresponds to 0.1 mm/s (rms) and a level of 120 dB corresponds to 1 mm/s (rms).

AS 2670 provides criteria corresponding to 106 dB to 112 dB for residential buildings during the daytime, and reducing to 103 dB during the night-time. These criteria apply to both continuous and intermittent vibration. For office and industrial buildings, the criteria are 112 dB and 118 dB, respectively.

For residential buildings, the US guideline recommends a criterion of 100 dB for frequent trains, or 108 dB for infrequent trains (i.e. less than 70 per day). These are understood to apply to the average train vibration levels. For schools, churches, quiet offices, etc, the recommended criteria are 3 dB higher than the residential criteria.

BS 6472 has similar criteria for continuous vibration, but also includes a dose relationship for intermittent events such as trains, which for a "low probability of adverse comment" would permit vibration levels of up to 109 dB, assuming 330 events of 8 second duration within the daytime period and/or 100 events of 8 second duration within the night-time period.

The DEC's *"Assessing vibration: a technical guideline"* is based on the guidelines contained in BS 6472–1992, and the acceptable values for intermittent vibration are the same as calculated above (namely 113 dB).

Proposed Vibration Criteria

The proposed criteria have therefore been based on the vibration dose values nominated in BS 6472, and the DEC's *"Assessing vibration: a technical guideline"* (109 dB), recognising that vibration levels above the continuous vibration levels nominated in AS 2670 (106 dB day, 103 dB night) would be perceptible and may result in adverse comment from sensitive receivers.

6.4 Source Vibration Levels

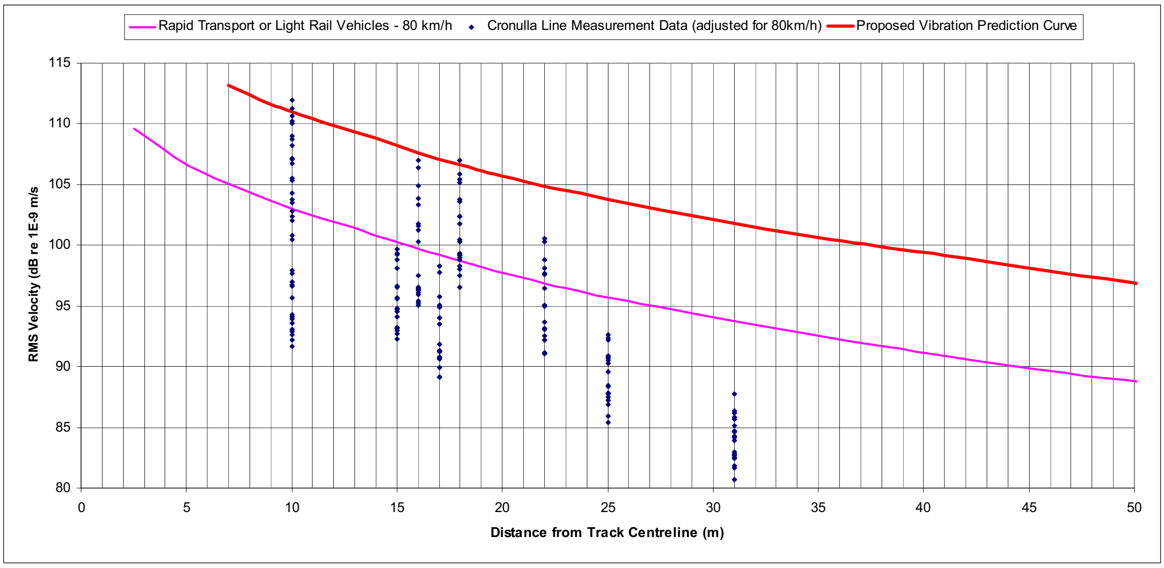
The US Federal Transit Administration's (FTA's) *"Transit Noise and Vibration Impact Assessment"* report provides indicative vibration levels versus distance for a variety of transport systems, including rapid transit rail systems. The base curve, shown in **Figure 6** shows the typical ground-surface vibration levels assuming rollingstock and rail in good condition and a train speed of 80 km/h. At other speeds, the vibration level is approximately proportional to 20 x log(speed/80 km/h), with a note that sometimes the speed has been observed to be as low as 10 to 15 x log(speed/80 km/h).

Vibration measurements undertaken by Heggies for the Cronulla Line Upgrade and Duplication Project are also presented in **Figure 6**, for comparison, adjusted for speed to represent the 80 km/h reference.

From the measurement results at four locations adjacent to the Cronulla Line (2 measurement distances per location), it is evident that approximately 50% of the measurement results are above the reference (rapid transport or light rail vehicles) line and 50% are below the reference line. The measurement results therefore appear to correlate well with the FTA reference levels for typical trains.

The upper line in **Figure 6**, labelled "Proposed Vibration Prediction Curve", represents the typical maximum vibration level and is 8 dB higher than the reference curve. On the basis of the measurement results at Cronulla and similar vibration measurements undertaken by Heggies on other projects, the difference between the 95th percentile (highest 1 in 20 trains) event and the median event is approximately 8 dB. This vibration curve, in conjunction with the typical 20 x log(speed/80 km/h) relationship has been used to predict the future vibration levels adjacent to the proposal.

Figure 6 Ground Surface Vibration Levels Versus Distance



(adapted from Figure 10-1 in FTA' s Transit Noise and Vibration Impact Assessment Report)

6.5 Assessment of Ground-Surface Vibration – Electric Passenger Trains

The theoretical maximum operational speed for an electric passenger train in the vicinity of the Glenfield North Junction is 115 km/h.

Assuming, as a worst case, that this speed was achieved and sustained along each of the tracks in the project area, the 109 dBA criterion contour would lie 14 m from the track centreline. None of the existing or planned sensitive dwellings lie inside the 109 dB criterion contour.

The 106 dB (daytime "perceptible" zone) and 103 dB (night-time "perceptible" zone) contours extend out to a maximum distance of 21 m and 31 m (from the track centrelines) respectively. No existing or planned sensitive receivers lie within the daytime "perceptible" zone.

Some dwellings on Railway Parade (Down Side, Glenfield) almost lie within the worst case (115km/h) night-time "perceptible" zone, however train speeds at this location are likely to be 70 to 100 km/h, which reduces the contour offset to 17 to 26 m. On this basis, vibration levels may be approaching perceptibility at some of the existing residential locations however the levels would be well below the 109 dB criterion.

6.6 Assessment of Ground-Surface Vibration – Freight Trains

In the SSFL Environmental Assessment, vibration emissions from the freight trains were predicted to comply with the human comfort and building damage criteria at all locations, and hence no mitigation measures were proposed.

