Environmental Impact Assessment Checklist

Location: Mariyung Maintenance Facility, 55 Orchard Road, Kangy Angy NSW 2258
Timeframe: Construction works would commence in late 2022 and be completed in early 2024.
Project Name: Mariyung Maintenance Facility Additional Works
Description of proposed activity
Background and need for the Proposal Transport for NSW (TfNSW) has recently delivered the Mariyung Maintenance Facility Project (Project) as part of the New Intercity Fleet Program (Program). The Project involved the construction and operation of a purpose-built Maintenance Facility to maintain the Mariyung Fleet at Kangy Angy on the NSW Central Coast. The Maintenance Facility includes infrastructure such as fleet maintenance building, approximately 6 kilometres of electrified railway, auxiliary workshops, material storage, wheel lathe, automatic train wash and site access roads. The Mariyung Maintenance Facility is being maintained and operated by RailConnect. TfNSW, on behalf of RailConnect, propose to construct a new warehouse, a building over the existing train wash (graffiti removal shelter), a new rail line within the facility (Road 5) and install a new train lift system (the Proposal). These additions to the existing maintenance facility are required for additional storage, additional train access into the facility and to allow train cleaning 24/7. This Checklist assesses both construction and operation of these enhancements. **Location** The project is located at a purpose-built maintenance facility in Kangy Angy within the Central Coast Local Government Area (LGA) north of Sydney. The site is located at the down-track side (the line on which trains travel away from Sydney towards Newcastle) of the Main North Line, between Tuggerah and Ourimbah railway stations. The site is generally bordered by the Main North Rail Line rail corridor to the south, and Orchard Road to the north-west. Residential receivers on rural properties generally surround the site to the north, south and west, with industrial precincts to the south-east and north-east (on the opposite side of the rail corridor to the site). The Figure B.1 in Appendix B shows an aerial image of the maintenance facility within a local context. **Scope of works** The scope of works can be summarised within four elements; construction of a new warehouse, construction of a graffiti removal shelter, construction and installation of Road 5 (additional maintenance road) and installation of a new train lift system at Road 1. Refer to Figure B.2 in Appendix B for the existing and proposed site layout and Appendix C for location photos. Appendix D provides the proposed Plans for the four elements. The scope of works is as follows:

Site establishment

The following tasks would be undertaken in order to establish works on site.

- Transport equipment to site and general set-up, including some clearing of existing vegetation (identified under the heading *Vegetation Removal* below) and setting up of temporary fencing for safe access.
- Site Investigation, including site survey and condition surveys.
- Establish site compounds and access
- Mobilisation of personnel, plant, site offices and amenities, storage containers, generator, communications, water, and sewer, including any other enabling equipment.
- Installing any environmental controls required by this planning approval or the construction environmental management plan (CEMP).

Warehouse

The works would include construction of a warehouse to be used for the storage of 'slow moving' spare train equipment. The warehouse would include the following:

- an approximately 37 metre by 26 metre warehouse building, containing 955m^2 of floor area
- the warehouse would have a 3° sloped roof, with the highest point being 8.8 metres at the southern elevation and the lowest point being 6.7 metres at the northern elevation
- the warehouse would be constructed in a similar style to the existing maintenance facility building, mimicking the colours, materials and finishes
- one 5.5 metre wide by 5 metre tall roller shutter door would be provided at the western elevation, leading to the existing vehicle access areas along the southern and eastern sides of the main maintenance facility building. A pedestrian door would be located immediately south of the roller door
- emergency pedestrian egress would be provided at the south-eastern corner of the building via a set of stairs
- the finished floor level is to match the existing ground level at the warehouse roller door entry. This is the highest point of the natural ground level, meaning fill would be required beneath the building. The lowest point of the natural ground level is at the south-eastern corner of the proposed building and approximately 2 metres of fill would be required in this location. Fill would be retained using suitable retaining structures.
- tree and vegetation removal (detailed under the heading *Vegetation Removal* below).

The operation of the warehouse is primarily for the storage of spare and additional equipment or train pieces. The warehouse would be stocked by forklift (where materials would be delivered to existing delivery points within the site and transferred via forklift to the warehouse). It is anticipated that the stocking of the warehouse would occur during standard working hours. Taking materials from the warehouse to the main facility building would also occur during standard working hours.

Graffiti removal shelter

The works would include construction of a graffiti removal shelter to be used for the washing of trains to remove graffiti and any other debris/stains which may be present on the trains. The shelter is proposed over the existing track, east of the current graffiti removal area which is currently an uncovered space. The shelter would include the following:

- an approximately 30 metre by 10.5 metre shelter building, with openings at the eastern and western elevations, allowing for trains to drive beneath the shelter. The shelter would be able to accommodate a single car.
- the shelter would have a 3° sloped roof, with the highest point being approximately 8.4 metres at the southern elevation and the lowest point being approximately 8 metres at the northern elevation
- the shelter would be constructed in a similar style to the existing maintenance facility building and proposed warehouse, mimicking the colours, materials and finishes
- internally the shelter would cover one rail track and would have two pedestrian paths at either side of track
- three sets of new two-way platform stairs; two mobile sets within the graffiti shed and one adjacent to the southern façade, outside the shelter
- relocation of existing services in and around the facility (including light poles, fire hydrants and existing stairs).

The current operation of the maintenance facility allows for graffiti removal in this area; however, this area is currently uncovered, and train washing can only occur during standard hours due to noise limitations imposed by the Operational Noise Impact Review (ONVR) which was approved in accordance with the planning approval requirements for the Mariyung Maintenance Facility. The new shelter is proposed to allow train graffiti removal and subsequent washing to occur 24 hours per day, 7 days a week (24/7), as the shelter would provide additional noise attenuation.

Road 5

A new track and associated operational infrastructure would be laid south of the existing Road 4 in the areas set aside for this future expansion purpose and would be known as Road 5. This road would connect to an existing track stub (for this specific expansion) in the west and would terminate in the east, aligned with Roads 1-4, in the area adjacent to existing Roads 1-4 and in an identical fashion. Road 5 would run through the existing maintenance facility passing through the existing southern roller doors.

Minor internal works within the maintenance facility would also be required to allow for integration with all existing services and systems, including the signalling system. These works are limited to some internal steel structures attached to the existing building columns, maintenance systems (depot protection, retractable overhead wires) and working platforms for door and roof level maintenance with appropriate lighting and other utilities.

Train Lift

A new train lift is proposed in addition to the existing six car train lift system on Road 1 within the existing maintenance facility. Train lifting is a process used for removing/exchanging under train components, generally bogies and traction equipment. The existing train lift system allows for six cars to be lifted at once. The new train lift would allow an additional four cars to be lifted at once, allowing for a total of 10 cars to be lifted along Road 1 and subsequently increasing the maintenance opportunities throughout of the facility. The additional 4 car lifting system was identified as a future addition in the original maintenance facility design and this expansion now forms part of this planning assessment.

The two train lift systems would operate independently, meaning either one or both of the systems can be used at any time, which means a 10-car train would be separated to utilise the two lifting systems.

The new train lift system would utilise identical equipment to the existing 6-car system and would be located fully within the existing maintenance facility and would be operated in accordance with the existing train lift systems.

Construction duration

Construction works would commence in late 2022 and be completed in early 2024.

Construction hours

The works would be carried out within the following standard construction hours:

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

Any works required to be completed outside the above construction hours due to reasons such as safety or access, would be identified and assessed in accordance with the TfNSW out of hours work protocol detailed in the TfNSW *Construction Noise and Vibration Strategy* (DMS-ST-157) (2019d).

Construction plant and equipment

Equipment proposed to be used for the activities listed above would typically include, but not be limited to, the following:

- Trucks including semi-trailer, concrete, flat bed, tilt and HIAB
- Light vehicles
- Excavator and attachments
- Concrete pump
- Concrete vibrator
- Concrete saw
- Cement mixer
- Generator
- Hand and power tools, hammer drills and testing equipment
- Heavy and light rollers
- Pneumatic tools
- Cranes including 35t mobile crane & 100T crane, franna
- Lifting equipment e.g. forklift / dolly table / jack
- Welding equipment
- Core drill
- Jackhammer
- Grinder

Construction personnel

It is anticipated that a workforce of up to around 10-50 staff would be required on site at any one time. It is expected most workers would drive to site; therefore, an additional 10-50 light vehicles may utilise the site.

Ancillary facilities

Temporary facilities for worker use are proposed for use during construction. These locations are to the south-west of the warehouse and north-east of the intersection of Redgate Road and Tate Way. Figure B.3 in Appendix B identifies these two locations.

The area adjacent to the warehouse would be used for site offices and staff facilities (including bathrooms), construction vehicle access to the warehouse and laydown storage area. The area adjacent to Redgate Road would be used only as a laydown area and for vehicle parking. Public access along the unnamed gravel road to the north would be maintained and dust suppression would also be installed as necessary.

Vegetation Removal

Tree and vegetation removal would be required to construct the warehouse and to install the laydown area adjacent to the warehouse. An Ecological Constraints Assessment (ECA) in this area has been undertaken and is provided at Appendix F. The areas of vegetation to be removed are recently planted native vegetation and are considered as low conservation vegetation.

Vegetation removal would be limited to the area identified in the ECA (see also Figure B.4 in Appendix B) and vegetation replacement would be in accordance with the associated existing percent of growth cover identified in the report. Condition 6 of this assessment provides details of the required replanting.

Site Characteristics

Land use

The proposed works are located within the suburb of Kangy Angy in the Central Coast local government area (LGA). The works would be undertaken entirely within the footprint of the existing Mariyung Maintenance Facility. The works are adjacent to the Main North railway and are generally surrounded by vegetation and rural residential properties. The approximate distance to the nearest sensitive receiver of the proposed works in the Maintenance Facility is 180 metres south-east.

Flora and fauna

Vegetation within the area of the proposed works is limited to landscaped areas including recently established small plants and shrubs. The proposed works are in a disturbed area around existing railway tracks and associated infrastructure. There are adjacent areas of “Ecological Exclusion Zones” within the overall footprint of the existing Maintenance Facility, these are outside the proposed Additional Works area and would not be impacted by the works.

Prior to the Maintenance Facility construction, the site contained two threatened ecological communities and one threatened flora species (Swamp Sclerophyll Forest, Lowland Rainforest and Biconvex Melaleuca (*Melaleuca biconvexa*)) as well as potential habitat for other threatened species. While these communities are not within the footprint of the Additional Works, they remain in lands adjacent to the Maintenance Facility site.

Five threatened fauna species were recorded in fauna surveys for the Maintenance Facility REF; Varied Sittella (*Daphoenositta chrysoptera*), Little Bentwing-bat (*Miniopterus australis*), Eastern Bentwing Bat (*Miniopterus fuliginosus*), Southern Myotis (*Myotis aelleni*), and Grey-headed Flying-fox (*Pteropus poliocephalus*). All threatened species recorded within the study area are listed as Vulnerable under the TSC Act, while the Grey-headed Flying-fox is listed as Vulnerable under the EPBC Act.

The following species are also considered a risk for the site as species which may potentially inhabit the study area: Swamp Sclerophyll Forest on Coastal Floodplains, Biconvex Paperbark (*Melaleuca biconvexa*), Swift Parrot (*Lathamus discolor*), Regent Honeyeater (*Anthochaera phrygia*), Mahony’s Toadlet (*Uperoleia mahonyi*) and Wallum Froglet (*Crinia tinnula*).

As part of the ecology assessment WSP have prepared an Ecological Constraints Assessment which is attached at Appendix F. This assessment reviewed areas where vegetation is proposed to be removed and identified species and quality of vegetation removal and identified whether any potential habitat exists in these areas. The assessment found that:

> *"The four areas requiring repurposing are in areas previously disturbed during the facilities construction and are situated on unnaturally elevated and imported substrates. Whilst the vegetation varied across the four repurposing sites, they were all consistent as miscellaneous ecosystems – native landscape plantings. No extant native vegetation occurred in the study area."* (p. 5 WSP, 2022)

The study found that all areas subject to disturbance are of low conservational significance, although areas near the site work areas are considered as having a high conservational significance. Figure B.4 in Appendix B shows the areas considered high and low conservational significance. The areas of low ecological significance contain native plantings, however due to their young age cohort, high disturbance levels and lack of floristic structure are considered a low constraint risk.

While the proposed work areas are of low conservational significance, they do contain a variety of trees, shrubs and grasses. In Study Area 1 (a 20 metre by 20 metre plot area, where the new warehouse is proposed) the following was identified (see Table 1):

Table 1: Vegetation structure of Study Area 1

Attribute	Native species growth form						Exotic Species	Total
	Trees	Shrubs	Grass	Forb	Fern	Other		
Number of species	1	8	9	11	0	3	13	45
Percent cover	0.5	5.55	11.6	2.9	0	0.4	1.7	22.65

Within this area a total of five *Eucalyptus robusta* (Swamp Mahogany) stems were recorded in the plot area, which extrapolates to approximately 125 stems per hectare.

In Study Area 2 (a 10 metre by 40 metre plot area, where the secondary laydown area is proposed) the following was identified (see Table 2):

Table 2 Vegetation structure of Study Area 2

Attribute	Native species growth form						Exotic Species	Total
	Trees	Shrubs	Grass	Forb	Fern	Other		
Number of species	3	11	8	11	1	2	21	57
Percent cover	0.4	8	14	4.1	0.1	0.3	8.4	35.3

Within this area a total of three tree stems, comprising one *Eucalyptus robusta*, one *Glochidion ferdinandi* (Cheese Tree) and one *Acacia maidenii* (Maiden's Wattle), were recorded in the plot area (Figure 2.1), which extrapolates to approximately 75 stems per hectare.

Heritage

Aboriginal

The Maintenance Facility site is within the boundary of the Darkinjung Local Aboriginal Land Council and in the parish of Tuggerah County of Northumberland. A number of previous archaeological investigations have been undertaken in the region, and across the site specifically. An Aboriginal Heritage Impact Permit (AHIP) is in place for Maintenance Facility works nearby, however the Additional Works would not encroach into the AHIP boundary.

An extensive Aboriginal Heritage Information Management System (AHIMS) search was undertaken on 26 August 2022 (refer Appendix E). The search identified [redacted] Aboriginal sites located within the search area (see Figure 1 below). The findings of the extensive search are consistent with the AHIP and previous extensive searches and the Additional Works would not encroach on the location of these known Aboriginal sites.

