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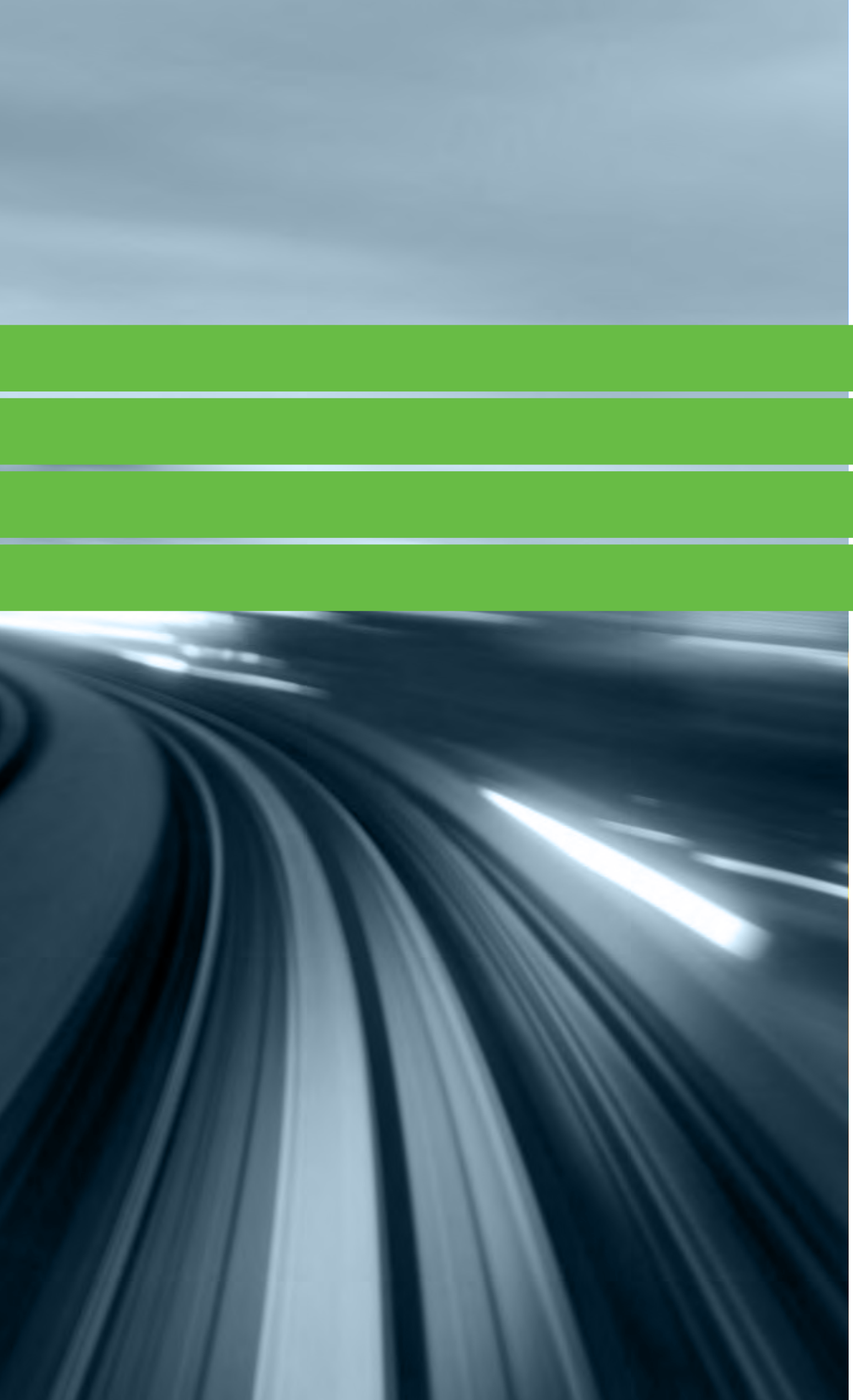

10 NOISE AND VIBRATION - CONSTRUCTION

10.1 Introduction

This section summarises the results of the noise and vibration assessment undertaken by SLR Consulting Australia Pty Ltd for the major civil construction works (refer to Technical Paper 2). It describes the assessment methodology, a summary of the existing noise environment, the potential noise and vibration impacts during construction and the proposed mitigation measures. Operational noise and vibration will be assessed in EIS 2.

The noise and vibration assessment is based upon the project description and construction methodologies outlined in Chapter 7. This represents one example of how the project could be constructed. During the detailed design stage, and following the award of the construction contract(s), the construction methodologies would be reviewed based on the detailed design.

Contractors would be required to prepare a Construction Noise and Vibration Impact Statement (CNVIS) for each major stage of works or activity, outlining the potential noise and vibration impacts, proposed mitigation measures, and community consultation process. These would be required to be approved by TfNSW prior to the works being undertaken.

In determining feasible and reasonable mitigation measures for each construction site, the CNVIS must incorporate the mitigation measures described in the project's Conditions of Approval, and follow the guidelines in the NWRL Construction Noise and Vibration Strategy (CNVS) - refer to Appendix E of Technical Paper 2.

Should the construction contractor's methodology or construction program differ from that on which the noise and vibration assessment is based, then alternative mitigation measures may be appropriate. For example, acoustic sheds are currently proposed at sites where spoil removal is anticipated to occur at night-time. These may not be required if spoil removal is not undertaken at night-time or if other noise mitigation measures can be applied to achieve the Noise Management Levels (NMLs), for example stockpiling the spoil underground with the access to underground working being covered or sealed with acoustic panels.

Section 10.8 details proposed noise and vibration management strategies for each station site and construction location.

10.2 Methodology

The main steps involved in the noise and vibration assessment were to:

- Characterise the existing noise environment based on attended and unattended noise measurements at representative locations across the project area.
- Map sensitive receivers.
- Determine noise and vibration management levels in accordance with relevant guidelines.
- Conduct modelling to quantify the potential noise and vibration impacts.
- Assess the significance of potential impacts identified.
- Examine proposed construction methodologies and identify mitigation measures that are likely to be required to minimise construction noise and vibration impacts.
- Prepare and document the mitigation measures that would be implemented during construction.

10.3 Director-General's Requirements, Conditions of Approval and Statement of Commitments

Table 10.1 sets out the Director-General's Requirements (DGRs), the Conditions of Approval (CoA) and the Statement of Commitments (SoCs) as they relate to construction noise and vibration, and where these have been addressed within this chapter. Unless otherwise stated, references are to chapters of EIS 1 in relation to major civil works.

Table 10.1 Director-General's Requirements, Conditions of Approval and Statement of Commitments

DGR Reference	Description	Addressed
Noise	The assessment of construction noise shall have consideration of the Interim Construction Noise Guidelines (DECC, 2009)	Construction noise assessment relating to major civil construction in Sections 10.6 and 10.7. Construction noise assessment relating to rail systems and stations construction to be addressed in EIS 2.
CoA Reference	**Description**	**Addressed**
2.6	In relation to operational noise and vibration, the Proponent shall ensure that: ▪ the project rail corridor is designed consistent with the I*nterim Guideline for the Assessment of Noise from Rail Infrastructure Project*s (DECC, 2007); ▪ the project stabling facilities are designed consistent with the *Industrial Noise Policy* (EPA, 2000); and ▪ the project is designed to consistent with *Assessing Vibration: A Technical Guideline* (DECC, 2006).	Operational noise and vibration to be addressed in EIS 2.
3.6	The Proponent shall review the noise and vibration impacts of the project during construction (including construction traffic) and operation, considering all reasonable and feasible mitigation options at existing and planned future receivers.	Construction noise and vibration assessment relating to major civil construction in Section 10.7 and 10.8. Construction noise and vibration assessment relating to rail systems and stations construction, and operations to be addressed in EIS 2.

SoC Reference	Description	Addressed
20	A detailed noise and vibration assessment of the proposed construction activities, including blasting if required, would be undertaken as part of design development and would include the investigation of the potential need for reasonable and feasible mitigation in accordance with relevant policies and guidelines.	Construction noise and vibration assessment relating to major civil construction in Section 10.7 and 10.8. Construction noise and vibration assessment relating to rail systems and stations construction to be addressed in EIS 2.
21	Consult with local Councils, Growth Centres Commission and RailCorp in relation to land use planning and development controls to minimise the need for physical noise mitigation.	Consultation in relation to the design of the rail line and noise mitigation in relation to land use planning is detailed in Chapter 5. As part of this consultation, has been undertaken with the Departmental Precinct Landuse Group. Consultation would be ongoing with this group and with local Councils, Growth Centres Commission and RailCorp during the development of EIS 2.
22	In regard to operational noise, the *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects* (Department of Planning, 2007) would be used to implement the following activities: Modelling of operational noise impacts (including ground borne noise) in more detail as part of the design development; Identification of acoustic mitigation measures to meet, where reasonable and feasible, the design goals; and Select representative locations for the project at which it is appropriate to later assess compliance.	Operational noise to be addressed in EIS 2.

23	In regard to train stabling operational noise, the following would be undertaken: Determine the extent of any physical noise mitigation measures in consultation with Department of Environment and Climate Change, RailCorp and Growth Centres Commission; and Review the results of RailCorp's investigations into addressing horn noise and consider the feasibility in consultation with RailCorp of implementing a low volume horn test.	Operational noise to be addressed in EIS 2.
24	Investigate feasible and reasonable mitigation measures to manage operational vibration in consultation with Councils, the Department of Environment and Climate Change and RailCorp.	Operational noise to be addressed in EIS 2.

10.4 Existing environmental conditions

The existing noise environment varies along the length of the proposed alignment, as would be expected from the wide range of commercial, urban, residential and industrial land uses within the study area.

Ambient noise measurements were undertaken at 10 locations along the proposed alignment, supplemented with attended measurements to confirm the major noise sources influencing the measurements. This information was supplemented with ambient noise data collated during the previous NWRL proposal and other recent projects, resulting in a total of 25 representative locations across the project area.

Ambient noise surveys are undertaken to establish the baseline noise levels upon which the construction NMLs are based. The noise parameters most relevant to construction noise are described below and are evaluated during the daytime (7 am to 6 pm), evening (6 pm to 10 pm) and night-time (10 pm to 7 am) periods:

- **RBL**
  Rating Background Level – This is 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 and is used to set the LAeq(15minute) NMLs for residential receivers.
- **LAeq(period)**
  The Energy Average Noise Level evaluated over a defined measurement period (typically 15 minutes for construction noise or the relevant daytime, evening or night-time period for ambient noise monitoring).
- **LAmax or LA1(1min)**
  The "typical maximum noise level" for an event, used in the assessment of potential sleep disturbance during night-time periods.

Unattended noise monitors were placed at sensitive receiver locations in the vicinity of all construction sites for a minimum period of one week. The results of the unattended noise survey are summarised in **Table 10.2**. The location of the unattended noise monitors are illustrated in the Site Plan in **Figure 10.1** and Appendix B of Technical Paper 2.

Table 10.2 Summary of Unattended Noise Logging - Construction Noise Parameters

Location	Noise Level (dBA)[1]					
	Daytime 7.00 am to 6.00 pm		Evening 6.00 pm to 10.00 pm		Night-time 10.00 pm to 7.00 am	
	RBL	L_{Aeq}	RBL	L_{Aeq}	RBL	L_{Aeq}
BG01	45	56	41	54	32	51
BG02	49	55	41	52	31	48
BG03	55	61	52	60	35	55
BG04	45	53	41	51	34	49
BG05	37	50	38	48	30 2	45
BG06	50	61	47	59	31	54
BG07	54	70	48	67	30	65
BG08	54	64	45	59	34	54
BG09	47	53	45	52	38	47
BG10	46	53	45	52	36	50
BG11	36	52	35	46	31	43
BG12	51	61	48	60	33	57
BG13	51	60	50	58	34	54
BG14	47	62	48	61	38	58
BG15[3]	39	49	41	48	39	48
BG16[3]	45	55	46	53	37	51
BG17	48	62	44	59	32	56
BG18	54	63	52	60	47	58
BG19	52	64	49	62	32	59
BG20	41	52	41	50	33	48
BG21	51	60	51	58	39	55
BG22	52	68	51	66	39	63
BG23	44	57	43	51	34	48

Location	Noise Level (dBA)[1]					
	Daytime 7.00 am to 6.00 pm		Evening 6.00 pm to 10.00 pm		Night-time 10.00 pm to 7.00 am	
	RBL	L_{Aeq}	RBL	L_{Aeq}	RBL	L_{Aeq}
BG24[3]	45	59	49	59	38	55
BG25[3]	43	53	44	54	30 2	58

Note 1: The RBL and LAeq noise levels have been obtained using the calculation procedures documented in the NSW Industrial Noise Policy (INP).
Note 2: In accordance with the INP, where the RBL is found to be less than 30 dBA, then it is set to 30 dBA.
Note 3: Where the daytime RBL is lower than the evening RBL, then the daytime RBL has been used to determine the construction NMLs.

10.5 Sensitive receivers

A review of the existing and proposed land uses within an area approximately 100m either side of the proposed alignment and construction sites was undertaken to identify the nature and location of sensitive receivers. This information was collated from a combination of site inspections, street-level imagery and review of aerial photography.

For the construction noise and vibration assessment, all residential receivers are considered to be of a sensitive nature. Other sensitive receivers include commercial premises, educational facilities, schools, childcare centres, places of worship and hospitals.

Some facilities such as sound recording studios, performance spaces and precision laboratories have an increased sensitivity to noise and vibration. Adjacent to the NWRL proposal area, such facilities include:

- The Hills Centre for Performing Arts.
- Hillsong Church and its recording studio (HUB building).

A number of commercial buildings have been identified along the alignment as being potentially sensitive to noise and vibration. Detailed inspections of such buildings have not yet been undertaken. They would be investigated in more detail as the design progresses and any relevant protocols or mitigation measures discussed in this chapter would be implemented.

10.6 Construction noise and vibration management levels

10.6.1 Airborne construction noise

Airborne noise would occur at all construction sites and would be primarily associated with surface activities or underground activities where there is an airborne noise path between the source and receiver (ie not fully shielded).

Construction NMLs are based on the *Interim Construction Noise Guideline* (ICNG – DECC 2009), administered by the Office of Environment and Heritage (OEH).

The interim guideline contains NMLs for sensitive land uses including residential, commercial and industrial receivers. These are provided in **Table 10.3** and **Table 104** for residential and other sensitive receivers respectively.

At locations where the construction noise levels are predicted to exceed the NMLs, consideration would be given to applying all feasible and reasonable work practices for each site and activity to minimise the potential noise impacts.

In addition to identifying feasible and reasonable work practices, a CNVS has been developed for the NWRL project. The CNVS documents the best-practice techniques specific to the NWRL project for managing construction noise and vibration, and implementing feasible and reasonable mitigation measures.

The strategy includes a standard suite of mitigation measures which would be implemented across all NWRL construction sites (such as noise attenuation walls restricting noisy works to daytime hours only, periodic notification of proposed works, adherence to construction respite periods and use of non-tonal reversing alarms). It also includes additional mitigation measures where construction noise is predicted to exceed the NMLs (such as noise monitoring, individual briefings, respite offers and in some instances at night, arranging and providing alternative accommodation). These measures are primarily aimed at a pro-active working relationship with affected sensitive receivers.

Table 10.3 Airborne NMLs for Residential Receivers (from ICNG)

Time of Day	Noise Management Level (NML) LAeq(15minute)	How to Apply
Recommended standard hours: **Monday to Friday 7.00 am to 6.00 pm** **Saturday 8.00 am to 1.00 pm** **No work on Sundays or public holidays**	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see Section 7.2.2 of the ICNG.

