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The Northern Road Upgrade Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park

NSW Environmental Impact Statement /
Commonwealth Draft Environmental Impact Statement

Volume 1: Main Report

June 2017

Roads and Maritime Services

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7 Assessment of key Issues

This chapter provides an assessment of the key environmental issues for the project as identified in the SEARs and as per the relevant requirements of Schedule 2, Part 3 of the (NSW) Environmental Planning and Assessment Regulation 2000, Section 97 of the EPBC Act and Schedule 4 of the Commonwealth EPBC Act Regulation 2000.

Chapter 11 – Environmental risk analysis, provides an overview of how environmental issues for the project were identified and evaluated through an environmental risk analysis process. This process was followed to assign an environmental risk category to each potential impact, including identification of any additional key issues (in addition to those identified in the SEARs), or other issues to be addressed. It is noted that no additional key issues were identified.

The key environmental issues addressed in this chapter are as follows:

- Traffic and transport (Section 7.1)
- Noise and vibration (Section 7.2)
- Biodiversity (Section 7.3)
- Socio-economic and land use (Section 7.4).

For each key issue the following information is provided:

- A description of the existing environment, which includes (where relevant) all components of the environment as defined in Section 528 of the EPBC Act
- An assessment of the potential direct and indirect impacts of the project during construction and operation, with consideration of the scale, intensity, duration, timing and frequency of the potential impacts. This assessment has been prepared in accordance with:
  - Secretary's Environmental Assessment Requirements (SEARs) issued by the Secretary of the NSW Department of Planning and Environment on 9 March 2016.
  - Commonwealth EIS Assessment Requirements issued by the Commonwealth Department of Environment and Energy on 24 August 2016
  - *Significant impact guidelines 1.1 – Matters of national environmental significance* (Department of Sustainability, Environment, Water, Populations and Communities, 2013)
  - *Significant impact guidelines 1.2 – Actions on, or impacting upon, Commonwealth Land, and actions by Commonwealth agencies* (Department of Sustainability, Environment, Water, Populations and Communities, 2013)
  - All relevant NSW and Commonwealth assessment guidelines, plans and policies.
- Consideration of the influence of relevant planning matters
- A description of proposed measures to be implemented to avoid, minimise, manage, mitigate, offset and/or monitor the potential impacts of the project
- Identification of potential residual impacts remaining after the implementation of mitigation measures. Where potential residual impacts have been identified as being significant, these impacts have been quantified.

A summary of the environmental risk analysis results for these key issues is provided in Table 11-3, including a summary of potential impacts, environmental management measures, and residual impacts.

The proposed environmental management measures in this chapter are collated in Chapter 12.

The assessment of key issues is supported by detailed investigations, which have been documented in the working papers. To the extent of any inconsistency between this main volume of the EIS and the working papers, the former prevails.

SEARs / Commonwealth assessment requirements specific to each key issue are documented in the relevant sections in Chapter 7. General assessment requirements relevant to all key issues – and where these have been addressed – are documented in Table 7-1.

Table 7-1 EIS assessment requirements – Environmental impacts and mitigation

Requirement	Where addressed in EIS
Secretary's Environmental Assessment Requirements (NSW EP&A Act)	
The Environmental Impact Statement (EIS) must meet the minimum form and content requirements in clauses 6 and 7 of Schedule 2 the Environmental Planning and Assessment Regulation 2000. Where relevant, the assessment of the key issues below, and any other significant issues identified in the risk assessment, must include: • adequate baseline data; • consideration of potential cumulative impacts due to other development in the vicinity; and • measures to avoid, minimise and if necessary, offset the predicted impacts, including detailed contingency plans for managing any significant risks to the environment.	Chapter 7, Chapter 8 and Chapter 9
Commonwealth EIS Guidelines (Commonwealth EPBC Act)	
The EIS must include a description of the environment of the proposal site and the surrounding areas that may be affected by the action. It is recommended that this include the following information: A description of the environment in all areas of potential impact, including all components of the environment as defined in Section 528 of the EPBC Act: • Ecosystems and their constituent parts, including plants and animals, people and communities, landscapes and soils • Natural and physical resources, including water resources and air • The qualities and characteristics of locations, places and areas • Heritage values of places • The social, economic and cultural aspects of a thing mentioned in preceding dot-points.	Chapter 7 and Chapter 8
The EIS must include a description of all of the relevant impacts of the action. Relevant impacts are impacts that the action will have or is likely to have on a matter protected by a controlling provision. Impacts during both the construction, operational and (if relevant) the decommissioning phases of the project should be addressed, and the following information provided: • A detailed assessment of the nature and extent of the likely short-term and long-term relevant impacts • A statement of whether any relevant impacts are likely to be unknown, unpredictable or irreversible	Chapter 7 and Chapter 8

Requirement	Where addressed in EIS
• Analysis of the significance of the relevant impacts • Any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	
The EIS should also provide a detailed assessment of any likely impact that this proposed action may facilitate MNES at the local, regional, state, national and international scale.	Chapter 7 and Chapter 8
If the conclusion is made that any relevant controlling provision or element of a relevant controlling provision will not be impacted by the proposed action, then justification must be provided for how this conclusion has been reached. This includes any threatened species or ecological communities that are likely to be present on site, heritage items/places likely to be on site and other relevant elements of the environment that may be impacted by the proposed action.	Chapter 7 and Chapter 8
Quantification and assessment of impacts should: • Be against appropriate background/baseline levels • Be prepared according to best practice guidelines and compared to best practice standards • Consider seasonal and temporal variations where appropriate (including temporal changes in the sensitivity of the receptor) • Be supported by maps, graphs and diagrams as appropriate to ensure information is readily understandable; and Guidelines and standards used to quantify baselines and impacts should be explained and justified.	Chapter 7 and Chapter 8
For information given in a draft Environmental Impact Statement, the draft must state: • The source of the information • How recent the information is • How the reliability of the information was tested • What uncertainties (if any) are in the information • What guidelines, plans and/or policies have been considered during preparation of the EIS.	Chapter 7 and Chapter 8 Guidelines, plans and policies are also discussed in Chapter 3
The EIS must provide information on proposed safeguards and mitigation measures to manage the relevant impacts of the action. Specific and detailed descriptions of proposed measures must be provided and substantiated, based on best available practices and must include the following elements. A consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including: • A detailed description of the environmental outcomes the measures are expected to achieve including details of any baseline data or proposed	Chapter 7, Chapter 8 and Chapter 12

Requirement	Where addressed in EIS
monitoring to demonstrate progress towards achieving these outcomes • A description of proposed safeguards and mitigation measures to deal with relevant impacts of the action, including mitigation measures proposed to be taken by State governments, local governments or the Proponent • Assessment of the expected or predicted effectiveness of the mitigation measures • Any statutory or policy basis for the mitigation measures • The cost of the mitigation measures • The likely cost of the mitigation measures.	
The EIS must provide details of the likely residual impacts upon a matter protected by a controlling provision after the proposed avoidance and mitigation measures have been taken into account. This includes: a) The reasons why avoidance or mitigation of impacts may not be reasonably achieved b) Quantification of the extent and scope of significant residual impacts.	Chapter 7 and Chapter 8
Offsets should compensate for an impact for the full duration of the impact.	Section 7.3
Offsets must directly contribute to the ongoing viability of the protected matter impacted by the project and deliver an overall conservation outcome that maintains or improves the viability of the protected matter, compared to what is likely to have occurred under the 'status quo' (i.e. if the action and associated offset had not taken place).	Section 7.3
Note: Offsets do not make an unacceptable impact acceptable and do not reduce the likely impacts of a proposed action. Instead, offsets compensate for any residual significant impact.	Section 7.3
The EIS must provide: a) Details of the offset package to compensate for significant residual impacts on a protected matter b) An analysis of how the offset package meets the requirements of the EPBC Act Offsets Policy.	Section 7.3
The EIS must include information on any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. This must include: • A description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.	Chapters 7, 8 and 12

7.1 Traffic and transport

This chapter describes the existing traffic conditions influencing The Northern Road, identifies the potential impacts to those conditions as a result of the construction and operation of the project, and assesses those impacts in light of the project. This chapter also recommends environmental management measures to reduce the impacts of the project.

The working paper, Traffic and Transport Assessment (Appendix G) has been used to inform this chapter.

Table 7-2 sets out the Secretary's Environmental Assessment Requirements (SEARs) as they relate to traffic and transport impact and states where in this EIS these have been addressed.

It is noted that there are no specific Commonwealth EIS guidelines in relation to traffic and transport. General Commonwealth EIS guidelines in relation to the assessment are described above including the assessment of residual impacts, which have been addressed in Section 7.1.6.

Table 7-2 EIS Secretary's Environmental Assessment Requirement for traffic and transport

Requirement	Where addressed in EIS
Traffic and Transport — including: details of how: • the preferred alignment, design and staging, • the proposed intersections, interchanges and connections to the surrounding road network, and • associated road infrastructure facilities.	Section 7.1
meet the traffic and transport objectives of the proposal, taking into account the following local and regional issues: • adjacent sensitive land uses, • the Western Sydney Airport, • transport connectivity to and from existing communities and centres (such as South West Growth Centre), • future growth areas, • the Broader Western Sydney Employment Area, • approved and proposed infrastructure projects (including other • proposed upgrades of The Northern Road, Bringelly Road Upgrade Stages 1 and 2, and the proposed M12 Motorway between M7 and The Northern Road), • traffic (vehicular, cyclist and pedestrian) needs;	Section 7.1.2 Section 7.1.3 and Section 7.1.4
• an assessment and modelling of operational traffic and transport impacts on the local and regional road network, and M4 Western Motorway, including an assessment of road user safety, and discussion of the currency of baseline traffic and transport data;	Section 7.1.4
• a detailed assessment of public transport impacts and opportunities, including a summary of bus routes that would utilise the proposed bus	Section 7.1.4

Requirement	Where addressed in EIS
lanes;	
• an assessment of potential impacts the proposal may have on aviation associated with the Western Sydney Airport	Section 7.1.5
• an assessment of impacts on cyclist and pedestrian access and safety, and description of proposed cyclist and pedestrian routes, having consideration of opportunities to integrate cycleway and pedestrian elements with surrounding networks and facilitate connectivity between existing communities and with proposed future land uses; and	Section 7.1.3 and Section 7.1.4
construction traffic and transport impacts of the proposal (including ancillary facilities) and associated management measures, in particular: • impacts to the road network (including safety and level of service, pedestrian and cyclist access, and disruption to public transport services and access to properties), • access and route identification and scheduling of transport movements, • the number, frequency and size of construction related vehicles (passenger, commercial, heavy and oversized vehicles), • effects on commercial and industrial access, including staff and customer parking, • the nature of existing traffic on construction access routes (including consideration of peak traffic times), and • the need to close, divert or otherwise reconfigure elements of the road network associated with construction of the proposal, having reference to the cumulative construction impacts of other major projects preparing for or commencing construction.	Section 7.1.3, Section 7.1.4 and Section 7.1.5

7.1.1 Assessment methodology

The information sources used in carrying out the assessment are identified throughout this chapter. A complete list of information sources used in the assessment is also provided in the working paper. The assessment methodology identifies where those sources of information have been verified through either validation of traffic survey data, traffic signal data and calibration and validation of the traffic model itself. Traffic forecasts have been based on:

- Operation of the Western Sydney Airport by the mid 2020's
- Standard Land Use 2014 assumptions from Bureau of Statistics and Analytics (BSA) including South West Priority Growth Area, Western Sydney Priority Growth Area and Western Sydney Airport
- Completion of The Northern Road upgrade between Glenmore Parkway and Jamison Road by 2021
- Completion of Bringelly Road upgrade between Camden Valley Way and The Northern Road before 2021.

The Northern Road Upgrade traffic model has been developed using the Aimsun modelling platform (version 8.1.0) and has been calibrated and validated according to the principles outlined in the Roads and Maritime Services *Traffic Modelling Guidelines, 2013*.

High-level land use forecasting and mode split has been undertaken using the Transport for NSW Sydney Strategic Transport Model (STM) which has been used to provide initial network structure and to generate future growth scenarios.

Future demand was generated based on forecast traffic volumes from Roads and Maritime Sydney Traffic Assignment Model (STAM).

A detailed description of the traffic and transport assessment methodology is provided in Appendix G - Traffic and Transport and summarised below.

Construction traffic

The assessment of construction traffic and transport impacts involves a review of the types of construction activities proposed, staging of works, working hours and the need for temporary periods of road occupancy to allow for construction. Potential impacts on general traffic, local traffic, access, and bus operations were assessed, and mitigation and management measures to minimise impacts proposed.

Operational traffic

Traffic modelling is a core component of the appraisal of the project and has been used to forecast and evaluate traffic impacts of future land use and planned road network improvements in the vicinity of The Northern Road. The operational traffic assessment was planned and executed to support the design of the proposed upgrade. It was also aimed at achieving the key project objectives of:

- Development and demand – support the Western Sydney Airport, land use change and residential growth; balancing functional, social, environmental and value for money considerations
- Connectivity to airport – provide a resilient connection to the Western Sydney Airport site for freight and people
- Integrated network – provide road improvements to support and integrate with the broader transport network
- Customer focus – provide meaningful engagement with customers and stakeholders throughout the program life
- Improving facilities for public and active transport.

To inform the impact assessment of the project an Aimsun microsimulation traffic model was developed. The microsimulation model allows the simulation of detailed interactions between vehicles. The model is part of a wider model of The Northern Road corridor that is being used for assessing the functional performance of The Northern Road Upgrade between Mersey Road, Bringelly and Jamison Road, Penrith.

The Northern Road base models have been validated against travel times recorded during the same period as the turning movement surveys.

As recommended by the Roads and Maritime *Traffic Modelling Guidelines (2013)*, the target for validation of each route in each hour is for the modelled average travel time for each route to be within 1 minute, or 15 per cent (whichever is higher) of observed travel times.

Analysis of travel time and modelled congestion along The Northern Road indicates that the model generally meets the requirements for travel time comparisons, with modelled peak direction travel times being within the required 15 per cent of observed in all cases except one (northbound between 7.00am to 8.00am). This result is close to the target and is not considered a substantial difference from the observed travel time that would affect the model's suitability for this study.

Based on these calibration and validation results, the models are considered adequately validated for the purposes of assessing the project.

Further detail regarding the development, calibration and validation of this model is detailed in *The Northern Road Upgrade Mersey Road, Bringelly to Jamison Road, Penrith Traffic Model Calibration and Validation Report* (Jacobs, 2015) provided in Appendix G.

Sources of input data for the assessment of operational traffic impacts included 2011 census Journey to Work data, demographic and workforce data, Roads and Maritime crash statistics, and traffic count data comprising:

- Intersection turning movement surveys collected in November 2014 and July 2015
- Automatic traffic counts (ATC) collected in July 2015
- SCATS (traffic signal system) detector counts collected in July 2015
- Floating-car travel time surveys undertaken in October 2015.

Future traffic demand used for the traffic and transport assessment was developed based on data provided by Roads and Maritime from the Strategic Traffic Assignment Model (STAM) for the project.

The traffic and transport assessment considered the following scenarios:

- Existing 2015 base case
- 2021 and 2031 without the project (Do minimum)
- 2021 and 2031 with the project.

The 'without The Northern Road Upgrade (between Mersey Road and Glenmore Parkway)' scenario includes the following road upgrades and land uses:

- Proposed M12 Motorway (by 2031)
- Western Sydney Airport (by 2031)
- Realignment of the existing The Northern Road around the Western Sydney Airport site as a two-lane undivided road.

A summary of the options included in each scenario is presented in Table 7-3.

Table 7-3 Summary of options tested for this assessment

Site Name	2015 base case	2021 without the project	2021 with the project	2031 without the project	2031 with the project
M12 Motorway	X	X	X	✓	✓
Western Sydney Airport	X	X	X	✓	✓
The project	X	X	✓	X	✓

Although 2021 has been adopted as the year of opening, the actual year of opening is more likely to be 2019/20. However, adopting the 2021 forecast year as the year of opening is a conservative assumption and acceptable for the purposes of modelling the project.

An assessment of the traffic and transport impacts of the project assesses the traffic and transport impacts for two design years (2021 and 2031) for the weekday peak periods. The cumulative impacts of the increase in background traffic as well as the impacts of road upgrades and the forecast levels of development within the study area have been included in the assessment.

The assessment also considers the impacts on all road users including public transport, pedestrians and cyclists.

7.1.2 Existing environment

The following sections outline the existing environmental conditions relevant to traffic and transport conditions. This is considered to provide a baseline of existing traffic conditions from which potential impacts from the project have been modelled and assessed.

The Northern Road is a State road within Sydney's road network and is one of the main north–south connections in south-western Sydney. It stretches from Narellan, west of Campbelltown, via Penrith to Bligh Park south-east of Richmond.

For the majority of its length between Mersey Road, Bringelly and Glenmore Parkway, Glenmore Park, The Northern Road is a two-lane rural road on a single carriageway. North of Glenmore Parkway, on approach to the M4 Western Motorway, The Northern Road widens to two lanes in each direction. The Northern Road is generally 80 km/h between Mersey Road and Glenmore Parkway, dropping to 60 km/h through Luddenham town centre.

Within the context of the study area, the regional road network comprises The Northern Road and Elizabeth Drive, which are the key north–south and east–west routes for regional trips. All other roads in the study area are considered to be local roads. Other regional routes in western Sydney (e.g. M4 Motorway, M7 Motorway, Mulgoa Road, Mamre Road) have not been included either because of their distance from the study area, or because they are not considered viable alternatives to a fully upgraded The Northern Road.

Existing traffic volumes

The traffic and transport assessment adopted a study area defined by The Northern Road and its connecting roads:

- Mersey Road
- Dwyer Road
- Eaton Road
- Adams Road
- Park Road
- Elizabeth Drive
- Littlefields Road
- Gates Road
- Vineyard Road
- Longview Road
- Kings Hill Road
- Chain-O-Ponds Road
- Defence Establishment Orchard Hills (DEOH) entry road (private road)
- Bradley Street.

Traffic volumes on the road network within the study area were derived from traffic surveys undertaken between November 2014 and July 2015. These volumes are shown in Table 7-4.

Table 7-4 Existing traffic volumes

Road / location	Between	ADT (vehicles per day)	AM peak 1hr (8.00-9.00am)	PM peak 1 hr (4.30:5.30pm)
The Northern Road	Glenmore Parkway and Bradley Street	21,982	1,601	1,878
	Chain-O-Ponds Rd and Kings Hill Road	17,499	1,285	1,563
	Littlefields Rd and Elizabeth Drive	15,206	1,097	1,371
	Elizabeth Drive and Park Road	15,737	1,096	1,397
Bradley Street	West of The Northern Road	6,832	534	541
DEOH Access	East of The Northern Road	1,513	168	66
Chain-O-Ponds Road	West of The Northern Road	290	27	16
Kings Hill road	West of The Northern Road	2,532	219	186
Longview Road	East of The Northern Road	Not available	13	15
Gates Road	East of The Northern Road	Not available	19	25
Littlefields Road	West of The Northern Road	1,752	131	144
Elizabeth Drive	East of The Northern Road	11,534	849	919
Park Road	West of The Northern Road	6,342	470	501
Adams Road	East of The Northern Road	Not available	134	161
Dwyer Road	South of The Northern Road	Not available	50	74

Existing travel characteristics – mode of travel

An analysis of the Journey to Work data based on the 2011 census data shows that the car driver and car passenger are the predominant mode of travel for people living and working within the study area. Employment trips provide a good indication of the total mode share of the area and are particularly relevant given the major developments would be employment related.

The Journey to Work data presented in Table 3-3 (Section 3.3.2) indicate that car journeys to work, whether as passenger or driver make up some 90 per cent of the total trips into or out of the study

area. Only two per cent of trips to work in the area are made by public transport. Public transport mode share is higher for residents in the study area who work outside of the study area. Eight per cent of these trips use public transport. Car usage however remains dominant with 88 per cent of trips from the study area involving a car.

Public transport

Public transport in the study area is provided exclusively by bus services. Route 789 operates between Penrith and Luddenham, predominantly along The Northern Road. This is a peak hour only service and only operates twice a day on weekdays. No services are provided on weekends. There are currently fourteen bus stops associated with this bus route within the study area. Route 789 and associated stops within the study area are shown in Figure 7-1.

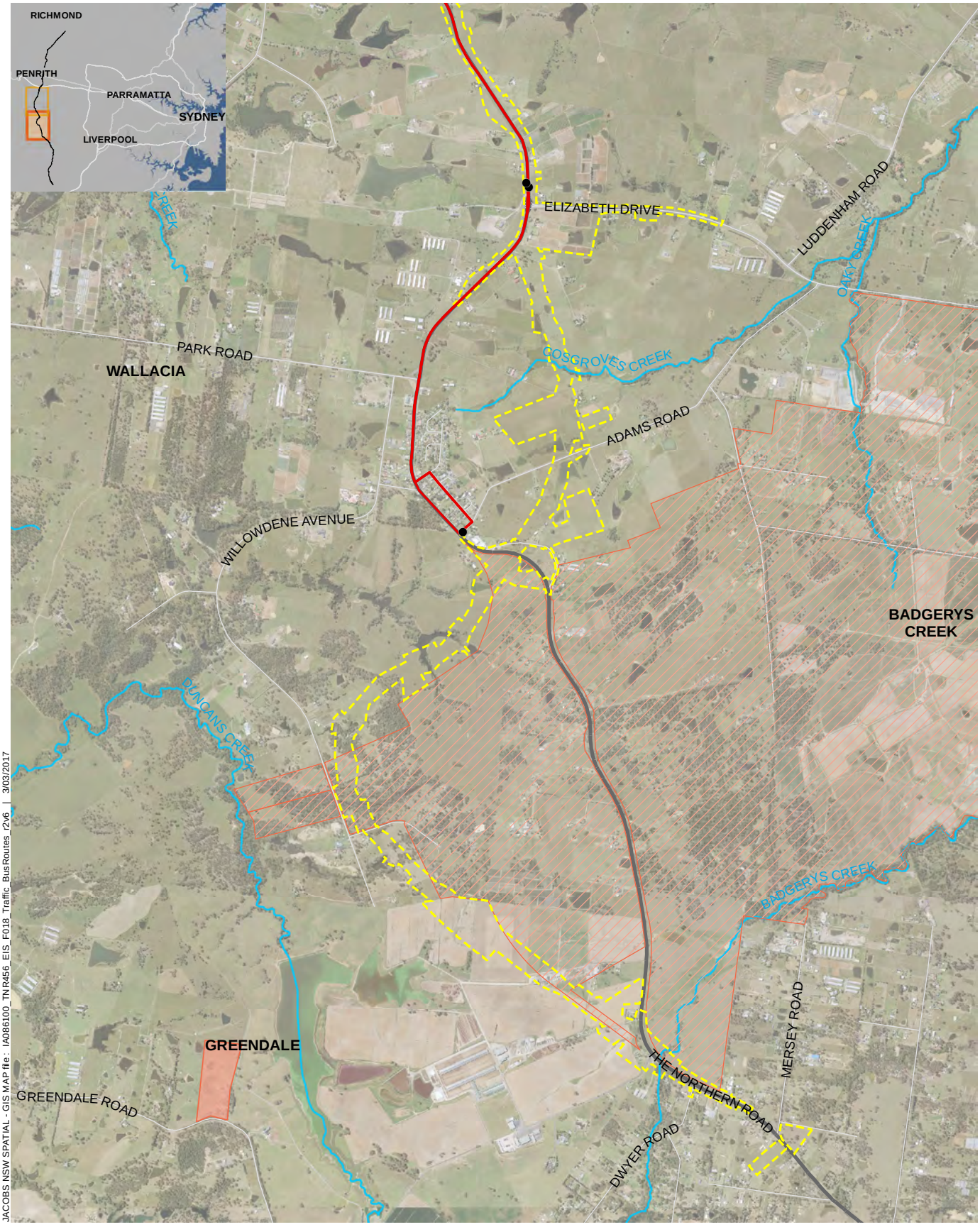


Figure 7-1 | Bus routes and stops in the project area

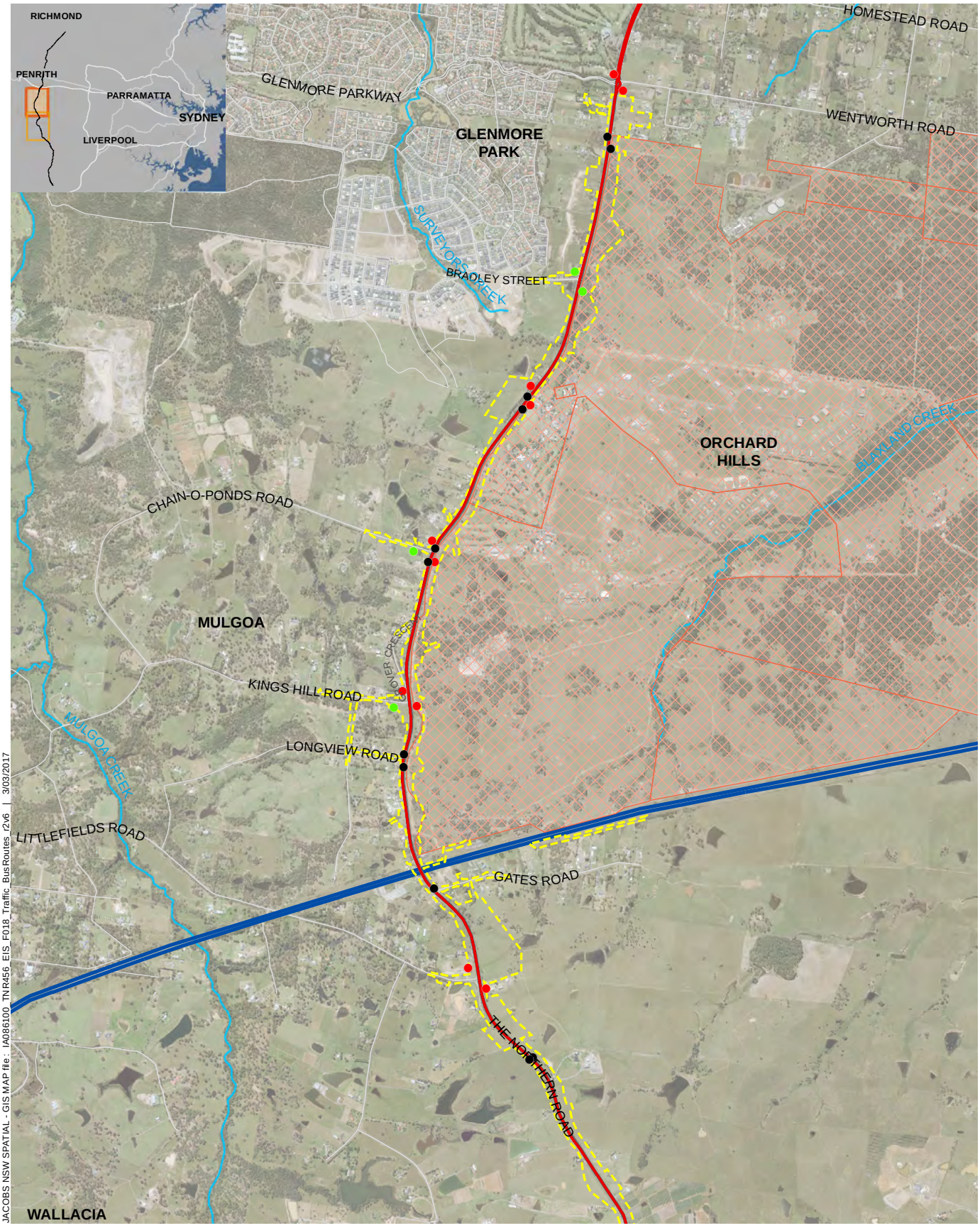


Figure 7-1 | Bus routes and stops in the project area

Pedestrian and cycling network

There is currently limited pedestrian infrastructure provided along The Northern Road. There are no formal continuous footpaths provided along The Northern Road in the majority of the study area. However, a short section of footpath is provided on the western side of the road between Roots Avenue and the service station near Park Road at Luddenham.

