Appendix E

CONSTRUCTION NOISE AND VIBRATION IMPACT ASSESSMENT

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Powering Sydney's Future
TransGrid

Potts Hill to Alexandria transmission cable project

Construction Noise and Vibration Impact Assessment

Potts Hill to Alexandria transmission cable project
Construction Noise and Vibration Impact Assessment

Client: TransGrid

ACN: 609 169 959

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, PO Box Q410, QVB Post Office NSW 1230, Australia
T +61 2 8934 0000 F +61 2 8934 0001 www.aecom.com
ABN 20 093 846 925

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Glossary, acronyms and abbreviations

Glossary

Term	Definition
A Weighted decibels [dB(A)]	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Airborne noise	Airborne noise is sound transmitted through the air/atmosphere, e.g. conversation between people.
Alignment	The geometric layout (e.g. of a road) in plan (horizontal) and elevation (vertical).
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Assessment background level [ABL]	The overall background level for each day, evening and night period for **each day** of the noise monitoring.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Busbar	A series of elevated metallic bars within an electrical substation which comprises a system of electrical conductors on which power is concentrated for high capacity distribution.
Cable bridges	A purpose built bridge made typically of reinforced concrete structures, through which the transmission cables are integrated for support and protection.
Cable circuit	A series of three phase alternating current transmission cables which make up an electrical circuit to carry an electrical current. A single circuit transmission cable typically comprises a minimum of three cables per circuit.
Community	A group of people living in a specific geographical area or with mutual interests that could be affected by the project.
Conduit	A protective tube or pipe system for individual electric cables. Sometimes referred to as a ‘duct’.
Construction	Includes all physical work required to construct the project and also includes construction planning such as the development of construction management plans.
Construction laydown areas	Areas required for temporarily storing materials, plant and equipment and providing space for other ancillary facilities, such as project offices, during construction. All construction laydown areas would also be used for stockpiling.
Day	The period from 7:00 am to 6:00 pm Monday to Saturday and 8:00 am to 6:00 pm Sundays and public holidays.
Decibel [dB]	The measurement unit of sound.

Term	Definition
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows: 0dB(A) Threshold of human hearing 30dB(A) A quiet country park 40dB(A) Whisper in a library 50dB(A) Open office space 70dB(A) Inside a car on a freeway 80dB(A) Outboard motor 90dB(A) Heavy truck pass-by 100dB(A) Jackhammer/Subway train 110 dB(A) Rock Concert 115dB(A) Limit of sound permitted in industry 120dB(A) 747 take off at 250 metres
Detailed design	The stage of the project following concept design where the design is refined, and plans, specifications and estimates are produced, suitable for construction.
Equivalent continuous sound level [L_{eq}] and A-weighted equivalent continuous [$L_{Aeq(15min)}$]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy. The INCG defines $L_{Aeq(15min)}$ as 'the A-weighted equivalent continuous (energy average) A-weighted sound pressure level of the construction works under consideration over a 15-minute period and excludes other noise sources such as industry, road, rail and the community.
Evening	The period from 6:00 pm to 10:00 pm Monday to Sunday and public holidays.
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Ground-borne noise	Ground-borne noise is noise generated by vibration transmitted through the ground into a structure, e.g. tunnelling works affected residential building above.
Heavy vehicle	A vehicle what has a gross vehicle mass (GVM) or aggregate trailer mass (ATM) of more than 4.5 tonnes.
High noise generating works	Works which use high noise generating equipment such as jack hammers, rock breakers, piling rigs and diamond saws.
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
inner Sydney	Includes the Sydney Central Business District (CBD) and eastern suburbs.
Joint bay	An enlarged section of excavated trench in which cables are joined together.
L_{10}	The sound pressure level exceeded for 10 per cent of the measurement period. For 10 per cent of the measurement period it was louder than the L_{10}.
L_{90}	The sound pressure level exceeded for 90 per cent of the measurement period. For 90 per cent of the measurement period it was louder than the L_{90}.
Light vehicle	A vehicle up to a B99 in size. A B99 vehicle is the 99th percentile vehicle size.

Term	Definition
L_{max}	The maximum sound pressure level measured over the measurement period.
L_{min}	The minimum sound pressure level measured over the measurement period.
Methodology	The method for analysis and evaluation of the relevant subject matter.
Night	The period from 10:00 pm to 7:00 am Monday to Saturday and 10:00 pm to 8:00 am Sundays and public holidays.
Pre-construction	All work prior to, and in respect of the state significant infrastructure, that is excluded from the definition of construction.
Project area	The project area comprises the overall potential area of direct disturbance by the project, which may be temporary (for construction) or permanent (for operational infrastructure) and extend below the ground surface. The project area includes the location of operational infrastructure and construction work sites for: • the transmission cable route (including the entire road reserve of roads traversed); • special crossings of infrastructure or waterbody; • substation sites requiring upgrades (noting that all works would be contained within the existing site boundaries); and • construction laydown areas.
Proponent	The person or organisation that proposes to carry out the project or activity. For the purpose of the project, the proponent is TransGrid.
Rating background level [RBL]	The overall background level for each day, evening and night period for the **entire length** of noise monitoring.
Feasible and reasonable	Consideration of best practice taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. 'Feasible' relates to engineering considerations and what is practical to build. 'Reasonable' relates to the application of judgement in arriving at a decision, taking into account mitigation benefits and cost of mitigation versus benefits provided, community expectations and nature and extent of potential improvements.
Road reserve	The area comprising roads, footpaths, nature strips and public transport infrastructure (including indented bus bays, bus shelters and bus stop signage).
Secretary's Environmental Assessment Requirements (SEARs)	Requirements and specifications for an environmental assessment prepared by the Secretary of the Department of Planning and Environment under section 5.16 of the *Environmental Planning and Assessment Act 1979* (NSW).
Sensitive receiver/receptor	Includes residences, educational institutions (including preschools, schools, universities, TAFE colleges), health care facilities (including nursing homes, hospitals), religious facilities (including churches), child care centres, passive recreation areas (including outdoor grounds used for teaching), active recreation areas (including parks and sports grounds), commercial premises (including film and television studios, research facilities, entertainment spaces, temporary accommodation such as caravan parks and camping grounds, restaurants, office premises, retail spaces and industrial premises).
Sound power level	The total sound emitted by a source.
Sound pressure level	The amount of sound at a specified point.
Switchbay	Part of a substation within which the switch and control equipment relating to a given circuit are contained.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.

Term	Definition
Transmission cable	An insulated wire that conducts an electrical current at voltages greater than 132 kV.
Underboring	This is a trenchless method for installing cables involving passing the conduits under infrastructure (such as a road or railway corridor) or a watercourse. Underboring could be via thrust boring (also known as micro tunnelling) or horizontal directional drilling.
Vibration intensive works	Works which use vibration intensive equipment such as jack hammers, piling rigs and rock breakers.
Warning tape	Tape that is buried directly above underground services to provide visual warning during subsequent excavation.
Work site	A specific section of the project area for carrying out project construction activities such as trenching and excavation, establishment of a joint bay, underboring or installing a cable bridge. The work site would be fenced off from public access and may include associated activities such as traffic management measures.

Abbreviations and acronyms

Abbreviation/ Acronym	Definition
ABL	Assessment Background Level
AVATG	Assessing Vibration: A Technical Guideline
CNVMP	Construction Noise and Vibration Management Plan
dB	Decibels
DEFRA	UK Department for Environment, Food and Rural Affairs
DIN 4150	German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures
DPE	Department of Planning and Environment
ECRTN	NSW Environment Criteria for Road Traffic Noise
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EP&A Act	Environmental Planning and Assessment Act 1979
ICNG	Interim Construction Noise Guideline
LGA	Local Government Areas
NATA	National Association of Testing Authorities, Australia
NCA	Noise Catchment Area
NML	Noise Management Level
NPfI	Noise Policy for Industry
RBL	Rating Background Level
RNP	NSW Road Noise Policy
SEARs	Secretary's Environmental Assessment Requirements
VDVs	Vibration Dose Values

Executive summary

Introduction

TransGrid is the manager and operator of the major high-voltage electricity transmission network in New South Wales (NSW) and the Australian Capital Territory (ACT). TransGrid is seeking approval under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the construction and operation of a new 330 kilovolt (kV) underground transmission cable circuit between the existing Rookwood Road substation in Potts Hill and the Beaconsfield West substation in Alexandria (the project).

The project has been identified as a solution to address existing issues in the electricity supply network for inner Sydney, which is characterised by ageing and deteriorating electricity infrastructure and forecast increases in consumer demand.

As the project is state significant infrastructure under section 5.12 of the EP&A Act, an Environmental Impact Statement (EIS) has been prepared to assess the impacts of the project. This technical report has been developed in support of the EIS.

Project works

The transmission cable circuit would be about 20 kilometres long and would generally be located within existing road reserves, at existing electrical infrastructure sites, within public open space and on previously disturbed areas across three local government areas (LGAs). The project would comprise the following key components:

- cable works connecting Rookwood Road substation with the Beaconsfield West substation;
- special crossings of infrastructure or watercourses;
- upgrade works at the Rookwood Road and Beaconsfield West substations;
- conversion works at the Beaconsfield West and Sydney South substations; and
- temporary construction laydown areas to facilitate construction of the project.

Construction noise and vibration

AECOM Australia Pty Ltd (AECOM) has been commissioned by TransGrid to undertake a Construction Noise and Vibration Impact Assessment of the project. The project does not include the installation of noise generating plant, nor does it include any work which would generate road traffic during operation. As such an operational noise assessment is not required.

Given its metropolitan context, the project would at times require high noise generating plant (e.g. jack hammering, rock breaking, piling rigs and diamond saws) to be operated in proximity to noise sensitive receivers during construction activities. The assessment has focused on identifying worst case impacts and mitigation measures to minimise these impacts to noise sensitive receivers, wherever possible. While construction works would be undertaken during standard construction hours some works would be required outside of standard construction hours for constructability, safety and traffic management reasons.

The construction noise assessment was conducted in accordance with the *Interim Construction Noise Guideline* (ICNG) as required by the Secretary's Environmental Assessment Requirements (SEARs) for the project.

Nine construction scenarios have been developed based on the proposed construction activities for the works. The construction scenarios are considered to represent the noisiest activities likely to occur. The following construction scenarios have been considered:

- site preparation;
- trenching and excavation;
- excavation and construction of cable joint bays;
- construction of special crossings which would include cable bridges or underboring of cable conduits;

- cable pulling;
- construction laydown areas;
- spoil and waste management;
- restoration of surfaces; and
- upgrade works at Rookwood Road, Beaconsfield West and Sydney South substations.

Each construction noise scenario was modelled separately and all equipment was assumed to be operating simultaneously during each construction scenario, unless otherwise noted, to provide a conservative approach.

To facilitate the assessment at nearby noise and vibration sensitive receivers, noise catchment areas were identified (i.e. areas in which receivers are considered to experience a similar noise environment). Noise and vibration sensitive receivers include residential properties, educational facilities, places of worship, recreational areas and some commercial and industrial properties (dependent on their use). Unattended and attended noise measurements were completed to characterise the existing noise environment of each noise catchment area. The measured noise levels were used to establish construction noise management levels for residential properties in accordance with the ICNG.

The assessment undertaken for the project indicates there would be exceedances of the noise management levels at a large number of residential and non-residential noise sensitive receivers close to the works.

The works likely to have the largest impact on noise sensitive receivers are the trenching and excavation works and subsequently the surface restoration works. This is due to the extent of the works, over 20 km, and the construction activities to be undertaken. Construction noise levels would exceed the noise management levels at a significant number of receivers, with many receivers being considered ‘highly noise affected’ as per the definition in the ICNG (noise level ≥75 dB(A)). However, as these works are progressive, each receiver is not affected for a long time. For the trenching and excavation works, receivers may be affected for around eight weeks. Furthermore, at any one receiver, construction noise levels would slowly increase over the duration as the works approach the receiver (around four weeks), would remain fairly constant while the works are directly in front of the receiver (around four days) and would then slowly decrease again as the works move away (around four weeks). However, for surface restoration works, receivers may be affected for about 3-5 weeks.

Construction noise levels from the excavation of the joint bays and then the cable pulling activities may affect a different number of receivers due to the discrete locations of the works, which would be confirmed during detailed design. Joint bays are expected to be required around every 600-800 metres along the transmission cable route. Construction noise levels would exceed the noise management levels at a number of receivers, with some receivers being considered ‘highly noise affected’. These works are likely to last for around five weeks and two weeks respectively.

Other works to be undertaken at discrete locations include the construction of special crossings, which involves the installation of the transmission cable circuit in a cable bridge or via underbore under infrastructure or watercourses. Construction noise levels would exceed the noise management levels at a number of receivers, with very few receivers being considered ‘highly noise affected’. Special crossings are likely to be completed in a period of up to 10 weeks at each crossing, however works would be staged and not continuous over the 10 week period.

Noise sensitive receivers near the Rookwood Road, Beaconsfield west and Sydney South substations would experience construction noise which exceeds the noise management levels, however no receivers are likely to be highly noise affected. Substation works would continue for up to six months for the Rookwood Road substation, and up to nine months at both Beaconsfield West and Sydney South substations.

The construction laydown areas would be in use for the duration of the construction period (around 24 months), however noise levels from the sites are significantly lower than those generated by the other construction scenarios, with no receivers expected to be ‘highly noise affected’.

The scenarios described above represent 'reasonable worst case scenarios', based on the location of proposed plant and numbers of plant in operation at any one time. Therefore, the numbers of affected receivers are considered conservative. The actual number of affected receivers at any one time is expected to be lower than those predicted.

While works would be undertaken during standard construction hours wherever possible (as defined in the ICNG), there are circumstances such as where work is required by licence or approval conditions, or due to safety, constructability, and traffic management concerns, where works would be required outside of standard construction hours. This would include where construction is not permitted by transport authorities at or near certain road or rail infrastructure during daytime hours or weekdays due to potential disruption to peak travel and traffic. Construction at rail crossings would be timed to occur during planned Transport for NSW rail maintenance shutdowns wherever possible. Works outside of standard construction hours have the potential to result in noise impacts during night time hours and contribute to sleep disturbance impacts.

In circumstances where works are required outside of standard construction hours, targeted community consultation would take place with affected residents and sensitive receivers to ensure they are aware of the works in advance. An Out-of-hours Protocol would be implemented to identify management measures which would be implemented to reduce and mitigate noise impacts as far as feasible and reasonable.

Mitigation measures

Noise mitigation measures have been recommended to reduce the construction noise impact at adjacent receivers including for works outside of standard construction hours. The measures include:

- the preparation of a Construction Noise and Vibration Management Plan (CNVMP);
- targeted notification of affected receivers;
- noise monitoring;
- induction and training of construction workers;
- appropriate selection and maintenance of equipment;
- use of hoardings and temporary noise barriers;
- scheduling of work for less sensitive time periods and use of respite periods, where reasonable and feasible as part of an Out-of-hours Protocol; and
- construction traffic management.

In order to minimise impact from vibration intensive works (i.e. works which use vibration intensive equipment such as jack hammers, piling rigs and rock breakers), minimum working distances have been recommended for both human comfort and structural damage. Vibration intensive works include the use of rock breakers, piling rigs and jack hammers during the trenching and excavation works and during the joint bay excavation works. These works are likely to affect any one receiver for around a week. Where vibration intensive works cannot be avoided and are required within the minimum working distances, recommendations have been provided to avoid and minimise the potential for impacts. These include:

- vibration monitoring during the initial stages of vibration intensive works to determine site specific minimum working distances;
- works scheduling and respite periods;
- equipment selection and maintenance; and
- pre- and post-construction building condition surveys.

In addition it should be noted that a number of the noise mitigation measures would also mitigate construction vibration. Blasting is not proposed for this project.

Construction road traffic noise

The road traffic noise associated with traffic movements during construction was assessed in accordance with the *NSW Road Noise Policy* (RNP) guidelines.

For arterial roads, increases in road traffic noise levels due to construction traffic is expected to be less than 2 dB during the day and the night given the existing high noise levels from traffic on these roads. As such road traffic noise levels are predicted to comply with the RNP.

Local roads vary in existing traffic volumes and generally accommodate less through traffic than arterial roads. It is expected that some local roads may experience noise level increases greater than 2 dB during daytime and night-time hours due to construction traffic from the project, where existing traffic volumes are considerably low. Notwithstanding, it is expected that overall road traffic noise levels would still comply with relevant $L_{Aeq(1hr)}$ noise levels under the RNP for local roads. Therefore no further assessment is required for these roads, in accordance with the RNP. In addition, the majority of truck movements are associated with spoil removal from trenching and excavation works, and as such impacts on local roads would be temporary, limited to the project construction hours and for a relatively short timeframe.