Table 10.4 Airborne NMLs for Sensitive Land Uses (other than Residential) (from ICNG)

Land Use	Management Level, LAeq(15minute) (Applies when Land Use is being Utilised)
Classrooms at schools and other educational institutions	Internal noise level 45 dBA
Hospital wards and operating theatres	Internal noise level 45 dBA
Places of Worship	Internal noise level 45 dBA
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dBA
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dBA
Community Centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

10.6.2 Ground-borne construction noise

Ground-borne noise during construction may be experienced by sensitive receivers located close to the tunnels or other underground excavations (including stations, service facilities and crossover caverns). Whilst ground-borne noise may also be audible during construction activities on the surface, the airborne noise levels are likely to be higher and more prominent.

Ground-borne NMLs for residential receivers are based on levels provided in the ICNG. These are provided in **Table 10.5**.

Ground-borne noise is usually not a significant disturbance to building occupants during the day due to higher ambient levels which mask the audibility of ground-borne noise emissions. For daytime periods, the ICNG does not provide NMLs, but instead specifies that the human comfort vibration guidelines are applicable.

During evening and night-time periods however, when ambient noise levels are lower, ground-borne noise is more prominent and may result in adverse comment from building occupants.

Table 10.5 Ground-borne NMLs for Residential Receivers (from ICNG)

Time of Day	Ground-borne Noise Management Levels (NMLs) - $L_{Aeq(15minute)}$
Daytime 7am to 6pm	Human comfort vibration objectives only
Evening 6pm to 10pm	40 dBA – Internal
Night-time 10pm to 7am	35 dBA – Internal

At locations where the construction noise levels are predicted to exceed the NMLs, consideration must be given to applying all feasible and reasonable work practices for each site and activity to minimise the potential noise impacts. Further guidance is provided in the CNVS.

10.6.3 Ground-borne 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.
- Those in which the integrity of the building or the structure itself may be prejudiced.

People are able to "feel" vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion).

As a guide, safe working distances for typical items of vibration intensive plant are provided in the CNVS. The safe working distances are quoted for both "cosmetic" damage (based on British Standard BS 7385:2-1993) and human comfort (based on *Assessing Vibration - a technical guideline* – DEC 2006). Cosmetic damage is very minor in nature and readily repairable. It does not affect the structural integrity of the building.

To ensure that buildings in close proximity to the proposed construction activities are not damaged by the proposed construction works, the following control measures would be put in place:

- If there is a risk that a building or structure may be damaged, building condition surveys would be undertaken prior to and following construction to identify any change in building condition as a result of the construction activities.
- The safe working distances for cosmetic damage would be complied with at all times, unless otherwise approved by the relevant authority.
- Attended vibration measurements would be required at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.

A conservative vibration damage screening level of 7.5 mm/s has been adopted for the NWRL project and has been established with reference to the minor cosmetic damage criteria in British Standard BS 7385 Part 2-1993. The vibration levels specified in this standard are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure.

The recommended screening level of 7.5 mm/s is also applicable to heritage structures, unless it is known that the structure is already structurally unsound – in which case, a lower screening level may

be applicable. At this stage in the assessment, no heritage structures have been identified in close proximity to the NWRL alignment which are known to be structurally unsound.

Consistent with the airborne noise assessment, consideration must be given to identifying all feasible and reasonable work practices, and implementing the mitigation and management measures identified in the CNVS.

10.6.4 Blasting

Blasting may be required if hard rock is encountered during the excavation works. Guidance in relation to acceptable overpressure and vibration from blasting is provided in the ICNG, which specifies that the assessment should be based on the levels in the *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZEC 1990).

Should blasting be required, an assessment of the realistic worst-case noise and vibration levels would need to be undertaken and compared with noise and vibration criteria. Alternative construction methods such as penetrating cone fracture would be considered if the predicted noise and vibration levels from blasting exceed the criteria.

10.6.5 Construction traffic noise

During construction, spoil removal and product deliveries would result in additional heavy vehicle movements on public roads. Whilst specific guidance on acceptable noise levels associated with construction traffic is not provided by OEH, the potential noise impacts have been identified using guidance in the NSW Road Noise Policy (RNP) (DECCW, 2011).

One of the objectives of the RNP is to protect against excessive decreases in amenity as the result of a project by applying relevant noise increase criteria. In this respect, the RNP notes that a noise level increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person. On this basis, construction traffic NMLs set at 2 dB above the existing road traffic noise levels during the daytime and night-time periods are considered appropriate to identify the onset of potential noise impacts. At locations where the predicted construction traffic noise levels are more than 2 dB above the existing levels, consideration has been given to identifying all feasible and reasonable work practices to minimise the potential impacts.

Sleep disturbance

The OEH's most recent noise policy considers sleep disturbance as the emergence of the maximum level (LA1(1minute) or LAmax) above the LA90(15minute) background level at the time. The appropriate screening criterion for sleep disturbance is determined to be a maximum level 15 dB above the RBL, normally during the night-time period (10pm to 7am). Where this criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

- Additional guidance is provided in the RNP which contains a section on sleep disturbance that includes a summary of current literature. The RNP concludes that:
- Maximum internal noise levels below 50 dBA to 55 dBA are unlikely to cause awakening reactions.
- One or two events per night, with maximum internal noise levels of 65 dBA to 70 dBA, are not likely to affect health and wellbeing significantly.

On the basis of the above guidance, a sleep disturbance NML of 55 dBA (internal) has been adopted, which equates to an external noise level of 65 dBA (assuming open windows).

10.7 Identification of impacts

10.7.1 Construction noise and vibration modelling

The following major construction sites have been identified for the major civil construction works (refer to Chapter 7; section 7.9):

- Epping Services Facility and Epping Decline (sites 1 and 2).
- Cheltenham Services Facility (site 3).
- Cherrybrook Station (site 4).
- Castle Hill Station (site 5).
- Hills Centre Station (site 6).
- Norwest Station (site 7).
- Bella Vista Station, Balmoral Road pre-cast site and Memorial Avenue pre-cast site (sites 8, 9 and 10).
- Kellyville Station (site 11).
- Rouse Hill Station (site 14).
- Cudgegong Road Station and Tallawong Stabling Facility (site 17).
- Excavation of mined tunnels between Epping and Bella Vista Station, including cross passages, crossover caverns and Parramatta Epping Rail Link stub tunnels.
- Civil excavation and construction works for surface track section north of Bella Vista Station including cuttings, embankments and viaduct / bridge structures (sites 12, 13, 15 and 16).

At each site, construction activities are likely to occur over several years. Site establishment activities would initially be required at all construction sites as described in Chapter 7. These works would predominantly be undertaken during the standard daytime construction hours. Construction site hoardings would be erected to also act as noise barriers as part of this stage.

At the Cherrybrook, Hills Centre and Bella Vista Station sites, tunnel boring machine (TBM) launch, support and retrieval facilities would be provided as described in Chapter 7. The Epping Decline site is also proposed to be used as a TBM retrieval site for the TBM cutter head components only. Establishment of these sites, including excavation of the access shafts would predominantly be undertaken during the standard daytime construction hours.

Several construction sites are proposed to include activities which would be undertaken on a 24 hour per day basis. At these sites, high noise generating activities would be substantially enclosed within acoustic sheds (where required) in order to minimise the potential noise impacts at sensitive receivers. It should be noted, however that these acoustic sheds cannot be erected until certain preparatory works are completed. Until such time as the acoustic sheds have been established, the activities at these sites would be predominantly undertaken during standard daytime construction hours.

Construction noise and vibration emissions have been assessed for each of the major worksites and proposed construction phases (including site establishment, excavation and construction). For each worksite and construction phase, a noise and vibration modelling scenario was developed to assist in calculating the likely noise and vibration levels. These scenarios are considered representative of the typical worst case impacts.

The ICNG recommends that the realistic worst-case or conservative noise levels from the source should be predicted for assessment locations representing the most noise-exposed residences or

other sensitive land uses. For each construction site, residences and other sensitive receivers have been grouped together into receiver areas or 'catchments', which comprise those receivers which will experience a similar level of construction noise. For each of these receiver areas the noise levels are predicted at the most noise-exposed location, which will usually be the closest receiver.

Other sensitive receivers within the catchment would generally experience lower noise levels compared with the most noise-exposed location, with levels decreasing by typically 6 dB as the distance from the source to the receiver is doubled, and by up to 10 dB or 15 dB when the receiver is shielded by other structures, buildings or rows of housing.

For each construction scenario, a computer noise model was developed to assist in predicting the noise and vibration levels within the nearest sensitive receiver areas. The noise model was developed using a software program (SoundPLAN - Version 7.0) which has the ability to calculate noise levels at specific locations.

The computer noise model incorporates a comprehensive range of acoustical parameters including:

- The source noise levels from various items of construction plant.
- The location of sensitive receivers.
- The three dimensional ground topography.
- The comparative height of noise sources and receivers.
- The noise shielding effects of intervening noise barriers, structures or acoustic sheds.
- The likely operating patterns of construction plant.

This calculation process is consistent with the requirements of Australian Standard AS2436-2010 Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites.

For the assessment of ground-borne noise and vibration impacts, noise and vibration levels have been predicted on the basis of typical noise/vibration level versus distance relationships based on previous projects with similar ground conditions (ie Ashfield Shale and Hawkesbury Sandstone).

For the assessment of road traffic noise on public roads, the change in noise levels has been assessed on the basis of the existing traffic movements on local and arterial road network, the typical noise levels associated with heavy vehicle movements and the proposed number of truck movements, particularly during the sensitive night-time period.

For each construction site and major work phase, consideration has been given to reducing the potential noise and vibration impacts through the implementation of feasible and reasonable mitigation measures. These measures comprise a three-part approach including:

1. Site specific mitigation measures (refer Section 10.8).
2. Standard mitigation measures to be implemented across all NWRL construction sites.
3. Additional mitigation measures to be implemented where the construction noise and vibration levels remain above the noise and vibration management levels.

Approaches 2 and 3 are described in greater detail in the CNVS.

10.7.2 Epping Services Facility and Epping Decline

The Epping Services Facility (on the western side of Beecroft Road) would ultimately be used as a tunnel ventilation site and emergency access and egress facility. The Epping Decline (on the eastern side of Beecroft Road) would be utilised to provide vehicular access to the proposed running tunnels and would be a temporary site used during construction only.

Construction activities at the Epping Services Facility site would include the demolition of an existing commercial building and excavation of shafts to the two tunnels below. The site would also be used for spoil removal during the underground tunnelling works, with truck access via Beecroft Road. At the Epping Decline, construction activities would include the excavation of the decline tunnel, and spoil removal associated with road header tunnelling works. Truck access would be via Beecroft Road.

At both sites, acoustic sheds would be constructed as a noise mitigation measure prior to the commencement of 24 hour per day spoil removal.

Airborne construction noise

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.6**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Location BG01 (refer to**Figure 10.1**). The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Beecroft Road and rail traffic on the Northern Line.

Table 10.6 Nearest sensitive receivers to Epping Services Facility and Epping Decline

Receiver Area	Receiver Type	Location Relative to Works (m)1		Construction NMLs LAeq(15minute) (dBA)		
		Epping Decline	Epping Services Facility	Day	Evening	Night
A – Residences between Cambridge and Derby Street	Residential	40	245	55	46	37
B – Residences Cambridge Street	Residential	70	100	55	46	37
C – Commercial Cambridge Street	Commercial	100	100	70	N/A	N/A
D – School	Educational (School)	135	135	55	N/A	N/A

Receiver Area	Receiver Type	Location Relative to Works (m)1		Construction NMLs LAeq(15minute) (dBA)		
		Epping Decline	Epping Services Facility	Day	Evening	Night
E – Commercial adjacent	Commercial	5	5	70	N/A	N/A
F – Residences Edensor Street South	Residential	20	20	55	46	37
G - Residences Edensor Street North	Residential	40	120	55	46	37

Note 1 The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Note 2 Refer to **Table 10.2** for RBLs and **Table 10.3** for noise criteria used to determine NML

An aerial photograph of the construction sites and nearest sensitive receivers is provided in **Figure 10.2**. A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.7** for each construction scenario.

Table 10.7 Predicted noise level exceedances at Epping Services Facility and Epping Decline

Receiver Area		Noise Modelling Scenario									
		Epping services facility – earthworks and site establishment (daytime)	Epping services facility – excavation of vertical shaft (daytime)	Epping services facility – roadheader support operations and spoil removal with acoustic shed (night-time)	Epping services facility – shaft concreting (daytime)	Epping services facility – shaft concreting (evening)	Epping decline tunnel – earthworks and site establishment (daytime)	Epping decline – excavation of decline shaft (daytime)	Epping decline – roadheader support operations and spoil removal with acoustic shed (night-time)	Epping decline – shaft concreting (daytime)	Epping decline – shaft concreting (evening)
A	Residences between Cambridge and Derby Street										
B	Residences Cambridge Street										
C	Commercial Cambridge Street			N/A		N/A			N/A		N/A
D	School			N/A		N/A			N/A		N/A
E	Commercial adjacent			N/A		N/A			N/A		N/A
F	Residences Edensor Street South										
G	Residences Edensor Street North										

 Compliance

 ≤ 10 dB exceedance

 10 dB to ≤ 20 dB exceedance

 > 20 dB exceedance or LAeq(15minute) > 70 dBA

During the standard daytime construction period, noise levels are predicted to be highest during the site establishment and excavation phases (including rock breakers). For these construction phases:

- NML exceedances of up to 31 dB are predicted at the nearest residential receivers in Area F during Epping Services Facility works.
- NML exceedances of up to 20 dB and 22 dB are predicted at the nearest residential receivers in Area A and G during Epping Decline site works.

During subsequent construction activities, the noise modelling scenarios include the benefit of construction site noise barriers (hoardings) and site buildings which assist in reducing the potential noise impacts.

For night-time spoil management operations associated with the underground tunnelling, an acoustic shed was included in the modelling for the purpose of reducing airborne noise levels as far as practical. With the proposed acoustic sheds at the Epping Services Facility and Epping Decline sites:

- Noise levels are predicted to comply with the NMLs at all residential receivers
- If trucks are used to remove spoil, then compliance is predicted at the services facility. For the Decline site, the predicted exceedance is up to 14 dB in Area G.

On site night-time LA_{max} truck noise

The L_{Amax} noise levels associated with individual truck movements are predicted to be 59 dBA at the nearest residential receivers in Edensor Street and 62 dBA at the nearest residential receivers in Cambridge Street / Beecroft Road. There are expected to be up to two truck movements per hour. In relation to the predicted LA_{max} noise levels from on site truck movements:

- At residences in Edensor Street and Cambridge Road, the maximum noise levels are predicted to exceed the sleep disturbance screening criterion by up to 12 dB and 15 dB respectively. This indicates that more detailed analysis is required.
- The maximum noise levels of 59 dBA (Edensor Street) and 62 dBA (Cambridge Road) comply with the sleep disturbance NML of 65 dBA (external). Maximum noise levels are therefore unlikely to cause awakening reactions.
- The maximum noise levels at both locations are at the lower range of the existing LA_{max} noise levels.

On the basis of the above, it is concluded that the risk of sleep disturbance is low.