The SSFL used the dose relationship from BS 6472 in conjunction with freight train vibration measurements at three locations along the Main North Line. The analysis indicated that:

> *"…the VDV criteria of 0.2 (daytime) and 0.13 (night-time) would be met even at 10 metres from every track. This represents a value that would provide a "low probability of adverse comment", rather than a vibration level that would be undetectable."*

The slewing of the SSFL to allow for the construction of the Glenfield North Junction does not move any part of the SSFL tracks to within 10 m of any sensitive receiver (the closest is at least 40 m away), and as such the vibration levels from the SSFL are still expected to comply with the criteria.

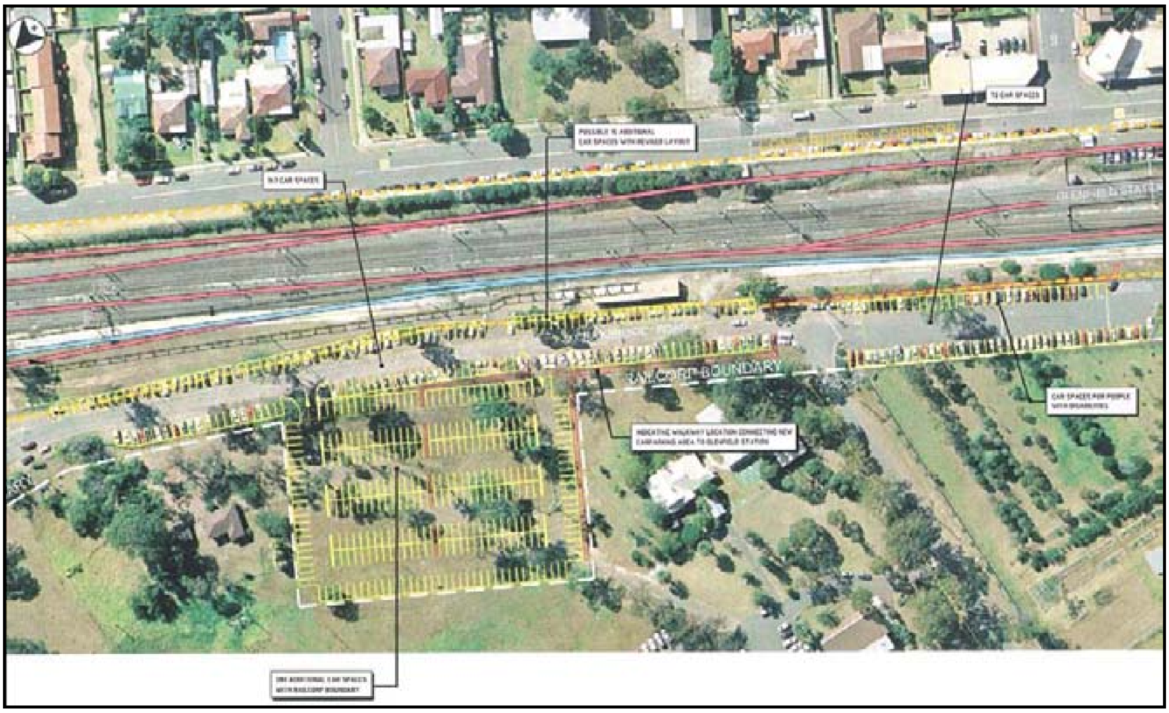
7 OPERATIONAL CARPARK NOISE

7.1 Proposed Layout and Capacity

The Glenfield Junction (Stage A) works include the upgrade of existing parking facilities and the construction of a new carpark adjacent to the existing site.

The existing parking area is located on western side of Glenfield Station along the station access road and currently provides 219 on-street car spaces. The planned upgrade would result in an additional 15 on-street car spaces. The proposed new carpark could provide up to 280 off-street car spaces. The planned car parking arrangements are shown in **Figure 7**.

Figure 7 Planned commuter car parking arrangement



Source: Parsons Brinckerhoff

As noted in the *"South West Rail Link Submissions Report – Additional Traffic and Transport Assessment"* (Parsons Brinckerhoff, 2007), for the purposes of analysis, it is assumed that the current car parking arrangement on the western side of Glenfield Station (219 spaces) is fully utilised and that the additional provision of car parking (up to 295 additional spaces) would also be fully utilised. Additionally, it is highly likely that the large majority of users of the new western side car park would continue to be commuters, meaning that car parking spaces would be used only once during the day and the majority of traffic and parking activity associated with the western side car park would occur during the morning and afternoon peak periods.

In the worst case scenario, with the majority of parking activity occurring in the 1-hour morning and afternoon peaks, there would be an additional 295 vehicles per hour (for one hour) on the access road and Glenfield Road. Parsons Brinckerhoff calculate that this represents a 20% increase in traffic on Glenfield Road during the 1-hour peak periods (6:30-7:30am in the morning and 5:30-6:30pm in the afternoon) and a 5% increase in the overall average annual daily traffic at this location.

7.2 Noise Impact Assessment

7.2.1 Road Traffic Noise

The relevant assessment criteria are set out in the DEC's publication "*Environmental Criteria for Road Traffic Noise*" (ECRTN). The objectives applicable are shown in **Table 13**.

Table 13 Road Traffic Noise Objectives

Type of Development	**Criteria**		
	Day (7am – 10pm) dBA	**Night (10pm – 6am) dBA**	**Where criteria are already exceeded**
Land use developments with potential to create additional traffic on **collector** road	$L_{Aeq(1hour)}$ 60	$L_{Aeq(1hour)}$ 55	Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB.
Land use developments with potential to create additional traffic on **local** roads	$L_{Aeq(1hour)}$ 55	$L_{Aeq(1hour)}$ 50	

For the purposes of this assessment, it has been assumed that the afternoon peak occurs entirely within the daytime period, and that of the morning peak traffic, 50% arrives before 7:00am, and 50% arrives afterwards.

On the access road (defined as a local road for the purposes of this analysis), calculations show that the traffic would generate $L_{Aeq(1hour)}$ noise levels of 52 dBA during the afternoon peak, and 48 dBA during the 'night-time' portion of the morning peak at the closest point of the Hurlstone Agricultural High School. On Glenfield Road, the overall noise levels are not know, but the expected increase of 20% during the 1-hour peak would result in an increase of less than 1 dBA.

Consequently the predicted noise levels meet the ECRTN objectives.

