10. Noise and vibration

10.1 Introduction

The scope of the noise and vibration assessment reported in this chapter was to identify the type and extent of noise impacts generated by the proposed Ipswich to Springfield PTC on sensitive receptors in the study area. The assessment provides a description of ambient noise levels (day and night) for the study area. Also provided is an assessment of the potential noise and vibration impacts of the construction and operation stages of the proposal. The mode of transportation (i.e. rail or bus) is currently undecided and therefore an assessment has been undertaken for both modes. It must be understood that this Environmental Impact Study does not consider future development in the area as the receiving environment could substantially change over the next 5-10 years. Noise standards may also change over this period. Therefore the issues pertaining to noise will need to be assessed in greater detail as part of any future environmental assessments undertaken for approval of the project.

10.2 Description of the study area

The area to the north of the Cunningham Highway is largely medium density residential housing with the area to the south of the Cunningham Highway being largely undeveloped rural land, although development of the area is likely in the immediate future.

Major noise sources in the area include the Amberley Air Force Base located to the west of the study area and Swanbank Power Station located to the east and north of the preferred corridor.

10.2.1 Previous noise studies

Noise monitoring was conducted in the study area over a 7-day period from Tuesday 23 March 2004 to Tuesday, 30 March 2004 as part of the SWTC Impact Assessment Study undertaken by SKM. Noise levels were recorded at three locations east, central and west as described in Table 10-1.

Table 10-1: Noise monitoring locations – SWTC study

Location	Address	Description	AMG coordinates	
			Easting (m)	Northing (m)
East	Keidges Road, Redbank Plains	Rural grazing land, adjacent to dam	487,200	6,939,425
Central	Barrams Road, South Ripley	Rural farmhouse, approximately 3 km south of Swanbank Power Station	481,250	6,936,850
West	127 South Deebing Creek Road, Deebing Heights	Rural residential dwelling approximately 200 m from road	475,800	6,938,375

The measured noise levels are provided in Table 10-2.

Table 10-2: Measured noise levels – SWTC study

Location	L_A10 (18 hour)	Day (7:00 am – 6:00 pm)			Evening (6:00 pm – 10:00 pm)			Night (10:00 pm – 7:00 am)		
		L_{A90}	L_{A10}	L_{Aeq}	L_{A90}	L_{A10}	L_{Aeq}	L_{A90}	L_{A10}	L_{Aeq}
East	48.1	33	45	47	44	53	56	37	46	47
Central	45.9	30	43	47	37	47	52	32	48	48
West	45.6	34	46	58	33	42	48	30	36	41

The L_{A10} noise levels presented in Table 10-2 are the median levels recorded for each period (i.e. 50% of L_{A10} values were higher and 50% lower over the entire monitoring period). The L_{Aeq} was the calculated equivalent continuous noise level over the entire monitoring period and the L_{A90} levels are the 10th percentile values (considered to be representative of the average of the measured noise levels during the quiet periods). The $L_{A10\ (18\ hour)}$ is the average of the hourly L_{A10} results between 6:00 am and midnight.

10.2.2 Estimated background noise levels

The above noise monitoring results are relevant to the Ipswich to Springfield PTC, particularly in the semi-rural areas to the south of the Cunningham Highway as land uses have not changed significantly since this monitoring regime. The background noise levels in the more developed areas around the preferred corridor can be expected to be higher, particularly during the daytime period.

Australian Standard AS 1055.2 gives estimated average background A-weighted sound pressure levels ($L_{A90,T}$) for different areas containing residences in Australia. It is estimated that the area along the preferred corridor to the north of the Cunningham Highway would correspond to the R2-R3 noise area categories and hence the estimated background noise will be as shown in Table 10-3.

Table 10-3: Estimated background noise levels (from AS 1055.2 – 1997)

Noise area category (Notes 1 and 2)	Description of neighbourhood	Average background A-weighted sound pressure level $L_{A90,T}$					
		Monday to Saturday			Sundays and public holidays		
		07:00 – 18:00	18:00 – 22:00	22:00 – 07:00	07:00 – 18:00	18:00 – 22:00	22:00 – 07:00
R2	Areas with low density transportation	45	40	35	45	40	35
R3	Areas with medium density transportation or some commerce or industry	50	45	40	50	45	40

Noise sensitive receptors in the study area include residences, education and health facilities.

When the future Environmental Impact Statement is commissioned prior to construction, physical monitoring activities will be conducted and appropriate noise modelling undertaken. The identification of current potential sensitive indicators is considered as sufficient for this Environmental Impact Study, creating a focal area for future investigation.