There are no formal cycle facilities provided in the study area. The study area is covered by the *Penrith Accessible Trails Hierarchy Strategy (2012)* and the *Liverpool City Council Bike Plan (2009)*; neither of these documents identifies any plans for future cycle facilities in the study area.

The Roads and Maritime Cycleway Finder classifies The Northern Road as a high difficulty on-road environment for cyclists.

Freight routes

The Northern Road forms a significant north–south freight function in the region. The Northern Road is currently approved for 26 metre B-doubles and 4.6 metre high vehicles between Mersey Road and Glenmore Parkway. Elizabeth Drive to the east of The Northern Road and Park Road to the west are also approved routes for 26 metre B-doubles. Analysis of existing heavy vehicle flows shows that heavy vehicles comprise between 11 and 19 per cent of daily traffic along The Northern Road between Mersey Road and Glenmore Parkway. Heavy vehicle volumes are generally higher to the north of Elizabeth Drive and comprise a higher proportion of daily traffic.

Existing road network performance

The performance of the existing road network is largely dependent on the operating performance of intersections that are the critical capacity control points. The 'Level of Service' (LoS) is the standard measure used to assess the operational performance of intersections. Level of Services is ranked from LoS A to LoS F, with LoS A representing the best performance and LoS F the worst.

The criteria used to determine intersection Level of Service on the basis of average delay is outlined in Table 7-5 as defined by Roads and Maritime in the *Guide to Traffic Generating Developments* (2002).

Table 7-5 Level of Service criteria for intersections

Level of Service	Average Delay per Vehicle (sec)	Traffic Lights, Roundabouts	Give Way and Stop Signs
A	<14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; incidents would cause excessive delays at signals Roundabouts require other control modes	At capacity, requires other control mode
F	>70	Over capacity; unstable operation	Over capacity; unstable operation

Existing (base case) intersection LoS for key intersections along The Northern Road, derived from the microsimulation traffic model is shown in Table 7-6. The microsimulation model shows that currently all intersections operate satisfactorily during the peak periods.

Table 7-6 Existing intersection performance

Intersection	2015 AM peak		2015 PM peak	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
The Northern Road/Bradley St	27	B	34	C
The Northern Road/DEOH Access	10	A	16	B
The Northern Road/Chain-O-Ponds Rd	8	A	10	A
The Northern Road/Kings Hill Rd	11	A	10	A
The Northern Road/Littlefields Rd	13	A	13	A
The Northern Road/Elizabeth Rd	24	B	19	B
The Northern Road/Park Road	26	B	19	B

Queuing at the intersection of The Northern Road and Bradley Street has been observed increasing as the development of the Glenmore Park residential subdivision has proceeded. Completion of this subdivision is likely to increase traffic flows out of Bradley Street in the morning peak and into Bradley Street in the evening peak and consequently increase delays at this intersection. To address this issue in the short-term, the installation of temporary traffic signals and minor intersection works have been committed to as part of the Glenmore Park Stage 2 development. These traffic signals are in place and would remain until the intersection is reconfigured as part of the project, at which time this would be replaced with a new upgraded signalised intersection.

Existing travel times and travel speeds

Travel times and travel speeds provide an additional means of assessing the functional performance of a road. These have been assessed for the project, the results of which are outlined in Table 7-7. In summary, analysis of observed average speeds (based on floating car travel time surveys) along The Northern Road shows that traffic travels generally slower than the sign posted speed limits. This is due primarily to delays at roundabouts, traffic turning right at priority intersections and delays caused by cars being unable to overtake heavy vehicles. Despite these delays, current observed travel times and average travel speeds correspond to a Level of Service C or better.

Table 7-7 Existing travel speeds along The Northern Road

Segment	Direction	Travel Time (mm:ss)	Average Travel Speed (km/hr)	LoS
Morning Peak				
Between Mersey Road and	NB	06:47	65	B

Segment	Direction	Travel Time (mm:ss)	Average Travel Speed (km/hr)	LoS
Elizabeth Drive	SB	07:27	60	B
Between Elizabeth Drive and Glenmore Parkway	NB	07:22	60	B
	SB	07:03	63	B
Evening Peak				
Between Mersey Road and Elizabeth Drive	NB	06:30	68	B
	SB	07:31	59	C
Between Elizabeth Drive and Glenmore Parkway	NB	07:53	56	C
	SB	06:51	65	B

Road safety and crash history

A total of 121 crashes were recorded on The Northern Road between Mersey Road and Glenmore Parkway over a five-year period from 2009-2010 until 2013-2014. Of these crashes, the main types of crashes were:

- Rear end (40 per cent)
- Head on, not overtaking (13 per cent)
- Off to left - curve (seven per cent)
- Off to left – straight (six per cent).

There were five fatal crashes in the reporting period. The remaining crashes resulted in injury and non-injury crashes:

- Fatal crashes – 5
- Injury – 57
- Non-injury – 59.

Midblock traffic count data from surveys in July 2015 have been used to calculate average daily traffic numbers for this section of The Northern Road. This has allowed for calculation of a crash rate per 100 million vehicle kilometres travelled (VKT) as well as a crash rate per km per year. The observed crash rate was 1.5 crashes per kilometre of road per year with a crash rate frequency of 25.9 crashes per 100 million VKT. The observed casualty crash rate per kilometre of road per year is significantly lower than the average performance for similar roads in NSW.

7.1.3 Assessment of potential construction impacts

Construction sequencing along the alignment has not yet been defined. For the purposes of this assessment, construction of the project is assumed to take place over three stages, delivered through three separate construction contracts as outlined in Section 5.5.

Table 7-8 outlines the indicative duration for the various construction activities for the project. The construction workforce is expected to fluctuate, depending on the construction activity and number of activities occurring concurrently. The timing and duration of construction activities would be confirmed once a construction contractor is appointed to the project, however it is expected that the indicative durations of construction activities outlined in Table 7-8 would apply to the project.

Table 7-8 Indicative construction activity timing

Construction activity	Duration of activity	Work outside standard hours Yes/No	Haulage % at night
Early works	6 months	Y	<1%
Earthworks	18 months	N	N/A
Road work (widening and new roads) and intersection work	4 months	Y	~ 5%
Construction of bridge over Adam Road	6 months	Y	~ 5%
Drainage work	15 months	Y	~ 1%
Pavements	18 months	Y	~ 10%
Utility relocation	15 months	Y	<1%
Finishing work	9 months	Y	<1%

Where reasonable and feasible construction works would be carried out during standard working hours as defined by the Interim Construction Noise Guideline (OEH 2009) and presented in Table 7-9. Most of the noisiest activities would be able to be carried out during standard construction hours. However, a number of construction activities would need to be undertaken outside of standard working hours for reasons including public and construction worker safety and to avoid substantial traffic delays on The Northern Road and surrounding road network (for example, delivery of large items of plant or materials requiring oversize vehicles).

Table 7-9 Standard working hours

Day	Start time	Finish time
Monday to Friday	7am	6pm
Saturday	8am	1pm
Sunday and public holidays	No work	

Up to 21 temporary ancillary facilities are proposed during construction. All ancillary facilities are located within or adjacent to the construction site. Access to the construction site would only be possible from The Northern Road or Elizabeth Drive for heavy vehicles as shown in figure 5-10. Light vehicles would be allowed to additionally access the construction site from Willodene Avenue.

Ancillary facilities located between Glenmore Parkway and Elizabeth Drive can be accessed from the existing TNR or from within the construction site. For ancillary sites located between Elizabeth Drive and Mersey Road they can only be accessed by an internal access track located along the mainline construction.

Proposed site access points to each of the construction ancillary facilities and the likely haulage routes to and from each site are shown in Figure 5-12.

Construction traffic generation

The majority of traffic generated during construction would be from plant equipment and material deliveries including:

- Construction material
- Spoil removal
- Construction plant
- Construction personnel.

Light vehicle movements would be associated with staff movements to and from the site. At any one stage of construction, the peak construction workforce is likely to comprise up to 40 construction, site management personnel and sub-contractors at each of the sites representing the three phases of construction. This equates to 120 personnel for the project in total. The time of greatest impact of construction traffic to the surrounding road network would be during the morning and evening peak period.

Based on arrivals to and departures from site at peak periods each working day, traffic generation is likely to be in the order of 230 additional light vehicle movements per day (115 in the morning and 115 in the afternoon). This figure is derived based on the arrival and departure movements of the (estimated maximum) 120-person work force, with consideration for a vehicle occupancy factor of 1.04 persons per (light) vehicle. Assuming that 80 per cent of these light vehicles arrive (and depart) in the same hour, the likely peak hour volume (rounded) on the busiest days would be in the order of 92 vehicle movements per hour with almost all of these vehicles arriving at the worksite in the morning and leaving in the afternoon.

The majority of this traffic would likely travel along The Northern Road from the north, with a small proportion travelling along Elizabeth Drive from the east. This volume of traffic would be well within the capacity that these roads have been designed for and within the daily fluctuation of observed traffic volumes along The Northern Road and Elizabeth Drive. The increase in traffic due to construction would equate to about 2.2 per cent increase on The Northern Road and about 0.3 per cent increase on Elizabeth Drive, which would be negligible impact. Furthermore, the average traffic generation for any one worksite would be around one third of the peak volume at 62 two-way vehicle trips per day.

The number of truck movements to any one work site is likely to be in the order of 100 trucks per day based on assessment of similar projects. This would equate to about 12-13 truck movements per hour in the peak hours. This number of trucks is unlikely to have a significant traffic impact on the road network. Typically the type of trucks that construction would generate would be truck-and-dog vehicles (19 m), heavy rigid vehicles (12.5 m) and concrete trucks (8.8 m).

About 90 per cent of light and heavy vehicle trips associated with construction are expected to travel along The Northern Road, with the remaining 10 per cent expected to travel along Elizabeth Drive. The likely increase in average daily traffic (ADT) volume as a result of construction activities would be less than five per cent, which is likely to have a negligible impact on the LoS along The Northern Road and Elizabeth Drive.

Impacts on road network operation

Construction activity is likely to impact traffic operation in the following instances:

- Reduced speed limits at traffic switches: During construction of the Mersey Road to Eaton Road section, traffic would be diverted from the existing The Northern Road alignment to a single carriageway on the newly construction alignment to allow for the closure of the existing The Northern Road alignment through the Western Sydney Airport site. Traffic would be required to travel at reduced speeds through locations where traffic would be redirected to the opposing carriageway during construction work

- Construction near live traffic: reduced speed limits and active traffic control would be required wherever construction activities would be taking place near live traffic. That is likely to occur at the locations of tie-in and bridge work and also where widening of the existing corridor is planned
- Temporary traffic calming: A temporary roundabout is likely to be in operation during the construction of traffic signals at the intersection of The Northern Road and Luddenham south access. Reduced speed limits would be required in the vicinity of this temporary roundabout.
- Temporary traffic signals may be required where the existing The Northern road intersects with the proposed new alignment near Eaton Road, Luddenham. These temporary signals would be used to allow safe access to and from the main compound site (C8).

In general, as about half of the project is being constructed offline to the existing The Northern Road, and adjacent arterial roads, impacts to traffic operation on the existing road network would be minimised.

Access impacts

Access to some properties may be affected by the construction activities, particularly in areas where construction would be occurring along the existing The Northern Road corridor. This could be either though the loss of existing access arrangements or the alterations of access arrangements.

Where property access is temporarily affected alternative access arrangements would be made in consultation with residents. A construction plan would be prepared to identify and address access issues that are not already covered by the proposed access plan outlined in Section 7.1.4.

Parking

Staff parking is likely to be provided on site at each construction compound. It is not expected that surplus parking demand from construction activities would reduce the availability of surrounding public parking, or parking for customers of commercial premises within the project study area.

Impacts on road safety

Construction activity along The Northern Road is likely to have the following impacts on road safety without effective mitigation:

- Reduced traction or control on temporary pavement surfaces
- Increased likelihood of conflicts between cars, trucks and construction vehicles
- Reduced lane widths and increased proximity to barriers increasing potential of collisions
- Increased potential for driver distraction around construction activities
- Decreased visibility of temporary line marking and other traffic control measures
- Increased potential of collision at construction site egress points.

Road safety impacts from construction are addressed through the development of an effective Construction Traffic Management Plan (CTMP) as detailed in Section 7.1.6

Impacts on other modes of transport

During construction of the project the following impacts to buses and bus passengers are likely:

- Reductions in speed when travelling through construction activity areas including traffic switches and tie in works. When travelling through these zones, bus speeds would be limited to the prevailing construction speed limit (most likely 40 or 60 km/h subject to the specific construction activity being completed and operational and safety requirements)

- Temporary relocation of stops away from construction zones, particularly where works are being undertaken within the existing The Northern Road corridor. Based on the spacing of stops and the staging of construction activities, this is likely to affect up to three pairs of stops at any one time during construction for a period of up to two years. The maximum additional distance passengers would need to travel as a result of relocated bus stops would be for the bus stop located at Gates Road, where passengers would need to travel up to an additional 650 m to reach the relocated bus stop at Littlefields Road
- Alternative access to relocated bus stops may need to be provided depending of where the bus stops are relocated. This may involve the construction of temporary footpaths adjacent to construction zones
- During construction, pedestrian and cyclists may need to use alternative temporary paths where one side of The Northern Road may be inaccessible. This may involve the provision of temporary alternative access routes to properties in the study area to ensure that safe pedestrian and cycling access is maintained during the course of construction. As construction would take place in stages, these temporary arrangements are likely to be in place for up to three years.

Cumulative construction impacts

A detailed assessment of the likely cumulative impact of the project with other projects in the region is provided in Chapter 9 – Cumulative Impacts. Chapter 9 discusses the project's cumulative impacts in respect of all the key disciplines, for construction and operation phases.

7.1.4 Assessment of potential operational impacts

The assessment criteria for road network planning for the project relate to:

- Provision of adequate capacity on the higher order road network to cater for forecast traffic based on a minimum intersection Level of Service D for morning and evening peak period operation
- Minimising queue length and turn bay overflow along The Northern Road
- Minimising travel times along The Northern Road
- Provision of optimum intersection configurations that are sensitive to physical constraints and land ownership
- Minimising impacts on all other road users such as public transport, pedestrians and cyclists.

Intersection performance criteria are outlined in Section 7.1.2. These criteria have been used to assess the performance of intersections along The Northern Road based on outputs from The Northern Road microsimulation traffic model, with average delays for intersections extracted from Aimsun for the morning (07.30 to 08.30) and evening (16.30 to 17.30) peak one-hour periods. As the M4 Motorway is outside of the project study area, the impacts of the project on the M4 Motorway are not considered in this assessment. These impacts are considered in the Review of Environmental Factors for The Northern Road upgrade between Glenmore Parkway and Jamison Road, which includes the project as one of the key assumptions.

Intersection performance without the project

Table 7-10 summarises intersection operation along the existing The Northern Road corridor under the 'without the project' scenario. In general, testing of the forecast traffic flows on The Northern Road under the future year scenarios shows that intersections along The Northern Road would continue to perform acceptably by 2021, with the exception of The Northern Road and Bradley Street. Delays at this intersection have been observed to increase as development in Glenmore Park proceeds, and this growth is likely to increase delays at this intersection to beyond acceptable levels by 2021. However this impact on performance would be offset by the proposed temporary intersection works including the temporary traffic signals.

Analysis of later future scenarios shows there would be insufficient capacity along The Northern Road under the existing arrangement by 2031. This corresponds with increased traffic associated with the proposed M12 Motorway and the Western Sydney Airport site and development of SWPGA and WSPGA.

Table 7-10 Intersection performance summary 'without the project'

Intersection	2015		2021		2031	
	Av. Delay (sec)	LoS	Av. Delay (sec)	LoS	Av. Delay (sec)	LoS
Morning peak 1 hr						
The Northern Road/Bradley Street	27	B	30	C	>100	F
The Northern Road/DEOH Access	10	A	10	A	57	E
The Northern Road/Chain-O-Ponds Road	8	A	10	A	46	D
The Northern Road/Kings Hill Road	11	A	11	A	>100	F
The Northern Road/Littlefields Road	13	A	15	B	>100	F
The Northern Road/M12	-	-	-	-	>100	F
The Northern Road/Elizabeth Dr	24	B	20	B	>100	F
The Northern Road/Park Road	26	B	14	A	>100	F
The Northern Road/Western Sydney Airport Access	-	-	-	-	>100	F
Evening peak 1 hr						
The Northern Road/Bradley Street	34	C	58	E	>100	F
The Northern Road/DEOH Access	16	B	17	B	86	F
The Northern Road/Chain-O-Ponds Road	10	A	12	A	59	E
The Northern Road/Kings Hill Road	10	A	9	A	63	E
The Northern Road/Littlefields Road	13	A	15	A	98	F
The Northern Road/M12	-	-			>100	F
The Northern Road/Elizabeth Dr	19	B	18	B	>100	F
The Northern Road/Park Road	19	B	14	A	>100	F
The Northern Road/Western Sydney Airport Access	-	-	-	-	>100	F

Intersection performance with the project

Table 7-11 summarises the performance of intersections under the 'with project' scenarios (2012 and 2031).

The results for The Northern Road as it existed in 2015 (i.e. the base case) are the same as those presented in Table 7-11. In general, testing of the forecast traffic flows with the project shows that the project would relieve the capacity constraints that currently exist along The Northern Road, particularly at the existing give-way and stop sign controlled intersections where traffic signals would be provided or right turn movements would be removed.

Modelled intersection delays also show that the intersections would generally perform with higher delays in 2031 than 2021. This is consistent with the increase in traffic forecast between these years as a consequence of the higher intensity of land use at the Western Sydney Airport, the construction of the M12 Motorway, and development of SWPGA and WSPGA.

Analysis of the intersection performance along The Northern Road with the project shows that most of the intersections within the study area would operate satisfactorily under the 2021 and 2031 future year scenarios with Level of Service (LoS) C or better. The only exception being the intersection of The Northern Road and Elizabeth Drive which would be operating near capacity in the evening peak hour at LoS D by 2021. This is due to the large volumes of conflicting traffic movements that are forecast to travel through this intersection by 2021.

It would be noted from Table 7-10 that some intersections would perform at a worse LoS in 2021 with the project than without the project. The LoS measurement, for a signalised intersection, is a based on the weighted average delay of all the vehicles travelling through it. When a (previously unsignalised) intersection becomes signalised, some movements (such as the entry to / exit from side roads) would be provided a share of priority, while others (such as the mainline straight through movement) would have their priority reduced and be subject to occasional delays when lights are red. Because the majority of traffic on The Northern Road is on the mainline / straight through, the average delay would be weighted more heavily against this higher volume of traffic, which would otherwise not be considered if the intersection remained unsignalised. As a consequence, the average delay for the intersection would increase, resulting in a worse LoS.

Intersections are signalised primarily for safety reasons. Over time and as traffic volumes increase (as predicted on The Northern Road), the LoS benefits would be realised as can be seen in Table 7-11 for 2031.

Table 7-11 Intersection performance summary 'with the project'

Intersection	2015		2021		2031	
	Av. Delay (sec)	LoS	Av. Delay (sec)	LoS	Av. Delay (sec)	LoS
Morning peak						
The Northern Road/Bradley Street	27	B	30	C	36	C
The Northern Road/DEOH Access	10	A	22	B	31	C
The Northern Road/Chain-O-Ponds Road	8	A	11	A	17	B
The Northern Road/Kings Hill Road	11	A	15	B	27	B
The Northern Road/Littlefields Road	13	A	17	B	33	C

Intersection	2015		2021		2031	
The Northern Road/M12	-[1]	-[1]	-[1]	-[1]	27	B
The Northern Road/Elizabeth Drive	24	B	41	C	41	C
The Northern Road/Park Road	26	B	-	-	-	-
The Northern Road Existing/The Northern Realigned (southern Luddenham access)	-	-	21	B	26	B
The Northern Road/Western Sydney Airport Access	-[1]	-[1]	-[1]	-[1]	30	C
Evening peak						
The Northern Road/Bradley Street	34	C	33	C	42	C
The Northern Road/DEOH Access	16	B	20	B	25	B
The Northern Road/Chain-O-Ponds Road	10	A	14	A	22	B
The Northern Road/Kings Hill Road	10	A	26	B	32	C
The Northern Road/Littlefields Road	13	A	15	B	18	B
The Northern Road/M12	-[1]	-[1]	-[1]	-[1]	33	C
The Northern Road/Elizabeth Drive	19	B	44	D	45	D
The Northern Road/Park Road	19-	B-	-	-	-	-
The Northern Road Existing/The Northern Realigned (southern Luddenham access)	-	-	18	B	22	B
The Northern Road/Western Sydney Airport Access	-[1]	-[1]	-[1]	-[1]	40	C

1. M12 Motorway and Western Sydney Airport would be built after 2021

Travel times with and without The Northern Road upgrade

Table 7-12 provides a comparison of modelled travel times along the existing The Northern Road corridor with and without the project, averaged over the morning peak hour (07.30 to 08.30). The modelled travel times indicate that the project would result in reduction of travel times in both directions along The Northern Road when comparing the project scenario with the Do Minimum scenario. In this section, northbound travel times are likely to remain similar to those without the project since the project would introduce delays at five new signalised intersections.

Table 7-12 Comparison of modelled travel times 'without the project' and 'with the project'

Segment	Direction	2021 (mm:ss)	2031 (mm:ss)
Morning Peak			
Between Mersey Road and Elizabeth Drive	NB(1)	07:41	>30:00

Segment	Direction	2021 (mm:ss)	2031 (mm:ss)
	NB(2)	06:41	07:11
	SB(1)	07:31	26:55
	SB(2)	06:03	06:59
Between Elizabeth Drive and Glenmore Parkway	NB(1)	07:35	08:36
	NB(2)	05:36	06:40
	SB(1)	08:11	25:39
	SB(2)	06:53	08:24
Evening Peak			
Between Mersey Road and Elizabeth Drive	NB(1)	09:30	>30:00
	NB(2)	06:57	07:24
	SB(1)	07:55	>30:00
	SB(2)	06:11	06:27
Between Elizabeth Drive and Glenmore Parkway	NB(1)	11:06	11:05
	NB(2)	05:44	06:27
	SB(1)	11:58	>30:00
	SB(2)	07:08	08:40

(1) Without the project, (2) With the project

Impacts on local roads and access

The project would include the provision of a wide central median that would remove existing right turns at some intersections and property accesses. Table 7-13 summarises the changes to access as a result of the project and also outlines the maximum additional travel distance and time that would result from changes to access.