Figure 1: Search area and location of Aboriginal Sites (Source: AHIMS 2022)

Non-Aboriginal

The only development known to have taken place in the period before the construction of the railway line in the 1880s was the creation of Old Chittaway Road, the original alignment of which ran through the eastern corner of the Maintenance Facility boundary. This is likely to have been an unsealed road, and archaeological evidence is therefore unlikely to remain.

The present fabric of the railway line indicates that the rail, sleepers and underlying ballast have been replaced since construction. It is also possible that the existing bridge carrying the line over Turpentine Road/ Chittaway Creek replaced an earlier timber structure. However, it is unlikely that archaeological evidence of the possible timber bridge remains, as it would have been removed during earthworks for the present structure. Further, these are located away from the proposed Additional Works location.

By the mid-twentieth century, Turpentine Road had been laid out to the west of Ourimbah Road. As with Old Chittaway Road this was an unsealed road, and archaeological remains of the early period of its use are therefore unlikely to remain. Development of the study area since the 1950s has included construction of two houses and residential buildings, and vegetation clearance for use of part of the study area as pasture. While some remains may be present from this period any relics associated with this period have low potential to reach the level of local significance.

There are no listed heritage items within or in proximity to the Maintenance Facility site.

<u>Hydrology and flooding</u>

The nearest waterway to the proposed works (Ourimbah Creek) is approximately 500 metres north of the Additional Works location. Broadly, Chittaway Creek flows into Bangalow Creek, Ourimbah Creek and on to Tuggerah Lake at Chittaway Point.

Much of the Maintenance Facility site was previously characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek. Significant in-filling occurring during construction of the Maintenance Facility and site drainage has been installed and is operational. Council mapping shows the site as flood planning area and subject to the probable maximum flood (PMF) level. Despite this mapping, flood potential at the site is currently minimal due to the significant in-filling which occurred recently across the site. The Maintenance Facility is largely impervious concrete surfaces at the location of the Additional Works.

Stormwater runoff from construction works would generally flow towards Chittaway Creek and into Ourimbah Creek. The Project has the potential to adversely impact water quality within the Ourimbah Creek catchment and floodplain, and Tuggerah Lake during construction and operation if activities are not appropriately managed.

Run-off from disturbed surfaces and earthworks could potentially affect water quality in adjacent creeks and drainage lines due to sedimentation during construction and operation of the Project. In addition, there is the potential for accidental spillage/leakage of rail construction materials including fuels, lubricants and hydraulic oils from construction plant and equipment.

The groundwater table across the site was measured during initial investigations for the construction of the facility in 2016 and found that the groundwater table is expected to range from surface to approximately 4.7 metres below ground level. The interception of groundwater may occur as part of the Project, particularly where groundwater occurs within a couple of meters from the existing surface and where areas of deeper excavation, such as the graffiti removal shelter where excavation would be up to two metres beneath the existing ground level are proposed.

Soils and contamination

While only minor excavation is required, it would be limited to within approximately 2 metres of the surface. All proposed excavation would be through engineered fill from the recent construction of the Maintenance Facility.

Noise

The site is currently an operational Maintenance Facility. A noise wall borders the eastern boundary, providing attenuation from existing operational activities. Beyond the Maintenance Facility site there are scattered residential properties (semi-rural) and a rail corridor to the south and east. The Pacific Highway is approximately 1km to the north.

Noise impacts from the facility were originally assessed in the Operational Noise and Vibration Review (ONVR). This assessment found that noise levels were likely to exceed the Project Specific Noise Limits (PSNL) (i.e. the noise levels deemed acceptable for sensitive receivers in the day and night) at several receivers, and as such these properties qualified for at property acoustic treatments. Once undertaken, the at property acoustic treatments would then bring predicted noise levels down to the PSNL for each receiver. The at property acoustic treatments were installed (where the resident accepted the offer) and were installed to the relevant Australian Standards. Noise validation of noise generated from the Mariyung Maintenance Facility have been undertaken and were found to be consistent with the noise levels of the ONVR. In summary of these findings, sites which had the greatest noise impacts are detailed below (see Table 3):

Table 3: Summary of existing/approved noise levels of the top four most affected surrounding receivers

Receiver	Maximum predicted noise level – ONVR1 ($L_{eq\ 15\ minute}$ dBA)		PSNL ($L_{eq\ 15\ minute}$ dBA)	
	Day	Day	Day	Night
R34 - 170 Old Chittaway Road	58	58	54	40
R35 - 150 Old Chittaway Road	56	57	54	40
R36 - 130 Old Chittaway Road, Fountaindale	53	55	54	40
R12 - 19 Ourimbah Road	53	53	49	40

Full details of the maximum predicted noise levels and the PSNL for the surrounding sensitive receivers can be found in the WSP Noise Modelling Assessment which is attached at Appendix G on page 1 in Table 1.1.

Control Measures

Will a project and site specific CEMP be prepared? **Yes**

Are appropriate control measures already identified in an existing CEMP? **Yes, as below**

A Construction Environmental Management Plan (CEMP) or equivalent has previously been developed for the facility, this CEMP would be updated for the proposed works, addressing how the specified control/mitigation measures identified in this Checklist are to be implemented.

Climate Change Impacts

Is the site likely to be adversely affected by the impacts of climate change? If yes, what adaptation/mitigation measures will be incorporated into the design?

No. The impacts on the proposed works from climate change are considered negligible due to the scale and nature of the proposed works.

Climate change projections for 2030 and 2070 for the Proposal site are summarised in Table 4 below.

Table 4 Climate change projections

Climate projections for Sydney Metropolitan Area (Adapt NSW) \ Climate Effect	Climate Projections 2030	Climate Projections 2070
Mean temperature change (°C)	0.7 °C	2.1 °C
Single day heat over 35°C	~ 9 days	~ 26 days
Change in rainfall (%)	+ 0.4 %	+ 6.5 %
Changes in number of days a year Forest Fire Danger Index (FFDI) > 50 (severe fire weather)	+ 0.7 days	+ 5 days

There is a predicted increase in annual rainfall, single day heat, mean temperature and the prevalence of storms over the life of the Proposal. The proposed design would consider climate change where relevant. A revised climate risk assessment would be prepared for the additional works to assess how the new additions would respond to climate change.

Legislative Framework

The *Environmental Planning & Assessment Act 1979 (EP&A Act)* establishes the system of environmental planning and assessment in NSW. Division 5.1 specifies the environmental impact assessment requirements for activities undertaken by public authorities, such as TfNSW, which do not require development consent under Part 4 of the EP&A Act. Division 15, Section 2.91 of the *State Environmental Planning Policy (Transport and Infrastructure) 2021* (SEPP (Transport and Infrastructure)) allows for the development of 'rail infrastructure facilities' by or on behalf of a public authority without consent on any land. Consequently, development consent is not required for the Proposal, however, the environmental impacts of the Proposal have been assessed under the provisions of Division 5.1 of the EP&A Act. Section 171(2) of the EP&A Regulation 2021 defines the factors which must be considered when determining if an activity assessed under Division 5.1 of the EP&A Act has or is likely to have a significant impact on the Environment. The impact assessment tables of this checklist provide an environmental impact assessment of the factors in the Proposal and Appendix A specifically responds to the factors for consideration under Section 171(2) of the EP&A Regulation 2021.

SEPP (Transport and Infrastructure)

Sections 2.10-2.15 of the SEPP (Transport and Infrastructure) require that public authorities undertake consultation with councils and other agencies when proposing to carry out development without consent. Table 5 provides details of consultation requirements for the Proposal under the SEPP (Transport and Infrastructure).

Table 5 SEPP (Transport and Infrastructure) consultation details

Section	Relevance to the Proposal
2.10: Consultation with Councils- development with impacts on council-related infrastructure or services	Consultation is required where the development would result in: • substantial impact on stormwater management services • generating traffic that would place a local road system under strain • involve connection to or impact on a council owned sewerage system • involve connection to and substantial use of council owned water supply • significantly disrupt pedestrian or vehicle movement • involve significant excavation to a road surface or footpath for which Council has responsibility. There is no proposed impact to Council related infrastructure and services. Therefore, consultation with Council is not required. Should this change during design development, consultation with Council would occur.
2.11: Consultation with Councils- development with impacts on local heritage	Where development would: • substantially impact on a local heritage item (if not also a State heritage item) • substantially impact on a heritage conservation area. There is no proposed impact to local heritage items or heritage conservation areas. Therefore, consultation with Council is not required.
2.12: Consultation with Councils- development with impacts on flood liable land	Where development would: • change flood patterns other than to a minor extent – consultation with Council is required The Proposal is located on flood prone land, however, works would not impact existing flood patterns due to previous fill placed on site and the limited extent of new cut and fill proposed. Accordingly, consultation with Council is not required.
2.13: Consultation with State Emergency Service- development with impacts on flood liable land	Where development is located on: • flood liable land – written notice must be given (together with a scope of works) to the State Emergency Service. Any response to the notice received from the State Emergency Service within 21 days after the notice is given must be taken into consideration. The Proposal is located on flood prone land. Accordingly, consultation with the State Emergency Service (SES) is required regarding this aspect. Formal notification of the works in accordance with the Transport and Infrastructure SEPP has been provided to the SES and a response was received on 4 October 2022. The SES suggested consideration of site design and stormwater management that minimises any risk to the community and staff. This would be considered during detailed design.

2.14: Consultation with Councils- development with impacts on certain land within the coastal zone	Where development would: • impact on land within a coastal vulnerability area and is inconsistent with certified coastal management program that applies to that land. The Proposal is not located within a coastal vulnerability area. Consultation with Council is not required regarding this aspect.
Clause 2.15 | Consultation with public authorities other than Councils	For *specified development* which includes consultation with the Office of Environment and Heritage (OEH) for development that is undertaken adjacent to land reserved under the *National Parks and Wildlife Act 1974*, and other agencies specified by the Infrastructure SEPP where relevant. The Proposal is not located adjacent to land reserved under the *National Parks and Wildlife Act 1974*. Accordingly, consultation with the OEH now the Environment, Energy and Science (EES) Group part of the Department of Planning, Industry and Environment (DPIE) on this matter is not required.
Clause 2.122 | Consultation with Relevant roads authority	For *traffic-generating development* specified in Column 1 of the Table to Schedule 3 that involves new premises of the relevant size or capacity, or an enlargement or extension of existing premises, being an alteration or addition of the relevant size or capacity – written notice of the intention to carry out the development must be given to the relevant Road's authority in relation to the development. Any response to the notice that is received from the relevant Road's authority within 21 days after the notice is given must be taken into consideration. The Proposal is not deemed a traffic-generating development. Accordingly, consultation with the relevant division of Transport for NSW is not required for the Proposal.

Impact Assessment - Construction

Aspect	Nature and extent of impacts (negative and positive) during construction if control measures implemented	Proposed Control Measures	Endorsed [for Rail Development and Delivery, E&S Branch use only]	
			Y/N	Comments
Flora and fauna	As described in the Ecological Constraints Assessment (Appendix F), the Proposal would require removal of native but low conservational value vegetation. This vegetation had been planted as part of the previous construction works for the maintenance facility. While the vegetation itself is not identified as substantial it does form revegetation requirements of the original works and therefore is important to replace in order to ensure impacts are consistent with the original maintenance facility approval. Mitigation for the proposed removal is to include an equal area replanted as that which has been removed. These areas can include replanting in laydown areas where vegetation is removed upon demobilisation and where additional replanting area is required (to replace vegetation removed within the warehouse footprint), alternate areas around the site should be pursued. Replanting is to be in accordance with existing percentage growth forms of each area (excluding any weed species) (see Tables 3.1 and 3.3 of the Ecological Constraints Assessment). Ecological Exclusions Zones occur within the wider Maintenance Facility footprint, however the proposed works would not encroach on these areas. Refer to Appendix H for the location of Ecological Exclusions Zones. Fauna is not anticipated to be present within the works area as access is limited due to the existing security fencing in place surrounding the Facility. However, it is acknowledged that many species of fauna (frogs,	1. A pre-clearance inspection would be undertaken by the project Environmental Representative to mark clearly vegetation that is approved for clearance or, trimming and to inspect for any fauna. 2. Construction personnel would be made aware of the potential for wildlife to enter the works area and would be instructed not to interfere with any wildlife present. 3. In the event that any injured wildlife is encountered on site, works in the area would cease and WIRES would be contacted on 1300 094 737. 4. Should any unexpected vegetation require trimming or removal this would be assessed and approved via a TfNSW Vegetation Trimming and Removal application. 5. Ecological Exclusions Zones would be physically demarcated for the duration of construction and shown on Environmental Control Maps. 6. Areas for vegetation removal are to be measured and recorded in a replanting section in the CEMP (unless otherwise agreed by the SE&SO). Replanting can include transplanting existing vegetation and/or planting new vegetation. Replanting on site or immediately surrounding the site is to equal the amount of vegetation removed (in square	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction if control measures implemented	Proposed Control Measures	Endorsed [for Rail Development and Delivery, E&S Branch use only]	
			Y/N	Comments
	reptiles, birds and mammals) were recorded in the surrounding area during field surveys undertaken for construction of the Maintenance Facility, and small fauna could potentially enter the works area.	metres). Replanting coverage is to be locally Ynative species, in accordance with existing percentage growth from tables of each area (excluding any weed species) (see Tables 3.1 and 3.3 of the Ecological Constraints Assessment). 7. Weed species within the project work areas are to be removed and disposed of appropriately.		
Water	The Maintenance Facility is bounded by Ourimbah Creek and its flood plains to the north and east, Bangalow Creek in the west and the Main North railway in the south. The Proposal also crosses over Chittaway Creek towards the southern end of the site and a tributary of Ourimbah Creek towards the south of Ourimbah Road. The topography typically falls south to north from the Main Northern Rail line into the Ourimbah Creek catchment which is part of the larger Tuggerah Lake catchment. Ourimbah Creek is the nearest waterway, located approximately 500 metres north of the proposed works site. The proposed works area is located with the Maintenance Facility site on rail land raised above the level of Chittaway & Ourimbah Creeks. The surrounding land slopes towards Chittaway & Ourimbah Creeks which is located in a local low point. Surface water within the Maintenance Facility drains to recently installed drainage network, comprising a combination of detention basins, catch drains, cess drains and other subsurface drains. The detention basin then flows into the existing stormwater drainage	8. Prior to commencement of works a site specific Erosion and Sediment Control Plan would be prepared in accordance with the 'Blue Book' Managing Urban Stormwater: Soils and Construction Guidelines (Landcom, 2004) and updated throughout construction so it remains relevant to the activities. The Erosion and Sediment Control Plan measures would be implemented prior to commencement of works and maintained throughout construction. 9. Any stormwater drains within the Proposal area would be marked on the ECM and appropriately controlled. 10. All fuels, chemicals and hazardous liquids would be stored away from drainage lines within an impervious bunded area in accordance with Australian Standards, EPA Guidelines and TfNSW's *Chemical Storage and Spill Response Guidelines* (DMS-SD-066) (2019b). 11. A fully-stocked spill kit(s) would be present at all times during construction and situated	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction if control measures implemented	Proposed Control Measures	Endorsed [for Rail Development and Delivery, E&S Branch use only]	
			Y/N	Comments
	network along Turpentine Road, which discharges to an un-named creek and on to Ourimbah Creek. There is the potential for spills or mobilisation of sediment to impact surrounding water quality; however, considering the scale of the work, distance to the waterway, and with the implementation of controls, it is considered unlikely that the proposed works would impact on water quality. Groundwater levels were recorded during construction of the existing Maintenance Facility. These investigations noted that the water table across the sites is generally shallow, with groundwater levels ranging from the existing surface level to approximately 4.7 metres below ground level within the Project site. The maintenance facility however was raised during original works. The water level was measured beneath the original ground level and therefore would be lower than the current ground level (which has been raised). The proposed works would involve minor excavation to around 2 metres, wholly within engineered fill, and as such excavations are unlikely to encounter groundwater. In the event that groundwater is encountered, works would proceed in accordance with the TfNSW *Water Discharge and Reuse Guideline* (DMS-SD-024). As such, any impacts to groundwater are considered unlikely.	around areas of high risk (such as drains). Staff would be trained in their appropriate use. 12. In the event of a pollution incident, works would cease in the immediate vicinity and the Contractor would immediately notify the TfNSW Project Manager and TfNSW Senior Environment and Sustainability Officer in accordance with *TfNSW Environmental Incident Procedure* (EMF-FM-PR-0001). 13. Plant and equipment would be inspected regularly and checked for oil leaks. 14. Refuelling of plant and equipment, and vehicle/concrete truck wash downs would only occur off site or in a bunded or fully contained area on site. 15. In the event that any groundwater is encountered, water would be managed in accordance with the TfNSW *Water Discharge and Reuse Guideline* (DMS-SD-024). 16. Appropriate mitigations would be implemented in accordance with the requirements of TfNSW's Concrete Washout Guideline (DMS-SD-112) (TfNSW 2019c).		
Air quality	Excavations associated with the works would have the potential to generate a limited amount of dust, which could impact the air quality in the immediate vicinity of the works. However, potential dust impacts are considered to be minor and contained within the	17. Works would be visually monitored for dust emissions and all attempts made to prevent/address emissions through the use of watering and/or covering of exposed surfaces where necessary. This is to be especially	Y	