10.3 Project construction noise assessment criteria

There is currently no legislative limit for construction noise in Queensland. In the absence of such legislative limits, operational noise limits have been used as a guide.

Thus the road traffic noise criterion has been adopted as a guide for an assessment criterion for construction noise. In this instance the criteria would be an $L_{10(18\ hour)}$ of 68 dB(A).

10.3.1 Vibration criteria

Standards that may be used for measuring and assessing the impacts of vibration are:

- British Standard BS 7385: Part 2-1993 Evaluation and Measurement for Vibrations in Buildings – Part 2 Guide to Damage Levels from Ground-Borne Vibration
- German Standard DIN 4150, Part 3-1986: Structural Vibration in Buildings: Effects on Structures
- British Standard BS 6472 Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)
- Australian Standard AS 2670.2-1990 Evaluation of Human Exposure to Whole Body Vibration, Part 2: Continuous and Shock Induced Vibrations in Buildings (1 Hz to 80 Hz).

Ground vibration of occupied buildings has the potential to cause discomfort to human occupants, to cause damage to sensitive equipment, or in severe cases may cause structural damage to buildings. Ground vibration may also occur continuously or only intermittently, depending on the source. The effect of vibration may also depend on the dominant vibration frequencies.

Three forms of vibration criteria would be applied to construction activities to cover the following effects that may result from construction activities:

- human disturbance
- building contents damage
- structural damage.

Human disturbance

An individual's perception of vibration is considered to depend very strongly on previous experience and expectations. Table 10-4 provides guidelines for assessing human disturbance impacts from vibration.

Table 10-4: Human comfort vibration criteria

Type of occupancy	Day or night	RMS1 Vibration levels in mm/s corresponding to a 'Low probability of adverse comment' (mm/s)			
		Continuous vibration (16 hour day, 8 hour night)		Transient vibration excitation (several occurrences per day)	
		Vertical	Horizontal	Vertical	Horizontal
Critical working areas	Day Night	0.1 0.1	0.3 0.3	0.1 0.1	0.3 0.3
Residential	Day Night	0.2 to 0.4 0.14	0.3 to 0.6 0.42	6 to 9 0.14 to 2.0	18 to 27 0.3 to 6.0
Offices	Day Night	0.4 0.4	1.2 1.2	6 to 13 6 to 13	18 to 38 18 to 38
Workshops	Day Night	1.2 1.2	3.2 3.2	9 to 13 9 to 13	27 to 38 27 to 38

Note 1: RMS = Root mean square.
Source: AS 2670 – 1990.

The levels presented in Table 10-4 are based on the root mean square vibration level. To determine the allowable peak vibration levels a 'crest' multiplication factor is applied (the ratio of the peak level to RMS level). The crest factor varies from 1.4 for construction activities of a continuous nature such as vibratory rolling, up to 4 or greater for intermittent activities such as rock-breaking.

Structural damage

Structural damage due to vibration is assessed using the guidelines present in BS 7385: Part 2 – 1993. This standard sets guideline values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated (cosmetic damage). Table 10-5 shows guideline vibration levels derived from BS 7385.

Table 10-5: Transient vibration guide values – minimal risk of cosmetic damage

Type of building	Peak component particle velocity in frequency range of predominant pulse		
	Below 4 Hz	4 Hz to 15 Hz	15 Hz and above
Industrial and heavy commercial buildings	3.7 mm/s at 1 Hz or Maximum displacement of 0.6 mm (zero to peak)	50 mm/s at 4 Hz and above	
Residential or light commercial type buildings		15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Source: BS7385 – Part 2:1993

Further, BS 7385 states that:

- minor damage is possible at vibration magnitudes greater than twice those listed in Table 10-5
- major damage to a building may occur at magnitudes greater than four times those listed Table 10-5
- the guideline values do not take into account fatigue considerations of building materials
- the guideline values do not take into consideration resonant response effects of the structure (dynamic magnification).

10.4 Project operational noise assessment criteria

10.4.1 Environmental Protection (Noise) Policy 1997

The Environmental Protection (Noise) Policy 1997 (EPP (Noise)) is subordinate legislation to the *Environmental Protection Act 1994* and has the objective of protecting the acoustic environment. It provides the framework on which noise limits may be determined to protect the ambient noise environment enjoyed by the community.