1.0 Introduction

TransGrid is the manager and operator of the major high-voltage electricity transmission network in New South Wales (NSW) and the Australian Capital Territory (ACT). TransGrid is seeking approval under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the construction and operation of a new 330 kilovolt (kV) underground transmission cable circuit between the existing Rookwood Road substation in Potts Hill and the Beaconsfield West substation in Alexandria (the project).

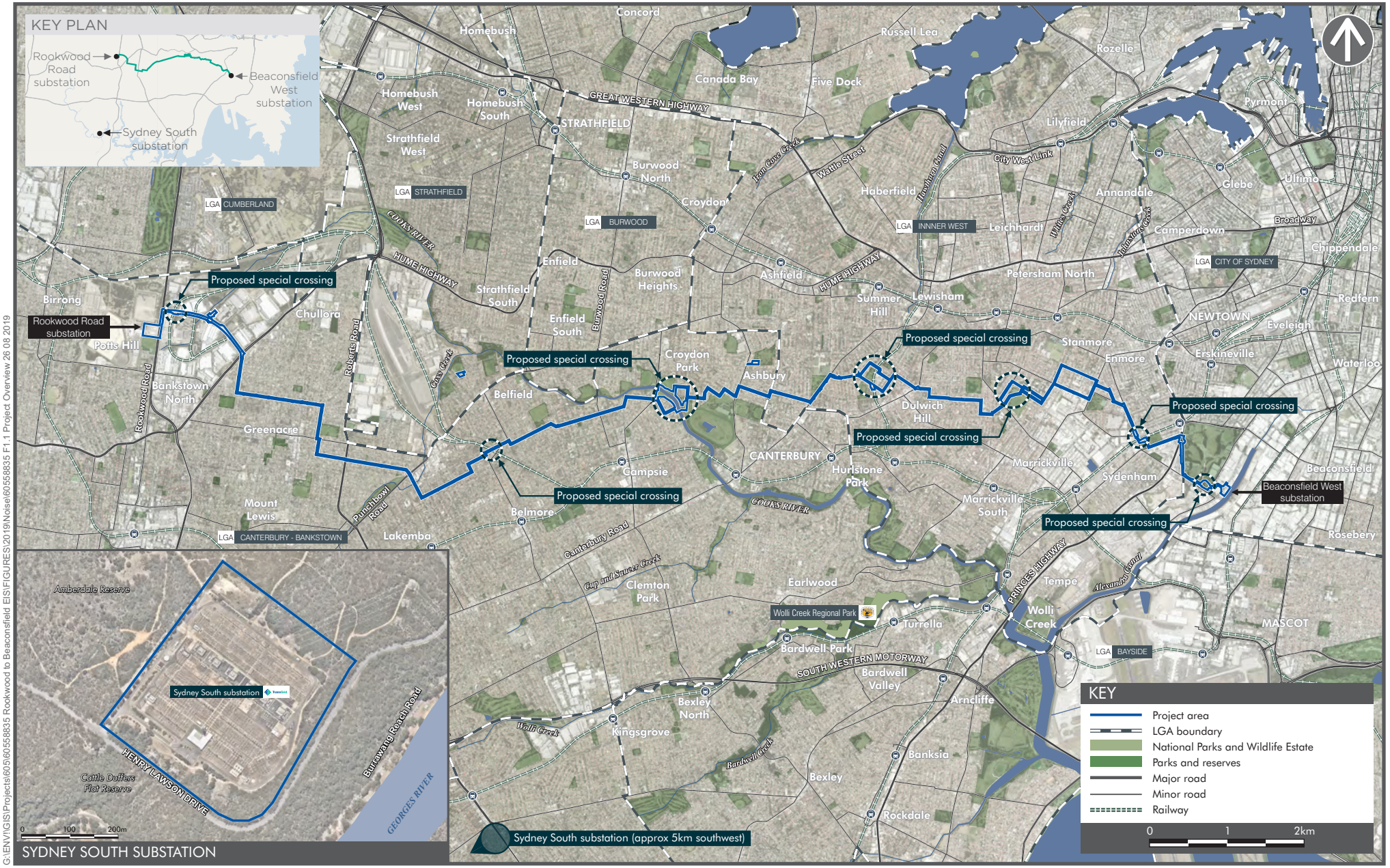
The project has been identified as a solution to address existing issues in the electricity supply network for inner Sydney, which is characterised by ageing and deteriorating electrical infrastructure and forecast increases in consumer demand.

As the project is state significant infrastructure under section 5.12 of the EP&A Act, an Environmental Impact Statement (EIS) has been prepared to assess the impacts of the project. This construction noise and vibration technical report has been developed in support of the EIS.

1.1 Project overview

The transmission cable circuit would be about 20 kilometres long and would generally be located within existing road reserves, at existing electrical infrastructure sites, within public open space and on previously disturbed areas as shown in **Figure 1-1**. The project would comprise the following key components:

- cable works connecting Rookwood Road substation with the Beaconsfield West substation;
- special crossings of infrastructure or watercourses;
- upgrade works at the Rookwood Road and Beaconsfield West substations;
- conversion works at the Beaconsfield West and Sydney South substations; and
- temporary construction laydown areas to facilitate construction of the project.



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PROJECT OVERVIEW

Powering Sydney's Future

Potts Hill to Alexandria Transmission Cable Project

Note: The project area is confined to the roadway reserve with the exception of parks and existing substations
Source: Department of Finance, Services and Innovation - Spatial Services (2018), Nearmap (2018)

FIGURE 1-1

1.2 Purpose of this technical report

This technical report has been prepared in accordance with the revised Secretary's Environmental Assessment Requirements (SEARs) issued for the project on 20 August 2019 by the Planning Secretary of the NSW Department of Planning, Industry and Environment (DPIE).

The SEARs relevant to this technical assessment are presented in **Table 1-1**.

Table 1-1 Noise and vibration SEARs

SEARs		Section addressed
Noise and Vibration	• an assessment of the likely construction noise impacts of the project under the *Interim Construction Noise Guidelines* (ICNG) (DECC, 2009);	Noise impacts are discussed in **Section 6.4**.
	• n assessment of the likely vibration amenity and structural impacts of the project under the *Assessing Vibration: A Technical Guideline (DECC, 2006)* and *German Standard DIN 4150-3 Structural Vibration – Effects of vibration on structures*, including consideration of impacts to the structural integrity and significance of heritage items;	Vibration impacts are discussed in **Section 6.7**.
	• where blasting is required during construction, an assessment of blast impacts in accordance with relevant guidelines; and	Blasting is not required.
	• measures to be implemented to minimise noise impacts, including the use of staging the construction and respite periods to reduce impacts on sensitive land uses.	Management and mitigation measures are outlined in **Section 7.0**.

2.0 Description of the project

2.1 Project components

Key components of the project are listed below. A detailed description of the project is provided in **Chapter 4 Project description** of the EIS:

- cable works connecting Rookwood Road substation with the Beaconsfield West substation comprising:
  - a 330 kV underground transmission cable circuit comprising three cables installed in three conduits;
  - another set of three conduits for a possible future 330 kV transmission cable circuit if it is required;
  - four smaller conduits for carrying optical fibres;
  - around 26-30 joint bays, per circuit, where sections of cable would be joined together, located approximately every 600-800 metres along the transmission cable route;
  - link boxes and sensor boxes associated with each joint bay to allow cable testing and maintenance;
  - optical fibre cable pits for optical fibre cable maintenance;
- seven special crossings of infrastructure or watercourses including two rail lines (at Chullora and St Peters), one freight line (Enfield Intermodal rail line at Belfield), one light rail line (at Dulwich Hill), the Cooks River and its associated cycleway (at Campsie/Croydon Park), a playground (at Marrickville) and the southern wetland at Sydney Park (at Alexandria);
- upgrade works at the Rookwood Road and Beaconsfield West substations to facilitate the new 330 kV transmission cable circuit;
- conversion works at the Beaconsfield West and Sydney South substations to transition the existing Cable 41 from a 330 kV connection to a 132 kV connection; and
- five temporary construction laydown areas to facilitate construction of the project.

Associated works required to facilitate the construction of the project, such as potential utility relocations, have been considered. No major relocations are anticipated and where smaller services may need to be moved to accommodate the transmission cable circuit, this relocation would be restricted to within the project area assessed in this EIS.

The project does not include the cable pulling and jointing works for the possible future second transmission cable circuit. This activity, should it be required, would be subject to separate assessment and approval as per the requirements of the EP&A Act.

Several route options and alternative construction methods are being considered as part of the project. These are described further in **Section 2.4**

2.2 Project location

The project would be located in the suburbs of Potts Hill, Yagoona, Chullora, Greenacre, Lakemba, Belmore, Belfield, Campsie, Croydon Park, Ashbury, Ashfield, Dulwich Hill, Marrickville, Newtown, St Peters, Alexandria and Picnic Point in the following local government areas (LGAs):

- City of Canterbury-Bankstown;
- Strathfield;
- Inner West; and
- City of Sydney.

The location of the project is shown on **Figure 1-1**.

The project would be located primarily within road reserves, at existing electrical infrastructure sites, within public open space and on previously disturbed areas. The project has been and would continue to be designed to avoid impacts to private property and open spaces where possible; however, there would be a need for both the use of public open space and easements over some private commercial properties due to significant existing constraints within the road reserve. Land uses adjacent to the road reserves in which the project would be located are mainly residential, with relatively short sections of commercial and mixed uses in the suburbs of Dulwich Hill and Petersham. The project would be located close to industrial areas at the western and eastern ends of the project around Potts Hill, Chullora, Greenacre, Marrickville, St Peters and Alexandria. The existing Sydney South substation at Picnic Point is surrounded by the George's River National Park.

The locations of the proposed special crossings are provided in **Table 2-1**.

Table 2-1 Location of proposed special crossings

Location	Crossing type	Infrastructure or watercourse crossed
Muir Road, Chullora	Cable bridge	Rail line
Enfield Intermodal Terminal, Belfield	Underbore	Freight rail line
Cooks River, Campsie/Croydon Park/Ashbury	Cable bridge or underbore (preferred)	Cooks River and cycleway
Arlington Light Rail Station, Dulwich Hill	Underbore	Dulwich Hill light rail line or station
Amy Street, Marrickville	Underbore	Playground near Henson Park
Bedwin Road, St Peters	Cable bridge	Rail line
Sydney Park, Alexandria	Underbore	Wetland

2.3 The project area

The project area comprises the overall potential area of direct disturbance by the project, which may be temporary (for construction) or permanent (for operational infrastructure) and extends below the ground surface. It includes all options under consideration for the project as described in **Section 2.4**.

The project area includes the location of operational infrastructure and construction work sites for:

- the transmission cable route (including the entire road reserve[1] of roads traversed);
- special crossings of infrastructure or watercourses;
- substation sites requiring upgrades (noting that all works would be contained within the existing site boundaries); and
- construction laydown areas.

While the boundaries of the project area represent the physical extent of where project infrastructure may be located, or construction works undertaken, it does not mean that this entire area would be physically disturbed or that indirect impacts would not be experienced beyond this area. Should the project be approved, the detailed design would aim to refine the location of project infrastructure and work sites within the boundaries of the project area assessed in this EIS.

There is a possibility that to minimise impacts on other utilities or transport corridors (roads and rail), that deviations from the assessed project area may be required. In this event, specific impacts of this approach would be assessed further. Future changes to the project may require additional assessment and approval as described in more detail in **Chapter 5 Statutory planning and approval process**.

[1] Road reserve is defined as the area comprising roads, footpaths, nature strips and public transport infrastructure (including indented bus bays, bus shelters and bus stop signage).

The location of joint bays and the location of the transmission cable circuit within the road reserve (e.g. kerbside or non-kerbside) is yet to be determined and is subject to detailed design.

2.4 Options under consideration

The project includes route options and alternative construction methods in locations as outlined below and shown in Figure 4-6 in **Chapter 4 Project description** of the EIS. As the project design develops, a preferred option would be selected for each location. However, approval may be sought for some options where further design and engineering information is required before a preferred option can be selected.

The project options are discussed below by geographical area, from west to east.

2.4.1.1 Cooks River

There are three options for the transmission cable route in the vicinity of the Cooks River at Campsie/Croydon Park and two options for special crossing methods, including:

- Option 1: the transmission cable route travels in a south-easterly direction along Cowper Street from the intersection with Brighton Avenue, Campsie and then east on Lindsay Street. At the cul-de-sac at the end of Lindsay Street, there are two special crossing options of the Cooks River into Lees Park before the cable route continues on to Harmony Street, Ashbury:
  - Option 1a: construct a cable bridge parallel to and to the north of the existing Lindsay Street pedestrian bridge; or
  - Option 1b: install the conduits under the Cooks River via underboring (this is the preferred option); or
- Option 2: the transmission cable route travels in a north-easterly direction from Byron Street at the intersection with Brighton Avenue, Campsie, through Mildura Reserve. From this parkland, the conduits would be underbored beneath the Cooks River, surfacing in Croydon Park near the cul-de-sac of Croydon Avenue in Croydon Park. The cable route then travels north along Croydon Avenue, east along Dunstan Street, and south along Hay Street, before continuing east along Harmony Street; or
- Option 3: the transmission cable route travels in an easterly direction from Byron Street at the intersection with Brighton Avenue, Campsie, then in a south-easterly direction through Mildura Reserve, between residences and the Cooks River until the cul-de-sac at Lindsay Street. From here, there are two special crossing options of the Cooks River into Lees Park before the cable route continues on to Harmony Street, Ashbury, which are the same for Option 1:
  - Option 3a: construct a cable bridge parallel to and to the north of the existing Lindsay Street pedestrian bridge; or
  - Option 3b: install the conduits under the Cooks River via underboring.

A description of the cable bridge and underboring methods is provided in **Section 2.5**, with further detail in **Chapter 4 Project description** of the EIS.

2.4.1.2 Dulwich Hill light rail corridor

There are two options for the transmission cable route crossing of the Dulwich Hill Light Rail corridor in the vicinity of the Arlington Light Rail station, Dulwich Hill. This includes:

- Option 4a: the transmission cable route travels northeast along Windsor Road from the intersection with Arlington Street, then east on Terry Road. At the Terry Road cul-de-sac, the conduits would be underbored beneath the rail corridor, surfacing at the Hill Street cul-de-sac. From here the cable route continues along Hill Street to Denison Road; or
- Option 4b: the transmission cable route travels southeast along Constitution Road from the intersection with Arlington Street, before crossing into the southern end of Johnson Park. From here, the conduits would be underbored beneath the rail corridor near the Arlington light rail station. The transmission cable route then continues along Constitution Road and then north on Denison Road.

2.4.1.3 Henson Park

There are two options for the transmission cable route crossing in the vicinity of Henson Park, Marrickville including:

- Option 5a: the transmission cable route continues northeast on Centennial Street to a car park. From here it travels in an easterly direction through a grassed verge between the tennis courts and Henson Park oval to near the Amy Street playground. The conduits would be underbored beneath the playground, surfacing at Amy Street. The transmission cable route then turns east on to Horton Street; or
- Option 5b: the transmission cable route travels north on Sydenham Road from Centennial Street, turning northeast on to Neville Street, then southeast on Surrey Street to Amy Street before continuing along Charles Street.

2.4.1.4 Marrickville

There are two options for the transmission cable route in the vicinity of Addison Road, Marrickville. Note that the project may include one or both options at this location including:

- Option 6a: the transmission cable route travels north along Agar Street from the intersection with Illawarra Road, then east on to Newington Road and south down Enmore Road to the intersection with Scouller Street; and/or
- Option 6b: splitting the two circuits as there is insufficient space along Addison Road to accommodate both circuits. One circuit would travel along Newington Road (as for Option 6a) and one circuit would travel east on Addison Road from the intersection with Illawarra Road, then north on Enmore Road to the intersection with Scouller Street.

2.5 Construction works

Construction activities would be limited to the identified project area and include the activities summarised in **Table 2-2**. A substantial portion of the transmission cables would be installed using pre-laid conduits. The conduits would only require the excavation of short sections of trench at a time (an average of 20 metres at any one location), with backfilling occurring as soon as each section of the conduits has been installed. Depending on the overall construction program and associated number of work crews required, it is expected that trenching and excavation would occur concurrently at multiple work sites along the transmission cable route.

