NSW GOVERNMENT

Transport Access Program

Doonside Station Upgrade

Noise and Vibration Impact Assessment

Artist's impression of the proposed Doonside Station Upgrade, subject to detailed design

November 2021

NOISE AND VIBRATION IMPACT ASSESSMENT

Transport Access Program
Doonside Station Upgrade

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Transport for New South Wales

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1.0 Introduction

The Umwelt Acoustic team has prepared a construction noise and vibration impact statement (CNVIS) as part of the Review of Environmental Factors (REF) associated with the Transport for New South Wales (Transport for NSW) Transport Accessibility Program (TAP) upgrade works at the Doonside Railway Station (the Proposal).

The Proposal involves the upgrade works to Doonside Station, approximately 38 kilometres (km) west of Central Station in the Blacktown Local Government Area. Doonside Station, shown in **Figure 1**, is comprised of two island platforms (Platforms 1 and 2 on the northern side of the station and Platforms 3 and 4 on the southern side of the station).

The area surrounding Doonside Station is mainly comprised of low density residential zones. Other nearby land uses include shops on Hill End Road to the north of the station featuring a range of small-scale retail and food and drink premises. A Neighbourhood Centre is located immediately to the south of the station and Doonside Public School is located to the south east.

The duration of the upgrade works to Doonside Station (the construction phase) is expected to take up to 18 months, scheduled to commence in early 2022. The construction works are scheduled to occur within standard work hours (with COVID-19 approved hours on weekends where applicable). Apart from utilising seven planned rail shutdown periods, out of hours work may also be scheduled outside of rail shutdown periods. Approval from Transport for NSW would be required for any out of hours work and the affected community would be notified as outlined in Transport for NSW's Construction Noise and Vibration Strategy (TfNSW, 2019).

1.1 The Proposal

The Proposal includes the following key elements:

- four new lifts connecting the platforms and station entries to the existing footbridge, with canopies for weather protection at the lift landings
- removal of existing stairs from the footbridge to Platforms 3 and 4 and replacement with new stairs facing the eastern end of the platform
- removal of the platform canopy on Platforms 3 and 4 between the existing stairs and platform building
- changes to the existing footbridge, stairs and ramps including replacement of stair treads and handrails where necessary and installation of a new roof
- continuous canopy coverage on both platforms from the new lifts to the boarding assistance zones
- two new accessible parking spaces on Cross Street
- one new accessible parking space on Doonside Road
- reconfiguration of the existing kiss and ride bay on Cross Street

- changes to the existing station building layout on Platforms 1 and 2 for the provision of a new family accessible toilet
- changes to the existing station building layout on Platforms 3 and 4 for the provision of a new communications room
- footpath and platform regrading to provide accessible pathways where required throughout the station precinct
- new bicycle hoops near the Doonside Road ramp entrance
- new bicycle hoops near the Cross Street ramp entrance
- improvements to closed circuit TV (CCTV) security, lighting and wayfinding to improve safety and security
- electrical upgrades to accommodate the new infrastructure, including installation of a new padmount transformer.

1.2 Construction Activities

1.2.1 Work Methodology

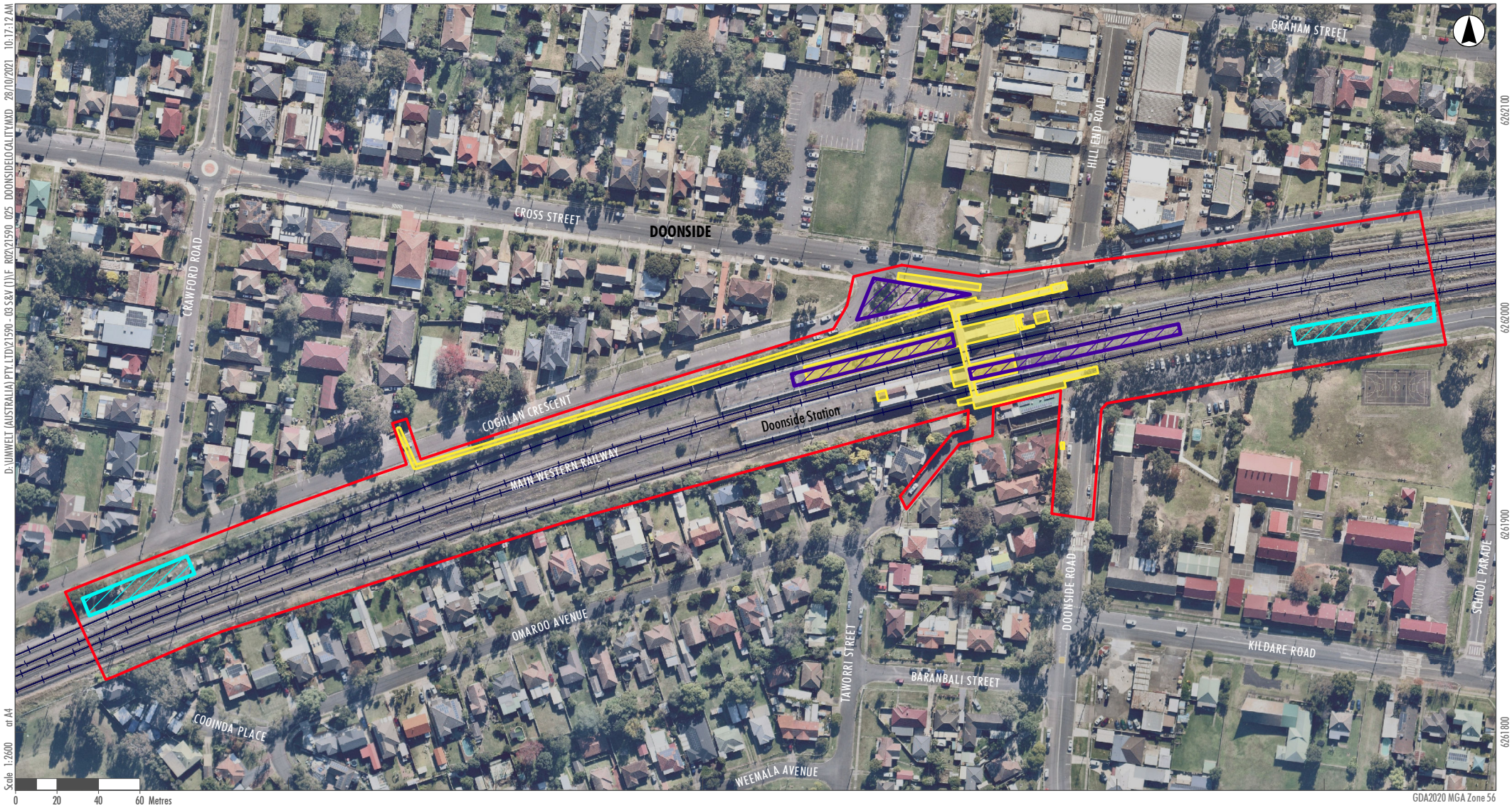
Subject to approval, construction is expected to commence in early 2022 and take around 18 months to complete. The construction methodology will be further developed during the detailed design of the Proposal by the nominated Contractor in consultation with Transport for NSW.

The proposed construction activities for the Proposal are identified in **Table 1.1**. This staging is indicative and based on the current concept design and may change once the detailed design methodology is finalised. The staging is also dependent on the Contractor's preferred methodology, program and sequencing of work.

Table 1.1 Indicative Construction Staging For Key Activities

Stage	Activities
Site establishment and enabling work	• establish site compounds (i.e. fencing, site offices, amenities and plant/material storage areas) • establish temporary facilities as required (temporary toilets, temporary construction lights etc.) • erect site hoarding as required • service location and relocation • establish tree protection zones (TPZs) if required
Utilities	• confirm location of existing underground utilities • establish protection areas around utilities not required to be relocated • relocate utilities as required • install new padmount transformer on the northern side of Doonside Station • install new underground combined services route including LV service main, connecting from the existing padmount substation 11778 to the new padmount transformer

Stage	Activities
Lift installation	• prepare sites and position cranes and piling rigs for lifts • temporary earthworks and dismantling of fencing and barriers to allow piling rigs to reach desired locations • excavation of lift pits and lift landing footings (including temporary shoring if required) • piling works for lifts and lift landings • waterproof (as required) • install reinforcement, formwork and concrete to form the lift pits and footings • erect glass and steel shaft structures • install structural supports for lift landings • install lift landings • install lifts, including fit-out
Ramps, footbridge and stairs	• demolish existing stairs on Platforms 3 and 4 and install new stairs facing the eastern end of the platform • remove existing rooves on the ramps, footbridge and stairs install structural steel and roofing for ramps, footbridge and stairs • remove existing handrails to the ramps, footbridge and stairs • install new handrails for the ramps, footbridge and stairs • strengthen existing footbridge
Station Building work	• reconfigure existing male and female toilet on Platforms 1 and 2 to allow for a new family accessible toilet • reconfigure existing storage room on Platforms 3 and 4 into a new communications room • excavate pits for canopy structural supports • install formwork and pour concrete pads for canopy structural supports • install canopy structural supports • install canopy and connect drainage to existing stormwater system • regrade existing platform
Interchange	• excavate and establish new kerb on Cross Street • line mark accessible parking spaces and kiss and ride bays on Cross Street • install new parking signs reconfigure the existing roadway (kerb ramps, line marking, etc.) to accommodate accessible car spaces and kiss and-ride spaces • excavate paved area from lift four to the forecourt of School Parade • re-pave area from lift four to the forecourt of School Parade • install new bicycle parking adjacent to the ramps on both sides of the station
Demobilisation	• dismantle construction compounds/hoarding areas and remove of all construction-related plant and equipment from site
Testing and commissioning	• test electrical, communications and signalling components • commissioning of new lifts



Legend

- Proposal Area
- Proposed Work Areas
- Laydown Area
- Construction Compound
- Railway Line

FIGURE 1

Site Locality Map

Image Source: Nearmap (Jun 2021) Data source: NSW DFSI (2020)

2.0 Proposed Construction Scenario Assessments

2.1 Construction Activities

Noise modelling has been undertaken for five indicative construction scenarios that represent each of the five major construction scope packages of the Project. The activities are anticipated during normal line operations and during routine rail shutdown periods:

- Site establishment and enabling work
- Lift installation, ramps, footbridge, and stairs construction work
- Station building work
- Interchange
- Demobilisation, testing and commissioning work

Each construction scenario described in **Table 2.1** has been nominated based on the client-supplied project information reference in **Table 1.1**.

Table 2.1 Construction Scenarios – Doonside Railway Station

Activity ID no.	Stage	Activities	Timing
1	**Site establishment and enabling work**	• establish site compound and laydown areas (i.e., fencing, site offices, amenities, and plant/material storage areas) • establish temporary facilities as required (temporary toilets, temporary construction lights etc.) • erect site hoarding as required • service location and relocation • establish tree protection zones (TPZs) if required • confirm location of existing underground utilities • establish protection zones around utilities not required to be relocated • relocate utilities as required • install new electricity pillar on the northern side of Doonside Station • install new underground LV service main, connecting from the existing padmount substation 11778 to the new electricity pillar	Standard hours and 48-hour rail shutdown periods

Activity ID no.	Stage	Activities	Timing
2	**Lift installation, ramps, footbridge, and stairs construction**	• prepare sites and position cranes and piling rigs for lifts • temporary earthworks and dismantling of fencing and barriers to allow piling rigs to reach desired locations • excavation of lift pits and lift landing footings (including temporary shoring if required) • piling works for lifts and lift landings • demolish existing stairs on Platforms 3 and 4 and install new stairs • waterproof (as required) • install reinforcement, formwork, and concrete to form the lift pits and footings • erect glass and steel shaft structures • install structural supports for lift landings • install lift landings • install lifts, including fit-out. • remove existing rooves on the ramps, footbridge and stairs install structural steel and roofing for ramps, footbridge, and stairs • remove existing handrails to the ramps, footbridge, and stairs • install new handrails for the ramps, footbridge, and stairs • strengthen footbridge • install new combined service route • install new pad-mount transformer	Standard hours and 48-hour rail shutdown periods
3	**Station Building work**	• reconfigure existing male and female toilet on Platforms 1 and 2 to allow for a new family accessible toilet • reconfigure existing storage room on Platforms 3 and 4 into a new communications room • excavate pits for canopy structural supports • install formwork and pour concrete pads for canopy structural supports • install canopy structural supports • regrade platform surface (where required) and install tactile • install canopy and connect drainage to existing stormwater system	Standard hours and 48-hour rail shutdown periods

Activity ID no.	Stage	Activities	Timing
4	**Interchange**	• excavate and establish new kerb on Cross Street • line mark accessible parking spaces and kiss and ride bays on Cross Street • install new parking signs reconfigure the existing roadway (kerb ramps, line marking, etc.) to accommodate accessible car spaces and kiss and-ride spaces • excavate paved area from lift four to the forecourt of School Parade • re-pave area from lift four to the forecourt of School Parade • install new bicycle parking adjacent to the ramps on both sides of the station	Standard hours
5	**Demobilisation, testing and commissioning**	• dismantle construction compounds/hoarding areas and remove of all construction-related plant and equipment from site • test electrical, communications, security and signalling components • commissioning of new lifts	Standard hours

Table 2.2 presents the list of likely mechanical plant items to be used on-site cross-referenced to each of the modelled scenarios. Impacts associated with four temporary construction compounds/laydown areas required to accommodate a site office, amenities, laydown and storage area for materials have also been considered.