The long-term objective of the EPP (Noise) is to achieve an ambient $L_{Aeq\ (24\ hour)}$ noise level of 55 dB(A) or less for the majority of Queensland's population.

The EPP (Noise) introduces the concept of 'beneficial assets'. A 'beneficial asset' is an airport, approved industrial estate, navigable waterway, public road or railway. It is recognised that, although the operation or use of beneficial assets may have significantly adverse effects on the environmental values, they are necessary for the community’s environmental, social and economic well-being. However, it is intended that, as far as practical, any significantly adverse effects from their use or operations be progressively reduced.

Rail noise criteria

A rail corridor is defined as a beneficial asset under the EPP (Noise) and as such, target noise levels would be assessed against the planning levels taken from Schedule 1 of the policy as follows:

- 65 dB(A), assessed as the 24 hour average equivalent continuous A-weighted sound pressure level
- 87 dB(A) assessed as a single event maximum sound pressure level.

Road noise criteria

While busway noise does not specifically meet the definition of a beneficial asset, it is proposed that its function is similar to that of a public road, and therefore the criteria applying to public roads have been adopted. Schedule 1 of the EPP (Noise) provides two planning levels. These are based on criteria for public roads and are considered to be relevant to the busway. These levels are outlined below:

- the following levels assessed as the $L_{10\ (18\ hour)}$ level:

i) for a state-controlled road – 68 dB(A)

ii) for another public road – 63 dB(A).

- a planning level of 60 dB(A) assessed as the highest $L_{Aeq\ (1\ hour)}$ noise level, in dB(A), between 10:00 pm and 6:00 am
- a planning level of 80 dB(A), assessed as a single event maximum sound pressure level (L_{max}).

10.4.2 Sleep disturbance

Sleep disturbance criteria should also be applied to busway traffic during the night time period. Sleep disturbance criteria are not applicable to railway noise as the railway noise criteria are explicitly provided in the EPP (Noise).

In order to avoid sleep disturbance, the maximum acceptable internal noise levels (L_{Amax}) from the busway corridor should not exceed approximately 50-55 dB(A). For the purposes of this assessment we would consider 50 dB(A) as the recommended acceptable noise level, with 55 dB(A) considered as a maximum acceptable level. Based on a typical noise reduction of 10 dB(A) for standard building construction with open windows, the recommended external noise levels become 60 dB(A) (recommended) and 65 dB(A) (maximum).

10.4.3 Educational and health building criteria

The internal noise level inside school classrooms or health buildings should not exceed $L_{10\ (1\ hour)}$ of 48 dB(A) based on the *Main Roads Traffic Noise Management: Code of Practice*. Based on a typical noise reduction of 10 dB(A) for standard building construction with open windows, the recommended external noise levels become 58 dB(A) $L_{10\ (1\ hour)}$ which is approximately equivalent to an L_{Aeq} level of 55 dB(A).

10.5 Noise assessment methodology

For the purposes of the noise assessment, operational noise impacts for the preferred corridor have been based on rail pass-by noise. The train pass-by noise levels have been calculated using a sound power level of 126 dB(A) based on a six carriage Electric Multiple Unit (EMU) as derived from data supplied by Queensland Rail.

Since it is unknown at this stage whether the trains will be three or six carriages, conservative noise propagation calculations have been based on the length of a three carriage EMU (72 m) using the sound power of a six carriage EMU.

For comparison the distance from the preferred corridor required to achieve the maximum noise level criterion of 87 dB(A) was calculated using the following equation.

$$R = \frac{10^{\left(\frac{(SWL-SPL)}{10}\right)}}{\pi \times L} \text{ line source or } R = \sqrt{\frac{10^{\left(\frac{(SWL-SPL)}{10}\right)}}{2 \times \pi}} \text{ point source}$$

where R = distance from corridor to achieve criteria

SWL = train sound power level dB(A) [126 dB(A)]

SPL = maximum sound pressure level criterion dB(A) [84.5 dB(A)[1]]

L = train length [72 m]

The most conservative result is obtained assuming a line source and the resulting separation distance to achieve the criteria is found to be approximately 60 m. This result is then used to assess the number of potentially affected residential properties within a 60 m distance from the centreline of the preferred corridor.

A similar analysis can be undertaken with regard to construction noise impact. Assuming an 'average' hourly sound power of 120 dB(A) from construction machinery and using the 68 dB(A) as the target noise level, the distance required to meet criteria was calculated to be approximately 150 m either side of the centreline of the preferred corridor.