Table 7-13 Summary of key access changes

Access impact location	Affected movement	Maximum additional travel distance (km)	Maximum additional travel time (min:sec)
Mersey Road to Western Sydney Airport access	Right turn from The Northern Road (coming from the north) into properties to the west of The Northern Road	1.6	2:32

Access impact location	Affected movement	Maximum additional travel distance (km)	Maximum additional travel time (min:sec)
	Right turn into The Northern Road (to travel south) from properties to the west of The Northern Road	1.6	2:32
	Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road	1.7	2:37
	Right turn into The Northern Road (to travel north) from properties to the east of The Northern Road	0.9	2:01
Western Sydney Airport access to Luddenham southern access	Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road	8.8	9:10
	Right turn into The Northern Road (to travel north) from properties to the east of The Northern Road	5.8	5:40
Luddenham southern access to Eaton Road	Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road	4.7	4:52
	Right turn into The Northern Road (to travel north) from properties to the east of The Northern Road	1.0	2:03
Eaton Road access to Elizabeth Drive	Right turn into The Northern Road (to travel north) from properties to the east of The Northern Road	4.9	5:02
	Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road	0.4	0:58
Elizabeth Drive to Littlefields Road	Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road	4.4	4:39
	Right turn into The Northern Road (to travel north) from properties to the east of The Northern Road	4.2	4:28
	Right turn from The Northern Road (coming from the north) into properties to the west of The Northern Road	4.8	4:54

Access impact location	Affected movement	Maximum additional travel distance (km)	Maximum additional travel time (min:sec)
	Right turn into The Northern Road (to travel south) from properties to the west of The Northern Road	4.9	5:02
Existing Elizabeth Drive	Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road	1.2	2:14
	Right turn into The Northern Road (to travel north) from properties to the east of The Northern Road	1.5	2:29
Littlefields Road to Longview Road	Right turn from The Northern Road (coming from the north) into properties to the west of The Northern Road	3.4	3:12
	Right turn into The Northern Road (to travel south) from properties to the west of The Northern Road	4.3	3:54
	Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road	3.0	2:54
	Right turn into The Northern Road (to travel north) from properties to the east of The Northern Road	2.3	2:24
	Right turn into Gates Road from The Northern Road (coming from the south)	0.3	0.54
	Right turn out of Gates Road into The Northern Road (to travel north)	1.7	1.54
Longview Road to Kings Hill Road	Right turn from The Northern Road (coming from the north) into properties to the west of The Northern Road and properties along the existing Vineyard Road	1.2	1:36
	Right turn into The Northern Road (to travel south) from properties to the west of The Northern Road and properties along the existing Vineyard Road	0.9	1:18
Kings Hill Road to Chain-O-Ponds Road	Right turn from The Northern Road (coming from the north) into properties to the west of The Northern Road	2.5	3:12

Access impact location	Affected movement	Maximum additional travel distance (km)	Maximum additional travel time (min:sec)
	Right turn into The Northern Road (to travel south) from properties to the west of The Northern Road	1.7	2:37
	Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road	1.0	2:05
	Right turn to The Northern Road (to travel north) from properties to the east of The Northern Road	2.5	3:12
Chain-O-Ponds Road to DEOH	Right turn from The Northern Road (coming from the north) into properties to the west of The Northern Road	2.1	2:12
	Right turn to The Northern Road (to travel south) from properties to the west of The Northern Road	2.1	2:12
DEOH to Bradley Street	Right turn from The Northern Road (coming from the north) into properties to the west of The Northern Road	1.1	1:30
	Right turn into The Northern Road (to travel south) from properties to the west of The Northern Road	1.6	1:54
	Right turn into DEOH from the Northern Road (coming from the south)	-	0:42
	Right turn out of DEOH to the Northern Road (to travel north)	-	0:42
Bradley Street to Glenmore Parkway	Right turn from The Northern Road (coming from the north) into properties to the west of The Northern Road	2.4	2:30
	Right turn into The Northern Road (to travel south) from properties to the west of The Northern Road	3.2	3:06
	Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road	1.3	1:36
	Right turn into The Northern Road (to travel north) from properties to the east of The Northern Road	2.2	2:18

Plots of each of the proposed alternative access outlined in Table 7-13 are provided in Appendix G.

Impacts on public transport and active transport

The project includes the provision of a dedicated kerbside bus lane in each direction between Mersey Road and Glenmore Parkway. This bus lane would allow buses to travel north and south along The Northern Road without being affected by general traffic congestion and delays.

Impacts to the existing 789 bus route through the area would generally be minimal, with benefits being provided through the provision of a dedicated bus lane. The signalisation of intersections on The Northern Road between Elizabeth Drive and Glenmore Parkway may add up to two minutes of delay to this route; however this is well within the variability of long cross-regional bus route.

The majority of existing bus stops would be relocated nearby, for example from the entry side to the exit side of an intersection. However bus stops between Kings Hill Road and Littlefields Road would be relocated a substantial distance from existing bus stops. The maximum additional distance passengers would need to travel as a result of relocated bus stops would be for the bus stop located at Gates Road, where passengers would need to travel up to an additional 650 m to reach the relocated bus stop at Littlefields Road. Some additional bus stops would also be provided. The location of proposed bus stops for the project is shown in Figure 7-1.

As shown in Figure 7-1, the relocated bus stops have been placed at or near intersections of The Northern Road and adjoining side roads, rather than mid-block. Moving the bus stops closer to side roads would make them more accessible to a greater number of the surrounding properties and provides a signalised intersection provides controlled pedestrian crossing point close to the bus stop to enhance passenger safety. While some bus users would be required to travel further to reach the nearest bus stop, others would conversely have a shorter distance to travel.

These bus lanes would support the operation of a high-frequency, ‘rapid’ tier bus service between Liverpool and Penrith via the Western Sydney Airport, providing the operating conditions required to deliver the travel speed and reliability that customers would expect from a higher-order, centre-to-centre public transport connection.

The project would introduce a number of substantial improvements for pedestrians and cyclists along The Northern Road, which would serve to partially offset the increased distances some residents would be required to travel to reach their nearest bus stop. These improvements include:

- A shared path along the western side of The Northern Road between Mersey Road and Glenmore Parkway
- A five metre wide footway would be provided on the eastern side of The Northern Road between Mersey Road and Glenmore Parkway, with a 1.5 metre wide footpath provided as warranted such as between bus stops and adjacent intersections
- New signalised pedestrian crossings at all upgraded intersections where traffic lights are to be provided.

The project would facilitate the following cyclist and pedestrian routes:

- The Northern Road between Mersey Road and Glenmore Parkway.

The project would facilitate cycle and pedestrian connectivity of the following communities:

- Glenmore Park
- Orchard Hills golf course
- Luddenham town centre including Holy Family Catholic Primary School and Luddenham Public School.

The shared path along the length of the project would connect with similar facilities planned or under construction along The Northern Road north of Glenmore Parkway, Glenmore Park, and south of Mersey Road, Bringelly. The shared path would also provide opportunities for future connection to the following pedestrian and cycle networks:

- Shared path facilities that may be included as part of the M12 Motorway

- Pedestrian and cycle access to the Western Sydney Airport.

Overall, the project would improve the accessibility and safety for pedestrians and cyclists along The Northern Road by providing dedicated space for cyclists and pedestrians that is separated from traffic and reducing the potential of conflicts with cars. Formal pedestrian and cycle crossing facilities would also be provided at all signalised intersections, which would improve safety for pedestrians and cyclist to cross roads that would otherwise be uncontrolled.

Impacts on parking

With the exception of the section of The Northern Road through Luddenham, parking is not currently permitted along the length of The Northern Road between Mersey Road and Glenmore Parkway. The project would not remove parking availability through Luddenham.

Impacts on freight transport and aviation

The project would improve reliability and travel times for freight traffic currently travelling on The Northern Road by providing additional traffic capacity and relieving existing traffic constraints, particularly at existing priority and roundabout intersections along The Northern Road. The project would also reduce travel time and improve reliability for freight travelling to the Sydney Motorway network via the M4 Western Motorway and providing an alternative route for freight traffic travelling to and from the Western Sydney Airport.

In the future, The Northern Road would become a route for construction traffic from the Western Sydney Airport and proposed M12 Motorway and would become the primary route from these construction activities to the Sydney Motorway network. The project would ensure that this construction traffic would have a safe and reliable route to the M4 Western Motorway.

Design of the project has been undertaken based on requirements to conform to restrictions associated with height and visibility when in close proximity to the Western Sydney Airport. Furthermore, the design accounts for an access to the Western Sydney Airport and consequently there is unlikely to be any impact of the project on associated aviation activities.

Impacts on road safety

The project would result in the following improvements to road safety:

- The Northern Road would be upgraded with additional lanes and a divided carriageway, removing the need for opposing-lane overtaking and the associated risk of head-on crashes
- Reduced congestion at intersections, which would reduce the likelihood of vehicle crashes at intersections, especially rear-end type crashes
- The new alignment of The Northern Road would be designed to a higher design speed allowing for safer travel along the corridor with intersection designs accommodating B-double trucks
- Many existing priority-controlled intersections would be upgraded to signal control. This would provide more formal opportunities for making right hand turns onto and off The Northern Road. Other uncontrolled right hand turns would be removed, reducing conflicts along The Northern Road
- Formal pedestrian crossings would be provided at all signalised intersections and a wide off-road shared path would be provided along the length of the project. This would reduce conflicts between pedestrians, cyclists and cars
- Realignment of The Northern Road around Luddenham Town Centre would reduce the volumes of cars and trucks travelling through this area and reduce conflicts with local traffic and pedestrians in this higher pedestrian activity area
- New heavy vehicle inspection areas would be constructed as part of the project at Grover Crescent and south of Longview Road. These stations would increase safety of heavy vehicle operations along The Northern Road and wider Sydney road network by ensuring heavy vehicles are compliant and roadworthy.

Performance against traffic and transport objectives

The upgrade and realignment of The Northern Road has been developed in response to the traffic and transport objectives. Specifically, to provide a road that connects to the Western Sydney Airport at Badgerys Creek, supports major land use changes and urban growth, and integrates with the broader transport network.

The overall traffic and transport assessment for the operational phase of the project has been conducted in parallel with the concept design, as part of an iterative process where the design has been guided by outputs from a number of specialist assessments. The design has aimed to achieve a number of objectives relating to the capacity and connectivity of the road, while the traffic and transport assessment has modelled various operating scenarios so as to provide reliable forecasts on which to base the design of the road and its intersections with other connecting roads.

One of the objectives of the project has been the need to identify a new alignment for that part of The Northern Road directly impacted by the Western Sydney Airport at Badgerys Creek. The section of The Northern Road that is now proposed to be realigned, between Dwyer Road, Bringelly and Elizabeth Drive, Luddenham, accommodates the planned airport site.

The project has been designed to accommodate the future growth that is planned for western Sydney, including the Western Sydney Airport, and the South West and Western Sydney Priority Growth Areas. It would achieve this partly through the alignment and intersections that have been designed, and partly through the connectivity with the existing and planned surrounding road network. The Northern Road main carriageway and intersections are designed to accommodate the forecast growth in traffic to 2041, during which time major changes are planned in land use and intensity of development. The traffic and transport assessment has produced forecasts of traffic demand, based on assumptions about this future growth, to inform and influence key aspects of the design in terms of the number of lanes, location and configuration of intersections, and connections to adjoining local roads and private properties.

The project would provide a resilient, long-term connection to the airport site via the proposed signalised service entry point. The design has taken account of existing land use, through the local access strategy outlined in this section (above), to ensure that access to private property is maintained and made safer. While the project area currently provides no facilities for active transport, and limited public transport facilities, the project design incorporates and integrates active transport infrastructure that would connect to the planned shared path network along The Northern Road to the north of Glenmore Parkway, Glenmore Park, and to the south of Mersey Road, Bringelly. The proposed active transport facilities would play a critical strategic role through the provision of a north–south ‘spine’ to which future active transport connections can be made, for example along the future M12 Motorway corridor, and the Bringelly Road corridor.

Similarly, the project’s design for the upgrade of public transport infrastructure along The Northern Road would provide a strategic north–south connection, as well as critical links to the planned airport, from which future services could expand along other existing and planned east–west routes.

The traffic and transport assessment documented in this section has accounted for all of these key factors and the project’s design, which is described in detail in Chapter 5, incorporates these considerations in response to the findings of the traffic and transport assessment. The project’s likely operational impacts on traffic and transport therefore have been managed through the design, to achieve the overall objectives of the project such that any residual impacts (see Section 7.1.7) are minimal. On balance, when weighed against the project’s overall benefits, the residual impacts discussed in Section 7.1.7 are considered to be justified because of the improvements to safety, connectivity and transport capacity that the project would bring.

7.1.5 Summary of impacts to the environment of Commonwealth land

A summary of potential traffic and transport impacts to the environment of Commonwealth land as a result of construction and operation of the project is provided in this section. Affected Commonwealth land includes the DEOH land, and land that has been acquired by the Commonwealth for the purposes of developing the Western Sydney Airport at Badgerys Creek.

Potential construction impacts

The potential impacts on traffic and transport on Commonwealth land during construction is discussed and assessed in Section 7.1.3. Further to the assessment in Section 7.1.3, construction impacts on Commonwealth land would be limited to temporary changes to access to the DEOH land, with no change to access to land within the site of the Western Sydney Airport.

The temporary access changes to the DEOH site would be necessary to facilitate construction of the widened The Northern Road, which would comprise a new signalised intersection at the main DEOH entrance, and a new u-turn bay on the western side of The Northern Road at the DEOH entrance intersection. During construction, traffic switches and temporary changes to access would be managed in accordance with the overall staging of construction, with DEOH access being maintained continuously through each stage of construction. Overall, the project's construction would have little or no impact on traffic and transport on Commonwealth land, over and above the impacts already described and assessed in Section 7.1.3.

Potential operation impacts

The alignment bypasses the proposed site for the Western Sydney Airport at Badgerys Creek. The proponent for the development and operation of the airport is the Australian Government Department of Infrastructure and Regional Development (DIRD).

The road alignment has been progressively reviewed by DIRD to assess for compliance with the relevant aviation guidelines, including the standards for the International Civil Aviation Organization (ICAO) and Federal Aviation Administration (FAA).

The road design has taken into account the short-term one runway airport layout and the longer term two way airport layout developed by DIRD. The road design has been developed with consideration of the constraints imposed by the Glide Path Building Restriction Area, Obstacle Limitation Surface, Public Safety Zones, High Intensity Approach Lighting (HIAL) Systems, Aircraft Isolation and Compass Calibration Areas.

The project's long-term operational impacts on traffic and transport on Commonwealth land would be positive. Access to the DEOH site would be improved through the upgrading and signalising of the intersection at the site's main entrance. Further, the project's design includes formalising access to the site of the Western Sydney Airport, which would facilitate access for service vehicles and deliveries.

7.1.6 Environmental management measures

Expected environmental outcomes

Options development and concept design investigations described in Chapter 4 have sought to minimise traffic and transport impacts as far as possible. Additionally, the majority of long-term impacts of the project have been addressed through design and subsequent design stages.

Project-specific management measures identified in Table 7-14 have been developed with the aim of effectively minimising or mitigating, as far as practical, traffic and transport impacts described above. Specific outcomes that would be achieved through the implementation of effective environmental management measures include:

- Undertake works in accordance with the relevant Traffic Management Plans and associated traffic control plans
- Ensure safe and continuous traffic movement for construction workers and the general public
- Maintain the capacity of existing roads where possible during construction in order to minimise road user delays
- Maintain continuity of access to local roads and properties
- Appropriate consultation with impacted residents and businesses and stakeholders
- Compliance with the relevant legislative requirements and project conditions of approval.

Expected effectiveness

Roads and Maritime are experienced in managing all modes of traffic throughout construction of road projects. The measures contained in the CTMP and outlined in Table 7-14 are based on previous road projects and are designed to effectively mitigate construction related impacts.

The CTMP would be prepared in accordance with the requirements in the NSW Centre for Road Safety publication *Guidelines for Road Safety Audit Practices* and AGRS06 *Austroads Guide to Road Safety Part 6: Road Safety Audit*. The CTMP would form part of the overall Construction Environmental Management Plan.

In addition, prior to opening of any temporary traffic management measure outlined within the CTMP, a person who is qualified in the RMS "Design and Inspect Traffic Control Plans" course would carry out an inspection to verify that any pavement markings, road signs and other traffic control devices have been installed in accordance with the CTMP. The CTMP would be amended as applicable should any measures not be considered effective.

Access would be maintained during the construction period. While access arrangements would be outlined in the CTMP, the effectiveness of those arrangements and the need for any alternative and/or temporary access arrangements would be agreed with affected property managers/owners.

For the operational phase, the road design including intersection layouts has been modelled using the Aimsun microsimulation traffic model. As shown in Section 7.1.4, the project effectively caters for increased traffic demand in 2021 and 2031 from land use changes, as well as providing new and upgraded infrastructure for pedestrians, cyclists and public transport.

Table 7-14 outlines environmental management measures that have been developed to specifically manage potential impacts which have been predicted as a result of the proposed works.

Table 7-14 Traffic and transport environmental management measures

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
Construction impacts	T-1	A Construction Traffic Management Plan (CTMP) would be developed, approved, implemented and monitored as part of the project. The TMP would: • Outline the general principles and procedures for the development of specific construction traffic control plan (CTP's), taking into consideration where possible other construction works utilising similar haulage and access routes • Ensure safe and continuous traffic movement for construction workers and the general public • Maintain the capacity of existing roads where possible • Identify the requirements for temporary speed restrictions where traffic may pose a safety risk to workers • Maintain continuity of access to local roads and properties, particularly along the existing alignment of The Northern Road (may require temporary u-turn facilities). Where access is affected, RMS would consult with residents for alternative access arrangements • Details of access to construction sites including measures to prevent construction vehicles queuing on public roads	Construction contractor	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the CTMP to confirm effectiveness of measures.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
		• Provide temporary traffic control where necessary • Provide appropriate warning and signage for traffic in the vicinity of work areas • Include methods to minimise road user delays such as undertaking works around live traffic including tie-in and bridge work outside of peak periods • Undertake construction activities off-line where possible to minimise the requirement to operate temporary traffic control and reduced speed zones • Develop a communication plan to advise local residents and businesses of any changes to traffic conditions during construction • Consult with bus operators regarding temporary bus stop relocations during construction and proposed bus stops during operation.			
Construction staging	T-2	Staging plans to be prepared in consultation with adjoining contractors and for each stage of the upgrade.	Construction contractor	Construction	Proven to be effective. The requirements for staging plans would be outlined within the TMP. Monitoring and reporting requirements of the TMP to confirm effectiveness of measures.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
Road damage	T-3	Undertake a pre-construction dilapidation survey of local roads used for construction. Defects caused by construction activities would be rectified prior to completion of construction.	Construction contractor	Construction	Proven to be effective.
Property access	T-4	Access to properties along affected roads would be maintained during construction. The need for any alternative and/or temporary access arrangements would be agreed with affected property managers/owners.	Construction contractor	Construction	Proven to be effective. Access arrangements would be outlined in the TMP, the effectiveness of those arrangements and the need for any alternative and/or temporary access arrangements would be agreed with affected property owners.

7.1.7 Residual impacts

The environmental management measures identified would generally be effective in mitigating the traffic and access impacts of the project both during construction and in operation to an acceptable level. However it is expected that a residual impact would remain following implementation of the environmental management measures. A summary of these residual impacts is presented below, including reasoning as to why avoidance or mitigation of these impacts would not be able to be achieved.

Construction

Potential residual traffic impacts that may occur as a result of construction of the project would include:

- Reduced travel speeds and increased delays through construction areas. This would be necessary to ensure that construction work is carried out safely in and around operational roads. This impact is considered to be minor and not significant.
- Temporary changes to accessibility for pedestrians and cyclists when access to roadside areas may need to be restricted during construction. This would require pedestrians and cyclists to potentially travel further to reach their destination and would be necessary to undertake construction in these locations. This impact is considered to be minor and not significant.
- Temporary changes to the location and accessibility of bus stops during relocation and construction. This would result in passengers not being able to board or alight from buses at the locations they are used to and may require them to travel further to and from temporary or relocated bus stops (conversely, some passengers would benefit through closer proximity to temporary or relocated bus stops). The temporary or relocated bus stops would be necessary to enable construction in these areas. This impact is not considered to be significant.

Operation

Potential residual traffic impacts that may occur following the completion of the project when it is in operation would include:

- Access to and from properties along The Northern Road would generally be restricted to left in and left out access arrangements due to the construction of a median between the carriageways of The Northern Road. This would restrict right turn movements to intersections and u-turn bays, which would require motorists to travel further to access these facilities. Overall, this would result in longer travel distances and times for trips for those affected by this change in access. It would also increase traffic along the local roads that provide these turning facilities. This would be necessary as part of the design which includes a solid median along The Northern Road for the length of the project. The median would assist in improving road safety by removing the need for opposing-lane overtaking and the associated risk of head-on crashes. The additional travel distance is considered to be moderate, for those motorists affected by traffic detours, but is not considered to be significant.
- Bus stops would be relocated along The Northern Road. For some passengers, these stops may be closer to their destination, however for others they could potentially be further increasing the distance and time travelled to reach their bus stop, by as much as 650 m. This is necessary to place bus stops at strategic locations along the corridor, coinciding with major intersections to provide safe crossing points for passengers to get to and from bus stops and areas of primary public transport demand. This impact is not considered to be significant.
- Immediately after construction, it is likely that delays along The Northern Road would increase at existing intersections where traffic signals are proposed. These traffic signals would delay vehicles travelling north or south along The Northern Road; however this is unlikely to be the case for vehicles entering or exiting The Northern Road. Over time, as traffic growth is realised, this residual impact of traffic signal installation would decline. This would be necessary to maintain safe and efficient operation of these intersections under the proposed design speed,

geometry and forecast future traffic volumes. This impact is considered to be minor and not significant.

Traffic volumes along The Northern Road through Luddenham town centre are likely to decrease as a result of the project, as the project would provide a faster alternative for vehicles travelling between Eaton Road and Elizabeth Drive. This is a consequence of providing a high speed and high capacity alternative route past Luddenham town centre. This impact is considered to be positive, but is not considered to be significant.

7.2 Noise and vibration

This chapter identifies the noise and vibration impacts from construction and operation of the project. This chapter also recommends environmental management measures to reduce the impacts of the project.

The working paper summarises the Noise and Vibration Assessment (Appendix H) chapter.

Table 7-15 sets out the Secretary's Environmental Assessment Requirements (SEARs) and requirements of the Commonwealth EIS Guideline as they relate to noise and vibration impacts and states where in this EIS these have been addressed.

Table 7-15 Secretary's Environmental Assessment Requirement for noise and vibration

Requirements	Where addressed in the EIS
Secretary's Environmental Assessment Requirements (NSW EP&A Act)	
Noise and Vibration — including: • an assessment of the noise impacts of the proposal during operation, consistent with the Road Noise Policy (DECCW 2011), NSW Industrial Noise Policy (EPA 2000) and relevant guidelines. The assessment must include specific consideration of impacts to receivers (such as, but not limited to, dwellings, child and aged care centres, educational establishments, hospitals, motels, nursing homes, places of worship, or recreation), including specific consideration of sleep disturbance and, as relevant, the characteristics of noise (e.g. low frequency noise), and identify reasonable and feasible mitigation measures;	Section 7.2.6 Appendix H – Noise and vibration Assessment
• an assessment of construction noise and vibration impacts, consistent with the Interim Construction Noise Guideline (DECCW 2009) and Assessing Vibration: a technical guideline (DEC 2006). The assessment must have regard to the nature of construction activities (including transport, tonal or impulsive noise-generating works and the removal of operational noise barriers, as relevant), the intensity and duration of noise and vibration impacts, cumulative effects of construction works undertaken concurrently, the nature, sensitivity and impact to potentially affected receivers, the need to balance timely conclusion of noise and vibration-generating works with periods of receiver respite, and other factors that may influence the timing and duration of construction activities (such as traffic management), and mitigation and management measures;	Section 7.2.5 Appendix H – Noise and vibration Assessment Cumulative noise impacts are addressed Chapter 9

Requirements	Where addressed in the EIS
• if blasting is required, addressing the relevant requirements of Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZECC, 1990); and	Blasting would not be required for the project
• if relevant, an indication of potential for works outside standard working hours, including predicted levels and exceedances, justification for the activity and discussion of available mitigation and management measures.	Section 7.2.8
Commonwealth EIS Guidelines (Commonwealth EPBC Act) Requirements	
Impacts to the environment (as defined in section 528) should include but not be limited to the following: • Road noise and vibration impacts on everyday activities and on sensitive environmental receptors (all sensitive receptors within the community and natural environment). Discussion and quantification/modelling of road noise impacts should include the range and frequency of noise, noise contours, cumulative exposure, peak noise and variations in noise patterns due to seasonal and meteorological factors • Noise and vibration from construction activities and machinery.	• Section 7.2.6 (operational) • Section 7.2.5 (construction) Appendix H – Noise and vibration Assessment

7.2.1 Policy framework and relevant guidelines

This assessment of impact has been prepared in accordance with the following regulatory guidelines:

- Road Noise Policy (RNP) (DECCW, 2011)
- Noise Criteria Guideline (Roads and Maritime Services, 2015)
- Noise Mitigation Guideline (Roads and Maritime Services, 2015)
- Model Validation Guideline (Roads and Maritime Services 2016)
- Industrial Noise Policy (NSW EPA, 2000)
- Procedure: Preparing an operational traffic and construction noise and vibration assessment report (RTA, 2011)
- Environmental Noise Management Manual (Roads and Maritime Services, 2001)
- Calculation of Road Traffic Noise (UK Department of Transport, 1988)
- Construction Noise and Vibration Guideline (Roads and Maritime Services, 2016)
- Interim Construction Noise Guideline (ICNG) (Department of Environment and Climate Change NSW, 2009)
- Assessing Vibration: a technical guideline (DEC, 2006)
- AS1055 Acoustics - Description and measurement of environmental noise (Standards Australia, 1997)

- AS IEC 61672.1—2004 - Electroacoustics—Sound level meters, Part 1: Specifications (Standards Australia, 2004)
- BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2 (BSI, 1993)
- DIN 4150:Part 3-1999 Structural vibration - Effects of vibration on structures (Deutsches Institute fur Normung, 1999).