7.2.2 Carpark Stationary Noise

The noise emissions from the carpark (other than those associated with car movements on the access roads) are termed stationary noise emissions. These noise emissions include the sounds associated with cars starting and stopping, and car doors closing. The additional car parking spaces will result in an increase in noise emissions of this type.

At the nearest sensitive receiver, the Hurlstone Agricultural High School administration building, the increase may be between 3 and 5 dBA, however the likely morning peak traffic flows for the car parking area on the western side of Glenfield Station would occur between 6:30 am and 7:30 am, finishing approximately an hour before weekday classes begin. Similarly the likely afternoon peak traffic flows would occur between 5:30 pm and 6:30 pm, approximately two hours after classes finish. It is expected therefore that the noise impact on the administration and educational components of the school will be minimal.

As the boarding components of the school and the Glenfield residential receivers are located a much greater distance away, the noise impact at these locations is expected to be negligible.

8 CONSTRUCTION NOISE

TIDC has developed a draft Construction Noise Strategy for Rail Projects. This document requires a Construction Noise and Vibration Management Plan (CNVMP) to be developed as part of the approvals process. The guidelines in TIDC's Construction Noise Strategy will be utilised in the preparation of CNVMP when more detailed information about the proposed construction methodologies is available. This will include an assessment of feasible and reasonable mitigation measures to reduce the potential noise and vibration impacts of the proposed construction works. The CNVMP is undertaken at a later stage (after the Environmental Assessment) to ensure that the construction details are current and accurate.

The following provides a preliminary assessment of the potential noise impacts during construction and the likely mitigation measures that may be required.

8.1 Construction Noise Metrics

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

$L_{A1(60second)}$ 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. This parameter is 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 respectively. The $L_{A10(15\ minute)}$ construction noise goals are based on the L_{A90} background noise levels.

The subscript "A" indicates that the noise levels are filtered to match normal human hearing characteristics (ie A-weighted).

8.2 Construction Noise Goals

The DEC's "*Environmental Noise Control Manual"* provides guidelines for assessing the noise impact from construction sites. The DEC's general approach to the control of noise from construction sites involves the following:

- **Limiting hours of operation for "noisy" construction work** - The DEC normally limits construction works to the following time periods: 7.00 am to 6.00 pm from Monday to Friday, 8.00 am to 1.00 pm on Saturdays and no work on Sundays and Public Holidays.
- **Use of silenced equipment** - All practical measures should be used to silence equipment, particularly in instances where extended hours of operation are required.
- **Compliance with noise emission objectives**:
  - 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 is greater than 26 weeks, the L_{A90} background + 5 dBA noise goal is applicable to residential and other noise sensitive receiver locations (eg, schools, hospitals, nursing homes, etc). The $L_{A10(15\ minute)}$ construction noise goal is based on the local L_{A90} background noise level during the relevant time period (day, evening or night).

For retail and commercial buildings, it is generally accepted that receivers are 5 dBA to 10 dBA less sensitive to noise emissions than residential receivers. For these receivers, an L_{A10} noise objective of L_{A90} background + 10 dBA has been conservatively applied. These criteria are only relevant in areas without nearby residential dwellings, otherwise the more stringent residential criteria will apply.

As part of the SWRL EA, unattended background noise monitoring was undertaken during April and July 2006 at seven locations along the proposed route between Glenfield and Leppington. Three of these noise monitoring locations are adjacent to the proposed Glenfield Junction (Stage A) works, and have been utilised for this assessment. The full results of the unattended noise monitoring are presented in **Appendix C** and summarised in **Table 14**. The locations of the noise loggers (SWBG5, SWBG6, SWBG7) are illustrated in **Figure 2**.

As discussed in **Section 3.2.1**, the background noise data has been segregated into the relevant times of day to assist in setting noise criteria for construction noise emissions. The L_{A90} noise levels are the rating background noise levels (RBL), determined using the procedures set out in the DEC's Industrial Noise Policy.

The noise logging results have been used to estimate the L_{A90} background noise levels at locations throughout the proposed construction works for the purpose of determining the relevant L_{A10} noise construction objectives. **Table 14** presents the relevant L_{A10} construction noise objectives for nearby receiver groups, based on the L_{A90} background noise levels at the nearest equivalent unattended noise monitoring location. The receiver groups correspond to the work areas defined in the Constructability and Programme Review (*South West Rail Link Feasibility Report - Constructability and Programme Review* - Revision 3, 12 May 2006).

At the proposed time of construction, some of the areas adjacent to the construction sites may have undergone development, for example, the land described as Area B in **Table 3**. These new noise sensitive receivers would also be subject to potential noise impacts. As the specific details of the development are not known at this stage, the potential future dwellings have not been included in the assessment. Construction noise impacts would be assessed in more detail prior to commencing works (refer **Section 8.8**) and any available information on new noise-sensitive receivers would be included at this stage.

Table 14 Summary of LA10 Noise Objectives for Nearby Receiver Groups

Work Area		Description of Nearest Receiver Locations and Distance from Proposed Construction Works	LA10 Construction Noise Objective (dBA)[1]		
			Day	Evening	Night
1	Glenfield Junction North	Glenfield Road Residential (100 m) Foreman Street Residential (100 m) Slessor Road Residential (160 m)	46	46	40
2	Glenfield Station	Railway Parade Residential (100 m) Hurlstone Agricultural High School (45 m)	52	51	44
3	Glenfield Junction South[2]	Newtown Road Residential (130 m)	46	47	42
-	Carpark	Hurlstone Agricultural High School (20 m) The Liverpool District office of DET (20 m) Railway Parade Residential (70 m)	46	47	42

Note 1: The LA10 construction noise goals are applicable at the nearest and/or most affected residential receiver or other noise sensitive receiver location.

Note 2: SWBG 7, while located a significant distance away from the nearest affected receiver near this work area, this location was used to determine the noise objectives. The nearest affected receivers will be subjected to background noise levels similar to SWBG 6 (which recorded noise levels between 2 dBA and 6 dBA louder). Consequently the construction noise assessment at this location will provide conservative results.

Note 3 As the carpark was not originally identified as a worksite, no noise logging was undertaken in this locality. The background noise levels from SWBG 7, which is similarly located in a quiet area setback from main roads and the rail lines have been used for this assessment.

8.3 Construction Planning

Overall Planning

The construction scenarios presented in this preliminary assessment are based on the concept construction strategies discussed in the Constructability and Programme Review (*South West Rail Link Feasibility Report - Constructability and Programme Review* - Revision 3, 12 May 2006). The construction staging used in this report is base on the updated information provided by Tenix in *Construction Sequence for Early Opening of Glenfield Junction (North)(2 March 2007)*.