Table 2.2 Mechanical Plant Items Cross-Referenced Against Modelled Scenarios

Equipment/Plant	Activity ID no.				
	1	2	3	4	5
hand tools	X	X	X	X	X
all-terrain forklift	X	X	-	-	X
street sweeper	-	-	X	X	-
12 tonne crane truck	-	X	-	-	-
hi-rail crane truck	X	X	X	-	X
hi-rail flat bed truck	X	X	X	-	X
water cart	-	-	-	X	-
demolition saw	-	X	X	X	-
generator (5 kVA – 25 kVA)	X	X	-	-	-
petrol pressure washer	-	-	X	X	X
light towers for night works	X	X	X	-	-
vacuum truck	-	X	-	-	-
bore rig (Comacchio Geo205 / Hanjin DB8)	-	X	X	-	-
chainsaw	X	X	-	-	-

Equipment/Plant	Activity ID no.				
	1	2	3	4	5
10 tonne smooth drum roller	-	-	-	X	-
rivet buster	X	-	X	X	-
oxy-acetylene burner	X	X	X	-	-
piling rigs (bore)	-	X	-	-	-
hi-rail piling rig (25t)	-	X	-	-	-
jackhammer	X	X	X	X	-
air-compressor	X	X	X	X	-
4 tonne excavator	X	X	X	X	-
2.5 tonne excavator	X	X	X	X	-
1.5 tonne excavator	X	X	X	X	-
Hydrema hi-rail excavator	X	X	X	X	-
250 tonne crane	-	X	X	-	-

The list of equipment/plant items in **Table 2.2** may not be exhaustive and other ancillary equipment may be required to be used on-site, however, it is considered that the above list would generally be representative of a likely worst-case mechanical plant noise sources and associated construction activity noise sources.

2.2 Working Hours

The majority of work required for the Proposal (including the delivery of plant and equipment) would be undertaken during recommended standard hours defined by the *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Climate Change (DECC), 2009) as:

- 7.00 am to 6.00 pm Monday to Friday
- 8.00 am to 1.00 pm Saturdays
- no work on Sundays or public holidays.

Certain work may need to occur outside recommended standard hours and would include night work and works during routine rail shutdown periods. Rail shutdowns are scheduled closures of the rail corridor that would occur regardless of the Proposal when part of the rail network is temporarily closed and trains are not operating.

Work may be required outside the recommended standard hours to minimise disruptions to customers, pedestrians, motorists and nearby sensitive receivers; and to ensure the safety of railway workers and operational assets. It is estimated that approximately seven scheduled rail shutdown periods outside the recommended standard hours would be required to facilitate the following:

- service relocation works
- electrical works

- piling works for lifts
- lift installation
- works on the station including regrading, construction of canopies and works involving service routes.
- works on the footbridge

Work outside recommended standard hours may also be scheduled outside rail shutdown periods. Approval from Transport for NSW would be required for any out of hours work and the affected community would be notified as outlined in Transport for NSW's *Construction Noise and Vibration Strategy* (TfNSW, 2019).

2.3 Extended Working Hours During COVID-19

The Minister for Planning and Public Spaces has made a number of Orders under Section 10.17 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) in response to the COVID-19 pandemic. This includes the *Environmental Planning and Assessment (COVID-19 Development – Infrastructure Construction Work Days No. 2) Order 2020* (the 'Order'), which commenced on 24 December 2020, and is applicable to construction activities for projects which have been subject to an assessment under Division 5.1, or approval under Division 5.2 of the EP&A Act. The Order extends the standard construction hours to allow infrastructure construction work on Saturday, Sunday and Public holidays (7.00 am to 6.00 pm), without the need for any approval (excluding high noise generating works such as rock breaking or pile driving and the like).

These extended working hours were due to expire on 25 March 2021. However, on Wednesday 24 March 2021, the NSW Government introduced the COVID-*19 Legislation Amendment (Emergency Measures) Bill 2020* (the 'Bill'), which was subsequently passed by parliament, and came into effect on 25 March 2021. A section of the Bill enabled the extension of the extended working hours until 31 March 2022.

Whilst no further assessment of the environmental impacts are required for these extended working hours, in the event that Transport for NSW would seek to utilise the extended working hours permitted by the Order, advance notification would be provided to the community.

3.0 Existing Ambient Noise Environment

3.1 Background Noise Levels

3.1.1 Assumed Background Noise Levels

Due to COVID-19 lockdowns and travel restrictions between Local Government Areas (LGA), noise monitoring fieldwork was not undertaken as part of this assessment and the typical background noise levels representative of 'urban residential' receivers were adopted for this assessment.

Based on a review of the development and zoning proximate to the site, noise management levels were derived for the proposal based on the adoption of typically conservative background noise levels sourced from Table 2.3 of the NSW EPA's *Noise Policy for Industry* (NPfI) (EPA, 2017), representative to that of the 'Urban residential' LEP zoned land-use receiver categories.

The 'Urban residential' receiver type is an apt classification for residential receivers in the site proximity, as the description of the 'Urban residential' receiver category is an area with an acoustical environment that has any combination of being dominated by 'urban hum' (the aggregate sound of many unidentifiable, mostly road/rail traffic and/or industrial related sound sources) or industrial source noise, has through-traffic with characteristically heavy and continuous traffic flows during peak periods, or is near commercial districts or industrial districts. The background noise levels (RBL) for receivers in proximity to the site are Daytime 45 dBA, Evening 40 dBA and Night 35 dBA.

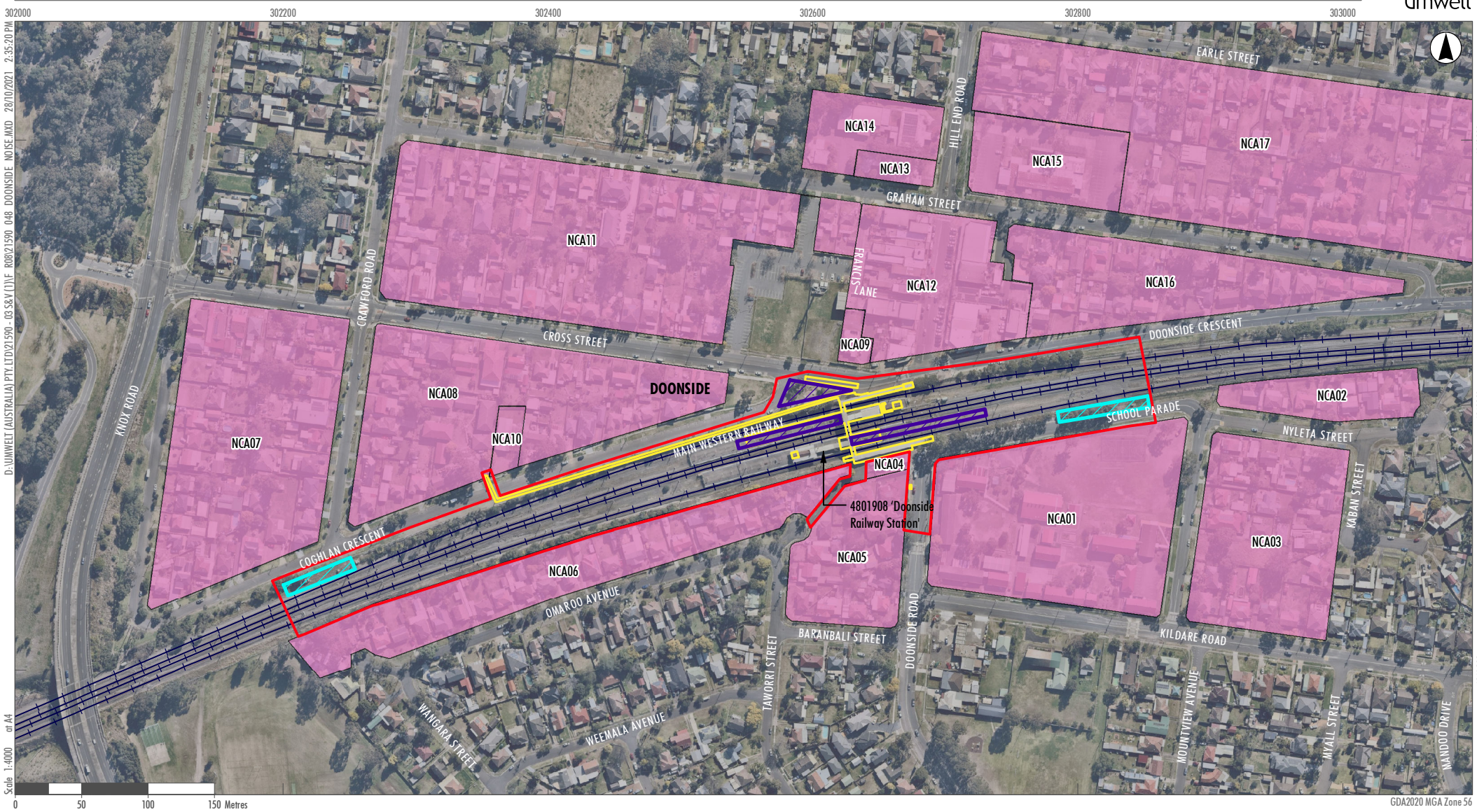
Presented in **Table 3.1**, the RBL for receivers in proximity to the site have been conservatively adopted for this assessment, being equal to the 'Urban residential' receiver category of the NPfI and the CNET Noise Area Category R2.

Table 3.1 Adopted Rating Background Levels [dBA]

Receivers	Time Period	RBL
Potentially affected residential receivers	Day	45
	Evening	40
	Night	35

3.2 Receivers

Proposed receivers to be used in the assessment were numbered starting from the eastern (Up) end of the Project area moving in a generally clockwise direction. Modelled receiver numbers, type and address details are shown in **Table 3.2**. Receivers have been grouped as catchment areas bound by the rail corridor and streets as shown in **Figure 2.**



Legend

- Proposal Area
- Proposed Work Areas
- Laydown Area
- Construction Compound
- Noise Catchment Areas (NCA)
- Railway Line

Image Source: Nearmap (Jun 2021) Data source: NSW DFSI (2020), TfNSW (2021)

FIGURE 2

Noise Catchment Area Map

Table 3.2 Modelled Noise Catchment Area Receiver Identification, Type And Address Details

Noise Catchment Area (NCA)	Receiver Type	Address
NCA01	Educational Institution – Primary School	Doonside Public School, 367 Kildare Road, Doonside Buildings are all 1 storey in height.
NCA02	Residential Receivers	Residences south of the rail corridor and north of Nyleta Street, 1 to 9 Nyleta Street, Doonside.
NCA03	Residential Receivers	Residences south of Nyleta Street and east of School Parade, 2 to 10 School Parade, Doonside.
NCA04	Commercial Receivers	Moshim's Discount House, 2 Doonside Road, Doonside.
NCA05	Residential Receivers	Residences west of Doonside Road, east of Eastwood Lane, Illoura Place and Taworri Street, Doonside. Residences including: 4 to 12 Doonside Rd; 4 Eastwood Lane; 1 to 2 Illoura Pl, and; 21 and 23 Taworri Street, Doonside.
NCA06	Residential Receivers	Residences south of the rail corridor, west of Eastwood Lane, north of Omaroo Avenue, and east of Cooinda Place, Doonside. Residences including: 1 and 2 Cooinda Pl; 1 to 33 Omaroo Ave; 3 Eastwood Ln, and; 4 Illoura Pl, Doonside.
NCA07	Residential Receivers	Residences west of Crawford Road, north of Coghlan Crescent.
NCA08	Residential Receivers	Residences north of Coghlan Crescent, east of Crawford Road and south of Cross Street, Doonside. The eastern boundary adjoins the Commuter Car Park.
NCA09	Residential Receivers	3 Cross Street, Doonside.
NCA10	Place of Public Worship	Doonside Christadelphian Ecclesia, 15 Coghlan Crescent, Doonside.
NCA11	Residential Receivers	Residences north of Cross Street, west of Crawford Road and south of Graham Street, Doonside.
NCA12	Commercial	Doonside Town Centre.
NCA13	Pre-schools and day care facilities	Doonside Kindergarten Inc., 32 Hill End Road, Doonside.
NCA14	Educational institutions (e.g. schools, TAFE colleges)	Doonside Community Centre, 31 Graham Street, Doonside.
NCA15	Hotel	Doonside Hotel, 23 Graham Street, Doonside.
NCA16	Residential Receivers	Residences north of Doonside Crescent, east of Hill End Road and south of Graham Street, Doonside.
NCA17	Residential Receivers	Residences north of Graham Street, east of Hill End Road, south of Earle Street and west of Milson Road, Doonside.

3.2.1 Heritage Items

Doonside Railway Station is classified as a local Heritage Item. The locally listed heritage items comprise:

- two Station Buildings - Platforms 1 and 2, Platforms 3 and 4,
- signal Box - incorporated in Platforms 1 and 2 building.
- structures listed in the heritage item Doonside Railway Station Group includes two island platforms and the steel Footbridge.

4.0 Assessment Criteria

4.1 Construction Noise Criteria

Railway station upgrades are a construction project covered by the *Construction Noise and Vibration Strategy* (CNVS) (TfNSW, 2018). The CNVS outlines the methodology to be undertaken to assess, mitigate and manage construction noise and vibration from *TfNSW Infrastructure and Place Division* (IP) projects.