7.2.2 Assessment methodology

The assessment methodology for noise and vibration impacts involved:

- Identifying the study area including:
  - Identification and classification of sensitive receivers. Receivers were classified using a combination of recent aerial and ground photography, web based information sources, cadastral data (government database) and field work
  - Grouping noise receivers into Noise Catchment Areas (NCA). This grouping is directed by procedures in the Interim Construction Noise Guideline (ICNG) and is primarily based on the measured background noise levels, types of receivers in the area and potential noise impacts from localised construction activities.
- Background noise monitoring to identify existing noise levels. Background noise is measured a multiple locations throughout the study area using calibrated, industry standard, type 1 noise loggers. The noise loggers measure for a period of at least one week to obtain an average noise level applicable to the day, evening and night-time periods
- Validation of noise models using data from concurrent background noise and traffic surveys. The noise and traffic data are combined and compared through a detailed 3D noise model. Variations between the model and the measured parameters are compared using the RMS Model Validation Guideline. Using the validated model with project specific traffic data provides operational noise predictions that satisfy the guideline tolerances
- Modelling of operational noise, and construction noise and vibration. Operational noise is modelled and predicted using project specific traffic data verified by the project traffic engineering consultants. Construction noise is modelled and predicted using construction sound power levels as per the RMS Construction Noise and Vibration Guideline and construction scenarios which assume worst-case scenarios for construction activities: sources operating concurrently, minimum offset distances between source and receiver and no mitigation measures
- Assessment of those noise predictions against relevant construction and operational noise criteria. For construction, the guidelines are the EPA Interim Construction Noise Guideline (ICNG) and the RMS Construction Noise and Vibration Guideline (CNVG). For operational noise the applicable guidelines are the EPA Road Noise Policy and the RMS Noise Criteria Guidelines (NCG)
- Identification of mitigation measures for any operational noise impacts identified as per the RMS Noise Mitigation Guideline (NMG)
- Identification of feasible and reasonable environmental management measures. The Interim Construction Noise Guideline (Department of Environment and Climate Change (DECC) 2009) (ICNG) defines ‘feasible’ and ‘reasonable’ as:
  - Feasible: A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements
  - Reasonable: Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the cost of applying.

The study area and noise and vibration sensitive receivers

Table 7-16 summarises the number and type of the noise and vibration sensitive receivers within the 600 m study area. These are the habitable buildings and parks that may potentially be impacted by noise or vibration from construction or operation of the project. The counts provided relate to the number of receivers included within the construction noise study area specifically. The operational noise study area is a smaller subset of this wider study area, primarily as it does not extend beyond the northern and southern extents of the road project, and extends only to 600 m from the project (other than where receivers at which the Relative Increase Criterion may be triggered. These receivers have been identified from aerial photography, GIS databases and information gathered from site visits.

Table 7-16 Summary of noise sensitive receivers considered in this assessment

Receiver type	Number of buildings
Residential properties	1306
Commercial properties	23
Educational buildings	10
Places of worship	4
Outdoor recreational areas	4
Industrial buildings	2
TOTAL	1349

Noise Catchment Areas

Receivers are grouped into Noise Catchment Areas (NCAs) to enable a logical grouping of receivers affected by the same works to assist with the assessment, consultation or notification. The NCA's used in this assessment are detailed in Table 7-17 and indicated in Figure 7-2.

NCA boundaries were determined by considering:

- Factors affecting how construction noise would propagate into a given area (eg topography and screening by buildings)
- The level of background noise in that area
- The type(s) of receivers within that area (eg residences, commercial or industrial premises etc.)
- The grouping of receivers into bands of similar construction noise impact.

Table 7-17 Noise Catchment Areas used in this assessment

NCA	Description
NCA 1	Properties in suburban Glenmore Park and semi-rural Orchard Hills (north) at which background noise is determined by traffic conveyed on The Northern Road, Glenmore Parkway and the M4 Motorway

NCA	Description
NCA 2	Semi-rural properties located between Bradley Street, Glenmore Park and Elizabeth Drive, Luddenham at which background noise is determined by traffic on The Northern Road
NCA 3	Semi-rural properties located near the junction between The Northern Road and Elizabeth Drive in Luddenham, at which background noise is determined by traffic on The Northern Road and Elizabeth Drive
NCA 4	Semi-rural properties east of Luddenham, presently removed from major roads. Background noise is determined by rural noise sources
NCA 5	Properties in suburban Luddenham and its semi-rural surrounds. Existing background noise to these receivers results from traffic on The Northern Road
NCA 6	Semi-rural properties in Badgerys Creek at which background noise is determined by traffic on The Northern Road
NCA 7	Semi-rural properties located adjacent to new section of the project with minimal exposure to traffic noise on The Northern Road
NCA 8	Semi-rural properties in Greendale and Bringelly at which background noise is determined by traffic on The Northern Road

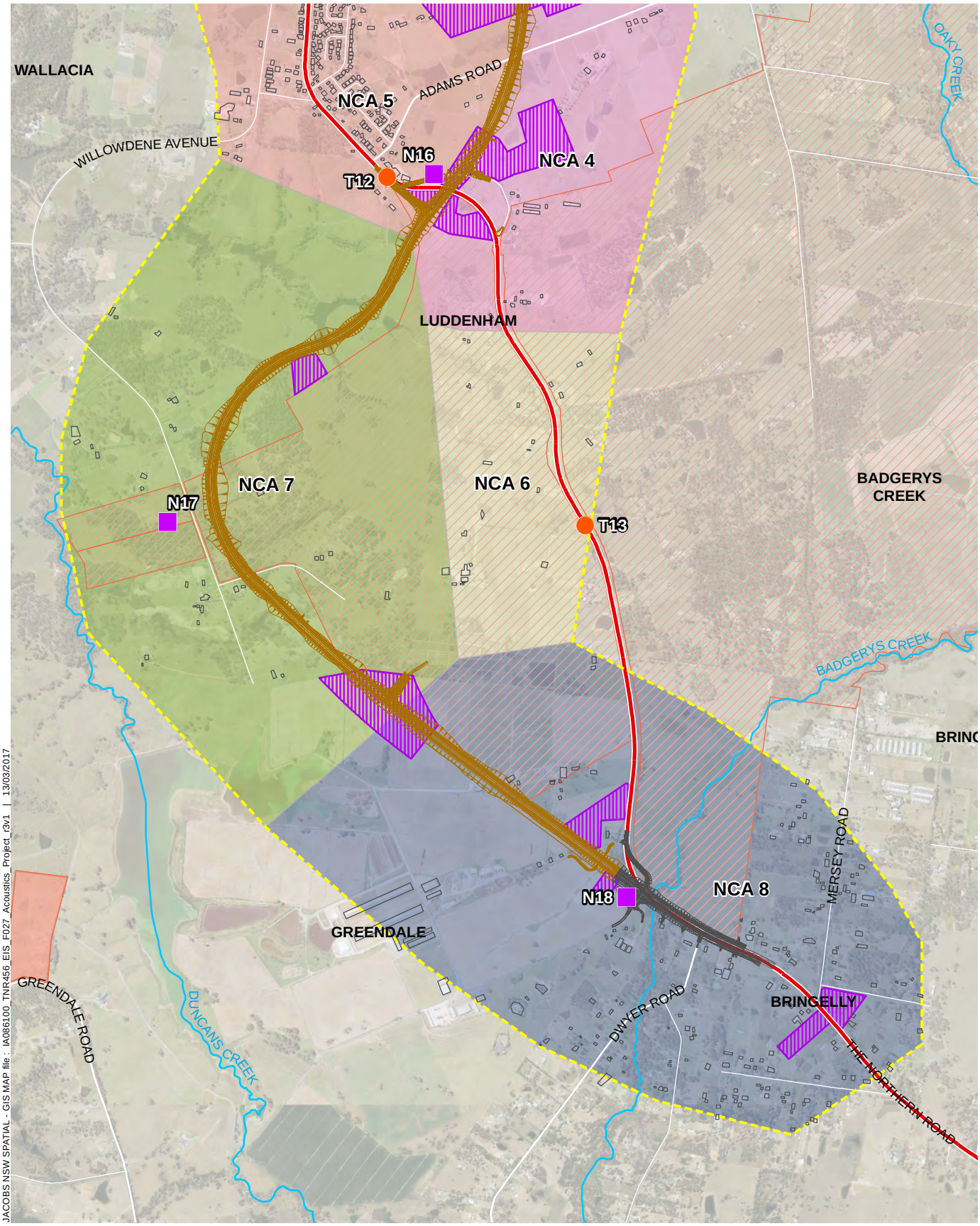


Figure 7-2 | Project context indicating sensitive receivers, noise monitoring and traffic count locations

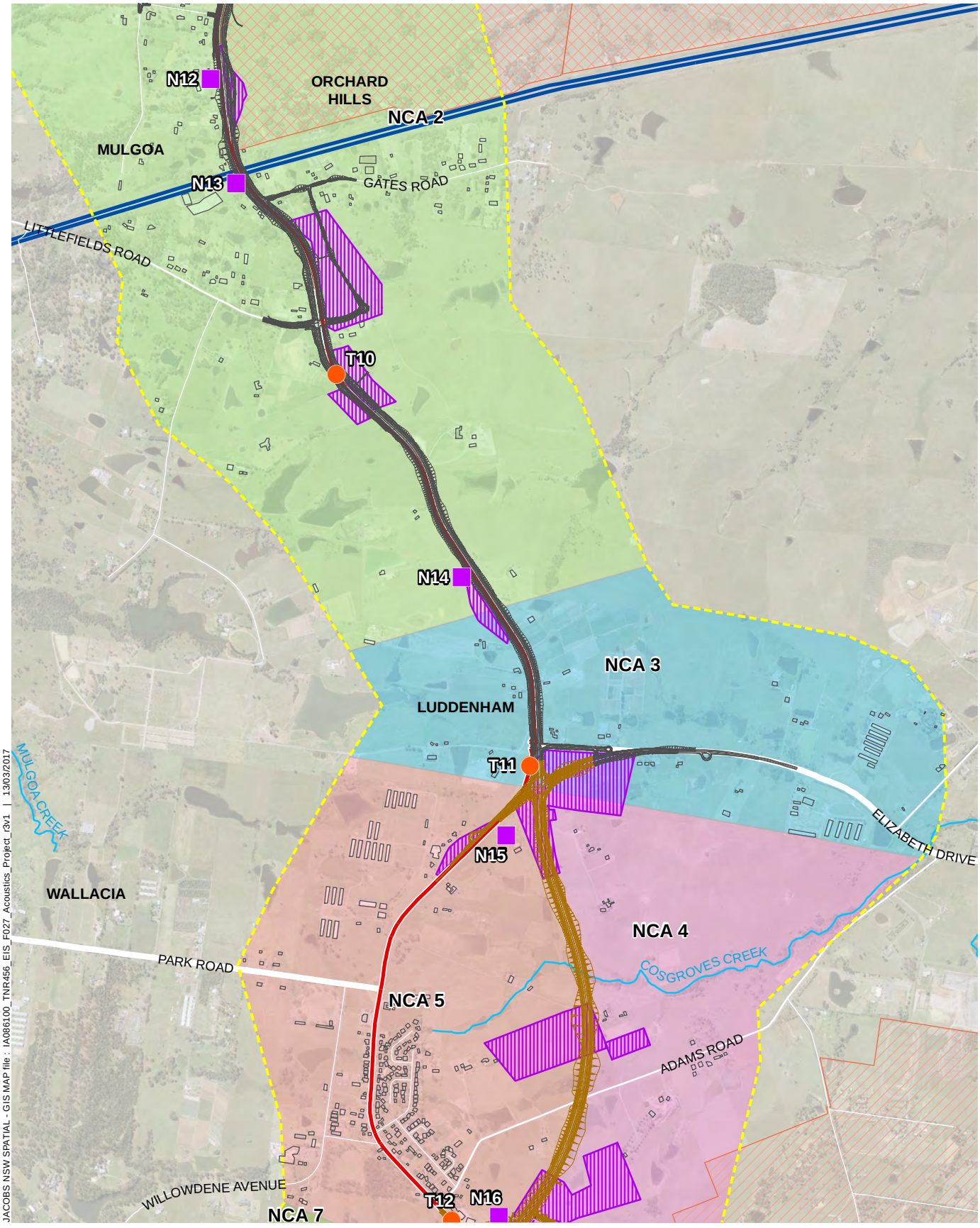


Figure 7-2 | Project context indicating sensitive receivers, noise monitoring and traffic count locations

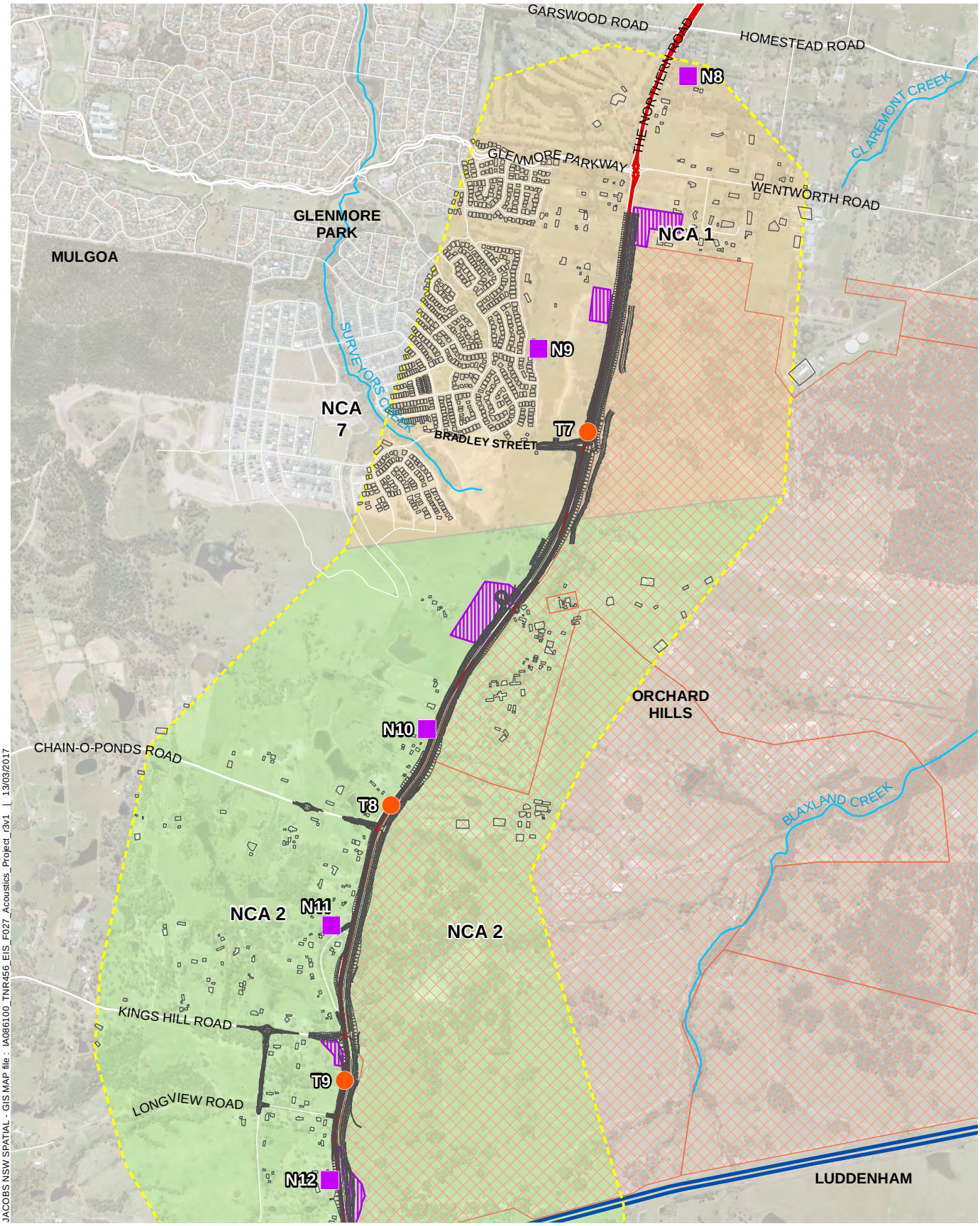


Figure 7-2 | Project context indicating sensitive receivers, noise monitoring and traffic count locations

7.2.3 Criteria

Construction noise and vibration criteria

The effects of construction noise on the community relate to the type, timing and duration of the works, existing background noise level, and the intensity and character (eg, whether a constant or impulsive noise) of the noise from the works. This section outlines the assessment of noise from construction of the project in accordance with the Roads and Maritime Construction Noise and Vibration Guideline (CNVG), the Roads and Maritime application of the Interim Construction Noise Guideline (ICNG). Where impact is predicted, "reasonable and feasible" noise mitigation is outlined in Section 7.2.8.

The following noise and vibration assessment criteria are relevant to the construction of the project:

- Noise Management Levels (NML's) applied to the assessment of surface construction activities and construction sites
- Sleep disturbance criteria applied to the assessment of construction activities that may be carried out during the night-time (10pm to 7am)
- Construction traffic noise criteria
- Construction vibration criteria.

Construction noise management levels

The CNVG specifies that each sensitive receiver potentially impacted by construction of the project be assigned a Noise Management Level (NML) which is defined by the ICNG's noise goals.

For residential receivers, the NMLs are defined as an allowable emergence above the Rating Background Level (RBL). The RBL for each NCA have been conservatively determined from the lowest measured representative background noise data for the area. Where the night-time background monitoring was found to be influenced by extraneous noise sources (eg, noise from insects), RBLs were determined from the monitoring data of nearby and similarly located noise loggers. Non-residential receivers are assigned fixed-value NML's.

The CNVG requires that all feasible and reasonable mitigation measures be applied where construction noise is predicted to exceed the NML.

Table 7-18 outlineshow NMLs are determined for residential receivers potentially impacted by noise from construction of the project.

Table 7-18 also outlines how receivers that may be 'highly noise affected' by the project's construction works may be identified. In such instances, restrictions to construction hours may apply to minimise these impacts.

Table 7-18 Construction Noise Management Levels for residential receivers

Time of day	Noise Management Level (NML) $L_{Aeq(15\ min)}$*	How to apply
Recommended standard hours Monday to Friday 7.00am to 6.00pm Saturday	Noise affected (RBL + 10dB(A))	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and the duration, as well as contact

Time of day	Noise Management Level (NML) $L_{Aeq(15\ min)}$*	How to apply
8.00am to 1.00pm No work on Sundays or public holidays		details.
	Highly noise affected (75 dB(A))	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected (RBL + 5dB(A))	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see Section 7.2.2 of the ICNG (DECC, 2009).

Source: Interim Construction Noise Guideline (DECC 2009)

The following NML's apply for non-residential receivers:

- Industrial premises: external LAeq(15min) 75 dB(A)
- Offices, retail outlets: external LAeq(15min) 70 dB(A)
- Classrooms: internal LAeq(15min) 45 dB(A)
- Places of worship: internal LAeq(15min) 45 dB(A)
- Active recreational areas; external LAeq(15min) 65 dB(A)

Sleep disturbance screening criterion

The assessment of the potential for sleep disturbance within residences from night-time construction works is taken from the Interim Construction Noise Guideline (ICNG), which prescribes the following sleep disturbance "screening criterion":

LAmax ≤ LA90(15min) + 15dB(A)

This screening criterion indicates that sleep disturbance may be possible where the LAmax maximum noise level from construction exceeds the background noise level by more than 15 dB(A). Where this screening criterion is not met, more detailed analysis is required at the detailed design stage.

Project specific construction noise management levels

The construction NMLs and sleep disturbance screening criterion for residential receivers adopted in this assessment are summarised in Table 7-19. As a conservative measure, the lowest of all RBLs within any one NCA has been used to determine the NML.

Table 7-19 Construction Noise Management Levels (NMLs) and sleep disturbance criteria

NCA	Monitored or determined RBL dB(A)				Noise Management Level (NML) $L_{Aeq(15\ minute)}$ dB(A)				Sleep disturbance screening criterion L_{Amax} dB(A) (RBL+15dB)
					Standard hours (RBL+10dB)	Out-of-hours (OOH) (RBL+5dB)			
	Standard hours	OOH Day	OOH Evening	OOH Night	Day	Day	Evening	Night	
1	48	51	49	44	58	56	54	49	59
2	47	48	43	36	57	53	48	41	51
3	46	53	46	35	56	58	51	40	50
4	37	38	38	37	47	43	43	42	52
5	42	44	43	34	52	49	48	39	49
6	42	44	43	34	52	49	48	39	49
7	37	38	38	37	47	43	43	42	52
8	48	53	47	42	58	58	52	47	57

* Out-of-hours periods refers to Saturday 1pm-6pm

The NML for each non-residential receiver within the study area is detailed in Table 7-20.

Table 7-20 Non-residential receivers within project area

Non Residential Receiver	No. of buildings	Land Use	NCA	NML* $L_{Aeq(15\ minute)}$ dB(A)
Penrith Anglican College	4	Educational	1	45 (Internal)
Luddenham Public School	5	Educational	5	45 (Internal)
Holy Family Catholic Primary School	1	Educational	5	45 (Internal)
St James Anglican Church	1	Place of Worship	5	45 (Internal)
Sacred Heart Parish	1	Place of Worship	5	45 (Internal)
Luddenham Uniting Church	2	Place of Worship	5	45 (Internal)
Glenmore Ridge Dr Park	N/A	Active Recreation	1	65
Sales Park	N/A	Active Recreation	5	65
Willmington Reserve	N/A	Active Recreation	5	65
Luddenham Showground	N/A	Active Recreation	5	65
Penrith Golf and Recreation Club	3	Commercial	1	70
Produce Direct and Pet Care	3	Commercial	1	70
Orchard Hills Veterinary Hospital	1	Commercial	1	70
Horse N Around	3	Commercial	2	70
The Honey Shed	1	Commercial	3	70
Sydney Society of Model Engineers	1	Commercial	3	70
Caltex Service Station	2	Commercial	5	70
Quality Meats Butcher	1	Commercial	5	70
2903 The Northern Road, Luddenham	1	Commercial	5	70
Luddenham Auto Repairs	1	Commercial	5	70

Non Residential Receiver	No. of buildings	Land Use	NCA	NML* $L_{Aeq(15\ minute)}$ dB(A)
Ali's Bakery	1	Commercial	5	70
Shell Service Station	1	Commercial	5	70
IGA	3	Commercial	5	70
David's Stall Fruit and Veg	1	Commercial	5	70
Luddenham Progress Hall	1	Commercial	5	70
Board my Paws	1	Commercial	8	70
Water Filtration Plant	1	Industrial	1	75
Power Station 2552 The Northern Road	1	Industrial	2	75
Luddenham Showground	1	Stables	23	N/A
2042-2550 The Northern Road, Orchard Hills	81	Military	2	N/A

* When in use

Construction traffic noise criteria

The assessment of noise impact arising from construction vehicles on public roads (as opposed to when they operate within a construction site) is assessed in accordance with the CNVG, which states that where construction traffic would not increase existing traffic noise levels by more than 2 dB(A), then no further assessment is required. Where the increase in existing traffic noise due to construction traffic is predicted to be greater than 2 dB(A) then further assessment using the NCG is required.

Vibration criteria - preservation of human comfort

Vibration from construction activities should comply with the EPA vibration guideline and AS2670.2 (DEC 2006). The NSW EPA classifies vibration as one of three types:

- Continuous – Where vibration occurs uninterrupted and can include sources such as machinery and constant road traffic;
- Impulsive – Where vibration occurs over a short duration (typically less than 2 seconds) and occurs less than three times during the assessment period, which is not defined. This may include activities such as occasional dropping of heavy equipment or loading / unloading activities;
- Intermittent – Occurs where continuous vibration activities are regularly interrupted, or where impulsive activities recur. This may include activities such as rock hammering, drilling, pile driving and heavy vehicle or train pass-bys.

Maximum and preferred values for continuous and impulsive vibration are defined in Table 7-21. Application of the criteria considers the level as well as the duration of exposure and the time of day, and similar to the noise criteria, also has separate values for residential and non-residential receivers.

Table 7-21 Preferred and maximum weighted Roads and Maritime values for continuous and impulsive vibration acceleration (m/s2) 1-80 Hz

Location	Assessment period	Preferred values		Maximum values	
		z-axis	x and y axis	z-axis	x and y axis
Continuous vibration					
Critical areas[2]	Day or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
Workshops	Day or night-time	0.04	0.029	0.080	0.058
Impulsive vibration					
Critical areas[2]	Day or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92
Daytime is 7.00am to 10.00pm and night-time is 10.00pm to 7.00am Such as hospital operating theatres or precision laboratories.					

Intermittent vibration impact may be present when continuous vibration sources operate sporadically throughout the assessment period. This type of impact is assessed using vibration dose values (VDVs). The VDV method is more sensitive to peaks in the acceleration waveform and makes corrections to the criteria based on the duration of the source's operation. The VDV is calculated using the overall weighted Roads and Maritime acceleration of the vibrating source in each orthogonal axis and the duration which the vibration occurs. Preferred and maximum VDVs are defined in Table 7-22.

Table 7-22 Acceptable vibration dose values for intermittent vibration (ms-1.75)

Locations	Daytime (7.00am – 10.00pm)		Night-time (10.00pm – 7.00am)	
	Preferred values	Maximum values	Preferred values	Maximum values
Critical areas[1]	0.10	0.20	0.10	0.02
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60
Includes operating theatres, precision laboratories and other areas where vibration sensitive activities may occur.				