10.5.1 Sensitive receptor impacts

The results indicate that noise impacts would occur within a buffer distance of 150 m from the corridor, sensitive receptors were identified within this zone. Noise sensitive receptors within this zone include residences and residential developments, the West Ipswich Primary School at approximate Chainage 1.0 km and the University of Queensland, Ipswich campus and the Ipswich showground at Chainage 1.5–2.0 km.

Other receptors within a zone of 1 km from the preferred corridor but outside of the 150 m buffer include the Yamanto Tavern, the George and Eileen Hastings Sports Ground and the Gateway CBD commercial precinct in Springfield. It is unlikely that these receptors will be negatively impacted upon as a result of noise from the Ipswich to Springfield PTC. Refer to Figure 13-1 and the complete list of identified receptors as indicated in Section 13.5.4.

10.6 Construction noise assessment

During construction it is likely the chosen noise criteria will be exceeded for up to 150 m from the construction site. The number of properties within the zone of potential impact along the preferred corridor is 252 properties. Based on a 60 m zone of potential impact, the operational phase will potentially affect 61 properties.

Since very strict standards regarding noise and vibration issues exist, Queensland Transport will need to comply with all these during design and construction of the project. The receiving environment is continually changing and since the date of construction commencement is unclear, no specific modelling has been undertaken.

[1] Allowing for 2.5 dB(A) facade reflection

The construction plant and equipment expected to be employed on the proposal has been identified. The final construction and resource utilisation plans would be determined following the appointment of the successful contractor. Table 10-6 lists the likely construction plant and equipment usage at each of the major work sites. Not all the construction plant and equipment outlined in Table 10-6 would be used at each work site.

Table 10-6: Equipment likely to be used during various construction activities and locations

Activities	Plant and equipment
Demolition and Utility Works	Hydraulic Demolition Hammers Trucks Excavators Small equipment
Earthworks	Dozers D10 Excavators Scrapers Dump trucks Rollers825 Vibrating rollers
Haulage of Spoil	Dump trucks
Delivery of Aggregates and Cement Products	Dump trucks Batch plant
Bridges	Piling rigs Concrete pumps Carpenter/formwork Excavators/rock breaking
Surface Roadworks	Excavators, graders, water tankers, dozers, asphalt pavers, multi-tyred rollers

Normal hours for construction activities would be limited to standard daytime construction hours of 7:00 am to 6:00 pm on Monday to Saturday in Queensland with no (or limited) work at night, on Sundays or on Public Holidays.

Work outside these hours may occasionally be required for the following activities:

- relocation of utility services during hours of light traffic
- preparation of road diversions during off-peak hours
- construction of project elements which require temporary road closure outside normal hours in order to minimise disruption in traffic
- delivery of bulk items of equipment during off-peak periods to minimise disruption.

Night works may also be required through some built up areas (i.e. West Ipswich). The type and extent of night works through particular areas would also need to be restricted due to the proximity of sensitive noise receptors. Night works may also be required for the placement of structural spans over Brisbane Road, Moffat Street and Lobb Street.

Each activity undertaken outside the normal work hours would require the regulatory authority and local residents to be informed of the timing and duration prior to the work commencing. Additional noise attenuation measures may be required for equipment used during off-peak construction periods depending on the nature and location of the work.

Typical noise levels for construction equipment are given in *AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites*. Typical noise levels from equipment likely to be used during the construction of the project are shown in Table 10-7. The noise levels generated by construction activities will vary depending upon the combination of equipment in operation at any one time, as well as the location and duration of the individual activities.

Typical strategies for managing noise from construction sites are suggested in AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites. Examples of some possible mitigation strategies are outlined in Section 10.6.4 and Table 10-8.

Table 10-7: Typical noise levels for construction equipment

Equipment type	Sound power level dB(A)
Pile driver (2 tonne drop hammer)	114 to 128
Trenching hammer (sheet piles)	114 to120
Rotary bored piles	112 to 124
Scrapers	116 to 121
Crane, truck mounted	118 to 120
Rollers	110 to 119
Dozers	115 to 118
Graders	114 to 118
Excavators	114 to 118
Dump trucks	102 to 114
Saw cutting equipment	105 to 118
Slip form paver	99 to 112
Trucks	103 to 108

Source: AS 2436-1981: Guide to Noise Control on Construction, Maintenance and Demolition Sites

Table 10-8: Construction noise sources and possible mitigation measures (from AS 2436)