The SWRL construction and commissioning program is anticipated to commence in 2009 with completion in 2012 (a construction period of three and a half years). The Glenfield Junction (Stage A) works could be completed by 2011 (a construction period of at least two years).

Note that the Glenfield Junction (Stage A) works include the preparation of the James Meehan Estate worksite. It is assumed however, that the establishment of worksites involves minimal construction work, and is unlikely to result in a significant noise impact. This assumption will be reviewed when the CNVMP is compiled (at which stage more information concerning worksite preparation will be known). If further assessment is required, it will take into account additional sensitive receivers not covered here, including Macquarie Field House, Ajuga School, Glenfield Park School, and Campbell House School.

Working Hours

The majority of the works can be carried out during normal construction hours, however for safety reasons and to avoid significant traffic disruptions, some activities would need to be undertaken outside normal hours.

Scheduled track possessions will be utilised during the construction period. A track possession is a planned shutdown of a section of the network taking place generally on a weekend between 2 am Saturday to 2 am Monday.

Construction activities requiring track possessions include:

- Connections to existing track.
- Upgrading of existing crossovers.
- Excavation under new bridge spans.
- Modifications to existing overhead wiring structures and signalling.
- Utility relocation works near to or across operating tracks.
- Installing new flyovers.
- Testing and commissioning.

All other works can take place outside possessions and would not affect train operations as long as the sites are adequately hoarded and the existing infrastructure and operations are not affected.

8.4 General Approach to Noise Modelling

SoundPLAN V6.3 software was used for modelling the construction noise. The model includes ground topography, buildings and representative noise sources as discussed below. At the relatively small distances between construction sites and receivers, weather effects have little influence on noise propagation and hence neutral meteorological conditions were assumed.

The calculated 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. Predicted noise levels have been calculated for both “typical” construction activities and “worst case” activities, assuming plant operating in the area closest to the respective receivers.

In practice the noise levels would vary due to plant and equipment moving about the work sites and because not all plant and equipment would operate at the same time. In some cases, reductions in noise levels would occur when plant are located in cuttings or behind embankments or buildings.

Whilst not included in the noise modelling, it is noted that safe work practice requirements may result in the use of audible warning devices and detonators.

8.5 Typical Sound Pressure Levels

Sound pressure levels for typical items of plant required to carry out the works are listed in **Table 15**. These noise levels are representative of modern plant operating with noise control measures in good condition. The list of plant items is indicative only, and is based on Heggies previous experience on similar projects. The actual plant items utilised will be determined on the basis of the requirements of the construction contractor. As discussed in **Section 8.8**, when more information is known, a more detailed assessment will be undertaken for CNVMP.

Table 15 Sound Pressure Levels for Plant Items

Item	Typical Plant Type	Noise Level at 7 m (dBA)	
		Typical Maximum Level (L_{Amax})	Noise Level for Modelling (L_{A10})
Heavy Rockbreaker	On excavator KATO 750	103	98
Excavator KATO	KATO 750	86	83
Boring Rig (Diesel)	-	85	82
Bulldozer	Caterpillar D9	88	83
Skidsteer	-	85	82
Crane	60 t 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
Generator	Diesel	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 Vibrator	-	80	78
Ballast Regulator	-	96	93
Ballast Tamper	-	96	93

8.6 Construction Noise Modelling Scenarios

On the basis of the construction program and methodology discussed in Section 1.4 of the Constructability and Programme Review, it is anticipated that construction noise levels would be highest during the following scenarios.

The modelled construction scenarios are indicative only and are intended to identify the likelihood of any significant noise impacts that would need to be considered in further detail at a later design stage. The Contractor would be required to prepare a detailed Construction Noise and Vibration Impact Statement prior to commencement of construction activities.

8.6.1 Site Specific Works

North of Glenfield Station

- **Scenario 1 - Track and Crossover Removal.** This scenario involves the use of a crane, semi-trailer, front end loader, skid steer loader and ballast tamper.

Glenfield Junction North

- **Scenario 1 - Piling Works.** This scenario involves the use of a boring rig, front end loader, semi-trailer, vibratory pile driver and impact piling rig.
- **Scenario 2 - Earthworks.** This scenario involves the use of an excavator, dozer, front end loader, dump truck and product truck.
- **Scenario 3 - Superstructure Construction.** This scenario involves the use of a crane, semi-trailer, generator, concrete saw, jackhammer, concrete truck and concrete pump.
- **Scenario 4 - Track Construction.** This scenario involves the use of a crane, skid steer loader, semi-trailer, ballast regulator and ballast tamper.

Glenfield Junction South

- **Scenario 1 - Piling Works.** This scenario involves the use of a boring rig, front end loader, semi trailer, vibratory pile driver and impact piling rig.
- **Scenario 2 - Earthworks.** This scenario involves the use of an excavator, dozer, front end loader, dump truck and product truck.

Carpark Worksite

- **Scenario 1 - Earthworks.** This scenario involves the use of an excavator, dozer, front end loader, dump truck and product truck.
- **Scenario 2 - Carpark Construction.** This scenario involves the use of a crane, semi-trailer, generator, concrete truck and concrete pump

8.6.2 General Corridor Earthworks and Track Works

The following three scenarios are representative of typical activities and plant during track works. The duration of noisy work close to individual receivers would only be a fraction of the overall proposed duration as the construction works will move progressively along the rail corridor.

- **Scenario 1 - Excavation and Compaction.** This scenario involves the widening and modification of embankments and cuttings and general earthworks in preparation for the laying of new track. Typical plant items include an excavator, a bulldozer, a dump truck, a front end loader, and a vibratory roller. Vibratory sheet piling or rock breaking could potentially be required, subject to conditions found on site, but would not be typical activities in this scenario.
- **Scenario 2 - Over Head Wiring (OHW).** This scenario involves the installation of over head wire and supporting structures. Typical plant items include a boring rig, a concrete mixer, a crane, and an elevated work platform.
- **Scenario 3 - Track Laying.** This scenario involves the laying of new track. Typical plant items include a track laying machine, a tamper, a ballast regulator and a rail grinder. Under normal conditions, only one of these machines would be operated at a time in the immediate vicinity of any given residence.

8.6.3 On-Site Truck and Vehicle Movements

The maximum (L_{Amax}) noise emission of a typical truck in good condition is in the order of 83 dBA at 7 m. Skidsteer loaders generate similar noise levels. This level applies only when the truck engine is at high load. The $L_{A10(15minute)}$ or average maximum noise levels would always be somewhat lower. Depending on the numbers of trucks operating, their positions and the general intensity of movements, the $L_{A10(15minute)}$ noise levels would be approximately 5 dBA or more lower than the L_{Amax} levels.