The project would involve the construction of seven special crossings that would involve either the installation of a cable bridge or underboring (i.e. an underground crossing). Works for these crossings would be undertaken in coordination with the relevant asset owner (e.g. road or rail authorities).

The construction of the project would require a number of work sites along the transmission cable route and at special crossings. Each work site represents an area of disturbance required to undertake the construction activity (e.g. trenching, cable bridge installation, underboring) and would be located within the project area.

Table 2-2 Summary of construction activities

Construction activity	Description
Site preparation	• implementation of traffic management changes (such as safety barriers and road signage) to facilitate access and egress to/from the work sites; • installation of environmental control measures (such as sediment barriers); • vegetation clearing and tree removal, where required; • establishing construction laydown areas and ancillary facilities including temporary offices and worker amenities, site fencing and provision of power/services; and • delivery and storage of plant and equipment at construction laydown areas and work sites.

Construction activity	Description
Trenching and excavation	• clearing of surface vegetation along excavation area if required; • saw cutting of the road surface/pavement and lifting this material using a backhoe/front end loader. If rock is encountered, a rock breaker may be used to loosen the material; • removal of material down to the base of the trench using an excavator and placement of spoil directly onto trucks to be transported to a licensed facility. The trench would typically be around 3 metres wide and 1.2 metres deep but could be deeper or shallower depending on the presence of utilities; and • installation of shoring as a precaution against slump or collapse where necessary, particularly where deeper sections of trench are required (i.e. deeper than 1.4 metres).
Relocation of minor utilities/services	• use of non-destructive digging methods to expose buried services to guide the excavator; and • minor relocations, if required, would occur within the road reserve and be subject to consultation with the relevant asset owner/operator.
Conduit installation and backfilling	• laying the transmission cable conduits on plastic spacers to provide the required clearance from the side walls and bottom of the trench; • placing the optic fibre communication cable conduits into position; • backfilling the trench with engineered backfill; • laying of polymeric covers and warning tape, marked with appropriate warnings in case of accidental excavation; and • installation of the road base and temporary restoration of the road surface to allow vehicles and other road users to travel across the area.
Excavation and establishment of joint bays	• excavation of joint bays via open trenching; • installation of erosion and stormwater flow controls and barriers; • erecting fencing or hard barriers as required; • provision for vehicle access, worker amenities and equipment storage; • temporary covering with steel plates to provide access to adjacent properties where required; and • excavation of nearby pits to facilitate the installation of link and sensor boxes.
Cable pulling and jointing	• installation of a tent or demountable building over the joint bay to provide a controlled work environment and dry work site; • pulling cables through the conduits which is fed from large drums holding 600-800 metres of cable; and • connecting sections of cables at the joint bay.
Permanent road restoration	• removing the temporary road surface; • backfilling with road base up to surface level, where required; • reinstating pavement; and • reinstating the remaining areas that were excavated with spoil or other fill material to pre-construction levels and final finishing to match existing as appropriate (e.g. footpath and/or kerb and gutter), or as otherwise agreed with the relevant roads authority.

Construction activity	Description
Cable markers	• once restoration activities have been completed, cable markers would be installed along the transmission cable route to give warning of the presence of the cables and the need to make enquiries before digging; • markers may include: - small signs attached to road kerbs; - concrete marker posts (between 800 to 900 millimetres tall) along the transmission cable route in vegetated areas where surface markers would be difficult to see; or - flush-markers constructed of concrete that are around 50-100 millimetres thick.
Cable bridges	• establishment of the work site and access including vegetation clearing (where required); • boring and earthworks for the bridge piers; • installation of the pre-cast cable bridge and steel cage (where required) by crane; • integration with the conduits in the road reserve; and • reinstatement of the work site.
Underboring	• underboring around 4 to 10 metres below the ground surface by either thrust boring or horizontal directional drilling (HDD); • thrust boring would require a launch pit (at least 4 m metres deep) and associated work site of up to around 800 square metres and a receive pit and work site of about 100 square metres; • HDD would require a work site at the drill launch area of up to around 800 square metres and a receive pit for the drill exit of around 1.5 metres deep; and • work sites would be restricted to the road reserve and public open space areas where feasible and reasonable to limit the need for vegetation removal.
Substation upgrades	• site establishment; • earthworks and excavations needed for cable entries and footings for new equipment; • installation of new infrastructure (such as switchbays and busbars); • removal of redundant infrastructure; • installation and connection of new cables; • commissioning of cables; and • demobilisation.

2.5.1 Staging and timing of construction activities

An indicative duration of construction activities is provided in **Table 2-3**. The timing is subject to the detailed design and the final construction approach. For example, some works, such as trenching and excavation, would be undertaken by multiple work crews working along the transmission cable route. Staging of activities outside of certain hours would also influence the construction approach.

Should the project be approved, construction is planned to occur over 24 months, commencing in 2020. It is estimated that around 15 months would be required for civil construction works and conduit installation and about nine months for cable pulling and jointing, testing and commissioning. The transmission cable circuit is expected to be completed and commissioned in 2022/23.

Table 2-3 Indicative timing of typical construction activities

Construction activity	Indicative duration
Excavation, conduit (pipe) installation and trench backfilling	Conduits for each 600-800 metre cable section would take up to eight weeks to install (with most properties exposed to around two weeks of trench excavation activity).
Joint bay construction	Each individual joint bay would take up to three weeks to establish (in addition to trenching works). Each joint bay contains one cable circuit.
Cable pulling	Cable pulling at each joint bay for each 600-800 metre cable section would typically take up to two weeks to complete.
Cable jointing	Cable jointing would typically take up to three weeks to complete at each joint bay.
Special crossings - Cable bridges	Each cable bridge crossing is expected to take around 10 weeks to complete in total, however works would be staged and not continuous over the 10 week period.
Special crossings - Underboring	Each underbore is expected to take around eight to 10 weeks to complete in total, however works would be staged and not continuous over this period.
Substation works	Construction works at the Rookwood Road substation is expected to take around four to six months, while works at the Beaconsfield West and Sydney South substations are expected to take around six to nine months at each site.

2.5.1.1 Construction hours

Construction works would be undertaken during standard daytime construction hours as specified in the *Interim Construction Noise Guideline* (DECC, 2009) where reasonable and feasible to do so. However, it is expected that works outside standard construction hours would also be required, as described below.

Standard construction hours are:

- Monday to Friday 7am to 6pm;
- Saturday 8am to 1pm; and
- No work on Sundays and public holidays.

It is likely that construction works would be required at night time (after 10pm) due to the requirements of relevant road and rail authorities. These works could include, but are not limited to, works within major road reserves (i.e. on State and regional roads such as Rookwood Road and Old Canterbury Road), through signalised intersections, or at special crossings. Work outside standard construction hours may be required for safety reasons and/or to limit disruption to road traffic and rail services.

Cable jointing works at each joint bay would need to be undertaken continuously i.e. 24 hours. Some works at the substation sites may also need to be undertaken outside of standard construction hours due to outage constraints on the existing infrastructure (i.e. the need to maintain power supply to customers).

Cable bridges and underboring at rail corridors would be timed with other rail works to limit disruption to freight and/or passenger rail services. These works could be undertaken outside of standard construction hours including at night time or over weekends, subject to approval of the relevant rail authority.

Scheduled construction activities, work hours and duration would be further refined through consultation with relevant government agencies and would be outlined in the CEMP for the project.

2.5.2 Construction precincts

The transmission cable route has been divided into five construction precincts. These precincts broadly align with similar land uses. A description of each precinct follows:

- **Precinct 1** includes the areas between the Rookwood Road substation and the Hume Highway, including the industrial area of Chullora along Muir Road;
- **Precinct 2** includes the areas between the Hume Highway and Brighton Avenue near the Cooks River including the residential areas of Greenacre, Lakemba, Belmore, Belfield and Campsie;
- **Precinct 3** includes the areas from the Cooks River to Illawarra Road including the residential areas of Croydon Park, Ashbury, Ashfield, Dulwich Hill and Marrickville;
- **Precinct 4** includes the area between Illawarra Road and the Bankstown rail line including the residential areas of Marrickville, Enmore and Newtown; and
- **Precinct 5** includes the areas between the Bankstown rail line and the Beaconsfield West substation including the residential areas of St Peters and the recreational area of Sydney Park in Alexandria.

2.5.3 Construction laydown areas

As part of the construction of the project, temporary construction laydown areas would be required to store materials, equipment, excavated spoil and provide space for other ancillary facilities such as site offices. Five locations have been investigated as potential construction laydown areas. The final number and location is subject to ongoing consultation with the relevant landowners and would be determined during detailed design.

Stockpiling of excavated spoil at the construction laydown areas would be ongoing for the duration of the civil works (around 15 months). Stockpiling would be managed by erosion and sediment controls in accordance with *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004) (The Blue Book).

While it is expected that construction would require the use of transportable roadside facilities for individual work sites, provision for temporary site offices would be located within construction laydown areas for the duration of construction (up to two years).

Construction laydown areas would be fenced and would have lighting for security and to facilitate night works.

Driveways may need to be created from gravel or similar material to enable heavy vehicles to enter/exit the site. At construction laydown areas at Cooke Park and Peace Park, extended driveways would be required to access the laydown areas. The construction of these driveways would require ground disturbance and potentially tree removal.

Temporary infrastructure at the construction laydown areas, including noise mitigation controls (such as hoardings), driveways and stockpile areas, would involve minimal subsurface ground disturbance (i.e. excavation) and would be removed once construction is complete.

For works at the Rookwood Road and Sydney South substation sites, sufficient space exists at each location to store materials and equipment; therefore, no additional laydown areas would be required.

The proposed locations and areas required for the five potential construction laydown areas are listed in **Table 2-4**.

Table 2-4 Potential construction laydown areas

Potential construction laydown area	LGA	Potential area (hectares)
12 Muir Road, Chullora	Canterbury-Bankstown	0.48
Cooke Park, Belfield	Strathfield	0.37
Peace Park, Ashbury	Inner West Council	0.45
Camdenville Park, St Peters	Inner West Council	0.18
Beaconsfield West substation, Alexandria	City of Sydney	0.85

2.6 Cable operation and maintenance

Once the transmission cables have been installed, generally only visual inspections would be required. This would involve regularly driving along the transmission cable route to check for hazards or activities (such as excavation works in the vicinity) that could impact the underground cables or cable bridges. Ongoing physical access to the transmission cables is not required however ongoing monitoring of the cable for damage (missing/worn cable markers) and outages would occur. This would be through access to the link boxes and sensor boxes located near the joint bays. Optical fibre cables installed alongside the transmission cables would be monitored at the optical fibre cable pits.

Pits for link and sensor boxes and optical fibre cables would generally be located in the footpath/road verge but in some cases where there is insufficient space, they may be required in the roadway. Roadway access would be managed with standard traffic controls.

Regular checks of the pits would ensure they are accessible and that the pit does not contain water or tree roots. Cable bridge structures would be inspected to ensure structural integrity and aesthetics are being maintained.

2.7 Other relevant technical information

2.7.1 Plant and equipment

The following typical plant and equipment are likely to be used during construction of the project:

- chainsaws;
- diamond saws;
- jackhammers;
- rock breakers;
- hand tools;
- hydraulic excavators;
- drill rig;
- spoil haulage trucks;
- mobile cranes and elevated working platforms;
- piling rigs;
- concrete trucks;
- winch trucks;
- low loaders;
- vacuum tankers/trucks;
- light vehicles;
- temporary generators;
- compressors;
- backhoes/front-end loaders;
- mixing plant;
- road millers;
- asphalt machine; and
- heavy rollers.

2.7.2 Site access and traffic movements

Access for heavy vehicles would be required throughout the project area. The standard of access along the transmission cable route would be sufficient to permit passage of excavators, spoil haulage trucks, concrete trucks, low loaders and mobile cranes. The estimated vehicle movements required for construction is outlined in **Table 2-5**. The vehicle numbers estimated do not include private vehicles used by the workforce to arrive at the work site, or traffic management vehicles. The vehicle numbers for the 'transmission cable route' assume four work crews operating concurrently at multiple locations within the project area. The final number of work crews, materials and vehicle movements would be determined during detailed design and construction planning.

Table 2-5 Anticipated vehicle movements

Location	Activity	Number of vehicle movements per day
Construction laydown areas	Delivery/pickup of plant and materials, spoil transfer (at relevant sites)	Vehicle movements per construction laydown area, per day: • Light: 3-4; and • Heavy: 12.
Transmission cable route – trenching and joint bay excavation	Delivery of plant and materials, removal of spoil, general construction	Vehicle movements for four work sites, per day: • Light: 16; and • Heavy: 96.
Special crossings	Delivery of plant and materials, removal of spoil, general construction	• Light: 10-12; and • Heavy: 8-10.
Substation upgrade – Rookwood Road	Delivery of plant and materials, removal of spoil	• Light: 3-4; and • Heavy: 4.
Substation upgrade – Beaconsfield West	Delivery of plant and materials, removal of spoil	• Light: 3-4; and • heavy: 4.
Substation upgrade – Sydney South	Delivery of plant and materials, removal of spoil	• Light: 5-6; and • Heavy: 6.

Equipment and materials would be held in storage at the laydown areas until needed and delivered to the relevant work sites. Larger plant and cable materials may be delivered at night to avoid disrupting daytime traffic. Materials such as the cable drums may be temporarily stored near the trench and would be securely stored and barricaded.

Where the trench intersects another road or access to properties is required to enable construction works, vehicle and pedestrian passage would be restored as soon as possible after excavation has passed the intersection or access point.

2.7.3 Workforce

Typical workforce requirements are set out in **Table 2-6**. The numbers presented in **Table 2-6** are an estimate only of the number of workers likely needed to undertake construction activities. Additional workers would be required for traffic management. It is expected that multiple work crews would be spread along the transmission cable route and at the substation sites. A peak construction workforce of around 70 personnel is expected to be required for the project, assuming four work crews operating concurrently on works associated with the transmission cable route (i.e. excluding substation upgrades and special crossings).

Table 2-6 Typical workforce requirements

Construction activity	Workforce estimate (per work site)
Trenching and backfilling	4 to 6
Cable pulling	12 to 15
Permanent road restoration	4 to 6
Cable jointing	4 to 6
Cable bridge construction	8 to 10
Underboring	4 to 6
Substation upgrades	20 to 30

3.0 Assessment methodology

3.1 Study area

The study area for this report comprises a buffer of up to 1,000 metres around the transmission cable route, construction laydown areas and substation sites. The study area is shown on **Figure 3-1**.

3.2 Approach and methodology

The approach to this Construction Noise and Vibration Impact Assessment (CNVIA) was to:

- identify the noise and vibration sensitive receivers likely to be affected by construction noise and vibration;
- establish the existing background noise levels in the vicinity of the project by noise monitoring (refer to **Table 4-3**);
- establish construction noise management levels (NMLs), which are based on background noise levels and vibration limits, which would apply to the project in accordance with the relevant guidelines and policies listed in **Section 3.3** (refer to **Table 5-2**, **Table 5-3**, **Table 5-4 Table 5-6** and **Table 5-7**);
- predict noise levels from typical worst case construction scenarios;
- identify the likely impact from airborne construction noise levels at nearby residential and other sensitive receivers, by comparing the predicted noise level against the NMLs, during construction of the project (refer to **Sections 6.4** to **6.7**);
- predict vibration levels and identify potential impacts from construction vibration;
- identify the likely noise impacts generated by additional construction traffic on public roads during construction of the project (refer to **Section 6.6**);
- recommend environmental management and mitigation measures where necessary to reduce and manage construction noise and vibration impacts from the project (refer to **Section 7.0**); and
- address the SEARs relevant to noise and vibration listed in **Table 1-1**.

3.3 Statutory context, policy and guidelines

The relevant legislation, policies and guidelines for the assessment of noise and vibration in NSW that have been considered during the preparation of this report include:

- *Interim Construction Noise Guideline* (ICNG), Department of Environment and Climate Change (DECC), 2009;
- *Assessing Vibration: A Technical Guideline* (AVATG), Department of Environment and Conservation (DEC), 2006;
- *NSW Road Noise Policy* (RNP), Department of Environment, Climate Change and Water (DECCW), 2011;
- *Noise Policy for Industry* (NPfI), Environment Protection Authority (EPA), 2017;
- German Standard DIN 4150: *Part 3 1999 Structural Vibration in Buildings - Effects on Structures*, 1999;
- British Standard 6472: Part 1 2008 *Evaluation of Human Exposure to Vibration in Buildings*, 2008;
- Australian Standard AS 2436-2010, *Guide to noise and vibration control on construction, demolition and maintenance sites*, 2010;
- Australian Standard AS 1055.1-1997 – *Acoustics – Description and measurement of environmental noise, Part 1: General procedures*, 1997; and

- UK Department for Environment, Food and Rural Affairs (DEFRA) *Update of noise database for prediction of noise on construction and open sites*, 2006.