Vibration criteria - structural damage

The OEH vibration guideline does not address the potential for damage to structures. Instead, the Australian Standard AS2187.2-2006 Explosives – Storage, Transport and Use provides guidance for the assessment of structural damage to buildings caused by vibration. This section of the standard is based on the British Standard 7385: Part 2 Evaluation and measurement of vibration in buildings and is used as a guide to assess the likelihood of building damage from ground vibration including piling, compaction, construction equipment and road and rail traffic. The standard recommends levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur based on the type of structure affected.

The standard uses the peak particle velocity (PPV) parameter to quantify vibration and specifies damage criteria for frequencies within the 4 Hz to 250 Hz range for buildings. The criteria levels identified in the standard are outlined in Table 7-23.

Table 7-23 BS 7385 Structural damage criteria

Group	Type of structure	Peak particle velocity (PPV) - mm/s		
		4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	15 to 20	20 to 50	50

The levels for structural damage outlined in the standard refer to non-continuous vibration sources and are considered 'safe limits' up to which no damage due to vibration effects are expected to occur for the various building types. Where vibration is continuous these levels may be reduced by up to 50 per cent and additional assessment against the standard would be necessary.

Where heritage structures are impacted, the German DIN Standard 4150-3 Structural Vibration, Part 3: Effects of Vibration on Structures can be used for guidance. This standard recommends guideline values for short-term vibration impact on heritage structures and have been summarised in 7-24.

Table 7-24 DIN 4150-3 Vibration guidelines for heritage buildings

Type of structure	Guideline values for velocity - mm/s			
	Vibration at the foundation at a frequency of			Vibration at the horizontal plane of the highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	
Heritage buildings	3	3 – 8	8 – 10	8

Operational noise criteria

Operational noise refers to the noise from traffic using the road once it is opened to the public – the 'operational' phase of the project. The potential for operational noise impacts is assessed against the RMS Noise Criteria Guideline (NCG) which describes the Roads and Maritime implementation of the Road Noise Policy (RNP).

A residence may be assigned new road, redeveloped road, transition zone or relative increase criteria depending on how the project would influence noise levels.

Under this project a new road is defined as a bypass road where the road extends beyond the existing road corridor. In this project the bypass around Luddenham is assessed as a new road. Receivers adjacent to the new section of road are assigned new road criteria: 55 dB(A) during the daytime and 50 dB(A) during the night-time.

A redeveloped road is when a road is upgraded by widening and or duplication to increase its traffic carrying capacity. Receivers adjacent to the redeveloped sections of road are assigned redeveloped road criteria: 60 dB(A) during the daytime and 55 dB(A) during the night-time.

Where new and redeveloped roads meet a criteria transition zone is required to described the change between the new and redeveloped criteria. The transition zone describes a linear, propagation based change between the two criteria in 1 dB steps. Receivers in the transition zone are assigned the lowest transition criteria affecting the property.

An additional test - known as the relative increase criteria is applied to protect residences within quiet areas from large (more than 12 dB(A)) increases in noise due to the project. For the purposes of assessment against the NCG, the project is a redeveloped road except for the following two new road segments:

- The Luddenham bypass between Dwyer Road in the south and Elizabeth Drive in the north;
- The upgraded Elizabeth Drive approach lanes which "substantially realign" the existing approach lanes.

The project includes transition zones at:

- The junction of the redeveloped road and new bypass road segments 400 m north-west of Dwyer Road, Greendale
- The junction of the redeveloped road and new bypass road segments immediately south of Elizabeth Drive
- The interface of the redeveloped and new segments of the Elizabeth Drive approach to the project.

Further detail on NCG transition zones and NCG controlling criteria type (ie new, redeveloped, transition zone or relative increase criteria) attributed to each residential receiver as part of this assessment are provided Appendix H. This was used to determine the noise assessment criteria for residential receivers as summarised in 7-25.

Table 7-25 NCG noise criteria for residences

Road category	Type of project/land use	Assessment Criteria	
		Daytime (7am-10pm)	Night-time (10pm-7am)
Freeway/arterial/ sub-arterial roads	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	55 dB(A) LAeq (15hour) (external)	50 dB(A) LAeq (9hour) (external)
	Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	60 dB(A) LAeq (15hour) (external)	55 dB(A) LAeq (9hour) (external)
	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments		
	Existing residences affected by increases in traffic noise of 12 dB(A)or more from new freeway/arterial/sub-arterial roads	Existing LAeq (15hour) (external) + 12 dB(A) [capped at 55 dB(A)]	Existing LAeq (9hour) (external) + 12 dB(A) [capped at 50 dB(A)]
	Existing residences affected by increases in traffic noise of 12 dB(A)or more from redeveloped freeway/arterial/sub-arterial roads	Existing LAeq (15hour) (external) + 12 dB(A) [capped at 60 dB(A)]	Existing LAeq (9hour) (external) + 12 dB(A) [capped at 55 dB(A)]
Local roads	Existing residences affected by noise from new local road corridors Existing residences affected by noise from redevelopment of existing local roads	55 dB(A) LAeq (1hour) (external)	50 dB(A) LAeq (1hour) (external)

Noise criteria for non-residential land uses are presented in Table 7-26 .

These criteria are based on the level of impact, below which, normal operations or use can continue with minimal interruption or disturbance. These criteria are applied in the assessment of eligibility of residences for mitigation where predicted operational noise levels exceed these criteria. This is father discussed in Appendix H, the outcomes of which are summarised in Section 7.2.6.

No motels, aged care facilities or hospital wards were identified within the study area of this assessment.

Table 7-26 NCG noise criteria for non-residential land uses

Existing sensitive land use	Assessment criteria dB(A)		Additional Considerations
	Day (7 a.m.–10 p.m.)	Night (10 p.m.–7 a.m.)	
School classrooms	40 $L_{Aeq,1hour}$ (internal) when in use	–	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000).
Places of Worship	40 $L_{Aeq,1hour}$ (internal)	40 $L_{Aeq,1hour}$ (internal)	The criteria are internal, ie the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what is in these areas that may be affected by road traffic noise.
Open space (active use)	60 $L_{Aeq,15hour}$, (external) when in use	–	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion. Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, eg playing chess, reading. For areas where there may be a mix of passive and active recreation, eg school playgrounds, the more stringent criteria apply. Open space may also be used as a buffer zone for more sensitive land uses.

Assessing potential for sleep disturbance

Roads and Maritime's Environmental Noise Management Manual (ENMM) Practice Note iii indicates that:

- Maximum internal noise levels below 50–55 dB(A) are unlikely to cause awakening reactions, and
- One or two noise events per night with maximum internal noise levels of 65–70 dB(A) are not likely to significantly affect health and wellbeing.

Given the that it is generally accepted that the level of traffic noise within a dwelling having its windows open is 10 dB(A) lower than the corresponding noise level immediately outside the facade (refer ICNG), these internal noise goals may be re-expressed as external noise goals as follows:

- Maximum external noise levels below 60–65 dB(A) are unlikely to cause awakening reactions, and
- One or two noise events per night with maximum external noise levels of 75-80 dB(A) are not likely to significantly affect health and wellbeing.

A "maximum noise event" is defined as any vehicle pass-by for which

- LAmax – LAeq(1 hour) ≥ 15 dB(A)

Practice Note iii states that the maximum noise level assessment should be used as a tool to help prioritise and rank mitigation strategies, but should not be applied as a decisive criterion in itself.

7.2.4 Existing environment

Presently, daytime and night-time ambient noise within the study area is determined by traffic conveyed on the existing The Northern Road, and secondarily, on adjoining roads such as the M4 Western Motorway and Elizabeth Drive.

The existing (or baseline) noise environment was established by carrying out long-term, unattended noise surveys along the study corridor to determine the existing level of background noise at all receivers potentially affected by the project. These monitoring results are also used to establish construction noise parameters.

Traffic count surveys were undertaken concurrently with the long term unattended noise monitoring surveys. The traffic data and average traffic speeds collected during the tube counts are detailed in Appendix H. These traffic counts have been used only for the specific purpose of calibrating the noise model and do not form part of the traffic modelling undertaken for the project's traffic and transport assessment as outlined in Section 7.1. The locations in which background noise monitoring surveys and traffic count surveys were carried out are shown on Figure 7-2.

Background noise level data have been used to determine the RBL, which are used to define the NML's) in accordance with the Interim Construction Noise Guideline. The noise surveys were also used to determine the existing daytime (15 hour) and night-time (9 hour) traffic noise levels, which were also used to validate the noise model.

The results of unattended noise monitoring are presented in Table 7-27 and Table 7-28.

Analysis of audio recordings of the ambient noise sources present during the background noise monitoring indicated the presence of insect noise during night periods at some monitoring locations. Given that insects may not be present during winter months, further analysis was undertaken to ensure noise contributed by insects was excluded when determining the true background noise level. Where this was not possible, background noise levels were conservatively estimated from comparable logger locations.

Table 7-27 Unattended monitoring results (Construction noise parameters)

Traffic count location	Location	Monitored noise level dB(A)			Typical LAmax noise levels from environmental noise sources dB(A)[1]
		RBL	L_{Aeq}	L_{Amax}	
Daytime					
N9	2095/2113 The Northern Road, Glenmore Park	48	55	64	HV intermittent (60), LV constant (55),
N10	2289 / 2293 The Northern Road, Mulgoa	46	61	75	HV frequent (70-75) LV constant (60-65)
N11	1 Grover Crescent, Mulgoa	47	55	69	HV frequent (55-60), LV common (50)
N12	2519 / 2527 The Northern Road, Mulgoa	48	62	74	HV including idling (65-75), LV constant (50-55)
N13	2567 The Northern Road, Mulgoa	48	61	76	HV common (65-80) LV constant (55-60),

Traffic count location	Location	Monitored noise level dB(A)			Typical LAmax noise levels from environmental noise sources dB(A)[1]
		RBL	L_{Aeq}	L_{Amax}	
N14	2785 The Northern Road, Luddenham	46	61	72	HV frequent (70-80), LV frequent (55-60)
N15	2426 The Northern Road, Luddenham	37	54	67	Distant traffic constant (40), HV occasional (50-55)
N16	18 Eaton Road, Luddenham	42	56	70	LV occasional (40-45), Trucks occasional (<75)
N17	295 Willowdene Avenue, Luddenham	37	47	65	Distant traffic
N18	1675 The Northern Road, Greendale	48	59	72	HV occasional (<75) LV common (50)
Evening					
N9	2095/2113 The Northern Road, Glenmore Park	49	55	62	Motorbikes (70-75) HV infrequent (55-65), LV (55)
N10	2289 / 2293 The Northern Road, Mulgoa	44	58	72	HV frequent (65-75) LV frequent (60)
N11	1 Grover Crescent, Mulgoa	43	55	65	HV frequent (60-70), LV frequent (50-55), residential noise infrequent (70)
N12	2519 / 2527 The Northern Road, Mulgoa	43	58	72	LV frequent (50-55), HV frequent (65-70), Motorbike occasional (70-75), residential noise (55-60)
N13	2567 The Northern Road, Mulgoa	44	58	73	HV frequent (70-80) LV occasional (55-60)
N14	2785 The Northern Road, Luddenham	46	56	68	HV occasional (<90), residential noise (50), LV infrequent
TN15	2426 The Northern Road, Luddenham	35	43	56	HV (55), LV constant (35-40)
N16	18 Eaton Road, Luddenham	43	57	68	Infrequent LV (55), HV (<75)
N17	295 Willowdene Avenue, Luddenham	38	45	59	

Traffic count location	Location	Monitored noise level dB(A)			Typical LAmax noise levels from environmental noise sources dB(A)[1]
		RBL	L_{Aeq}	L_{Amax}	
N18	1675 The Northern Road, Greendale	47	58	68	HV (<75), LV (55-50)
Night-time					
N9	2095/2113 The Northern Road, Glenmore Park	44	54	60	HV occasional (50-60) LV intermittent (50-55),
N10	2289 / 2293 The Northern Road, Mulgoa	33	58	71	HV (65-75), LV common (55-60)
N11	1 Grover Crescent, Mulgoa	36	50	61	HV infrequent (55-60)
N12	2519 / 2527 The Northern Road, Mulgoa	38	56	68	HV occasional (65-70) LV infrequent (60)
N13	2567 The Northern Road, Mulgoa	36	56	71	HV occasional (75), LV infrequent (55)
N14	2785 The Northern Road, Luddenham	35	54	67	HV frequent (<75) LV infrequent (55)
N15	2426 The Northern Road, Luddenham	36	45	53	LV infrequent (35-40), infrequent HV (50-55)
N16	18 Eaton Road, Luddenham	34	55	66	Occasional HV idling (65-70)
N17	295 Willowdene Avenue, Luddenham	37 **	46	54	Local traffic (65)
N18	1675 The Northern Road, Greendale	42	54	67	HV (<75), LV (55-60)

1. HV Heavy Vehicles, LV Light Vehicles

Table 7-28 Unattended noise monitoring results (Traffic noise parameters)

Traffic count location	Site	LAeq (15hour)	LAeq (9hour)	LAmax (15hour)	LAmax (9hour)
N9	2095/2113 The Northern Road, Glenmore Park	55	54	64	61
N10	2289 / 2293 The Northern Road, Mulgoa	61	58	74	72
N11	1 Grover Crescent, Mulgoa	55	50	67	63
N12	2519 / 2527 The Northern Road, Mulgoa	60	56	74	69

Traffic count location	Site	LAeq (15hour)	LAeq (9hour)	LAmax (15hour)	LAmax (9hour)
N13	2567 The Northern Road, Mulgoa	61	56	75	72
N14	2785 The Northern Road, Luddenham	61	54	71	67
N15	2426 The Northern Road, Luddenham	53	45	65	56
N16	18 Eaton Road, Luddenham	56	55	69	67
N18	1675 The Northern Road, Greendale	59	54	70	68

7.2.5 Assessment of potential construction impacts

Construction noise modelling

Prediction of construction noise levels at sensitive receivers was modelled using the Soundplan (Version 7.3) noise modelling software based on the ISO9613 prediction algorithm. This three-dimensional model accounts for noise source and receiver locations, ground and air absorption as well as any acoustic shielding provided by intervening topography and structures.

The sound power level adopted for each item of plant and equipment in the modelling of construction noise is indicated in Table 7-29. The schedule of plant and equipment to be used would be confirmed with the final construction program. Predictions of construction noise impact consider, variously, each works stage running concurrent with all 21 ancillary facilities operating simultaneously.

Table 7-29 also indicates the periods of exposure to any particular activity any one receiver may expect. These periods would vary according to a receiver's set back and line of view to the works between buildings.

Table 7-29 Plant sound power levels used in the modelling of construction noise

Construction phase	Typical plant and equipment	Sound Power Level dB(A) $L_{Aeq(15min)}$
Early Works (indicative time of exposure to any one receiver: 2-6 weeks)	Truck mounted crane Light vehicles Excavator Generator Bobcat Dump trucks	104 88 109 101 104 111
Earthworks (indicative time of exposure to any one receiver: 4-12 weeks)	Excavator Dump trucks Vibratory roller (20-30T) Light vehicles Bulldozer Grader Water cart Bobcat	109 114 110 * 88 112 112 107 104

Construction phase	Typical plant and equipment	Sound Power Level dB(A) $L_{Aeq(15min)}$
Road work (indicative time of exposure to any one receiver: 2-12 weeks)	Excavator Bulldozer Water cart Grader Dump truck Spray sealing equipment Concrete truck and pump Asphalt paver (plus truck) Concrete saw Vibratory roller (20-30T) Franna crane Slip-forming machine	109 112 107 112 111 103 108 108 114 110 * 99 102
Bridge construction (indicative time of exposure to any one receiver: 12-26 weeks)	Excavators Light vehicles Generator Rock breaker Concrete trucks and pump Welding equipment Mobile crane Impact piling Oxy-cutting equipment	109 88 101 126 * 108 105 104 121 * 98
Drainage work (indicative time of exposure to any one receiver: 2-12 weeks)	Excavator Light vehicles Generator Jackhammer Concrete truck and pump Truck mounted crane Vibratory roller (20-30T)* Bored piling Bobcat	109 88 101 118 * 108 104 110 112 104
Paving (indicative time of exposure to any one receiver: 2-8 weeks)	Excavator Light vehicles Generator Asphalt paver (plus truck) Concrete trucks and pump Concrete saw Vibratory roller (20-30T) Slip-forming machine Truck mounted crane	109 88 101 108 108 119 * 110 * 102 104
Utility Relocation (indicative time of exposure to any one receiver: 2-8 weeks)	Excavator Bored piling Light vehicles Truck mounted crane Generators Dump trucks Plate compactor Concrete trucks and pump	109 112 88 104 101 111 106 108

Construction phase	Typical plant and equipment	Sound Power Level dB(A) $L_{Aeq(15min)}$
Finishing work (indicative time of exposure to any one receiver: 2-8 weeks)	Excavator Generator Light vehicles Dump trucks Concrete trucks and pump Hydromulching equipment Truck mounted crane Water cart Vibratory roller(20-30T) Bobcat Road marking machine Welding equipment	109 101 88 111 108 116 104 107 110 * 104 108 105
Concurrently operating Ancillary Facilities		
Ancillary Facilities	Front end loader Excavator Road truck Compressor Welding equipment Light vehicles Generator	112 109 108 109 105 88 101
Ancillary Facilities C5 and C8 (each incorporating a pugmill)	Front end loader Excavator Road truck Compressor Welding equipment Light vehicles Generator Pugmill*	112 109 108 109 105 88 101 110

* Note: these levels include a 5dB(A) penalty for annoying noise characteristics

Predicted construction noise impacts

Construction noise impacts have been assessed based on the indicative timeframes and staging of works as presented in Chapter 5, which also outlines the justification for works outside standard hours in Section 5.4.14.

Due to the nature of construction works, impacts during construction are generally considered to be short-term, where construction noise levels at any receiver would reduce as works progress away from a receiver. This increases where receivers are located next to ancillary facilities impacting the same receiver for a longer period of time. However for the most part, construction noise impacts are considered short-medium term.

As a conservative approach, noise modelling has assumed that all 21 ancillary facilities (as outlined in Chapter 5) would operate simultaneously for the entire duration of the construction program. Noise modelling has also considered the noise impacts that may arise from the operation of ancillary facilities alone. This allows for the assessment of worst case impacts, as well as any longer term impacts arising from the operation of ancillary facilities even once mainline road works have moved beyond a sensitive receiver.

Construction of the project would be contained to standard construction hours where it is feasible and reasonable to do so. However, some works would likely need to be undertaken during evening, night or weekend periods as required to ensure safe work practices or to avoid unacceptable impacts on traffic and disruptions to the road network (refer to Chapter 5). Two construction activities have been assessed for out-of-hours work, namely bridgeworks and paving. Bridgeworks

is confined to Adams Road bridge, while paving would occur at tie-ins, cross overs, and any sections of The Northern Road that is under traffic.

The predicted L_{Aeq} noise level from all standard hours (daytime) and out-of-hours (Saturday afternoons, evenings and nights) construction works is presented in full for each receiver in Appendix H. This includes noise contours and NML exceedances at receivers predicted to result from the two loudest out-of-hours work scenarios being night-time paving and bridge works.

All predictions are based on the assumption that the standard project-specific noise mitigation measures are applied as outlined in Section 7.2.8. In instances where after the application of standard noise mitigation measures there still remain receivers at which NMLs are exceeded (as summarised in the table below), the CNVG directs that the project should consider implementing the additional mitigation measures detailed in Appendix C of the CNVG where feasible and reasonable. These are summarised in Appendix H and should be considered in the application of management measures during construction.

A summary of potential impacts to receivers grouped per NCA is presented in Table 7-30 for impacts during standard hours and Table 7-31 for impacts outside standard hours. These tables indicate the worst case construction noise levels predicted for the least and most affected residences and also indicate the count of residences at which the NML is exceeded.

In summary, during standard hours works, it is predicted that:

- The NML will not be exceeded at any time for most receivers (>60 per cent) within NCAs 1, 6 and 8
- Across the entire study area, noise from even the loudest works will comply with the NML at 80 per cent of all residences
- Of all works scenarios, road works and paving are expected to generate the greatest number of NML exceedances at residences, which are mostly located in NCAs 1, 2 and 5
- The highest NML exceedances are predicted to occur at residences within NCA 2
- At 195 residences (11 per cent of all residences) within the study area the worst case exceedance of the NML from any standard hours works would be 10 dB(A) or less. At such times of peak impact, construction noise would be clearly audible
- At 118 residences within the study area (7 per cent) the worst case exceedance of the NML would be between 10-20 dB(A). At such times of peak impact, construction noise would be moderately intrusive
- At 29 residences within the study area (2 per cent) the worst case exceedance may be more than 20 dB(A). At such times of peak impact, construction noise would be highly intrusive
- At times of the loudest works (road works and paving) 39 residences are predicted to be highly noise affected (noise levels > 75dB(A)). Fewer residences would be highly noise affected during quieter works (eg, 0 residences during bridge works). NCA 2 is predicted to have the highest number of highly noise affected receivers (25 during paving works)
- Within most NCAs, it is expected that noise from the nearest ancillary facility (in isolation of noise from any other mainline works) may exceed the NML by up to 10 dB(A) at a small number of receivers (up to 12 receivers within NCA 5) when that facility is operating at peak capacity. Additionally, one receiver in each of NCA 4 and NCA 5 may be exposed to noise levels up to 20 dB(A) above the NML during times of peak operations.

In summary, during out-of-hours work, it is predicted that:

- Across the entire study area, noise from even the loudest works will comply with the NML at 60 per cent of all residences
- Paving is the out-of-hours work predicted to generate the greatest number of NML exceedances at residences, which are mostly located in NCAs 1, 2, 5 and 8
- The highest NML exceedances are predicted to occur at residences within NCA 2

- At 209 residences (12 per cent of all residences) within the study area the worst case exceedance of the NML from any out-of-hours work would be 5 dB(A) or less. At such time of peak impact, construction noise would be noticeable
- At 313 residences within the study area (18 per cent) the worst case exceedance of the NML would be between 5-15 dB(A). At such times of peak impact, construction noise would be clearly audible
- At 99 residences within the study area (6 per cent) the worst case exceedance of the NML would be between 15-25 dB(A). At such times of peak impact, construction noise would be moderately intrusive
- At 73 residences within the study area (4 per cent) the worst case exceedance may be more than 25 dB(A). At such times of peak impact, construction noise would be highly intrusive
- Noise from the ancillary facilities (in isolation of noise from any other mainline works) may give rise to exceedances of the NML at up to 539 residences when nearby facilities are operating at peak capacity. The NML exceedance is predicted to be greater than 15 dB(A) at 31 of these residences.

Exceedances of the sleep disturbance screening criterion are predicted to be highest from paving works and for residences within NCAs 2, 3 and 5.

Over all NCAs, 87 residences may be exposed to exceedances of more than 15 dB(A) and 22 residence to exceedances of more than 25 dB(A) above the sleep disturbance screening criterion when paving works are most adjacent to those receivers.

Over all NCAs, noise from ancillary facilities alone may give rise to exceedances of the sleep disturbance criterion within 225 residences.

Exceedances of the NML from standard hours works are predicted at the following non-residential receivers within the study area. The noise levels reported relate to periods when works are nearest to the subject site:

- Power Station - minor exceedances of up to 2 dB(A)
- Horse N Around – moderate exceedances of up to 11 dB(A) at the most affected building
- Shell Service Station – moderate exceedances of up to 17 dB(A)
- IGA Luddenham – moderate exceedances of up to 12 dB(A)
- Luddenham Public School - minor exceedances of up to 4 dB(A)
- St James Anglican Church - moderate exceedances of up to 11 dB(A)
- Luddenham Uniting Church – minor exceedances of up to 2 dB(A).

A summary of construction and operational impacts per NCA is provided in Section 7.2.6. A detailed assessment is provided in Appendix H.

All construction impacts are based on the defined NMLs, representative worst-case noise construction scenarios which are used to predict the noise emission from construction activities. These worst-case scenarios typically assume all equipment / ancillary facilities operate concurrently, minimal offset distances between equipment and receivers and reference equipment sound power levels as per the RMS CNVG.

The construction contractor may develop different NMLs, construction scenarios, timings, offset distances, equipment and concurrent / overlapping activates. The construction impacts in this case will likely be different to the impacts assessed as part of this report. In all cases, during the detailed design stages, the construction contractor will be responsible for re-assessing all construction noise and vibration impacts in accordance with the ICNG and RMS CNVG and providing a detailed Construction Noise and Vibration Management Plan (CNVMP), which describes the construction impacts and the necessary noise, vibration and management mitigation measures which will be

implemented throughout the project. The CNVMP will also reference the project specific Environmental Protection Licence (EPL) which may require specific mitigation measures.