Noise sources associated with truck operations also include the short-term noise events of material being dumped into stockpiles or into the trucks. While trucks move about on worksites, nearby receivers tend to associate truck noise emission with that of other construction equipment on the site. Hence, representative truck noise sources have been included in each of the site noise models.

8.7 Predicted Construction Noise Levels

8.7.1 Site Specific Works

Typical distances between the construction sites and existing residential receivers range from 20 m to more than 200 m.

Indicative construction noise levels at sensitive receiver are shown in **Table 16**. The predicted L_{A10} noise levels at the nearest locations exceed the construction noise goals by clear margins (at some locations by up to 34 dBA). In order to reduce the potential impact of the construction noise emissions, the noise mitigation and management measures in **Section 8.8** should be implemented, where feasible and reasonable.

For works inside the corridor, the highest noise levels are predicted to generally occur during piling works. This is due to the operation of noisier items such as the rock breaker and impact piling rig. These works would generally be limited to daytime use only, including weekend track possessions. Where possible, bored piling would be used in lieu of sheet piling to reduce noise intrusion into the surrounding community.

At the carpark worksite, due to the intensive nature of the expected construction works and because the sensitive receivers are located very close to the worksite, significant exceedances are expected during both earthworks and carpark construction (civil works such as concrete laying).

Table 16 Predicted L_{A10} Construction Noise Levels - Site Specific Works

Construction Site	Typical Receiver Location	L_{A10} Daytime[1] Construction Noise Objectives (dBA)	Predicted L_{A10} Construction Noise Levels (dBA) - Scenario[2]			
			1	2	3	4
Glenfield Junction North	Glenfield Road Residential (100 m)	46	74	63	65	60
	Foreman Street Residential (100 m)		53	35	39	65
	Slessor Road Residential (160 m)		72	56	60	53
Glenfield Station	Railway Parade Residential (100 m)	52	59	-	-	-
	Hurlstone Agricultural High School (45 m)		46	-	-	-

Construction Site	Typical Receiver Location	LA10 Daytime[1] Construction Noise Objectives (dBA)	Predicted LA10 Construction Noise Levels (dBA) - Scenario[2]			
			1	2	3	4
Glenfield Junction South	Newtown Road Residential (130 m)	46	50	73	-	-
Carpark	Hurlstone Agricultural High School (20 m)	46	80	81	-	-
	The Liverpool District office of DET (20 m)		80	81	-	-
	Railway Parade Residential (70 m)	52	69	70	-	-

Note 1 Daytime construction noise objectives are presented in this table as most works would occur during this time period. Night-time noise objectives are listed in Table 14 and are typically 8 dBA lower than the daytime objectives.

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.

Due to the close proximity of residential receivers to the works, the construction noise objectives would be exceeded at many locations along the corridor. This is relatively common on major infrastructure projects, particularly where there is no opportunity to provide a large buffer zone.

It is recognised that such exceedances may be concerning for surrounding residents and particular effort should be directed towards the implementation of all feasible and reasonable noise mitigation and management strategies.

For new track sections, construction works would be limited to daytime hours only (unless essential for traffic management or safety reasons) in order to reduce any potential impacts as much as possible. Due to the high exceedances at sensitive receivers adjacent to the carpark worksite, particular attention will be applied to site specific noise mitigation at this location in the CNVMP.

The fact that noise criteria exceedances have been identified does not necessarily indicate that the works should not proceed, but rather, highlights the importance of managing the works to minimise both the noise levels and duration of the predicted exceedances. Potential mitigation measures are discussed further in **Section 8.8**.

8.7.2 Corridor Earthworks and Track Works

Noise emissions from the proposed track works would be most intensive during earthworks, overhead wiring, signalling and track laying. The construction noise levels in **Table 17** represent the predicted LA10 noise levels during operation of typical plant items. Note that the corridor earthworks are not occurring in Work Area 3 (Glenfield Junction South) or the carpark.

The daytime construction noise objectives are between 46 dBA to 52 dBA. These noise levels are appropriate for long term activities and are well within the range of other normal ambient noise. Although some track construction activities would have only a short duration at any given location, the long term criteria have been applied for assessment, in recognition of the proposed overall construction period.

For short periods of time, criterion exceedances of up to 27 dBA are likely at the nearest receivers, with the greatest exceedances occurring during the track laying activity. Noise levels during other activities are predicted to be 5 dBA to 10 dBA lower, but may occur over a longer period of time than the track works. In all cases, the predicted noise levels would not be sustained. Lower noise levels would occur when the plant is located away from receivers or is operating on a less noise intensive task.

Table 17 Predicted LA10 Construction Noise Levels – Corridor Earthworks and Track Construction

Construction Site	Typical Receiver Location	LA10 Daytime [1] Construction Noise Objectives (dBA)	Predicted LA10 Construction Noise Levels (dBA)-Scenario[2]		
			1[3]	2	3
Glenfield Junction North	Glenfield Road Residential (100 m)	46	66	64	73
	Foreman Street Residential (100 m)		66	64	73
	Slessor Road Residential (160 m)		62	60	69
North of Glenfield Station	Railway Parade Residential (100 m)	52	66	64	73
	Hurlstone Agricultural High School (45 m)		74	72	79

Note 1 Daytime construction noise objectives are presented in this table as most works would occur during this time period. Night-time noise objectives are listed in Table 14 and are typically 10 dBA lower than the daytime objectives.

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.

Note 3 Rock breakers would generally not be required for excavation works, as the cuttings are predominantly in clay and shale. If required, noise from a rockbreaker would be 10 dBA to 15 dBA higher than predicted for earthworks (Although this may be reduced by shielding if the works are being undertaken at the base of a cutting).

8.7.3 Noise from Construction Traffic on Local Roads

On the roads immediately adjacent to the site, the community may associate truck movements with the construction works. Once the trucks move onto collector and arterial roads the truck noise is likely to be perceived as part of the general road traffic.

Access is proposed via appropriate easements and other suitable locations along the corridor, resulting in many access points. Construction traffic would be dependent on the active work areas, minimising the number of days of heavy vehicle traffic at each access point.