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			Y/N	Comments
	Maintenance Facility footprint due to the small scale earthworks required, the material to be excavated (engineered fill) and the short-term duration of excavation. Dust generation from access via the unsealed road adjacent to the secondary laydown area is also a potential impact. This impact can however be mitigated by dust suppression measures surrounding this laydown area. Emissions from construction equipment would be minimal and short-term. It is not expected that these emissions would result in any noticeable decrease in local air quality due to the low number of construction vehicles compared to existing surrounding vehicular traffic, particularly along Enterprise Drive and existing vehicle traffic to the site.	considered for the secondary laydown area adjacent to the unsealed road. 18. Construction works that generate dust would not be undertaken during strong winds or in weather conditions where high levels of dust or airborne particulates are likely. 19. Vehicles transporting waste or other materials that may produce dust would be covered during transportation. 20. Construction plant and equipment would be turned off when not in use. 21. Inspections/surveillance would be undertaken to identify any vehicle, plant or equipment that is causing visible emissions. If any defective vehicles, plant or equipment are identified, operation of this machinery would cease and service/maintenance would be undertaken.		
Soils and contamination	The Proposal would involve minor disturbance of soils with minimal excavation required and, with the implementation of the control measures outlined in this document, it is considered that this risk can be managed. The proposed work areas have been previously disturbed and are to be located on existing hardstand areas or within areas of imported fill. As such the potential for encountering contamination, acid sulfate soil or saline soils is unlikely. However, due to the nature of sites operation there is a risk of encountering typical rail-related contaminants and hazardous materials within the Proposal area.	22. An erosion and sediment control plan and/or ECM would be prepared (refer to the water section above). 23. An appropriate Unexpected Finds Protocol, considering asbestos containing materials and other potential contaminants, would be included in the CEMP. Procedures for handling asbestos containing materials, including licensed contractor involvement as required, record keeping, site personnel awareness and waste disposal to be undertaken in accordance with WorkCover requirements.	Y	

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			Y/N	Comments
	There has been no record of contamination/spills on site in the proposed works areas, however should contamination be encountered the associated control measures would mitigate adverse risk.			
Noise and vibration	The nearest noise sensitive receivers to the proposed works are 170 Old Chittaway Road and 19 Ourimbah Road. In accordance with the TfNSW *Construction Noise and Vibration Strategy* (DMS-ST-157) (2019d) it is considered that these noise impacts could be appropriately mitigated through the implementation of standard mitigation measures identified in the *Construction Noise and Vibration Strategy* and detailed in this Checklist. Where possible, works would be undertaken during standard construction hours (7am – 6pm Monday to Friday and 8am-1pm Saturdays). The proposed construction works would not involve any vibration intensive activities. Appendix G includes a noise assessment of the proposed works at the nearest sensitive receiver (170 metres south-east of the proposed works) during construction. Standard hours works are predicted to exceed background levels by up to 16dBA. A temporary generator would be required within the Maintenance Facility compound area. Selecting a silenced noise generator would ensure its operation is only marginally audible (if not inaudible) to any sensitive receivers.	24. The proposed works would be undertaken in accordance with the TfNSW *Construction Noise and Vibration Strategy* (DMS-ST-157) (2019d). 25. Noise and vibration mitigation measures would be included in the CEMP in accordance with the TfNSW *Construction Noise and Vibration Strategy* (DMS-ST-157) (2019d). 26. Should plant and equipment to be used differ from that included in the noise predications (Appendix G), the Contractor should update the noise predictions prior to construction commencing. Additional mitigation measures required under the TfNSW *Construction Noise and Vibration Strategy* (2019d) would be applied. 27. In the event that Out-of-Hours Works (OOHW) would be required, an OOHW Application would need to be submitted to TfNSW for approval prior to OOHW being undertaken. 28. Use less noise-intensive equipment where reasonable and feasible. Where noise intensive equipment (ie for jackhammering, rock breaking etc) must be used, one-hour respite periods would be observed for every three hours of consecutive use where noise	Y	

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			Y/N	Comments
		would be noticeable for nearby heritage, residential and commercial properties. 29. A dilapidation survey should be prepared prior to the commencement of works for any buildings, infrastructure or roads which may be damaged by vibration during construction. 30. Construction personnel would be inducted/tool boxed on the location of sensitive receivers prior to works commencing. 31. All equipment would be maintained to ensure that equipment noise levels do not exceed the manufacturer's recommended levels. If equipment is found to be excessively noisy, the contractor would modify or repair the equipment or remove it from the site. 32. Selection of the temporary generator is to consider operating noise levels, quieter equipment to be preferred as far as practicable. 33. All machinery and equipment would be switched off when not in use. 34. Non-tonal reversing beepers (or an equivalent mechanism) would be fitted and used on all construction vehicles and mobile plant regularly used on site (i.e. greater than one day). 35. Any complaints regarding noise would be investigated and responded to in a timely manner.		

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Aboriginal heritage	During archaeological investigations for the construction of the Maintenance Facility, an artefact scatter was identified (AHIMS ID 45-3-4017) within the Maintenance Facility site and, subsequently, an Aboriginal Heritage Impact Permit (AHIP C0003251) was obtained. The artefact scatter was salvaged (48 artefacts) under AHIP C0003251 with the salvaged artefacts reburied within a vegetation retention area of the Maintenance Facility site in 2020 in accordance with the AHIP. The proposed works would be undertaken in a previously disturbed and developed area of the Maintenance Facility. The proposed extent of works is outside the artefact reburial site and AHIP boundary and would not impact the reburial site in any way. The proposed works would involve excavation within engineered fill of the newly constructed Maintenance Facility, and as such, are considered unlikely to encounter any Aboriginal items. An extensive AHIMS search was undertaken on 26.08.22 (refer Appendix E). The search identified four Aboriginal sites located within the search area. These findings are consistent with the AHIP and the Additional Works would not encroach on the location of these known Aboriginal sites.	36. If unforeseen Aboriginal heritage items are uncovered during construction, the procedures contained in TfNSW's Unexpected Heritage Finds Guideline (DMS-SD-115) (2019e) would be followed and works within the vicinity of the find would cease immediately. The TfNSW Project Manager and TfNSW SE&SO (or E&S equivalent) would immediately be notified so they can assist in co-ordinating next steps which are likely to involve consultation with an Aboriginal heritage consultant, Heritage NSW and the Local Aboriginal Land Council. 37. In the event that skeletal remains are identified, work would cease immediately in the vicinity of the remains, the area would be cordoned off and the find reported to the TfNSW Project Manager and TfNSW SE&SO. The proponent would contact the local NSW Police who would make an initial assessment as to whether the remains are part of a crime scene or possible Aboriginal remains. If the remains are thought to be Aboriginal, Heritage NSW (HNSW) would be notified. A HNSW officer would determine if the remains are Aboriginal or not; and a management plan would be developed in consultation with the relevant Aboriginal stakeholders before work recommences.	Y	
Non-Aboriginal heritage	The Non-Aboriginal heritage Assessment (Artefact, 2016a) undertaken for the Mariyung Maintenance Facility Project REF identified the "Main North railway and Turpentine Road/Chittaway Creek underpass" as	38. In the event that any unanticipated archaeological deposits are identified within the project site during construction, the procedures contained in TfNSW's *Unexpected*	Y	

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	being of potential heritage significance. However, neither are listed on any heritage registers. The proposed works would be outside of the rail corridor of the Main North railway and would not involve impact to the existing fabric of the railway or the Turpentine Road/Chittaway Creek underpass. The proposed works are within the boundary of the newly constructed Maintenance Facility and would not impact any items of non-Aboriginal heritage.	*Heritage Finds Guideline* (DMS-SD-115) (2019e) would be followed and works within the vicinity of the find would cease immediately. The Contractor would immediately notify the TfNSW Project Manager and the TfNSW E&SO (or E&S equivalent) so they can assist in co-ordinating the next steps which are likely to involve consultation with an archaeologist and HNSW. Where required, further archaeological work and/or consents would be obtained for any unanticipated archaeological deposits prior to works recommencing at the location.		
Community, social and economic	Potential community impacts would be limited to noise, traffic and visual. These impacts are discussed in the relevant sections of this Checklist. As the proposed construction works would be temporary in nature and located within the existing Mariyung Maintenance Facility, impacts on the amenity of the local community are expected to be minor. The proposed works would be undertaken within the Mariyung Maintenance Facility, and due to their minor nature, it is not anticipated that there would be any social impacts as a result of the construction of the proposed works.	39. The proposed control measures identified in the noise and vibration, traffic and visual sections of this Checklist would be implemented to minimise any impacts on the local community. 40. The community would be notified prior to the commencement of works, and kept informed of construction progress, activities and impacts in accordance with the Community Liaison Management Plan (CLMP).	Y	
Traffic and parking	Vehicle movements (10- 20 per day) for the proposed works would be generated by construction workers travelling to/from the Mariyung Maintenance Facility site as well as vehicle movements associated with the delivery of equipment and materials including	41. Vehicle movements would be limited to existing roads (around Enterprise Drive) and the existing Maintenance Facility access. 42. Access along the unnamed gravel road to the north would be maintained at all times.	Y	

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			Y/N	Comments
	prefabricated sections of structures. All access would be via the main entrance on Enterprise Drive. There would also be daily localised movements of construction worker vehicles between the Mariyung Maintenance Facility car park and the works area. These movements would be via the internal Maintenance Facility access road only and would not impact traffic on public roads. Vehicle movements associated with the proposed works would be short-term over the period of construction. The overall number of vehicle movements anticipated on surrounding roads is considered to be low (up to 20 additional vehicles per day) compared to the overall traffic volumes on these roads, particularly those associated with industrial areas on Enterprise Drive. No significant impacts on traffic flow or access as a result of construction vehicle movements are anticipated. Overall numbers of large vehicle movements are expected to be low, around three per day for normal works, with up to 10 a day for the occasional higher intensity days (i.e. a concrete pour day). It is anticipated that this level of traffic would not have a significant impact on existing traffic conditions. The area adjacent to Redgate Road would be used only as a laydown area and for vehicle parking. This would generate a minor increase in traffic and movements along this road and has the potential to increase dust from vehicle movements. Access along this road would however be maintained at all times and laydown areas			

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			Y/N	Comments
	would only be located on the side of the road (out of the road space).			
Waste	Waste that would be generated by the proposed works includes concrete, asphalt, soil, offcuts and packaging from formwork and prefabricated materials, and potentially excess gravel and/or ballast. Construction personnel would also generate general litter.	43. All wastes would be securely stored to prevent the escape of pollutants from the work site. 44. Waste material that is taken off site would be classified and managed in accordance with the EPA *Waste Classification Guidelines 2014* and would be disposed of in accordance with the *Protection of the Environment Operations Act 1997*, including disposal at an appropriately licenced facility. 45. An appropriate Unexpected Finds Protocol, considering asbestos containing materials and other potential contaminants, would be included in the CEMP. Procedures for handling asbestos containing materials, including licensed contractor involvement as required, record keeping, site personnel awareness and waste disposal, would be undertaken in accordance with SafeWork NSW requirements. 46. The following actions in relation to minimising waste during construction would be considered: o waste avoidance, including action to reduce the amount of waste generated o resource recovery, including re-use, recycling, reprocessing and energy recovery	Y	