Guidance and principal requirements regarding the management of noise and vibration from construction in NSW are contained in the:

- *Interim Construction Noise Guideline* (ICNG) (DECC, 2009)
- *Assessing Vibration: A technical guideline* (AVTG) (Department of Environment and Conservation (DEC), 2006)

4.1.1 Construction Hours

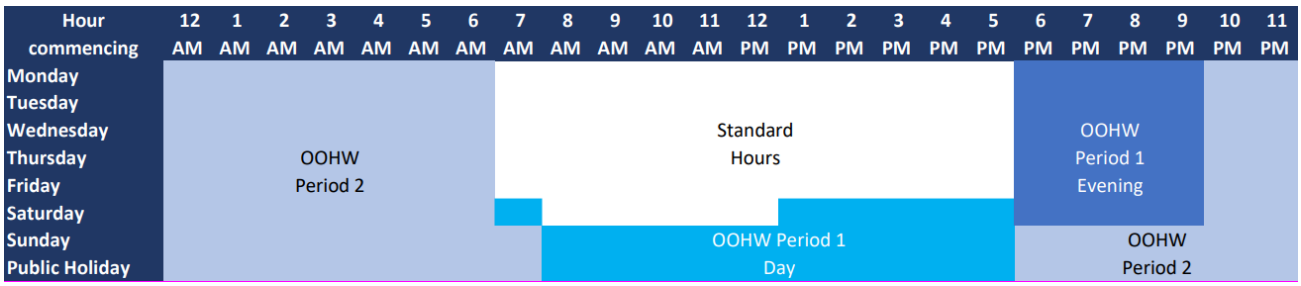
Time periods are defined in the CNVS for different types of construction activities and for standard construction hours (including the delivery of plant and equipment) and out-of-hours works (OOHW) as shown in **Table 4.1**. OOHW Periods 1 and 2 are included in the period described by the ICNG as 'outside the recommended standard hours'. **Table 4.2** presents the time periods visually.

Table 4.1 Construction Hours as Defined in CNVS

Time Period	Construction hours	Monday – Friday	Saturday	Sunday/Public Holiday
Day	Standard construction hours	7.00 am – 6.00 pm	8.00 am – 1.00 pm	No work
Evening	OOHW Period 1	6.00 pm – 10.00 pm	7.00 am – 8.00 am and 1.00 pm – 10.00 pm	8.00 am – 6.00 pm
Night	OOHW Period 2	10.00 pm – 7.00 am	10.00 pm – 8.00 am	6.00 pm – 7.00 am
Construction Activities with special audible characteristics (high noise impact, impulsive or tonal noise emissions)		8.00 am – 5.00 pm[1]	9.00 am – 1.00 pm[1]	No work

Note [1] Works may be carried out in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block, unless otherwise approved by Transport for NSW.

Table 4.2 Construction Hours as Defined in CNVS



4.1.2 Noise Assessment Criteria

For this Proposal a detailed quantitative noise assessment is required to be undertaken as it is likely that some site noise impacts could have special audible characteristics, the duration of work will exceed six weeks, and there are a moderate to large number of impacted receivers including moderate to high-density residential buildings and, at times, commercial buildings.

The applicable criteria for construction noise impacts are given in the ICNG. **Table 4.3** presents the ICNG construction Noise Management Level (NML) for representative receivers surrounding the proposal area. The assessment levels are intended to guide the need for, and the selection of, feasible and reasonable work practices to minimise construction noise impacts.

Table 4.3 ICNG Construction Noise Management Levels, dB(A)

Land use	Construction time	Noise Management Level LAeq, 15 minute
Residential	Recommended standard hours	RBL + 10 dBA
	Outside recommended standard hours	RBL + 5 dBA
Classrooms at schools and other educational institutions	Applicable when property is in use	Internal noise level[1] 45 dBA
Hospital wards and operating theatres	Applicable when property is in use	Internal noise level 45 dBA
Places of Worship	Applicable when property is in use	Internal noise level 45 dBA
Community Centres	Applicable when property is in use	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses[2]. Internal noise level 40 dBA
Industrial premises	Applicable when property is in use	External[3,4] LAeq (15 minute) 75 dBA
Offices, retail outlets	Applicable when property is in use	External[4] LAeq (15 minute) 70 dBA
Other businesses that may be very sensitive to noise, where the noise level is project specific: Childcare centres	Applicable when property is in use	Internal LAeq[5] (15 minute) ≤ 40 dBA External LAeq[6] (15 minute) ≤ 55 dBA
Active recreation areas	Applicable when property is in use	External LAeq (15 minute) 65 dBA
Passive recreation areas	Applicable when property is in use	External LAeq (15 minute) 60 dBA
Rough Sleepers	Outside recommended standard hours	Project Notifications, Specific Notifications and consideration of well-being.

Notes [1] Applies at the centre of the room in use, most exposed to the construction noise, and can include both airborne and ground-borne noise

[2] Community Centres generally provide community spaces for life-long learning, social and cultural activities and typically contain a multi-use hall. The assumed conservatively representative design use from AS2107 was for assembly halls and conference rooms within Educational Buildings, resulting in a recommended 'maximum' internal noise level of LAeq (15 minute) 40 dBA.

[3] The external noise levels should be assessed at the most-affected occupied point of the premises.

[4] The external noise levels should be assessed at the most-affected occupied point of the premises.

[5] From the Association of Australian Acoustical Consultants (AAAC) Guideline for Child Care Centre Acoustic Assessment (the GCCCAA), September 2010, any location within the *outdoor* play or activity area of the Centre during the hours when the Centre is operating.

[6] Any location within the *indoor* play or sleeping areas of the Centre during the hours when the Centre is operating (the GCCCAA).

Where a quantitative noise assessment is to be undertaken, the construction airborne noise objectives are based on the ICNG. The Construction Noise Management Levels (NML) for the different receivers and different time periods based on the adopted RBLs (refer **Table 3.1**) are summarised in **Table 4.4**. The criterion for sleep disturbance is given in Section A.1.2 of the CNVS.

Table 4.4 Proposed Construction Noise Management Levels, dBA

Land Use	Time period	RBL	Noise affected NML[1] LAeq, 15 minute	Highly Noise Affected NML LAeq, 15 minute	Sleep Disturbance Level (LAmax)
All residential receivers	Recommended standard hours[2]	45	55 (45+10)	75	Not applicable[3]
	Outside recommended standard hours (Saturday 1.00 pm – 10.00 pm)	45	50 (45+5)	Not applicable[4]	Not applicable
	Outside recommended standard hours (evening)	40	45 (40+5)	Not applicable	Not applicable
	Outside recommended standard hours (night time)	35	40 (35+5)	Not applicable	65 dBA[5] LAmax
Sensitive land uses (other than residences)	Applicable when property is in use	Not applicable	Refer to **Table 4.3** above	Not applicable	Not applicable

Notes [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] Recommended standard hours: Monday to Friday 7.00am – 6.00pm; Saturday 8.00am – 1.00pm.

[3] Sleep disturbance only applicable during OOHW2 (Night) period

[4] Noise assessment levels for Highly Noise Affected are not defined outside of standard hours

[5] On an hourly basis between 10.00pm – 7.00am, determine the number and distribution of LAmax noise levels greater than 65 dBA where LAmax- LAeq exceeds 15 dB. Where increasing as a result of the project, take account of maximum noise levels when prioritising, selecting and designing noise control measures.

4.2 Sleep Disturbance

The ICNG recommends that where construction works are planned to extend over two or more consecutive nights, the Project should consider maximum noise levels and the extent and frequency of the maximum noise level events exceeding the RBL. The potential for both sleep disturbance and awakenings should be considered in the assessment and is assessed by comparison of the predicted noise levels against the screening levels. The NSW EPA's sleep disturbance screening level for industrial noise is based on the $L_{A1,1minute}$ level (equivalent to the LAmax) of a noise event which should not exceed the ambient L_{A90} noise level by more than 15 dB.

Where sleep disturbance criteria exceedance for more than two consecutive nights cannot be avoided due to reasonable and feasible justification, the delivery partner must consult with the community and consider further mitigation prescribed in **Section 5.0** such as duration reduction or alternative accommodation.

4.3 Construction Vibration Criteria

The applicable criteria for construction vibration impacts are given in the CNVS, stated in terms of the potential for vibration to cause:

- Damage to structures, which may be:
  - Commercial or industrial structures
  - Residential buildings
  - Heritage structure or objects
- Disruption to receivers, which may be:
  - Occupants of commercial or industrial premises
  - Occupants of residential premises
- Equipment or objects within commercial or industrial premises that are sensitive to vibration.

4.3.1 Criteria for Potential Damage to Structures from Vibration

Criteria for potential damage to structures are given in:

- *Australian Standard AS 2187: Part 2-2006 Explosives - Storage and Use - Part 2: Use of Explosives* (AS2187)
- *British Standard BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings – Part 2* (BS7385)
- German Institute for Standardisation *DIN 4150-3:1999-02 Structural vibration – Effects of vibration on structures* (DIN4150) also has criteria of particular reference for heritage structures.

4.3.1.1 Residential or Commercial/Industrial Structures

Criteria for vibration effects on building structures recommended in the CNVS are given in BS7385. The criteria in BS7385 are given in terms of peak component (x-, y- or z-axes separately) vibration velocity values from transient (impulsive) vibration events. The criteria for continuous vibration are recommended to be 50% lower than for impulsive vibration. The vibration criteria for the protection of structures and buildings from cosmetic damage (e.g. hairline cracks in drywalls, etc.) are given in **Table 4.5.**

Table 4.5 Vibration Criteria for Minimal Risk of Cosmetic Damage to Structures (Peak Vibration Velocity (ppv) mm/s)

Type of structure	Peak Component Particle Velocity (mm/s)		
	4 Hz - 15 Hz	15 Hz - 40 Hz	40 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50 [transient (impulsive) vibration] 25 (continuous vibration)		

Type of structure	Peak Component Particle Velocity (mm/s)		
	4 Hz - 15 Hz	15 Hz - 40 Hz	40 Hz and above
Un-reinforced or light framed structures	15 increasing to 20 [transient (impulsive) vibration]	20 increasing to 50 [transient (impulsive) vibration]	50 [transient (impulsive) vibration]
Residential or light commercial type buildings	7.5 increasing to 10 (continuous vibration)	10 increasing to 25 (continuous vibration)	25 (continuous vibration)

4.3.1.2 Heritage Protected Structures

Assessment guidelines for vibration damage to heritage-protected structures are commonly referenced from the DIN4150. This standard differentiates between short-term and long-term vibration, where short-term vibration is caused by sources such as drop-hammers, impact piling, etc. All other sources of vibration are considered to be long-term.

The DIN4150 guideline value for heritage-protected structures for long-term vibration is 2.5 mm/s peak particle velocity (PPV) in the horizontal plane at all frequencies. This guideline value is primarily intended for older, sensitive, above-ground structures (typically buildings).

4.3.2 Criteria for Human Perception of Vibration

Criteria for potential human perception of vibration are given in *Assessing Vibration: A technical guideline* (the 'vibration guideline') (DEC, 2006). The criteria in the vibration guideline are given for continuous vibration, impulsive vibration and for intermittent vibration. For continuous and impulsive vibration, the criteria are given in terms of root-mean-square (rms) vibration acceleration (m/s^2) in the frequency range 1 - 80 Hertz (Hz). For intermittent vibration, the criteria are given in terms of vibration dose value (VDV), which is a parameter used for assessing the combined magnitude and the total duration of vibration impacts.

The criteria given in the vibration guideline for continuous or impulsive vibration relevant to the receivers in the area are given in **Table 4.6**. The frequency weightings are given in Appendix B3 of the vibration guideline.

Table 4.6 Criteria for Continuous and Impulsive Vibration for Human Comfort (Weighted Vibration Acceleration m/s^2 at 1-80 Hz)

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis[2]	x- and y-axes[2]	z-axis	x- and y-axes
Continuous vibration					
Residences	Day	0.010	0.0071	0.020	0.014
	Night	0.007	0.005	0.014	0.010
Offices, schools, educational institutions, or places of worship	Day or Night	0.020	0.014	0.040	0.028

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis[2]	x- and y-axes[2]	z-axis	x- and y-axes
Impulsive vibration					
Residences	Day	0.30	0.21	0.60	0.42
	Night	0.10	0.071	0.20	0.14
Offices, schools, educational institutions, or places of worship	Day or Night	0.64	0.46	1.28	0.92

Notes [1].Day time period is 7am - 10pm. Night time period is 10.00 pm – 7.00 am.

[2] Typically the x-direction is the horizontal radial direction oriented directly between the source and receiver, the y-direction is the horizontal tangential direction, and the z-direction is the vertical direction.

The criteria for intermittent vibration given in the vibration guideline for the relevant receivers in the area proximate to the site are shown in **Table 4.7**. The VDV is calculated using the frequency-weighted rms acceleration as described in the vibration guideline.

Table 4.7 Vibration Criteria For Intermittent Vibration (VDV $m/s^{1.75}$)

Location	Day time period[1]		Night time period[1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions or places of worship	0.40	0.80	0.40	0.80

Note [1] Day time period is 7.00 am – 10.00 pm. Night time period is 10.00 pm – 7.00 am

4.3.3 Criteria for Effects of Vibration on Sensitive Equipment or Objects

The CNVG states that where appropriate, objectives for the satisfactory operation of critical instruments or manufacturing processes should be sourced from manufacturer's data and/or other published objectives. The CNVG lists some references containing example criteria for typical vibration-sensitive equipment.

Criteria for the protection of other types of vibration-sensitive objects should be established on a case-by-case basis.