The construction traffic would utilise the following roads:

- An access track parallel to Quarter Sessions Rd running from Campbelltown Road to the James Meehan Estate worksite.
- The existing entrance to the Glenfield Waste Disposals off Railway Parade, which links up with an underpass beneath the East Hills Line.
- The access road that runs south from the roundabout on Glenfield Road (to access the carpark construction area)
- Glenfield Road and Cambridge Avenue (to link up with the M5 and Hume Highway)

The number of truck movements at each site has not yet been finalised, however information provided by Parsons Brinckerhoff indicates that the works at this location could generate approximately 20 dump truck trips per work day (i.e. 40 movements) during the peak earthworks period.

The relevant assessment criteria are set out in the DEC's publication "*Environmental Criteria for Road Traffic Noise*" (ECRTN). The objectives applicable to residential areas in the daytime period range from 55 dBA for local roads to 60 dBA for collector and arterial roads. These criteria apply to permanent traffic noise.

Assuming that a maximum of 4 dump truck trips (i.e. 8 movements) occur in any one hour, calculations show that the construction traffic would generate $L_{Aeq(1hour)}$ noise levels of 55 dBA at a distance of 10 m. The predicted noise levels therefore meet the ECRTN objectives and are consequently regarded as acceptable for construction activities.

Noise from idling trucks near construction sites can also impact on amenity in some instances. The current construction traffic arrangements are not likely to occur next to residences, so this is not anticipated to be a problem. The finalised construction traffic arrangements will be reviewed during the CNVMP assessment.

8.8 Potential Noise Mitigation

In view of the predicted noise criteria exceedances, noise mitigation is recommended to minimise the impact of construction noise at nearby residential receivers. The following measures would need to be considered:

- **The contractor(s) would prepare and implement a site-specific Construction Noise and Vibration Management Plan (CNVMP) including consideration of the measures listed below and any other initiatives identified to minimise the noise impact.**
- Noise intensive construction works would be carried out during normal construction hours wherever practicable. Where works involving the operating line need to be carried out during weekend possessions, noise intensive activities should be scheduled to occur during the daytime, where possible.
- Quietest available plant suitable for the relevant tasks would be used.
- The duration of noise intensive activities would be minimised insofar as possible.
- Where appropriate and effective, site hoardings or temporary noise barriers would be used to provide acoustic shielding of noise intensive activities or fixed plant items.
- Rock breakers would be of the "Vibro-silenced" or "City" type, where feasible and reasonable.
- Activities resulting in highly impulsive or tonal noise emission (eg rock breaking) would be limited to 8 am to 12 pm Monday to Saturday and 2 pm to 5 pm Monday to Friday (except where essential during track possessions).
- Noise awareness training would be included in inductions for site staff and contractors.
- Noise generating plant would be orientated away from sensitive receivers, where possible.
- Notification would be provided to residents via newspaper advertising and letterbox drops, advising of the nature and timing of works, contact number and complaint procedures.
- Discussions with nearby schools regarding the implementation of noise management measures such as the scheduling of the noisiest construction activities outside of exam periods.

- 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 15**.
- Deliveries would be carried out within standard construction hours, except as directed by the Police or RTA, or as required for possession work.
- 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 where possible.
- Trucking routes to be via major roads, where possible.
- Trucks would not be permitted to queue near residential dwellings with engines running.

There is also a requirement to protect the occupational health and safety (OHS) of patrons and staff during the proposed construction activities. The CNVMP should address Section 49 of the Occupational Heath and Safety Regulation 2001.

9 CONSTRUCTION VIBRATION

TIDC are currently preparing a Construction Noise Strategy for Rail Project. This document, which is currently in draft form requires a Construction Noise and Vibration Management Plan (CNVMP) to be developed as part of the approvals process. The guidelines in TIDC's Construction Noise Strategy will be utilised in the preparation of CNVMP when more detailed information about the proposed construction methodologies is available. This will include an assessment of feasible and reasonable mitigation measures to reduce the potential noise and vibration impacts of the proposed construction works. The CNVMP is undertaken at a later stage (after the Environmental Assessment) to ensure that the construction details are current and accurate.

The following provides a preliminary assessment of the potential vibration impacts during construction and the likely mitigation measures that may be required.

9.1 Operational Vibration Metrics

The three primary metrics used to describe construction vibration are:

PPV "Peak Particle Velocity" evaluated at the building footings and used to assess the risk of damage to structures.

V_{rms} "Root mean squared vibration velocity", a vibration parameter used to assess human response to continuous or intermittent vibration.

eVDV "Estimated Vibration Dose Value", the overall vibration exposure assessed over the daytime or night-time period to assess human response to intermittent vibration.

9.2 Construction Vibration Goals

The standards normally used as a basis for assessing the risk of vibration damage to structures are German Standard DIN 4150 Part 3 1999 and British Standard BS 7385 Part 2 1993.

For continuous vibration or repetitive vibration with potential to cause fatigue effects, DIN 4150 provides the following PPV values as safe limits, below which even superficial cosmetic damage is not to be expected:

- 10 mm/s for commercial buildings and buildings of similar design.
- 5 mm/s for dwellings and buildings of similar design.
- 2.5 mm/s for buildings of great intrinsic value (eg heritage listed buildings).

For short term vibration events (ie those unlikely to cause resonance or fatigue), DIN 4150 offers the criteria shown in **Table 18**. These are maximum levels measured in any direction at the foundation <u>or</u> in the horizontal axes, in the plane of the uppermost floor.

Table 18 DIN 4150 - Structural Damage - Safe Limits for Short Term Building Vibration

Group	Type of Structure	Peak Particle Velocity (mm/s)			
		At Foundation At a Frequency of		Plane of Floor of Uppermost Storey	
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Note: For frequencies above 100 Hz, the higher values in the 50 Hz to 100 Hz column should be used.

These levels are “safe limits”, up to which no damage due to vibration effects has been observed for the particular class of building. “Damage” is defined by DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls.

Human comfort is normally assessed with reference to British Standard BS 6472 1992 or Australian Standard AS 2670.2 1990. For daytime activities, the limiting objective for continuous vibration at residential or commercial receivers is V_{rms} 0.4 mm/s. BS 6472 1992 also contains a formula for the Vibration Dose Value (VDV), which can be used to evaluate intermittent vibration or vibration levels that vary significantly over time. As the vibration approaches continuous, this VDV trends to the continuous vibration criterion.

As noted in **Section 6.3**, the NSW Department of Environment and Conservation document *Assessing vibration: a technical guideline* is based on guidelines contained in BS 6472–1992, and the acceptable values for continuous and intermittent vibration are the same.

9.3 Ground Vibration - Safe Working Distances for Intensive Activities

As a guide, safe working distances for typical items of vibration intensive plant are listed in **Table 19**. Safe working distances are quoted for both “cosmetic” damage (refer DIN 4150) and human comfort (refer BS 6472).