Table 7-30 Summary of predicted construction noise impacts at each NCA during standard hours

NCA	NML (Standard Hours)		Construction Stage: Early works	Earthworks	Roadwork-	Bridge work	Drainage	Paving	Utility Relocation	Finishing Works	Ancillary Facilities only
1	58	Range of predicted noise levels (dB(A))	34-77	38-82	40-84	30-63	39-83	40-84	36-80	39-83	27-63
		Number of Residences: Complying	1194	1179	1164	1204	1175	1164	1188	1175	1204
		Number of Residences: 0-10 dBA above NML	16	27	41	7	31	41	20	31	7
		Number of Residences: 10-20 dBA above NML	1	4	5		4	5	2	4	
		Number of Residences: 20+ dBA above NML		1	1		1	1	1	1	
		Highly noise affected ≥75dBA	1	1	1		1	1	1	1	
2	57	Range of predicted noise levels (dB(A))	39-78	44-83	46-85	34-61	45-84	46-85	42-81	45-84	34-61
		Number of Residences: Complying	63	47	39	128	44	39	55	44	128
		Number of Residences: 0-10 dBA above NML	39	30	34	9	32	34	32	32	9
		Number of Residences: 10-20 dBA above NML	33	50	50		49	50	46	49	
		Number of Residences: 20+ dBA above NML	2	10	14		12	14	4	12	
		Highly noise affected ≥75 dBA	4	15	25		17	25	10	17	
3	56	Range of predicted noise levels (dB(A))	43-73	48-78	50-80	43-61	49-79	50-80	46-76	49-79	35-61
		Number of Residences: Complying	10	6	4	20	4	4	7	4	20
		Number of Residences: 0-10 dBA above NML	5	8	7	3	10	7	8	10	3
		Number of Residences: 10-20 dBA above NML	8	7	9		7	9	8	7	
		Number of Residences: 20+ dBA above NML		2	3		2	3		2	
		Highly noise affected ≥75dBA		2	6		3	6	1	3	
4	47	Range of predicted noise levels (dB(A))	49-63	50-68	52-67	52-65	51-66	52-67	50-63	51-66	46-60
		Number of Residences: Complying									1
		Number of Residences: 0-10 dBA above NML	13	9	8	6	8	8	10	8	14
		Number of Residences: 10-20 dBA above NML	3	6	7	10	8	7	6	8	1
		Number of Residences: 20+ dBA above NML		1	1			1			
		Highly noise affected ≥75 dBA									

NCA	NML (Standard Hours)		Construction Stage: Early works	Earthworks	Roadwork-	Bridge work	Drainage	Paving	Utility Relocation	Finishing Works	Ancillary Facilities only
5	52	Range of predicted noise levels (dB(A))	39-83	43-88	45-90	45-72	44-89	45-90	41-86	44-89	38-69
		Number of Residences: Complying	177	146	117	23	131	117	162	131	211
		Number of Residences: 0-10 dBA above NML	33	54	75	199	69	75	44	69	12
		Number of Residences: 10-20 dBA above NML	10	19	23	1	18	23	13	18	1
		Number of Residences: 20+ dBA above NML	4	5	9	1	6	9	5	6	
		Highly noise affected ≥75dBA	4	5	5		5	5	4	5	
6	52	Range of predicted noise levels (dB(A))	40-48	44-53	46-55	43-51	45-54	46-55	42-51	45-54	39-47
		Number of Residences: Complying	14	12	11	14	12	11	14	12	14
		Number of Residences: 0-10 dBA above NML		2	3		2	3		2	
		Number of Residences: 10-20 dBA above NML									
		Number of Residences: 20+ dBA above NML									
		Highly noise affected ≥75 dBA									
7	47	Range of predicted noise levels (dB(A))	43-64	48-69	50-71	40-49	49-70	50-71	46-67	49-70	40-49
		Number of Residences: Complying	4			17			1		17
		Number of Residences: 0-10 dBA above NML	12	8	5	2	6	5	14	6	2
		Number of Residences: 10-20 dBA above NML	3	10	13		12	13	4	12	
		Number of Residences: 20+ dBA above NML		1	1		1	1		1	
		Highly noise affected ≥75dBA									
8	58	Range of predicted noise levels (dB(A))	41-69	46-74	48-76	41-66	47-75	48-76	44-72	47-75	41-66
		Number of Residences: Complying	83	78	72	93	74	72	80	74	93
		Number of Residences: 0-10 dBA above NML	20	16	22	12	20	22	17	20	12
		Number of Residences: 10-20 dBA above NML	2	11	11		11	11	8	11	
		Number of Residences: 20+ dBA above NML									
		Highly noise affected ≥75 dBA			2		1	2		1	

Table 7-31 Summary of predicted construction noise impacts at each NCA during out-of-hours work

NCA	NML OOH (Night)		OOH Work Stage		Ancillary Facilities only	Sleep Disturbance Screening Criterion	OOH Work Stage		Ancillary Facilities only
			Bridge work	Paving			Bridge work	Paving	
1	49	Range of predicted noise levels (dB(A))	30-63	35-79	27-63	59	33-66	39-83	30-66
		Number of Residences – Complying	1138	1034	1138		1199	1178	1199
		Number of Residences – 0-5 dBA above NML	57	137	57		10	21	10
		Number of Residences – 5-15 dBA above NML	16	35	16		2	11	2
		Number of Residences – 15-25 dBA above NML		4				1	
		Number of Residences – ≥25dBA above NML		1					
2	41	Range of predicted noise levels (dB(A))	34-61	41-80	34-61	51	37-64	45-84	37-64
		Number of Residences – Complying	22	1	22		79	15	79
		Number of Residences – 0-5 dBA above NML	44	11	44		39	24	39
		Number of Residences – 5-15 dBA above NML	60	43	60		19	34	19
		Number of Residences – 15-25 dBA above NML	11	32	11			50	
		Number of Residences – ≥25dBA above NML		50				14	
3	40	Range of predicted noise levels (dB(A))	35-61	45-75	35-61	50	38-64	49-79	38-64
		Number of Residences – Complying	6		6		12	2	12
		Number of Residences – 0-5 dBA above NML	6		6		4	2	4
		Number of Residences – 5-15 dBA above NML	7	7	7		7	7	7
		Number of Residences – 15-25 dBA above NML	4	8	4			9	
		Number of Residences – ≥25dBA above NML		8				3	
4	42	Range of predicted noise levels (dB(A))	46-60	50-62	46-60	52	49-63	53-68	49-63
		Number of Residences – Complying					1		1
		Number of Residences – 0-5 dBA above NML	1		1		11	8	11
		Number of Residences – 5-15 dBA above NML	14	11	14		4	7	4
		Number of Residences – 15-25 dBA above NML	1	5	1			1	
		Number of Residences – ≥25dBA above NML							
5	39	Range of predicted noise levels (dB(A))	38-69	40-85	38-69	49	41-72	44-89	41-72
		Number of Residences – Complying	1		1		125	44	126

NCA	NML OOH (Night)			OOH Work Stage		Ancillary Facilities only	Sleep Disturbance Screening Criterion	OOH Work Stage		Ancillary Facilities only
				Bridge work	Paving			Bridge work	Paving	
		Residences	0-5 dBA above NML	60	18	62		84	109	83
			5-15 dBA above NML	151	159	150		14	48	14
			15-25 dBA above NML	11	33	10		1	18	1
			≥25dBA above NML	1	14	1			5	
6	39	Range of predicted noise levels (dB(A))		39-47	41-50	39-47	49	42-50	45-54	42-50
		Number of Residences	Complying					12	8	12
			0-5 dBA above NML	12	6	12		2	6	2
			5-15 dBA above NML	2	8	2				
			15-25 dBA above NML							
			≥25dBA above NML							
7	42	Range of predicted noise levels (dB(A))		40-49	45-66	40-49	52	43-51	49-70	43-51
		Number of Residences	Complying	9		9		19	4	19
			0-5 dBA above NML	8	3	8			2	
			5-15 dBA above NML	2	13	2			12	
			15-25 dBA above NML		3				1	
			≥25dBA above NML							
8	47	Range of predicted noise levels (dB(A))		41-66	43-71	41-66	57	44-71	47-75	44-71
		Number of Residences	Complying	34	20	34		76	63	76
			0-5 dBA above NML	31	34	31		21	22	21
			5-15 dBA above NML	36	37	36		8	13	8
			15-25 dBA above NML	4	14	4			7	
			≥25dBA above NML							

Construction traffic noise impact

The volumes of construction traffic predicted to be generated by the project are outlined in Section 7.1 above. The project's construction traffic would access construction sites using only designated heavy vehicle routes such as the M4 Motorway, Elizabeth Drive and The Northern Road. Based on this information, predicted noise impacts as a result of construction traffic have been assessed and provided graphically in Appendix H.

This assessment indicates that construction traffic would not increase existing traffic noise levels by more than 2dB, and therefore no further assessment of construction traffic noise impacts is required.

Table 7-32 summaries the increase in traffic noise levels at receivers adjacent to the project arising from the addition of peak construction traffic volumes to existing traffic volumes.

Table 7-32 Predicted increase in traffic noise due to additional construction traffic

Haul Route	Existing Traffic Volumes				Proposed Additional Construction Traffic Volumes				Increase in traffic noise	
	Day (7am-10pm)		Night (10pm-7am)		Day (7am-10pm)		Night (10pm-7am)		Day	Night
	L	H	L	H	L	H	L	H	dB(A)	dB(A)
Along The Northern Road, between…										
Glenmore Parkway and Bradley Street	16,764	2,354	2,347	503	197	176	10	49	0.2	0.3
Chain-O-Ponds Rd and Kings Hill Road	13,685	1,480	1,972	355	197	176	10	49	0.3	0.4
Littlefields Rd and Elizabeth Drive	11,859	1,357	1,667	319	197	176	10	49	0.3	0.4

Table 7-32 shows that construction traffic will not increase existing traffic noise levels by more than 0.5 dB. Mitigation measures are only required is construction noise increases are greater than 2 dB. Therefore, no construction traffic mitigation measures are required as a result.

Construction vibration

The potential for vibration impact to either residents or buildings from the project may reasonably be expected to be contained to the construction phase of the project. The construction program is expected to include the use of equipment such as rock breakers, vibratory rollers and impact piling rigs that could give rise to vibration impact.

Vibration from the project's construction processes could potentially impact humans, buildings or other vibration-sensitive 'special uses' such as medical imaging or electronics facilities. However, all non-residential uses (including commercial properties) are sufficiently well removed from the project such that no impact is predicted. Residential receivers are the only type of receiver within the study area potentially affected by construction vibration.

The project's construction activities may give rise to three types of vibration impact, each of which is assessed against different standards. Vibration from construction works may:

- Adversely affect human comfort: this is assessed EPA, Assessing Vibration: A Technical Guideline (DEC 2006)
- Cause cosmetic damage (eg surface cracks) to conventional buildings such as residences and light commercial buildings: this is assessed against the guidance of Australian Standard AS2187.2-2006 Explosives – Storage, Transport and Use provides guidance for the assessment of structural damage to buildings caused by vibration, or
- Cause cosmetic damage to buildings or structures of "particular sensitivity" (eg, heritage or structurally unsound items): for such structures, the assessment is made against German Standard DIN 4150: Part 3-1999.

No blasting is expected to be required in the construction of the project.

Safe work distances are presented in Table 7-33.

Table 7-33 Safe working distances for vibration intensive plant (TfNSW 2013)

Plant item	Rating/description	Safe working distance	
		Cosmetic damage (British Std 7385)	Human response (DECCW)
Vibratory roller	<50 kN (typically 1-2 t) <100 kN (typically 2-4 t) <200 kN (typically 4-6 t) <300 kN (typically 7-13 t) >300 kN (typically 13-18 t) >300 kN (> 18 t)	5 m 6 m 12 m 15 m 20 m 25 m	15 m to 20 m 20 m 40 m 100 m 100 m 100 m
Small hydraulic hammer	300 kg – 5 to 12 t excavator	2 m	7 m
Medium hydraulic hammer	900 kg – 12 to 18t excavator	7 m	23 m
Large hydraulic hammer	1600 kg – 18 to 34 t excavator	22 m	73 m
Vibratory pile driver	Sheet piles	2 m to 20 m	20 m
Pile boring	≤800 mm	2 m	n/a
Jackhammer	Hand held	1 m	Avoid contact with structure

The safe working distances presented in Table 7-33 are indicative and would vary depending on the item of plant and local geotechnical conditions. The cosmetic damage thresholds apply to typical buildings under typical geotechnical conditions and vibration monitoring is recommended at specific sites. Where structures are more sensitive such as heritage items, more stringent conditions may be applicable and should be considered individually.

In relation to human response, the safe working distances relate to continuous vibration. For most construction activities, vibration emissions are intermittent and higher vibration levels over shorter periods are acceptable. Additional assessment should be undertaken where the human response criteria are exceeded.

Vibration intensive plant scheduled to be operated during the construction program include:

- Vibratory rollers during earthworks, bridge construction and other stages

- Jack hammers during drainage works
- Impact piling and rock breaking during bridgeworks.

Based on the safe working distances to preserve the structural integrity of dwellings recommended in Table 7-33, structural damage criteria would be complied with where vibratory rolling or rock breaking is operated not closer than 22 m from any dwelling or sensitive structure. Impact piling required for bridge works is expected to occur not closer than 190 m to the nearest residence, and so, is not predicted to cause structural damage.

Vibratory rolling is expected to be undertaken within 100 m of residences (for various stages of works) and so may impact human comfort within those residences. In these cases, the procedures outlines in Appendix C of the CNVG are to be followed in order to mitigate any such potential impacts. These measures include notification strategies, vibration monitoring, offering of periods of respite and offering of alternative accommodation.

Although the precise location of vibration-intensive works and the final section of plant would need to be confirmed during detailed design, Table 7-34 indicates the number of vibration-sensitive receivers expected to be situated within the 22 m (preservation of structural integrity of buildings) and 100m (protection of human comfort) safe working distances.

Table 7-34 Indicative count of receivers within safe working distances of vibration-intensive works

Noise Catchment Area	Number of receivers within Safe Working Distance for…					
	Preservation of structural integrity of buildings (22m buffer zone)			Protection of human comfort (100m buffer zone)		
	Residential	Commercial	Military	Residential	Commercial	Military
NCA 1	1			8		
NCA 2	20	2	35	63	3	44
NCA 3				6	1	
NCA 4				1		
NCA 5	4	2		15	3	
NCA 6						
NCA 7				1		
NCA 8	2			12		
Total	27	4	35	106	7	44

The heritage assessment identifies that the general and site-specific mitigation measures listed would minimise impacts on non-Aboriginal heritage to an acceptable level to proceed with the project as assessed.

7.2.6 Assessment of potential operational impacts

Assessment scenarios

Assessment of the project's operational noise impacts compares the modelled traffic noise levels resulting from the "Build" and "No Build" (or "Do Nothing") options. Note that the "Do Nothing" option is based on the assessment of The Northern Road in its existing alignment, rather than its

diverted alignment (the “Do Minimum” option) as described in Chapter 4 of the EIS. This provides a more conservative approach for the assessment of noise impacts.

In accordance with the RNP, the following four scenarios were modelled, where 2021 is taken to be the year of opening of The Northern Road project:

Year of Opening – 2021, No Build (Do Nothing)

Modelling is based on 2021 traffic on the existing road network

Year of Opening – 2021, Build

Modelling is based on 2021 traffic volumes for the road network that includes the newly-upgraded The Northern Road and the diversion around the Western Sydney Airport.

10 Years after Opening – 2031, No Build (Do Nothing)

Modelling is based on the 2031 traffic volumes on an unchanged road network (i.e. The Northern Road is not upgraded). This future traffic scenario includes the additional trips generated by forecast land use changes (ie Western Sydney Airport and Western Sydney Priority Growth Area) and other road network changes (proposed M12, Bringelly Road upgrade, etc).

10 Years after Opening – 2031, Build

Modelling is based on the 2031 traffic volumes based on a road network that includes The Northern Road, the diversion around the Western Sydney Airport. This future traffic scenario includes the additional trips generated by forecast land use changes (ie Western Sydney Airport and Western Sydney Priority Growth Area) and other road network changes (proposed M12, Bringelly Road upgrade, etc).

Each of these scenarios is modelled for both daytime (7am-10pm) and night-time (10pm-7am) periods.

Identifying receivers that qualify for consideration of noise mitigation

Noise impacts predicted during operation of the project are considered long-term impacts as they would occur for the lifetime of the project.

Any of the following three triggers qualify a receiver for consideration of noise mitigation. Note that these do not prescribe that a receiver shall receive mitigation necessarily, as there are matters of the “reasonableness and feasibility” of the measures to also consider. These triggers are:

- The predicted total noise level to a receiver in the project “Build year” is 5 dB(A) or more above the relevant NCG noise criterion (the cumulative limit) and it is the project road noise that contributes most to this increase; or
- The noise level contribution from the road project is “acute”, which is to say, greater than either 65 dB(A)$L_{eq,15hour}$ during daytime periods or 60 dB(A)$L_{eq,15hour}$ during night periods (regardless of the level of noise contributed from non-project roads)
- The predicted total noise level to a receiver for the project Build year both exceeds the NCG noise criterion AND the increase in noise created by the project (i.e. the Build minus the No Build noise level) is greater than 2 dB(A).

Operational noise impacts prior to consideration of mitigation

Detailed predictions of the project’s operational noise at each receiver within the operational noise assessment area are presented in Appendix H – Noise and vibration assessment. Of these, there are 77 receivers which qualify for the consideration of noise mitigation as outlined in Table 7-35.

Table 7-35 Summary of receivers that qualify for consideration of noise mitigation

Noise Catchment Area	Number of receivers assessed	Number of receivers exceeding NCG Criteria	Number of receivers qualifying for consideration of mitigation	Mitigation Trigger			
				1	2	3	4
NCA 1	647	17	4			1	3
NCA 2	108	41	25			6	19
NCA 3	15	10	5			1	4
NCA 4	32	14	5			4	1
NCA 5	238	92	9			5	4
NCA 6	20	9					
NCA 7	20	17	17			10	7
NCA 8	39	15	12			7	5
Total	**1 103**	**215**	**77**	**0**	**0**	**34**	**43**

Mitigation trigger: 1) Cumulative limit, 2) Acute, 3) >2dB(A) increase, 4. Combination of triggers

In summary, the following unmitigated traffic noise impacts were identified:

- Most receivers in the study area are expected to experience some increase in traffic noise. For receivers close to the alignment, the increase may result in an exceedance of the operational noise criteria
- The receivers expected to be subject to the greatest increase in traffic noise are the:
  - semi-rural receivers adjacent to the new bypass alignment in the vicinity of Willowdene Avenue, and
  - Semi-rural receivers located near either the bypass' northern or southern junctions with the existing The Northern Road. These receivers will have noise exposure to both the existing Northern Road and the new bypass
- Operational noise mitigation is not required for 1026 receivers (93 per cent of all receivers) within the study area
- There are 77 receivers (74 unique buildings) which qualify for consideration of noise mitigation. All triggering receivers are residences other than three classroom buildings at Luddenham Public School. These 77 mitigation-qualifying receivers are shown in Appendix H
- With reference to the mitigation qualification triggers, of these 77 receivers:
  - none were triggered by the cumulative limit (alone)
  - 34 were triggered by the "Build minus No Build > 2 dB(A)" test (only), and
  - 43 receivers were triggered due to a combination of both triggers
- No receivers were identified as acute alone (in absence of other triggers).

The preferred operational noise mitigation options for these receivers are discussed below.

Consideration of operational noise mitigation

This section identifies options for mitigating the operational noise impacts predicted for the 77 receivers identified in Table 7-35. The method for determining a receiver's eligibility for mitigation is outlined in Roads and Maritime *Noise Mitigation Guideline* (NMG). The potential noise mitigation

measures that may be applied by Roads and Maritime to those receivers that qualify for consideration of additional noise mitigation measures are outlined below in order of preference of application given in the RNP:

1. Low noise pavement surfaces
2. Noise mounds
3. Noise walls
4. At-property treatments.

At source mitigation - low noise pavement

The use of low-noise pavement is a preferred form of noise mitigation on road projects, as this form of mitigation reduces noise levels external to receivers and also provides benefit to the wider community, rather than only to individually targeted receivers. The use of Open Graded Asphalt or Stone Mastic Asphalt pavements can reduce noise levels by -2 dB(A) compared to Dense Graded Asphalt.

Whilst the use of low noise pavement is preferable as it reduces external noise levels and provide benefit to the wider community, it is not considered feasible due on-going maintenance requirement given that it is located close to an intersection. However, a quieter pavement in the form of dense graded ashphaltic concrete would be used.

Noise attenuation through noise barriers (mounds or walls)

A noise barrier (e.g. noise mound) provides similar benefits to those provided by a quieter pavement surface through reducing both external and internal levels of noise.

As there are no groupings of four or more closely-spaced receivers of those eligible for consideration of mitigation, the use of noise barriers has not been identified as a mitigation measure for this project.

Where there are four or more closely spaced receivers that would benefit, a combination of noise treatment options, where feasible and reasonable, would be investigated further in detailed design in accordance with the NMG.

Noise mitigation to the 77 mitigation-eligible receivers will need to be provided by means of at-property acoustic treatments.

Additional noise mitigation option: at-property treatments

Where noise barriers and/or low noise pavements are not considered feasible and/or reasonable, noise impacts at affected dwellings would be mitigated by at-property treatments. The objective of this form of mitigation is to provide building treatments that reduce internal traffic noise to levels that would have prevailed had the external traffic noise criteria been able to be achieved.

The specific form of acoustic building treatment applied to achieve these reductions is considered on an individual basis in response to the existing construction of the dwelling. Building element treatments are more effective when applied to masonry structures than to lightly clad timber frame structures. Caution should be exercised before providing treatments for buildings in a poor state of repair, as they may be less effective in these cases and may not provide any appreciable noise reduction benefit.

Any treatments proposed would be considered in consultation with the landowner.

The NMG identifies that the treatments provided by the Roads and Maritime would be limited to:

- The installation of courtyard screen walls
- Fresh air ventilation systems that meet Building Code of Australia requirements with the windows and doors shut

- Upgraded windows and glazing and solid core doors on the exposed facades of masonry structures only (these techniques would be unlikely to produce any noticeable benefit for light frame structures with no acoustic insulation in the walls)
- Upgrading window and door seals and treatment of sub floor ventilation
- The sealing of wall vents
- The sealing of the underfloor below the bearers
- The sealing of eaves.

At-property treatments are considered the most reasonable form of noise mitigation for the 77 receivers (housed within 74 buildings) for which exceedances of operational noise criteria have been predicted by this assessment. These 77 receives eligible for at-property treatments are shown on Table 7-36. A summary of the predicted noise impacts at these 77 receivers qualifying for consideration of noise mitigation is provided in Table 7-36.