4.3.4 Combined Structural and Human Perception Vibration Criteria for Residential Buildings

Recommended minimum working distances for vibration generating equipment from sensitive receivers (i.e. the receiver building or its occupants) are given in Table 20 of the CNVS, reproduced in **Table 4.8**. The minimum working distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. Vibration monitoring is recommended to confirm the minimum working distances at specific sites.

Table 4.8 Recommended Minimum Working Distances for Vibration Generating Plant Sensitive Receivers [CNVS Table 20]

Plant Item	Rating/Description	Minimum Working Distance (metres)[1]	
		Cosmetic Damage (Residential Building)	Human Response
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5	15 to 20
	< 100 kN (Typically 2-4 tonnes)	6	20
	< 200 kN (Typically 4-6 tonnes)	12	40
	< 300 kN (Typically 7-13 tonnes)	15	100
	> 300 kN (Typically 13-18 tonnes)	20	100
	> 300 kN (> 18 tonnes)	25	100
Small Hydraulic Hammer	(300 kg - 5 to 12 t excavator)	2	7
Medium Hydraulic Hammer	(900 kg - 12 to 18 t excavator)	7	23
Large Hydraulic Hammer	(1600 kg - 18 to 34 t excavator)	22	73
Vibratory Pile Driver	Sheet piles	2 to 20	20
Pile Boring	≤ 800 mm	2 (nominal)	N/A
Jackhammer	Hand held	1 (nominal)	Avoid contact with structure

Note [1] More stringent conditions may apply to heritage or other sensitive structures

4.4 Construction Traffic Noise Criteria

Noise from construction traffic is assessed against the road traffic noise criteria:

- *NSW Road Noise Policy* (RNP) (Department of Environment, Climate Change and Water (DECCW), 2011)
- *Environmental Noise Management Manual* (ENMM) (Roads and Traffic Authority, 2001)
- *Noise Criteria Guideline* (NCG) (Roads and Maritime, 2015)

5.0 Construction Noise Assessment

5.1 Construction Scenarios

Noise impacts have been assessed for five construction noise scenarios expected to occur at different stages during construction. All five scenarios will occur within standard construction working hours. If required, scenarios 1, 2 and 3 may operate during OOHW periods 1 and 2 as well. The sound power levels (SWL) for each scenario have been used in accordance with the values supplied in the CNET, AS2436 and company databases are shown in **Table 5.1**.

Table 5.1 Proposed Plant/Equipment Noise Emissions Cross-Referenced Against Modelled Scenarios

Equipment/Plant	Sound Power Levels (SWL), Leq dBA	Modelled Scenarios				
		1	2	3	4	5
hand power tools (2-3 Items)	110	X	X	X	X	X
all-terrain forklift	92	X	X	-	-	X
street sweeper	103	-	-	X	X	-
12 tonne crane truck	105	-	X	-	-	-
hi-rail crane truck	104	X	X	X	-	X
hi-rail flat bed	103	X	X	X	-	X
water cart	107	-	-	-	X	-
Demolition/concrete saw[1]	118	-	X	X	X	-
generator (5 kVA – 25 kVA)	103	X	X	-	-	-
petrol pressure washer	103	-	-	X	X	X
light towers for night works	93	X	X	X	-	-
vacuum truck	109	-	X	-	-	-
bore rig (Comacchio Geo205/Hanjin DB8)	107	-	X	X	-	-
chainsaw 4-5 hp[1]	114	X	X	-	-	-
10 tonne smooth drum roller	107	-	-	-	X	-
rivet buster	118	X	-	X	X	-
oxy-acetylene burner	96	X	X	X	-	-
piling rigs (bore)[1]	112	-	X	-	-	-
hi-rail piling rig (25t)[1]	116	-	X	-	-	-
Jackhammer[1]	126	X	X	X	X	-
air-compressor	109	X	X	X	X	-
4 tonne excavator	100	X	X	X	X	-
2.5 tonne excavator	100	X	X	X	X	-
1.5 tonne excavator	100	X	X	X	X	-
Hydrema hi-rail excavator	110	X	X	X	X	-
250 tonne crane	113	-	X	X	-	-

Note [1] As a correction factor for noise with special audible characteristics, SWLs used for the purpose of estimating noise impact have been increased by 5 dBA where works will include: power saws for the cutting of timber, masonry and steel; grinding of metal, concrete or masonry; rock/line drilling; bitumen milling and profiling; jack hammering, rock hammering and rock breaking; or impact piling.

5.2 Construction Noise Impacts

5.2.1 Recommended Standard Hours

The range of predicted LAeq,15minute noise levels for construction activities undertaken during recommended standard [construction] hours have been assessed against the noise management levels (NML) in **Table 5.2** and **Appendix A**. The results of the assessment in **Table 5.2** indicates that construction noise levels are anticipated to exceed the NML during recommended standard hours for each of the construction scenarios at different receiver locations. The assessment of the construction activities undertaken during recommended standard hours triggers the implementation of standard and additional mitigation measures discussed in **Section 6.0**.

Table 5.2 Predicted Construction Noise Levels – Recommended Standard Hours

NCA	NML dB(A)	Approximate Separation Distance[1], m	Predicted Noise Levels, Leq dB(A) per Construction Scenarios				
			1	2	3	4	5
NCA01	55	73	**65-78**	**66-79**	**66-81**	**66-78**	**57-64**
NCA02	55	78	**61-65**	**61-65**	**61-65**	**61-65**	**54-61**
NCA03	55	77	**63-65**	**64-66**	**64-66**	**64-66**	**56-62**
NCA04	70	35	**72-90**	**75-90**	**80-90**	**72-90**	**57-65**
NCA05	55	35	**61-80**	**63-81**	**65-80**	**63-80**	**55-65**
NCA06	55	35	**63-79**	**63-80**	**64-80**	**64-80**	**57-70**
NCA07	55	27	**59-74**	**59-74**	**59-74**	**59-74**	**54-74**
NCA08	55	102	**58-73**	**58-74**	**59-74**	**59-75**	**51-69**
NCA09	55	53	**71-76**	**73-79**	**73-80**	**72-78**	**62-70**
NCA10	55	162	**61-63**	**62-64**	**61-64**	**61-64**	**54-57**
NCA11	55	124	**59-70**	**60-72**	**60-72**	**60-71**	**50-62**
NCA12	70	62	**68-76**	**69-77**	**69-79**	**68-77**	**58-65**
NCA13	55	194	**65-66**	**66-66**	**67-67**	**66-66**	**56-56**
NCA14	50	221	**64-64**	**65-65**	**64-66**	**64-65**	**54-55**
NCA15	55	171	**64-65**	**65-66**	**65-66**	**64-65**	**55-56**
NCA16	55	74	**60-69**	**61-70**	**61-70**	**60-69**	**53-63**
NCA17	55	143	**58-63**	**59-64**	**58-64**	**58-64**	**50-56**

Note [1] Approximate separation distance to the centre of the station or the nearest distance to the eastern/western compound areas.

5.2.2 Outside Recommended Standard Hours – OOWH Period 1 - Day

The range of predicted $L_{Aeq,15minute}$ noise levels for construction activities undertaken outside recommended standard hours during out-of-hours work period 1 (OOHW1) have been assessed against the noise management levels (NML) in **Table 5.3** and **Appendix A**. The results of the assessment in **Table 5.3** indicates that construction noise levels are anticipated to exceed the NML during OOHW1 for each of the constructions scenarios at different receiver locations. The assessment of the construction activities that could be undertaken outside of recommended standard hours triggers the implementation of standard and additional mitigation measures discussed in **Section 6.0**.

Table 5.3 Predicted Construction Noise Levels – Outside Recommended Standard Hours OOHW Period 1 - Day

NCA	NML dB(A)	Approximate Separation Distance[1], m	Predicted Noise Levels, Leq dB(A) per Construction Scenarios				
			1	2	3	4	5
NCA01	N/A	73	65-78	66-79	66-81	66-78	57-64
NCA02	50	78	**61-65**	**61-65**	**61-65**	**61-65**	**54-61**
NCA03	50	77	**63-65**	**64-66**	**64-66**	**64-66**	**56-62**
NCA04	70	35	**72-90**	**75-90**	**80-90**	**72-90**	57-65
NCA05	50	35	**61-80**	**63-81**	**65-80**	**63-80**	**55-65**
NCA06	50	35	**63-79**	**63-80**	**64-80**	**64-80**	**57-70**
NCA07	50	27	**59-74**	**59-74**	**59-74**	**59-74**	**54-74**
NCA08	50	102	**58-73**	**58-74**	**59-74**	**59-75**	**51-69**
NCA09	50	53	**71-76**	**73-79**	**73-80**	**72-78**	**62-70**
NCA10	55	162	**61-63**	**62-64**	**61-64**	**61-64**	**54-57**
NCA11	50	124	**59-70**	**60-72**	**60-72**	**60-71**	**50-62**
NCA12	70	62	**68-76**	**69-77**	**69-79**	**68-77**	58-65
NCA13	55	194	**65-66**	**66-66**	**67-67**	**66-66**	**56-56**
NCA14	50	221	**64-64**	**65-65**	**64-66**	**64-65**	**54-55**
NCA15	55	171	**64-65**	**65-66**	**65-66**	**64-65**	**55-56**
NCA16	50	74	**60-69**	**61-70**	**61-70**	**60-69**	**53-63**
NCA17	50	143	**58-63**	**59-64**	**58-64**	**58-64**	**50-56**

Note [1] Approximate separation distance to the centre of the station or the nearest distance to the eastern/western compound areas.

5.2.3 Outside Recommended Standard Hours – OOWH Period 1 - Evening

The range of predicted $L_{Aeq,15minute}$ noise levels for construction activities undertaken outside recommended standard hours during out-of-hours work period 1 (OOHW1) have been assessed against the noise management levels (NML) in **Table 5.4** and **Appendix A**. The results of the assessment in **Table 5.4** indicates that construction noise levels are anticipated to exceed the NML during OOHW1 for each of the constructions scenarios at different receiver locations. The assessment of the construction activities that could be undertaken outside of recommended standard hours triggers the implementation of standard and additional mitigation measures discussed in **Section 6.0**.

Table 5.4 Predicted Construction Noise Levels – Outside Recommended Standard Hours OOHW Period 1 - Evening

NCA	NML dB(A)	Approximate Separation Distance[1], m	Predicted Noise Levels, Leq dB(A) per Construction Scenarios				
			1	2	3	4	5
NCA01	N/A	73	65-78	66-79	66-81	66-78	57-64
NCA02	45	78	**61-65**	**61-65**	**61-65**	**61-65**	**54-61**
NCA03	45	77	**63-65**	**64-66**	**64-66**	**64-66**	**56-62**
NCA04	70	35	**72-90**	**75-90**	**80-90**	**72-90**	57-65
NCA05	45	35	**61-80**	**63-81**	**65-80**	**63-80**	**55-65**

NCA	NML dB(A)	Approximate Separation Distance[1], m	Predicted Noise Levels, Leq dB(A) per Construction Scenarios				
			1	2	3	4	5
NCA06	45	35	**63-79**	**63-80**	**64-80**	**64-80**	**57-70**
NCA07	45	27	**59-74**	**59-74**	**59-74**	**59-74**	**54-74**
NCA08	45	102	**58-73**	**58-74**	**59-74**	**59-75**	**51-69**
NCA09	45	53	**71-76**	**73-79**	**73-80**	**72-78**	**62-70**
NCA10	55	162	**61-63**	**62-64**	**61-64**	**61-64**	**54-57**
NCA11	45	124	**59-70**	**60-72**	**60-72**	**60-71**	**50-62**
NCA12	70	62	**68-76**	**69-77**	**69-79**	**68-77**	58-65
NCA13	55	194	**65-66**	**66-66**	**67-67**	**66-66**	**56-56**
NCA14	50	221	**64-64**	**65-65**	**64-66**	**64-65**	**54-55**
NCA15	55	171	**64-65**	**65-66**	**65-66**	**64-65**	**55-56**
NCA16	45	74	**60-69**	**61-70**	**61-70**	**60-69**	**53-63**
NCA17	45	143	**58-63**	**59-64**	**58-64**	**58-64**	**50-56**

Note [1] Approximate separation distance to the centre of the station or the nearest distance to the eastern/western compound areas.

5.2.4 Outside Recommended Standard Hours – OOWH Period 2

The range of predicted $L_{Aeq,15minute}$ noise levels for construction activities undertaken outside recommended standard hours during out-of-hours work period 2 (OOHW2) have been assessed against the noise management levels (NML) in **Table 5.5** and **Appendix A**. The results of the assessment in **Table 5.5** indicates that construction noise levels are anticipated to exceed the NML during OOHW2 for each of the construction scenarios at different receiver locations. The assessment of the construction activities that could be undertaken outside of recommended standard hours triggers the implementation of standard and additional mitigation measures discussed in **Section 6.0**.