Construction traffic noise

Traffic noise levels have been predicted for residential receivers located on the proposed access routes to the Epping Decline site and the Epping Services Facility. In this instance, the access to both sites would be via Carlingford and Beecroft Roads which are sub-arterial roads with significant daytime flows.

Given that night-time spoil removal is proposed, the night-time L_{Aeq} increase and sleep disturbance have also been assessed.

The predicted night-time noise level increase (L_{Aeq}) associated with construction traffic complies with the 2 dB allowance, therefore sensitive receivers are not likely to notice an increase in the average road traffic noise levels during construction. There are expected to be up to two movements or events per hour during the night and, whilst there is an exceedance of the external sleep disturbance NML of 65 dBA (of up to 11 dB), the L_{Amax} levels would be comparable with other heavy vehicles using the sub-arterial roads.

Ground-borne construction noise

Ground-borne construction noise impacts are not anticipated to be appreciable for the Epping Services Facility on the basis that the proposed demolition and excavation works would be on the surface and undertaken during daytime periods when ambient noise levels are highest.

At the nearest residential and commercial buildings adjacent to the Epping Services Facility, ground-borne noise levels are likely to be audible during daytime rock breaker activities; however airborne noise levels associated with the rock breaker works are likely to be much higher than the ground-borne noise levels and therefore more prominent. The airborne noise levels associated with rock breaker activities during the daytime periods are included in the airborne noise modelling results.

The potential ground-borne noise impacts associated with the excavation of the main tunnels, Epping Decline, Epping crossover cavern and Parramatta to Epping Rail Link stub tunnels are discussed in Section 10.7.13.

Ground-borne vibration

During rock breaker activities at the Epping Services Facility, ground-borne vibration levels may be perceptible at the nearest residential and commercial receivers. Potential impacts would be mitigated by undertaking rock breaking works during daytime periods and observing respite periods.

At the nearest commercial building, attended vibration measurements would be required at the commencement of potentially high vibration activities to ensure that vibration levels remain below the safe vibration levels associated with minor cosmetic building damage.

10.7.3 Cheltenham Services Facility

The Cheltenham Services Facility would be used as a tunnel ventilation site and emergency access and egress facility during construction. The facility is located approximately midway between Epping Station and Cherrybrook Station, adjacent to Cheltenham Oval.

Construction activities would include excavation of the vertical and horizontal shafts to the two tunnels below. The site would also be used for spoil removal associated with the shaft excavation works.

Light vehicle access is proposed to be directly on and off Castle Howard Road at the Murray Road reservation. Two options are currently being investigated for heavy vehicle access which are:

- Access on and off Kirkham Street. This option would require a new intersection to be developed on Kirkham Road and the establishment of an access road through bushland to the proposed site.
- Access directly on an off the M2 motorway. This option would require the construction of new on and off ramps to the motorway.

It is anticipated an acoustic enclosure would be required to house the construction ventilation system.

Airborne construction noise

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.8**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG02 and BG03 (refer to **Figure 10.1**). The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on the M2 motorway, local roads and natural sources.

Table 10.8 Nearest sensitive receivers to Cheltenham Services Facility

Receiver Area	Receiver Type	Location Relative to Works (m)[1]	Construction NMLs LAeq(15minute) (dBA)		
			Day	Evening	Night
A - Residences North East of Castle Howard Road, between Oaklands Road and Murray Road	Residential	125	59	46	36
B - Residences North East of Castle Howard Road, between Murray Road and Lyne Road, in addition to the residences on the South West of Castle Howard Road, adjacent to the tennis courts	Residential	30	59	46	36
C - Residences South of the M2 Motorway, South and East of vegetated area bordering Kerry Avenue and Merinda Avenue	Residential	155	65	57	40
D - Residences South of the M2 Motorway, North and West of the vegetated area bordering Kerry Avenue and Merinda Avenue	Residential	110	65	57	40
E - Cheltenham Oval	Active Recreational (Oval)	15	65	N/A	N/A

Note 1 The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Note 2 Refer to **Table 10.2** for RBLs and **Table 10.3** for noise criteria used to determine NML

An aerial photograph of the construction sites and nearest sensitive receivers is provided in **Figure 10.3**. A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.9** for each construction scenario.

Table 10.9 Predicted noise level exceedances at Cheltenham Services Facility

Receiver Area		Noise Modelling Scenario		
		Cheltenham – earthworks and site establishment (daytime)	Cheltenham – excavation of shaft (daytime)	Cheltenham – shaft concreting (daytime)
A	Residences North East of Castle Howard Road, between Oaklands Road and Murray Road			
B	Residences North East of Castle Howard Road, between Murray Road and Lyne Road, in addition to the residences on the South West of Castle Howard Road, adjacent to the tennis courts			
C	Residences South of the M2 Motorway, South and East of vegetated area bordering Kerry Avenue and Merinda Avenue			
D	Residences South of the M2 Motorway, North and West of the vegetated area bordering Kerry Avenue and Merinda Avenue			
E	Cheltenham Oval			

 Compliance

 ≤ 10 dB exceedance

 10 dB to ≤ 20 dB exceedance

 > 20 dB exceedance or LAeq(15minute) > 70 dBA

During excavation there would be a high exceedance of the NML of more than 20 dB at Area B, and minor exceedances of less than 10 dB at Areas A and E. Compliance is expected at Areas C and D. Compliance is expected during concreting at all receivers with the exception of Area B.

On Site Night-time LAmax Truck Noise

No night-time LAmax truck noise impacts are predicted at the Cheltenham Services Facility site as construction would occur during daytime and possibly the evening periods only.

Construction traffic noise

Traffic noise levels have been predicted on the access routes to the Cheltenham Service Facility. In this instance, the access to the sites would be via either Kirkham Street or the M2 Motorway which are arterial and sub-arterial roads with significant daytime flows. The assessment results are in compliance with the 2 dB allowance. It is noted that no night-time activities are proposed at this site.

Ground-borne construction noise

Ground-borne construction noise is not anticipated to be appreciable during the shaft excavation works as the major sources would be on the surface and undertaken during daytime periods when ambient noise levels are highest.

The potential ground-borne noise impacts associated with the excavation of the shaft / tunnels between the services facility and the running tunnels during the night-time periods is discussed in section 10.7.13.

Ground-borne vibration

During rock breaker activities at the Cheltenham Services Facility, ground-borne vibration levels may be perceptible at the nearest residential receivers. On the basis that the nearest residential buildings are approximately 10m from the proposed shaft, attended vibration measurements would be required at the commencement of potentially high vibration activities, to ensure that vibration levels remain below the safe vibration levels associated with minor cosmetic building damage.

10.7.4 Cherrybrook Station

Cherrybrook Station would be located on Castle Hill Road between Robert Road and Franklin Road.

Following site establishment works, excavation of the station cavern would commence. The station cavern would then be used as the TBM assembly and launch site for the drive from Cherrybrook Station towards Epping. TBM support services would be required at the station to facilitate the continuous TBM operations and spoil removal from the tunnels.

An acoustic shed would be established as a mitigation measure to reduce airborne noise impacts at sensitive residential receivers during the night-time period. TBM operations including pre-cast concrete segment storage, spoil handling, TBM services and loading of spoil on to heavy vehicles at night would occur within the acoustic shed. Spoil handling may also occur outside of the acoustic shed, however this would be limited to daytime periods.

At a later stage in the construction program, TBM retrieval would also occur at the Cherrybrook Station site. This would include the TBMs from the drive to Epping, except for the cutter head components which would be retrieved from the Epping Decline site, and the TBM units from the drive from Bella Vista Station.

A new signalised intersection would be provided on Castle Hill Road, likely to be located at the existing Glenhope Road intersection. A light vehicle entry would also be established at Franklin Road at a signalised intersection on Castle Hill Road.

Airborne construction noise

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.10**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG04 and BG05 (refer to **Figure 10.1**). The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Castle Hill Road, other local roads and natural sources.

Table 10.10 Nearest sensitive receivers to Cherrybrook Station

Receiver Area	Receiver Type	Location Relative to Works (m)[1]	Construction NMLs $L_{Aeq(15minute)}$ (dBA)		
			Day	Evening	Night
A - Residences on Robert Road and Oliver Way to the West and North	Residential	7	47	43	33
B - Residences on Kayla Way to the North-East	Residential	7	47	43	33
C - Tangara School	Educational (School)	130	55	N/A	N/A
D - Inala School	Educational (School)	80	55	N/A	N/A
E - Residences on and South of Castle Hill Road, East of Staley Circuit	Residential	35	55	46	39
F - Residences South of Castle Hill Road, between Staley Circuit and Glenhope Road	Residential	35	55	46	39
G - Residences South of Castle Hill Road, West of Glenhope Road	Residential	30	55	46	39
G – Kindalin Childcare	Childcare	30	50	N/A	N/A

Note 1 The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Note 2 Refer to **Table 10.2** for RBLs and **Table 10.3** for noise criteria used to determine NML

An aerial photograph of the construction sites and nearest sensitive receivers is provided in **Figure 10.4**. A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.11** for each construction scenario.

Table 10.11 Predicted noise level exceedances at Cherrybrook Station

Receiver Area		Noise Modelling Scenario					
		Earthworks and Site Establishment (daytime)	Excavation of the station box (daytime)	TBM Support and Spoil Removal with Acoustic Shed No Onsite Trucks (night-time)	TBM Support and Spoil Removal with Acoustic Shed Including Onsite Trucks – 3 m fence (night-time)	TBM Support and Spoil Removal with Acoustic Shed Including Onsite Trucks – 6 m fence (night-time)	Station Box Construction (daytime)
A	Residences on Robert Road and Oliver Way to the West and North						
B	Residences on Kayla Way to the North-East						
C	Tangara School			N/A	N/A	N/A	
D	Inala School			N/A	N/A	N/A	
E	Residences on and South of Castle Hill Road, East of Staley Circuit						
F	Residences South of Castle Hill Road, between Staley Circuit and Glenhope Road						
G	Residences South of Castle Hill Road, West of Glenhope Road						
G	Kindalin Childcare Centre			N/A	N/A	N/A	

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 70 dBA

During the standard daytime construction period, noise levels are predicted to be highest during the site establishment and station excavation with NML exceedances greater than 20 dB predicted at the nearest residential receivers in Areas A, B, E and G and at the Kindalin Childcare Centre. Exceedances of the NMLs of up to 10 dB are expected at Tangara School and Inala School during site establishment and station excavation activities.

For night-time spoil management operations associated with the underground tunnelling, an acoustic shed of double skin construction was included in the modelling to achieve compliance with night-time NML at the residences adjacent to the site. If trucks are used to remove spoil from the shed during the night-time period, their impact can be reduced from an exceedance of up to 10 dB to a much lesser margin of 1 dB by increasing the perimeter 3m high noise wall to 6m.

On site night-time LAmax truck noise

The LAmax noise levels associated with individual truck movements are predicted to be 60 dBA at the nearest residential receivers on Castle Hill Road to the south and 50 dBA at the nearest residential receivers on Kayla Way to the north of the site. These predicted noise levels include attenuation from the nominal 3m high perimeter site hoarding, and levels would be up to 5 dB higher at residences opposite the site entry and at the upper levels of the two storey Kayla Way residences.

There are expected to be up to 18 truck movements per hour. In relation to the predicted LAmax noise levels from on site truck movements:

- At residences in Kayla Way and Castle Hill Road, the maximum noise levels are predicted to exceed the sleep disturbance screening criteria by up to 10 dB to 15 dB and 11 dB to 16 dB respectively. This indicates that more detailed analysis is required.
- The maximum noise levels of 55 dBA (Kayla Way) and 65 dBA (Castle Hill Road) comply with the sleep disturbance NML of 65 dBA (external). Maximum noise levels are therefore unlikely to cause awakening reactions.
- The maximum noise levels of 55 dBA (Kayla Way) and 65 dBA (Castle Hill Road) are at the mid and upper range respectively of the existing LAmax noise levels (47 dBA to 63 dBA and 53 dBA to 63 dBA).

On the basis of the above, it is concluded that the risk of sleep disturbance is moderate.

Construction traffic noise

Traffic noise levels have been predicted for residential receivers located on the proposed access routes to the Cherrybrook Station site. In this instance the access to the site would be via Castle Hill Road which is a sub-arterial road with significant daytime flows.

For night-time movements associated with spoil removal the noise level increase (LAeq) associated with construction traffic complies with the 2 dB allowance, therefore sensitive receivers are not likely to notice an increase in the average road traffic noise levels during construction. There are expected to be up to 18 movements or events per hour during the night and, whilst there is an exceedance of the sleep disturbance screening criterion (of up to 27 dB) and external sleep disturbance NML of 65 dBA (by up to 11 dB), the LAmax levels would be similar to other heavy vehicles using Castle Hill Road.

Ground-borne construction noise

Ground-borne construction noise is not anticipated to be appreciable during the establishment of the TBM launch site as the major sources would be on the surface and work would be undertaken during daytime periods when ambient noise levels are highest.

At the nearest residential buildings adjacent to the station box, ground-borne noise levels are likely to be audible during daytime rock breaker activities; however airborne noise levels associated with the rock breaker works are likely to be much higher than the ground-borne noise levels and therefore more prominent. The airborne noise levels associated with rock breaker activities during the daytime periods are included in the airborne noise modelling results.

The potential ground-borne noise impacts associated with the excavation of the tunnels is discussed in Section 10.7.13.

Ground-borne vibration

During rock breaker activities at the Cherrybrook Station site, vibration levels may be perceptible at the nearest residential receivers. On the basis that the nearest residential buildings are approximately 50m from the proposed shaft, vibration levels are anticipated to remain well below the safe vibration levels associated with minor cosmetic building damage.

10.7.5 Castle Hill Station

Castle Hill Station would be located within Arthur Whitling Park and part of Old Northern Road reserve.

Following site establishment works, major civil works would involve excavation of the cut and cover station box, road header launch for the excavation of the tunnel crossovers on the eastern side of the station and spoil removal from the station excavation and the crossover tunnel.

An acoustic shed has been included in the noise modelling as a mitigation measure to reduce airborne noise impacts at sensitive residential receiver locations during the night-time period. Spoil handling, road header services and loading of spoil on to heavy vehicles at night would occur within the acoustic shed. Spoil handling may also occur outside of the acoustic shed, however this would be limited to daytime periods. A possible alternative to the construction of an acoustic shed would be for the spoil to be stockpiled underground during the night-time period with the top of the station box being covered or sealed with acoustic panels. In this scenario, spoil would be removed from the site during the following daytime shift.

Construction activities would also require the partial closure of Old Northern Road and the relocation of the local bus interchange and layover.

Airborne construction noise

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.12**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Location BG06 (refer to **Figure 10.1**). The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Old Northern Road, other surrounding roads and mechanical plant at nearby shopping centres.

Table 10.12 Nearest sensitive receivers to Castle Hill Station

Receiver Area	Receiver Type	Location Relative to Works (m)1	Construction NMLs LAeq(15minute) (dBA)		
			Day	Evening	Night
A – Commercial North West Castle Hill Shopping Centre	Commercial	20	70	N/A	N/A
B – Commercial adjoining North	Commercial	2	70	N/A	N/A
C – Residences McMullen Avenue North East	Residential	30	60	52	36
D – Residences Brisbane Road South East	Residential	46	60	52	36
E – Residences Old Northern Road South	Residential	35	60	52	36
F - Commercial Old Northern Road South	Commercial	10	70	N/A	N/A

Note 1 The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Note 2 Refer to **Figure 10.2** for RBLs and **Table 10.3** for noise criteria used to determine NML

An aerial photograph of the construction sites and nearest sensitive receivers is provided in **Figure 10.5**. A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.3** for each construction scenario.

