Transport for NSW

Chapter 10
Noise and vibration

NSW GOVERNMENT

Contents

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10. Noise and vibration

This chapter provides a summary of the noise and vibration assessment. It describes the applicable noise and vibration criteria and the existing noise environment, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Paper 3 (Noise and Vibration).

10.1 Approach

Similar to other transport infrastructure projects, the project has the potential to generate noise, particularly during construction. A noise and vibration assessment has been carried out in accordance with the *Interim Construction Noise Guideline* (DECC, 2009) and *Rail Infrastructure Noise Guideline* (NSW EPA, 2013), as the key guiding documents to assessing and managing potential noise and vibration impacts in NSW. The noise and vibration assessment has also been carried out in accordance with:

- the SEARs (see Appendix A (SEARs compliance table))
- other relevant standards and guidelines, including those for vibration, road traffic noise, industrial noise, development near rail corridors, and the management of construction noise and vibration.

A detailed description of the legislative and policy context for the assessment is provided in section 2 of Technical Paper 3 (Noise and Vibration). An overview of the approach to the assessment is provided below. Further information on the assessment methodology is provided in sections 2 and 3 of Technical Paper 3.

10.1.1 Study area

The study area for the noise and vibration assessment was developed based on the potential extent of the impacts of project activities, including:

- construction activities at work areas and compounds
- construction heavy vehicle routes
- noise and vibration generated by the operation of light rail vehicles and permanent infrastructure.

The study area was divided into 20 noise catchment areas based on the types of sensitive receivers and ambient noise levels as shown on Figure 10.1. A detailed description of noise catchment areas and their characteristics is provided in section 2.2.1 of Technical Paper 3 (Noise and Vibration).

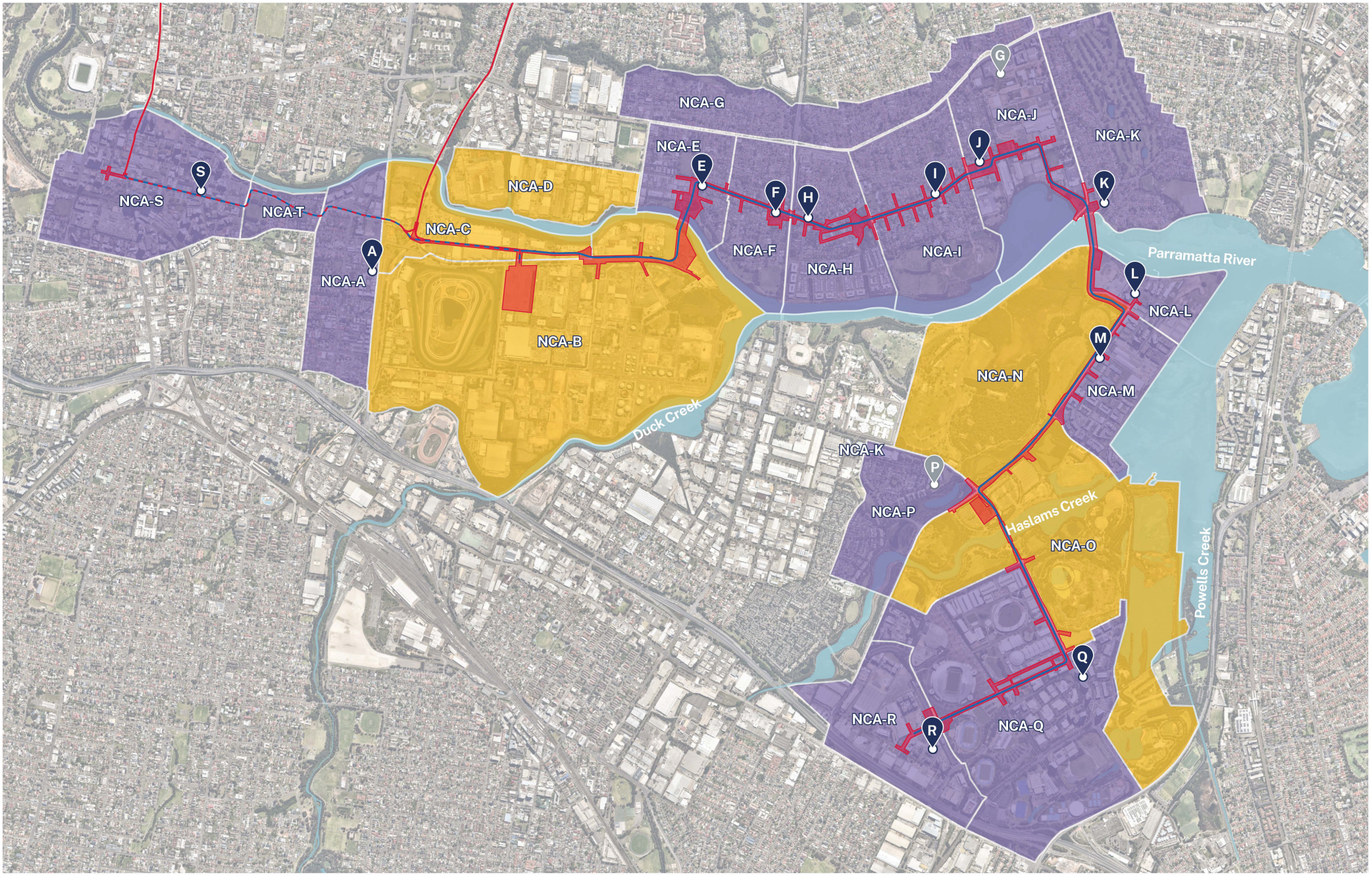

Figure 10.1 Noise catchment areas and monitoring locations

10.1.2 Key tasks

Tasks to characterise the existing environment and potential noise sources

This part of the assessment involved:

- identifying noise sensitive receivers in the study area
- undertaking attended and unattended noise measurements at representative locations (see Figure 10.1)
- determining noise and vibration management levels/criteria in accordance with relevant guidelines
- identifying potential noise sources during construction and operation
- defining construction scenarios and developing representative 'realistic worst-case' scenarios with indicative durations (see section 10.4.1), based on the assumption that the two loudest items of construction equipment would be used at the same time within individual construction scenarios (see Figure 10.2)
- identifying construction activities that would occur during the primary project working hours (see section 7.5), and those that would occur outside these hours (i.e., 'out-of-hours work') and where they would be located) – it is noted that out-of-hours work would only be required at specific locations (further information is provided in section 3.3.3 of Technical Paper 3 (Noise and Vibration).

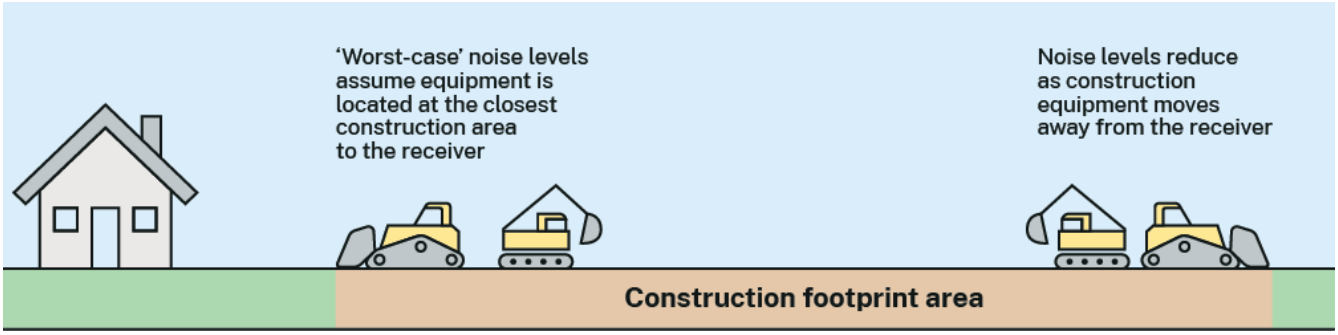

Figure 10.2 Worst-case noise levels for the construction work areas

Impact assessment, including modelling tasks

This part of the assessment involved:

- developing a three-dimensional representation of the study area by digitising the local terrain, receiver buildings and structures
- modelling to conservatively predict noise levels during construction and during operation (at the year of opening and 10 years after opening)
- undertaking a qualitative assessment of potential noise impacts associated with operating the light rail stops and the expanded Parramatta Light Rail stabling and maintenance facility
- assessing the potential for traffic noise impacts during construction (as a result of the movement of construction vehicles) and operation (as a result of the proposed changes to the road network)
- identifying structures within the minimum vibration and groundborne noise working distances
- assessing the significance of predicted noise and vibration levels by comparing them to the management levels/criteria
- identifying the potential cumulative impacts of construction occurring consecutively with other major projects (which can contribute to construction fatigue)

- assessing the effectiveness of potential mitigation measures and identifying residual noise impacts following their implementation
- identifying feasible and reasonable measures to mitigate predicted exceedances of the management levels/criteria, including appropriate standard and additional measures.

10.1.3 How potential impacts have been avoided or minimised

The approach to design development has included a focus on avoiding and/or minimising the potential for impacts during all key phases of the design process. As described in Chapter 5 (Design development, alternatives and options) a project corridor and alignment options assessment process was carried out to identify the preferred alignment. This process considered a range of factors, including potential noise and vibration impacts.

The design for the project has been refined to avoid impacts on sensitive receivers where possible, including:

- maximising use of existing transport corridors
- co-locating the stabling and maintenance facilities needed for the project with the existing Parramatta Light Rail stabling and maintenance facility, which is located within an industrial area
- siting construction compounds away from sensitive receivers as far as practicable
- selecting light rail vehicles based on noise and vibration performance.

10.2 Noise and vibration criteria

An individual's perception of noise is influenced by their environment. A noise level that is perceived to be loud in one situation may appear quiet in another. Figure 10.3 shows a comparison of noise levels from common sources.

A summary of the key criteria used to undertake the noise and vibration assessment is provided in this section. Further information on the criteria is provided in Appendix E of Technical Paper 3 (Noise and Vibration).

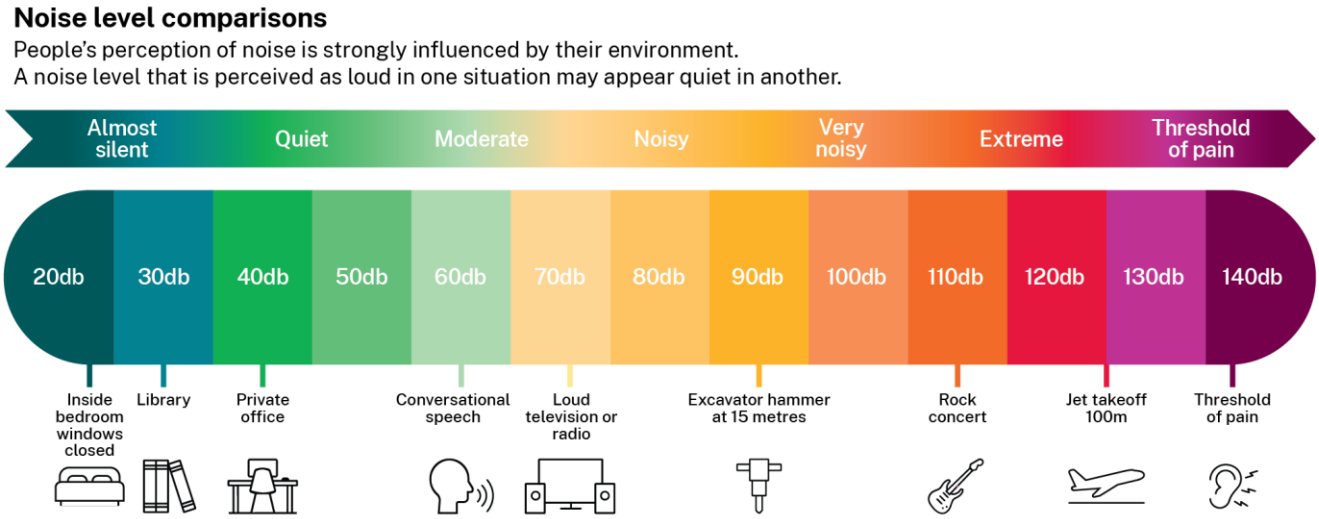

Figure 10.3 Noise level comparisons

10.2.1 Construction

Construction noise management levels – airborne noise

Project specific noise management levels were developed for sensitive receivers based on existing background noise levels (known as rating background levels) in the study area in accordance with the *Interim Construction Noise Guideline* (DECC, 2009). During recommended standard hours (see section 7.5):

- the 'noise affected' noise management level (the point above which there may be some community reaction to noise) is the rating background level plus 10 decibels (dB)
- the 'highly affected' noise management level (the point above which there may be strong community reaction to noise) is 75 dBA.

Outside recommended standard hours the noise management level is the rating background level plus 5 dB.

The noise management levels are not mandatory limits. Where construction noise levels are predicted or measured to be above the noise management levels, feasible and reasonable work practices are proposed to minimise noise impacts.

The project specific noise management levels for residential and non-residential receivers are shown in Table 10.1 and Table 10.2 respectively. The noise management levels for non-residential receivers only apply when the facilities are in use.

Table 10.1 Project-specific construction noise management levels – residential receivers

Noise catchment area (see Figure 10.1)	Suburb / area	Noise management levels (dBA) ($L_{Aeq(15min)}$)					
		Standard construction hours		Outside standard construction hours			
		Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (L_{Amax})
A	Camellia and Rosehill	61	75	56	54	45	55
E	Rydalmere suburban area 1	52	75	47	44	38	52
F	Rydalmere suburban area 2	57	75	52	50	41	52
G	North of Victoria Road	57	75	52	45	40	52
H	Ermington suburban area 1	57	75	52	50	41	52
I	Ermington suburban area 2	50	75	45	44	40	52
J	Ermington and Melrose Park redevelopment area	53	75	48	45	41	52
K	Melrose Park / West Ryde suburban area	47	75	42	42	37	52
L	Wentworth Point (near ferry wharf)	58	75	53	52	43	53
M	Wentworth Point (east of Hill Road)	63	75	58	56	41	52
P	Newington	54	75	49	50	44	54
Q	Sydney Olympic Park centre	60	75	55	53	46	56
R	Carter Street Precinct	60	75	55	53	50	60
S	Parramatta CBD	68	75	63	58	48	58

Table 10.2 Project-specific construction noise management levels – non-residential receivers

Land use	Noise management level (dBA) ($L_{Aeq(15min)}$) (external)
Classrooms at schools and other educational institutions	55
Hospital wards and operating theatres (not applicable to study area)	55
Places of worship	55
Active recreation	65
Passive recreation	60
Commercial premises	70
Industrial premises	75
Hotels, temporary accommodation	70 (day/evening) / 50 (night)

Construction sleep disturbance

There is potential for sleep disturbance impacts where night works are located close to residential receivers. Where construction works are planned to extend over more than two consecutive nights, the *Interim Construction Noise Guideline* recommends an assessment of sleep disturbance impacts.

The *Interim Construction Noise Guideline* refers to the *Environmental Criteria for Road Traffic Noise* (NSW EPA, 1999) to assess the potential impacts of sleep disturbance. To limit the level of sleep disturbance, the L_{Amax} level should not exceed the rating background level by more than 15 dB (see Table 10.1).