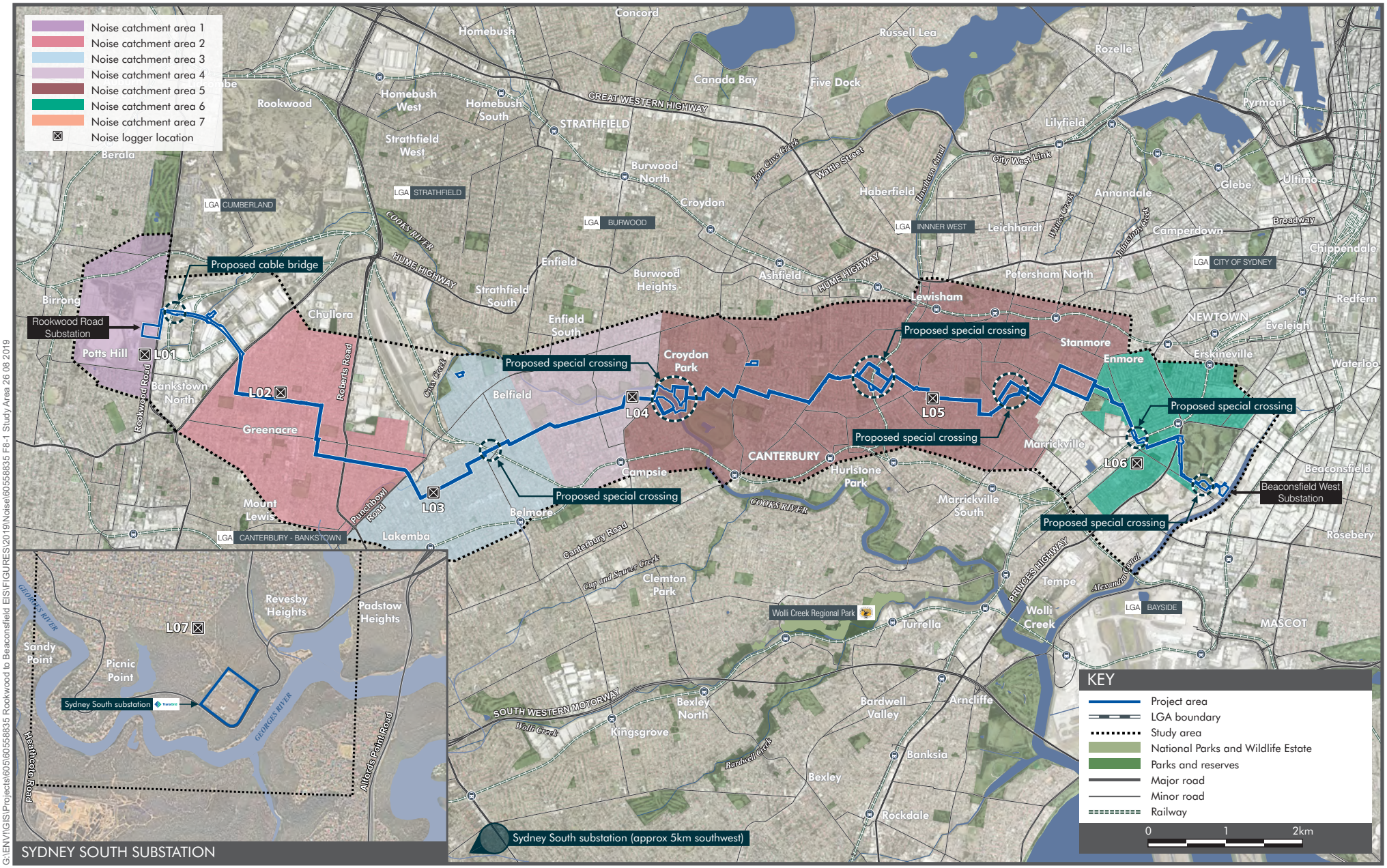

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FIGURE 3-1

Note: The project area is confined to the roadway reserve with the exception of parks and existing substations
The noise catchment areas group receivers which have a similar noise environment together and are focussed on noise sensitive land uses such as residential areas
Source: Department of Finance, Services and Innovation - Spatial Services (2018), Nearmap (2018)

4.0 Description of the existing environment

4.1 Noise sensitive receivers

4.1.1 Noise catchment areas

The project area was divided into seven noise catchment areas (NCAs), as shown on **Figure 3-1**. The NCAs were determined by reviewing existing land use and identifying groups of noise sensitive receivers which are likely to be exposed to a similar noise environment. For urban and suburban environments ambient noise levels in these areas are typically controlled by transport infrastructure and noise generating industry.

Noise sensitive receivers for the project include people within noise sensitive land uses as defined by the ICNG, being:

- residential areas;
- educational establishments;
- hospitals;
- places of worship;
- active recreational areas;
- passive recreational areas; and
- community centres.

Commercial and industrial receivers are generally not considered noise sensitive, however some may comprise specific uses which are considered noise sensitive. For example; child care centres, aged care and theatres (when in use) are considered noise sensitive receivers. Where a number of commercial and industrial receivers are located together and are not considered sensitive, they have not been included in an NCA; however they have still been assessed within this report.

A description of the NCAs developed for this project and their location is presented below in **Table 4-1**.

Table 4-1 Noise catchment areas and description

NCA	Description of noise catchment areas
1	Includes mainly low density residential properties within Yagoona, Potts Hill and Regents Park. This NCA is also adjacent to industrial properties within Potts Hill and Chullora.
2	Includes mainly low density residential properties within Greenacre but also includes some high and medium density residential properties. Bordered by industrial properties to the northwest and northeast. Greenacre Town Centre is located in the centre of the NCA and includes Greenacre Area Community Centre. Other non-residential noise sensitive receivers include St John Vianney Catholic Church, St John Vianney Catholic Primary School, Good Shepherd Church, Sydney Full Gospel Church, Greenacre Public School, Banksia Road Public School, Greenacre Montessori Academy Child Care Centre, Playtime Child Care Centre, Tiny Tots Kindergarten, Funtime Child Care Centre, Kindy Academy Child Care Centre, Mickey's World Child Care Centre, Alnoori Muslim School, Al Sadiq College, Liberty Church of Christ, KU Karingal Preschool, Holy Saviour Primary School and Wangee Road Child Care Centre.

NCA	Description of noise catchment areas
3	Includes mainly medium and high density residential properties within Lakemba, Belmore and Belfield. The Enfield Intermodal Terminal is located to the northwest. Other non-residential noise sensitive receivers include St Michael's Catholic Primary School, Belfield Uniting Church, Church of St Michael the Archangel, St Andrews Anglican Church, Lakemba Mosque, Hanaro Presbyterian Church, Saint Therese Catholic Church, St Therese's Catholic Primary School, three Care for Kindies Child Care Centres, Hamden Park Public School, Canterbury Vale School, Colonial Preschool Child Care Centre, Embassy Church, Belmore North Public School and Star Academy Kids Learning Centre.
4	Includes a mix of low, medium and high density residential properties within Croydon Park and Campsie. Other non-residential noise sensitive receivers include Love of Learning Child Care Centre and Little Learning School Child Care Centre, Oz Education Child Care Centre, Harcourt Public School and Croydon Park Baptist Church.
5	Includes mainly low density residential properties within Campsie, Croydon Park, Ashbury, Canterbury, Ashfield, Hurlstone Park, Dulwich Hill, Lewisham, Marrickville and Stanmore with some medium and high density residential properties. Other non-residential noise sensitive receivers include child care centres, Sydney Private Hospital, Bethel Nursing Home, Ashbury Public School, Summer Hill Aged Care Services Nursing Home, Woodstock Child Care Centre, Summer Hill Public School and St Patrick's Catholic Primary School and Trinity Grammar School, Summer Hill Children's Centre, St Patrick's Catholic Church, Lewisham Public School, Christian Brothers' High School Lewisham, Newington College, Petersham Primary School, Addison Road Early Learning Centre, Learn & Laughter Early Learning Centre, Enmore Road Early Learning Centre, Canaan Presbyterian Church, Petersham Baptist Church and Marrickville Kingdom Hall of Jehovah's Witnesses, St Francis Xavier Catholic School, Canterbury Public School, and Croydon Park Public School.
6	Includes mainly low density residential properties within Enmore, Newtown, Erskineville and St Peters but also includes some medium and high density residential properties. Industrial properties are located to the west and east. Sydney airport is located to the south. Other non-residential noise sensitive receivers include Camdenville Public School, St Pius Catholic Primary School, St Peters Public School, Only About Children Child Care Centre and St Pius Enmore Catholic Church.
7	Includes mainly low density residential properties within Picnic Point, Revesby Heights and Alfords Point.

4.2 Unattended noise monitoring

Long term noise monitoring was undertaken within each NCA to determine existing background noise levels. Long-term unattended noise monitoring was conducted at three locations during February 2018, at one location during May 2018 and at three locations during May 2019. One noise logger was placed within each NCA at a representative location as shown in **Table 4-2**. The locations of the noise loggers are shown on **Figure 3-1**. The noise loggers were calibrated prior to and after the monitoring period with a drift in calibration not exceeding ± 0.5 dB(A).

Table 4-2 Noise logger locations

NCA	Logger ID	Location	Model	Serial number	Monitoring date
1	L01	Boardman street, Yagoona	ARL 215	194639	13 - 22 February 2018
2	L02	Merrett Crescent, Greenacre	ARL 315	15-299-444	13 - 21 February 2018
3	L03	Yangoora Road, Lakemba	ARL 315	15-203-504	15 – 24 May 2019
4	L04	Byron Street, Campsie	Rion NL52	876010	15 – 24 May 2019
5	L05	Pile Street, Dulwich Hill	Rion NL21	876010	15 – 24 May 2019
6	L06	Brown Street, St Peters	Rion NL21	265112	14 - 22 February 2018

NCA	Logger ID	Location	Model	Serial number	Monitoring date
7	L07	Claverdon Avenue, Picnic Point	ARL 315	15-299-444	7 - 16 May 2018

4.2.1 Instrumentation

All the acoustic instrumentation employed during the noise measurements complies with the requirements of *AS IEC 61672.1-2004 Electroacoustics - Sound level meters - Specifications* and were within their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. calibration in the last two years).

In accordance with the NPfI, noise monitoring affected by adverse weather conditions or extraneous noise events was excluded from the monitoring data. The NPfI advises that data may be affected where adverse weather, such as wind speeds higher than five metres per second or rain, occurs. Weather data were acquired from the Bureau of Meteorology's Canterbury weather station (station ID 60901).

4.2.2 Noise measurements

The loggers measured continuous noise levels over the monitoring periods. Based on the noise logger data, the L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels of each representative noise logger location (representative of the respective NCA) were then determined. The $L_{A1,}$ L_{A10} and L_{A90} noise levels are the levels exceeded for 1%, 10% and 90% of the monitoring period respectively. The L_{A90} is taken as the background level. The L_{A1} is indicative of the maximum noise levels due to individual noise events such as the pass-by of a heavy vehicle. The L_{Aeq} level is the equivalent continuous sound level and has the same sound energy over the sample period as the actual noise environment with fluctuating sound levels.

The L_{A90} noise levels were analysed to determine a single assessment background level (ABL) for each day, evening and night period for each monitoring location (representative of the respective NCA) in accordance with the NPfI. The ABL is established by determining the lowest ten-percentile level of the L_{A90} noise data acquired over each day, evening and night-time period.

The rating background level (RBL) representing the day, evening and night-time periods is based on the median of individual ABLs determined over the entire monitoring period. **Table 4-3** presents individual RBLs for each time period for each NCA.

Table 4-3 also presents the existing L_{Aeq} ambient noise levels selected for each day, evening and night-time period, determined in accordance with the NPfI. An overall representative L_{Aeq} noise level is determined by logarithmically averaging L_{Aeq} noise levels for each assessment period for the entire monitoring period. The noise logging results are presented in **Annexure A**.

Table 4-3 Unattended noise measurement results in dB(A) for all NCAs

NCA	RBL L_{A90} dB(A)			Log Average L_{Aeq} dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
NCA 1	45	45[2]	39	63	58	52
NCA 2	38	38[2]	35	53	50	45
NCA 3	40	40[2]	38	59	57	53
NCA 4	33	33[2]	32	54	45	44
NCA 5	34	34[2]	30	58	57	48
NCA 6	42	42[2]	35	61	60	56
NCA 7	30[3]	30[2]	30[3]	49	45	40

Notes:
1. In accordance with the NPfI:
   a. Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays and public holidays.
   b. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday and public holidays.
   c. Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays and public holidays.
2. Where measured Evening RBLs are higher than Daytime RBLs, Evening RBLs adjusted to the same as the daytime RBL in accordance with the NPfI (INP application notes).
3. Where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A) in accordance with the NPfI.

4.3 Site observations

Attended noise measurements were undertaken for a minimum of 15 minutes at each ambient noise logging location. The purpose and value of the attended noise measurements was for the operator to develop an understanding of the noise environment at the measurement location. The attended noise measurement results were similar to the background noise logging, so have not been reproduced in the assessment.

The following observations about the existing acoustic environment were noted during attended noise measurements and also from the results of the unattended noise monitoring:

- the acoustic environment of NCA 1 is characterised by constant road traffic noise and some industrial noise mainly during the daytime. This is typical of a suburban environment which is usually characterised by local traffic with intermittent traffic flow, with the night time noise levels often defined by the natural environment;
- the acoustic environment of NCA 2 is characterised by local traffic noise from Rawson Road and some industrial noise mainly during the daytime;
- the acoustic environment of NCA 3 is characterised by local traffic on Yangoora Road and distant traffic on Punchbowl Road, at all times of the day;
- the acoustic environment of NCA 4 is characterised by distant traffic noise from Georges River Road, Brighton Avenue and local traffic at all times of the day;
- the acoustic environment of NCA 5 is characterised by traffic noise from New Canterbury Road and local traffic at all times of the day;
- the acoustic environment of NCA 6 is characterised by aircraft noise and local traffic noise at all times of the day; and
- the acoustic environment of NCA 7 is characterised by fauna and local traffic noise at all times of the day.

These observations show the study area is primarily dominated by traffic noise at all locations and is typical of an urban environment.

5.0 Construction noise management levels

5.1 Interim Construction Noise Guideline

The ICNG is a NSW Government document that identifies ways to manage impacts of construction noise on residences and other noise sensitive land uses. It is the principal guideline for the assessment and management of construction noise in NSW and is used to establish construction noise management levels (NML).

As the proposed works are expected to continue for a period of more than three weeks and are within relatively close proximity to noise sensitive receivers, a quantitative assessment, based on 'reasonable' worst case construction scenarios, has been carried out for these works. Noise levels resulting from construction activities are predicted at nearby noise sensitive receivers using environmental noise modelling software and compared to the noise management levels, derived in accordance with the ICNG.

Where an exceedance of the NMLs is predicted, the ICNG advises that receivers can be considered 'noise affected' and the proponent should apply all feasible and reasonable work practices to minimise the noise impact. The proponent should also inform all potentially impacted residents of the nature of the works to be carried out, the expected noise level and duration, as well as provide contact details to facilitate feedback from affected residents during construction.

The ICNG also states that during recommended standard construction hours where construction noise levels reach 75 dB(A) at residences, residential receivers can be considered as 'highly noise affected' and the proponent may be required to consider restricting hours of very noisy works (such as rock breaking or road cutting) to provide respite periods. In this assessment, receivers are considered as 'highly noise affected' where noise levels are 75 dB(A) or above, regardless of the time of day. Respite periods could be a negotiated outcome with highly noise affected receivers, taking into account times identified by the community when they are less sensitive to noise, or considering whether the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

The ICNG defines what is considered to be feasible and reasonable as follows:

- **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 overall adverse social, economic and environmental effects, including the cost of the measure".