Table 7-36 Summary of receivers eligible for at-property treatment

Address	Flr	Land Use	Predicted noise level dB(A) NO Build				Predicted noise level dB(A) Build				NCG Criteria		Predicted Exceedance dB(A) Build			
			2021		2031		2021		2031				2021		2031	
			D	N	D	N	D	N	D	N	D	N	D	N	D	N
Receivers located within NCA 1																
2019 The Northern Rd Glenmore Park	GF	Residential	65	59	66	59	65	58	66	60	60	55	5	3	6	5
2023 The Northern Rd Glenmore Park	GF	Residential	64	58	64	58	64	57	65	59	60	55	4	2	5	4
1 Bradley St Glenmore Park	GF	Residential	63	56	63	57	63	56	65	58	60	55	3	1	5	3
2032 The Northern Rd Orchard Park	GF	Residential	60	53	60	54	62	55	63	57	60	55	2	0	3	2
Receivers located within NCA 2																
2-18 Littlefields Rd (1) Luddenham	GF	Residential	61	54	60	55	61	54	63	56	60	55	1	0	3	1
2-18 Littlefields Rd (1) Luddenham	F1	Residential	63	56	63	57	65	58	67	60	60	55	5	3	7	5
2785-2787 The Northern Rd Luddenham	GF	Residential	63	56	63	57	63	56	65	58	60	55	3	1	5	3
2627-2635 The Northern Rd Mulgoa	GF	Residential	60	53	60	54	63	56	65	58	60	55	3	1	5	3
2627-2635 The Northern Rd Mulgoa	F1	Residential	62	55	63	56	65	58	67	60	60	55	5	3	7	5
2575-2579 The Northern Rd Mulgoa	GF	Residential	58	51	59	52	60	53	62	55	60	55	0	0	2	0
2567-2573 The Northern Rd (1) Mulgoa	GF	Residential	63	56	63	57	65	58	67	60	60	55	5	3	7	5
2561 The Northern Rd (1) Mulgoa	GF	Residential	57	50	57	51	59	52	61	54	60	55	0	0	1	0
2529-2537 The Northern Rd Mulgoa	GF	Residential	64	57	65	58	64	56	65	59	60	55	4	1	5	4
2 Longview Rd (3) Mulgoa	GF	Residential	64	57	64	58	63	55	65	58	60	55	3	0	5	3
4 Grover Cr (1) Mulgoa	F1	Residential	58	51	59	52	59	52	61	54	60	55	0	0	1	0
2359-2365 The Northern Rd Mulgoa	GF	Residential	65	58	66	59	65	58	66	60	60	55	5	3	6	5

Address	Flr	Land Use	Predicted noise level dB(A) NO Build				Predicted noise level dB(A) Build				NCG Criteria		Predicted Exceedance dB(A) Build			
			2021		2031		2021		2031				2021		2031	
			D	N	D	N	D	N	D	N	D	N	D	N	D	N
2351-2357 The Northern Rd (4) Mulgoa	GF	Residential	66	60	67	61	65	58	67	60	60	55	5	3	7	5
2345-2349 The Northern Rd Mulgoa	GF	Residential	65	58	66	60	64	57	66	59	60	55	4	2	6	4
2309-2317 The Northern Rd (1) Mulgoa	GF	Residential	65	59	66	60	64	57	66	59	60	55	4	2	6	4
2289-2293 The Northern Rd (1) Mulgoa	GF	Residential	65	58	65	59	64	57	66	59	60	55	4	2	6	4
Lot3/DP29081	GF	Residential	66	59	66	60	65	58	66	60	60	55	5	3	6	5
2297-2307 The Northern Rd (2) Mulgoa	GF	Residential	67	60	67	61	65	58	67	60	60	55	5	3	7	5
2373-2379(4) The Northern Rd Mulgoa	GF	Residential	68	61	69	62	66	59	68	61	60	55	6	4	8	6
1 Gates Rd (1) Mulgoa	GF	Residential	61	54	61	55	62	55	64	57	60	55	2	0	4	2
2580-2592 The Northern Rd Mulgoa	GF	Residential	63	57	64	58	65	58	68	61	60	55	5	3	8	6
2751 The Northern Rd Luddenham	GF	Residential	60	53	60	54	61	54	63	56	60	55	1	0	3	1
2751 The Northern Rd (1) Luddenham	GF	Residential	65	58	66	59	67	60	69	62	60	55	7	5	9	7
2587 The Northern Rd (1) Luddenham	GF	Residential	64	57	65	59	66	58	68	61	60	55	6	3	8	6
2295 The Northern Road Mulgoa	GF	Residential	66	59	66	60	64	57	66	59	60	55	4	2	6	4
Receivers located within NCA 3																
2843-2857 The Northern Rd (4) Luddenham	GF	Residential	63	56	63	57	64	57	66	58	60	55	4	2	6	3
2825-2841 The Northern Rd (5) Luddenham	GF	Residential	64	57	64	58	65	58	67	60	60	55	5	3	7	5
2311-2337 Elizabeth Dr (1) Luddenham	GF	Residential	61	57	63	54	62	55	64	56	56	51	6	4	8	5
2311-2337 Elizabeth Dr (1) Luddenham	F1	Residential	65	56	65	58	64	57	66	58	56	51	8	6	10	7
2859 The Northern Rd (1) Luddenham	GF	Residential	57	50	56	49	56	49	58	51	56	51	0	0	2	0

Address	Flr	Land Use	Predicted noise level dB(A) NO Build				Predicted noise level dB(A) Build				NCG Criteria		Predicted Exceedance dB(A) Build			
			2021		2031		2021		2031				2021		2031	
			D	N	D	N	D	N	D	N	D	N	D	N	D	N
Receivers located within NCA 4																
140 Adams Rd (1) Luddenham	GF	Residential	46	39	45	39	58	51	60	53	55	50	3	1	5	3
2422-2430 The Northern Rd (3) Luddenham	GF	Residential	52	45	49	45	55	48	57	50	55	50	0	0	2	0
2420 The Northern Rd (2) Luddenham	GF	Residential	49	42	48	42	57	49	58	51	55	50	2	0	3	1
105-115 Adams Rd Luddenham	GF	Residential	47	40	47	41	55	48	57	50	55	50	0	0	2	0
125 Adams Rd (3) Luddenham	GF	Residential	48	41	50	43	54	47	56	49	55	50	0	0	1	0
Receivers located within NCA 5																
Luddenham Public School (2)	GF	Educational	57	52	49	51	52	47	51	50	50	-	2	-	1	-
Luddenham Public School (3)	GF	Educational	58	53	48	51	53	48	51	51	50	-	3	-	1	-
Luddenham Public School (1)	GF	Educational	57	52	48	51	52	47	51	50	50	-	2	-	1	-
2320-2390 The Northern Rd (2) Luddenham	GF	Residential	51	44	49	43	58	51	59	52	55	50	3	1	4	2
18 Eaton Road Luddenham	GF	Residential	59	49	59	53	61	51	62	56	55	50	6	1	7	6
16 Eaton Rd Luddenham	GF	Residential	60	53	59	53	60	53	61	55	55	50	5	3	6	5
14 Eaton Rd Luddenham	GF	Residential	60	53	59	54	59	52	60	54	55	50	4	2	5	4
2215 The Northern Rd (1) Luddenham	GF	Residential	56	49	51	49	54	47	56	50	55	50	0	0	1	0
45 Adams Rd (1) Luddenham	GF	Residential	50	41	51	44	61	54	62	56	55	50	6	4	7	6
Receivers located within NCA 6																
No receivers qualify																

Address	Flr	Land Use	Predicted noise level dB(A) NO Build				Predicted noise level dB(A) Build				NCG Criteria		Predicted Exceedance dB(A) Build			
			2021		2031		2021		2031				2021		2031	
			D	N	D	N	D	N	D	N	D	N	D	N	D	N
Receivers located within NCA 7																
230A Willowdene Ave (1) Luddenham	GF	Residential	39	32	32	33	44	37	45	38	44	42	0	0	1	0
500 Willowdene Ave (1) Luddenham	GF	Residential	40	33	40	34	54	47	55	49	52	45	2	2	3	4
405 Willowdene Ave (1) Luddenham	GF	Residential	34	32	38	33	49	44	52	45	45	44	4	0	7	1
365 Willowdene Ave (1) Luddenham	GF	Residential	40	34	40	34	55	48	56	50	52	45	3	3	4	5
365 Willowdene Ave (3) Luddenham	GF	Residential	40	33	39	33	51	44	53	46	51	45	0	0	2	1
325 Willowdene Ave (1) Luddenham	GF	Residential	31	32	37	32	45	42	50	44	43	43	2	0	7	1
295 Willowdene Ave (1) Luddenham	GF	Residential	38	32	34	33	47	40	47	42	46	44	1	0	1	0
350 Willowdene Ave (2) Luddenham	GF	Residential	38	31	37	32	51	44	52	45	49	43	2	1	3	2
260 Willowdene Ave Luddenham	GF	Residential	32	32	32	33	47	41	48	43	44	43	3	0	4	0
320 Willowdene Ave (1) Luddenham	GF	Residential	39	32	39	33	53	46	54	47	49	42	4	4	5	5
Lot1/DP838361	GF	Residential	39	31	38	32	51	44	53	46	50	43	1	1	3	3
Lot1/DP838361	GF	Residential	36	30	36	30	52	45	54	47	48	42	4	3	6	5
Lot1/DP838361	GF	Residential	36	30	36	30	52	45	53	47	48	42	4	3	5	5
5 Vicar Park Lane, Luddenham	GF	Residential	40	33	39	34	54	47	55	49	43	42	11	5	12	7
400 Willowdene Ave Luddenham	GF	Residential	42	35	43	37	56	49	57	50	53	47	3	2	4	3
460 Willowdene Ave (1) Luddenham	GF	Residential	40	33	39	34	60	53	61	55	51	45	9	8	10	10

Address	Flr	Land Use	Predicted noise level dB(A) NO Build				Predicted noise level dB(A) Build				NCG Criteria		Predicted Exceedance dB(A) Build			
			2021		2031		2021		2031				2021		2031	
			D	N	D	N	D	N	D	N	D	N	D	N	D	N
300-315 Willowdene Ave Luddenham	GF	Residential	36	27	36	30	50	43	51	44	45	42	5	1	6	2
Receivers located within NCA 8																
165 Greendale Rd (4) Greendale	GF	Residential	49	42	48	42	55	48	57	50	55	50	0	0	2	0
165 Greendale Rd (3) Greendale	GF	Residential	49	43	49	43	58	51	59	52	55	50	3	1	4	2
165 Greendale Rd (2) Greendale	GF	Residential	52	45	51	45	61	54	62	56	55	50	6	4	7	6
1592 The Northern Rd (1) Bringelly	GF	Residential	59	53	59	53	62	55	63	57	60	55	2	0	3	2
1602 The Northern Rd (3) Bringelly	GF	Residential	60	53	59	54	63	56	64	57	60	55	3	1	4	2
2 Dwyer Rd Bringelly	GF	Residential	63	56	63	57	64	57	65	58	60	55	4	2	5	3
1635 The Northern Rd (1) Bringelly	GF	Residential	60	53	60	54	62	55	63	56	60	55	2	0	3	1
1655 The Northern Rd (2) Bringelly	GF	Residential	59	52	58	53	61	54	62	55	60	55	1	0	2	0
165 Greendale Rd (1) Greendale	GF	Residential	57	50	57	51	59	53	61	54	55	50	4	3	6	4
165 Greendale Rd (1) Greendale	GF	Residential	59	52	59	53	64	57	65	59	60	55	4	2	5	4
165 Greendale Rd (2) Greendale	GF	Residential	60	53	59	53	63	56	64	58	60	55	3	1	4	3
1615 The Northern Rd (1) Bringelly	GF	Residential	62	55	62	56	63	56	65	58	60	55	3	1	5	3

Sensitivity analysis

A sensitivity analysis of the noise modelling results was undertaken in order to ensure that the proposal adequately accounts for potential variations in actual future vehicle speeds and/or traffic mix.

A sensitivity factor of between 0.5-2.0 dB(A) has been added iteratively to all predicted noise levels. Incrementing sensitivity by 1 dB(A) allows for an increase in speed of about 15 km/h to 20 km/h or a corresponding increase in heavy vehicle volumes of about 15 to 20 percent for the upgraded and bypass sections of the project respectively.

Figure 7-3 indicates the change in the number of at-property treatments that would be recommended by this assessment if 0.5 dBA is incrementally added to or subtracted from the assessment's noise level predictions.

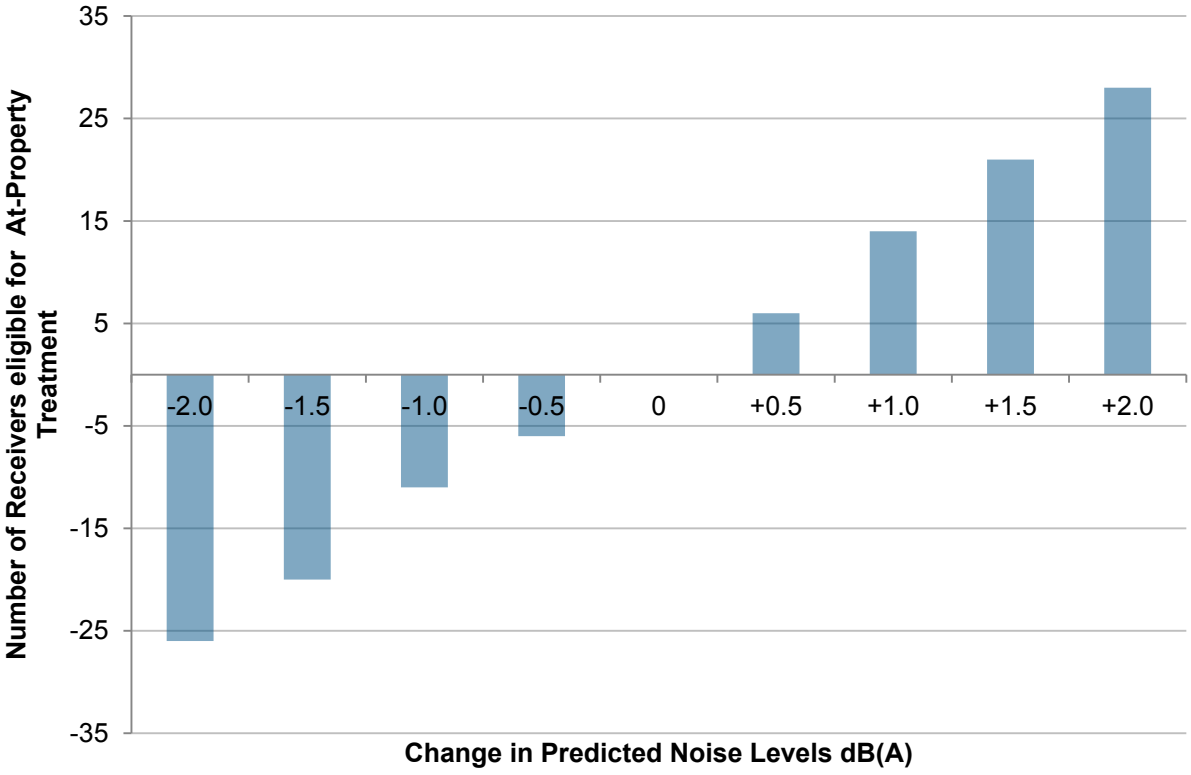


Figure 7-3 Noise assessment sensitivity analysis

Maximum noise level assessment

Investigating the frequency of maximum noise level events seeks to quantitatively indicate both potential for sleep disturbance within residences and whether noise impacts may be expected from the project during night periods. Investigating the frequency, extent and temporal distribution of maximum noise level events assists in the prioritisation of any mitigation (triggered by other considerations).

The assessment of maximum noise level events is based on the night-time traffic noise data acquired from noise monitoring location 12. This dataset was chosen for the assessment as the monitoring location from which it was acquired best reflects the exposure of receivers likely to be most impacted from the project's night-time traffic movements.

The number and distribution of existing night-time maximum noise events are shown in Figure 7-4 and Figure 7-5.

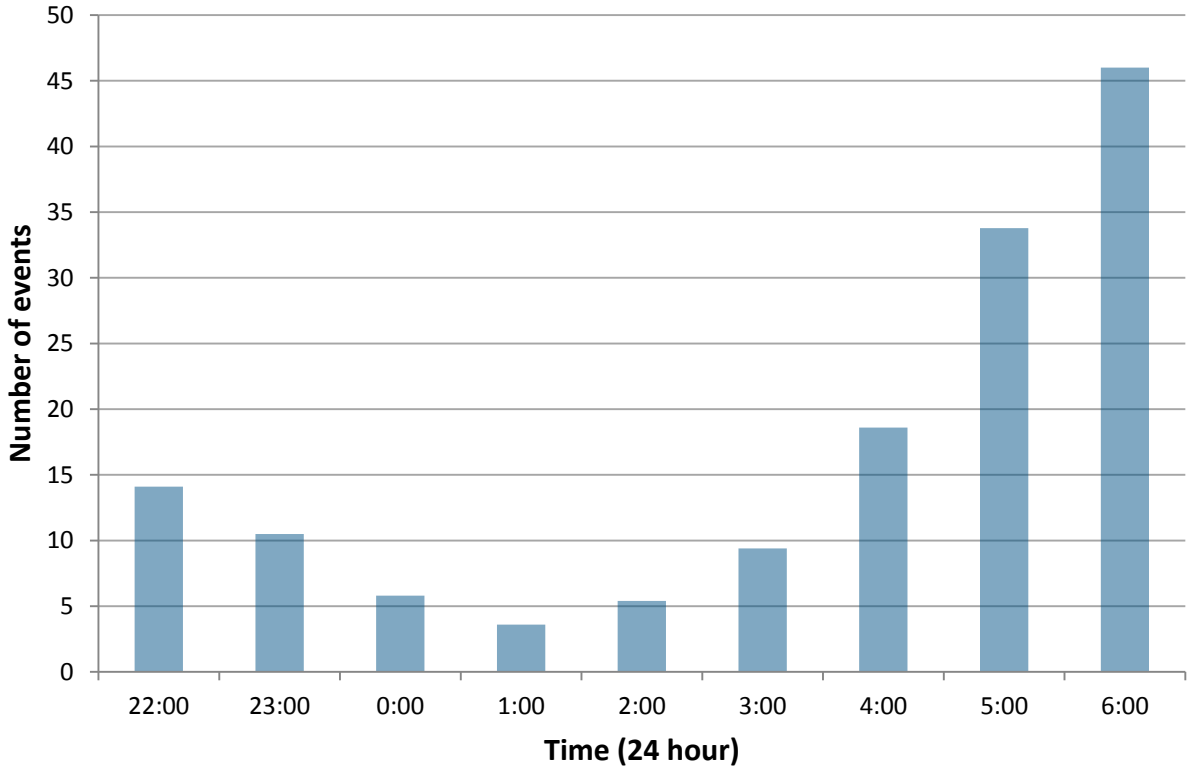


Figure 7-4 Number of noise events greater than 65dB(A) (Night-time)

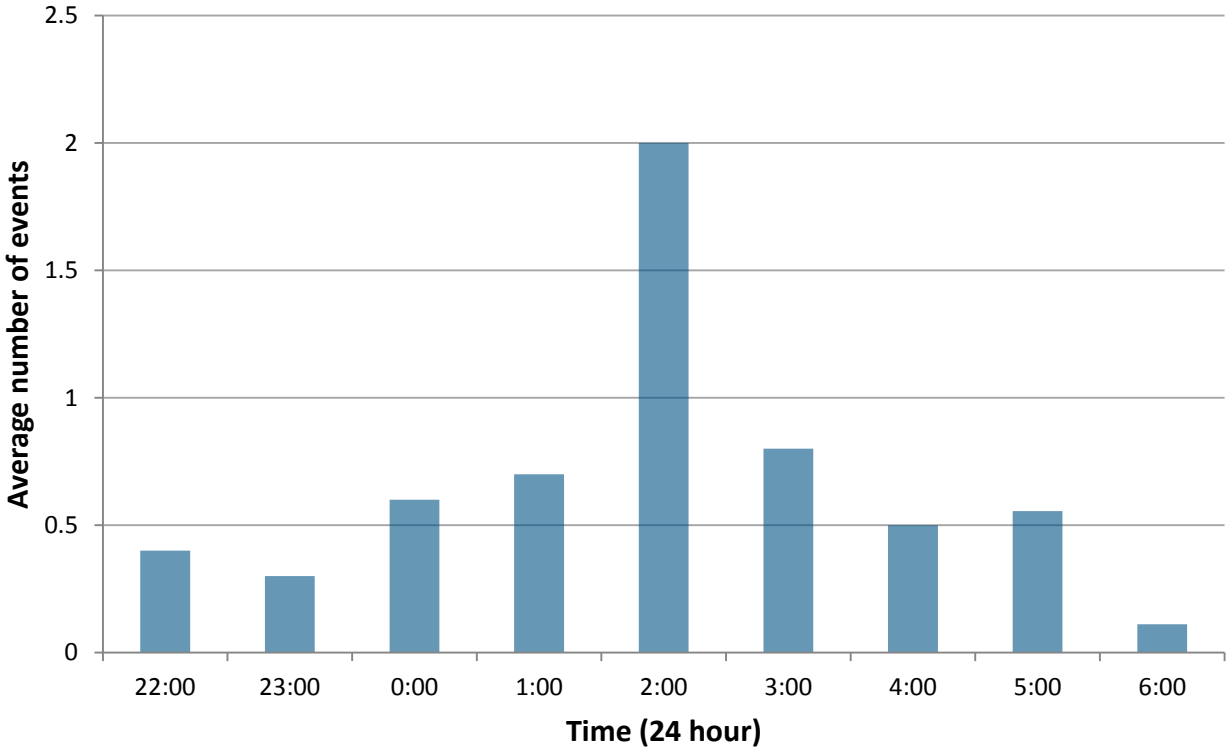


Figure 7-5 Average number of events when LAMax - LAeq >15dB(A) (Night-time)

Figure 7-4 indicates that the number of existing maximum noise events greater than 65dB(A) during night periods presently is relatively low during the early and middle periods of the night, but increases substantially in the period 4am-7am.

Figure 7-5 indicates that there are presently few maximum noise events during night periods (about four per cent of all measured noise events greater than 65dB(A)). The number of maximum noise events is greatest at 2am and reduces in the early morning hours.

From the traffic noise monitoring data, maximum noise levels within those residences closest to the road may be expected to exceed 65 dB(A) for about 147 noise events during an average night. Typically, in any single night period, six of these 147 events would exceed the prevailing LAeq noise level by more than 15 dB(A).

Given that the project is expected to increase the number of night-time heavy vehicle movements and also that it proposes seven new signalised intersections along the alignment including at South Luddenham and Glenmore Park, the design would likely increase the number of engine compression braking events and the incidence of start-stop traffic.

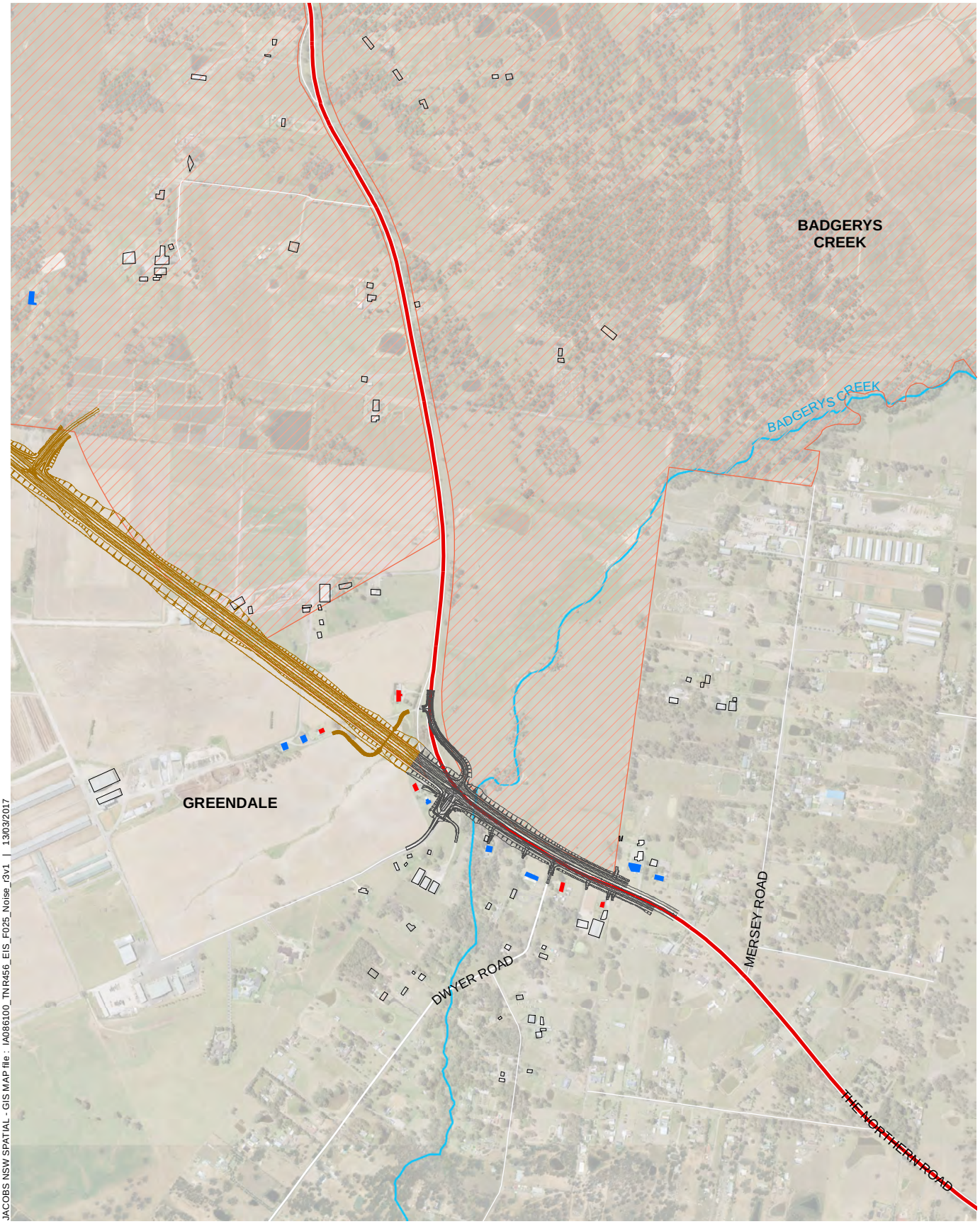
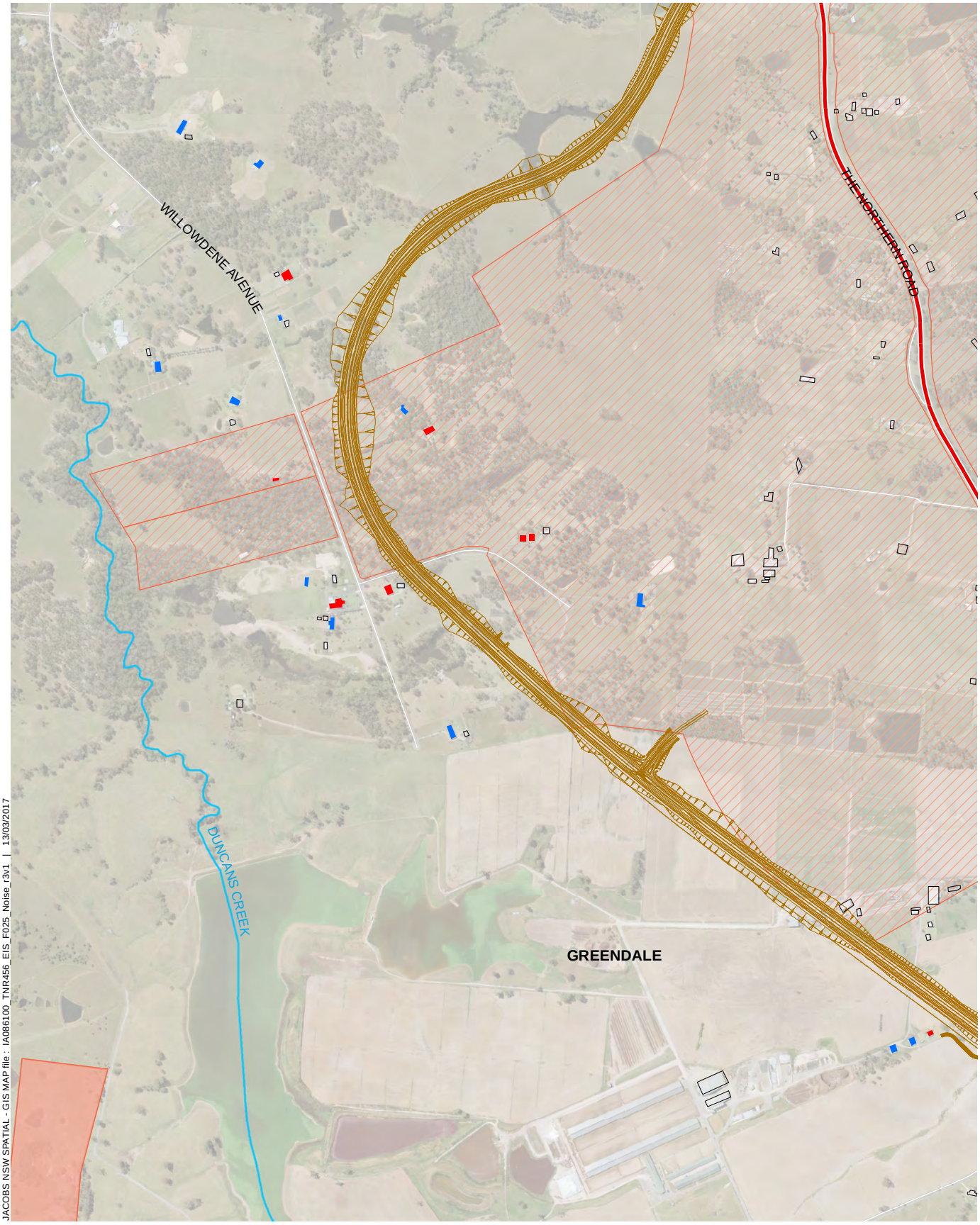