Construction road traffic noise

The potential impacts of construction traffic travelling on public roads are assessed in accordance with the *NSW Road Noise Policy* (DECCW, 2011a). An initial screening test is first applied to evaluate if road traffic noise levels are expected to increase by more than 2 dB due to construction traffic. Where this is considered likely, further assessment is required using the road traffic noise criteria in Table 10.3.

Where road traffic noise levels are predicted to increase by 2 dB or more, and the road traffic noise criteria is also exceeded, feasible and reasonable mitigation and management measures would be considered to minimise impacts.

Table 10.3 Construction road traffic noise criteria

Development type	Day (7am to 10pm) (dBA)	Night (10pm to 7am) (dBA)
Existing residences affected by additional traffic on arterial roads generated by land use developments	60 $L_{Aeq(15hour)}$	55 $L_{Aeq(9hour)}$
Existing residence affected by additional traffic on local roads generated by land use developments	55 $L_{Aeq(1hour)}$	50 $L_{Aeq(1hour)}$

Other construction criteria

A range of other construction criteria have been used in the assessment, including:

- groundborne noise
- vibration (human comfort and structures).

Further information is provided in sections 3.2.2 and 3.2.3 of Technical Paper 3 (Noise and Vibration).

10.2.2 Operation

Operational noise trigger levels – airborne noise

Light rail vehicle operations

The operational noise trigger levels for light rail vehicles have been defined in accordance with the *Rail Infrastructure Noise Guideline* (NSW EPA, 2013) and are shown in Table 10.4.

Where the project results in rail noise levels exceeding the noise trigger levels, the noise assessment needs to identify mitigation measures with the objective of reducing airborne noise to below the trigger levels, where feasible and reasonable. The *Rail Infrastructure Noise Guideline* (NSW EPA, 2013), requires noise to be assessed at project opening and for a future design year typically, taken to be 10 years after opening.

The two timeframes assessed for the project are the at-opening scenario in 2029, and a future scenario based on operation forecasts in 2039.

Table 10.4 Operational light rail vehicles airborne noise trigger levels

Sensitive land use	Period[1]	Trigger level (dBA)
Residential, mixed-use developments and hotels	Day	60 $L_{Aeq(15\ hour)}$ and 80 L_{Amax}
	Night	50 $L_{Aeq(9\ hour)}$ and 80 L_{Amax}
Schools, educational institutions and child care centres	Day and night (when in use)	40 $L_{Aeq(1hour)}$ internal or 50 $L_{Aeq(1hour)}$ external
Places of worship	Day and night (when in use)	40 $L_{Aeq(1hour)}$ internal or 50 $L_{Aeq(1hour)}$ external
Open space – passive use	Day and night (when in use)	60 $L_{Aeq(1hour)}$ external
Open space – active use	Day and night (when in use)	65 $L_{Aeq(1hour)}$ external
Commercial premises (public buildings, exhibition areas, café, bar, retail, offices and restaurant)	Day and night (when in use)	40 $L_{Aeq(1hour)}$ internal or 60 $L_{Aeq(1hour)}$ external

Note: 1. Day is 7am to 10pm. Night is 10pm to 7am.

Other operational criteria

A range of other operational criteria have been used in the assessment, including:

- airborne noise associated with the stabling and maintenance facility, substations and light rail stops
- groundborne noise associated with light rail vehicles
- ground vibration associated with light rail vehicles (human comfort, structures and sensitive equipment).

Further information is provided in section 4 of Technical Paper 3 (Noise and Vibration).

10.3 Existing environment

10.3.1 Sensitive receivers

Noise sensitive land uses are defined based on the type of occupancy and the activities performed. For the assessment, sensitive land uses have been categorised as:

- residential – residences and mixed-use developments (typically commercial on the ground floor and residential above)
- non-residential (including schools, places of worship, passive and active recreational areas, hotels, commercial buildings and industrial premises).

Detailed mapping of sensitive receivers, including heritage items, is provided in section 2.2 of Technical Paper 3 (Noise and Vibration).

10.3.2 Existing noise levels

The ambient noise environment surrounding the project site is variable, and typically dominated by road traffic noise. Noise monitoring was carried out at 11 locations to quantify and characterise the ambient noise environment across the study area (see Figure 10.1). Existing noise levels were measured at those receivers considered to most represent the existing noise levels in each noise catchment area. In addition, for noise catchment areas G, P and S, rating background levels were sourced from recent acoustic reports for areas representative of the most-affected residences.

A summary of the monitoring results is provided in Table 10.5. The measured noise levels were used to characterise the existing noise environment and to determine the criteria used to assess the potential impacts of the project.

Table 10.5 Summary of noise monitoring results

Noise catchment area (see Figure 10.1 and Table 10.1)	Rating background level (dBA) ($L_{A90(Period)}$)			Ambient noise descriptors (dBA) ($L_{Aeq(period)}$)			Road traffic noise levels (dBA) ($L_{Aeq(period)}$)	
	Day	Evening	Night	Day	Evening	Night	Day	Night
A	51	49	40	61	60	57	61	57
E	42	39	33	57	55	50	56	50
F	47	45	36	60	56	59	59	59
G	47	40	35	64	59	45	-	-
H	47	45	36	60	56	59	59	59
I	40	39	35	57	54	50	56	50
J	43	40	36	59	56	51	58	51
K	37	37	32	55	50	45	54	45
L	48	47	38	59	57	51	58	51
M	53	51	36	63	63	57	63	57
P	44	45	39	55	54	54	-	-
Q	50	48	41	59	59	55	59	55
R	50	48	45	61	52	49	60	49
S	58	53	43	69	67	62	-	-

10.4 Assessment of construction impacts

10.4.1 Potential noise sources

Construction typically requires the use of heavy machinery, which can generate high noise and vibration levels at nearby receivers. The potential impacts vary greatly depending on the intensity and location of construction activities, the type of equipment used, existing background noise levels, intervening terrain and prevailing weather conditions.

Potential noise and vibration sources during construction include:

- operation of mobile and stationary construction plant and equipment
- operation of construction compounds and other ancillary facilities (known as fixed sources)
- construction vehicle movements.

The assessment uses worst-case scenarios to determine potential impacts from the noisiest 15 minute period that is likely to occur for each work activity, as required by the *Interim Construction Noise Guideline*. The worst-case scenarios used to assess the potential impacts of constructing the project are detailed in section 3.3.5 of Technical Paper 3 (Noise and Vibration) and include:

- clearing and removal (scenario S01.02)
- construction compounds – installation of services and utilities (scenario S02.02)
- spoil and ballast – screening and crushing (scenario S03.01)
- substations – construction and installation works (scenario S04.02)
- light rail track and public domain – earthworks (scenario S05.02)
- modifications to the stabling and maintenance facility – track work (scenario S06.03)
- stops – finishing works (scenario S07.02)
- bridges – piling for bridge foundations, including temporary jetties (scenario S08.02)
- road works and other pavement – earthworks (scenario S09.02).

10.4.2 Predicted noise levels

An assessment of the predicted noise impacts was carried out at potentially affected receivers in each noise catchment area for the worst-case construction scenarios. The predicted noise levels are representative of the worst-case situation where construction equipment is at the closest point to the most affected receiver. The calculations also assume that many items of construction equipment are in use at the same time. However, actual noise levels would vary over the construction period as the location of works would change and not all equipment would operate at all times.

Three categories of noise management level exceedances are identified:

- less than 10 dB exceedance
- 10 to 20 dB exceedance
- more than 20 dB exceedance.

A summary of the predicted impacts is provided in the following sections. The approach to managing the potential for impacts is described in section 10.7.

Residential receivers

Predicted noise management level exceedances (without the implementation of mitigation) are shown in Table 10.6 for worst-case construction scenarios. Key impacts are summarised below.