Plant	Source of noise	Possible remedies/alternatives
Piling equipment	Pneumatic/diesel hammer or vibrator driver	Enclose hammer head and top of pile in acoustic screen, acoustically dampen sheet steel plies to reduce vibration and resonance
	Impact on pile	Use resilient pad (dolly) between pile and hammer head
	Cables, pile guides	Careful alignment of pile and rig
	Power unit	Silenced exhaust, use of acoustic screens
Heavy Plant	Engine	Silenced exhaust, closed enclosure panels
Compressor, Generator	Compressor, Generator	Acoustically dampen casing, acoustic screening
Batching Plant	Engine	Substitute electric motor
	Filling	Don’t let aggregates fall from an excessive height
Pumps	Engine pulsing	Acoustic screening
Pneumatic Rock Breakers	Tool	Fit a muffler or silencer, this would reduce the noise without impairing efficiency
	Bit	Use dampened bit to eliminate 'ringing'
	Air line	Leaks in air line should be sealed

Source: AS2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites

10.6.1 Site clearance, drainage and earthworks

The site clearance, construction of site drainage, and general earthworks are likely to generate the most significant noise impacts during construction. The following equipment is likely to be involved in the site clearance and earthworks phase of the project:

- removal of vegetation using sawing equipment, bulldozers etc.
- dump trucks
- scrapers
- graders
- rollers/compactors
- water carts.

Not all equipment is expected to operate simultaneously or at maximum level continuously and therefore a cumulative sound power of 120 dB(A) is adopted.

As discussed earlier, the noise level is likely to exceed the chosen criteria for up to 150 m from the site. During this stage it is important that the community is kept well informed with regard to likely noise producing activities, their duration and the likely exceedance of the noise criteria. Where possible, noise producing activities should be scheduled during normal business hours in order to minimise the potential impact on the community.

No tunnelling is anticipated in the final design. Some ‘cut and cover’ activities will however be undertaken, especially in the planned Ripley Valley Town Centre.

10.6.2 Bridge/viaduct construction

Bridge or viaduct construction will concentrate activities in one location for an extended period of time and hence noise impacts during this phase of the project are likely to be significant. It will be critical that the community is kept well informed with regard to scheduled noise producing activities, their duration and the likely exceedance of the noise criteria.

10.6.3 Haul roads

It is likely that dump trucks would be employed during the site clearance and bulk earthworks phases of the project. It is anticipated that haul roads, and hence the associated noise impact will follow the preferred corridor.

It is not anticipated the haulage traffic will add significantly to noise from major roads in the area, however, the use of local roads as well as site entry and exits points could be sources of significant noise impact. General construction traffic from workforce, visitors and other deliveries would not result in a significant increase in the traffic.

It will be important to minimise the use of local roads in order to reduce the impact on sensitive receptors along the preferred corridor. In addition, haulage activities should be limited to standard daytime construction hours. Any activity to be undertaken outside the normal work hours would require the regulatory authority and local residents to be informed of the nature, timing and duration prior to the work commencing.

Once final design is complete and material sources and haulage routes identified, these specific sites and routes would be assessed in terms of impact, alternatives and potential mitigation strategies. This component will form part of further environmental impact assessments that would need to be undertaken prior to the final project approval.

10.6.4 Mitigation strategies

AS 2436 – 1981 Guide to Noise Control on Construction Maintenance and Demolition Sites sets out practical recommendations to assist in the mitigation of construction noise. Some possible strategies that could be implemented for the Ipswich to Springfield PTC are outlined below (where applicable):

- adopt best working practices that limit noise emissions
- limit construction hours to 7.00 am to 6.00 pm Monday to Saturday with minimal work at night, Sunday’s or Public Holiday
- installation of temporary noise barriers where noise producing activities are located close to noise sensitive receptors

- fitting of more efficient residential silencers or exhausts to mobile equipment engines providing up to 5 dB(A) of additional attenuation compared to a standard silencer
- checking of engine covers for close fitting, maintenance of silencers and mechanical condition.
- regular maintenance and noise testing for major items of construction equipment that are significant contributors to construction noise levels
- scheduling of construction to minimise the multiple use of the most noisy items of equipment near sensitive receptors
- enclosing of fixed plant with acoustic enclosures providing from 15 to 30 dB(A) attenuation. Enclosures could be applicable for areas where generators or ventilation systems are operating for long periods during the construction phase
- maximising the offset distance between noisy plant items and nearby sensitive receptors, where possible
- community consultation with local residents and building owners to assist in the alleviation of community concerns.