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			Y/N	Comments
		○ waste disposal, including management of all disposal options in the most environmentally responsible manner and in line with legislative requirements. 47. Wastes would be recycled where possible. 48. The construction contractor must prepare the Waste and Resource Recovery Reporting Template (EMF-WM-TT-0074). The workbook must be submitted biannually and include data for the period ending 30 June or 31 December.		
Economic	The proposed works are not expected to have any negative economic impacts and may have positive economic impacts from employing local businesses.	No control measures are required.	Y	
Visual	The proposed works are located amongst existing rail infrastructure and the wider Maintenance Facility is generally surrounded by a combination of stands of vegetation, sections of a five metre high noise barrier, and other rail and road infrastructure. Considering existing visual barriers and surrounding topography, visibility of the construction works outside of the Maintenance Facility would be limited. The warehouse is the largest structure to be constructed on site and would be the most visually prominent due to the height of the building. In addition, as fill is proposed to create a level surface for the warehouse the height of the building at the south eastern corner would be approximately 10.8 metres above existing ground level. The warehouse is set within the existing context of the maintenance facility and would be both partially screened by vegetation and	49. Work sites would be maintained in a clean and tidy condition at all times. 50. Construction waste would be removed from site as quickly as feasible. 51. Worksite compounds would be screened with shade cloth (or similar material where necessary) to minimise visual impacts from key viewing locations outside the Maintenance Facility complex 52. During construction, graffiti would be removed in accordance with TfNSW's Standard Requirements.	Y	

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			Y/N	Comments
	would also blend in with the existing maintenance facility building behind, which is taller than the proposed warehouse. The visual impact therefore would be minimal as the works would remain consistent with the existing context and built from within the site. The design of the proposed Additional Works would also match that of the adjacent buildings in materials and finish. Construction compound areas within the site would be generally screened from public view, however the laydown area adjacent to the unnamed road would be visible to the public during its operation. The construction contractor would be required to keep this laydown area tidy and clean, while also installing a shade cloth (or similar) to screen the laydown space from view. This would result in a minor, short term visual impact during construction.			
Urban design	Urban design impacts during construction would be short-term, temporary and limited to the minimal visual impacts identified above.	No control measures are required.	Y	
Geotechnical	The proposed works include excavations to up to two meters for the graffiti shed in order to provide new stair access to the existing under-train access pit. All ground penetration would be limited to previously disturbed/developed areas within the existing Maintenance Facility, the majority of which has already been raised using engineered fill. No geotechnical impacts are anticipated as a result of the proposed works as all excavation work would be limited to the upper two metres below ground level through engineered fill.	No control measures are required.	Y	

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			Y/N	Comments
	Due to the recent completion of the Maintenance Facility and current usage of the area, there is not expected to be any contamination encountered from excavations within the engineered fill.			
Land use	The proposed works would be undertaken within the boundaries of the existing Mariyung Maintenance Facility (zoned E3 – Environmental Management). The existing land use would not be altered during construction.	No control measures are required.	Y	
Risk	The proposed works carry potential risks that are ordinarily associated with construction works.	53. The proposed works would be carried out in accordance with the relevant approved Safe Work Method Statement (SWMS) or equivalent.	Y	
Climate Change	The proposed works would not contribute to climate change due to the small scale of the works. Minimal amounts of greenhouse gases would be generated by the proposed works. A climate-change risk assessment would be prepared in accordance with TfNSW *Climate Risk Assessment Guidelines SD-081* and *AS5334 - Climate change adaptation for settlements and infrastructure — A risk-based approach* (2019f) at the commencement of System Design Review (SDR) (or equivalent) stage of design. This assessment would include a review of any climate-change risk assessments prepared during concept design and identification of new risks	54. A climate-change risk assessment would be prepared in accordance with TfNSW *Climate Risk Assessment Guidelines SD-081* and *AS5334 - Climate change adaptation for settlements and infrastructure — A risk-based approach* (2019f) at the commencement of SDR (or equivalent) stage of design. 55. Greenhouse gas emissions generated during construction would be kept to a minimum through the implementation of emissions mitigation measures by the construction contractor. 56. Methods to manage emissions are incorporated into project inductions, training and pre-start/toolbox talks.	Y	

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			Y/N	Comments
		57. Plant and machinery are regularly checked and maintained in a proper and efficient condition. 58. Plant and machinery must be switched off when not in use, and not left idling.		
Sustainability	The development of the design for the Proposal has been undertaken in accordance with the TfNSW's *Sustainable Design Guidelines - Version 4.0* (2019a), where a 'Silver' rating is to be achieved. The Guidelines 'seek to deliver sustainable development practices by embedding sustainability initiatives into the planning, design, construction, operations and maintenance of transport infrastructure projects', grouping sustainability into seven key themes: energy and greenhouse gases; climate resilience; materials and waste; biodiversity and heritage; water; pollution control; and community benefit.	59. A suitably qualified and experienced Sustainability Manager who is responsible for implementing the sustainability objectives for the Project must be nominated by the design Contractor. The nominated Sustainability Manager is to be endorsed by the TfNSW Senior Manager Sustainability (SMS) or delegate prior to the preparation of the sustainability management plan (SMP). 60. A Sustainability Management Plan (SMP) is prepared and submitted by the design contractor to the SMS (or delegate) for approval at least 14 days prior to site mobilisation. 61. The SMP would include a completed electronic checklist demonstrating compliance with TfNSW's NSW Sustainable Design Guidelines Version 4.0 (DMS-ST-114) (TfNSW, 2019a). 62. The construction contractor must prepare SDG submissions with supporting evidence at 6 monthly intervals during the construction phase and at completion of the construction phase. A minimum silver rating must be achieved for the project.	Y	

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			Y/N	Comments
Cumulative impacts	The construction works would be undertaken while the maintenance facility continues to operate, therefore there would be an increase in activity on the site, primarily relating to noise, traffic and visual impact. The construction impacts in addition to existing operation has been considered in the subsections above. A search of the DPE Major Projects Register in September 2022 was undertaken for the suburbs including and surrounding Kangy Angy (Berkely Vale, Tuggerah, Mardi, Palmdale, Fountaindale, and Ourimbah) was undertaken and found no major projects have been approved in the area.	No control measures are required.	Y	
Other	The proposed works would not result in any other additional impacts to those assessed in this Checklist.	No control measures are required.	Y	
Management and mitigation measures	It is not anticipated that there would be any additional environmental impacts associated with the implementation of the proposed management and mitigation measures required for the works. A Construction Environmental Management Plan (CEMP) would identify appropriate mitigation measures including the project specific control measures identified in this table.	63. A Construction Environmental Management Plan (or equivalent as agreed by the TfNSW Senior Manager Environment and Sustainability (SMES)) would be prepared by the Contractor in accordance with the relevant requirements of *Environmental Management Plan Guideline – Guideline for Infrastructure Projects* (NSW Department of Planning Industry and Environment, 2020), for approval by the SMES, prior to the commencement of construction and following any revisions made throughout construction. 64. An Environmental Controls Map (ECM) shall be prepared and implemented in accordance with TfNSW's *Guide to Environmental Controls Map* (DMS-SD-015) (2019g) prior to the commencement of construction for	Y	

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			Y/N	Comments
		implementation for the duration of construction. The ECM is to be endorsed by the TfNSW SE&SO (or equivalent). The SE&SO is to be given a minimum period of seven days to review and endorse the ECM. Following receipt of the SE&SO's endorsement, the ECM shall be submitted to the SMES for approval, at least 14 days prior to commencement of construction (or such time as is otherwise agreed by the SMES). 65. Prior to the commencement of construction, all contractors would be inducted on the key project environmental risks, procedures, mitigation measures and conditions of approval. 66. Site inspections to monitor environmental compliance and performance would be undertaken during construction at appropriate intervals. Inspection reports including images would be sent to TfNSW within 48 hours of completing the inspection. 67. Any modifications to the Proposal, if approved, would be subject to further assessment and approval by TfNSW and relevant approval agencies. This assessment would need to demonstrate that any environmental impacts resulting from the modifications have been minimised.		

Impact Assessment - Operation

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			Y/N	Comments
Flora and fauna	The proposed works are within the Mariyung Maintenance Facility, in a highly disturbed area with limited trees and with not mature vegetation. Vegetation near the Proposal is limited to recently planted shrubs, trees and groundcovers in landscaped areas. Replanting of the vegetation removed as part of construction works is required in Control Measure 5, which would ensure going into operation the site would have an equal area replanted as that which had been removed. As such, it is not anticipated that there would be an ongoing flora impact from the Proposal. Fauna is not anticipated to enter the area of the proposed works as access is limited due to the existing rail corridor and Maintenance Facility fencing in place. However, it is acknowledged that many species of fauna (frogs, reptiles, birds and mammals) were recorded in the surrounding area during field surveys undertaken for construction of the Maintenance Facility, and small fauna could potentially enter the area during operation.	68. Replanting undertaken in accordance with Control Measure 5 is to be actively maintained for one year. Maintenance is to include bi-monthly checking of the plantings and replacement where plants have failed. A regular watering schedule for this year period is also to be established in the CEMP. 69. Any fauna encountered during operations would be managed in accordance with the Operational Environmental Management Plan (OEMP) for the Mariyung Maintenance Facility.	Y	
Water	Once the proposed works are completed, any stormwater runoff would be captured and flow to the existing stormwater draining system, and no impacts to surface water are anticipated. As all excavations would be filled during construction, there are not anticipated to be any operational impacts to groundwater during operation. During operation, the same extent of paved surfaces would likely result in a similar level of stormwater run-off volumes and flows to current levels. The existing stormwater management of the Maintenance Facility was designed with additional capacity which can cater for these additional upgrades.	70. Any water within the new works area would be directed to the existing stormwater management within the Maintenance Facility.	Y	

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			Y/N	Comments
Air quality	The proposed works would not result in impacts to air quality during operation. All surfaces would be sealed once construction is complete and no unsealed surfaces would remain during operation of the Proposal.	No control measures are required.	Y	
Soils and contamination	The proposed operations would not alter the existing risks of contamination from the facility, which are managed under the previous planning approvals and site management guides. All existing guidance would continue to be followed for the continued operation of the maintenance facility.	No control measures are required.	Y	
Noise and vibration	The Proposal would allow for a change to the existing operation on site and the changes in operation would have different noise profiles. Long term storage associated with the warehouse and the additional train lift system is unlikely to generate new noise compared with the existing maintenance facility operation. It is therefore unlikely that additional noise impacts would be generated from these aspects of the Proposal. The Road 5 works allowing additional access into the maintenance facility would allow for additional trains to be located on site, however frequency of train movements is unlikely to substantially change as the entry into the facility isn't being widened. The noise generated from this road would be identical to Roads 1-4 and therefore it is expected that the noise profile from this addition would remain consistent with the current operation. The construction of the graffiti removal shelter would allow 24/7 train washing. This would result in a change to the noise profile as currently train washing is only permitted during the day. The intention of the shelter is to provide additional noise attenuation in order to allow the operation of the graffiti removal during the night.	71. Operation of the Additional Works is to comply with the requirements of the ONVR Rev 11 dated 12/4/21 (Appendix I). Any measures required to comply with the ONVR should be detailed in the OEMP. 72. The ONVR is to be updated to include the scope of the Additional Works prior to works commencing. The noise criteria in the ONVR would not be changed without agreement of the TfNSW Senior Manager Environment & Sustainability. 73. Moving of equipment from the warehouse to the maintenance facility is only permitted during standard hours. 74. Where practical, the halting of graffiti removal operations using diesel high pressure hoses during periods where trains are arriving	Y	

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	It should also be noted that the graffiti wash building would provide new noise attenuation to the existing graffiti washing operation that occurs during the day. This would result in a reduced noise impact from graffiti washing during the day, compared to the current operation. Noise modelling and assessment for the graffiti wash operation has been undertaken by WSP and is attached at Appendix G. This report compared the noise generation from the graffiti wash against the project specific noise limits (PSNL) (noise levels set in the Operational Noise and Vibration Report (ONVR) which were deemed an appropriate level of noise generation) and against the operations maximum predicted noise level which were modelled in the ONVR. Modelling showed that the potential noise impacts associated with the proposed works would be generally less than that experienced during the existing operation of the maintenance facility, or generally less than the PSNL. This is apart from two sites (50 Orchard Road and 170 Old Chittaway Road), which would have a maximum noise level 1 dBA greater than the PSNL when graffiti wash operations occur at the same time as trains enter and exit the facility. These marginal exceedances are minor. It is generally accepted that an increase of less than 2dB is considered unnoticeable by most people. Given the infrequent nature of these events coinciding, an increase of this magnitude is considered acceptable. Based on this modelling the noise impacts from the new hours of operation of the graffiti removal is considered to be minor. The proposed works would not involve any new vibration generating activities during operation as vibration from Road 5 and the additional train lift would be consistent with the existing operation.	or departing from the maintenance facility at night. Use of the electric high pressure hoses could continue during these periods. Where this control is adopted, potential cumulative noise impacts would not occur, and predicted noise levels would comply at all locations. 75. Verification monitoring is to be undertaken following construction completion. Noise monitoring of all the new elements is to be compared against the WSP Noise Modelling Assessment (2022). Should noise be greater than the levels identified in Table 1.1, column 'Graffiti Removal Facility noise goal', for any parts of the works subject to this approval, then noise mitigation would be required to maintain these noise levels. Noise mitigation described in Section 2.4 of the Noise Modelling Assessment (WSP, 2022) should be the first noise mitigation that is investigated.		