Table 10.13 Predicted noise level exceedances at Castle Hill Station

Receiver Area		Noise Modelling Scenario				
		Earthworks and site establishment (daytime)	Excavation of the station box (daytime)	Roadheader operation and spoil removal with acoustic shed (night-time)	Station box construction (daytime)	Station box construction (evening)
A	Commercial North West Castle Hill Shopping Centre			N/A		N/A
B	Commercial adjoining North			N/A		N/A
C	Residences Garthowen Crescent and Old Northern Road North East					
C	Commercial McMullen Avenue North East			N/A		N/A
D	Residences Brisbane Road South East					
E	Residences Old Northern Road South					
F	Commercial Old Northern Road South			N/A		N/A

 Compliance

 ≤ 10 dB exceedance

 10 dB to ≤ 20 dB exceedance

 > 20 dB exceedance or LAeq(15minute) > 70 dBA

The predicted noise levels for demolition and excavation at the Castle Hill Station site indicate high exceedances of the NMLs for the daytime period at sites adjacent to and south of the site by more than 20 dB. These are a direct result of the relative close proximity of commercial receivers and residences to the construction.

For night time activities supporting the roadheader excavation, an acoustic shed was included in the modelling to enable compliance with the NMLs. The acoustic shed is required to provide high noise insulation and is of a double skin construction in the noise model.

During station box construction minor exceedances of the NML of less than 10 dB are predicted. Should concrete delivery and scheduling constraints require the station box to be constructed during the evening period, exceedances of more than 10 dB at the nearest residences are predicted.

On site night-time LAmax truck noise

The LAmax noise levels associated with individual truck movements is predicted to be 59 dBA at the nearest residential receivers on Terminus Street to the south of the site. These predicted noise levels include attenuation from the nominal 3m high perimeter site hoarding, and levels would be up to 5 dB higher at residences opposite the site entry.

There are expected to be up to 3 truck movements per hour. In relation to the predicted LAmax noise levels from on site truck movements:

- At residences on Terminus Street, the maximum noise levels are predicted to exceed the sleep disturbance screening criterion by up to 13 dB to 18 dB. This indicates that more detailed analysis is required.
- The maximum noise levels of 59 dBA to 64 dBA comply with the sleep disturbance NML of 65 dBA (external). Maximum noise levels are therefore unlikely to cause awakening reactions.
- The maximum noise levels of 59 dBA to 64 dBA are below the existing LAmax noise levels (66 dBA to 73 dBA).

On the basis of the above, it is concluded that the risk of sleep disturbance is low.

Construction traffic noise

Traffic noise levels have been predicted for residential receivers located on the proposed access routes to the Castle Hill Station site. In this instance the access to the site would be via Old Northern Road and Terminus Street, which are sub-arterial roads with significant daytime flows.

For night-time movements associated with spoil removal the noise level increase (LAeq) associated with construction traffic complies with the 2 dB allowance, therefore sensitive receivers are not likely to notice an increase in the average road traffic noise levels during construction.

There are expected to be up to three movements or events per hour during the night and, whilst there is an exceedance of the sleep disturbance screening criterion (of up to 30 dB) and external sleep disturbance NML of 65 dBA (by up to 11 dB), the LAmax levels would be similar to other heavy vehicles using Old Northern Road.

Ground-borne construction noise

Ground-borne construction noise is not anticipated to be appreciable at the nearest residences during the station box excavation as the major sources would be on the surface and undertaken during daytime periods when ambient noise levels are highest.

The nearest commercial buildings in Area B are located within 10m of the proposed station excavation works. Ground-borne noise levels are likely to be audible during rock breaker activities during the daytime period, however airborne noise levels associated with the rock breaker works are likely to be much higher than the ground-borne noise levels and therefore more prominent. The airborne noise associated with rock breaker activities is included in the airborne noise modelling results.

The Gold Class cinema complex is located approximately 50m from the station box excavation at the closest point. During rock breaker works, ground-borne noise levels would be up to LAeq(15minute) 43 dBA within the cinemas, assuming that a large rock breaker would be utilised. Noise levels of this magnitude would be clearly audible within the cinemas during the quieter periods of movies. During construction, attended measurements would be required at the commencement of rock breaking activities to confirm the magnitude of the ground-borne noise emissions. Alternative construction methods such as smaller rock breakers, the use of rock saws or implementation of respite periods may need to be considered to minimise the potential noise impacts (if required). The project team would liaise with stakeholders including Castle Towers management to consider methods to reduce these impacts.

The potential ground-borne noise impacts associated with the excavation of the tunnels and crossover cavern is discussed in Section 10.7.13.

Ground-borne vibration

The proposed Castle Hill Station excavation works are within 10 m of the nearest commercial buildings in Area B.

During rock breaker activities, ground-borne vibration levels may be perceptible at the nearest commercial receivers. Attended vibration measurements would be required at the commencement of high vibration activities to ensure that vibration levels remain below the safe vibration levels associated with minor cosmetic building damage.

10.7.6 Hills Centre Station

Hills Centre Station would be located within the existing Castle Hill Showground complex and would require the possession of areas associated with the Castle Hill Showground complex and The Hills Shire Council depot.

Following site establishment works, major civil works would involve excavation of the cut and cover station box. The station box would then be utilised to undertake a TBM maintenance program within the confines of the station box prior to advancing towards Cherrybrook Station.

The Hills Centre Station site would then become the TBM support site for the Hills Centre Station to Cherrybrook Station tunnel drive. TBM support services would be required at the station to facilitate the continuous TBM operations and spoil removal from the tunnels.

An acoustic shed would be established as a mitigation measure to reduce airborne noise impacts at sensitive residential receivers during the night-time period. TBM operations including pre-cast

concrete segment storage, spoil handling, TBM services and loading of spoil on to heavy vehicles at night would occur within the acoustic shed. Spoil handling may also occur outside of the acoustic shed, however this would be limited to daytime periods.

Light and heavy vehicle access to the Hills Centre Station site is proposed from Showground Road, Carrington Road and Salisbury Road.

Airborne construction noise

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.14**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG07 and BG08 (refer to **Figure 10.1**). The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Carrington Road, Showground Road and other local roads.

Table 10.14 Nearest sensitive receivers to Hills Centre Station

Receiver Area	Receiver Type	Location Relative to Works (m)[1]	Construction NMLs LAeq(15minute) (dBA)		
			Daytime	Evening	Night
A – Commercial adjoining South West	Commercial	35	70	N/A	N/A
B – Commercial adjoining North West	Commercial	35	70	N/A	N/A
C – Active Recreation – Castle Hill Showground	Active Recreation	5	65	N/A	N/A
D – Residences Showground Road North East	Residential	185	64	53	35
E – Hills Centre for Performing Arts	Other (Performance Space)	20	60	60	60
F - Residences Carrington Road South	Residential	30	64	50	39
G – Residence adjoining South West	Residence	15	64	50	39

Note 1 The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.
Note 2 For the Hills Centre for Performing Arts in Area E, a conservative external NML of 60 dBA has been applied. This assumes that the building façade provides a high degree of noise insulation to provide an acceptable indoor noise environment for performances. This NML is required to be reviewed during the site CNVIS.
Note 3 Refer to **Table 10.2** for RBLs and **Table 10.3** for noise criteria used to determine NMLAn aerial photograph of the construction sites and nearest sensitive receivers is provided in **Figure 10.6**. A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.15** for each construction scenario.

Table 10.15 Predicted noise level exceedances at Hills Centre Station

	Receiver Area	Noise Modelling Scenario				
		Earthworks and site establishment (daytime)	Excavation of the station box (daytime)	TBM support and spoil removal with acoustic shed (night-time)	Station box construction (daytime)	Station box construction (evening)
A	Commercial adjoining South West			N/A		N/A
B	Commercial adjoining North West			N/A		N/A
C	Active Recreation – Castle Hill Showground			N/A		N/A
D	Residences Showground Road North East					
E	Hills Centre for Performing Arts					
F	Residences Carrington Road South					
G	Residence adjoining South West					

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 70 dBA

A 3m high noise wall around the site perimeter was included in the noise model for all construction activities other than site establishment to comply with the NMLs. Site establishment and station excavation activities are predicted to exceed the NMLs at the Hills Centre for Performing Arts and the residences to the south (Areas F and G) by more than 10 dB during daytime operations. An acoustic shed for TBM and spoil removal operations was included in the models to reduce exceedances of the night-time NMLs. Nevertheless, with a shed of double skin construction, exceedances of up to 10 dB are predicted.

The actual noise insulation performance of the Hills Centre for Performing Arts would be reviewed during preparation of the site specific CNVIS.

On site night-time LAmax truck noise

The LAmax noise levels associated with individual truck movements are predicted to be 60 dBA at the nearest residential receivers on Showground Road to the north of the site and 58 dBA for residences to the south on Carrington Avenue. Note that the predicted noise levels include attenuation from the nominal 3m high perimeter site hoarding towards Carrington Avenue residences and no attenuation from the site access road leading from the site to Showground Road.

There are expected to be up to 18 truck movements per hour. In relation to the predicted LAmax noise levels from on site truck movements:

- At residences on Showground Road and Carrington Avenue, the maximum noise levels are predicted to exceed the sleep disturbance screening criterion by up to 15 dB and 9 dB respectively. This indicates that more detailed analysis is required.
- The maximum noise levels of 60 dBA (Showground Road) and 58 dBA (Carrington Avenue) comply with the sleep disturbance NML of 65 dBA (external). Maximum noise levels are therefore unlikely to cause awakening reactions.
- The maximum noise levels of 60 dBA (Showground Road) and 58 dBA (Carrington Avenue) are lower than the existing LAmax noise levels (75 dBA to 83 dBA and 65 dBA to 71 dBA).
- On the basis of the above, it is concluded that the risk of sleep disturbance is low.

Construction traffic noise

Traffic noise levels have been predicted for residential receivers located on the proposed access routes to the Hills Centre Station site. In this instance, the access to the site would be via Showground Road and Carrington Road, which are sub-arterial roads with significant daytime flows.

Given night-time spoil removal is proposed, the night-time LAeq increase and sleep disturbance have been assessed. Predicted noise levels associated with construction traffic complies with the 2 dB allowance, therefore sensitive receivers are not likely to notice an increase in the average road traffic noise levels during construction, if night-time access is via Carrington Road.

There are expected to be up to 18 movements or events per hour on Showground Road and nine movements or events per hour on Carrington Road during the night. Whilst there is an exceedance of the sleep disturbance screening criteria (of up to 31 dB) and external sleep disturbance NML of 65 dBA (by up to 11 dB for Showground Road and up to 14 dB for Carrington Road), the LAmax levels would be similar to those of other heavy vehicles already using Showground and Carrington Roads.

Ground-borne construction noise

Ground-borne construction noise is not anticipated to be appreciable at the nearest residences during the station box excavation as the major sources would be on the surface and undertaken during daytime periods when ambient noise levels are highest.

The Hills Centre for Performing Arts is located approximately 50m from the proposed station excavation works. Ground-borne noise levels would be up to LAeq(15minute) 43 dBA within the centre during rock breaker works, assuming that a large rock breaker would be utilised. Noise levels of this magnitude would be clearly audible within the centre during quiet periods of performances.

During construction, attended measurements would be required at the commencement of rock breaking activities to confirm the magnitude of the ground-borne noise emissions. Alternative construction methods such as smaller rock breakers, the use of rock saws or implementation of respite periods may need to be considered to minimise the potential noise impacts (if required). The project team would liaise with stakeholders including The Hills Centre for Performing Arts management to consider methods to reduce these impacts.

The potential ground-borne noise impacts associated with the excavation of the tunnels are discussed in Section 10.7.13.

Ground-borne vibration

During rock breaker activities at the Hills Centre Station, ground-borne vibration levels may be perceptible at the nearest residential and commercial receivers. On the basis that the nearest buildings are approximately 50m from the excavation works, vibration levels are anticipated to remain well below the safe vibration levels associated with minor cosmetic building damage.

10.7.7 Norwest Station

Norwest Station would be located on Norwest Boulevard opposite the Norwest shopping centre.

Following site establishment works, major civil works would involve excavation of the station cavern and associated spoil removal from the station excavation.

An acoustic shed would be established as a mitigation measure to reduce airborne noise impacts at sensitive residential receiver locations during the night-time period. Spoil handling and loading of spoil on to heavy vehicles at night would occur within the acoustic shed. Spoil handling may also occur outside of the acoustic shed, however this would be limited to daytime periods. As the station box excavation is nominally 200m long by 20m wide, it may not be feasible to construct an acoustic shed over the whole excavation area. Alternative mitigation measures may include a moveable acoustic enclosure, or excavation below acoustic panels located on top of the station box excavation.

Airborne construction noise

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.16**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Location BG09 (refer to **Figure 10.1**). The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Norwest Boulevard and mechanical services noise from the nearby shopping centre and commercial buildings.

Table 10.16 Nearest sensitive receivers to Norwest Station

Receiver Area	Receiver Type	Location Relative to Works (m)[1]	Construction NMLs LAeq(15minute) (dBA)		
			Day	Evening	Night
A – Commercial adjoining South	Commercial	15	70	N/A	N/A
B – Residences to the South	Residential	70	57	50	43
C – Hillsong Church, including recording studio	Worship	115	65	65	-
D – Commercial adjoining North	Commercial	15	70	N/A	N/A

Note 1 The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Note 2 Refer to **Table 10.2** for RBLs and **Table 10.3** for noise criteria used to determine NML

An aerial photograph of the construction sites and nearest sensitive receivers is provided in **Figure 10.7**. A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.7** for each construction scenario.

Table 10.17 Predicted noise level exceedances at Norwest Station

Receiver Area		Noise Modelling Scenario				
		Earthworks and site establishment (daytime)	Excavation of the station box (daytime)	Roadheader operation and spoil removal with acoustic shed (night-time)	Station box construction (daytime)	Station box construction (evening)
A	Commercial adjoining South			N/A		N/A
B	Residences to the South					
C	Hillsong Church			N/A		
D	Commercial adjoining North			N/A		N/A

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 70 dBA

The predicted noise levels for demolition and excavation at the Norwest Station site indicate high exceedances of the NMLs for the daytime period at the commercial receivers. These exceedances are 10 dB to 20 dB during earthworks / demolition and more than 20 dB during excavation. Compliance is predicted at the residences and the Hillsong Church for these activities. During station box construction no exceedances of the NMLs were predicted.

For the potential night time excavation works with rock breakers, an acoustic shed of standard construction was included in the modelling to enable compliance with the NMLs.

On site night-time LAmax truck noise

The LAmax noise levels associated with individual truck movements is predicted to be 58 dBA at the nearest residential receivers on Jacqui Circuit to the south of the site. Note that noise from vehicles would be unshielded at the site access, hence the predicted noise level does not consider any attenuation from the nominal 3m high perimeter site hoarding.

There are expected to be up to four truck movements per hour. In relation to the predicted LAmax noise levels from on site truck movements:

- At residences in Jacqui Circuit the maximum noise levels are predicted to exceed the sleep disturbance screening criterion by up to 5 dB. This indicates that more detailed analysis is required.
- The maximum noise levels of 58 dBA (Jacqui Circuit) comply with the sleep disturbance NML of 65 dBA (external). Maximum noise levels are therefore unlikely to cause awakening reactions.
- The maximum noise level of 58 dBA (Jacqui Circuit) is at the mid range of the existing L_{Amax} noise levels (53 dBA to 68 dBA).