Table 19 Recommended Safe Working Distances for Vibration Intensive Plant

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (DIN 4150)	**Human Response (BS 6472)**
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

The safe working distances given in **Table 19** are <u>indicative</u> and will vary depending on the particular item of plant and local geotechnical conditions etc. **Table 19** indicates that exceedances of the structural damage criteria (DIN 4150) may occur if a 13 tonne (or larger) roller or a heavy hydraulic hammer is operated within 20 m to 25 m of a residential building. Therefore, monitoring at the commencement of vibratory compaction or hydraulic hammering within 30 m of residential buildings would confirm compliance or non-compliance. In the event that non-compliance occurs, immediate corrective action should be taken.

The safe working distances apply to structural damage of typical buildings and typical geotechnical conditions. Portions of Hurlstone Agricultural High School are classified as heritage structures, and at this and any other identified heritage locations, vibration monitoring is recommended to confirm the safe working distances.

9.4 Assessment of Construction Vibration Impact

9.4.1 Cosmetic Damage

It is reasonable to assume that the construction activities would be managed such as to avoid structural damage due to vibration. In order to achieve this objective, the recommended safe working distances in Column 3 of **Table 19** should be observed. If it is necessary to work within these zones, vibration monitoring should be undertaken.

With the exception of the carpark works, it is anticipated that there will not be a need to operate any of the vibration intensive plant items in **Table 19** within 30 m of a sensitive receiver.

At the carpark site, some sensitive receiver locations are as close as 15 m from the edge of the worksite, and it will be necessary therefore to select smaller vibratory rollers (refer **Table 19**) for some works. The CNVMP will address this in more detail once the specifics of the construction methodology are known. This potential vibration impact is entirely manageable through correct plant selection and noise monitoring.

Vibration emissions from impact piling activities are difficult to predict at this stage, however they are an important potential impact source. The potential impact of piling work will be assessed in more detail at the CNVMP stage once more information concerning plant type and ground conditions is known. It is anticipated that any potential impacts will be satisfactorily mitigated on a case by case basis.

Portions of Hurlstone Agricultural High School are classified as heritage structures, and at this and any other identified heritage locations, vibration monitoring is recommended to confirm the safe working distances. The potential construction vibration impacts and mitigation measures will be assessed in more detail at the CNVMP stage.

9.4.2 Human Response

The safe working distances for human comfort can be quite extensive, as demonstrated in Column 4 of **Table 19**. For this worksite however, sensitive receivers are generally 40 m to 100 m from the majority of the works, and as generally 20 m to 40 m from the carpark works. It is consequently expected that the human comfort impact during corridor works will be very limited, but that the vibration emissions during the carpark construction will need to be appropriately managed.

At locations near to sensitive receivers, it is recommended that the roller be selected to minimise vibration, insofar as possible without compromising the ability to complete the required task. It is also recommended that monitoring be carried out on commencement of vibratory rolling to determine an acceptable duration consistent with BS 6472.

As for the cosmetic damage, this potential vibration impact is entirely manageable through correct plant selection and noise monitoring.

10 SUMMARY OF MITIGATION MEASURES

The following sections provide a summary of the mitigation measures that are recommended for the project.

Operational Noise (refer Section Section 5.3.3 and 5.9)

- Low level parapets to be used on grade separated flyovers.
- Compliance measurements to be undertaken after opening and following the introduction of the SWRL train timetable.

Operational Vibration (refer Section 6.5)

- No mitigation measures are required at this stage

Construction Noise (refer Section 8.8)

- The contractor(s) would prepare and implement a site-specific Construction Noise and Vibration Management Plan (CNVMP) including consideration of the measures listed below and any other initiatives identified to minimise the noise impact.
- Noise intensive construction works would be carried out during normal construction hours wherever practicable. Where works involving the operating line need to be carried out during weekend possessions, noise intensive activities should be scheduled to occur during the daytime, where possible.
- Quietest available plant suitable for the relevant tasks would be used.
- The duration of noise intensive activities would be minimised insofar as possible.
- Where appropriate and effective, site hoardings or temporary noise barriers would be used to provide acoustic shielding of noise intensive activities or fixed plant items.
- Rock breakers would be of the “Vibro-silenced” or “City” type, where feasible and reasonable.
- Activities resulting in highly impulsive or tonal noise emission (eg rock breaking) would be limited to 8 am to 12 pm Monday to Saturday and 2 pm to 5 pm Monday to Friday (except where essential during track possessions).
- Noise awareness training would be included in inductions for site staff and contractors.
- Noise generating plant would be orientated away from sensitive receivers, where possible.
- Notification would be provided to residents via newspaper advertising and letterbox drops, advising of the nature and timing of works, contact number and complaint procedures.
- 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 15**.
- Deliveries would be carried out within standard construction hours, except as directed by the Police or RTA, or as required for possession work.
- 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 where possible.
- Trucking routes to be via major roads, where possible.
- Trucks would not be permitted to queue near residential dwellings with engines running.
- The CNVMP should address Section 49 of the OHS Regulation 2001.

Construction Vibration (refer Section 9.3 and 9.4)

- Buffer zones would be established, and work within these zones limited to activities that have been assessed as safe or to activities undertaken in conjunction with strict vibration monitoring. The buffer zones will depend on the construction equipment selected (refer **Table 19**) and will be determined during the CNVMP assessment.
- The smallest suitable size of vibratory roller would be selected when working close to occupied residential buildings to minimise vibration impact (refer buffer distances in **Table 19**).
- Portions of Hurlstone Agricultural High School are classified as heritage structures, and at this and any other identified heritage locations, vibration monitoring is recommended to confirm the safe working distances. The potential construction vibration impacts and mitigation measures will be assessed in more detail at the CNVMP stage.
- Vibration due to carpark construction will be assessed in detail at the CNVMP stage.

11 CONCLUSIONS

Transport Infrastructure Development Corporation (TIDC) have requested that a supplementary noise assessment to the South West Rail Link (SWRL) Environmental Assessment (EA) be undertaken for the Glenfield Junction (Stage A) works. This assessment has been undertaken to enable, if necessary, the early commencement of the Glenfield Junction (Stage A) works. This assessment will be included in the Submissions Report of the SWRL EA.

The conclusions of this report may differ from those in the SWRL EA due to the availability of updated data and noise assessment guidelines. Specifically, the application of the "Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects" (IGANRIP) (NSW Government - February 2007) has led to new conclusions (which supersede the previous advice) regarding the consideration of operational noise barriers.