Table 5.5 Predicted Construction Noise Levels – Outside Recommended Standard Hours OOHW Period 2

NCA	NML dB(A)	Approximate Separation Distance[1], m	Predicted Noise Levels, Leq dB(A) per Construction Scenarios				
			1	2	3	4	5
NCA01	N/A	73	65-78	66-79	66-81	66-78	57-64
NCA02	40	78	**61-65**	**61-65**	**61-65**	**61-65**	**54-61**
NCA03	40	77	**63-65**	**64-66**	**64-66**	**64-66**	**56-62**
NCA04	70	35	**72-90**	**75-90**	**80-90**	**72-90**	57-65
NCA05	40	35	**61-80**	**63-81**	**65-80**	**63-80**	**55-65**
NCA06	40	35	**63-79**	**63-80**	**64-80**	**64-80**	**57-70**
NCA07	40	27	**59-74**	**59-74**	**59-74**	**59-74**	**54-74**
NCA08	40	102	**58-73**	**58-74**	**59-74**	**59-75**	**51-69**
NCA09	40	53	**71-76**	**73-79**	**73-80**	**72-78**	**62-70**
NCA10	55	162	**61-63**	**62-64**	**61-64**	**61-64**	**54-57**
NCA11	40	124	**59-70**	**60-72**	**60-72**	**60-71**	**50-62**
NCA12	70	62	**68-76**	**69-77**	**69-79**	**68-77**	58-65

NCA	NML dB(A)	Approximate Separation Distance[1], m	Predicted Noise Levels, Leq dB(A) per Construction Scenarios				
			1	2	3	4	5
NCA13	55	194	**65-66**	**66-66**	**67-67**	**66-66**	**56-56**
NCA14	50	221	**64-64**	**65-65**	**64-66**	**64-65**	**54-55**
NCA15	55	171	**64-65**	**65-66**	**65-66**	**64-65**	**55-56**
NCA16	40	74	**60-69**	**61-70**	**61-70**	**60-69**	**53-63**
NCA17	40	143	**58-63**	**59-64**	**58-64**	**58-64**	**50-56**

Note [1] Approximate separation distance to the centre of the station or the nearest distance to the eastern/western compound areas.

5.3 Sleep Disturbance Assessment

Predicted sleep disturbance at representative NCA receiver areas for residential receivers is only applicable during OOHW2 (Night) period.

The predicted sleep disturbance noise levels presented in **Table 5.6** show that all the modelled construction scenarios have the potential to result in non-compliance to sleep disturbance criteria at every assessed NCA.

It is understood that the construction works are scheduled to occur within standard work hours (with COVID-19 approved hours on weekends where applicable), however, where sleep disturbance criteria exceedance for more than two consecutive nights cannot be avoided due to reasonable and feasible justification, the delivery partner must consult with the community and consider further mitigation prescribed under **Table 6.2** noise management measures such as duration reduction or alternative accommodation.

Table 5.6 Sleep Disturbance Assessment

Receiver/NCA	Night Period RBL, dB(A)	Sleep Disturbance Criteria, LA1,1minute	Construction Scenario				
			1	2	3	4	5
NCA01 367 Kildare Rd, Doonside	35	Not applicable	-	-	-	-	-
NCA02 1 Nyleta St, Doonside	35	50	**64**	**65**	**65**	**65**	**58**
NCA03 10 School Pde, Doonside	35	50	**65**	**66**	**65**	**65**	**58**
NCA04 2 Doonside St, Doonside	35	Not applicable	-	-	-	-	-
NCA05 4 Eastwood Ln, Doonside	35	50	**80**	**81**	**81**	**80**	**65**
NCA06 3 Illoura Plc, Doonside	35	50	**79**	**80**	**81**	**80**	**69**
NCA07 29 Coghlan Cres, Doonside	35	50	**60**	**61**	**73**	**73**	**73**
NCA08 2A Cross St, Doonside	35	50	**73**	**76**	**76**	**76**	**67**

Receiver/NCA	Night Period RBL, dB(A)	Sleep Disturbance Criteria, LA1,1minute	Construction Scenario				
			1	2	3	4	5
NCA09 3 Cross St, Doonside	35	50	**77**	**81**	**80**	**79**	**70**
NCA10 15 Coghlan Crs, Doonside	35	Not applicable	-	-	-	-	-
NCA11 13 Cross St, Doonside	35	50	**70**	**77**	**75**	**75**	**67**
NCA12 Doonside Town Centre	35	Not applicable					
NCA13 32 Hill End Rd, Doonside	35	Not applicable	-	-	-	-	-
NCA14 31 Graham St, Doonside	35	Not applicable	-	-	-	-	-
NCA15 23 Graham St, Doonside	35	50	**65**	**67**	**66**	**66**	**55**
NCA16 251 Doonside Cres, Doonside	35	50	**69**	**70**	**70**	**70**	**60**
NCA17 21 Graham St, Doonside	35	50	**64**	**65**	**65**	**64**	**53**

5.4 Construction Vibration Impacts

The recommended minimum working distances for vibration generating plant is provided in **Table 5.7**.

Table 5.7 Recommended Minimum Working Distances for Vibration Generating Plant from Residential Sensitive Receiver (CNVS Table 20)

Plant Item	Rating/Description	Minimum Working Distance (metres)		Receivers within Minimum Working Distances
		Cosmetic Damage (Residential Building)	Human Response	
Vibratory Roller	< 50 kN (Typ. 1-2 t)	5	15 to 20	NCA01, Doonside Public School (~20 m) NCA04, Moshim's Discount House (12 m) NCA06, 3 Illoura Plc (~18 m) NCA09, 3 Cross Street, Doonside (~ 20 m) NCA12, Doonside Town Centre (2 Hill End Rd) (~20 m)
	< 100 kN (Typically 2-4 tonnes)	6	20	NCA01, Doonside Public School (~20 m) NCA04, Moshim's Discount House (12 m) NCA06, 3 Illoura Plc (~18 m) NCA09, 3 Cross Street, Doonside (~ 20 m) NCA12, Doonside Town Centre (2 Hill End Rd) (~20 m)

Plant Item	Rating/Description	Minimum Working Distance (metres)		Receivers within Minimum Working Distances
		Cosmetic Damage (Residential Building)	Human Response	
	< 200 kN (Typically 4-6 tonnes)	12	40	NCA01, Doonside Public School (~20 m) NCA04, Moshim's Discount House (12 m) NCA05, 6 Doonside Rd (~23 m) NCA05, 4 Eastwood Ln (~23 m) NCA06, 3 Illoura Plc (~18 m) NCA06, 4 Illoura Plc (~23 m) NCA09, 3 Cross Street, Doonside (~ 20 m) NCA12, Doonside Town Centre (2 Hill End Rd) (~20 m)
	< 300 kN (Typically 7-13 tonnes)	15	100	NCA01, Doonside Public School (~20 m) NCA05, 6 Doonside Rd (~23 m) NCA05, 4 Eastwood Ln (~23 m) NCA06, 3 Illoura Plc (~18 m) NCA06, 4 Illoura Plc (~23 m) NCA09, 3 Cross Street, Doonside (~ 20 m) NCA12, Doonside Town Centre (2 Hill End Rd) (~20 m)
	> 300 kN (Typically 13-18 tonnes)	20	100	NCA01, Doonside Public School (~20 m) NCA05, 6 Doonside Rd (~23 m) NCA05, 4 Eastwood Ln (~23 m) NCA06, 3 Illoura Plc (~18 m) NCA06, 4 Illoura Plc (~23 m) NCA09, 3 Cross Street, Doonside (~ 20 m) NCA12, Doonside Town Centre (2 Hill End Rd) (~20 m)
	> 300 kN (> 18 tonnes)	25	100	NCA01, Doonside Public School (~20 m) NCA05, 6 Doonside Rd (~23 m) NCA05, 4 Eastwood Ln (~23 m) NCA06, 3 Illoura Plc (~18 m) NCA06, 4 Illoura Plc (~23 m) NCA09, 3 Cross Street, Doonside (~ 20 m) NCA12, Doonside Town Centre (2 Hill End Rd) (~20 m)

Plant Item	Rating/Description	Minimum Working Distance (metres)		Receivers within Minimum Working Distances
		Cosmetic Damage (Residential Building)	Human Response	
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2	7	
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7	23	NCA01, Doonside Public School (~20 m) NCA04, Moshim's Discount House (12 m) NCA05, 6 Doonside Rd (~23 m) NCA05, 4 Eastwood Ln (~23 m) NCA06, 3 Illoura Plc (~18 m) NCA06, 4 Illoura Plc (~23 m) NCA09, 3 Cross Street, Doonside (~ 20 m) NCA12, Doonside Town Centre (2 Hill End Rd) (~20 m)
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22	73	NCA01, Doonside Public School (~20 m) NCA04, Moshim's Discount House (12 m) NCA05, 6 Doonside Rd (~23 m) NCA05, 4 Eastwood Ln (~23 m) NCA06, 3 Illoura Plc (~18 m) NCA06, 4 Illoura Plc (~23 m) NCA09, 3 Cross Street, Doonside (~ 20 m) NCA12, Doonside Town Centre (2 Hill End Rd) (~20 m)
Vibratory Pile Driver	Sheet piles	2 to 20	20	NCA01, Doonside Public School (~20 m) NCA04, Moshim's Discount House (12 m) NCA06, 3 Illoura Plc (~18 m) NCA09, 3 Cross Street, Doonside (~ 20 m) NCA12, Doonside Town Centre (2 Hill End Rd) (~20 m)
Pile Boring	≤ 800 mm	2 (nominal)	N/A	
Jackhammer	Handheld	1 (nominal)	Avoid contact with structure	

5.5 Construction Traffic Noise Impacts

Based on the description of the proposed works it is anticipated that the construction-related traffic movements will be minimal during the day/night-time periods and the traffic noise impacts associated with the construction activities would also be minor and insignificant. Therefore a detailed assessment of potential construction traffic noise on local roads near the construction site is not required.

6.0 Mitigation of Impacts

6.1 Mitigation Measures

The ICNG provides guidance on assessing potential impacts and managing construction work to minimise noise impacts on adjacent receivers. The potential construction noise impacts associated with the proposal have been assessed using the quantitative method of the ICNG, generally suited to longer term construction projects that are typically subject to an Environmental Impact Assessment (EIA) process.

The CNVS outlines Transport for NSW's approach to assessing, mitigating and managing construction noise. It provides a consistent approach to the evaluation, selection and design of the most appropriate noise and vibration control options during maintenance and construction.

Where standard mitigation measures have been implemented and where construction activity noise levels still exceed the NMLs at any receiver(s), the CNVS also provides additional mitigation management measures required to be implemented to reduce noise impact where feasible and reasonable.

The descriptions of the additional measures are provided in **Table 6.1**. The recommended additional non-standard noise mitigation measures given in CNVS Table 9 are reproduced in **Table 6.2**.

Table 6.1 Additional Management Measures

Additional Management Measure	Description
Period Notification (PN)	Advanced warning of upcoming works and potential disruptions can assist in reducing the impact on the community. Typically distributed on a monthly basis, notifications may consist of a letterbox drop, and/or email mailing lists, and published on the Transport for NSW website. Updates detail work activities, time periods over which these will occur, impacts and mitigation measures. Notification should be a minimum of seven days prior to the start of works. The approval conditions for projects may specify requirements for notification to the community about works that may impact on them.
Verification Monitoring (V)	Verification monitoring of noise and/or vibration levels during construction is in the form of routine checks of noise levels or following reasonable complaints, conducted at the affected receiver(s) or a nominated representative location. Where monitoring finds that the actual levels exceed those predicted in the assessment then immediate refinement of mitigation measures may be required and the CNVIS amended. Attended measurements are to be undertaken within a period of 14 days from the commencement of construction activities (or as agreed with the EMR/Transport for NSW). For project durations greater than three months, attended measurements are to be repeated on a three-monthly basis, where reasonable and feasible, as part of the audit cycle. Where OOWH are required, attended measurements must be undertaken at the time intervals described in the CNVIS, OOWH assessment, approval and/or licence conditions.

Additional Management Measure	Description
Specific Notification (SN)	Specific notifications are letterbox dropped, hand distributed, or phone calls, to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. Alternatively (or in addition to), communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities and provide an individual briefing. The specific notification provides additional information when relevant and informative to more highly affected receivers than covered in general letterbox drops. This form of communication is used to support periodic notifications, or to advertise unscheduled works.
Respite Offers (RO)	Respite Offers (RO) should be considered made where there are high noise and vibration generating activities near receivers. As a guide work should be carried out in continuous blocks that do not exceed 3 hours each, with a minimum respite period of one hour between each block. The actual duration of each block of work and respite should be flexible to accommodate the usage of and amenity at nearby receivers. The purpose RO is to provide residents with respite from an ongoing impact. This measure is evaluated on a project-by-project basis and may not be applicable to all IP projects. RO could comprise pre- purchased movie tickets, bowling activities, meal vouchers or similar offer.
Alternative Accommodation (AA)	Alternative accommodation (AA) options may be offered to residents living in close proximity to construction works that are likely to experience highly intrusive noise levels. The specifics of the offer will be identified on a project-by-project basis and should provide a like-for-like replacement for permanent residents, including provisions for pets, where reasonable and feasible. Additional aspects for consideration shall include whether the highly intrusive activities occur throughout the night or before midnight.
Alternative construction methodology (AC)	Where the vibration assessment identifies that the proposed construction method has a high risk of causing structural damage to buildings near the works, the proponent will need to consider alternative construction options that achieve compliance with the VMLs for building damage. For example, replace large rock breaker with smaller rock breakers or rock saws.
Respite Period (RP)	OOHW during evening and night periods will be restricted so that receivers are impacted for no more than three consecutive evenings and no more than two consecutive nights in the same NCA in any one week, except where there is a Duration Respite. A minimum respite period of four evenings/five nights shall be implemented between periods of evening and/or night works. Strong justification must be provided where it is not reasonable and feasible to implement these period restrictions and approval granted by Transport for NSW through the OOHW Approval Protocol. Note: this management measure does not apply to OOHW Period 1 – Days.