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			Y/N	Comments
Aboriginal heritage	The proposed works would not result in impacts to Aboriginal heritage during operation.	No control measures are required.	Y	
Non-Aboriginal heritage	The proposed works would not result in impacts to non-Aboriginal heritage during operation.	No control measures are required.	Y	
Community, social and economic	Potential negative community impacts during operation would be limited. These impacts are discussed in the relevant sections of this Checklist. The proposed works would support the Mariyung Maintenance Facility Project and wider Mariyung Fleet Program, which is being delivered to enhance rail passenger services, in particular for longer distance travel outside the Sydney metropolitan network. The proposed works would not result in any ongoing economic impacts during operation.	No control measures are required.	Y	
Traffic	There would be no additional vehicle movements generated by operation of the proposed works. There would be a minor increase in forklift movements, however these would be limited to within the site only. As such, there would be no impacts on traffic in the surrounding area.	No control measures are required.	Y	
Waste	The proposed works would generate minimal waste during operation. Wastewater generated from the graffiti wash would not change from the current wash operation. Any waste generated by operation of the Proposal would be disposed of at an appropriately licenced facility.	No control measures are required.	Y	
Visual	Once constructed, the proposed Additional Works would result in additional infrastructure within the existing Maintenance Facility. The new elements are consistent with the existing Maintenance Facility buildings and would not appear out of place within the highly modified Maintenance Facility. Lighting associated with the	76. Where possible, new structures would be coloured to appear similar to existing Maintenance Facility structures.	Y	

Aspect	Nature and extent of impacts (negative and positive) during operation	Proposed Control Measures	Endorsed [Rail Development and Delivery, E&S Branch use only]	
			Y/N	Comments
	works will be consistent with lighting of the existing operation, and any new light spill would be blocked by existing buildings, the new graffiti wash shed and by existing vegetation. Considering all of these factors, visual impacts during operation of the Proposal are anticipated to be low.			
Urban design	The proposed works would not result in any urban design related impacts in the surrounding area during operation. The design of the proposed structures is in keeping with existing rail infrastructure within the Mariyung Maintenance Facility.	No control measures are required.	Y	
Geotechnical	Once completed, the proposed works would not result in any geotechnical impacts during operation.	No control measures are required.	Y	
Land use	Land uses in the vicinity of the proposed works would not be altered. The works would provide enhanced operation of the facility for the maintenance of the New Intercity Fleet, using existing land.	No control measures are required.	Y	
Risk	No operational risks have been identified.	No control measures are required.	Y	
Climate Change	Emissions from the proposed works would be minimal and in isolation would not cause any climate change impacts.	No control measures are required.	Y	
Sustainability	As the design of the Proposal has been undertaken in accordance with a Silver rating under the TfNSW's *Sustainable Design Guidelines - Version 4.0* (2019a), the built infrastructure of the additional works would be designed in a manner that would allow for a sustainable ongoing operation. Existing sustainability practices of the facility would be maintained.	No control measures are required.	Y	
Cumulative impacts	The proposed works would allow for more efficient operations at the facility, including more space for storage and more locations within the maintenance facility for train repairs. The Road 5 was anticipated in the original assessment and would likely allow for a similar amount of train movements within the facility.	No control measures are required.	Y	

Aspect	Nature and extent of impacts (negative and positive) during operation	Proposed Control Measures	Endorsed [Rail Development and Delivery, E&S Branch use only]	
			Y/N	Comments
	Cumulative noise impacts have been discussed and mitigated in the sections above.			
Other	The proposed works would not result in any other additional impacts to those assessed in this Checklist.	No control measures are required.	Y	
Management and mitigation measures	It is not anticipated that there would be any additional environmental impacts associated with the implementation of the proposed management and mitigation measures required for the works.	77. The OEMP for the Mariyung Maintenance Facility must be updated to reflect the operational control measures of this planning approval.	Y	

Are you confident that the impacts of the activity are known and understood?	Yes
Are you confident that the impacts of the activity can be managed so as not to have an adverse impact?	Yes

I certify that to the best of my knowledge this EIA checklist:

- examines and takes into account to the fullest extent possible all matters affecting or likely to affect the environment as a result of activities associated with the project; and
- is accurate in all material respects and does not omit any material information.

Name		Signature	Date 20/09/22
Title	**Environment and Sustainability Manager** Environment & Sustainability Safety, Environment & Regulation		
Name		Signature	Date 18/11/2022
Title	**Senior Manager, Communications and Stakeholder Engagement** Community and Place Regional and Outer Metropolitan		
Name		Signature	Date 18/11/2022
Title	**Project Manager** Rail Delivery Infrastructure and Place		
Name		Signature	Date 21/11/2022
Title	**Senior Manager Environment & Sustainability** Environment & Sustainability Safety, Environment & Regulation		

THIS SECTION FOR RAIL DEVELOPMENT AND DELIVERY, ENVIRONMENT AND SUSTAINABILITY BRANCH USE ONLY

Project Approvals

Planning Approvals *(Refer to section 3 of the Guide to Planning and Environmental Approvals)*

Is the project a part of an activity/development which has already been approved under the EP&A Act ?

Yes ☐ If yes, does the approval need to be modified to accommodate the project?

If yes, identify requirements for modification. ----------

No ☒ If no, is the project to be assessed under Part 4 or Division 5?

If the project is to be assessed under Division 5.1, is it an activity that is likely to significantly affect the environment (including critical habitat) or threatened species, populations or ecological communities, or their habitats?

☐ Yes if yes, the project is required to be assessed under Division 5.2 .

☒ No, with the inclusion of the proposed control measures the project can be appropriately assessed under Division 5.1.

The environmental assessment has been undertaken in the context of Section 171(2) of the Environmental Planning & Assessment Regulation 2021 (refer to Appendix A).

☒ Yes

☐ No – further assessment required (planning approval cannot be granted).

Environmental Approvals *(Refer to section 2 of the Guide to Planning and Environmental Approvals)*

Identify all other approvals required for the project:

Tick appropriate box

No further assessment required.	✓			Further Assessment is required	

Approved		
I have examined and considered the Proposed Activity outlined in this Environmental Impact Assessment Checklist. Under delegation from the Secretary Transport of New South Wales, I determine that the Proposed Activity may be carried out subject to the following conditions of approval. 1. Works are to be undertaken in accordance with the Proposed Control Measures (including any Planning and Environment endorsement comments) identified in the impact assessment tables in this Environmental Impact Assessment Checklist	**Signature** **Name** Director Environment and Sustainability Rail Development and Delivery	**Date** **24/11/2022**

Abbreviations

Term	Meaning
AHIMS	Aboriginal Heritage Information Management System
AS	Australian Standard
ASS	Acid Sulfate Soils
BC Act	*Biodiversity Conservation Act 2016* (NSW)
CEMP	Construction Environmental Management Plan
DES	TfNSW Director Environment & Sustainability
DPE	NSW Department of Planning and Environment
E&S	Environment and Sustainability Branch of TfNSW
ECM	Environmental Controls Map
EMS	Environmental Management System
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EP&A Regulation	*Environmental Planning and Assessment Regulation 2021* (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)
EPL	Environment Protection Licence
Heritage Act	*Heritage Act 1977* (NSW)
HNSW	Heritage NSW
LEP	Local Environmental Plan
LGA	Local Government Area
NML	Noise Management Level
PoEO Act	*Protection of the Environment Operations Act 1997* (NSW)
SE&SO	Senior Environment and Sustainability Officer
SEPP	State Environmental Planning Policy
SEPP (Transport and Infrastructure)	*State Environmental Planning Policy (Transport and Infrastructure) 2021* (NSW)

References

Artefact 2016, *Non-Aboriginal Assessment*, Sydney

EPA, 2014, Waste Classification Guidelines, Sydney

Landcom, 2004, 'Blue Book' Managing Urban Stormwater: Soils and Construction, Volume - 4th Edition, Sydney

Renzo Tonin and Associates 2021, *Operational Noise and Vibration Review, Revision 11*, Sydney

TfNSW 2019a, Sustainable Design Guidelines - V 4.0 – (DMS-ST-114), Sydney

TfNSW 2019b, Chemical Storage and Spill Response Guidelines (DMS-SD-066), Sydney

TfNSW 2019c, Concrete Washout Guideline (DMS-SD-112), Sydney

TfNSW 2019d, Construction Noise and Vibration Strategy (DMS-ST-157), Sydney

TfNSW 2019e, Unexpected Heritage Finds Guideline, (DMS-SD-115), Sydney

TfNSW 2019f, Climate Risk Assessment Guidelines (DMS-SD-081), Sydney

TfNSW 2019g, Guide to Environmental Controls Map (DMS-SD-015), Sydney

WSP, 2016, *Review of Environmental Factors: New Intercity Fleet - Maintenance Facility*, Sydney

WSP, 2022, *Noise Modelling Assessment*, Sydney

Definitions

Term	Meaning
Concept design	The concept design is the preliminary design presented in this EIA Checklist, which would be refined by the Contractor (should the Proposal proceed) to a design suitable for construction (subject to Transport for NSW acceptance).
Construction	Includes all work in respect of the Project, other than survey, acquisitions, fencing, investigative drilling or excavation, building/road dilapidation surveys, or other activities determined by the TfNSW DES to have minimal environmental impact such as minor access roads, minor adjustments to services/utilities, establishing temporary construction compounds (in accordance with this approval), or minor clearing (except where threatened species, populations or ecological communities would be affected, unless otherwise agreed by the DES).
Contractor	The entity appointed by Transport for NSW to undertake the construction of the Proposal. The Contractor is therefore responsible for all work on the Proposal, both design and construction.
Determining authority	A Minister or public authority on whose behalf an activity is to be carried out or public authority whose approval is required to carry out an activity (under Division 5.1 of the EP&A Act).
Disability Standards for Accessible Public Transport	The Commonwealth Disability Standards for Accessible Public Transport 2002 (as amended), authorised under the Commonwealth *Disability Discrimination Act 1992* (DDA).
Out of hours work	Defined as work undertaken *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).
Proponent	A person or body proposing to carry out an activity under Division 5.1 of the EP&A Act.
The Proposal	The construction and operation of a new warehouse, a building over the existing train wash (graffiti removal shelter) a new rail road (Road 5) and install a new train lift system.
Sensitive receivers	Land uses which are sensitive to potential noise, air and visual impacts, such as residential dwellings, schools and hospitals.

Appendix A – Consideration of Section 171(2)

The following environmental factors, listed in section 171(2) of the *Environmental Planning and Assessment Regulation 2021,* have been considered taken into account to assess the likely impacts of the Proposal on the environment.

Factor	Impacts
(a) Any environmental impact on a community? The facility is not publicly accessible and therefore there would not be any interaction from the community with the works. The Proposal has the potential to result in short-term negative impacts during the construction phase due to increased noise and dust from construction activities, construction traffic and visual impacts.	Minor – short term
(b) Any transformation of a locality? The works would be undertaken in an existing maintenance facility and would allow works consistent with the existing use. During construction there would be some minor visual impacts associated with the presence of construction equipment and activities.	Minor – short term
(c) Any environmental impact on the ecosystem of the locality? The Proposal includes vegetation removal, this vegetation although primarily native has been recently planted and has been assessed as having a low conservational value. The works would include full replacement of vegetation which has been removed and as such the impact to the ecosystem is considered minor.	Minor – short term
(d) Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality? There is no reduction in aesthetic, recreational or scientific quality or value of a locality from the proposed works. The Proposal would have minor impacts on noise and dust from construction activities, additional construction traffic and ecology, however these impacts would be mitigated to ensure a minor to negligible impact.	Minor – short term
(e) Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations? There are no effects to significant or special value places for present or future generations, noting no works are proposed or permitted in the ecological exclusion zones and these areas would be clearly demarcated to ensure compliance.	Nil
(f) Any impact on the habitat of protected fauna (within the meaning of the *National Parks and Wildlife Act 1974*)? There are no effects to the habitat of protected fauna, noting no works are proposed or permitted in the ecological exclusion zones and these areas would be clearly demarcated to ensure compliance.	Nil
(g) Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air? The works are not expected to endanger any species of animal, plant or other form of life, noting no works are proposed or permitted in the ecological exclusion zones and these areas would be clearly demarcated to ensure compliance. In addition, control measures are imposed which identify management procedures for any unexpected fauna entering the site.	Nil
(h) Any long-term effects on the environment? There is no anticipated long-term effects on the environment.	Nil
(i) Any degradation of the quality of the environment? There is no anticipated degradation of the quality of the environment.	Nil

Factor	Impacts
(j) Any risk to the safety of the environment? Construction of the Proposal would be managed in accordance with a CEMP to reduce any risks to the environment.	Minor – short term
(k) Any reduction in the range of beneficial uses of the environment? There is no anticipated reduction in the range of beneficial uses on the environment.	Nil
(l) Any pollution of the environment? There is no anticipated pollution on the environment. Control measures are included which address any unexpected incidents and procedures to ensure impacts an minimal/negligible.	Minor – short term
(m) Any environmental problems associated with the disposal of waste? All waste requiring off-site disposal would be classified in accordance with the Waste Classification Guidelines (EPA 2014) prior to disposal at an appropriate waste facility licenced to accept waste of the relevant classification.	Minor – short term
(n) Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply? There are no anticipated increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply as a result of the works.	Nil
(o) Any cumulative environmental effect with other existing or likely future activities? There is no anticipated cumulative environmental effect with other existing or likely future activities and the Proposal has been assessed in conjunction with the continued operation of the maintenance facility.	Nil
(p) Any impact on coastal processes and coastal hazards, including those under projected climate change conditions? There is no anticipated impact on coastal processes and coastal hazards, including those under projected climate change conditions.	Nil
(q) Applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1 The local strategic plans, regional strategic plans and district strategic plans applicable to the maintenance facility were discussed in Section 5.2 of the REF for the main works approval (WSP, 2016). Overall, the REF concluded that the operation of the maintenance facility was considered to be consistent with the relevant sections of these various planning and strategic plans and policies. As the Proposal is generally consistent with the use and operation of the original approval it is considered that the alterations and additions would remain consistent with the relevant strategic plans and policies.	Nil change to approval
(r) Other relevant environmental factors In considering the potential impacts of this Proposal all relevant environmental factors have been considered, refer to Impact Assessment of this assessment.	Minor