On the basis of the above, it is concluded that the risk of sleep disturbance is low.

Construction traffic noise

Traffic noise levels have been predicted for residential receivers located on the proposed access routes to the Norwest Station site. In this instance, the access to the site would be via Norwest Boulevard and Windsor Road which are sub-arterial roads with significant daytime flows.

Given night-time spoil removal is proposed, the night-time L_{Aeq} increase and sleep disturbance have been assessed. The predicted noise level increase (L_{Aeq}) associated with construction traffic complies with the 2 dB allowance, therefore sensitive receivers are not likely to notice an increase in the average road traffic noise levels during construction.

There are expected to be up to four movements or events per hour during the night and, whilst there is an exceedance of the sleep disturbance screening criterion (of up to 23 dB) and external sleep disturbance NML of 65 dBA (of up to 11 dB), the L_{Amax} levels would be similar to those of other heavy vehicles already using Windsor Road and Norwest Boulevard.

Ground-borne construction noise

At the nearest commercial buildings, ground-borne noise levels are likely to be audible during daytime rock breaker activities; however airborne noise levels associated with the rock breaker works are likely to be much higher than the ground-borne noise levels and therefore more prominent. The airborne noise levels associated with rock breaker activities are included in the airborne noise modelling results.

The Hillsong HUB building, which contains a sound recording studio, is located approximately 170m from the proposed excavation works. Ground-borne noise emissions are not anticipated to be audible within the recording studio during the station excavation works.

The potential ground-borne noise impacts associated with the excavation of the main tunnels is discussed in Section 10.7.13.

Ground-borne vibration

During rock breaker activities, ground-borne vibration levels may be perceptible at the nearest commercial receivers.

At the nearest commercial building, attended vibration measurements would be required at the commencement of high vibration activities to ensure that vibration levels remain below the safe vibration levels associated with minor cosmetic building damage.

10.7.8 Bella Vista Station and Pre-cast Yards (near Balmoral Road and Memorial Avenue)

Bella Vista site

Bella Vista Station would be located on the corner of Old Windsor Road and Celebration Drive on the site of the existing Totally Home shopping centre.

Following site establishment works, excavation of the station cavern and cut and cover excavation would commence. The cut and cover excavation at the southern portion of the station site would then be used as the TBM assembly and launch site for the drive from Bella Vista Station to Cherrybrook Station. TBM support services would be required at the station to facilitate the continuous TBM operations and spoil removal from the tunnels.

An acoustic shed would be established as a mitigation measure to reduce airborne noise impacts at sensitive residential receivers during the night-time period. TBM operations including pre-cast concrete segment storage, spoil handling, TBM services and loading of spoil on to heavy vehicles at night would occur within the acoustic shed. Spoil handling may also occur outside of the acoustic shed, however this would be limited to daytime periods.

Light and heavy vehicle access to the Bella Vista Station site is proposed from Celebration Drive and Balmoral Road (via access roads through the Balmoral Road construction site).

Balmoral Road and Memorial Avenue pre-cast yard sites

The Balmoral Road site would be located on the corner of Old Windsor Road and Balmoral Road, to the north of the proposed Bella Vista Station. The site would be utilised for the adjacent cutting works, and for a concrete batch plant and pre-cast facility.

The concrete batch plant and pre-cast facility would support the tunnelling component of the project and would manufacture the pre-cast concrete ring segments for the tunnel. These activities would be required on a 24 hour per day basis in order to meet the production requirements with high noise activities being located within an acoustic shed to meet the noise level requirements at the nearest residential receiver locations.

The Memorial Avenue construction site would be located on the south eastern corner of Old Windsor Road and Memorial Avenue, extending back to Balmoral Road. The site would be utilised as a staging point for the construction of the elevated viaduct structure, and for a second concrete batch plant and pre-cast facility.

The Memorial Avenue facility would support the viaduct component of the project and would manufacture the pre-cast concrete segments required to construct the elevated viaduct. These activities would be required on a 24 hour per day basis in order to meet the production requirements with high noise activities being located within an acoustic shed to meet the noise level requirements at the nearest residential receiver locations.

Light and heavy vehicle access to the Memorial Avenue construction site is proposed to be off Memorial Avenue and via internal access roads, linking to the Kellyville Station construction site.

Airborne construction noise

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.18**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG10, BG11, BG12 and BG13 (refer to **Figure 10.1**). The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Old Windsor Road and other local roads.

Table 10.18 Nearest sensitive receivers to Bella Vista Station and Pre-cast Yards

Receiver Area	Receiver Type	Location Relative to Works (m)[1]	Construction NMLs LAeq(15minute) (dBA)		
			Day	Evening	Night
A – Residential adjoining East	Residential	7	46	40	36
B – Residential adjoining East	Residential	25	46	40	36
C – Residential on Celebration Drive	Residential	15	46	40	36
D – Commercial on Old Windsor Road adjacent to the South West	Commercial	195	70	N/A	N/A
E – Residential on Old Windsor Road to the South West	Residential	20	56	50	41
F – Other (church) on Old Windsor Road to the South West	Other (Church)	30	65	65	-
G - Residential on Old Windsor Road to the West (Sharrock Avenue)	Residential	75	61	53	38
H - Residential on Old Windsor Road to the West (Emmanual Terrace)	Residential	75	61	53	38
I - Commercial on Old Windsor Road to the West (Amona Street)	Commercial	75	70	N/A	N/A
J - Residential on Old Windsor Road to the West (Rothwell Circuit)	Residential	60	61	55	39

Note 1 The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Note 2 Refer to **Table 10.2** for RBLs and **Table 10.3** for noise criteria used to determine NML

An aerial photograph of the construction sites and nearest sensitive receivers is provided in **Figure 10.8**. A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in Table 1019 for each construction scenario.

Table 10.19 Predicted noise level exceedances at Bella Vista Station and pre-cast yards site – earthworks, excavation and construction

Receiver Area		Noise Modelling Scenario			
		Earthworks and site tablishment (daytime)	Excavation of the station box (daytime)	Station box construction (daytime)	Station box construction (evening)
A	Residential adjoining East				
B	Residential adjoining East				
C	Residential on Celebration Drive				
D	Commercial on Old Windsor Road adjacent to the South West				N/A
E	Residential on Old Windsor Road to the South West				
F	Other (church) on Old Windsor Road to the South West				
G	Residential on Old Windsor Road to the West (Sharrock Avenue)				
H	Residential on Old Windsor Road to the West (Emmanual Terrace)				
I	Commercial on Old Windsor Road to the West (Amona Street)				N/A
J	Residential on Old Windsor Road to the West (Rothwell Circuit)				

 Compliance

 ≤ 10 dB exceedance

 10 dB to ≤ 20 dB exceedance

 > 20 dB exceedance or LAeq(15minute) > 70 dBA

Table 10.20 Predicted noise level exceedances at Bella Vista Station and pre-cast yards sites – TBM support and pre-cast operation

Receiver Area		Noise Modelling Scenario	
		TBM Support and pre-cast yard operations (daytime)	TBM Support and pre-cast yard operations (night-time)
A	Residential adjoining East		
B	Residential adjoining East		
C	Residential on Celebration Drive		
D	Commercial on Old Windsor Road adjacent to the South West		N/A
E	Residential on Old Windsor Road to the South West		
F	Other (church) on Old Windsor Road to the South West		N/A
G	Residential on Old Windsor Road to the West (Sharrock Avenue)		
H	Residential on Old Windsor Road to the West (Emmanual Terrace)		
I	Commercial on Old Windsor Road to the West (Amona Street)		N/A
J	Residential on Old Windsor Road to the West (Rothwell Circuit)		

 Compliance

 ≤ 10 dB exceedance

 10 dB to ≤ 20 dB exceedance

 > 20 dB exceedance or LAeq(15minute) > 70 dBA

Airborne construction noise

The predicted noise levels for site establishment indicate high exceedances of the NMLs for construction at nearest residences adjacent to the eastern side of the station. These exceedances are 10 dB to 20 dB at Areas B and C and more than 20 dB at Area A. There are minor exceedances at the residences to the west and the adjoining commercial Area D of up to 10 dB.

During excavation of the station box an exceedance of up to 10 dB at Area B, up to between 10 and 20 dB at Area C and up to 1 dB at Area G was predicted, and during station box construction, compliance with the NMLs is predicted.

For the daytime TBM support and spoil handling, there are minor exceedances of up to 2 dB at Areas C and B and compliance elsewhere.

For the night-time TBM support and spoil handling, the predicted noise levels indicate minor exceedances of up to 10 dB at Area A and Area B. These are a result of the conveyors (enclosed) between the elevated concrete batch plant and adjacent (enclosed) concrete mixing and mounding areas. Mitigation by way of improved conveyor enclosure and increasing the shed noise insulation would reduce these exceedances. There are minor exceedances of up to 3 dB at Areas C, G and H, and these are primarily due to noise from the acoustic shed at the TBM spoil site and spoil truck movements. Potential mitigation is to provide a moderate increase in the normal noise insulation provided by the standard construction acoustic enclosure.

On site night-time L_{Amax} truck noise

The L_{Amax} noise level associated with individual truck movements is predicted to be 52 dBA at the nearest residential receivers on Sharrock Avenue to the west of the site. Note that the predicted noise level assumes night-time truck access would be via the Celebration Drive roundabout to the south and includes the nominal 3m high perimeter site hoarding.

There are expected to be up to 18 truck movements per hour. In relation to the predicted L_{Amax} noise levels from on site truck movements:

- At residences in Sharrock Avenue, the maximum noise levels are predicted to exceed the sleep disturbance screening criterion by up to 1 dB. Compliance is predicted at residences on Celebration Drive. This indicates that more detailed analysis is required.
- The maximum noise levels of 52 dBA (Sharrock Avenue) and 44 dBA (Celebration Drive) comply with the sleep disturbance NML of 65 dBA (external). Maximum noise levels are therefore unlikely to cause awakening reactions.
- The maximum noise levels of 52 dBA (Sharrock Avenue) and 44 dBA (Celebration Drive) are below the lower range of the existing LAmax noise levels.

On the basis of the above, it is concluded that the risk of sleep disturbance is low.

Construction traffic noise

Traffic noise levels have been predicted for residential receivers located on the proposed access routes to the Bella Vista Station site. In this instance the access to the site would be via Celebration Drive and Windsor Road which local and sub-arterial roads, noting the relevant section of Celebration Drive is north of the Brighton Drive roundabout. The existing traffic flows on Celebration Drive north of Brighton Drive are not available, however they are estimated to be up to only a few vehicles per hour, as only two or three residential properties are accessed. The noise level

from daytime movements to the site has been predicted to be 56 dBA to the residences on Celebration Drive, which marginally exceeds the local road criterion of 55 dBA.

Given night-time spoil removal is proposed the night-time LAeq increase and sleep disturbance have been assessed. The predicted night-time noise level increase associated with construction traffic on Windsor Road complies with the 2 dB allowance, therefore sensitive receivers are not likely to notice an increase in the average road traffic noise levels during construction.

There are expected to be up to 18 movements or events per hour during the night and, whilst there is an exceedance of the sleep disturbance screening criterion (of up to 25 dB) and external sleep disturbance NML of 65 dBA (of up to 11 dB), the LAmax levels would be similar to those of other heavy vehicles already using Windsor Road.

Ground-borne construction noise

At the nearest commercial buildings in Areas E and F adjacent to the proposed Bella Vista Station, ground-borne noise levels are likely to be audible during daytime rock breaker activities. Airborne noise levels associated with the rock breaker works are likely to be much higher than the ground-borne noise levels and therefore more prominent. The airborne noise levels associated with rock breaker activities during the daytime periods are included in the airborne noise modelling results.

For the proposed Balmoral Road and Memorial Avenue pre-cast sites, ground-borne noise levels associated with the proposed excavation works are not anticipated to be appreciable.

The potential ground-borne noise impacts associated with the excavation of the main tunnels is discussed in Section 10.7.13.

Ground-borne vibration

During rock breaker activities, ground-borne vibration levels may be perceptible at the nearest commercial receivers, but are anticipated to be well below the safe vibration levels associated with minor cosmetic building damage.

10.7.9 Kellyville Station

The Kellyville Station site currently encompasses a T-way car park, bus station and open space. Major construction works would involve viaduct launch and support, and station civil construction works on the viaduct structure. In addition temporary and permanent road works would be required, including the temporary relocation of some T-way facilities.

Access to the site would be on and off Samantha Riley Drive and Memorial Avenue. Internal access roads would be established adjacent to the alignment along the length of the site.

Airborne construction noise

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.21**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG15 and BG16 (refer to **Figure 10.1**). The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Old Windsor Road.

Table 10.21 Nearest sensitive receivers to Kellyville Station

Receiver Area	Receiver Type	Location Relative to Works (m)[1]	Construction NMLs LAeq(15minute) (dBA)		
			Day	Evening	Night
A – Residential on Bridget Pl North	Residential	140	49	44	44
B – Residential on Landy Pl East	Residential	75	49	44	44
C – Residential on Arnold Ave East	Residential	315	49	44	44
D – Residential on Ludlow St West	Residential	335	55	50	42
E – Residential on Old Windsor Rd to the South West	Residential	80	55	50	42

Note 1 The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Note 2 Refer to **Table 10.2** for RBLs and **Table 10.3** for noise criteria used to determine NML

An aerial photograph of the construction sites and nearest sensitive receivers is provided in **Figure 10.9**. A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.22** for each construction scenario.

Table 10.22 Predicted noise level exceedances at Kellyville Station

Receiver Area		Noise Modelling Scenario		
		Earthworks and site establishment (daytime)	Station construction (daytime)	Station construction (evening)
A	Residential on Bridget Pl North			
B	Residential on Landy Pl East			
C	Residential on Arnold Ave East			
D	Residential on Ludlow St West			
E	Residential on Old Windsor Rd West			

 Compliance

 ≤ 10 dB exceedance

 10 dB to ≤ 20 dB exceedance

 > 20 dB exceedance or LAeq(15minute) > 70 dBA

The predicted noise levels for site establishment and earthworks indicate compliance at Areas A, C and D and minor exceedances of up to 10 dB at Areas B and E.

During station construction compliance is predicted at all areas. Should construction be required during the evening, compliance is also predicted at all areas except Area B where a minor exceedance of up to 10 dB is predicted.

On site night-time LAmax truck noise

No night-time LAmax truck noise impacts are predicted at the Kellyville Station site as construction would occur during daytime and possibly the evening periods only.

Construction traffic noise

Traffic noise levels have been predicted for residential receivers located on the proposed access routes to the Kellyville Station site. In this instance the access to the site would be via Samantha Riley Drive and Windsor Road which are sub-arterial roads with significant existing daytime flows, hence project increases result in compliance with the 2 dB allowance. It is noted that no night-time activities are proposed at this site.

Ground-borne construction noise and vibration

No ground-borne construction noise and vibration impacts are predicted for the Kellyville Station site.

10.7.10 Rouse Hill Station

The Rouse Hill Station construction site currently encompasses a T-way bus station and car park. Major construction works would involve viaduct launch and support, and station civil construction works on the viaduct structure. In addition road works for the bus station and T-way would be required, with the bus station temporarily relocated during the construction works.

Airborne construction noise

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.23**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG19, BG20 and BG21 (refer to **Figure 10.1**). The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Old Windsor Road.