A description of ICNG NMLs is provided in **Table 5-1**. **Table 5-2** presents the actual noise management levels for this project that have been determined in accordance with the ICNG and are applicable at the noise sensitive receivers throughout the study area.

Table 5-1 ICNG residential noise management levels

Time of day	NML, LAeq,15min, dB(A)[1]	How to apply
Recommended standard hours: Monday to Friday: 7:00 am to 6:00 pm Saturday: 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise: • where the predicted or measured $L_{Aeq\ (15\ min)}$[2] is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level; and • the proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 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: - 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; and - 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 + 5 dB	• a strong justification would typically be required for works outside the recommended standard hours; • the proponent should apply all feasible and reasonable work practices to meet the noise affected level; and • 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.

Notes:
Source: based on Table 2, page 12 of the INCG (DECC, 2009)
1. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.
2. $L_{Aeq(15min)}$ is defined by the ICNG as 'the A-weighted equivalent continuous (energy average) A-weighted sound pressure level of the construction works under consideration over a 15-minute period and excludes other noise sources such as industry, road, rail and the community".

For work that is required to be undertaken outside of the recommended standard construction hours the ICNG states that where reasonable and feasible practices have been applied and noise levels are more than 5 dB(A) above the NML, community negotiation should be undertaken (see **Table 5-1** above). These negotiations are typically focused around longer working hours to reduce the overall program duration and respite provisions for special periods such as during school exams.

Work that is proposed outside of standard construction hours, as defined in the ICNG, generally requires strong justification to the relevant authorities. As noted in **Section 2.5.1.1** there are circumstances such as where work is required by licence or approval conditions, rail/road authority requirements or due to safety concerns where community negotiation would not be possible. In these circumstances, community consultation would take place to ensure that affected residents are aware in advance that the work would take place, including clear justification of why the work cannot be undertaken during standard construction hours.

Further to the above, as required by the ICNG, for this assessment, where the $L_{Aeq(15min)}$ noise levels exceed 75 dB(A) at the same receiver, respite measures should be considered. **Table 5-2** presents the NMLs applicable to residential receivers within the study area.

Table 5-2 Construction noise management levels – residential receivers

NCA	Period	RBL, L_{A90} dB(A)	Standard construction hours noise management levels[1], $L_{Aeq,15min}$, dB(A)	Outside of standard construction hours noise management levels[2], $L_{Aeq,15min}$, dB(A)
1	Day	45	55	50
	Evening	45	-	50
	Night	39	-	44
2	Day	38	48	43
	Evening	38	-	43
	Night	35	-	40
3	Day	40	40	45
	Evening	40	-	45
	Night	38	-	43
4	Day	33	43	38
	Evening	33	-	38
	Night	32	-	37
5	Day	34	44	39
	Evening	34	-	39
	Night	30	-	35
6	Day	42	52	47
	Evening	42	-	47
	Night	35	-	40
7	Day	30	40	35
	Evening	30	-	35
	Night	30	-	35

Notes:
1. Standard construction working hours are Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm.
2. Outside of standard construction hours - daytime refers to Saturday from 7:00 am to 8:00 am and 1:00 to 6:00 pm, Sunday 8:00 am to 6:00 pm and public holidays; evening refers to 6:00 pm to 10:00 pm Monday to Sunday and public holidays; night refers to 10:00 pm to 7:00 am Monday to Saturday and 10:00 pm to 8:00 am Sundays and public holidays.

Table 5-3 presents the NMLs applicable to other noise sensitive receivers, such as educational facilities and places of worship and commercial receivers as recommended by the ICNG. Hotels have been considered as a residential land use rather than a commercial land use. This provides a

conservative assumption as the residential NML is more stringent than that which would be applied to a commercial receiver.

Table 5-3 Construction noise management levels – Other receivers

Land Use	NMLs, $L_{Aeq,15min}$ (applies when properties are being used)	
	External noise level (dB(A))	Internal noise level (dB(A))
Commercial premises (including offices, retail outlets)	70	-
Industrial premises	75	-
Medical	55[2]	45
Classrooms at schools and other educational institutions	55[2]	45
Places of worship	55[2]	45
Active recreation areas	65	-
Community centres	55[2]	45[1]

Notes:
1. Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.
2. External noise level NMLs are based upon a 10 dB loss through an open window.

5.2 Sleep disturbance criteria

The ICNG requires a sleep disturbance analysis to be completed where construction works are planned to extend over more than two consecutive nights. The analysis should consider the likely maximum noise level, and the extent and the number of times that the maximum noise level exceeds the sleep disturbance screening level. The ICNG makes reference to the NSW *Environment Criteria for Road Traffic Noise* (NSW EPA, 1999) (ECRTN), now superseded by the *Road Noise Policy* (DECCW, 2011) (RNP), for guidance in assessing the potential for sleep disturbance.

The guidance provided in the RNP for assessing the potential for sleep disturbance recommends that to minimise the risk of sleep disturbance during the night-time period (10.00 pm to 7.00 am), the $L_{A1(1\ min),}$ noise level outside a bedroom window should not exceed the $L_{A90\ (15\ minute)}$ background noise level by more than 15 dB. The NSW EPA considers it appropriate to use this metric as a screening criterion to assess the likelihood of sleep disturbance. While this screening criterion is not a firm criterion to be met, where the criterion is met sleep disturbance is not likely. If this screening criterion is exceeded, a more detailed analysis must be undertaken to consider the likelihood of awakening reactions and the number of times this may happen during the night-time period.

The RNP contains a review of research into sleep disturbance which represents NSW EPA advice on the subject of sleep disturbance due to noise events. It concludes that having considered the results of research to date that, *'Maximum internal noise levels below 50 to 55 dB(A) are unlikely to cause awakening reactions'*. Therefore, given that an open window provides around 10 dB in noise attenuation from outside to inside, external noise levels of 60 to 65 dB(A) are unlikely to result in awakening reactions. Noise levels above 65 dB(A) may cause awakening and have been adopted as the awakening reaction level for the project.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers have been determined and are presented in **Table 5-4**. As part of the assessment the predicted maximum noise levels have been first compared against the screening criteria. If the screening criteria is exceeded the maximum noise levels are then compared against the awakening reaction criteria.

Table 5-4 Sleep disturbance criteria

NCA	Background noise level (L_{A90}), dB(A)	Sleep disturbance screening level $L_{A1(1\ minute)}$, dB(A) [1]	Awakening reaction $L_{A1(1\ minute)}$, dB(A)[2]
1	39	54	65
2	35	50	65
3	38	53	65
4	32	47	65
5	30	45	65
6	35	50	65
7	30	45	65

Notes:
1. Based on RBL + 15 dB(A), external level.
2. External $L_{A1(1\ min)}$ level, based upon a maximum internal noise level of 55 dB(A) and a 10 dB loss through an open window.

5.3 Construction traffic noise criteria

Noise from construction traffic on public roads is not covered by the ICNG. However, the ICNG does refer to the ECRTN, now superseded by the RNP, for the assessment of noise arising from construction traffic on public roads.

To assess noise impacts from construction traffic in accordance with the RNP, an initial screening test should be undertaken by evaluating whether existing road traffic noise levels would increase by more than 2 dB(A). Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. The RNP states that an “increase in up to 2 dB(A) represents a minor impact that is considered barely perceptible to the average person”. However, where the predicted noise level increase is greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion in the RNP, then noise mitigation should be considered for those receivers affected. The RNP does not require assessment of noise impact to commercial or industrial receivers.

5.4 Construction vibration criteria

Vibration criteria are set primarily according to whether the particular activities of interest are continuous in nature or intermittent, whether they occur during the daytime or night-time and the type of receiver to be assessed, e.g. industrial, commercial or residential.

The effects of vibration in buildings can be divided into the following categories:

- those in which the occupants or users of the building are inconvenienced or possibly disturbed, i.e. human disturbance or discomfort; and
- those in which building damage may occur.

Therefore, vibration levels at sensitive receiver locations must be controlled so as to prevent discomfort and regenerated noise, and in some extreme cases, structural damage.

The relevant standards and guidelines for the assessment of construction vibration are summarised in **Table 5-5**.

Table 5-5 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (DIN 4150)
Human comfort (tactile vibration)	Assessing Vibration: A Technical Guideline (AVATG)[1]

Notes:
1. This document is based upon the guidelines contained in British Standard 6472:1992, “Evaluation of human exposure to vibration in buildings (1-80 Hz)”. This British Standard was superseded in 2008 with BS 6472-1:2008 “Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting” and the 1992 version of the

Standard was withdrawn. However the Environment Protection Authority still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.

Vibration, at levels high enough, has the potential to cause damage to structures and disrupt human comfort. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent as follows:

- continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities;
- impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with durations of typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities; and
- intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include intermittent construction activity, impact pile driving, and jack hammers.

5.4.1 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration and therefore the German Standard (DIN 4150) has been used. This standard provides recommended maximum levels of vibration, which if not breached, reduce the likelihood of building damage caused by vibration for residential, non-residential and heritage structures. The criteria detailed in this standard which are applicable to the project are shown in **Table 5-6** . The standard also states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage.

Table 5-6 Structural damage safe limits (DIN 4150) for building vibration (Vibration peak particle velocity)

Group	Type of structure	Vibration velocity in mm/s			
		At foundation at a frequency of			Vibration at the horizontal plane of the highest floor
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 - 40	40 - 50	40
2	Dwellings and buildings of similar design and/or use	5	5 - 15	15 - 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order/heritage listed)	3	3 - 8	8 - 10	8

Notes:
1 At frequencies above 100 Hz, the values given in this column may be used as minimum values.

5.4.2 Human comfort

The assessment of intermittent vibration outlined in the NSW EPA guideline A*ssessing Vibration: A Technical Guideline* (AVTG) is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration arising from construction activities are listed in **Table 5-7**. The VDV criteria are based on the likelihood that a person would comment adversely on the level of vibration over the entire assessment period.

Table 5-7 Preferred and maximum vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime (7am – 10pm)		Night-time (10pm – 7am)	
	Preferred	Maximum	Preferred	Maximum
Critical areas[1]	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops[2]	0.8	1.6	0.8	1.6

Notes:

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. Places where sensitive equipment is stored or delicate tasks are undertaken require more stringent criteria than the residential criteria specified above.
2. Examples include automotive repair shops, manufacturing or recycling facilities. This includes places where manufacturing, recycling or repair activities are undertaken but do not require sensitive or delicate tasks.

6.0 Assessment of potential construction impacts

6.1 Construction scenarios and scheduling

Nine construction noise scenarios have been developed based on the proposed construction activities for the works and are presented in **Table 6-1**. The construction noise scenarios are considered to represent the noisiest activities likely to occur. For example, some additional construction activities such as cable jointing would also occur, however these are considered to be less noisy than those listed in **Table 6-1**.

The proposed timing of the works is also presented and has been informed by **Table 2-2** and **Table 2-3**.

Table 6-1 Construction noise scenarios and scheduling

Scenario	Location	Timing	Duration	Description
Site preparation	Work site	Standard construction hours and outside of standard construction hours (night-time) for construction works within major road reserves and through signalised intersections[1,2]	Up to one week	Short term works to clear the project area where required, including implementing traffic management and establishing environmental controls and ancillary facilities
Trenching and excavation	Transmission cable route	Standard construction hours and outside of standard construction hours (night-time) for construction works within major road reserves and through signalised intersections[1, 2]	Average rate of trenching of 20 metres per day. Each section between the joint bays may take up to eight weeks to complete	Linear progressive works. May occur at multiple locations along the transmission cable route at one time Steel plates maybe used to temporarily cover trenches
Excavation and construction of joint bays	Transmission cable route, one joint bay every 600-800 metres	Standard construction hours[4]	Up to five weeks to establish each joint bay, including excavation	Works to be undertaken at discrete locations along the transmission cable route [3]

Scenario	Location	Timing	Duration	Description
Special crossing - Cable bridges	Cable bridge locations as described in **Table 2-1**	Standard construction hours and outside of standard construction hours (night-time)	Up to ten weeks (not continuous) for each crossing	Works to be undertaken at up to three discrete locations
Special crossing - Underboring	Underboring locations as described in **Table 2-1**	Standard construction hours and outside of standard construction hours (night-time)	Up to ten weeks (not continuous) for each crossing	Works to be undertaken at up to five discrete locations
Cable pulling	Transmission cable route, between two adjacent joint bays for one cable pull	Standard construction hours and outside of standard construction hours (night-time)	Up to two weeks for each section	Works to be undertaken at discrete locations along the transmission cable route. May occur at multiple locations along the transmission cable route at one time
Construction laydown areas	Locations as described in **Table 2-4**	Standard construction hours and outside of standard construction hours (including night-time)	Duration of the project, estimated to be around 24 months	Primarily for construction plant parking, storage of equipment and deliveries, and spoil stockpiling. Stockpiling would occur for around 15 months
Restoration of surfaces	Transmission cable route	Standard construction hours and outside of standard construction hours (including night-time) for construction works within major road reserves and through signalised intersections[1,2]	Between 3-5 weeks per section	Linear progressive works. May occur at multiple locations along the transmission cable route at one time

Scenario	Location	Timing	Duration	Description
Spoil and waste management [5]	Roads surrounding the transmission cable route	Standard construction hours and outside of standard construction hours (including night-time)	Duration of the project estimated to be around 24 months	Trucks would be used to transport spoil during the trenching and conduit installation works, joint bay construction and restoration of surfaces. Trucks would be using both local and arterial roads
Rookwood Road, Beaconsfield West and Sydney South substation upgrade works	Rookwood Road, Beaconsfield West and Sydney South substations	Standard construction hours and outside of standard construction hours (including night-time)	Rookwood Road: 4 – 6 months Beaconsfield West: 6 – 9 months Sydney South: 6 – 9 months	Upgrade works at substation

Notes:

1 Night-works have been modelled within the following state and regional road reserves:
   i. Rookwood Road
   ii. Hume Highway crossing
   iii. Waterloo Road crossing
   iv. Juno Parade (between Maiden Street and Acacia Avenue)
   v. Roberts Road crossing
   vi. Punchbowl Road crossing
   vii. Burwood Road (between Carter Street and Bruce Avenue)
   viii. Fifth Avenue crossing
   ix. Brighton Avenue crossing
   x. Old Canterbury Road
   xi. New Canterbury Road crossing
   xii. Sydenham Road crossing
   xiii. Addison Road (between Illawarra Road and Enmore Road)
   xiv. Enmore Road (between Newington Road and Addison Road)
   xv. Llewellyn Street (between Lynch Lane and Edgeware Road)
   xvi. Edgeware Road (between Llewellyn Street and south of Darley Street)
   xvii. May Street (west of Campbell Street to Princes Highway)
   xviii. Princes Highway crossing.
2 Night-works have been modelled at the following signalised intersections including 100 m before and after the intersection along the alignment:
   i. William Holmes Drive/Rookwood Road
   ii. Rookwood Road/Muir Road
   iii. Muir Road/Worth Street
   iv. Muir Road/Hume Highway
   v. Rawson Road/Waterloo Road
   vi. Wangee Road/Punchbowl Road
   vii. Seventh Avenue/Fifth Avenue
   viii. Centennial Street/Sydenham Road
   ix. Illawarra Road/Addison Road/Agar Street
   x. Addison Road/Enmore Road
   xi. Enmore Road/Llewellyn Street
   xii. Llewellyn Street/Edgeware Road/Alice Street
   xiii. Edgeware Road midblock crossing
   xiv. May Street/Princes Highway
3 Joint bay locations would be determined during detailed design.
4 Joint bays would be generally located outside of major road reserves where possible, therefore it is assumed that night works would not be required for the excavation and construction of cable joint bays. However, it is anticipated that night-works may be required for two locations along regionally classified roads as directed by the traffic management authority – May Street and Edgeware Road.
5 The spoil and waste management construction noise scenario has not been modelled as it effectively comprises construction traffic movements, which have been assessed separately (refer to **Section 6.6**).

6.2 Construction noise sources

Construction noise sources and their respective L_{Aeq} sound power levels for each construction noise scenario stage are shown in **Table 6-2**.These sound power levels are typical values taken from data provided in Australian Standard AS2436-2010, *Guide to noise and vibration control on construction, demolition and maintenance sites* and the UK Department for Environment, Food and Rural Affairs (DEFRA) *Update of noise database for prediction of noise on construction and open sites* noise database and assume equipment is modern and in good working order.