Appendix B: Site Figures

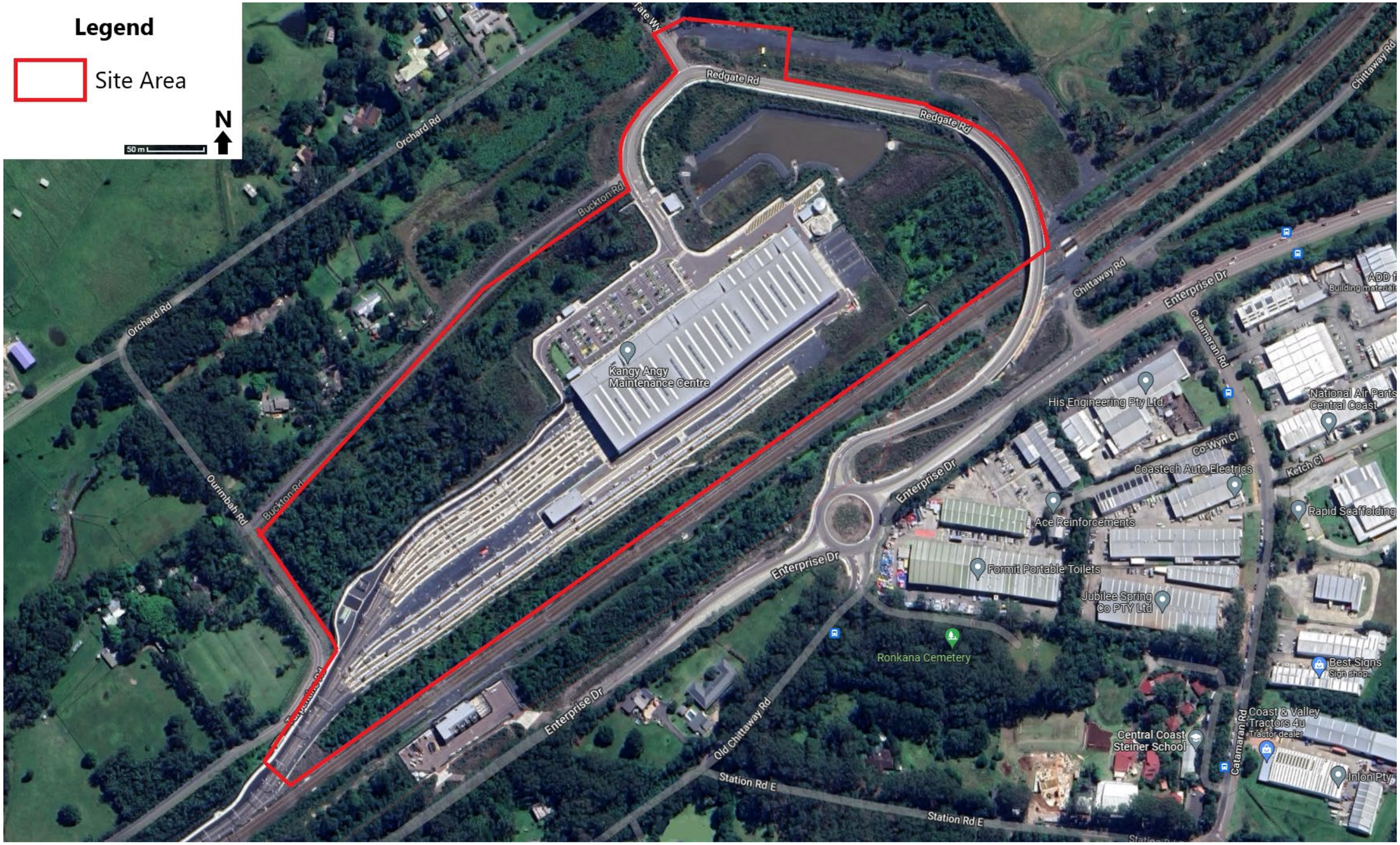


Figure B.1: The Site (Source: Google Maps 2022)

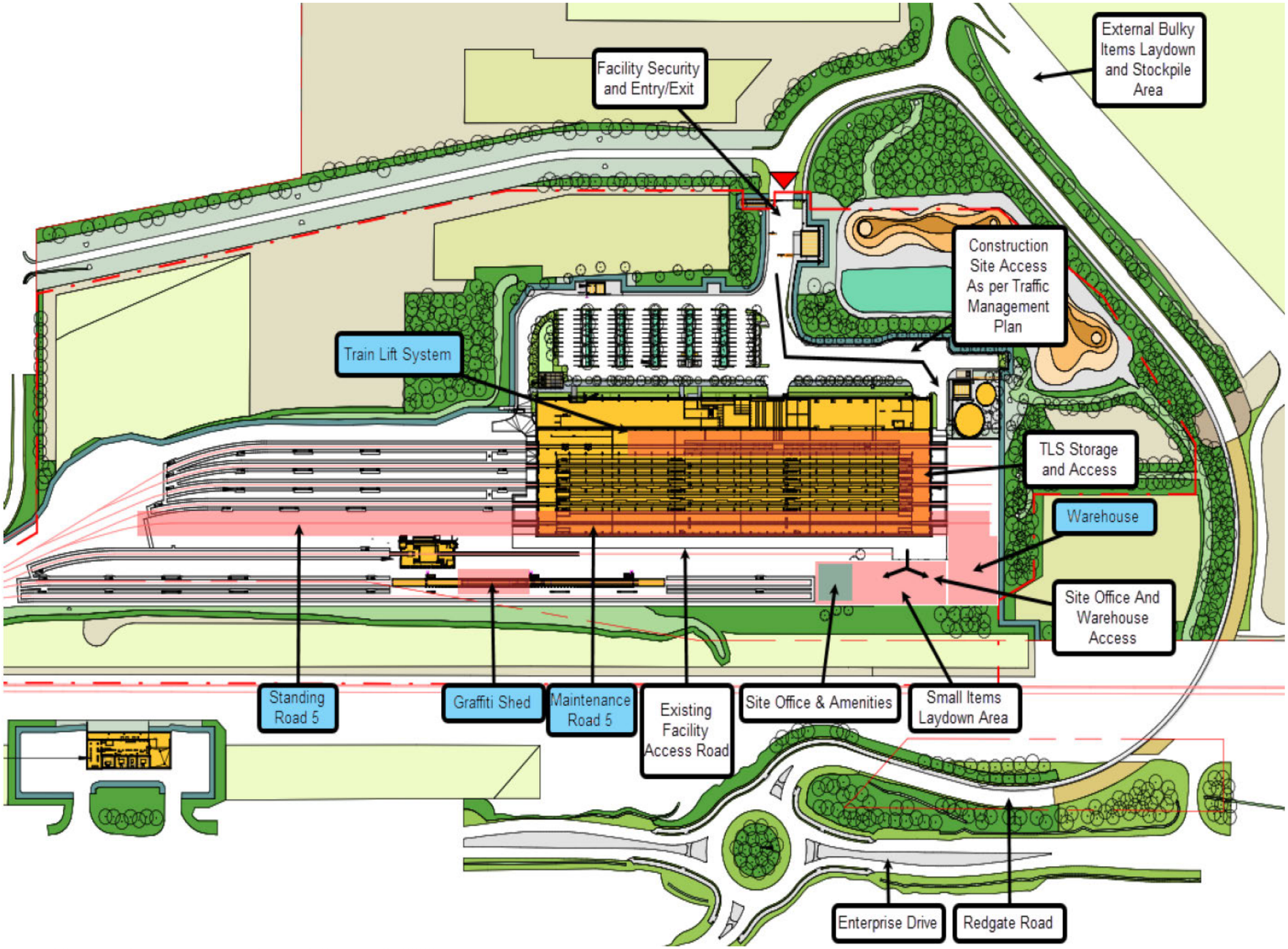


Figure B.2: The existing and proposed site layout (Source: UGL 2022)

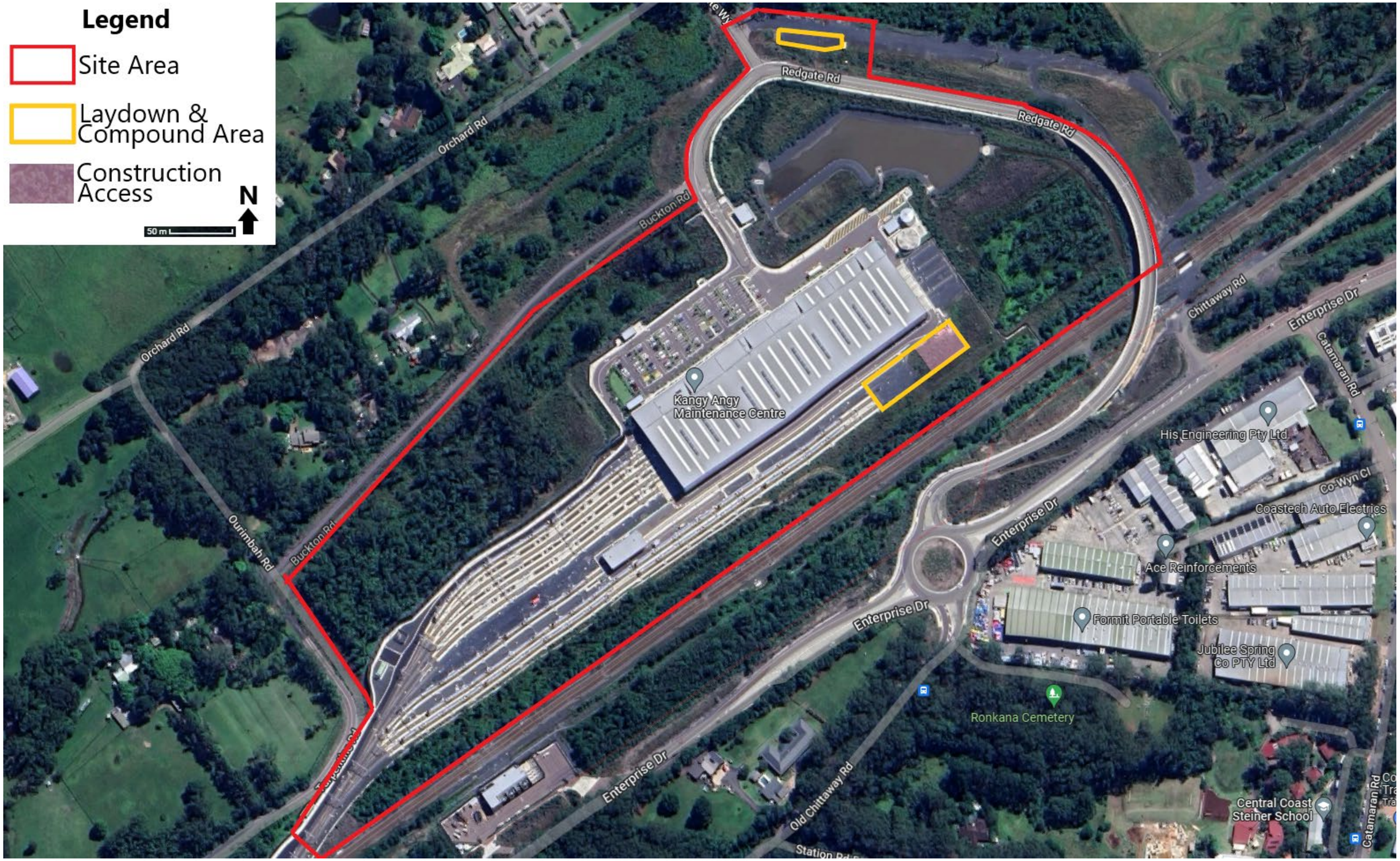


Figure B.3: The proposed site laydown and compound areas and construction access (Source: Google Maps 2022 and TfNSW 2022)

Figure B.4: Conservation Significance (Source: WSP 2022)

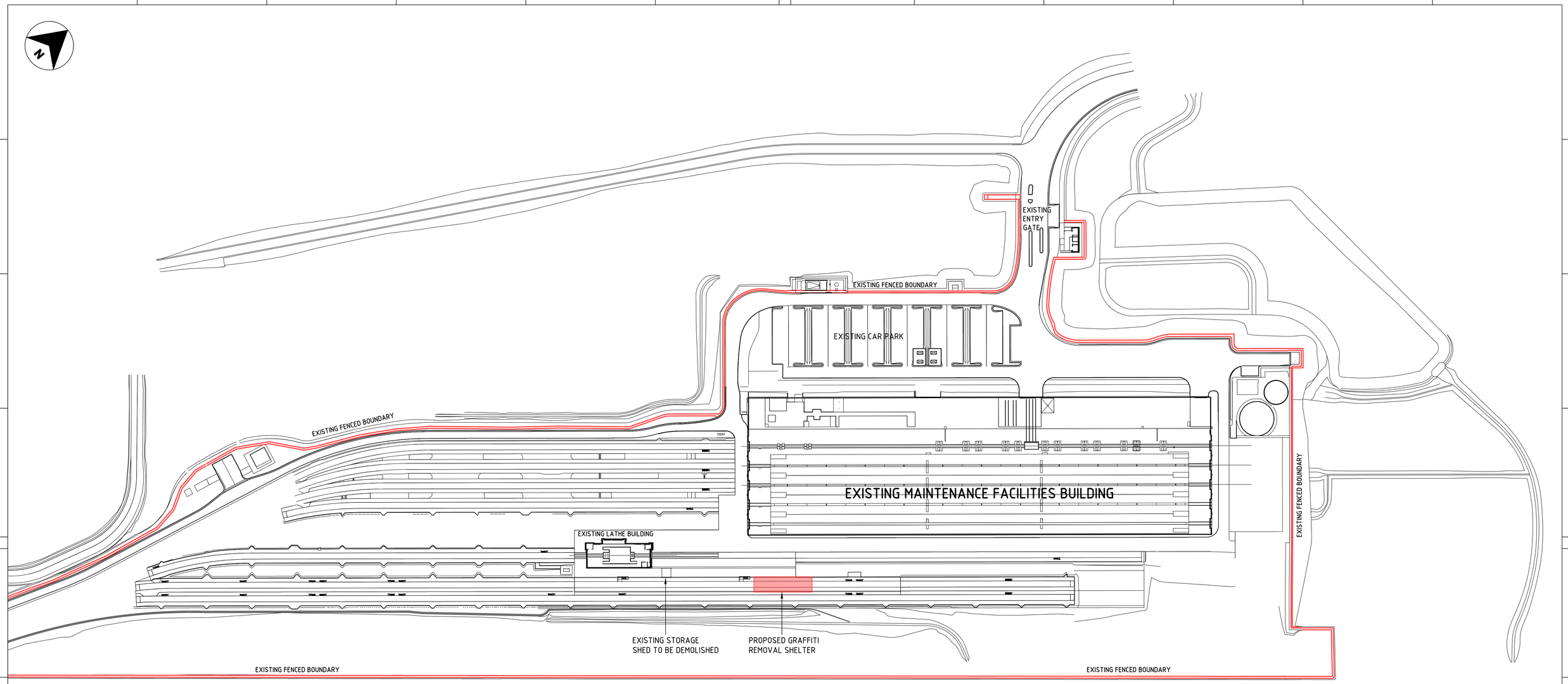
Appendix C: Site Photos

	
Location of proposed Road 5 (including similar infrastructure to adjacent roads)	Location of proposed Road 5 and overhead infrastructure

	
Location of proposed Road 5	Approximate proposed location of Biowash Shed

	
Proposed Road 5 to extend beyond shed to align with adjacent roads.	Proposed location of the Warehouse

Appendix D: Proposed Plans



1 - SITE PLAN

SCALE 1 : 1000

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3	CDR	NM/12/09/2022	RW/12/09/2022	HN/12/09/2022
2	PDR	NM/12/09/2022	RW/12/09/2022	HN/12/09/2022
1	SDR	NM/01/06/2022	RW/01/06/2022	HN/01/06/2022

CO-ORDINATE SYSTEM: ASSUMED | HEIGHT DATUM: ASSUMED | SCALE: NTS

NSW GOVERNMENT Transport for NSW

UGL

CCG ARCHITECTS

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DRG CHECK	NABEEL MARCUS	12/09/2022
DESIGN CHECK	ROBERT DALSUCHBY	12/09/2022
APPROVED	HISHAM NOORI	12/09/2022