Predicted impacts during recommended standard hours

The results summarised in Table 10.6 show that:

- most predicted exceedances are of a low magnitude (exceedances of less than 10 dB)
- the largest number of 10 to 20 dB and greater than 20 dB exceedances of the noise management levels are predicted to occur during the following scenarios:
  - earthworks associated with construction of the light rail and public domain works (S05.02)
  - piling for bridges (S08.02)
  - earthworks associated with road works and other pavement (S09.02)
- works associated with clearing and removal (S01.02), installation of services at construction compounds (S02.02), construction of substations (S04.02) and stops (S07.02) are also predicted to result in exceedances of the noise management levels; however, these exceedances are expected to be of shorter duration
- fewer exceedances are predicted for spoil and ballast screening and crushing (S03.01) and modification works at the stabling and maintenance facility (S06.03) due to the distance from sensitive receivers.

Table 10.7 summarises the noise catchment areas within which exceedances are predicted without the implementation of mitigation measures for worst-case construction scenarios. The table shows that a larger number of exceedances are generally predicted in noise catchment areas north of the Parramatta River where the project site is located close to residences. During recommended standard hours, noise catchment areas I (in Ermington) and K (in Melrose Park/West Ryde) are predicted to have the largest number of exceedances.

Predicted impacts during out-of-hours work

As shown in Table 10.6, the construction scenarios predicted to result in the largest number of exceedances are consistent with those identified for work during recommended standard hours. Due to the lower noise criteria for out-of-hours periods, the number of exceedances generally increases compared to that during recommended standard hours, with increases also observed for each subsequent out-of-hours period (for example when comparing daytime out-of-hours periods with the evening out-of-hours period). There is also an increase in the number of exceedances between the less than 10 dB, 10 to 20 dB, and greater than 20 dB categories, with an increase towards the higher magnitude of exceedances from the daytime out-of-hours period to the night out-of-hours periods. This is largely a result of the noise levels during each period remaining the same but the criteria reducing for each period.

The predicted location of exceedances is generally consistent with those identified during recommended standard hours as noted above (see Table 10.7). However, the number of exceedances predicted within each noise catchment area increases due to the lower criteria for each subsequent out-of-hours period. An example of where this is most notable is noise catchment area G (north of Victoria Road), which does not contain any portion of the project site. Daytime impacts are not predicted in this noise catchment area; however, at night, where there is a lower criterion, exceedances are predicted to occur.

Highly noise affected

The results summarised in Table 10.6 show that:

- the largest number of highly noise affected receivers are predicted to occur during the following scenarios:
  - clearing and removal (S01.02)
  - earthworks associated with construction of the light rail and public domain works (S05.02)
  - piling for bridges (S08.02)
  - road works and other pavement earthworks (S09.02)
- receivers are predicted to be affected by noise associated with services installation at construction compounds (S02) and stop construction (S07.02); however, the number of highly noise affected receivers would be lower
- receivers with the potential to be highly noise affected are generally located within noise catchment areas E to M (excluding noise catchment area G), which coincides with the locations where works would occur within predominately residential areas.

Table 10.6 Predicted number of exceedances of the noise management levels at residential receivers during work period

Scenario	Highly noise affected	Recommended standard hours			Out-of-hours (day)			Out-of-hours (evening)			Out-of-hours (night)		
Exceedance category (dB)		**<10**	**10 – 20**	**>20**	**<10**	**10 – 20**	**>20**	**<10**	**10 – 20**	**>20**	**<10**	**10 – 20**	**>20**
Clearing and removal (S01.02)	164	1,072	425	235	1,103	717	395	1,150	802	471	923	1,231	845
Construction compounds (S02.02)	81	785	261	95	1,294	400	196	1,317	483	241	1,281	1,016	484
Spoil and ballast (S03.01)	-	-	-	-	-	-	-	1	-	-	73	-	-
Substations (S04.02)	-	94	25	-	226	44	2	277	60	9	633	120	33
Light rail track and public domain works (S05.02)	394	1,196	649	477	1,058	958	745	1,068	995	853	1,081	1,175	1,405
Modifications to existing stabling and maintenance facility (S06.03)	-	-	-	-	-	-	-	1	-	-	140	-	-
Stops (S07.02)	38	414	130	42	789	212	86	860	253	108	1,241	501	239
Bridges (S08.02)	125	868	338	149	1,235	560	276	1,436	635	331	1,847	891	722
Roadworks and other pavement works (S09.02)	538	1,111	742	602	1,049	981	880	1,130	1,031	984	1,261	1,180	1,590

Table 10.7 Predicted number of exceedances of the noise management levels in residential noise catchment areas

		Noise catchment area													
Scenario	**Assessment period**	**A**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**P**	**Q**	**R**	**S**
Clearing and removal (S01.02)	Standard hours	0	185	190	0	261	520	132	440	3	1	0	0	0	0
	OOHW night	0	263	418	333	527	652	151	573	14	23	45	0	0	0
	Highly noise affected	0	18	12	0	42	52	24	16	0	0	0	0	0	0
Construction compounds (S02.02)	Standard hours	0	102	147	0	223	276	75	259	9	6	31	1	12	0
	OOHW night	0	253	403	143	487	516	144	573	19	30	192	5	16	0
	Highly noise affected	0	10	16	0	37	2	0	9	3	2	0	0	2	0
Spoil and ballast (S03.01)	Standard hours	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OOHW night	0	70	3	0	0	0	0	0	0	0	0	0	0	0
	Highly noise affected	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Substations (S04.02)	Standard hours	0	28	0	0	0	57	28	0	0	0	0	0	6	0
	OOHW night	0	142	100	18	0	268	98	139	0	7	1	0	13	0
	Highly noise affected	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Light rail track and public domain works (S05.02)	Standard hours	0	217	331	0	354	664	128	507	21	44	36	3	17	0
	OOHW night	2	268	438	500	536	718	152	586	28	73	317	10	22	11
	Highly noise affected	0	50	87	0	69	133	17	5	11	15	0	0	7	0
Modifications to existing stabling and maintenance facility (S06.03)	Standard hours	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OOHW night	12	112	15	1	0	0	0	0	0	0	0	0	0	0
	Highly noise affected	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stops (S07.02)	Standard hours	0	66	79	0	58	263	35	63	4	9	0	0	9	0
	OOHW night	14	206	320	32	282	524	135	377	12	27	41	0	11	0
	Highly noise affected	0	1	16	0	3	11	0	0	0	3	0	0	4	0
Bridges (S08.02)	Standard hours	0	199	306	0	256	98	0	433	7	5	51	0	0	0
	OOHW night	0	264	441	506	536	610	125	572	21	32	351	2	0	0
	Highly noise affected	0	10	42	0	45	11	0	15	2	0	0	0	0	0

		Noise catchment area													
Scenario	**Assessment period**	**A**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**P**	**Q**	**R**	**S**
Roadworks and other pavement works (S09.02)	Standard hours	0	233	342	0	333	672	140	562	22	32	96	5	18	0
	OOHW night	203	268	440	613	542	720	152	587	28	68	364	10	23	13
	Highly noise affected	0	81	119	0	60	199	24	15	14	15	0	1	10	0

Note: OOHW – out-of-hours work

Key to noise catchment areas: A - Camellia and Rosehill, E - Rydalmere suburban area 1, F - Rydalmere suburban area 2, G - North of Victoria Road, H - Ermington suburban area 1, I - Ermington suburban area 2, J - Ermington and Melrose Park redevelopment area, K - Melrose Park / West Ryde suburban area, L - Wentworth Point (near ferry wharf), M - Wentworth Point (east of Hill Road), P – Newington, Q - Sydney Olympic Park centre, R - Carter Street Precinct, S - Parramatta CBD.