Table 6-2 Equipment sound power levels

Construction stage	Equipment	Sound Power Level, dB(A)	
		L_{Aeq}	L_{A1}
Site preparation[1]	Excavator	98	106
	Dump truck	108	116
	Backhoe	96	104
	Delivery trucks	108	116
Trenching and excavation[2]	Backhoe	96	104
	Front end loader	104	112
	Jackhammer	105	113
	Dump truck	108	116
	Diamond saw	110	118
	Concrete truck	106	114
	Low loader	108	116
	Compressor	93	101
	Generator	90	98
	Vacuum truck	103	111
	Excavator	98	106
	Rock breaker	107	115
	Chainsaw	114	122
Excavation and construction of joint bays[2,3]	Backhoe	96	104
	Front end loader	104	112
	Jackhammer	105	113
	Dump truck	108	116
	Diamond saw	110	118
	Concrete truck	106	114
	Low loader	108	116
	Compressor	93	101
	Generator	90	98
	Vacuum truck	103	111
	Excavator	98	106
	Rock breaker	107	115

Construction stage	Equipment	Sound Power Level, dB(A)	
		L_{Aeq}	L_{A1}
Special crossings - Cable bridges[2]	Mobile crane	104	112
	Front end loader	104	112
	Excavator	98	106
	Compressor	93	101
	Generator	90	98
	Low loader	108	116
	Vacuum truck	103	111
	Auger borer	103	111
	Impact piling rig	116	124
	Concrete truck	106	114
Special crossings – Underboring[4]	Excavator	98	106
	Backhoe	96	104
	Jackhammer	105	113
	Diamond saw	110	118
	Dump truck	108	116
	Compressor	93	101
	Directional drill rig	103	111
	Vacuum truck	103	111
Cable pulling	Low loader	108	116
	Winch	92	100
Construction laydown areas	Light vehicles	90	98
	Heavy vehicles[5]	108	116
	Excavators	98	106
Restoration of surfaces	Rollers	103	111
	Asphalt paver	103	111
	Trucks	108	116
Spoil and waste management	Dump truck	108	116
Rookwood Road, Beaconsfield West and Sydney South substation works	Excavator	98	106
	Dump truck	108	116
	Concrete truck	106	114
	Mobile crane	104	112
	EWP	87	95

Notes:
1 Assumes construction equipment is operating 50% of the time in any 15 minute period.
2 Assumes construction equipment is operating 33% of the time in any 15 minute period.
3 Assumes that when the diamond saw is in use the chainsaw is not, i.e. the diamond saw and chainsaw are not in use simultaneously.
4 Assumes that the diamond saw/jack hammer is operating 33% of the time in any 15 minute period and would not operate during the same period as the directional drill rig and vacuum truck.
5 Assumes two heavy vehicle movements in any 15 minute period.

6.3 Modelling and conditions

In order to assess noise impacts during construction, a noise model was created and used to determine the likely noise levels during each construction noise scenario at noise sensitive receivers. Each construction scenario was modelled separately and all equipment listed in **Table 6-2** was assumed to be operating simultaneously during each construction scenario, unless otherwise noted (i.e. note 3 in **Table 6-2**).

The construction noise scenarios have been modelled in SoundPLAN Version 7.3 with the following features included in the noise model:

- ground topography (the level and shape of the surrounding land);
- ground absorption and reflection;
- buildings (including shielding of noise);
- residential and non-residential receivers; and
- construction noise sources for the project (as listed in **Table 6-2**).

It should be noted that the locations of joint bays have not been determined at this stage. Modelling has been completed at indicative discrete locations along the entire length of the transmission cable route for the 'excavation and construction of joint bays' and 'cable pulling' construction stages to provide approximate numbers of receivers potentially affected by these works.

Noise emissions from the construction activities have been modelled using an implementation of the ISO 9613 propagation algorithm.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions and also the location of the plant/equipment. The acoustic shielding calculated in the model due to fixed building structures would also vary as the construction equipment moves around the work site. For most construction scenarios, it is expected that the construction noise levels would frequently be lower than predicted, as the noise levels presented in this report are based on the noisiest activities likely to occur (i.e. the worst case).

Construction noise levels at the identified receivers have been assessed against the NMLs for standard construction hours and outside of standard construction hours for daytime, evening and night-time (as shown in **Table 5-2** and **Table 5-3**).

Mitigation measures for receivers have been specified in **Section 7.0**. These measures are considered to be feasible and reasonable and would reduce the impact of these exceedances.

6.4 Construction airborne noise assessment

Construction noise levels at the identified residential and non-residential sensitive receivers have been assessed against the NMLs for standard construction hours and outside of standard construction hours (night-time). Outside of standard construction hours (includes night-time) is considered to be the worst case period as it has the lowest NMLs.

6.4.1.1 Residential receivers

Based on the sound power levels of the equipment likely to be used in each construction scenario, the highest noise levels are likely to be generated by the following construction activities:

- site preparation;
- trenching and excavation;
- excavation of joint bays;
- special crossings;
- cable pulling; and
- restoration of road surfaces.

Key high noise generating equipment, based on sound power levels, includes jackhammers, diamond saws, rock breakers and piling rigs.

The predicted numbers of exceedances of the NMLs at residential receivers due to the construction works during both standard construction hours and works outside of standard construction hours (night) are shown in **Table 6-3**.

The numbers of receivers presented in this table are split into four categories:

- 1-10 dB exceedance - a noticeable exceedance of the NML;
- 11-20 dB exceedance – a clearly audible exceedance of the NML;
- greater than 20 dB exceedance – an intrusive exceedance of the NML; and
- greater than 75 dB(A) – highly affected receivers.

The following sections summarise the potential airborne noise impacts for each of the construction noise scenarios.

Site preparation

Site preparation works are likely to be completed in a period of up to one week at any one work site. Sensitive receivers near to the site preparation works would experience elevated noise levels during these works. Approximately 16,000 receivers during works outside of standard construction hours and 13,000 receivers during standard construction hours across the project area may experience noise levels above the noise management levels and 2,000 receivers may be highly noise affected (experience noise levels above 75 dB(A)).

Trenching and excavation

The trenching and excavation works are expected to progress at an average rate of around 20 metres per day. Receivers would generally be affected for around eight weeks. The predicted noise levels for these scenarios are therefore worst case noise levels, and represent the period where the works come closest to each receiver.

Approximately 21,500 receivers during works outside of standard works and 16,500 receivers during standard construction hours across the project area may experience noise levels above the NMLs and 2,000 receivers may be highly noise affected. However, at any one receiver, construction noise levels would slowly increase as the works approach the receiver (around four weeks), would remain fairly constant while the works are directly in front of the receiver (around four days) and would then slowly decrease again as the works move away (around four weeks). Therefore, the number of receivers affected at any one point in time would be much lower than stated above. For example, at a receiver located along the road where trenching and excavation is taking place, noise levels are expected to:

- increase by about 30 dB over the NML over a period of up to four weeks;
- remain above 75 dB(A) for about four days as the works are directly in front of the receiver; and
- decrease to the NML over a period of up to four weeks as the works move away.

An example of this change is shown diagrammatically in **Figure 6-1** and **Annexure B**.

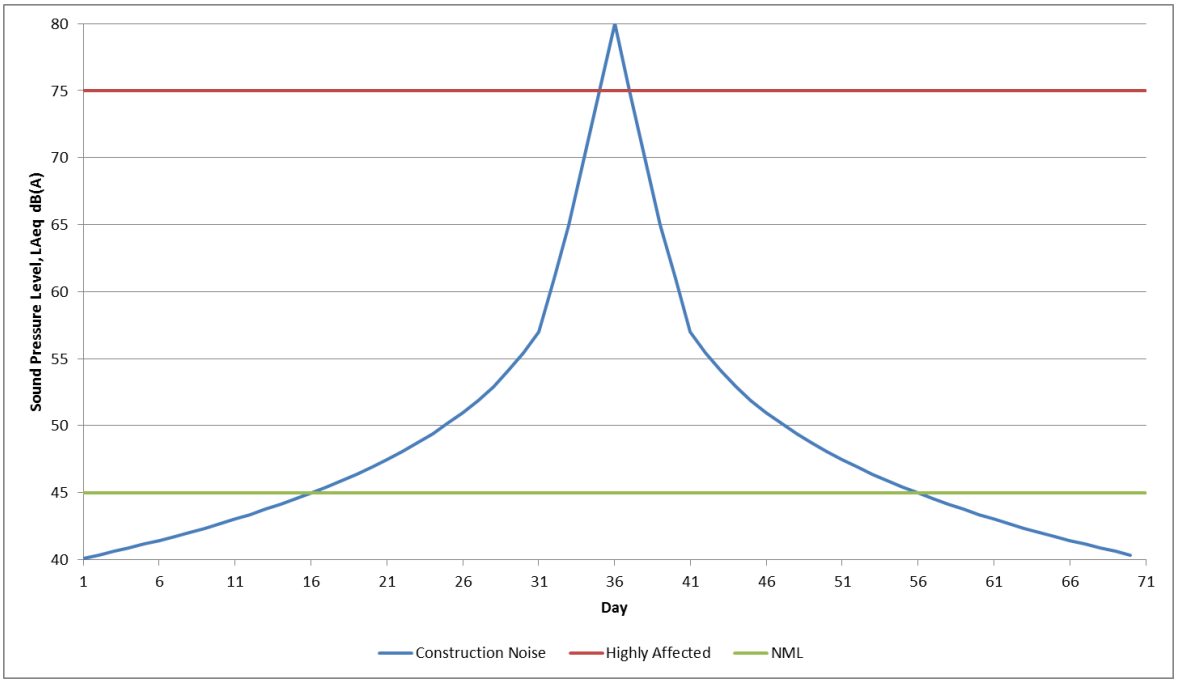

Figure 6-1 Variation in $L_{Aeq(15min)}$ noise level as works progress

Excavation and construction of cable joint bays

Excavation and construction of each joint bay is likely to take up to five weeks. Noise sensitive receivers around the joint bays would experience construction noise during these works. Approximately 8,000 receivers during standard construction hours across the project area may experience noise levels above the NMLs and 138 receivers may be highly noise affected during the entire project. It is noted that joint bay works were modelled at discrete locations along the entire transmission cable route, therefore the actual number of affected receivers may differ from those reported above, depending on the final location of the joint bays. As noted above, two joint bays (Edgeware Road and May Street) are likely to require night works. Potential impacts at these two locations would be addressed through the 'Out-of-hours Protocol' and the CNVMP. The actual joint bay locations would be determined during detailed design and the number of receivers affected would be re-evaluated.

Special crossings

Special crossings are likely to be completed in a period of up to 10 weeks at each crossing, however works would be staged and not continuous over the 10 week period. Sensitive receivers near the special crossings would also experience construction noise during these works. Approximately 12,000 receivers at night and 4,000 receivers during standard construction hours across the project area may experience noise levels above the NMLs and 31 receivers may be highly noise affected.

Cable pulling

Cable pulling is likely to be completed in a period of up to two weeks per cable section. Noise sensitive receivers near the cable pulling would also experience construction noise during these works. Approximately 14,500 receivers at night and 5,000 receivers during standard construction hours across the project area may experience noise levels above the NMLs and 86 receivers may be highly noise affected. As noted above, the location of joint bays is not yet confirmed and therefore the actual number of affected receivers may differ from those reported above, depending on the final location of

the joint bays. The actual joint bay locations would be determined during detailed design and the number of receivers affected would be re-evaluated.

Construction laydown areas

Laydown areas would be used for the majority of the overall construction period, with impacts expected to occur for up to 24 months. For work in the construction laydown areas, noise levels are predicted to exceed the NMLs at approximately 1,000 residential receivers at night and 220 receivers during standard construction hours for all laydown sites in total across all NCAs, however no receivers are expected to be highly noise affected. Stockpiling activities would also be undertaken for around 15 months. Stockpiling would be undertaken during the daytime and the night-time, whereas general laydown activities would not be continuous. Laydown activities would occur at the start and end of shifts with some movement in and out of the areas mid-shift to support construction activities along the transmission cable route. Therefore, when stockpiling activities are not ongoing there would be periods of no noise within the construction laydown area.

Restoration of road surfaces

The surface restoration works are progressive works and the overall duration of the activity is expected to be three to five weeks per section. Approximately 19,500 receivers at night and 17,000 receivers during standard construction hours across the project area may experience noise levels above the NMLs and 2,500 receivers may be highly noise affected. For surface restoration works, noise levels of greater than 75 dB(A) may be experienced for three days.

Works at Rookwood Road, Beaconsfield West and Sydney South substations

Noise sensitive receivers near the Rookwood Road, Beaconsfield west or Sydney South substations would experience construction noise during these works. Substation works are likely to be completed in a period of up to six months for the Rookwood Road substation and up to nine months for the Beaconsfield West and Sydney South substations. Approximately 670 receivers (32 in NCA 1, 2 in NCA 6 and 637 in NCA 7) at night and 80 receivers in NCA 7 only during standard construction hours may experience noise levels above the NMLs, however, no receivers are expected to be highly noise affected.

Results from the noise modelling are presented as noise contour layers over aerial maps in **Annexure C**. The exceedances located across the project area are shown in **Annexure D**.

Trucks used for spoil and waste management would be operating primarily on roads to and from work sites (i.e. outside work sites[2]), therefore truck movements have been assessed as part of the construction traffic assessment only.

[2] A specific section of the project area for carrying out project construction activities such as trenching and excavation, establishment of a joint bay or installing a special crossing. The work site would be fenced off from public access and may include associated activities such as traffic management measures.

Table 6-3 Number of residential buildings where noise levels may exceed NMLs for all construction scenarios

Scenario	Number of residential buildings where noise levels may exceed NML across the project area						
	Standard construction hours			Outside of standard construction hours (night)			Highly affected, > 75 dB(A)
	1-10 dB	11-20 dB	> 20 dB	1-10 dB	11-20 dB	> 20 dB	
NCA1							
Site preparation	0	0	0	46	1	0	0
Trenching and excavation	1	0	0	118	5	0	0
Excavation and construction of cable joint bays	1	0	0	-	-	-	0
Special crossings	0	0	0	0	0	0	0
Cable pulling	0	0	0	31	0	0	0
Construction laydown	0	0	0	0	0	0	0
Restoration of road surfaces	1	0	0	83	1	0	0
Works at Rookwood Road substation	0	0	0	32	0	0	0
NCA2							
Site preparation	1,225	507	415	2,334	415	161	336
Trenching and excavation	1,647	699	475	3,160	707	225	386
Excavation and construction of cable joint bays	999	121	48	-	-	-	26
Special crossings	0	0	0	0	0	0	0
Cable pulling	507	70	39	2,190	324	84	18
Construction laydown	0	0	0	0	0	0	0
Restoration of road surfaces	1,513	631	446	2,955	586	198	366

Scenario	Number of residential buildings where noise levels may exceed NML across the project area						
	Standard construction hours			Outside of standard construction hours (night)			Highly affected, > 75 dB(A)
	1-10 dB	11-20 dB	> 20 dB	1-10 dB	11-20 dB	> 20 dB	
NCA3							
Site preparation	700	184	248	678	126	51	232
Trenching and excavation	838	300	269	1,145	183	70	248
Excavation and construction of cable joint bays	339	54	30	-	-	-	22
Special crossings	145	24	11	540	83	23	4
Cable pulling	177	36	22	837	102	43	16
Construction laydown	56	0	0	186	29	0	0
Restoration of road surfaces	764	276	261	980	159	64	242
NCA4							
Site preparation	989	326	270	1,833	166	106	176
Trenching and excavation	1,560	427	354	2,506	350	138	190
Excavation and construction of cable joint bays	830	193	65	-	-	-	20
Special crossings	240	13	0	1,202	54	9	0
Cable pulling	563	128	44	1,161	302	104	13
Construction laydown	0	0	0	3	0	0	0
Restoration of road surfaces	1,492	404	345	2,286	245	131	191
NCA5							
Site preparation	4,026	1751	1581	6,156	1,551	549	1,130
Trenching and excavation	5,178	2,105	1,965	7,648	2,648	762	1,196
Excavation and construction of cable joint bays	3,862	713	219	-	-	-	62
Special crossings	2,832	362	80	6,835	2,460	369	25
Cable pulling	2,497	417	156	5,998	2,118	487	35
Construction laydown	103	42	0	448	95	36	0
Restoration of road surfaces	5,571	2,262	2,216	7,164	2,186	679	1,468

Scenario	Number of residential buildings where noise levels may exceed NML across the project area						
	Standard construction hours			Outside of standard construction hours (night)			Highly affected, > 75 dB(A)
	1-10 dB	11-20 dB	> 20 dB	1-10 dB	11-20 dB	> 20 dB	
NCA6							
Site preparation	338	91	161	1,143	292	191	152
Trenching and excavation	429	140	173	1,343	470	241	167
Excavation and construction of cable joint bays	204	19	14	-	-	-	8
Special crossings	31	3	2	575	50	5	2
Cable pulling	114	16	6	698	146	24	4
Construction laydown	19	0	0	263	22	0	0
Restoration of road surfaces	466	162	222	1,283	390	221	221
Works at Beaconsfield West substation	0	0	0	2	0	0	0
NCA7							
Sydney South substation	80	0	0	613	24	0	0

6.4.1.2 Other receivers

The numbers of non-residential noise sensitive receivers where noise levels are expected to exceed the NMLs during standard construction hours are shown in **Table 6-4**. Up to around 550 non-residential receivers are predicted to be affected in total at some point during the following activities:

- site preparation;
- trenching and excavation;
- excavation of joint bays;
- special crossings; and
- restoration of road surfaces.