The Glenfield Junction (Stage A) works are a component of the SWRL, which is a new line to Leppington from Glenfield. Construction of the SWRL is planned to begin in 2009, with the line operational by 2012. It is anticipated that the Glenfield Junction (Stage A) works could be completed by mid 2011.

The SWRL consists of a dual track, electrified passenger railway line, approximately 13 km long, from the existing junction of the East Hills Line and the Main South Line near Glenfield out to Leppington. The SWRL also incorporates an upgraded station at Glenfield, two new stations at Edmondson Park and Leppington, and a stabling facility west of the planned Leppington town centre.

The Glenfield Junction (Stage A) construction works comprise; safety fences, services investigation and relocation, track and crossover works, earthworks and drainage for the SSFL, and flyover works (piling, pile caps, substructure and precast superstructure).

The operational noise and vibration assessment for the Glenfield Junction (Stage A) works is restricted to the works between chainage 30.500 km and 32.900 km (measured along the East Hills Line). The remaining changes to rail operations (adjacent to and south of Glenfield Station) will be assessed separately.

Operational Rail Noise

Guidance in relation to operational noise goals for the proposal is provided in the IGANRIP. The interim guideline provides "noise trigger" levels that trigger the need for a project to conduct an assessment of the potential noise and vibration impacts from the project and examine what mitigation measures would be feasible and reasonable to apply to ameliorate the project's impacts.

For airborne noise created by the operation of surface track, trigger levels are provided for rail infrastructure projects including a "new railway line" or "redevelopment on an existing railway line". In the vicinity of Glenfield, the "redevelopment" trigger levels apply, and consist of two components; absolute L_{Aeq} and L_{Amax} noise level triggers and triggers based on the increase in L_{Aeq} and L_{Amax} noise levels.

The IGANRIP requires that the operational noise assessment determine both the individual and combined change in noise levels due to passenger and freight rail traffic. Further assessment of potential mitigation measures is only required where there is a noticeable increase in noise levels due to the project (defined as an increase of 2 dBA or more in L_{Aeq} or 3 dBA or more in L_{Amax}). This project is responsible for the slewing of the SSFL but not the additional freight traffic, consequently, the project increases (compared to the Year 2007 scenario) will be based on:

- The combined (freight and passenger rail traffic) noise level in Year 2011 (after opening); and

- The passenger rail traffic noise level (i.e not including freight) in Year 2017.

The combined freight and passenger rail traffic noise levels in Year 2017 are provided for discussion purposes but are not assessed against the IGANRIP trigger levels.

For the Year 2011 and Year 2017 noise modelling scenarios, the increase in "electric passenger train" noise levels is less than the noise trigger levels of 2 dBA and 3 dBA (for L_{Aeq} and L_{Amax} respectively) at existing and planned sensitive receiver locations, during all assessment periods.

For the Year 2011 noise modelling scenario, the increase in "all train" noise levels is less than the noise trigger levels of 2 dBA and 3 dBA (for L_{Aeq} and L_{Amax} respectively) at sensitive receiver locations, during all assessment periods.

Note that for the Year 2017 noise modelling scenario, the increase in noise levels due to the combination of electric passenger and freight trains is greater than the IGNARIP noise trigger levels, however as discussed above, this increase is not the result of the project. The impact of this increase is addressed in the SSFL Environmental Assessment.

Operational Rail Vibration

The effects of vibration in buildings can be divided into three main categories; those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be prejudiced. The levels of vibration required to cause damage to buildings tend to be at least an order of magnitude (10 times) higher than those at which people consider the vibration acceptable. Hence, the controlling criterion would still be the human comfort criterion, and it is therefore not necessary to set separate criteria for this proposal in relation to building damage from railway vibration.

The proposed human comfort criterion is based on the vibration dose values nominated in BS 6472, and the DEC's *"Assessing vibration: a technical guideline"* and is 109 dB, recognising that vibration levels above the continuous vibration levels nominated in AS 2670 (106 dB day, 103 dB night) would be perceptible and may result in adverse comment from sensitive receivers.

None of the existing or planned sensitive dwellings lie inside the 109 dB criterion contour.

The 106 dB (daytime "perceptible" zone) and 103 dB (night-time "perceptible" zone) contours extend out to a maximum distance of 21 m and 31 m (from the nearest track centrelines) respectively. No existing or planned sensitive receivers lie within the daytime "perceptible" zone. Vibration levels may be approaching perceptibility at some of the existing residential locations during the night-time period however the levels would be well below the 109 dB criterion.

In the SSFL Environmental Assessment, vibration emissions from the freight trains were predicted to comply with the human comfort and building damage criteria at all locations, and hence no mitigation measures were proposed. The slewing of the SSFL to allow for the construction of the Glenfield North Junction does not move any part of the SSFL tracks to within 10 m of any sensitive receiver (the closest is at least 40 m away), and as such the vibration levels from the SSFL are still expected to comply with the criteria.

Operational Carpark Noise

The existing carparking area on the western side of Glenfield Station is proposed to be upgraded and expanded to provide an additional 295 spaces.

The upgraded and expanded carpark is anticipated to be used primarily during the am and pm peak periods. Noise emissions are predicted to comply with the relevant noise goals at all locations.

Construction Noise and Vibration

At the majority of locations, the construction noise modelling indicates exceedances of the noise goals when plant and equipment are located in close proximity to residential and commercial receiver locations. This results primarily from the small distances involved between construction plant and the nearest receivers; especially at construction sites near Glenfield.

Particular effort would need to be directed towards the implementation of all feasible and reasonable noise mitigation and best practice management strategies. TIDC's Construction Noise Strategy requires the preparation of a Construction Noise and Vibration Management Plan (CNVMP) at a later stage in the assessment process when more detailed information is available. Whilst this report provides an indication of the likely mitigation measures that may be required during construction, specific measures will be provided in the CNVMP.

The fact that noise criteria exceedances have been identified does not necessarily indicate that the works should not proceed, but rather, highlights the importance of managing the works to minimise both the noise levels and duration of the predicted exceedances.

Vibration monitoring and buffer zones are proposed in order to minimise disruptions to the local community and prevent damage to nearby buildings during vibration-generating construction activities (such as vibratory rolling).

12 REFERENCES

This assessment has utilised the following references:

Australian Standard AS 2670.2:1990 *Evaluation of Human Exposure to Whole Body Vibration - Part 2: Continuous and Shock Induced Vibration in Buildings (1 Hz to 80 Hz)*.

British Standard BS 6472:1992, *Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)*.

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