WORK IN PROGRESS

KANGY ANGY

MAIN NORTH LINE - 93.329km TO 95.300km

GRAFFITI REMOVAL SHED ARCHITECTURE

SITE PLAN

FILE No. 21-066 | SHEET: 1 OF 1 | A1

STATUS: CDR | ©

DRG No. KAMF-WB-WSP-ALL-AR-DRG-0000021 | 0 | EDMS No. CV0847762 | 3

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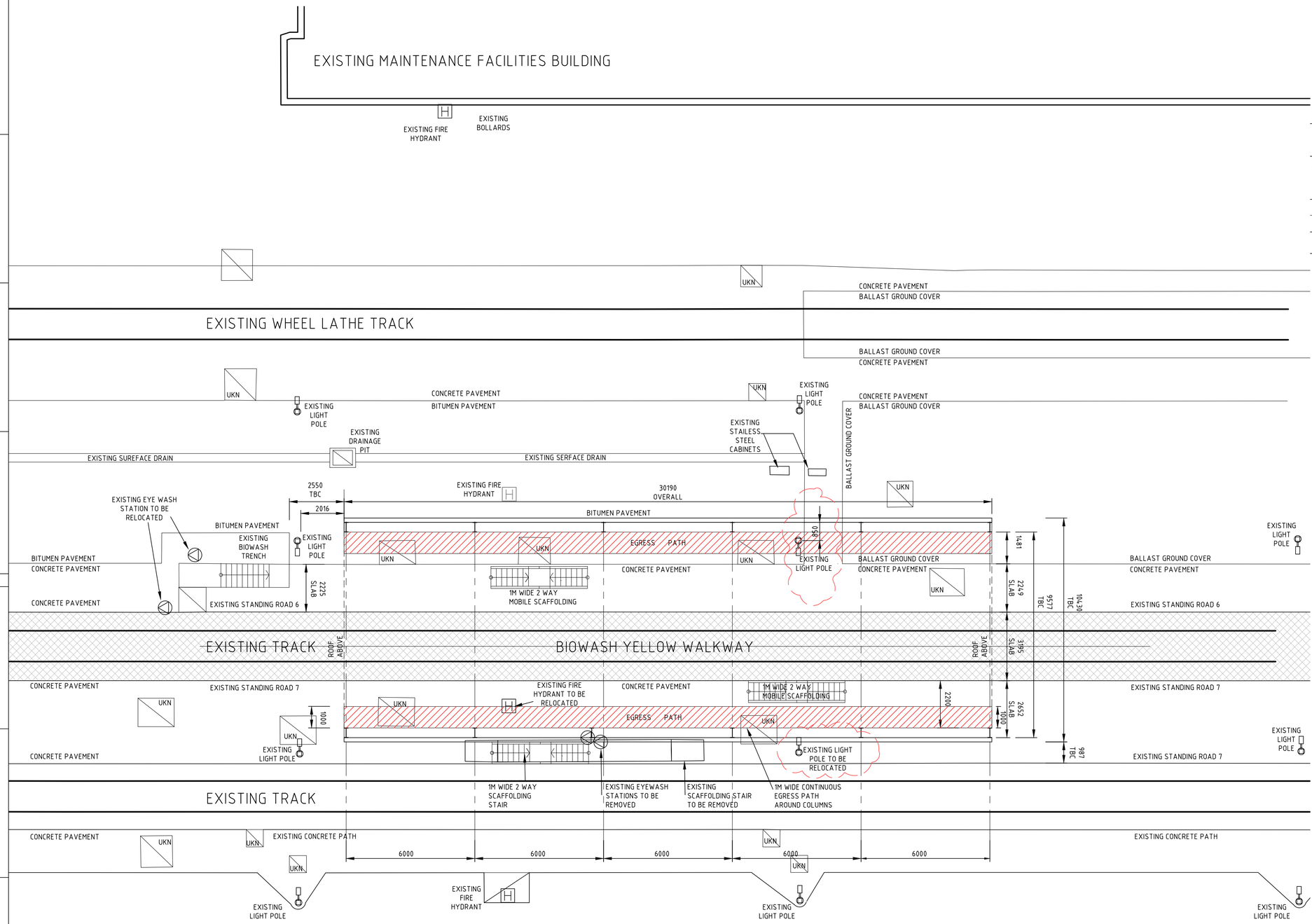
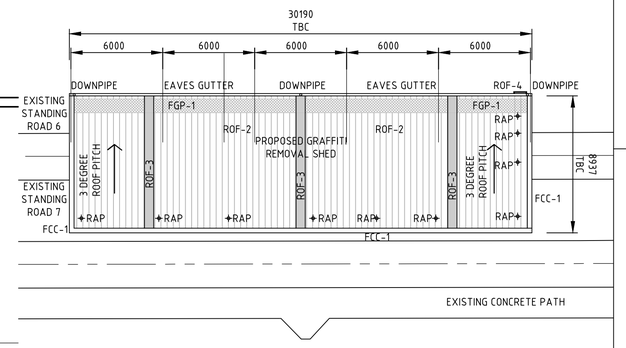


1 - GENERAL ARRANGEMENT PLAN

SCALE 1 : 200



2 - ROOF PLAN

SCALE 1 : 200

SAFETY ROOF ACCESS:
SHOWN ON THIS DRAWING IS A PROPOSED ROOF SAFETY ACCESS SYSTEM INCLUDING LADDER BRACKET, STAINLESS STEEL ANCHORING POINTS AND FIBRE GLASS MAINTENANCE PLATFORM.
ROOF ACCESS CONTRACTOR TO CONFIRM THE FINAL LAYOUT AND DETAILS TO AUSTRALIAN STANDARDS & BCA REQUIREMENTS PRIOR TO COMMENCEMENT OF ANY WORK.

Graffiti Wash
"All paints and sealants used are to be low VOC in accordance with the Australian Paint Approvals Scheme"
"The Graffiti Wash Shed egress path shall include a painted surface using a two-pack epoxy mastic paint that complies with the APAS VOC limit of 180g/L."
"Any precast concrete panels used in the design and construction of the Graffiti Wash Shed shall use low VOC joint sealant"

DRAWING COLOUR CODED - PRINT ALL COPIES IN COLOUR

AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
3	CDR	NM/12/09/2022	RW/12/09/2022	HN/12/09/2022
2	PDR	NM/12/09/2022	RW/12/09/2022	HN/12/09/2022
1	SDR	NM/01/06/2022	RW/01/06/2022	HN/01/06/2022

CO-ORDINATE SYSTEM: ASSUMED | HEIGHT DATUM: ASSUMED | SCALE: NTS

NSW GOVERNMENT Transport for NSW

UGL

CCG ARCHITECTS
NOMINATED ARCHITECTS: DAVID COOK (5086) HISHAM NOORI (5678)
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DRAWN	YOSWARIS DAWONG	12/09/2022
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DRG CHECK	NABEEL MARCUS	12/09/2022
DESIGN CHECK	ROBERT MCLOUGHLIN	12/09/2022
APPROVED	HISHAM NOORI	12/09/2022

UNDER IN PROGRESS

KANGY ANGY

MAIN NORTH LINE - 93.329km TO 95.300km

GRAFFITI REMOVAL SHED ARCHITECTURE

GENERAL ARRANGEMENT PLAN / ROOF PLAN

FILE No. 21-066 | SHEET: 1 OF 1 | A1

STATUS: CDR | ©

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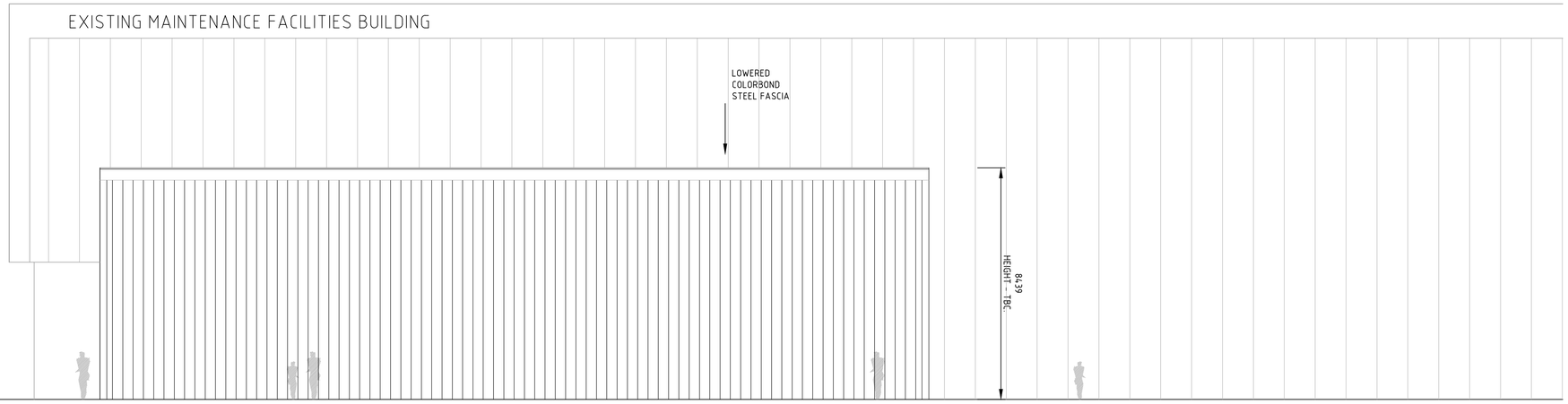

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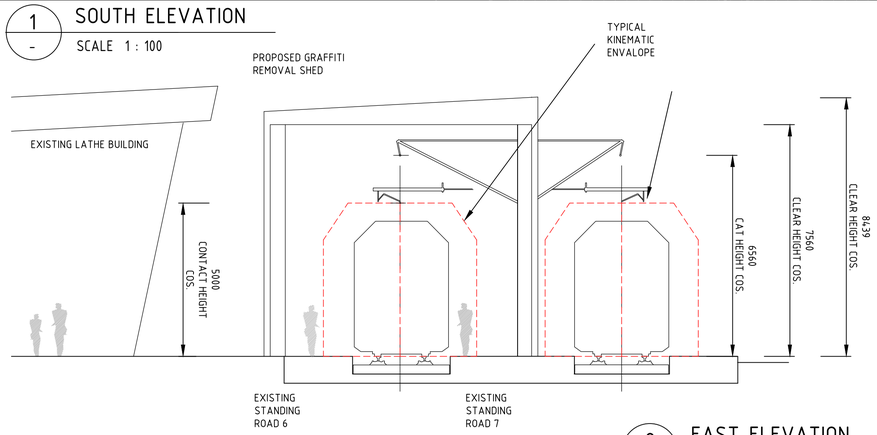

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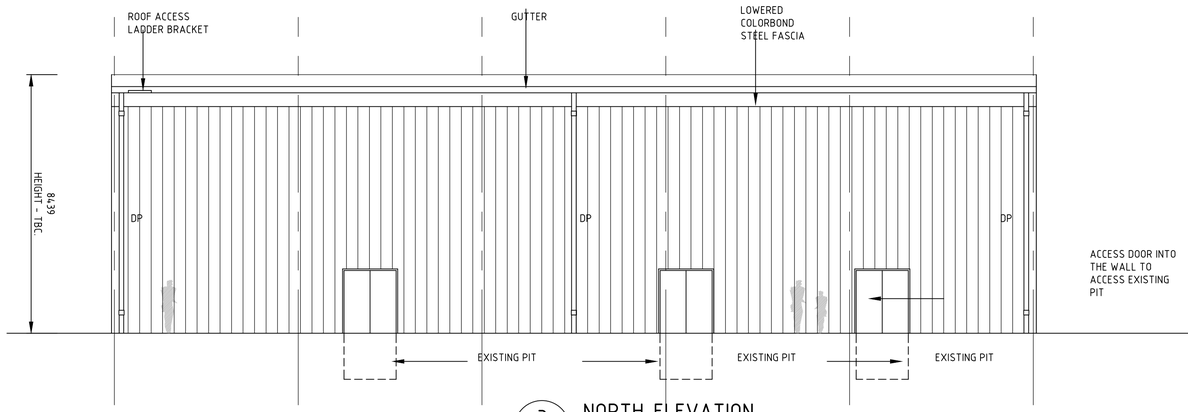

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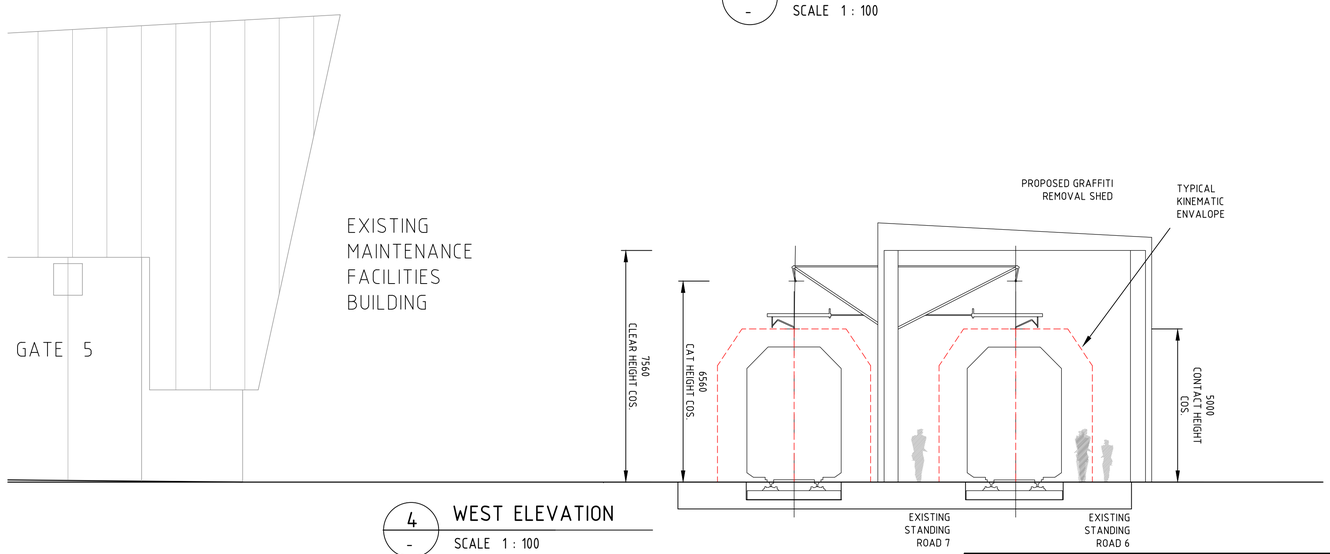