Table 10.23 Nearest sensitive receivers to Rouse Hill Station

Receiver Area	Receiver Type	Location Relative to Works (m)[1]	Construction NMLs LAeq(15minute) (dBA)		
			Day	Evening	Night
A – Commercial adjacent North East	Commercial	20	70	N/A	N/A
B – Active recreation South East	Active Recreational (tennis & playground)	260	65	65	N/A
C – Residential South East	Residential	370	51	46	38
D – Residential South	Residential	240	62	54	37
E – Passive recreation Cemetery South	Other (passive recreation)	160	60	N/A	N/A
F – Residential North West	Residential	380	61	56	44
G – Commercial to the North	Commercial	300	70	N/A	N/A

Note 1 The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Note 2 Refer to **Table 10.2** for RBLs and **Table 10.3** for noise criteria used to determine NML

An aerial photograph of the construction sites and nearest sensitive receivers is provided in **Figure 10.10**. A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.24** for each construction scenario.

Table 10.24 Predicted noise level exceedances at Rouse Hill Station

Receiver Area		Noise Modelling Scenario		
		Earthworks and site establishment (daytime)	Viaduct and station construction (daytime)	Viaduct and station construction (evening)
A	Commercial adjacent North East			N/A
B	Active recreation South East			
C	Residential South East			
D	Residential South			
E	Passive recreation Cemetery South			N/A
F	Commercial to the North			
G	Commercial to the North			N/A

The predicted noise levels for site establishment and earthworks indicate compliance at all areas except Area A where minor exceedances of up to 10 dB are expected.

During viaduct and station construction, compliance is predicted at all areas. Should construction be required during the evening then compliance is also predicted at all areas.

On site night-time LAmax truck noise

No night-time LAmax truck noise impacts are predicted at the Rouse Hill Station site as construction would occur during daytime and possibly the evening periods only.

Construction traffic noise

Traffic noise levels have been predicted for residential receivers located on the proposed access routes to the Rouse Hill Station site. Access to the site would be via Windsor Road which is a sub-arterial road with significant existing daytime flows. Hence project increases result in compliance with the 2 dB allowance. It is noted that no night-time activities are proposed at this site.

Ground-borne construction noise and vibration

Ground-borne construction noise and vibration impacts are not anticipated to be appreciable at the nearest residential and commercial receivers.

The Reading Cinema complex is located approximately 40m from the proposed excavation works at the closest point. No rock breaking works are anticipated to be undertaken at this location and the highest ground-borne noise levels are anticipated to be associated with bored piling activities. On the basis of the large offset distance to the proposed works, ground-borne noise levels from the piling works are not anticipated to be audible within the cinemas.

10.7.11 Cudgegong Road Station and Tallawong Stabling Facility

Major construction works would involve site establishment and earthworks including cutting and embankment construction. In addition there would be station civil construction works and bridge construction at Cudgegong Road and Tallawong Road.

Access to the site would be directly on and off Cudgegong Road, Tallawong Road and Schofields Road. Internal access roads would be established along the entire length of the site adjacent to the alignment.

Airborne construction noise

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.25**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG23, BG24 and BG25 (refer to **Figure 10.1**). The ambient noise environment at the nearest sensitive receivers is primarily controlled by traffic movements on local roads and other natural noise sources.

Table 10.25 Nearest sensitive receivers to Cudgegong Road Station and Tallawong Stabling Facility

Receiver Area	Receiver Type	Location Relative to Works (m)1	Construction NMLs LAeq(15minute) (dBA)		
			Day	Evening	Night
A - Residences North of the site, between Tallawong Road and Cudgegong Road	Residential	70	54	48	39
B - Residences North of the site, between Cudgegong Road and Terry Road	Residential	55	54	48	39
C - Residences South of the site, between Cudgegong Road and the West border of Castlebrook Lawn Cemetery and Crematorium	Residential	210	55	54	43
D - Residences South of Schofields Road, between Cudgegong Road and the West border of 80 Schofields Road	Residential	135	55	54	43
E - Residences South of Schofields Road and West of the West border of 80 Schofields Road	Residential	75	53	49	35
F – Residences North of Schofields Road and West of Tallawong Road	Residential	140	53	49	35

Note 1 The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Note 2 Refer to **Table 10.2** for RBLs and **Table 10.3** for noise criteria used to determine NML

An aerial photograph of the construction sites and nearest sensitive receivers is provided in **Figure 10.11**. A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.26** for each construction scenario.

Table 10.26 Predicted noise level exceedances at Cudgegong Road Station and Tallawong Stabling Facility

Receiver Area		Noise Modelling Scenario			
		General earthworks (daytime)	General earthworks (evening)	Station construction (daytime)	Station construction (evening)
A	Residences North of the site, between Tallawong Road and Cudgegong Road				
B	Residences North of the site, between Cudgegong Road and Terry Road				
C	Residences South of the site, between Cudgegong Road and the West border of Castlebrook Lawn Cemetery and Crematorium				
D	Residences South of Schofields Road, between Cudgegong Road and the West border of 80 Schofields Road				
E	Residences South of Schofields Road and West of the West border of 80 Schofields Road				
F	Residences North of Schofields Road and West of Tallawong Road				

 Compliance

 ≤ 10 dB exceedance

 10 dB to ≤ 20 dB exceedance

 > 20 dB exceedance or LAeq(15minute) > 70 dBA

Predicted noise levels indicated that during earthworks there are moderate exceedances at most of the surrounding areas.

During station construction compliance is predicted at all areas except Area B where there is a minor exceedance of up to 10 dB.

On site night-time LAmax truck noise

No night-time LAmax truck noise impacts are expected at the Cudgegong Road Station and Tallawong Stabling Facility sites as construction would occur during daytime and possibly the evening periods only.

Construction traffic noise

Traffic noise levels have been predicted for the access routes to the Cudgegong Road Station and Tallawong Stabling Facility site. Access to the site would be via Schofields Road which is a sub-arterial road with significant existing daytime flows, hence project increases result in compliance with the 2 dB allowance. It is noted that no night-time activities are proposed at this site.

Ground-borne construction noise and vibration

No ground-borne construction noise and vibration impacts are predicted for the Cudgegong Road Station and Tallawong Stabling Facility.

10.7.12 Civil excavation and construction works for surface track between Bella Vista Station and Tallawong Stabling Facility

The Bella Vista Station to Cudgegong Road Station section of the route consists of above ground tracks. The assessment of the section has been separated into three sub-sections, Bella Vista Station to Kellyville Station, Kellyville Station to Rouse Hill Station and Rouse Hill Station to Cudgegong Road Station. The proposed rail alignment in relation to nearby sensitive receivers is shown in Appendix B of Technical Paper 2.

The construction activities for the surface track would involve general earthworks, piling works and concreting, and then the placement of pre-cast viaduct sections.

Bella Vista Station to Kellyville Station

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.27**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG13, BG14 and BG15 (refer to **Figure 10.1**). The ambient noise environment at the nearest sensitive receivers is primarily controlled by traffic movements on local roads and other natural noise sources.

Table 10.27 Nearest Noise Sensitive Receivers – Bella Vista Station to Kellyville Station Viaduct

Receiver Area	Receiver Type	Location Relative to Works (m)1	Construction NMLs LAeq(15minute) (dBA)		
			Day	Evening	Night
A - Residences East of Old Windsor Road, from the North section of Arnold Avenue to the North border of the Celebration Drive shopping centre	Residential	160	49	46	44
B - Residences East of Old Windsor Road and South of Samantha Riley Drive	Residential	205	49	46	44
C - Residences West of Old Windsor Road, between Newbury Avenue and the North border of the Emmanuel Baptist Church	Residential	85	57	53	43
D - Commercial sites West of Old Windsor Road, on Sunnyholt Road and on Old Windsor Road	Residential	85	70	N/A	N/A

Note 1 The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Note 2 Refer to **Table 10.2** for RBLs and **Table 10.3** for noise criteria used to determine NML

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.28** for each construction scenario.

Table 10.28 Predicted noise level exceedances for Bella Vista Station to Kellyville Station

Receiver Area		Noise Modelling Scenario					
		General Earthworks and Site Establishment (daytime)	General Earthworks and Site Establishment (evening)	Piling works and concreting (daytime)	Piling works and concreting (evening)	Placement of pre-cast viaduct sections (daytime)	Placement of pre-cast viaduct sections (evening)
A	Residences East of Old Windsor Road, from the North section of Arnold Avenue to the North border of the Celebration Drive shopping centre						
B	Residences East of Old Windsor Road and South of Samantha Riley Drive						
C	Residences West of Old Windsor Road, between Newbury Avenue and the North border of the Emmanuel Baptist Church						
D	Commercial sites West of Old Windsor Road, on Sunnyholt Road and on Old Windsor Road		N/A		N/A		N/A

Compliance | ≤ 10 dB exceedance | 10 dB to ≤ 20 dB exceedance | > 20 dB exceedance or LAeq(15minute) > 70 dBA

Predicted noise levels indicate that at residences in the Areas A, B and C similar noise levels are predicted, and these noise levels for earthworks exceed the NMLs by the moderate amounts of 13 dB, 9 dB and 12 dB for the Areas A, B and C respectively. During piling and concreting, the exceedances reduce to 7 dB, 3 dB and 6 dB, and then during pre-cast placement further reduce to 4 dB and 3 dB at Area A and C with compliance at Area B.

Residences in Area D are adjacent to Old Windsor Road and existing traffic noise levels are generally similar in level to those predicted for construction activities. No appreciable construction noise impact is therefore expected in this area. At the commercial receivers compliance is predicted for all scenarios.

Kellyville Station to Rouse Hill Station

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.29**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG16, BG19, BG20, BG21 and BG22 (refer to **Figure 10.1**). The ambient noise environment at the nearest sensitive receivers is primarily controlled by traffic movements on local roads and other natural noise sources.

Table 10.29 Nearest Noise Sensitive Receivers – Kellyville Station to Rouse Hill Station Viaduct

Receiver Area	Receiver Type	Location Relative to Works (m)1	Construction NMLs LAeq(15minute) (dBA)		
			Day	Evening	Night
A - Residences East of Old Windsor Road, between the group of residences North East of the Windsor Road/Old Windsor Road junction and Samantha Riley Drive	Residential	30	55	51	42
B - Residences West of Old Windsor Road, between Newbury Avenue and the South border of Castlebrook Lawn Cemetery and Crematorium	Residential	80	62	54	37
C - Commercial sites West of Windsor Road, on Windsor Road and on Old Windsor Road	Commercial	85	70	N/A	N/A
D - Castlebrook Lawn Cemetery and Crematorium	Other	280	60	N/A	N/A
E – Residences East of Windsor Road, between Bellcast Road and Sanctuary Drive	Residential	35	51	46	38
F – Recreation area East of Windsor Road, between White Hart Drive, Sanctuary Drive and Bellcast Road	Other	60	65	65	N/A
G – Commercial site East of Windsor Road, between Rouse Hill Drive and White Hart Drive	Residential	45	70	N/A	N/A

Note 1 The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Note 2 Refer to **Table 10.2** for RBLs and **Table 10.3** for noise criteria used to determine NML

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.30** for each construction scenario.

Table 10.30 Predicted noise level exceedances for Kellyville Station to Rouse Hill Station

Receiver Area		Noise Modelling Scenario					
		General Earthworks and Site stablishment (daytime)	General Earthworks and Site stablishment (evening)	Piling works and concreting (daytime)	Piling works and concreting (evening)	Placement of pre-cast viaduct sections (daytime)	Placement of pre-cast viaduct sections (evening)
A	Residences East of Old Windsor Road, between the group of residences North East of the Windsor Road/ Old Windsor Road junction and Samantha Riley Drive						
B	Residences West of Old Windsor Road, between Newbury Avenue and the South border of Castlebrook Lawn Cemetery and Crematorium						
C	John XXIII Catholic Primary School		N/A		N/A		N/A
D	Commercial sites West of Windsor Road, on Windsor Road and on Old Windsor Road		N/A		N/A		N/A
E	Castlebrook Lawn Cemetery and Crematorium		N/A		N/A		N/A
F	Residences East of Windsor Road, between Bellcast Road and Sanctuary Drive						
G	Recreation area East of Windsor Road, between White Hart Drive, Sanctuary Drive and Bellcast Road						
H	Commercial site East of Windsor Road, between Rouse Hill Drive and White Hart Drive		N/A		N/A		N/A

 Compliance

 ≤ 10 dB exceedance

 10 dB to ≤ 20 dB exceedance

 > 20 dB exceedance or LAeq(15minute) > 70 dBA

Predicted noise levels at residential Area A indicate there would be high exceedances of up 23 dB during earthworks, up to 17 dB during piling and up to 14 dB during viaduct section placement. These exceedances would occur as the nearest residences are relatively close to the works.

Predicted noise levels at residential Area B indicate there would be minor exceedances of up 7 dB during earthworks, up to 1 dB during piling and no exceedance during viaduct section placement. These residences are also expected to experience construction noise levels that would be similar to those from existing traffic on Old Windsor Road, hence construction noise would be less noticeable. No appreciable construction noise impact is therefore expected in this area.

Predicted noise levels at educational Area C indicate there would be minor exceedances of up to 5 dB during earthworks, and no exceedance during piling and viaduct section placement. This school is also expected to experience construction noise levels that would be similar to those from existing traffic on Old Windsor Road, hence construction noise would be less noticeable. No appreciable construction noise impact is therefore expected in this area.

At commercial Area D compliance is predicted, and at passive recreation Area E there would be a minor exceedance of 7 dB during earthworks and compliance during piling and viaduct section placement.

At residential Area F there would be high exceedances of up to 27 dB during earthworks, up to 21 dB during piling and up to 18 dB during viaduct section placement. These exceedances are due to the nearest residences being relatively close to the works. Potential mitigation measures include the installation of a solid 3m high hoarding / barrier.

At passive recreation Area G and commercial Area H, there would be minor exceedances of 7 dB and 5 dB during earthworks, a 1 dB exceedance during piling and compliance during viaduct section placement.

Rouse Hill Station to Cudgegong Road Station

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.31**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG21, BG22 and BG23 (refer to **Figure 10.1**). The ambient noise environment at the nearest sensitive receivers is primarily controlled by traffic movements on local roads and other natural noise sources.

Table 10.31 Nearest Noise Sensitive Receivers Rouse Hill Station to Cudgegong Road Station Viaduct

Receiver Area	Receiver Type	Location Relative to Works (m)[1]	Construction NMLs LAeq(15minute) (dBA)		
			Day	Evening	Night
A - Commercial sites East of Windsor Road, North of White Hart Drive	Commercial	25	70	N/A	N/A
B - Castlebrook Lawn Cemetery and Crematorium	Other (passive recreation)	280	60	N/A	N/A
C - Residences South of the site and West of Windsor Road	Residential	200	61	56	44
D - Residences North of the site and West of Windsor Road	Residential	5	54	48	39

Note 1 The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Note 2 Refer to **Table 10.2** for RBLs and **Table 10.3** for noise criteria used to determine NML

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.32** for each construction scenario.

Table 10.32 Predicted noise level exceedances for Rouse Hill Station to Cudgegong Road Station

Receiver Area		Noise Modelling Scenario					
		General Earthworks and Site stablishment (daytime)	General Earthworks and Site stablishment (evening)	Piling works and concreting (daytime)	Piling works and concreting (evening)	Placement of pre-cast viaduct ections (daytime)	Placement of pre-cast viaduct sections (evening)
A	Commercial sites East of Windsor Road, North of White Hart Drive		N/A		N/A		N/A
B	Castlebrook Lawn Cemetery and Crematorium		N/A		N/A		N/A
C	Residences South of the site and West of Windsor Road						
D	Residences North of the site and West of Windsor Road						

 Compliance

 ≤ 10 dB exceedance

 10 dB to ≤ 20 dB exceedance

 > 20 dB exceedance or LAeq(15minute) > 70 dBA

At commercial Area A there would be a moderate exceedance of 10 dB during earthworks, and minor exceedance of 4 dB during piling and 1 dB during viaduct section placement.