Figure 7-6 | Receivers qualifying for consideration of noise mitigation



JACOBS NSW SPATIAL - GIS MAP file : IA086100_TNR456_EIS_F025_Noise_r3v1 | 13/03/2017

The Northern Road (Existing)
Redeveloped road sections
New road sections
Western Sydney Airport site (Commonwealth Land)
Defence Establishment Orchard Hills (Commonwealth Land)
Commonwealth lands

Receivers qualifying for consideration of noise mitigation (by mitigation trigger)
>2dB(A) increase
Combination of triggers
Receivers not qualifying for mitigation

0 200 400 m

N

Figure 7-6 | Receivers qualifying for consideration of noise mitigation

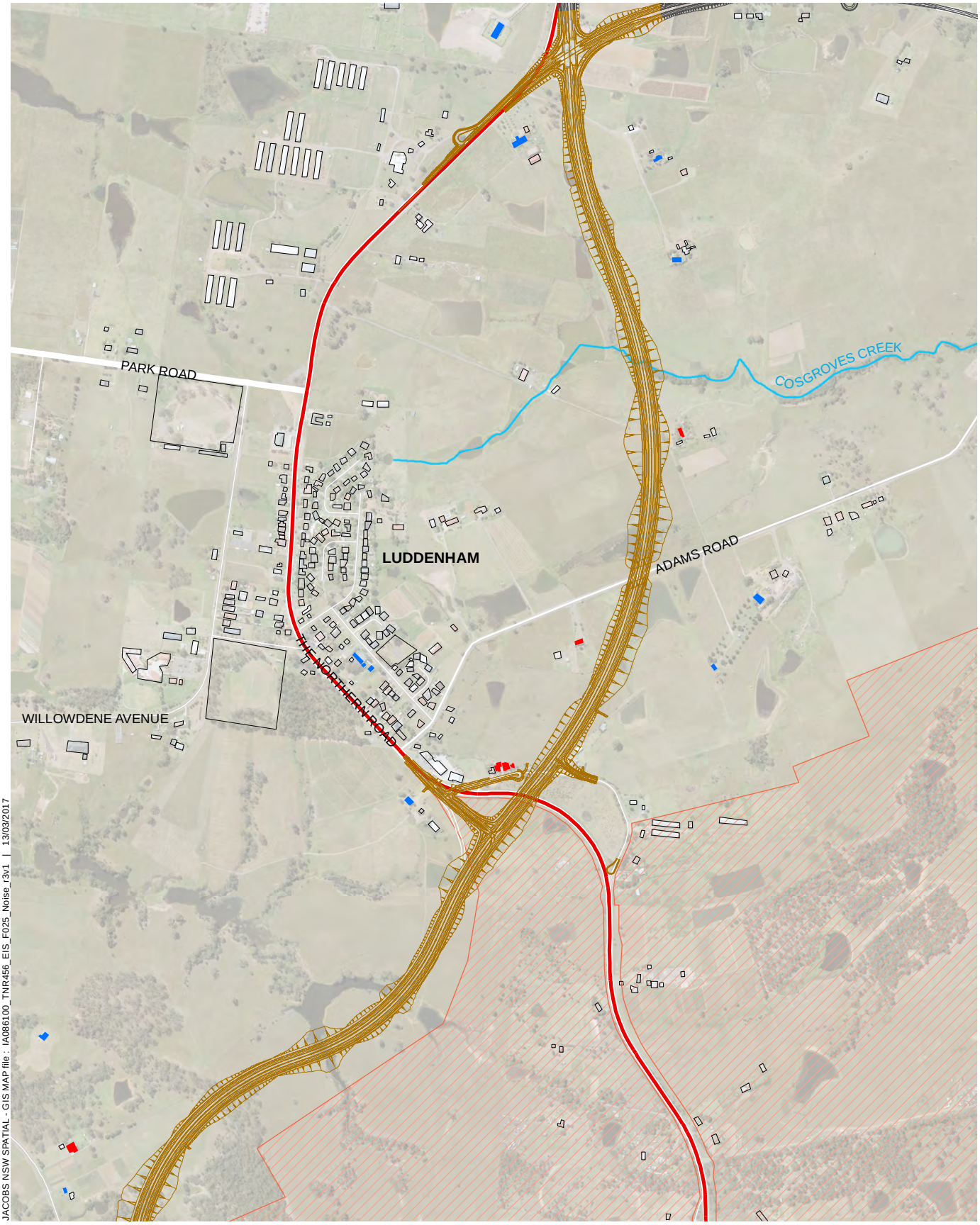


Figure 7-6 | Receivers qualifying for consideration of noise mitigation

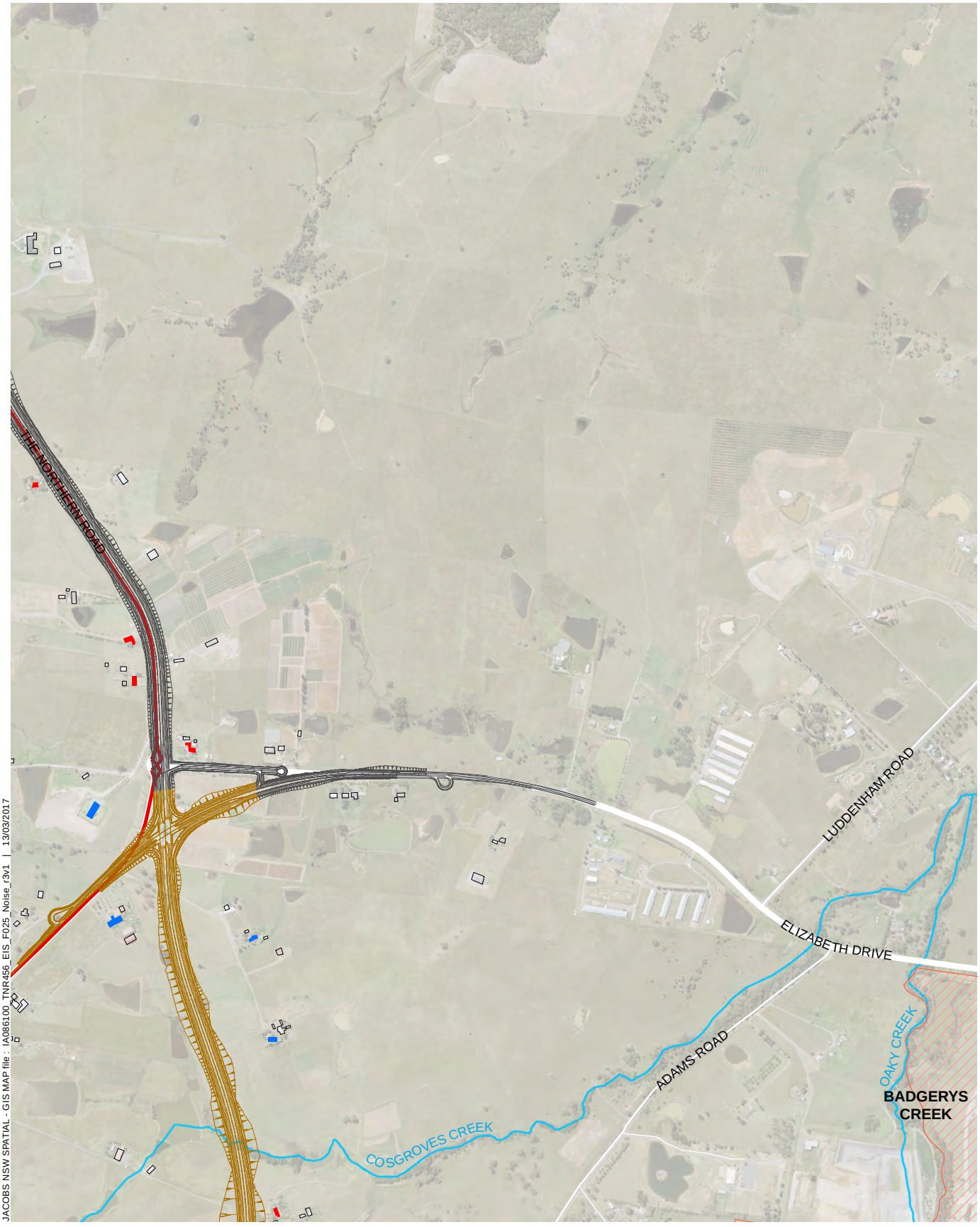


Figure 7-6 | Receivers qualifying for consideration of noise mitigation

Figure 7-6 | Receivers qualifying for consideration of noise mitigation

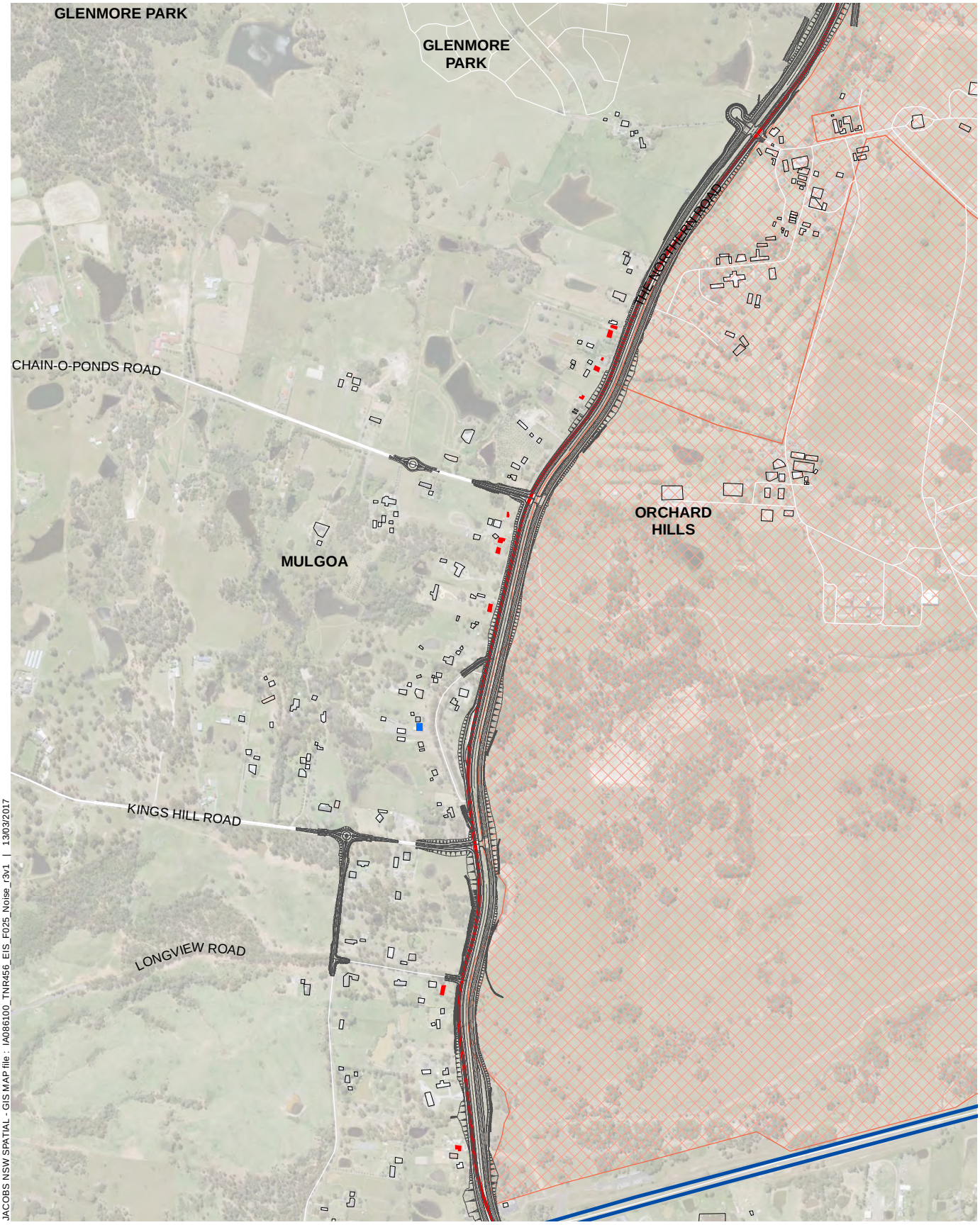


Figure 7-6 | Receivers qualifying for consideration of noise mitigation

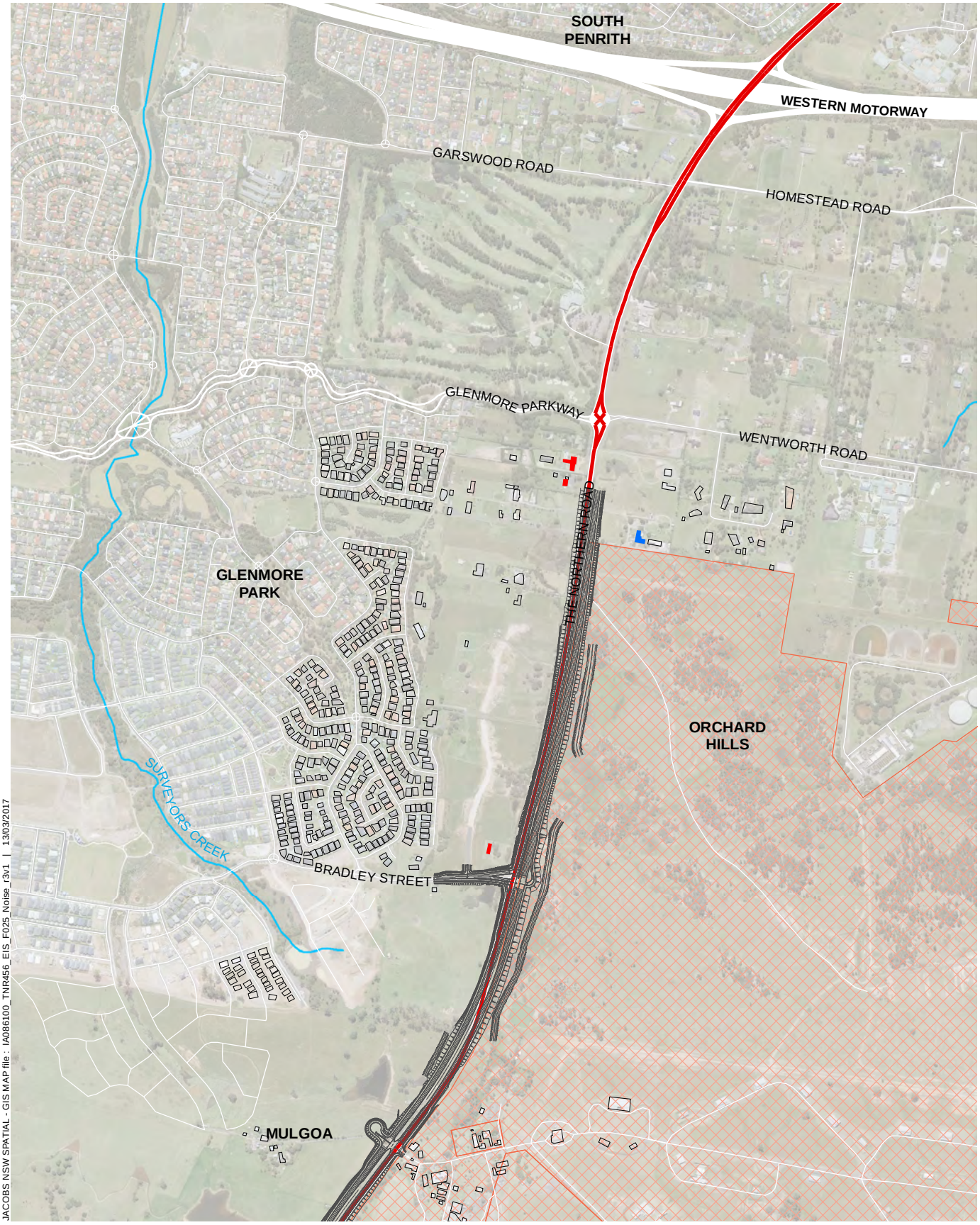


Figure 7-6 | Receivers qualifying for consideration of noise mitigation

7.2.7 Summary of impacts to the environment of Commonwealth Land

The potential noise and vibration impacts to the environment of Commonwealth land as a result of construction and operation of the project are outlined below.

Potential noise and vibration impacts related to the operation of the project are outlined in Section 7.2.6. Operational noise impacts to receivers located on Commonwealth land are summarised as:

- Six receivers located on Commonwealth land have been identified as being eligible for mitigation of the project's operational noise impacts. Of the six receivers, five are located on Commonwealth owned land at the planned western Sydney airport site. One other receiver is located on Commonwealth land located west of Willowdene Avenue
- At-property treatments are considered the most reasonable form of mitigation for all six receivers.

Potential noise and vibration impacts related to the construction of the project are outlined in Section 7.2.5. The potential for construction impacts to receivers located on Commonwealth land are summarised as:

- Of the 43 receivers within the study area situated on Commonwealth land, 38 may be impacted by noise from construction processes to some extent at some stage
- Worst case impacts are predicted from daytime paving works. Worst case exceedances of NMLs during such works would typically be between 8-15 dB(A) for most of these receivers, although exceedances of up to 18 dB(A) may occur at one receiver closest to the works. Most impacted receivers are located within NCA 2. These worst case impacts would occur only at times of peak construction activity, when all plant is operating concurrently at the location nearest each receiver. These levels of exposure are expected only infrequently, as paving works are expected to pass any single receiver within one or two weeks. It is expected that any NML exceedances would not exceed 10 dB(A) for much of the construction program, and separately, that no noise exceedances would results for the majority of the project's total construction program
- Predicted worst case construction noise levels from out-of-hours work (including the simultaneous operation of all 21 ancillary facilities) would exceed night-time NMLs at most receivers within Commonwealth land. During worst case night-time works, exceedances of night-time NMLs of up to 15-28 dB(A) may result for many receivers. Again, this represents a conservative worst case scenario when all plant is operating at a point nearest a given receiver. These worst case impacts would occur for only limited periods while works passed at their nearest point to these receivers.

7.2.8 Environmental mitigation measures

Expected environmental outcomes

Where possible, the project has been designed and planned to avoid and minimise construction and operational noise and vibration impacts.

Despite this, noise and vibration impacts would occur during construction of the project, and road traffic noise impacts would occur during operation.

Noise management throughout construction of the project would aim to achieve the NMLs throughout the alignment. Where these cannot be satisfied, construction noise impacts will be mitigated using reasonable and feasible noise and management mitigation measures as per the ICNG and RMS CNVG.

Specific outcomes that would be achieved through the implementation of environmental management measures include:

- Limiting the impact of construction related noise both within and outside standard construction hours

- For construction works beyond standard construction hours, take reasonable and feasible measures to minimise potential impacts to achieve the noise goals stated in this EIS
- Potentially affected property owners and occupants are to be notified well in advance (7 days or more) as to the scale, extent and duration of construction works, as required by the consultation and communications program
- Minimise potential operational noise from road traffic noise for newly exposed properties.
- Ensuring appropriate management and mitigation measures are implemented to comply with all relevant legislation.

Expected effectiveness

Roads and Maritime have experience in managing potential noise and vibration impacts as a result of road developments of similar scale and scope to this project.

A Construction Noise and Vibration Management Plan (CNVMP) would be prepared during the detailed design stage of the project and applied to all construction processes throughout the project. The CNVMP would be developed in accordance with Roads and Maritimes *Construction Noise and Vibration Guideline* (April 2016) The *Construction Noise and Vibration Guideline* was developed in accordance with the *NSW Interim Construction Noise Guideline* and calls for the application of feasible and reasonable measures to mitigate construction noise and vibration.

The CNVMP would include the requirement to monitor the effectiveness of construction mitigation measures at sensitive receivers. The frequency of monitoring would be outlined in the plan but would include the requirement for additional monitoring should complaints be received. The monitoring would be carried out to determine if construction methods or techniques need to be refined to minimise noise.

Ongoing spot checks of noise intensive plant and equipment would be carried out throughout construction to ensure compliance with manufactures specifications. Where actual noise levels are found to exceed the predicted worst case levels, the source of excessive noise generations would be identified, and any additional feasible and reasonable measures available would be implemented to either reduce noise emissions or reduce the impacts on receivers.

Construction activities associated with road construction are inherently noisy and are likely to result in exceedances of noise criteria.

Within 12 months of the commencement of operation of the project an operational noise review would be undertaken that would include monitoring to compare actual noise performance of the project against predicted noise performance. This review would assess the effectiveness of applied noise mitigation measures and if necessary provide reassessment of all feasible and reasonable mitigation measures.

Audits and reporting of the effectiveness of construction management measures is generally carried out to show compliance with management plans and other relevant approvals and would be outlined in detail in the CEMP and Construction Noise and Vibration Management Plan prepared for the project.

Table 7-37 outlines environmental management measures that have been developed to specifically manage potential impacts which have been predicted as a result of the proposed works.

Table 7-37 Environmental Management Measures – Noise and vibration

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
Construction noise impacts	NV-1	Construction Noise and Vibration Management Plan (CNVMP) would be prepared during the detailed design stage of the project and applied to all construction processes throughout the project. The CNVMP would be prepared in accordance with the requirements in the ICNG and RMS CNVG. The CNVMP would nominate: • noise goals at all sensitive receivers • restrictions on the hours of construction activity including an out-of-hours work procedure • works programming that has the aim of minimising impacts on sensitive receivers • noise and vibration mitigation measures consistent with the RMS CNVG • the project's commitments to noise and vibration monitoring and reporting • protocols for engaging with and notifying residents of any work processes that may impact them • Describe an out-of-hours work procedure (with proforma) to be applied to all construction assessments, which is consistent with the applicable Environmental Protection Licence (EPL) for the project.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting to confirm effectiveness of measures. Continuous improvement to be achieved through ongoing evaluation of monitoring results.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
		• a complaints mechanism so that residents may contact the project manager • a protocol to enable the project to respond quickly to non-compliances.			
	NV-2	Viable mitigation measures that would be expected to be deployed by the construction contractor once the final construction sequencing and scheduling is known include: • Restricting works to standard construction hours as far as practicable, considering safety and traffic management requirements • Selecting quieter plant and equipment • Erecting temporary acoustic hoarding to reduce noise form works within a confined area • Deploying mobile hoardings (eg, acoustic screen curtains mounted on a wheeled trailer) to track moving, but tightly-contained processes • Maximising offset distances between receivers and noisy plant or activities • Orientating plant and processes away from residences, where reasonably practicable • Scheduling works for times outside of heightened sensitivity for the impacted receiver, eg, outside of school hours;	Construction contractor	Construction	Expected to be effective. Monitoring and reporting to confirm effectiveness of measures. Continuous improvement to be achieved through ongoing evaluation of monitoring results.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
		• Scheduling respite periods for noise-intensive processes undertaken near receivers, eg. limiting operation of pavement sawing to three hours at a time • Planning any out-of-hours (OOH) works so that noisier works are carried out in the earlier part of the evening or night-time • Minimising the number of consecutive nights of works adjacent to any particular set of receivers • Restricting heavy vehicle movements, heavy deliveries and loading and unloading processes to daytime periods and to areas well away from receivers • Regularly maintaining and monitoring plant and equipment to ensure that their noise emissions are not excessive • Minimising the annoyance from reversing alarms by either fitting closed circuit monitors or non-tonal reversing alarms ("quackers") on vehicles or deploying 'spotters' to oversee reversing movements Reducing throttle settings and switching off equipment when it is not being used.			
	NV3	Implement operational noise mitigation early in the construction program, where possible, to minimise construction noise impacts	Roads and Maritime	Construction	Proven to be effective

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
Operational noise impacts	NV4	Where noise barriers and/or low noise pavements are not considered feasible and/or reasonable, noise impacts at affected dwellings would be mitigated by at-property treatments.	Roads and Maritime	Operation	Proven to be effective To be carried out in consultation with affected residents
	NV5	Within 12 months of the commencement of operation of the project an operational noise review would be undertaken. This would include: • Monitoring to compare actual noise performance of the project against predicted noise performance (noise criteria) • Background noise monitoring along the alignment with concurrent traffic counts at multiple locations. • A post operation noise model would be developed to include all as-built construction documentation. Final noise wall heights, accurate road survey data and revised receiver locations / types. • The model would be validated against the new background noise and traffic data. • Noise predictions using the at opening 2021 traffic data would be undertaken using the validated post operation noise model. • An assessment of the performance and effectiveness of applied noise mitigation measures together with a review and if necessary, reassessment of all feasible and	Construction contractor	Operation	Proven to be effective

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
		reasonable mitigation measures • Identification of any additional feasible and reasonable measures that would be implemented with the objective of meeting the criteria in the NSW Road Noise Policy (DECCW, 2011), when these measures would be implemented and how their effectiveness would be measured and reported.			