Non-residential receivers

Table 10.8 shows the number of non-residential receivers that are predicted to exceed the construction noise management level for each worst-case scenario. Only receiver types that have predicted exceedances are shown.

No impacts are predicted for the majority of non-residential receivers identified in the study area. The worst-case construction activities in terms of the number of receivers with the potential to be affected are earthworks associated with construction of the light rail track and public domain work (S05.02) and those associated with road works and other pavement (S09.02).

Exceedances at 84 non-residential receivers are predicted for the light rail track and public domain earthworks scenario (S05.02). Of these exceedances, most (66 receivers) are predicted to exceed the construction noise management levels by less than 10 dB and four are predicted to exceed the levels by more than 20 dB. Exceedances at 96 non-residential receivers are predicted for the earthworks associated with road works and other pavement scenario (S09.02). Of these, most (77 receivers) are predicted to exceed the construction noise management levels by less than 10 dB and six are predicted to experience exceedances greater than 20 dB.

Table 10.8 Predicted exceedances of the noise management levels at non-residential receivers for worst-case construction scenarios

	Receiver category														
Scenario	**Education**			**Recreation**			**Commercial**			**Hotel**			**Place of worship**		
Exceedance category (dB)	**<10**	**10 – 20**	**>20**	**<10**	**10 – 20**	**>20**	**<10**	**10 – 20**	**>20**	**<10**	**10 – 20**	**>20**	**<10**	**10 – 20**	**>20**
Clearing and removal (S01.02)	7	4	1	5	6	2	0	1	1	0	0	0	3	1	0
Construction compounds (S02.02)	13	4	1	3	5	2	3	1	1	2	0	0	2	1	0
Spoil and ballast (S03.01)	0	4	1	0	5	2	0	1	1	0	0	0	0	1	0
Substations (S04.02)	0	4	1	2	5	2	0	1	1	1	0	0	1	1	0
Light rail track and public domain works (S05.02)	11	4	1	7	8	2	42	1	1	2	0	0	4	1	0
Modifications to existing stabling and maintenance facility (S06.03)	0	4	1	1	5	2	0	1	1	0	0	0	0	1	0
Stops (S07.02)	6	4	1	4	5	2	1	1	1	0	0	0	1	1	0
Bridges (S08.02)	8	4	1	11	5	2	0	1	1	0	0	0	2	1	0
Roadworks and other pavement works (S09.02)	10	4	1	10	7	4	52	1	1	2	0	0	3	1	0

Sleep disturbance

The results of the sleep disturbance screening assessment are summarised in Table 10.9, which shows the predicted number of exceedances of the criteria in residential noise catchment area. The assessment is based on the assumption that high noise generating equipment would be used and also assumes the incorporation of mitigation (conservatively assumed to provide 10 dB of noise reduction). The number of exceedances of the sleep disturbance criteria would be less than shown most of the time, as high noise generating equipment would only be used for a relatively short periods and, as far as reasonably practicable, would only be used during recommended standard hours.

The receivers that would potentially be impacted are generally the same receivers for which high night-time impacts have been predicted, as discussed above.

The receivers with the potential to experience higher impacts are generally located in Rydalmere and Ermington (noise catchment areas E to J) where background noise levels are relatively low and residences are located close to the project site.

Table 10.9 Summary of number of exceedances of the sleep disturbance criteria in residential noise catchment areas

Noise catchment area	No exceedance	Exceedance less than 10 dB	Exceedance between 10 – 20 dB	Exceedance greater than 20 dB
A	294	2	0	0
E	47	93	49	79
F	75	113	130	127
G	819	5	0	0
H	88	226	124	109
I	142	255	146	183
J	40	55	32	26
K	244	239	73	31
L	5	3	8	13
M	5	30	21	18
P	413	48	0	0
Q	4	5	1	0
R	8	4	6	5
S	123	0	0	0

10.4.3 Construction road traffic noise

The results of the assessment indicate that an exceedance of the criteria in the NSW *Road Noise Policy* (DECCW, 2011a) is predicted along the following local road sections:

- John Street – South Street to Antione Street
- Fallon Street – South Street to John Street
- Fallon Street – Primrose Avenue to South Street
- Primrose Avenue – South Street to John Street
- Hilder Road – Tristram Street to Coffey Street.

Further modelling of all routes would be carried out during design development when construction traffic volumes and heavy vehicle routes are confirmed by the construction contractor. Where compliance with the criteria is unable to be achieved, reasonable and feasible noise mitigation and management measures would be considered (see section 10.7).

Sleep disturbance impacts associated with construction traffic are generally associated with maximum noise events due to compression braking and heavy vehicle passbys. The roads where the frequency of maximum noise events associated with the movement of heavy vehicles on public roads may increase by double or more during the construction period are:

- collector roads – South Street, Wharf Road, Hill Road
- local roads – Dawn Fraser Avenue, John Street, Fallon Street, Hilder Road.

10.4.4 Construction vibration

A total of 475 buildings across the study area are located within the area identified as having the potential to exceed the vibration screening level for cosmetic damage to unreinforced structures. In addition, 822 buildings are located within the area where vibration levels may exceed human comfort management levels. The majority of affected buildings are located in Ermington (noise catchment areas H and I).

Buildings have been assessed based on the assumption that they are lightweight (unreinforced) structures. However, it is likely that most would be reinforced structures. Dilapidation surveys would be carried out prior to construction to confirm the type and condition of the identified buildings and refine the vibration management levels (if required) based on the investigation (see section 10.7).

A total of 22 heritage structures have been identified within the vibration screening distance. Prior to construction, investigations (including dilapidation surveys of structures as relevant) would be carried out to determine if there are any features within these sites that are structurally unsound and/or subject to risk from construction vibration.

Construction vibration also has the potential to impact Aboriginal objects or non-Aboriginal archaeological remains located below the ground surface. Potential archaeological sites are described in Chapter 11 (Aboriginal heritage) and Chapter 12 (Non-Aboriginal heritage).

The potential for vibration impacts on heritage items would be confirmed during construction planning (see section 10.7). Other vibration sensitive receivers (such as utilities, imaging equipment etc) would be identified by survey and considered as part of construction planning activities.

The following sensitive infrastructure items have been identified within the vibration screening distance – Rydalmere Wharf, Ermington boat ramp, Sydney Olympic Park Wharf and Olympic Park Station.

In addition, there are a number of key utilities located within the project site (see section 7.8), as well as buried infrastructure that forms part of the remediation management infrastructure for remediated sites in Camellia and Sydney Olympic Park (described in Chapter 18 (Soils and contamination). Construction vibration during works near these utilities and infrastructure has the potential to cause impacts. The potential for vibration impacts on utilities and remediation management infrastructure would be confirmed with utility owners during construction planning. Based on worst-case construction activities and adopted vibration goals, it is anticipated that the vibration goals could be exceeded within five metres of construction works.

The approach to managing the potential for impacts is described in section 10.7.

10.5 Assessment of operation impacts

10.5.1 Operational airborne noise

This section summarises the results of the assessment of potential airborne noise impacts associated with light rail vehicle operations:

- on the new section of track between the Sandown Boulevard and Carter Street stops, which would be used by Parramatta Light Rail Stage 2 vehicles only (with the exception of the short section between Sandown Boulevard and the stabling and maintenance facility which would be used by Stage 1 vehicles to access the facility)
- on the existing section of track between the Parramatta Square and Sandown Boulevard stops, which would be used by both Parramatta Light Rail Stage 1 and Stage 2 vehicles
- at the Macquarie Street turnback in the Parramatta CBD, which would be used by Parramatta Light Rail Stage 2 vehicles only.