However, more than 50% of the NML exceedances are expected to be less than 10 dB. The highest impacts are expected during trenching and excavation. Noise levels at around 550 non-residential receivers are expected to exceed the NMLs during these works. However, it should be noted that this is for the extent of the project area and most receivers would only be affected for a discrete period of time.

The impacts of works around cable joint bays which includes their construction and cable pulling would affect many less receivers due to the discrete locations (in comparison to trenching and excavation along the entire route).

Construction noise levels at the following non-residential noise sensitive receivers are expected to exceed the NML at times:

- Little Angels Long Day Care Centre;

- Funtime Child Care;
- Fantastic Kids Family Day Care;
- Toddlers Ink Childcare;
- St John Vianney Catholic Primary School;
- St John Vianney Catholic Church;
- Lakemba Mosque;
- St Michael's Catholic Primary School;
- Church of St Michael the Archangel;
- Woodstock Child Care Centre;
- Goodstart Early Learning Ashfield;
- Sydney Private Hospital;
- Yeo Park Infants School;
- Ashfield Early Learning Centre;
- Summer Hill Public School;
- Christian Brothers' High School Lewisham;
- Lewisham Public School;
- Greek Orthodox Community Child Care Centre;
- Addison Road Child Care Centre;
- Newington College;
- Enmore Children's Centre;
- St Pius Catholic Primary School;
- Catholic Parish of Our Lady of The Southern Cross;
- St Pius Enmore Catholic Church;
- Only About Children Enmore; and
- Camdenville Public School;

Table 6-4 Number of non-residential sensitive receivers where noise levels exceed the NMLs

Scenario	Number of other buildings where noise levels are exceeding the noise management levels across the project area		
	1-10 dB	11-20 dB	> 20 dB
Site preparation	251	96	92
Trenching and excavation	302	138	107
Excavation and construction of cable joint bays	159	50	21
Special crossings	141	23	5
Cable pulling	110	32	18
Construction laydown	10	2	0
Restoration of road surfaces	286	124	103

Scenario	Number of other buildings where noise levels are exceeding the noise management levels across the project area		
	1-10 dB	11-20 dB	> 20 dB
Works at Rookwood Road and Beaconsfield West substations	0	0	0
Sydney South substation	0	0	0

Note that the impacts identified in **Table 6-4** apply when the properties are in use, i.e. during school hours or religious services. Some works would be undertaken outside of standard construction hours, during the night-time period and therefore sensitive receivers such as schools may not be affected significantly by the works.

6.4.1.3 Cumulative construction noise impacts

While most construction activities are expected to occur at separate times and locations, it is possible that noisy construction activities for the project may occur at the same time in close proximity to each other. These may include works at the substations, trenching and excavation, special crossings, and excavation and construction of joint bays. In these cases, it is possible that predicted noise levels may increase by up to 3 dB(A) and there is potential that this would increase the number of receivers where noise levels would be greater than 20 dB above the NMLs. Cumulative noise impacts from concurrent project activities would be managed by the measures described in **Section 7.0**.

6.4.2 Sleep disturbance assessment

While construction works would be undertaken during standard construction hours, some works outside of standard construction hours would be required for constructability, safety and traffic management reasons or to meet the requirements of government agencies. This section provides an assessment of the potential for sleep disturbance due to these night works.

Table 6-5 presents the predicted maximum $L_{A1\ (1\ min)}$ noise levels. The predicted $L_{A1(1\ min)}$ noise levels indicate that the awakening reaction criterion may be exceeded during the night-time construction works. Where the awakening reaction criterion is exceeded, consideration should be given to reasonable and feasible mitigation measures.

Site preparation

Noise levels at approximately 1,200 residential receivers in total for the project (along the entire transmission cable route) are predicted to potentially exceed the awakening reaction criteria for site preparation works, if undertaken during the night-time period. Site preparation works are likely to be completed in a period of up to one week at any one site.

Trenching and excavation

Noise levels at approximately 1,400 residential receivers in total for the project (along the entire transmission cable route) are predicted to exceed the awakening reaction criteria for the trenching and excavation during the construction period. However, as this scenario progresses linearly, along the transmission cable route it is expected that noise levels at up to 250 residential receivers at any one time may exceed the awakening reaction criteria. The highest impacts are expected during road cutting. These impacts are expected at receivers within NCAs 2, 3, 4, 5 and 6.

Special crossings

Noise levels at approximately 580 residential receivers in total for the project (for all special crossings collectively) are predicted to exceed the awakening reaction criteria for the special crossing scenario. Crossings are likely to be completed in a period of up to 10 weeks at each crossing location; however, works would be staged and not continuous over the 10 week period. These impacts are expected at receivers within NCAs 3 to 6.

Cable pulling

Noise levels at approximately 750 residential receivers in total for the project (along the entire transmission cable route) are predicted to exceed the awakening reaction criteria for the cable pulling scenario. These impacts are expected at receivers within NCAs 2 to 6. Cable pulling is likely to be

completed in a period of up to two weeks per section. As noted above the location of joint bays is not yet confirmed and therefore the actual number of affected receivers may differ from those reported above, depending on the final location of the joint bays. The actual joint bay locations would be determined during detailed design and the number of receivers affected would be re-evaluated.

Construction laydown areas

Noise levels at approximately 39 residential receivers in total for the project are predicted to exceed the awakening reaction criteria, for the construction laydown scenario. The laydowns are likely to be in use for up to 24 months, with stockpiling activities occurring for 15 months. These impacts are expected at receivers in NCAs 3 and 5.

Restoration of road surfaces

Noise levels at approximately 1,100 residential receivers in total for the project (along the entire transmission cable route) are predicted to exceed the awakening reaction criteria for the restoration of road surfaces. However, as this scenario progresses linearly, along the transmission cable route it is expected that approximately 100 residential receivers at any one time would exceed the awakening reaction criteria. These impacts are expected in NCAs 2, 3, 4, 5 and 6.

Works at Rookwood Road, Beaconsfield West and Sydney South substations

Noise levels from substation works are not expected to exceed the awakening reaction criteria at any noise sensitive receivers.

Table 6-5 Number of residential buildings where noise levels may exceed sleep disturbance and awakening reaction levels for construction scenarios potentially occurring at night

Scenario	Number of residential buildings where noise levels may exceed the sleep disturbance screening level and/or the awakening reaction level	
	Sleep disturbance screening level $L_{A1(1\ minute)}$, dB(A)	Awakening reaction level $L_{A1(1\ minute)}$, dB(A)
NCA1		
Site preparation	28	0
Trenching and excavation	47	0
Excavation and construction of cable joint bays	-[1]	[1]
Special crossings	0	0
Cable pulling	15	0
Construction laydown	0	0
Restoration of road surfaces	28	0
Works at Rookwood Road substation	7	0
NCA2		
Site preparation	2,124	225
Trenching and excavation	2,910	277
Excavation and construction of cable joint bays	[1]	[1]
Special crossings	0	0
Cable pulling	1,996	124
Restoration of road surfaces	2,124	225

Scenario	Number of residential buildings where noise levels may exceed the sleep disturbance screening level and/or the awakening reaction level	
	Sleep disturbance screening level $L_{A1(1\ minute)}$, dB(A)	Awakening reaction level $L_{A1(1\ minute)}$, dB(A)
NCA3		
Site preparation	568	120
Trenching and excavation	855	151
Excavation and construction of cable joint bays	[1]	[1]
Special crossings	787	106
Cable pulling	640	93
Construction laydown	154	16
Restoration of road surfaces	568	120
NCA4		
Site preparation	1,451	106
Trenching and excavation	2,105	131
Excavation and construction of cable joint bays	[1]	[1]
Special crossings	1,567	11
Cable pulling	1,245	104
Restoration of road surfaces	1,451	106
NCA5		
Site preparation	6,839	443
Trenching and excavation	8,256	549
Excavation and construction of cable joint bays	[1]	[1]
Special crossings	10,702	442
Cable pulling	7,411	368
Construction laydown	392	23
Restoration of road surfaces	6,839	443
NCA6		
Site preparation	1,323	269
Trenching and excavation	1,626	308
Excavation and construction of cable joint bays	[1]	[1]
Special crossings	749	24
Cable pulling	648	55
Construction laydown	179	0
Restoration of road surfaces	1,323	269
Works at Beaconsfield West substation	0	0

Scenario	Number of residential buildings where noise levels may exceed the sleep disturbance screening level and/or the awakening reaction level	
	Sleep disturbance screening level $L_{A1(1\ minute)}$, dB(A)	Awakening reaction level $L_{A1(1\ minute)}$, dB(A)
NCA7		
Sydney South substation	80	0

Notes:
1 These works are not proposed to be undertaken outside of standard hours therefore modelling for sleep disturbance has not been undertaken.

6.5 Summary of construction airborne noise impacts

The assessment undertaken for the project indicates there would be exceedances of the noise management levels at a large number of residential and non-residential noise sensitive receivers close to the works.

The works likely to have the largest impact on noise sensitive receivers are the trenching and excavation works and subsequently the surface restoration works. This is due to the extent of the works, over 20 km, and the construction activities to be undertaken. Construction noise levels would exceed the noise management levels at a significant number of receivers, with many receivers being considered 'highly noise affected' as per the definition in the ICNG (noise level ≥75 dB(A)). However, as these works are progressive each receiver is not affected for a long time. For the trenching and excavation works receivers may generally be affected for around eight weeks. Furthermore, at any one receiver, construction noise levels would slowly increase as the works approach the receiver, would remain fairly constant for a few days while the works are close to the receiver and would then slowly decrease again as the works move away. However, for road surface restoration works, receivers may be affected for about 3-5 weeks.

Construction noise levels from the excavation of the joint bays and then the cable pulling activities may affect a different number of receivers due to the discrete locations of the works, which would be confirmed during detailed design. Joint bays are expected to be required around every 600-800 metres along the transmission cable route. Construction noise levels would exceed the noise management levels at a number of receivers, with some receivers being considered 'highly noise affected'. These works are likely to last for around five weeks and two weeks respectively.

Other works to be undertaken at discrete locations include the construction of special crossings (i.e. cable bridges or underboring). Construction noise levels would exceed the noise management levels at a number of receivers, with very few receivers being considered 'highly noise affected'. Special crossings are likely to be completed in a period of up to 10 weeks at each crossing; however, works would be staged and not continuous over the 10 week period.

Noise sensitive receivers near the Rookwood Road, Beaconsfield West and Sydney South substations would experience construction noise which exceeds the noise management levels, however no receivers are likely to be highly noise affected. Substation works would continue for up to six months for the Rookwood Road substation and up to nine months at both Beaconsfield West and Sydney South substations.

The construction laydown areas would be in use for around 24 months, however noise levels from the sites are significantly lower than those generated by the other construction scenarios, with no receivers expected to be 'highly noise affected'.

The scenarios considered above represent 'reasonable worst case scenarios', based on the assumed location of plant and the number of plant operating concurrently. Therefore, the numbers of affected receivers are considered to be conservative. The actual number of affected receivers is expected to be lower than those predicted. In addition, all construction scenarios, with the exception of the excavation and construction of joint bays, have been assessed as being delivered during standard hours and outside of standard hours, in certain locations. The requirement for works to be completed outside of standard hours would be at the discretion of the relevant transport authorities. Therefore, the impacts are unlikely to be as extensive as have been modelled and reported.

A range of management measures have been recommended to reduce the noise impacts. These measures include consideration of respite periods, noise monitoring, choice of equipment and plant, scheduling of works, stationary noise shields and community consultation with affected receivers to achieve negotiated outcomes. Noise management measures would be documented in a Construction Noise and Vibration Management Plan (CNVMP) for the project, which would include an Out-of-hours Protocol which documents procedures and consultation measures for affected receivers to manage works outside of standard construction hours. Further information is provided in **Section 7.0**.

6.6 Construction traffic assessment

The construction traffic volumes are presented in **Table 2-5**. In summary the maximum construction traffic movements are anticipated to be:

- 12 heavy vehicle deliveries/spoil removals (24 movements) and up to two light vehicles (four movements) per work site per day, noting that four work sites may be operating concurrently at multiple locations with the project area;
- five heavy vehicles (10 movements) and up to six light vehicles (12 movements) per special crossing site;
- six heavy vehicles (12 movements) and up to two light vehicles (four movements) per construction laydown area;
- two heavy vehicles (four movements) and up to two light vehicles (four movements) at Rookwood Road and Beaconsfield West substations, per day; and
- three heavy vehicles (six movements) and up to three light vehicles (six movements) at the Sydney South substation per day.

In order for construction traffic to generate an increase in noise levels of greater than 2 dB, existing traffic levels along construction traffic routes would need to increase by around 60%.

For arterial roads, noise level increases due to project related construction traffic are expected to be less than 2 dB during the day and night-time periods, given existing high levels of traffic on these roads. Therefore, the potential noise impact is considered barely perceptible and no further assessment is required, in accordance with the RNP.

Local roads vary in existing traffic volumes and generally accommodate less through traffic than arterial roads. It is expected that some local roads may experience noise level increases greater than 2 dB during daytime and night-time hours due to construction traffic from the project, where existing traffic volumes are considerably low. In these instances, it is expected that the overall road traffic noise levels would comply with the $L_{Aeq(1hr)}$ noise levels for local roads under the RNP. Therefore, no consideration of noise mitigation is required, in accordance with the RNP.

The majority of the truck movements would be associated with transmission cable route activities (trenching, special crossings and joint bay excavation) and so noise impacts on local roads are expected to be limited to a short duration (up to 10 weeks) for an individual receiver. Truck movements would occur at any time throughout the work shift, but would not be continuous, i.e. there would be times when no trucks are travelling to or from work sites.

6.7 Construction vibration assessment

6.7.1 Predicted vibration – cosmetic damage and human comfort

Vibration-intensive works may include the use of jack hammers and rock breakers. The minimum working distances for these items of equipment from off-site receivers are shown in **Table 6-6** and are recommended to meet the criteria detailed in **Table 5-6** and **Table 5-7**. The distances indicate the minimum separation distances where no adverse impacts from vibration intensive works are likely in terms of human comfort or cosmetic damage to buildings/structures.

Based on the indicative construction activities assessed for the project, some works may occur within the minimum working distances for human comfort and cosmetic damage of residential/commercial buildings and heritage listed items. It is noted that the minimum working distances can vary from site

to site depending on ground conditions etc. To account for this the minimum working distances presented in **Table 6-6** are typically conservative in order to cover most sites and ground conditions. If vibration-intensive works are required within these minimum working distances, mitigation measures to control excessive vibration would be implemented as outlined in **Section 7.0**.

Works undertaken within the human comfort minimum working distances may cause some people to experience annoyance and concern for cosmetic damage. Receivers located within the minimum distances for human comfort would be notified of the potential impacts as part of the notification of highly noise affected receivers.

Works undertaken within minimum working distances for cosmetic damage may cause damage to buildings. However, damage to heritage and other buildings is unlikely to occur when the management measures have been implemented appropriately. These measures include undertaking attended vibration measurements at the work site when work commences, to determine site specific minimum working distances. These measurements would be made progressively at distances outside the minimum working distances to ensure no structure damage occurs and would provide detailed information regarding the transmission of vibration to allow site specific safe working distances to be determined.

Potential impacts on heritage items due to vibration (in relation to impacts to heritage significance) are assessed in the historic heritage assessment, in **Appendix J** of the EIS.