At passive recreation Area B and residential Area C there are no exceedances predicted during daytime works. Residential Area C shows a minor exceedance of up to 10 dB during site establishment and earthworks during the evening period.

At residential Area D there are high exceedances of up to 41 dB during earthworks, up to 35 dB during piling and up to 32 dB during viaduct section placement. These exceedances are due to the nearest residences being relatively close to the works. Potential mitigation measures include the installation of a solid 3m high hoarding / barrier.

The CNVS would also be implemented to manage the potential noise impacts. In particular, the strategy procedures and recommendations would be required where receivers are "highly noise affected". These may include letterbox drops, monitoring and consideration of temporary shielding.

Ground-borne noise and vibration assessment

Ground-borne construction noise is not anticipated to be appreciable for the proposed surface construction works between Bella Vista Station and the Tallawong Stabling Facility on the basis that airborne noise levels would be more prominent than the ground-borne noise levels.

The majority of existing buildings and structures adjacent to the proposed rail alignment between Bella Vista Station and Tallawong Stabling Facility are located more than 50 m from the proposed viaduct, ensuring that vibration levels would remain below the safe vibration levels associated with minor cosmetic damage. At locations where existing buildings and structures are located closer to the proposed excavation works, attended vibration monitoring may be required to maintain vibration levels below the safe vibration levels.

At locations where construction vibration levels are perceptible, the potential vibration impacts on building occupants would be managed in accordance with the procedures in the CNVS.

10.7.13 Excavation of mined tunnels between Epping and Bella Vista Station

Ground-borne construction noise

- **Epping Decline** – The decline at Epping is proposed to be mined using a roadheader. Minimal impacts from ground-borne construction noise are likely from these works, given the offset distance from the decline to the nearest receivers.
- **Epping crossover cavern** – The crossover cavern excavation is currently proposed to be mined with a roadheader. Residential receivers are situated directly above the cavern at a depth of between 28m to 36m (to rail height). When tunnelling works are directly underneath a particular receiver, ground-borne noise levels of between 30 dBA and 40 dBA are likely with corresponding (worst-case) minor exceedances of the LAeq(15minute) 35 dBA night-time NML of up to 5 dB.
- **Parramatta to Epping Rail Link stub tunnels** – The stub tunnels excavation is proposed to be mined with a roadheader. The depth of the tunnels are around 40m (to rail height), resulting in construction related ground-borne noise levels of between 30 dBA and 35 dBA. These predicted levels comply with the LAeq(15minute) 35 dBA night-time NML.
- **Cheltenham Services Facility support tunnel** – The support tunnel between the main tunnels and the services facility is expected to be mined with a rock breaker, and in order to reduce the potential noise and vibration impacts, construction activities are likely to be limited to daytime periods.
- **Castle Hill crossover cavern** – The crossover cavern excavation is currently proposed to be mined with a roadheader. Sensitive receivers are situated in the vicinity of the eastern end of the cavern which is at a depth of around 34m. Marginal exceedances of the night-time NML of 2 dB are predicted at the nearest residences when works are at the eastern end of the cavern.
- **Driven TBM tunnels** – The depth of the proposed railway tunnels varies from approximately 5m to 70m at the shallowest and deepest points respectively between Epping and Bella Vista Station. Given the progression rate of the TBM (around 20m per day), it is anticipated that the worst-case ground-borne noise impacts along the majority of the alignment would only be apparent for a relatively short period of time (ie several days for each TBM) whilst the tunnelling works are directly beneath a particular receiver. As the works progress and move away, a particular receiver's exposure to ground-borne noise would notably reduce. The night-time NML

of LAeq(15minute) 35 dBA is likely to be exceeded for up to four days as each TBM passes residential receivers within a slant distance of approximately 40m from the railway tunnels.

- **Roadheader tunnels** – The progress rate of road heading is notably less than the TBMs (around 4m per day), however at this stage, the vast majority of the alignment is proposed to be excavated using TBMs. The connection to the existing ECRL tunnels at Epping are proposed to mined with roadheaders. Worst-case ground-borne noise levels of around 35 dBA to 40 dBA are predicted at the nearest sensitive receivers in Oxford Street and Cambridge Street. Minor exceedances of the 35 dBA LAeq(15minute) night-time NML are therefore likely. As the majority of the potentially affected receivers in this location are of a commercial nature however, the impacts are likely to be minimal.
- **Cross passages** - Cross passages between tunnels would be spaced at regular intervals of approximately 240m and are proposed to be excavated with road headers, whilst niches and rooms would be excavated by hydraulic rock breaker. During the excavation works, the potential ground-borne noise impacts would be dependent on the tunnel depth. Excavation with rock breakers is likely to be limited to daytime periods in order to reduce the potential noise and vibration impacts.
- **Ground-borne vibration from tunnelling** - Construction related vibration levels from TBM and road headers would be much lower than the 7.5 mm/s screening level (relating to the threshold where minor cosmetic damage may occur). Vibration levels may however be noticeable within surface buildings which are located close to the main tunnel alignment. The impacts at these locations would only be apparent for a relatively limited period (ie one or two days) as the TBMs pass beneath a particular location. Vibration may also be perceptible at the Epping and Castle Hill crossover caverns when the tunnelling works are in the vicinity of the nearby surface receivers. Human comfort vibration impacts from tunnelling works would be managed in accordance with the CNVS.
- **Work trains within TBM tunnels** - It is currently assumed that work trains would be required during construction to transport labour and materials between the TBM support sites and the work front within the tunnels. Whilst the speed of these work trains is typically limited to approximately 10 km/h (for safety reasons), there is a possibility that the ground-borne noise and / or vibration trigger levels would be exceeded. At this stage in the assessment process, there is insufficient information to undertake a thorough assessment of the potential ground-borne noise and vibration impacts for this activity. The construction contractor would be required to undertake an assessment of the potential impacts associated with work trains (or alternative procedures) as part of the Construction Noise and Vibration Management Plan.

10.8 Mitigation measures

The Environmental Management Framework, provided in Appendix C, details the environmental, stakeholder and community management systems and processes for the construction of the NWRL.

As discussed in Section 10.7.1, a threefold approach to managing noise and vibration impacts is proposed for the construction phase of the NWRL. Mitigation measures have been developed to avoid, reduce and manage identified potential impacts. These mitigation measures and their application to the construction sites for the NWRL are presented in **Table 10.33**.

In addition to the site specific measures, a standard suite of mitigation measures would be implemented across all NWRL construction sites via the CNVS (refer Appendix E of Technical Paper 2). Where noise and vibration levels are predicted to remain above the noise and vibration

management levels, the final approach is to implement the additional mitigation measures documented in the CNVS.

Table 10.33 Summary of noise and vibration mitigation measures

No.	Mitigation Measure	Applicable Sites*
NV1	Noise and vibration mitigation measures described in the Construction Noise and Vibration Strategy would be implemented (refer Appendix E of Technical Paper 2).	All
NV2	An acoustic shed would be constructed to reduce impact of spoil removal during night-time periods.	1, 2, 4 – 6 and 8
NV3	An acoustic shed would be constructed at Norwest to reduce impact of vertical excavation (if required to be conducted during night-time periods).	7
NV4	An acoustic shed would be constructed to reduce impact of concrete pre-cast works during night-time periods.	9 and 10
NV5	3m high noise barriers (site hoardings) would be constructed around the perimeter of construction sites.	1 – 3, 5 – 7 and 14
NV6	6m high barriers would be constructed at Cherrybrook to manage night-time spoil truck movements.	4
NV7	3m high noise barriers (site hoardings) would be constructed at Bella Vista Station site on the north and eastern side of the main construction site and to the west of the station box.	8
NV8	Attended vibration monitoring would be undertaken at the nearest commercial building during high vibration activities to ensure vibration levels remain below safe limits.	1 and 5 – 7
NV9	Attended vibration monitoring would be undertaken at the nearest residential buildings during high vibration activities to ensure vibration levels remain below safe limits.	3 and 4
NV10	Noise measurements in the Gold Class cinema complex at Castle Hill during high vibration activities would be undertaken to determine ground-borne noise levels. Depending on the results of this monitoring, discussions would be held with the cinema managers to identify additional feasible and reasonable mitigation measures such as respite period and use of alternative equipment.	5
NV11	During construction, attended measurements would be undertaken at the commencement of rock breaking activities to confirm the magnitude of the ground-borne noise emissions in the Hills Centre for Performing Arts. Alternative construction methods such as smaller rock breakers, the use of rock saws or implementation of respite periods would be considered to minimise noise impacts, and implemented where reasonable and feasible.	6

No.	Mitigation Measure	Applicable Sites*
NV12	TBM works would be co-ordinated to avoid performance times when near / under the Hills Centre for Performing Arts, if feasible and reasonable.	6
NV13	Night-time truck access at Bella Vista Station site would be via the Celebration Drive roundabout to the south of the site.	8
NV14	No external night-time construction activities (ie forklift, front end loader, or similar activities) would be undertaken at the concrete pre-cast sites.	9 and 10
NV15	Noise from conveyors at the concrete pre-cast sites would be assessed during the Construction Noise and Vibration Impact Statements (which would be prepared for each major stage of works or activity) and additional measures implemented if feasible and reasonable (eg improved enclosures, low noise idlers).	9 and 10
NV16	Noise attenuation measures would be implemented where reasonable and feasible on tunnel ventilation equipment and other items of fixed plant (eg pumps, water treatment plant, diesel generators) that would be required to operate on a 24 hour per day, seven day per week basis in support of the underground works (eg ventilation fan enclosures and silencers, and additional enclosures and silencers for diesel generating equipment). At each site the combined LAeq noise from the operation of this equipment would aim to not exceed the rating background level at nearest residential receivers.	1 – 10
NV17	Further assessment would be undertaken of the potential ground-borne noise and vibration impacts associated with work train operations within the tunnels. This study would form part of the Construction Noise and Vibration Management Plan and include an assessment of feasible and reasonable mitigation measures.	4, 6 and 8

*Site 1 - Epping Services Facility, Site 2 - Epping Decline, Site 3 - Cheltenham Services Facility, Site 4 - Cherrybrook Station, Site 5 - Castle Hill Station, Site 6 - Hills Centre Station, Site 7 - Norwest Station, Site 8 - Bella Vista Station, Site 9 - Balmoral Road, Site 10 - Memorial Avenue, Site 11 - Kellyville Station, Site 12 - Samantha Riley Drive to Windsor Road, Site 13 - Old Windsor Road to White Hart Drive, Site 14 - Rouse Hill Station, Site 15 - Windsor Road Viaduct, Site 16 - Windsor Road Viaduct to Cudgegong Road, Site 17 - Cudgegong Road Station and Tallawong Stabling Facility, and Tunnels

Figure 10.1 Site Plan of Unattended Noise Logging Locations

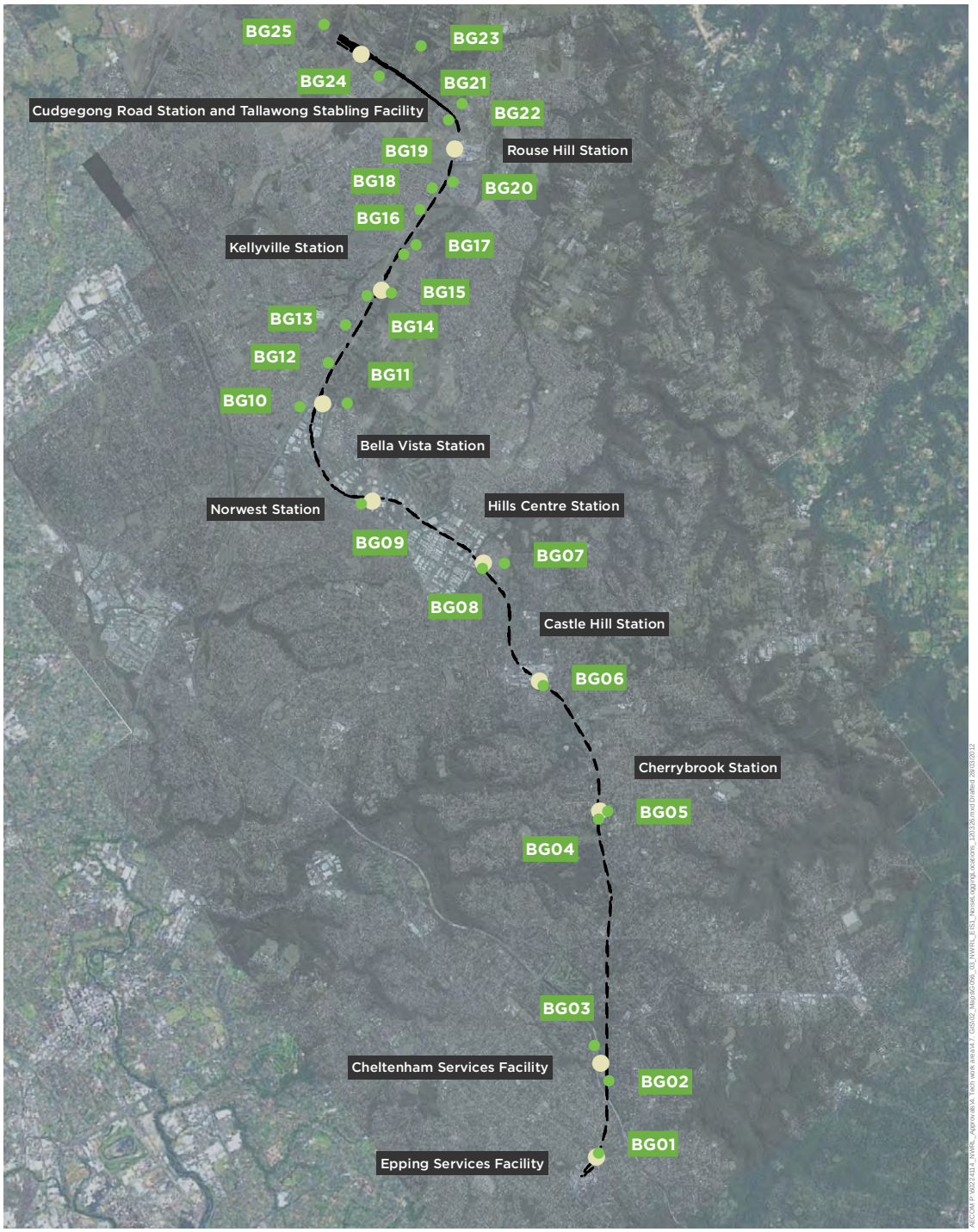

Figure 10.2 Location of sensitive receivers near Epping Services Facility and Epping Decline