Sandown Boulevard to Carter Street

Residential receivers

A summary of the range of predicted operational noise levels, and the number of receivers predicted to experience noise levels above the *Rail Infrastructure Noise Guideline* (NSW EPA, 2013) trigger levels, is provided in Table 10.10. Receivers would qualify for consideration of mitigation in the following cases:

- during the day (7am to 10pm) – $L_{Aeq(15hour)}$ 60 dBA and $L_{Amax(95\%)}$ 80 dBA noise trigger levels are exceeded; or
- during the night (10pm to 7am) – $L_{Aeq(9hour)}$ 50 dBA and $L_{Amax(95\%)}$ 80 dBA noise trigger levels are exceeded.

No residential receivers have been identified as qualifying for consideration for mitigation as both the L_{Aeq} and L_{Amax} exceedance conditions have been not met at any location.

Table 10.10 Summary of predicted operational noise levels – Sandown Boulevard to Carter Street – residential receivers

Noise catchment area	Day (7am to 10pm) *(Trigger - $L_{Aeq(15hour)}$ 60 dBA)*		Night (10pm to 7am) *(Trigger - $L_{Aeq(9hour)}$ 50 dBA)*		Maximum *(Trigger - $L_{Amax(95\%)}$ 80 dBA)*		Receivers qualifying for mitigation consideration
	Range (dBA)	No of exceedances	Range (dBA)	No of exceedances	Range (dBA)	No of exceedances	
E	38 - 58	0	33 - 53	14	47 - 76	0	0
F	39 - 58	0	34 - 54	35	49 - 78	0	0
H	34 - 61	1	29 - 56	21	44 - 80	0	0
I	37 - 60	0	33 - 55	62	46 - 79	0	0
J	41 - 61	1	36 - 57	3	51 - 80	0	0
K	43 - 55	0	39 - 50	0	56 - 70	0	0
L	41 - 59	0	36 - 54	3	52 - 78	0	0
M	36 - 58	0	31 - 53	7	53 - 77	0	0
R	32 - 59	0	27 - 55	3	49 - 80	0	0
Total	**32 - 61**	**2**	**27 - 57**	**149**	**44 - 80**	**0**	**0**

Non-residential receivers

A summary of the range of predicted operational noise levels for non-residential receivers, and the number of receivers predicted to experience noise levels above the trigger levels, is provided in Table 10.11.

Commercial receivers do not qualify for noise mitigation consideration under the requirements of the *Rail Infrastructure Noise Guideline*. As such, no mitigation has been recommended for commercial receivers that are predicted to experience noise levels above $L_{Aeq(1hour)}$ 60 dBA.

Table 10.11 Summary of predicted operational light rail vehicles airborne noise levels – Sandown Boulevard to Carter Street – non-residential receivers

Receiver type	Day (7am to 10pm)		Night (10pm to 7am)		Maximum		Receivers qualifying for mitigation consideration
	Range (dBA)	No of exceedances	Range (dBA)	No of exceedances	Range (dBA)	No of exceedances	
Educational institute	38 - 48	0	-	-	-	-	0
Active recreation	26 - 54	0	-	-	-	-	0
Passive recreation	29 - 53	0	-	-	-	-	0
Industrial	36 - 72	0	-	-	-	-	0
Commercial	34 - 64	2	-	-	-	-	0
Hotel	43 - 59	0	38 - 53	2	53 - 76	0	0
Mixed use	30 - 48	0	38 - 43	0	39 - 61	0	0

Sleep disturbance

Predicted maximum noise levels associated with light rail vehicle operations range from 39 to 80 dBA (L_{Amax}) across all noise catchment areas. No residential receivers qualify for mitigation consideration as noted above (see Table 10.10).

The directional warning bells fitted on light rail vehicles would only be used in the event of emergencies or where the driver considers there is a danger to public safety. The *Rail Infrastructure Noise Guideline* does not require assessment of warning bells where their use is only in emergency situations and, as such, their use has not been included in the noise modelling. Due to the distinctive nature of the warning bell sound, it is likely to be noticeable at residences immediately adjacent to the light rail track if it were to be sounded. However, infrequent use of the warning bells is not predicted to exceed the noise trigger level of L_{Amax} 80 dBA and therefore negligible impacts are expected.

Consideration of special events

Increased frequency of light rail services for special events at Sydney Olympic Park and Rosehill Gardens Racecourse could result in additional operational noise impacts. Predicted increased noise levels range from 1 dB during the day ($L_{Aeq(15hr)}$) to 2 dB during the night ($L_{Aeq(9hr)}$). While an increase in the frequency of light rail services would be noticeable, these predicted increases in noise levels would not be noticeable. There are no predicted increases in the maximum noise levels.

Parramatta Square to Sandown Boulevard

Between Parramatta Square and Sandown Boulevard, the light rail vehicles would use track constructed as part of Parramatta Light Rail Stage 1. Based on the increased light rail vehicles movements on this section of track, it is predicted that three additional non-residential receivers (two educational and one medical facility) would qualify for mitigation consideration. In addition, one residential receiver that qualified for mitigation consideration as part of the stage 1 assessment would experience increased noise levels requiring consideration as part of any mitigation works.

Macquarie Street turnback

There are no residential receivers located near the Macquarie Street turnback. The measured existing noise levels in the Parramatta CBD are already above the predicted L_{Aeq} and L_{Amax} noise levels for light rail vehicle operations. Whilst the project would introduce a new noise source into the environment, the potential for noise impacts would depend on whether the light rail noise would be clearly audible or intrusive above existing noise sources.

As commercial receivers do not qualify for mitigation under the requirements of the *Rail Infrastructure Noise Guideline*, no mitigation has been recommended.

Fixed facilities

Light rail stops (public address systems)

Public address systems are proposed for each light rail stop. Provided the public address systems are designed appropriately, the duration and infrequency of announcements would be unlikely to significantly contribute to the overall $L_{Aeq(15min)}$ noise levels at receivers. The assessment identified that while there is potential for temporary annoyance impacts on residential receivers at nine stops (John Street, Nowill Street, River Road, Murdoch Street, Atkins Road, Footbridge Boulevard, Hill Road and Carter Street), impacts are considered minimal due to the infrequency of announcements. However, where residential receivers are close to stops, the proposed location and operation of the public address systems would be reviewed during design development to ensure that potential noise impacts are minimised.

Substations

There are no predicted exceedances of the relevant trigger levels associated with the substations.

Stabling and maintenance facility

Noise levels associated with operation of the expanded facility are predicted to comply with the relevant trigger levels at all sensitive receivers.

Exceedances of the trigger levels are anticipated at potential future residences in residential/mixed use areas in the future Camellia town centre (identified by the *Draft Camellia-Rosehill Place Strategy* (DPIE, 2021b) during operation of the Stage 1 stabling and maintenance facility infrastructure. Operation of the Stage 2 infrastructure is predicted to increase these exceedances by up to 3 dB.

10.5.2 Operational groundborne noise

Sandown Boulevard to Carter Street

A total of 149 residential receivers are predicted to experience exceedances of the relevant trigger levels for night-time groundborne noise, and qualify for mitigation consideration. These receivers are mostly located between John Street in Rydalmere and Melrose Park, with the qualifying facades being located towards the back of the property (away from the project).

Parramatta Square to Sandown Boulevard

There are no predicted exceedances of the groundborne noise trigger levels from light rail vehicles operations between Parramatta Square and Sandown Boulevard.

Macquarie Street turnback

For the restaurants and retail shop buildings fronting the Macquarie Street turnback facility, airborne noise levels are anticipated to be the dominant noise source and above the groundborne noise levels. For receivers that are setback more than eight metres from the track that do not have a façade exposed to the track, groundborne noise levels are anticipated to be below L_{Asmax} 45 dBA, which is below the noise goal of 50 dBA and therefore further assessment is not necessary.

Stabling and maintenance facility

Operational groundborne noise levels associated with the facility are predicted to be negligible.