Table 6-6 Minimum working distances of vibration intensive equipment to be used during the project

Plant	Rating/description	Cosmetic damage – residential/commercial, m	Cosmetic damage – heritage, m	Human comfort – residential, m
Jack hammer	Hand-held	1 (nominal)	1 (nominal)	Avoid contact with structure
Hydraulic hammer (rock breaker)	300 kg – 5-12 t excavator	2	4	7
	900 kg – 12-18 t excavator	7	12	23
	1600 kg – 18-34 t excavator	22	34	73
Piling rig	Hammer – 12 t down force	15	24	50

7.0 Environmental management and mitigation measures

7.1 Management objectives

The construction noise and vibration assessment presented in **Section 6.0** of this report detailed a number of exceedances of the noise management levels and potentially the vibration criteria for this project. These were predicted as a result of a number of construction scenarios. As a result of these exceedances the following environmental management and mitigation measures have been identified and would be implemented to minimise noise and vibration impacts as far as feasibly and reasonably possible.

Minimising noise impacts has been considered throughout the planning and assessment phase and would continue to be a consideration for the construction. During construction, noise and vibration impacts would be minimised by identifying and applying 'feasible' and 'reasonable' measures in accordance with the ICNG.

A feasible measure is one that is capable of being put into practice. A reasonable measure is one where the overall benefits outweigh the adverse social, economic and environmental costs of the measure. When determining measures consideration is given to the:

- level of noise impact;
- benefits of the mitigation;
- cost effectiveness of the mitigation; and
- community views.

7.2 Environmental management and mitigation measures

7.2.1 Construction noise and vibration management plan

It has been identified that potential construction noise impacts at residences within the vicinity of the project may be high, in some cases exceeding the highly affected noise level. Therefore, it is recommended that a Construction Noise and Vibration Management Plan (CNVMP) be developed for the project before construction works begin. The CNVMP should include reasonable and feasible safeguards to manage the noise emissions from construction and manage any complaints which may be received. The CNVMP should include the following:

- identification of nearby residences and other sensitive land uses;
- description of approved hours of work;
- description and identification of all construction activities, including construction work sites, equipment and duration;
- description of work practices (generic and specific) which would be applied to minimise noise and vibration;
- a complaints handling process;
- noise and vibration monitoring procedures;
- overview of community consultation required for works where noise levels are expected to exceed the highly noise affected level (75 dB(A)) at residential receivers; and
- the Out-of-hours Protocol developed for the project.

Table 7-1 presents recommended noise and vibration mitigation measures. These are based upon standard mitigation measures contained within the EPA's ICNG.

Table 7-1 Noise and vibration mitigation measures

No.	Impact/issue	Environmental management and mitigation measures	Timing
	General		
NV1	CNVMP	A CNVMP will be developed as part of the CEMP for the project and will include reasonable and feasible safeguards to manage the noise emissions from construction and manage any complaints which may be received. The CNVMP will include the following: • identification of nearby residences and other sensitive land uses; • description of approved hours of work; • description and identification of all construction activities, including construction work sites, equipment and duration; • description of work practices (generic and specific) which will be applied to minimise noise and vibration; • a complaints handling process; • noise and vibration monitoring procedures; • overview of community consultation/notification required (see NV2); and • the Out-of-hours Protocol developed for the project.	Construction
NV2	Community consultation/ notification	Residents and other sensitive receivers impacted by noise and/or vibration from the proposed works which is expected to exceed the NML (as defined in **Table 5-2** and **Table 5-3**) and/or the vibration criteria (as summarised in **Table 5-6** and **Table 5-7**) will be notified at least seven days prior to the commencement of the particular activity. The information provided to the residents and other sensitive receivers impacted will include: • programmed times and locations of construction work; • the hours of proposed works; • construction noise and vibration impact predictions; and • construction noise and vibration mitigation measures to be implemented. Community consultation regarding construction noise and vibration is further detailed in the Community Consultation Framework in **Appendix C** of the EIS.	Construction

No.	Impact/issue	Environmental management and mitigation measures	Timing
NV3	Site inductions	All project personnel, contractors and subcontractors will undergo an environmental induction. The induction will at least include: • all project specific and relevant standard noise and vibration mitigation measures; • relevant licence and approval conditions; • permissible hours of work; • any limitations on high noise generating activities (e.g. use of jack hammering, rock breaking, piling rigs and diamond saws); • locations of nearest sensitive receivers; • construction employee parking areas; • designated loading/unloading areas and procedures; • site opening/closing times (including deliveries); • behavioural practices such as limiting the use of loud stereos/radios on-site and not dropping materials from height or metal items; • public complaints handling procedures; and • environmental incident management procedures.	Construction
NV4	Out-of-hours Protocol	Where feasible and reasonable, construction will be carried out during standard construction hours. However, given that some works will be undertaken outside of standard construction hours, an 'Out-of-hours Protocol' will be prepared as part of the CNVMP. This will evaluate the potential noise impacts of specific out-of-hours works and recommend appropriate mitigations measures such as: • community consultation with highly noise affected receivers; • procedures to determine negotiated outcomes in consultation with affected receivers (e.g. construction scheduling during sensitive periods such as exams where construction is in the vicinity of schools); • specific mitigation measures such as respite periods; and • a monitoring program.	Construction
NV5	Respite periods for works during standard construction hours works	Respite periods during standard construction hours will be identified in consultation with affected members of the community. Respite options will be considered when sensitive receivers are within the minimum working distances for vibration intensive works or are highly noise affected receivers (experiencing noise levels above 75 dB(A)). Respite options will include consideration of works schedules. Vibration intensive or high noise generating equipment will be used in continuous blocks, not exceeding three hours each with a minimum respite period of one hour between each block.	Construction

No.	Impact/issue	Environmental management and mitigation measures	Timing
NV6	Respite periods for works outside of standard construction hours	The need to consider respite periods will be triggered where the $L_{Aeq(15min)}$ noise levels exceed 75 dB(A) at the same receiver after midnight for three consecutive nights. Where this level is exceeded, respite periods will be considered in accordance with the Out-of-hours Protocol (refer to NV4).	Construction
NV7	Construction hours and scheduling	Where feasible and reasonable, construction will be carried out during standard construction hours. Where required to be completed outside of standard construction hours, in proximity to sensitive receivers, works generating high noise and/or vibration levels (including the use of rock breakers and diamond saws) will be scheduled during less sensitive time periods.	Construction
NV8	Noise monitoring	A noise monitoring program will be implemented for the duration of the works in accordance with the CNVMP and will focus on the use of high noise generating plant (e.g. jack hammering, rock breaking, piling rigs and diamond saws) and works outside of standard construction hours.	Construction
NV9	Equipment selection and placement	Equipment selection will consider potential noise and vibration impacts and quieter equipment and/or construction methods will be used where feasible and reasonable. Plant and equipment will: • have an operating sound power level of no more than those listed in **Table 6-2**; • be maintained and operated in an efficient manner, in accordance with manufacturer's specifications, to reduce the potential for adverse noise and vibration impacts; • be fitted with non-tonal reversing beepers (or an equivalent mechanism); • be throttled down or shut down when not in use; and • minimise noise through: - use of residential grade mufflers; - use of damped hammers such as "City" Model Rammer Hammers; and - silencing air parking brakes. High noise generating plant will: • be located so that the offset distance between the plant and adjacent sensitive receivers is maximised as far as possible; and • be directed away from sensitive receivers, where possible to do so.	Detailed design and construction

No.	Impact/issue	Environmental management and mitigation measures	Timing
NV10	Construction traffic	Potential noise impacts from construction vehicles will be minimised through the following: • traffic flow, parking and loading/unloading areas will be planned to minimise reversing movements within the work sites and at construction laydown areas; • loading and unloading of materials/deliveries will occur as far as possible from sensitive receivers; • shielding loading/unloading areas if close to sensitive receivers, where feasible (i.e. breaking the line of site between the area and the receiver); • fitting delivery vehicles with straps rather than chains for unloading, wherever possible; • selecting construction laydown area access points and roads as far away as possible from sensitive receivers; • locating delivery and haulage routes away from sensitive receivers, where possible; • scheduling deliveries during less sensitive times, where possible; • limiting the speed of vehicles; • restricting the use of engine compression brakes; and • maximising the storage capacity of construction laydown areas to reduce the need for truck movements during sensitive times (between midnight and 7:00 am).	Construction
NV11	Steel road plates	The use of road plates will be minimised, where possible. Where required to be used, the plates will be installed in a manner that minimises the potential for displacement by traffic loading and minimises any height difference with the adjacent road surface in order to reduce the potential for impact noise generation from tyres traversing the plates.	Construction
NV12	Stationary noise sources	Low noise emitting plant and equipment (such as those with built-in shielding and mufflers) will be used wherever possible. Noise generating plant at work sites (such as compressors and generators) will be directed away from and situated furthest away from sensitive receivers, where practicable. Machinery that is not in use will be switched off.	Construction
NV13	Shield sensitive receivers	Structures will be used to shield residential receivers from noise such as use of hoarding/noise curtains, where practicable, at construction laydown areas and special crossing work sites.	Construction

No.	Impact/issue	Environmental management and mitigation measures	Timing
	Receptor controls		
NV14	Building condition surveys and vibration monitoring	If vibration intensive equipment is to be used within the minimum working distances for cosmetic damage, then it is recommended that a different construction method with lower source vibration levels is used where feasible and reasonable. Where work within the minimum working distances for cosmetic damage is planned to occur: • attended vibration measurements will be undertaken at the work site when work commences, to determine site specific minimum working distances. As a precaution, where practicable, these measurements will be made at distances outside the minimum working distances to ensure no structural damage occurs and will provide detailed information regarding the transmission of vibration to allow site specific safe working distances to be determined; and • for listed heritage items and houses within heritage conservation areas, building conditions surveys will be undertaken. The survey will document the structural condition of these buildings/structures before construction commences and after construction is complete to identify any impacts on historical buildings/structures as a result of the project construction. Building condition surveys will be scheduled in consultation with property owners. Vibration intensive work will not proceed within the minimum working distances (recommended or site specific) unless a permanent vibration monitoring system is installed, to warn operators when vibration levels are approaching the peak particle velocity objectives as outlined in DIN 4150. For work scheduled to occur near a building, within the minimum working distance for human comfort but outside the minimum working distance for cosmetic damage, the affected receivers will be notified.	Construction

8.0 Conclusions

TransGrid is seeking approval under the EP&A Act for the project, which consists of the construction and operation of a new 330 kV transmission cable circuit between the existing Rookwood Road substation in Potts Hill and the Beaconsfield West substation in Alexandria. This Construction Noise and Vibration Impact Assessment has assessed the potential impacts of constructing the project, including airborne construction noise, traffic noise and construction vibration.

To facilitate the assessment, nearby noise and vibration sensitive receivers and NCAs were identified. Noise and vibration sensitive receivers include residential properties, educational facilities, places of worship, recreational areas and commercial and industrial properties which are used by sensitive land uses (e.g. day care facilities). Unattended and attended noise measurements were completed to characterise the existing noise environment of each NCA and establish NMLs.

The construction noise assessment was conducted in accordance with the *Interim Construction Noise Guideline* (ICNG) as required by the Secretary's Environmental Assessment Requirements (SEARs) for the project. The following construction scenarios have been considered, these are considered to be the noisiest activities likely to occur:

- site preparation;
- trenching and excavation;
- excavation and construction of cable joint bays;
- special crossings including cable bridges/underboring of cable conduits;
- cable pulling;
- construction laydown areas;
- restoration of surfaces;
- spoil and waste management; and
- works at Rookwood Road, Beaconsfield West and Sydney South substations.

The assessment undertaken for the project indicates there would be exceedances of the noise management levels at a large number of residential and non-residential noise sensitive receivers close to the works.

The works likely to have the largest impact on noise sensitive receivers are the trenching and excavation works and subsequently the surface restoration works. This is due to the extent of the works, over 20 km, and the construction activities to be undertaken. Construction noise levels would exceed the noise management levels at a significant number of receivers, with many receivers being considered 'highly noise affected'. However, as these works are progressive each receiver is not affected for a long time. For the trenching and excavation works receivers may be affected for around eight weeks. Furthermore, at any one receiver, construction noise levels would slowly increase as the works approach the receiver, would remain fairly constant while the works are directly in front of the receiver and would then slowly decrease again as the works move away. However, for surface restoration works receivers may be affected for about 3-5 weeks.

Construction noise levels from the excavation of the joint bays and then the cable pulling activities may affect a different number of receivers due to the discrete locations of the works, which would be confirmed during detailed design. Construction noise levels would exceed the noise management levels at a number of receivers, with some receivers being considered 'highly noise affected'. These works are likely to last for around five weeks and two weeks respectively.

Other works to be undertaken at discrete locations include the construction of special crossings. Construction noise levels would exceed the noise management levels at a number of receivers, with very few receivers being considered 'highly noise affected'. Special crossings are likely to be completed in a period of up to 10 weeks at each crossing; however, works would be staged and not continuous over the 10 week period.

Noise sensitive receivers near the Rookwood Road, Beaconsfield West and Sydney South substations would experience construction noise which exceeds the noise management levels, however no receivers are likely to be highly noise affected. Substation works would continue for up to six months for the Rookwood Road substation, and up to nine months at both Beaconsfield West and Sydney South substations.

The construction laydown areas would be in use for around 24 months, however noise levels from the sites are significantly lower than those generated by the other construction scenarios, with no receivers expected to be 'highly noise affected'.

There are circumstances where works would be required outside of standard construction hours, such as where work is required by licence or approval conditions or due to safety concerns. In these circumstances, community consultation would take place to ensure that affected residents are aware in advance that the work would take place and the management measures which would be implemented to reduce the noise impacts, where feasible and reasonable.

Noise mitigation measures have been recommended to reduce the construction noise impact at adjacent receivers. The measures include the:

- the preparation of a CNVMP;
- community consultation/notification;
- noise monitoring;
- induction and training of construction workers;
- appropriate selection and maintenance of equipment;
- use of hoardings and temporary noise barriers;
- scheduling of work for less sensitive time periods and use of respite periods, where feasible; and
- construction traffic management.

In order to minimise impact from vibration intensive works, minimum working distances have been recommended for both human comfort and structural damage. Vibration intensive works include the use of rock breakers, piling rigs and jack hammers during the trenching and excavation works and during the joint bay excavation works. These works are likely to affect any one receiver for around a week. For vibration intensive works required within the minimum working distances recommendations have been provided. These include:

- vibration monitoring during the initial stages of vibration intensive works to determine site specific minimum working distances;
- works scheduling and respite periods;
- equipment selection and maintenance; and
- building condition surveys.

In addition, it should be noted that a number of the noise mitigation measures would also mitigate construction vibration.

Construction road traffic noise

The road traffic noise associated with traffic movements during construction was assessed in accordance with RNP guidelines.

For arterial roads, noise level increase due to construction traffic is expected to be less than 2 dB given the existing high noise levels from traffic on these roads. As such road traffic noise levels are predicted to comply with the RNP.

Local roads vary in existing traffic volumes and generally accommodate less through traffic than arterial roads. It is expected that some local roads may experience noise level increases greater than 2 dB during daytime and night-time hours due to construction traffic from the project, where existing traffic volumes are considerably low. Notwithstanding, it is expected that overall road traffic noise levels would still comply with relevant $L_{Aeq(1hr)}$ noise levels under the RNP for local roads. Therefore, no

further assessment is required for these roads, in accordance with the RNP. In addition, the majority of truck movements are associated with trenching and excavation works, and as such impacts on local roads would be temporary, limited to the project construction hours and for a relatively short timeframe.

9.0 References

Interim Construction Noise Guideline (ICNG), Department of Environment and Climate Change (DECC), 2009;

Assessing Vibration: A Technical Guideline (AVATG), Department of Environment and Conservation (DEC), 2006;

NSW Road Noise Policy (RNP), Department of Environment, Climate Change and Water (DECCW), 2011;

Noise Policy for Industry (NPfI), Environment Protection Authority (EPA), 2017;

German Standard DIN 4150: *Part 3 1999 Structural Vibration in Buildings - Effects on Structures*, 1999;

British Standard 6472: Part 1 2008 *Evaluation of Human Exposure to Vibration in Buildings*, 2008;

Australian Standard AS 2436-2010, *Guide to noise and vibration control on construction, demolition and maintenance sites*, 2010;

Australian Standard AS 1055.1-1997 – *Acoustics – Description and measurement of environmental noise, Part 1: General procedures*, 1997; and

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