Additional Management Measure	Description
Duration Reduction (DR)	Where RP and respite periods are considered counterproductive in reducing the impact on the community for longer duration projects and where it can be strongly justified on a project-by-project basis, it may be beneficial to increase the number of evenings and/or nights worked through DR so that the project can be completed more quickly. The project team should engage with the impacted receivers where noise levels are expected to exceed the NML to demonstrate support for DR. A community engagement strategy must be agreed with and implemented in consultation with IP Community Engagement Representatives.

Table 6.2 When Triggered, How to Implement Additional Airborne Noise Management Measures

Construction hours	Receiver perception	dB(A) above RBL[1]	dB(A) above ANML	Additional management measures[2]
Standard Hours Monday-Friday (7.00am-6.00pm) Saturday (8am-1pm)	Noticeable	5 to 10	0	-
	Clearly audible	> 10 to 20	< 10	-
	Moderately intrusive	> 20 to 30	> 10 to 20	PN, V
	Highly intrusive	> 30	> 20	PN, V
	75 dB(A) or greater	N/A	N/A	PN, V, SN
OOHW Period 1 Monday-Friday 6.00pm-10.00pm Saturday (7.00am-8.00am, 1.00pm-10.00pm) Sunday/PH (8.00am-6.00pm)	Noticeable	5 to 10	< 5	-
	Clearly Audible	> 10 to 20	5 to 15	PN, RP[3], DR[3]
	Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RO, RP[3], DR[3]
	Highly intrusive	> 30	> 25	PN, V, SN, RO, RP[3], DR[3]
OOHW Period 2 Monday-Saturday (12.00am-7.00am, 10.00pm-12.00am) Sunday/PH (12.00am-8.00am, 9.00pm-12.00am)	Noticeable	5 to 10	< 5	PN
	Clearly Audible	> 10 to 20	5 to 15	PN, V, SN, RO[4], RP[3], DR[3]
	Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RO[4], RP[3], DR[3]
	Highly intrusive	> 30	> 25	PN, V, SN, RO[4], RP[3], DR[3], AA

Note s [1] As a correction factor for noise with special audible characteristics, sound power levels used for the purpose of estimating noise impact shall be increased by 5 dB(A) where works will include: power saws for the cutting of timber, masonry and steel; grinding of metal, concrete or masonry; rock/line drilling; bitumen milling and profiling; jack hammering, rock hammering and rock breaking; or impact piling.

[2] Abbreviation nomenclature: AA - Alternative Accommodation; DR - Duration Reduction; PN - Project Notification; RO - Project specific respite offer; RP - Respite Period; SN - Specific notification, individual briefings, or phone call, and; V - Verification monitoring.

[3] Respite periods and duration reduction are not applicable when works are carried out during OOHW Period 1 Day only (i.e. Saturday 6.00am-7.00am and 1.00pm-6.00pm, Sundays/Public Holidays 8.00am-6.00pm).

[4] Respite offers during OOHW Period 2 are only applicable for evening periods (i.e. Sundays / Public Holidays 6pm-10pm), and may not be required if a respite offer has already been made for the immediately preceding OOHW Period 1.

6.2 Additional Mitigation Measures Triggered By The Proposal

The additional mitigation measures required to address the potential noise impacts identified in **Section 5.2** during recommended standard hours are presented in **Table 6.3**.

Table 6.3 Recommended Additional Mitigation Measures during Recommended Standard Hours

Receiver/NCA	Receiver Perception Group - Additional Mitigation Measures per Construction Scenarios				
	1	2	3	4	5
NCA01	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	Clearly Audible -
NCA02	Clearly Audible -	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Clearly Audible -
NCA03	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Clearly Audible -
NCA04	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	Noticeable -
NCA05	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	Moderately intrusive - PN,V
NCA06	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	Moderately intrusive - PN,V
NCA07	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V
NCA08	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V
NCA09	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	Moderately intrusive - PN,V
NCA10	Clearly Audible -	Clearly Audible -	Clearly Audible -	Clearly Audible -	Clearly Audible -
NCA11	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Clearly Audible -
NCA12	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	75 dB(A) or greater - PN,V,SN	Noticeable -
NCA13	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Clearly Audible -
NCA14	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Clearly Audible -
NCA15	Clearly Audible -	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Clearly Audible -
NCA16	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Moderately intrusive - PN,V	Clearly Audible -
NCA17	Clearly Audible -	Clearly Audible -	Clearly Audible -	Clearly Audible -	Clearly Audible -

The additional mitigation measures required to address the potential noise impacts identified in **Section 5.2** outside recommended standard hours OOHW Period 1 - Day are presented in **Table 6.4**.

Table 6.4 Recommended Additional Mitigation Measures Outside Recommended Standard Hours OOHW Period 1 — Day

Receiver/NCA	Receiver Perception Group - Additional Mitigation Measures per Construction Scenarios				
	1	2	3	4	5
NCA01	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR
NCA02	Clearly audible - PN, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Clearly audible - PN, RP, DR
NCA03	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Clearly audible - PN, RP, DR
NCA04	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Noticeable -
NCA05	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA06	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA07	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA08	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA09	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA10	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Noticeable -
NCA11	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Clearly audible - PN, RP, DR
NCA12	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Noticeable -
NCA13	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Noticeable -
NCA14	Clearly audible - PN, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR

Receiver/NCA	Receiver Perception Group - Additional Mitigation Measures per Construction Scenarios				
	1	2	3	4	5
NCA15	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Noticeable -
NCA16	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Clearly audible - PN, RP, DR
NCA17	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR

The additional mitigation measures required to address the potential noise impacts identified in **Section 5.2** outside recommended standard hours OOHW1 are presented in **Table 6.5**.

Table 6.5 Recommended Additional Mitigation Measures Outside Recommended Standard Hours OOHW Period 1 — Evening

Receiver / NCA	Receiver Perception Group - Additional Mitigation Measures per Construction Scenarios				
	1	2	3	4	5
NCA01	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR
NCA02	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA03	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA04	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Noticeable -
NCA05	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA06	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA07	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR
NCA08	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA09	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA10	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Noticeable -

Receiver / NCA	Receiver Perception Group - Additional Mitigation Measures per Construction Scenarios				
	1	2	3	4	5
NCA11	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA12	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Noticeable -
NCA13	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Noticeable -
NCA14	Clearly audible - PN, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR
NCA15	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Clearly audible - PN, RP, DR	Noticeable -
NCA16	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA17	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Clearly audible - PN, RP, DR

The additional mitigation measures required to address the potential noise impacts identified in **Section 5.2** outside recommended standard hours OOHW1 are presented in **Table 6.6.**

Table 6.6 Recommended Additional Mitigation Measures Outside Recommended Standard Hours OOHW Period 2

Receiver/NCA	Receiver Perception Group - Additional Mitigation Measures per Construction Scenarios				
	1	2	3	4	5
NCA01	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA
NCA02	Moderately intrusive - PN, V, SN, RO, RP, DR	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Moderately intrusive - PN, V, SN, RO, RP, DR, AA	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA03	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA04	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Noticeable - PN

Receiver/NCA	Receiver Perception Group - Additional Mitigation Measures per Construction Scenarios				
	1	2	3	4	5
NCA05	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA
NCA06	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA
NCA07	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA
NCA08	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA
NCA09	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA
NCA10	Clearly audible - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR	Noticeable - PN
NCA11	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA12	Clearly audible - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR	Noticeable - PN
NCA13	Clearly audible - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR	Noticeable - PN
NCA14	Clearly audible - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR
NCA15	Clearly audible - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR	Clearly audible - PN, V, SN, RO, RP, DR	Noticeable - PN
NCA16	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Highly intrusive - PN, V, SN, RO, RP, DR, AA	Moderately intrusive - PN, V, SN, RO, RP, DR
NCA17	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR	Moderately intrusive - PN, V, SN, RO, RP, DR

The following section summarises the additional mitigation measures identified in **Table 6.3** to **Table 6.6** in accordance with the CNVS.

Scenario 1 – Site establishment and enabling work

In relation to the site establishment and enabling work:

- Construction activities could occur during recommended standard hours and during 48-hour rail shutdown periods
- Additional mitigation measures are triggered for scenario 1 during recommended standard hours as the activities range from being clearly audible to moderately intrusive in NCA08 and NCA11 and greater than 75 dB(A) in NCA01, NCA04, NCA05, NCA06, NCA09 and NCA12
- Additional mitigation measures are triggered for scenario 1 during OOHW1 as the activities range from clearly audible to highly intrusive to exceeding 75 dB(A)
- Additional mitigation measures are triggered for scenario 1 during OOHW2 as the activities range from clearly audible to highly intrusive to exceeding 75 dB(A).

Scenario 2 - Lift installation, ramps, footbridge, and stairs construction

In relation to the lift installation, ramps, footbridge, and stairs construction:

- Construction activities could occur during recommended standard hours and during 48-hour rail shutdown periods
- Additional mitigation measures are triggered for scenario 1 during recommended standard hours as the activities range from being clearly audible to moderately intrusive in NCA08 and NCA11 and greater than 75 dB(A) in NCA01, NCA04, NCA05, NCA06, NCA08, NCA09, NCA11 and NCA12
- Additional mitigation measures are triggered for scenario 1 during OOHW1 as the activities range from clearly audible to highly intrusive to exceeding 75 dB(A)
- Additional mitigation measures are triggered for scenario 1 during OOHW2 as the activities range from clearly audible to highly intrusive to exceeding 75 dB(A).

Scenario 3 – Building work

In relation to the building work:

- Construction activities could occur during recommended standard hours and during 48-hour rail shutdown periods
- Additional mitigation measures are triggered for scenario 3 during recommended standard hours as the activities range from moderately intrusive to greater than 75 dB(A) in NAC01, NCA04, NCA05, NCA06, NCA08, NCA05, NCA11 and NCA012
- Additional mitigation measures are triggered for scenario 1 during OOHW1 as the activities range from clearly audible to highly intrusive to exceeding 75 dB(A)
- Additional mitigation measures are triggered for scenario 1 during OOHW2 as the activities range from clearly audible to highly intrusive to exceeding 75 dB(A).

Scenario 4 – Interchange

In relation to the interchange works:

- Construction activities should only occur during recommended standard hours
- Additional mitigation measures are triggered for scenario 4 during recommended standard hours as the activities range from clearly audible to greater than 75 dB(A) in NCA01, NCA04, NCA05, NCA06, NCA08, NCA09, NCA11 and NCA12
- If construction extends into OOHW1 or OOHW2 additional mitigation measures are triggered for scenario 4 as the activities range from clearly audible to highly intrusive to exceeding 75 dB(A).

Scenario 5 – Demobilisation, testing and commissioning

In relation to the demobilisation, testing and commissioning:

- The related activities should only occur during recommended standard hours
- Additional mitigation measures are triggered for scenario 5 during recommended standard hours as the activities range from clearly audible to moderately intrusive
- If demolition activities extends into OOHW1 or OOHW2 additional mitigation measures are triggered for scenario 5 as the activities range from clearly audible to highly intrusive.

6.3 Construction Vibration Impacts

There are several buildings located within the minimum working distances from the construction activities listed in Table 20 of the CNVS (refer **Table 5.7**). To avoid cosmetic damage to building structures:

- the largest size vibratory roller that should be used should have maximum of 300 kN, and typically weigh less than 18 tonnes.
- the largest size hydraulic hammers that should be used should be less than an 18 t excavator.
- vibratory pile driving should be avoided less than 20 m from a receiver structure.

There are numerous receivers located at distances between 20 to 100 m from the extent of works where human response to vibration may be perceptible but cosmetic damage unlikely.

7.0 Recommendations

The following is recommended to reduce noise impacts associated with the Proposal:

- The standard noise mitigation and management measures described in Section 8.1 of the *Construction Noise and Vibration Strategy* (CNVS) (TfNSW, 2018) be implemented for all construction activities at the site.
- The additional noise mitigation management measures described in Section 8.2 of the CNVS be implemented for the construction sites and activities described in **Table 6.3** to **Table 6.6** to reduce noise impact where feasible and reasonable.
- Construction works required to be undertaken outside the recommended standard hours be assessed and approved on a case-by-case basis following the procedure which can be found in Figure 3 of the CNVS, 'Out-of-hours work assessment and approval procedure.'
- The vibration generating construction equipment not be used within the minimum working distances specified in Table 20 'Recommended minimum working distances from vibration intensive plant', Appendix D, CNVS.