10.5.3 Operational road traffic noise

To assess the potential operational noise impacts due to changes to the road traffic network as a result of the project, an initial screening test was carried out to evaluate whether noise levels would increase by more than 2 dB. Where noise levels increase by more than 2 dB and noise levels exceed the controlling criterion, then mitigation strategies should be considered to reduce potential noise impacts. The results of the assessment indicate that no section of road is predicted to experience noise level increases of more than 2 dB, based on the comparison between the 'no build' and 'build' traffic volumes for 2031.

At intersections where vehicles would cross over the light rail tracks, L_{AFmax} noise levels at the closest receivers could increase by about 5 to 7 dB and 0.6 dB for $L_{Aeq(15/9hour)}$ noise levels. Considering the forecast 'no build' and 'build' traffic volumes and intersections where vehicles would cross over rail tracks, noise levels are not predicted to be greater than 2 dBA at any sections of road, with the exception of South Street and Boronia Street in Rydalmere and Ermington respectively.

Sections of South Street and Boronia Street would require minor reconfigurations as a result of the project, where the eastbound traffic lanes would move closer to residences to the north of South Street and Boronia Street to allow for centre-running light rail tracks. Additionally, there are various intersections along South Street and Boronia Street where vehicles would cross over the light rail tracks.

The results of the noise modelling indicate that 32 receivers are predicted to experience an increase in noise level greater than 2 dB and receive noise levels above the *NSW Road Noise Policy* (DECCW, 2011a) controlling criteria for residences adjacent to collector roads, being $L_{Aeq(15hour)}$ 60 dBA for the day period and $LA_{eq(9hour)}$ 55 dBA during the night period.

A detailed road noise assessment would be carried out during design development to confirm the appropriate noise mitigation strategy (see section 10.7).

10.5.4 Operational vibration

Sandown Boulevard to Carter Street

A summary of predicted operational vibration levels for sensitive receivers is provided in Table 10.12. The predicted levels are below the relevant trigger levels. As a result, no human comfort or structural vibration impacts are anticipated.

Table 10.12 Summary of predicted operational vibration levels – Sandown Boulevard to Carter Street

Receiver type	Maximum vibration dose value - day ($m/s^{1.75}$)	Maximum vibration dose value – night ($m/s^{1.75}$)	Maximum peak particle velocity (mm/s)
Industrial	0.0418	0.0300	0.0990
Commercial	0.0146	0.0105	0.0329
Residential	0.0370	0.0266	0.0917
Educational institute	0.0007	0.0005	0.0018
Mixed use	0.0003	0.0002	0.0006
Non-sensitive	0.0114	0.0082	0.0324
Hotel	0.0059	0.0042	0.0154

Parramatta Square to Sandown Boulevard

There are no predicted exceedances of the vibration trigger levels from light rail vehicles operations between Parramatta Square and Sandown Boulevard.

Macquarie Street turnback

There are no predicted exceedances of the vibration trigger levels from light rail vehicles operations at the Macquarie Street turnback.

Camellia stabling and maintenance facility

Operational vibration levels associated with the facility are predicted to be negligible.

10.6 Cumulative impacts

10.6.1 Cumulative project impacts

Cumulative impacts due to various construction activities associated with the project occurring simultaneously with other projects would depend on a number of factors, including:

- the intensity and location of construction activities
- the type of equipment used by the contractor
- existing background noise levels
- intervening local structures
- the prevailing weather conditions.

The prediction of cumulative noise levels from more than one construction scenario operating close to another scenario within the project site is complex due to the number of noise sources and possible locations for a particular combination of construction works.

The predicted noise levels provided as part of the assessment (see section 10.4) are considered to be a worst-case and would decrease as the construction activity moves away from the sensitive receiver. In the event of multiple construction activities happening simultaneously, it is estimated that the worst-case levels provided as part of this assessment would not be affected, but may be audible at the receiver for a longer duration.

10.6.2 Cumulative impacts with other projects

The project is close to the location of other projects that are planned for construction. There is potential for cumulative construction impacts should construction works occur concurrently with the project in the same area. Construction of various projects over time could also lead to construction fatigue within the community. This would be further considered during the design development phase as construction methodologies are developed.

Construction noise and vibration management plans would be prepared for each individual project to minimise the potential for impacts on nearby sensitive receivers. Consultation and reasonable steps would be taken to co-ordinate works to minimise cumulative impacts and maximise respite for affected sensitive receivers.

10.6.3 Cumulative operational impacts

Cumulative operational impacts would mainly be associated with the interaction between Parramatta Light Rail Stage 1 and the project. The assessment of potential operational noise and vibration impacts (see section 10.5) has considered these, particularly light rail vehicles operations between Parramatta Square and Sandown Boulevard, to ensure that the cumulative impacts are identified and managed.

10.7 Mitigation and management measures

10.7.1 Approach to mitigation and management

Approach

The *Interim Construction Noise Guideline* and *Draft Construction Noise Guideline* (NSW EPA, 2020) acknowledges that, due to the nature of construction projects in urban areas, it is inevitable that there would be noise impacts near construction sites. During construction there would be noise impacts on some receivers during certain times and during certain construction activities. There is also the potential for sleep disturbance and vibration impacts on some receivers and buildings. Once operational, there would be limited exceedances of the operational noise trigger levels.

Mitigation measures have been developed with the aim of minimising or mitigating noise and vibration impacts. Key measures are described below. The measures have been developed based on best management practice, relevant standards and guidelines, and Transport for NSW's experience delivering major infrastructure projects.

Approach to managing the key impacts identified

The main potential for impacts would occur during construction. The *Construction Noise and Vibration Strategy* (Transport for NSW, 2019a) provides an overarching strategy to manage construction noise and vibration through feasible and reasonable measures. The CEMP would include a noise and vibration management plan to provide the framework for managing and mitigating potential construction noise and vibration impacts in accordance with the *Construction Noise and Vibration Strategy*. Activity-specific construction noise and vibration impact statements would detail standard and additional mitigation measures to be implemented based on predicted noise levels.

As described in section 7.5, it is proposed to undertake work during the primary project working hours, which would include some work outside the recommended standard hours defined by the *Interim Construction Noise Guideline* (DECC, 2009). Where work is not regulated by an environmental protection licence, an out-of-hours work protocol would be prepared to identify the process for considering, managing and approving work outside the primary project working hours. The protocol would include implementing feasible and reasonable measures and communication requirements in accordance with the *Construction Noise and Vibration Strategy*. Further information on the proposed contents of the protocol is provided in section 3.7.6 of Technical Paper 3 (Noise and Vibration).

Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure and vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure.

As the design progresses, the project would continue to be refined to minimise the potential for operational impacts. The airborne noise, groundborne noise, and vibration levels would continue to be assessed during design development. An operational noise and vibration review would be carried out to confirm noise and vibration predictions based on the final design and how predicted impacts would be mitigated. The review would define further design work and iterative modelling required to identify feasible and reasonable mitigation measures for operational noise and vibration.

Expected effectiveness

The noise and vibration assessment considered the effectiveness (and potential residual impacts) of a range of mitigation measures for the identified impacts. Options considered included (in order of preference):

1. Reducing the noise at the source

2. Reducing the noise in transmission (between source and receiver)

3. Reducing the noise at the receiver.

Control measures in transmission, such as noise barriers for operational impacts, have not been considered as most of the track form would be embedded rail allowing pedestrian and vehicle access across the tracks. The installation of an operational noise barrier parallel to the embedded track would affect pedestrian and vehicle access across the track.

The mitigation measures provided in section 10.7.2 have been identified as an outcome of the noise and vibration assessment. The proposed mitigation measures have been developed based on best management practice, relevant standards and guidelines, and Transport for NSW's experience delivering major infrastructure projects.