Community linked construction management may also be a viable noise control strategy in certain instances. Previous experience on similar major projects has demonstrated that affected sensitive receptors, when provided with sufficient warning, may be willing to endure higher construction noise levels for a shorter duration, in lieu of intermittent but extended periods of construction noise at lower levels.

Noise and vibration management plans, incorporating procedures for noise monitoring as well as other items such as noise mitigation measures, complaints procedures and delegation of responsibilities, would be prepared by the contractor(s) for the construction phase of the project. The plans would be a component of the project EMP and would outline noise monitoring locations, timing and duration of monitoring, processes for receipt and recording of complaints and corrective actions to be instigated. In addition plans would meet the requirements of the appropriate regulatory authorities depending on jurisdiction. Noise monitoring may be expected to include both attended and unattended monitoring, using noise loggers and frequency analysers, as appropriate.

Potential vibration mitigation

Structural damage to buildings from excessive ground vibration is unlikely, provided that the preferred corridor does not encroach closer than 40 m to sensitive buildings and that blasting is not undertaken during construction. Monitoring should however, be conducted during all construction activities where there is a potential for complaints that vibrations may exceed the human disturbance criteria.

The Main Roads Standard Specification for Environmental Management, MRS 11.51 outlines the following specifications for management of environmental impacts during the construction and/or the maintenance of works. The relevant specifications for ground vibration are as follows:

- 'the Contractor shall take reasonable actions to ensure that construction works do not result in vibration causing damage adjacent to the site
- 'prior to commencement of any activity, the Contractor shall undertake a condition survey of any structure within the zone of influence which is defined as within a radius of three times the safe distance, as defined in Table 5.1 (Section 11.3)
- 'the Contractor shall carry out monitoring at the nearest vibration sensitive receptor on commencement of and during piling or use of vibratory equipment
- 'if vibration levels are monitored and found to exceed the relevant vibration criteria given in Section 11.3 above then the contractor would modify the construction activities until compliance with the criteria has been achieved'.

10.7 Operational noise assessment

In the operational phase, potential noise impacts from the proposed Ipswich to Springfield PTC are primarily expected to relate to noise from bus or rail traffic. The noise assessment criteria are described in Section 10.4.1 and the noise methodology is described in Section 10.5. Due to the intermittent nature of noise associated with the transportation corridor, criteria based on maximum noise levels was considered the most appropriate method of assessment of noise from the preferred corridor.

Mitigation strategies

The following are considered possible strategies for the mitigation of operational noise:

- consider low noise road surfaces to mitigate tyre noise from busway traffic
- erect noise barriers where necessary to achieve the appropriate noise criteria
- ensure all transportation vehicles are well maintained and fitted with the appropriate silencing equipment
- undertake an on-going noise monitoring program to ensure that noise levels are maintained or improved
- structural designs to achieve noise attenuation will be considered using best practice, at the appropriate time, for areas where bridges or viaduct construction will be necessary.
- In areas which require special consideration of noise mitigation, such as adjacent the West Ipswich State School where the corridor will be elevated, it may be possible to build the structure as a viaduct with relatively high parapets, thereby providing substantial noise shielding. Also, in the case of a rail corridor, the use of track noise reduction treatments such as resilient rail fasteners and/or shredded rubber ballast mat would also provide substantial

reduction of wheel/rail noise emissions as well as reduction of structural sound radiation from the viaduct structure itself.

- In the Ripley town centre at the School Road TOD, it may be necessary to construct future adjacent sensitive buildings such as multi-storey residential dwellings with double-glazed windows and designing the buildings such that the non-sensitive internal spaces are located on the building façade adjacent to the railway line.

These measures will reduce the potential level of impact on surrounding areas from the Ipswich to Springfield PTC.

10.8 Additional assessment

The following additional assessments will be undertaken as part of any future environmental impact assessments undertaken for approval of the project:

- detailed noise modelling
- vibration predictions.

Target design criteria for busway noise will also be confirmed with the regulatory authorities. Noise mitigation measures will need to be designed accordingly.

Furthermore, no allowance has been made for effects of cuts, fills and grades at this point. This, as well as the increased noise on bridge/viaduct structures, will be addressed at a later stage once more detailed designs are available.

10.9 Conclusions

Although noise impacts will occur during the construction and operation phases of the preferred corridor, noise generation is not regarded as a fatal flaw for the purpose of corridor preservation.

A range of mitigation strategies can be adopted to minimise construction and operational noise impacts. No significant vibration impacts were identified.