8.0 Conclusions

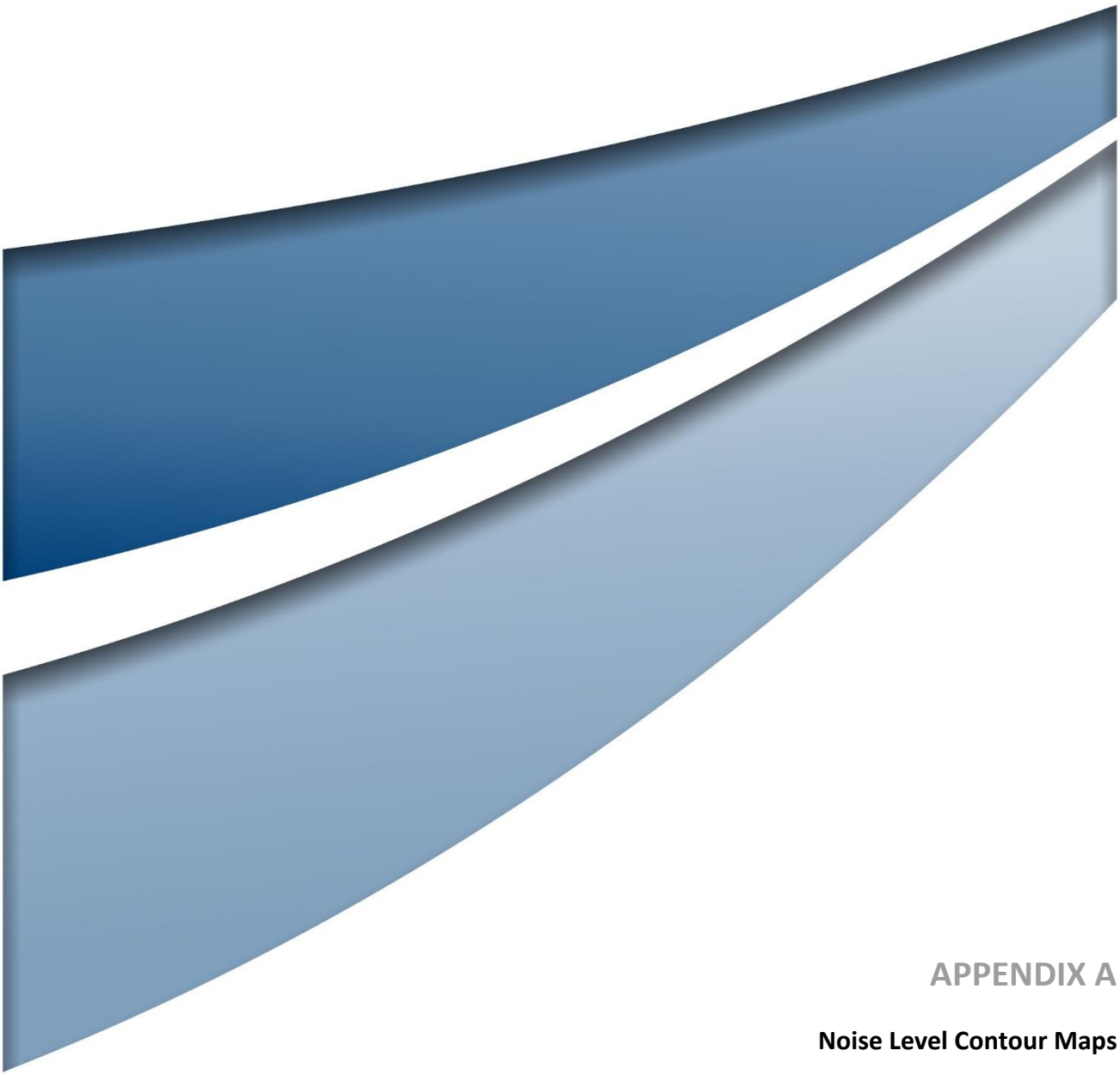
The assessment of construction noise impacts indicates that some additional construction noise mitigation and management measures would be required to be implemented for receivers during standard construction hours. If the Project is to be undertaken outside the recommended standard hours (or during out-of-hours Periods 1 and 2 as defined by the CNVS), the number of receivers requiring additional noise mitigation and the degree of mitigation required would increase.

The assessment of construction vibration indicates that heavy construction equipment should not be used in close proximity to nominated receiver locations (refer to **Section 5.0** for details).

The construction traffic noise impacts are expected to be negligible due to the low volume of construction vehicles that would access the site.

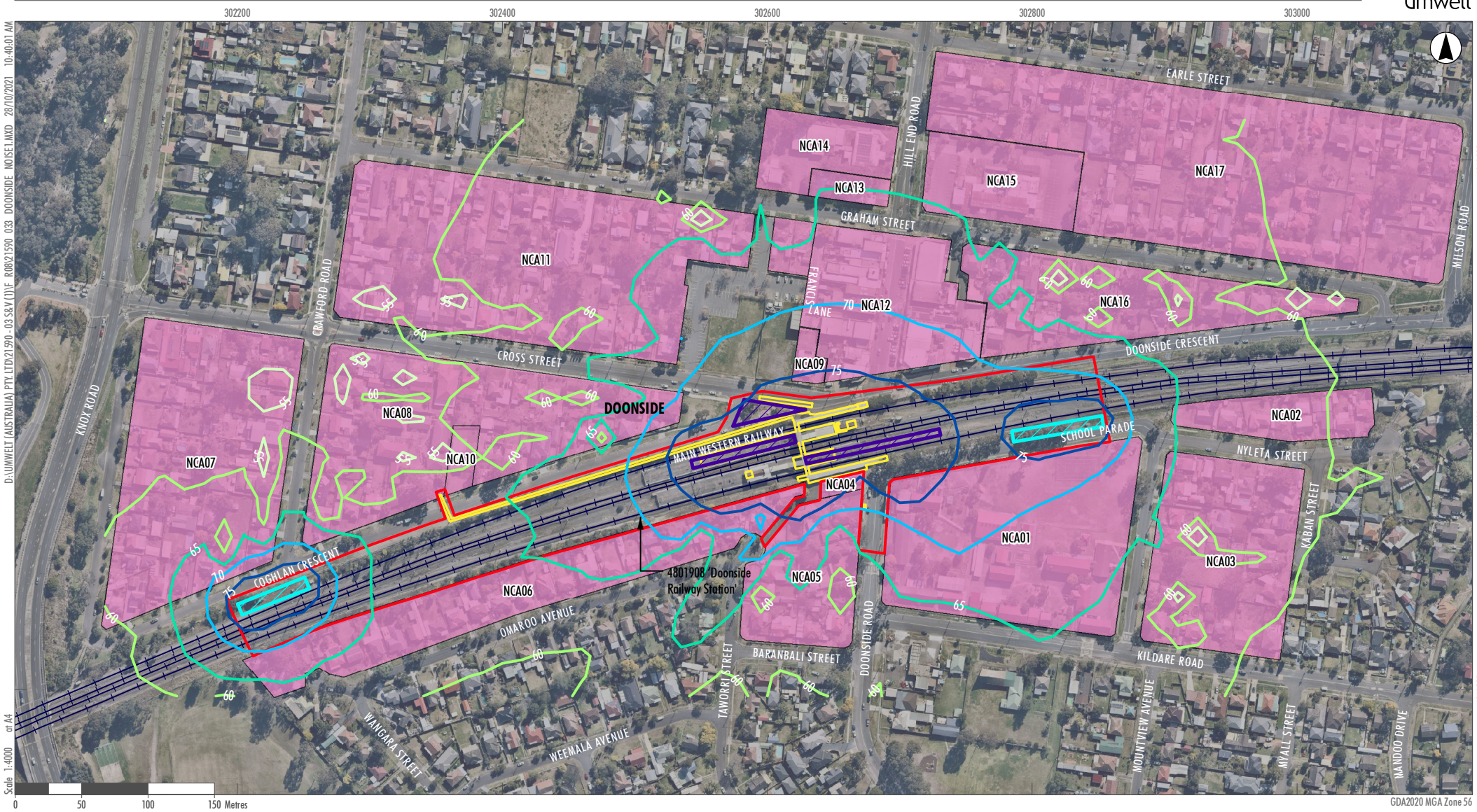
9.0 Glossary

Term	Meaning
Background noise	The underlying level of noise present in the ambient noise, when extraneous noise is removed and in the absence of the noise under investigation. This is described using the LA90 descriptor, see rating background level definition.
CNVIA	Construction Noise and Vibration Impact Assessment, a supporting assessment to the Environmental Impact Assessment required under the *Environmental Planning & Assessment Act 1979*
CNVIS	Construction Noise & Vibration Impact Statement, an assessment prepared during the project delivery phase to confirm noise and/or vibration management
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.
Ground-borne noise	Noise heard within a building that is generated by vibration transmitted through the ground into the structure from construction works, sometimes referred to as 'regenerated noise' or 'structure-borne noise.' Ground-borne noise levels are only applicable when higher than airborne noise levels.
Interchange	Transport interchange refers to the area/s where passengers transit between vehicles or between transport modes. It includes the pedestrian pathways and cycle facilities in and around an interchange.
Internal noise level	Applies at the centre of the room in use that is most exposed to the construction noise, and can include both airborne and ground-borne noise.
Noise Catchment Areas (NCA)	Grouped areas of receivers potentially affected from Proposal related noise and vibration.
Noise sensitive receiver	In addition to residential dwellings, noise sensitive receivers include, but are not limited to, hotels, entertainment venues, pre-schools and day care facilities, educational institutions (e.g. schools, TAFE colleges), health care facilities (e.g. nursing homes, hospitals), recording studios and places of worship/religious facilities (e.g. churches).
NSW Trains	From 1 July 2013, NSW Trains became the new rail provider of services for regional rail customers.
Out-of-hours works	Defined as works *outside* standard construction hours (i.e. outside of 7am to 6pm Monday to Friday, 8am to 1pm Saturday and no work on Sundays/public holidays).
Rail shutdown	Shutdown is the term used by railway building/maintenance contractors to indicate that they have taken possession of the track (usually a block of track) for a specified period, so that no trains operate for a specified time. This is necessary to ensure the safety of workers and rail users.
Rating background level (RBL)	The overall single-figure background noise level for each assessment period. Determination of the RBL is by the method described in the NSW Noise Policy for Industry (EPA, 2017). This approach aims to result in the noise management level being met for at least 90% of the time periods (15 minutes each) over which reactions of annoyance can occur.
Reasonable	Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.
Rough Sleeper	Rough sleepers are persons with no shelter or who are living in non-conventional accommodation. Non-conventional accommodation includes: living on the streets, sleeping in parks, squatting, staying in cars or railway carriages, or living in improvised dwellings.
Sensitive receivers	Land uses which are sensitive to potential noise, air and visual impacts, such as residential dwellings, schools and hospitals.



APPENDIX A

Noise Level Contour Maps



Legend

- Proposal Area
- Proposed Work Areas
- Laydown Area
- Construction Compound
- Noise Catchment Areas (NCA)
- Railway Line

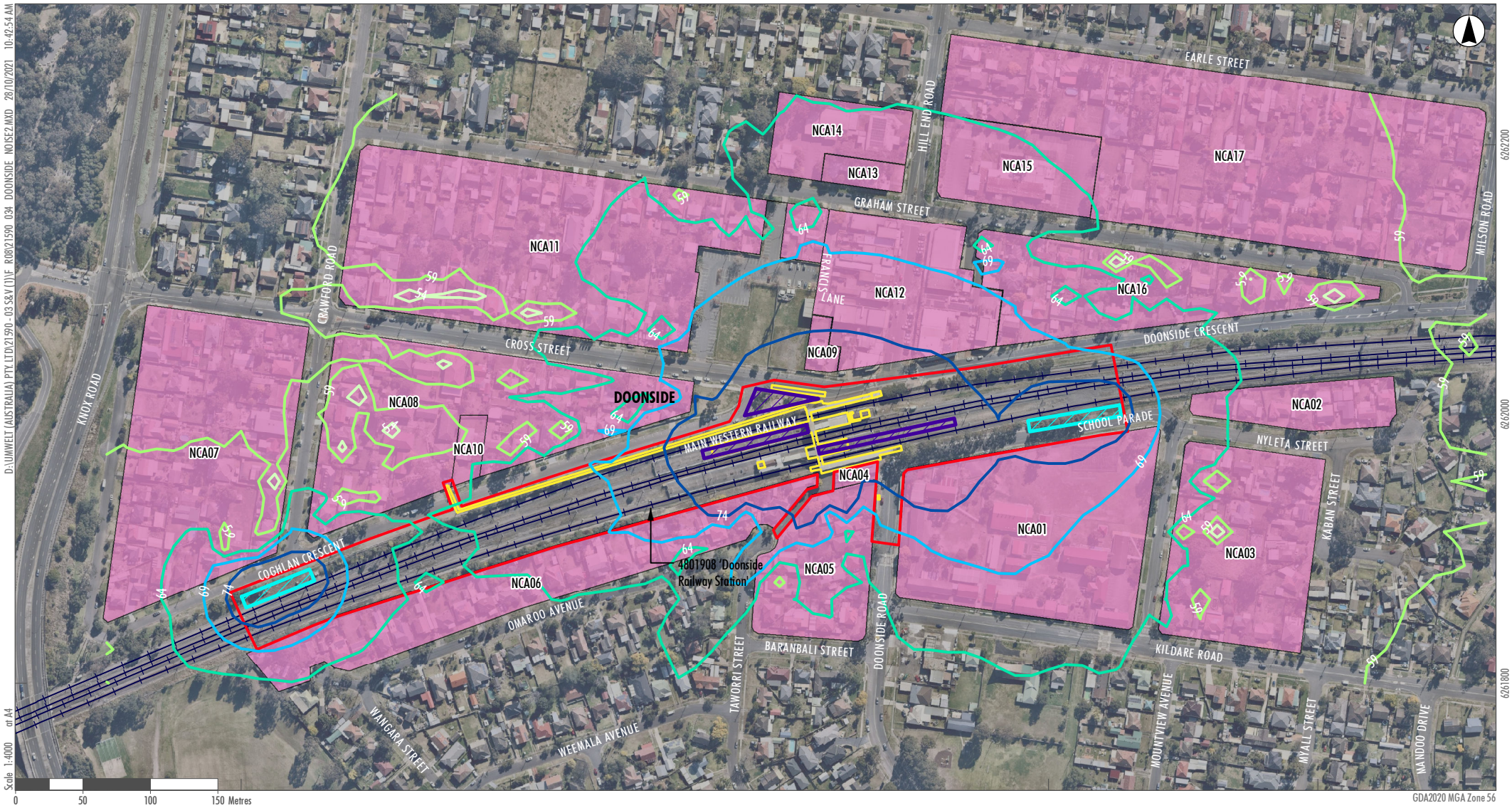
Noise Contours

- 55 dB(A)
- 60 dB(A)
- 65 dB(A)
- 70 dB(A)
- 75 dB(A)