The measures provide for the management of potential noise and vibration impacts through the implementation of various strategies and plans, in addition to ongoing design development and construction planning, which have aimed to avoid and minimise risks, as well as environmental impacts as far as possible. These processes also facilitate ongoing consultation with relevant stakeholders and provide the detail required to reduce noise and vibration impacts where possible.

Further information about the expected effectiveness of mitigation is provided in sections 3.4.5, 3.6.5 (construction) and 4.6 (operation) of Technical Paper 3 (Noise and Vibration).

10.7.2 List of mitigation measures

Measures that will be implemented to address potential noise and vibration impacts are listed in Table 10.13.

Table 10.13 Noise and vibration mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Confirming the approach to operational noise and vibration mitigation as part of the design process	NV1	An operational noise and vibration review of the developed design will be undertaken to review the potential for operational impacts and confirm feasible and reasonable mitigation measures to be incorporated in the design. The review will include: • reviewing compliance monitoring for Parramatta Light Rail Stage 1 to refine the assumptions used and confirm the effectiveness of the mitigation that has been implemented • surveying relevant buildings to determine appropriate internal noise trigger levels • a road traffic noise assessment for the reconfiguration of South and Boronia streets conducted in accordance with the *Noise Criteria Guideline* (Roads and Maritime, 2015a) and the *Noise Mitigation Guideline* (Roads and Maritime, 2015b) • consideration of feedback from, and preferences of, directly affected landowners/landholders. The operational noise and vibration review will be undertaken in consultation with relevant council(s) and the NSW EPA. The review will be developed in accordance with the *Rail Infrastructure Noise Guideline* (NSW EPA, 2013), the *Noise Policy for Industry* (NSW EPA, 2017) and the *Road Noise Policy* (DECCW, 2011).	Design
	NV2	Public address systems at stops will be designed to comply with the *Noise Policy for Industry* (NSW EPA, 2017) intrusiveness and sleep disturbance noise trigger levels at all locations.	Design

Impact/issue	Ref	Mitigation measure	Timing
Managing the potential for construction noise and vibration	NV3	Consideration will be given to implementing operational noise mitigation early in the construction program to reduce the potential for construction noise impacts, where the mitigation will not be impacted by future works.	Pre-construction, construction
	NV4	A noise and vibration management plan will be prepared as part of the CEMP and implemented during construction. The plan will detail processes, responsibilities and measures to manage noise and vibration and minimise the potential for impacts during construction, aligned with the results of community consultation, and consistent with the management approach and mitigation measures in the *Construction Noise and Vibration Strategy* (Transport for NSW, 2019a). Measures that mitigate potential noise and vibration at the source will be prioritised.	Pre-construction, construction
	NV5	Location and activity specific construction noise and vibration impact assessments will be undertaken: • prior to works with the potential to generate noise levels above 75 dBA and/or exceed relevant human response and cosmetic damage criteria for vibration • prior to works that need to occur outside the primary project working hours • where any changes to heavy vehicle routes affect local roads not considered by the noise and vibration assessment (Technical Paper 3 (Noise and Vibration)). The results of the assessments will be documented in construction noise and vibration impact statements. Where potential exceedances are identified, the statements will define feasible and reasonable mitigation and management measures, developed in accordance with the *Construction Noise and Vibration Strategy* (Transport for NSW, 2019a). The measures will be implemented for the duration of the activity.	Pre-construction, construction
	NV6	A minimum of 2.4 metre high solid hoarding will be provided around construction compounds located close to residential areas, where construction noise is predicted to exceed noise management levels during recommended standard hours, including those compounds currently proposed near sensitive receivers on/around: • John Street • Broadoaks Park • Ken Newman Park west and east • Hope Street • Wharf Road • Wentworth Point north • Hill Road north • Dawn Fraser Avenue east and west.	Construction

Impact/issue	Ref	Mitigation measure	Timing
	NV7	Appropriate respite periods will be identified, in consultation with the community and in accordance with the *Construction Noise and Vibration Strategy* (Transport for NSW, 2019a), for work: • with the potential to result in noise levels above 75 dBA • that need to occur outside the primary project working hours. The following will be taken into account when determining appropriate respite: • the need to efficiently undertake construction • the communities' preferred noise and vibration management approach • the construction schedules of other major projects in close proximity to the project works.	Construction
	NV8	Where construction activities are predicted to exceed noise management levels at sensitive receivers, no work would be permitted in that area one weekend per month, unless it is otherwise agreed by a substantial majority of the sensitive receivers impacted by the proposed works.	Construction
Cumulative impacts	NV9	The potential for cumulative construction impacts will be reviewed during construction planning in consultation with the proponents of other projects. Where the potential for cumulative impacts is identified, feasible and reasonable mitigation and management measures will be developed and included in the noise and vibration management plan (mitigation measure NV4).	Construction
Out of-hours work	NV10	An out-of-hours work protocol will be developed to define the process for considering, approving and managing out-of-hours work that is not regulated by an environment protection licence. The protocol will include implementing feasible and reasonable measures and communication requirements in accordance with the *Construction Noise and Vibration Strategy* (Transport for NSW, 2019a). Measures will focus on proactive communication and engagement with potentially affected receivers, provision of respite periods and/or alternative accommodation for defined exceedance levels.	Construction
	NV11	All work outside the recommended standard hours defined by the *Interim Construction Noise Guideline* (DECC, 2009) will be scheduled using the hierarchy of preferred working hours described by Chapter 7 (Project description – construction) (section 7.5) as far as practicable, and in consultation with the community and key stakeholders (including the NSW EPA). Highly noise and vibration intensive works, as defined by the *Construction Noise and Vibration Strategy* (Transport for NSW, 2019a) will be limited to recommended standard hours as far as practicable.	Construction
Construction vibration impacts	NV12	Where buildings or structures are predicted to exceed the screening criteria for structural damage, a dilapidation survey will be undertaken prior to any construction works. Where required, the vibration management level will be refined based on the type and condition of the building or structure. For heritage buildings and structures, the dilapidation survey will consider the heritage value of the structure in consultation with a structural engineer and heritage specialist.	Pre-construction

Impact/issue	Ref	Mitigation measure	Timing
	NV13	A survey will be undertaken to identify vibration sensitive receivers (including buildings, structures, utilities, remediation management infrastructure, heritage items or sites and equipment) within 200 metres of the project site. Vibration criteria will be identified based on relevant standards or manufacturer's data. Where vibration criteria are not available, conservative criteria will be used. Appropriate measures will be developed and implemented where potential exceedances of the criteria are identified.	Pre-construction
	NV14	Vibration generating activities will be managed to minimise the potential for impacts on vibration-sensitive receivers (identified in accordance with mitigation measure NV12). Prior to the commencement of vibration-intensive works within the minimum working distances for cosmetic damage, the potential for impacts will be assessed. This will include a more detailed assessment of potentially affected receivers to assess the susceptibility to damage from vibration. Where there is potential for damage, alternate methods that generate less vibration will be investigated and substituted where feasible and reasonable. For heritage items or sites, the more detailed assessment will consider the sensitivity of the receiver in consultation with a heritage specialist to ensure susceptible components are adequately monitored and managed. Where residual risks remain, vibration monitoring will be undertaken. Vibration monitors will provide real-time notification of exceedances of levels approaching cosmetic damage. Any identified vibration-related damage to the receivers will be rectified, including as recommended by a heritage specialist for heritage items.	Construction
Operational noise and vibration impacts	NV15	Monitoring of noise and vibration will be undertaken within 12 months of the commencement of operation to compare actual noise and vibration performance against that predicted by the operational noise and vibration review (mitigation measure NV1). The results of monitoring will be documented in an operational noise and vibration compliance report. Additional feasible and reasonable mitigation measures will be considered where any additional receivers are identified as qualifying for consideration of noise mitigation in accordance with the relevant guidelines.	Operation