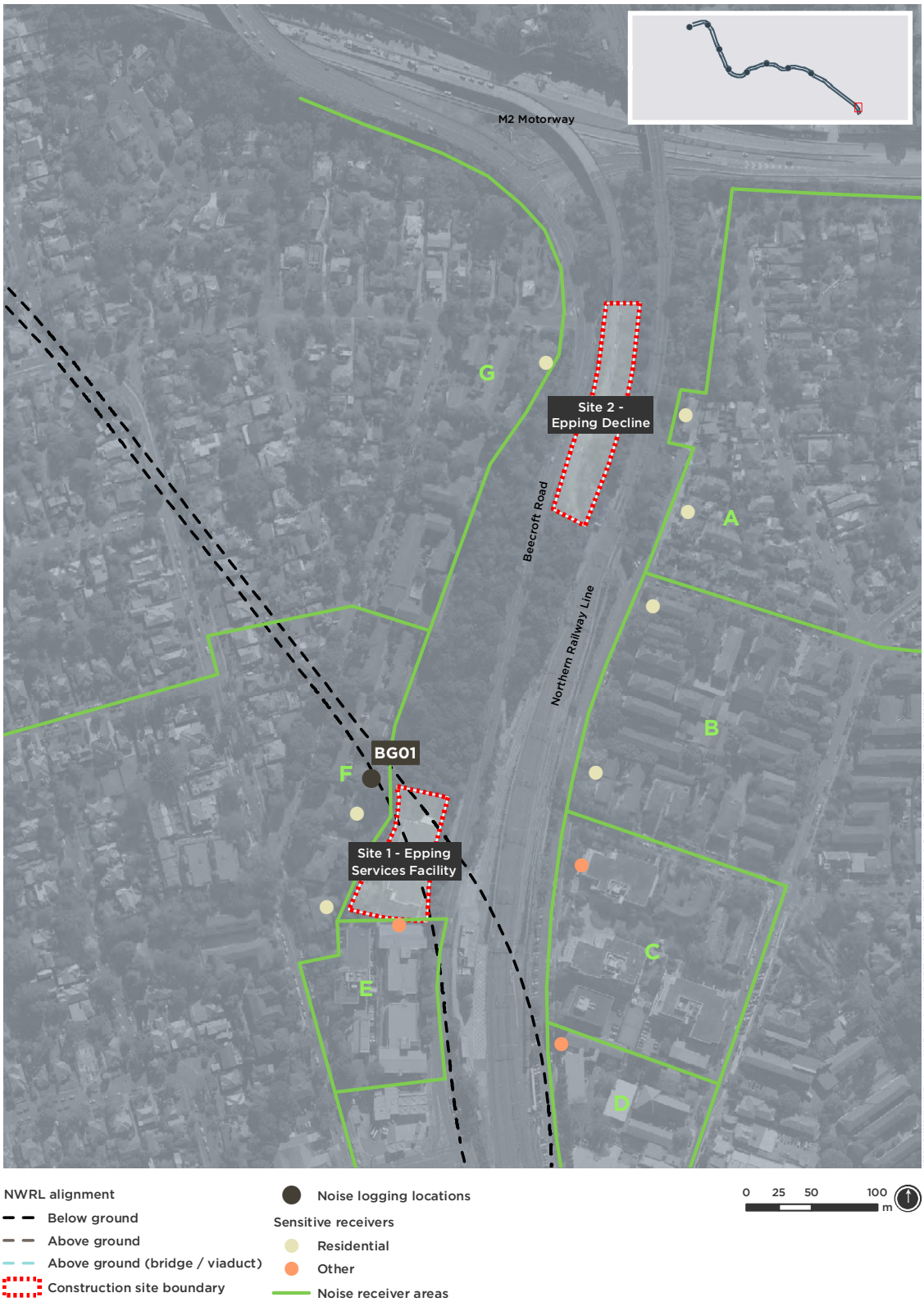

Figure 10.3 Location of sensitive receivers near Cheltenham Services Facility

Figure 10.4 Location of sensitive receivers near Cherrybrook Station

Figure 10.5 Location of sensitive receivers near Castle Hill Station

Figure 10.6 Location of sensitive receivers near Hills Centre Station

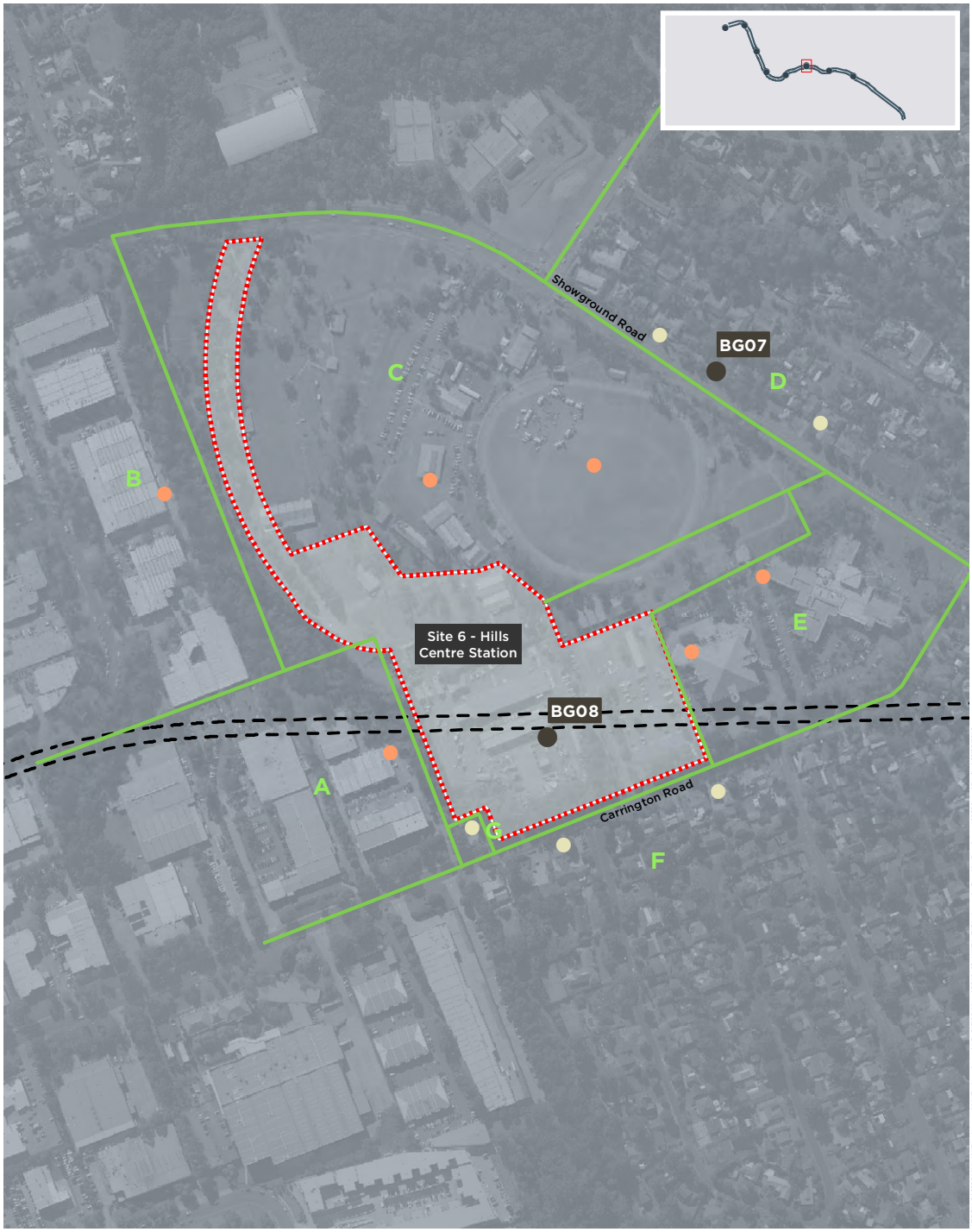

Figure 10.7 Location of sensitive receivers near Norwest Station

Figure 10.8 Location of sensitive receivers near Bella Vista Station and Pre-cast Facilities

Figure 10.9 Location of sensitive receivers near Kellyville Station

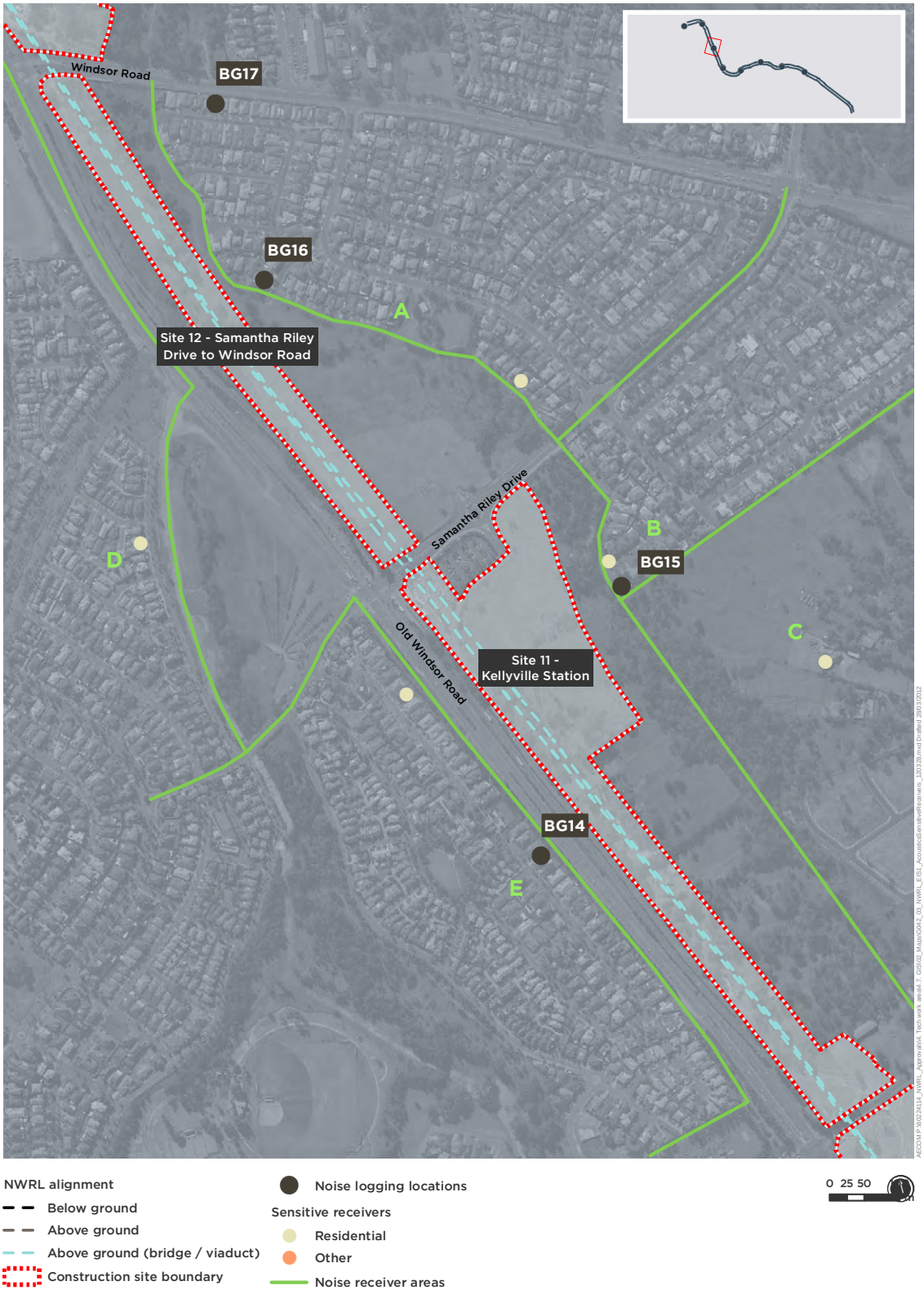

Figure 10.10 Location of sensitive receivers near Rouse Hill Station

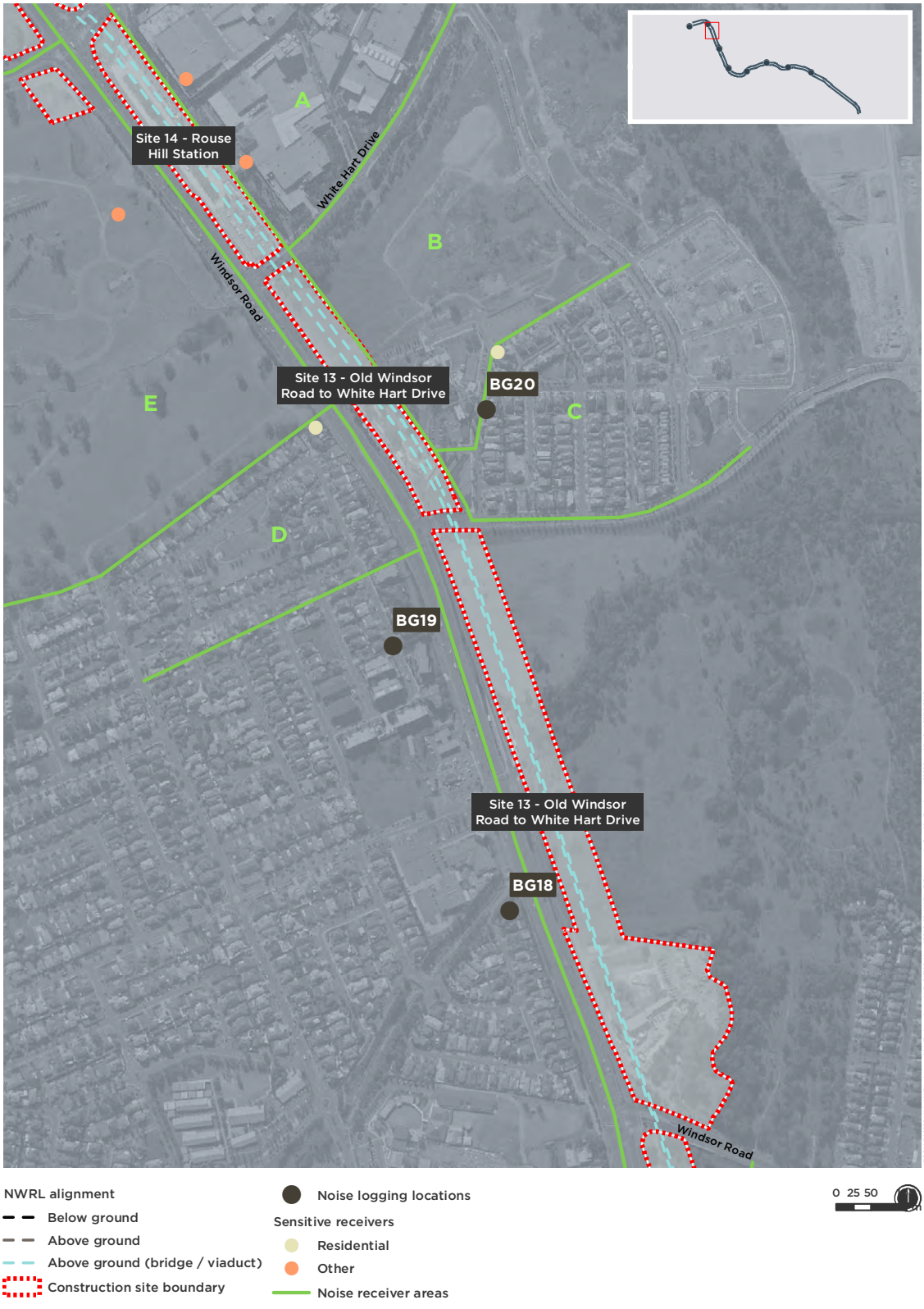

Figure 10.11 Location of sensitive receivers near Cudgegong Road Station and Tallawong Stabling Facility