Image Source: Nearmap (Jun 2021) Data source: NSW DFSI (2020), TfNSW (2021)

FIGURE A.1

Construction Scenario 1
Site establishment and enabling work



Legend

- Proposal Area
- Proposed Work Areas
- Laydown Area
- Construction Compound
- Noise Catchment Areas (NCA)
- Railway Line

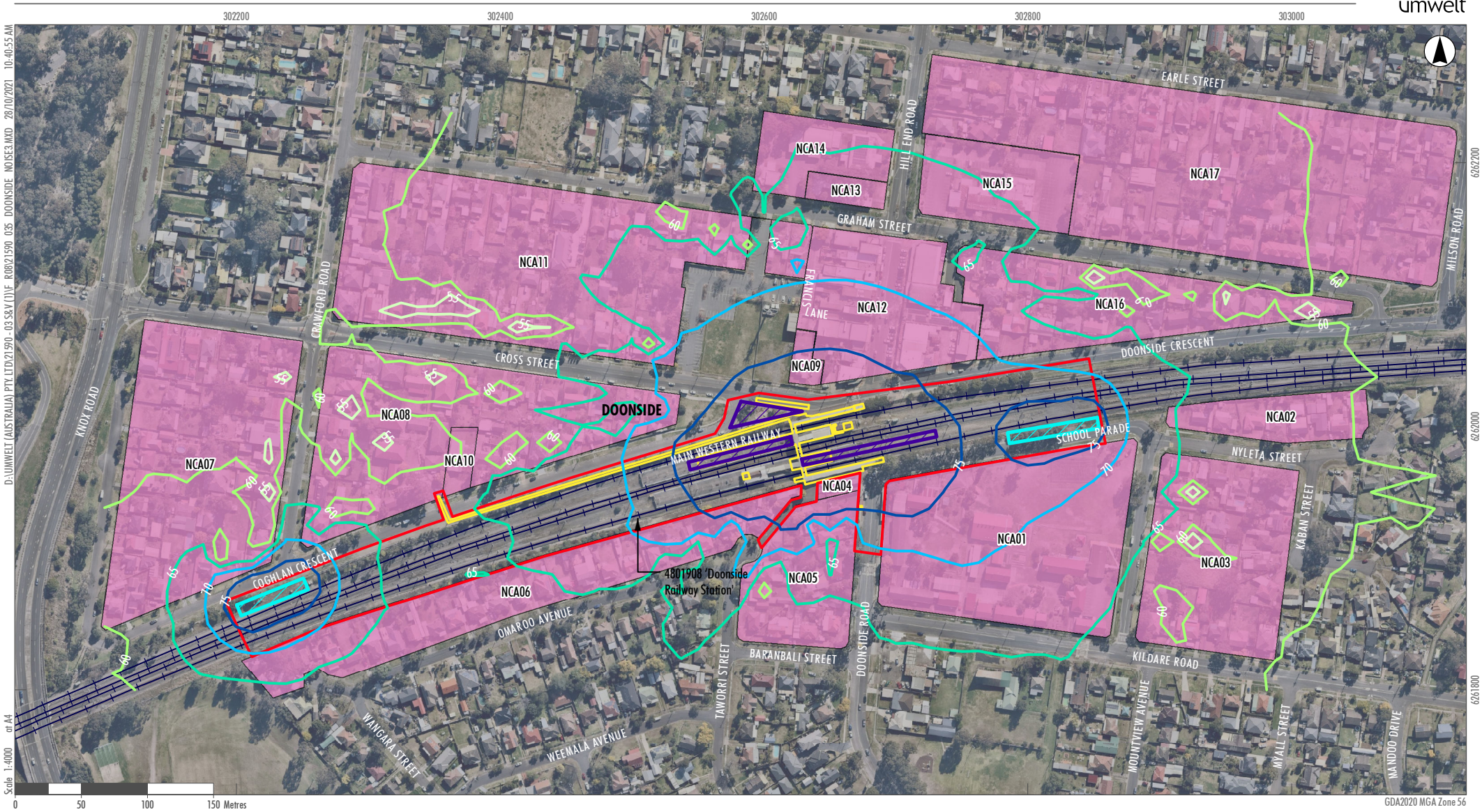
Noise Contours

- 54 dB(A)
- 59 dB(A)
- 64 dB(A)
- 69 dB(A)
- 74 dB(A)

Image Source: Nearmap (Jun 2021) Data source: NSW DFSI (2020), TfNSW (2021)

FIGURE A.2

Construction Scenario 2
Lift installation, ramps, footbridge, and



Legend

- Proposal Area
- Proposed Work Areas
- Laydown Area
- Construction Compound
- Noise Catchment Areas (NCA)
- Railway Line

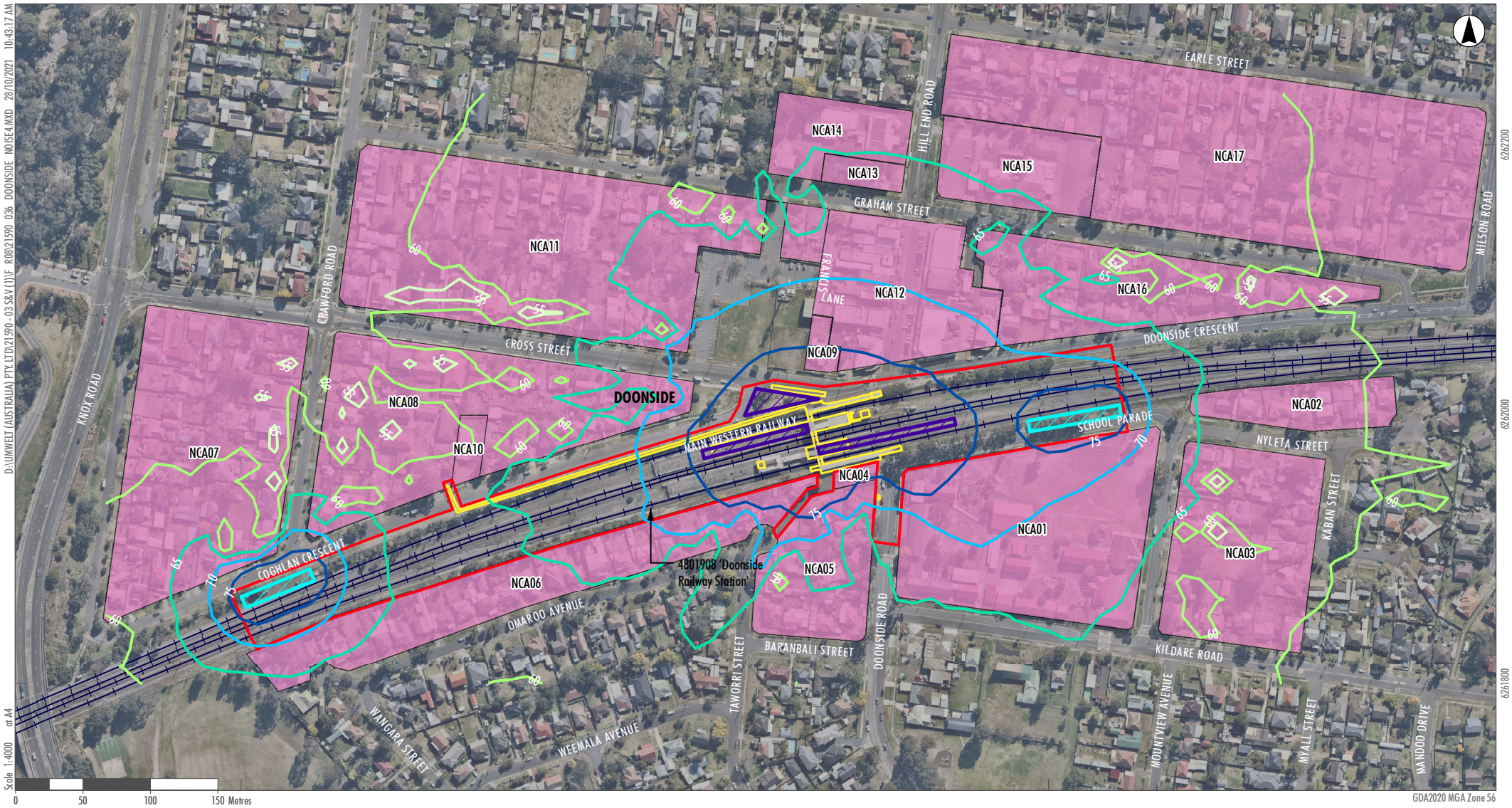
Noise Contours

- 55 dB(A)
- 60 dB(A)
- 65 dB(A)
- 70 dB(A)
- 75 dB(A)

Image Source: Nearmap (Jun 2021) Data source: NSW DFSI (2020), TfNSW (2021)

FIGURE A.3

Construction Scenario 3
Station Building work



Legend

- Proposal Area
- Proposed Work Areas
- Laydown Area
- Construction Compound
- Noise Catchment Areas (NCA)
- Railway Line

Noise Contours

- 55 dB(A)
- 60 dB(A)
- 65 dB(A)
- 70 dB(A)
- 75 dB(A)

Image Source: Nearmap (Jun 2021) Data source: NSW DFSI (2020), TfNSW (2021)

FIGURE A.4

Construction Scenario 4
Interchange work

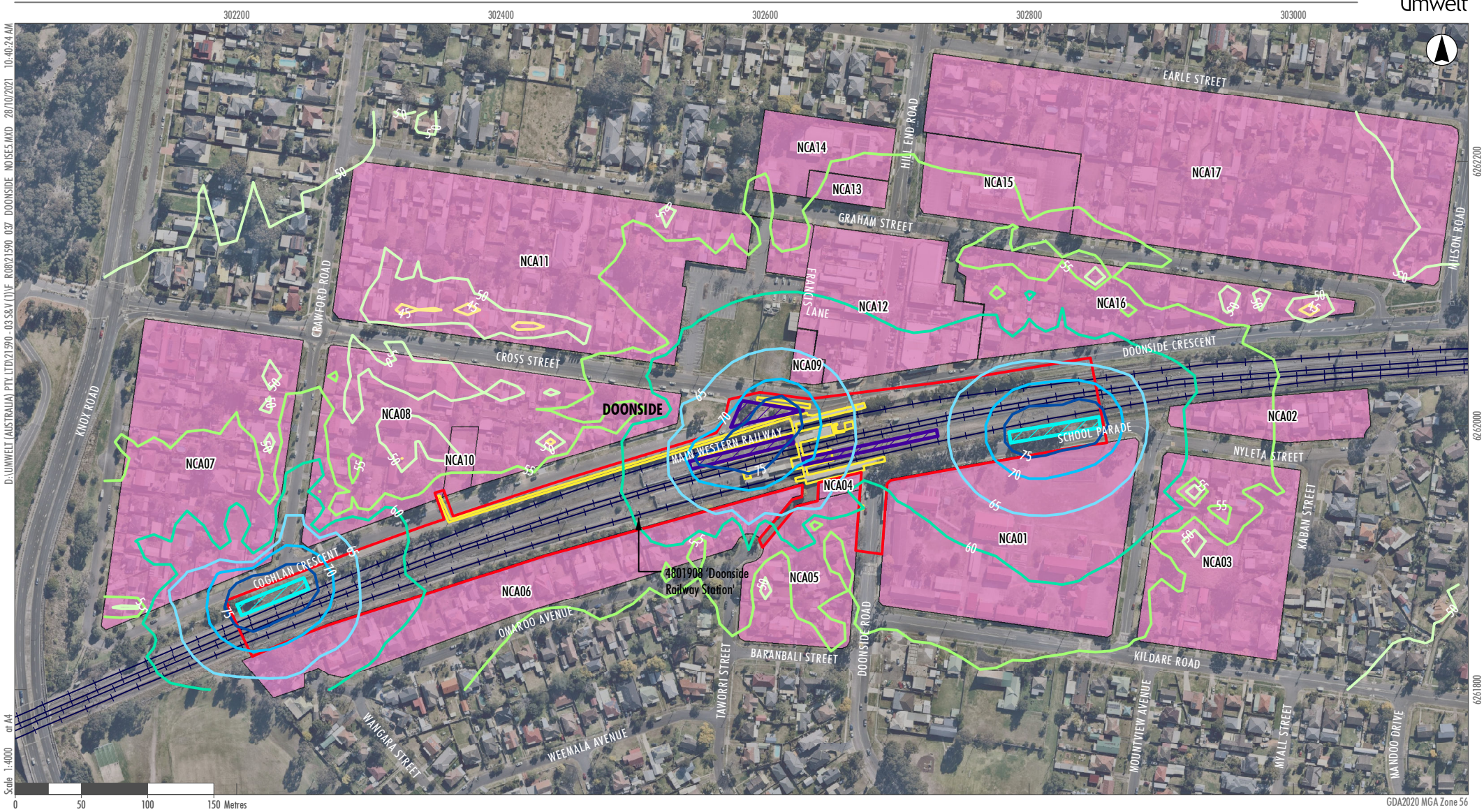


FIGURE A.5

Construction Scenario 5
Demobilisation, testing and commissioning

Image Source: Nearmap (Jun 2021) Data source: NSW DFSI (2020), TfNSW (2021)

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