4 WEST ELEVATION
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Graffiti Wash
"All paints and sealants used are to be low VOC in accordance with the Australian Paint Approvals Scheme"
"The Graffiti Wash Shed egress path shall include a painted surface using a two-pack epoxy mastic paint that complies with the APAS VOC limit of 180g/L."
"Any precast concrete panels used in the design and construction of the Graffiti Wash Shed shall use low VOC joint sealant"

DRAWING COLOUR CODED - PRINT ALL COPIES IN COLOUR

AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
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1	SDR	NM/01/06/2022	RW/01/06/2022	HN/01/06/2022

CO-ORDINATE SYSTEM: ASSUMED | HEIGHT DATUM: ASSUMED | SCALE: NTS

NSW GOVERNMENT Transport for NSW

UGL

CCG ARCHITECTS
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DRG CHECK	NABEEL MARCUS	12/09/2022
DESIGN CHECK	ROBERT DOLL SUCHBY	12/09/2022
APPROVED	HISHAM NOORI	12/09/2022

WORK IN PROGRESS

KANGY ANGY
MAIN NORTH LINE - 93.329km TO 95.300km
GRAFFITI REMOVAL SHED
ARCHITECTURE
ELEVATIONS

FILE No. 21-066 | SHEET: 1 OF 1 | A1
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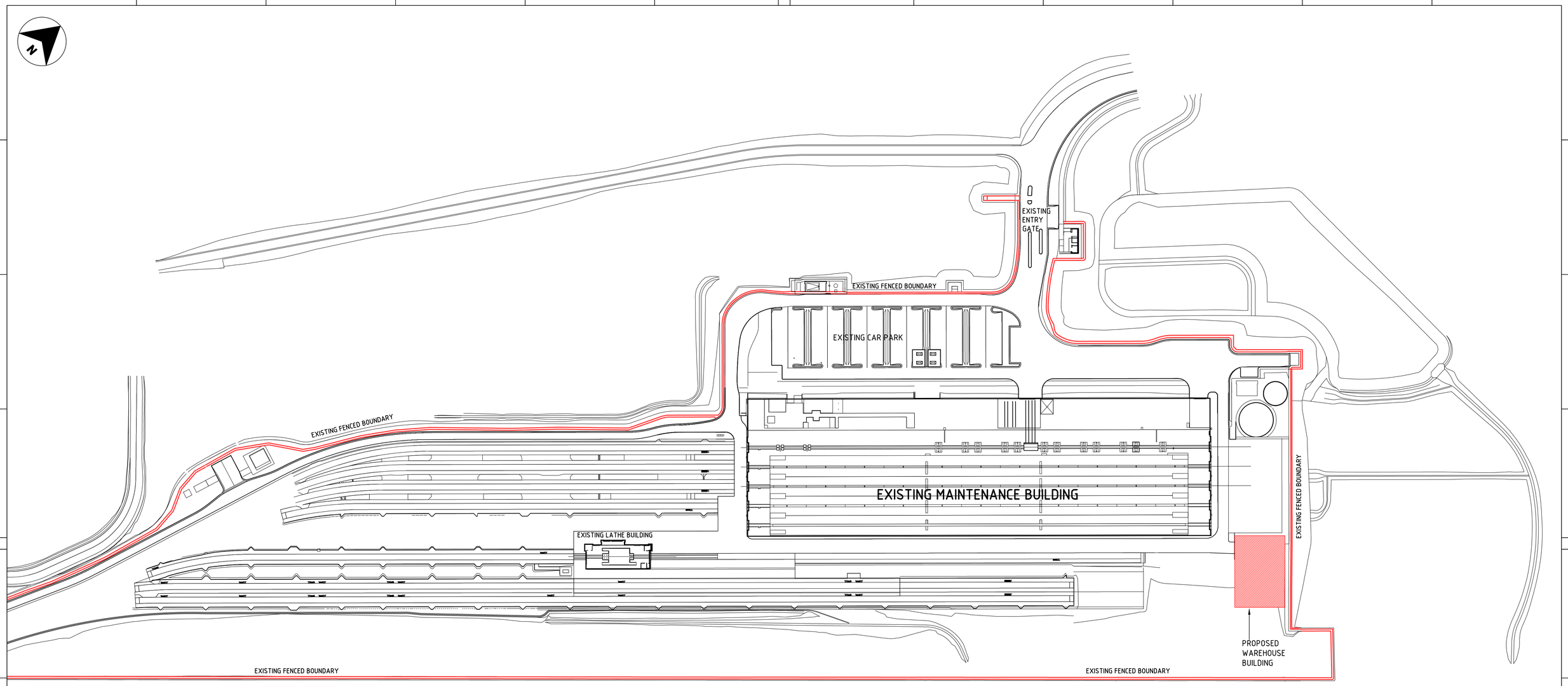

1 - SITE PLAN

SCALE 1 : 1000

DRAWING COLOUR CODED - PRINT ALL COPIES IN COLOUR

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CO-ORDINATE SYSTEM: | HEIGHT DATUM: | SCALE: 1:50

NSW GOVERNMENT | Transport for NSW

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DESIGN CHECK	ROBERT WILLOUGHBY	30.11.21
APPROVED	HISHAM NOORI	30.11.21

KANGY ANGY

MAIN NORTH LINE - 93.329km TO 95.300km

GRAFFITI SHELTER ARCHITECTURE

SITE PLAN

FILE No. 21-066 | SHEET: 1 OF 1

STATUS: CONCEPT DESIGN

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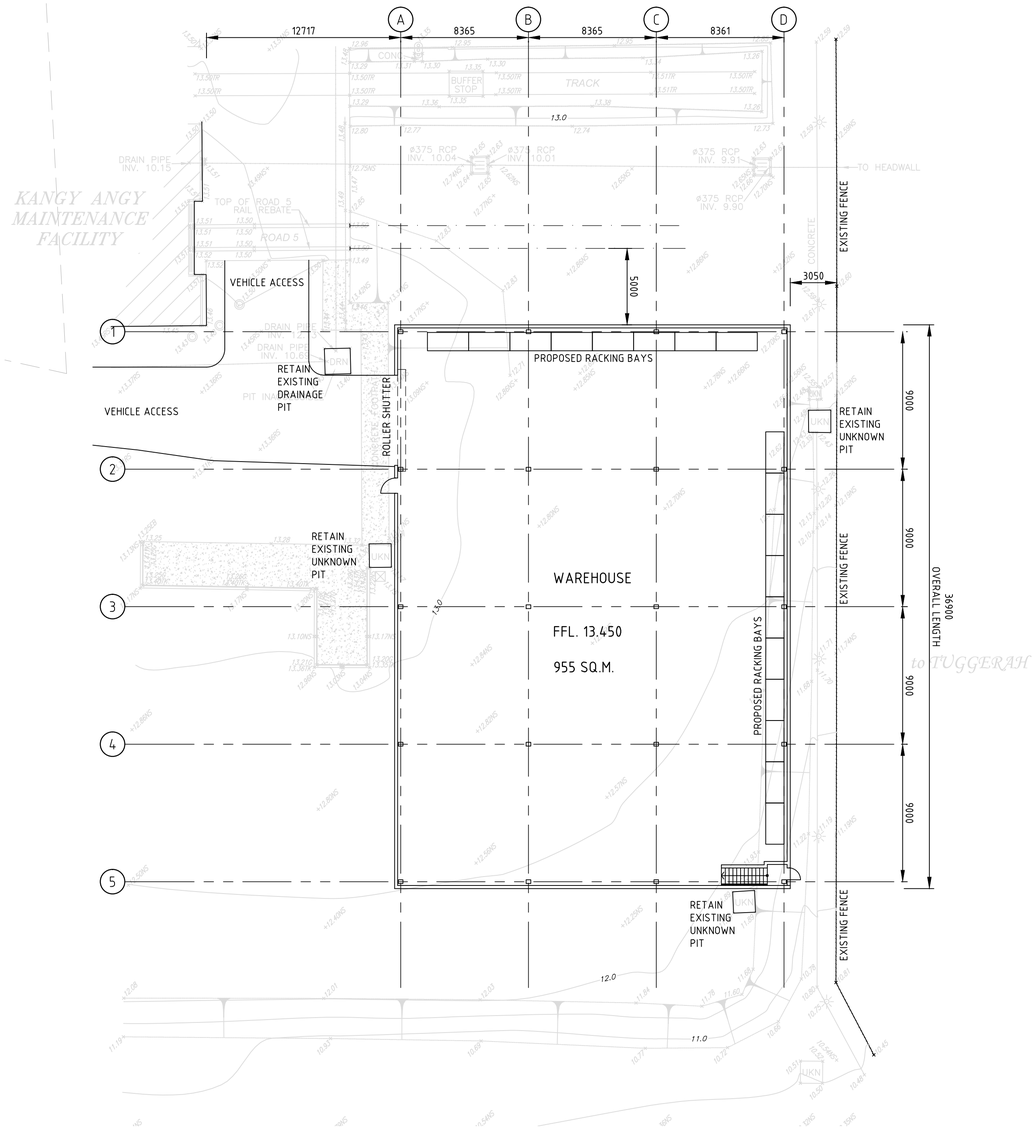

1 GENERAL ARRANGEMENT PLAN
00110 SCALE 1 : 200

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NSW GOVERNMENT | Transport for NSW

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DESIGN CHECK	ROBERT WILLOUGHBY	30.11.21
APPROVED	HISHAM NOORI	30.11.21

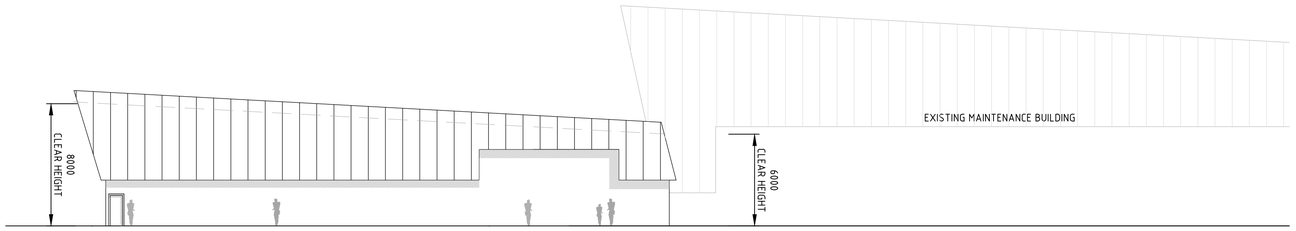
KANGY ANGY
MAIN NORTH LINE - 93.329km TO 95.300km
WAREHOUSE BUILDING
ARCHITECTURE
GENERAL ARRANGEMENT PLAN

FILE No. 21-066 | SHEET: 1 OF 1
STATUS: CONCEPT DESIGN

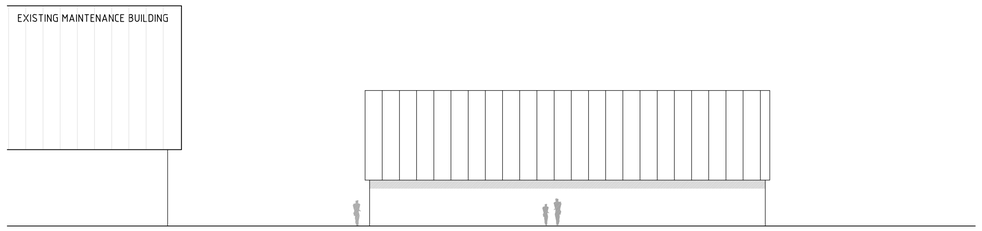
DRG No.	REV	VER	EDMS No.	AMD No.
512176-CCG-KEA-AR-DRG-00002	0	00	CVXXXXXXXX	A

DF 801*554

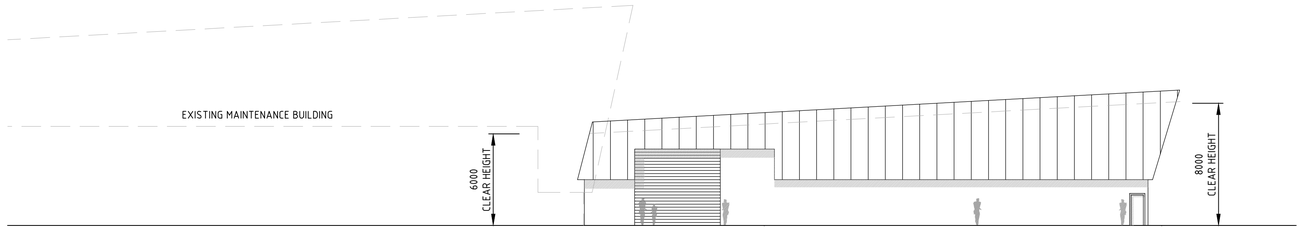
File Plotted
Plot Date & Time



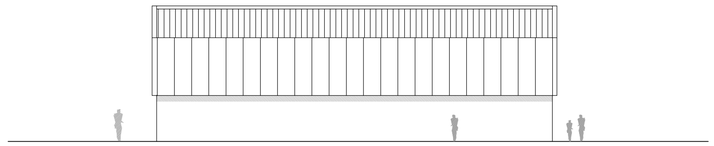
2 - EAST ELEVATION
SCALE 1 : 200



4 - SOUTH ELEVATION
SCALE 1 : 200



3 - WEST ELEVATION
SCALE 1 : 200



5 - NORTH ELEVATION
SCALE 1 : 200

2.0 0 4.0 10.0m
SCALE 1:200

DRAWING COLOUR CODED - PRINT ALL COPIES IN COLOUR

REV	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
A	CONCEPT DESIGN	NM/01.06.2022	RW/01.06.2022	HN/01.06.2022

CO-ORDINATE SYSTEM: | HEIGHT DATUM: | SCALE: 1:50

NSW GOVERNMENT | Transport for NSW

CCG ARCHITECTS
NOMINATED ARCHITECTS: DAVID COOK (5999) HISHAM NOORI (5970)
ACN 157 777 065
ARCHITECTS
LEVEL 2
3 WILSON STREET
NEWTOWN
NSW 2042
TEL (02) 9319 3077
Website: www.ccgarchitects.com.au
Email: projects@ccgarchitects.com.au
ARCHITECTURE

DRAWN	YOSWARIS DAWONG	30.11.21
DESIGNED	NABEEL MARCUS	30.11.21
DRG CHECK	NABEEL MARCUS	30.11.21
DESIGN CHECK	ROBERT WILLOUGHBY	30.11.21
APPROVED	HISHAM NOORI	30.11.21

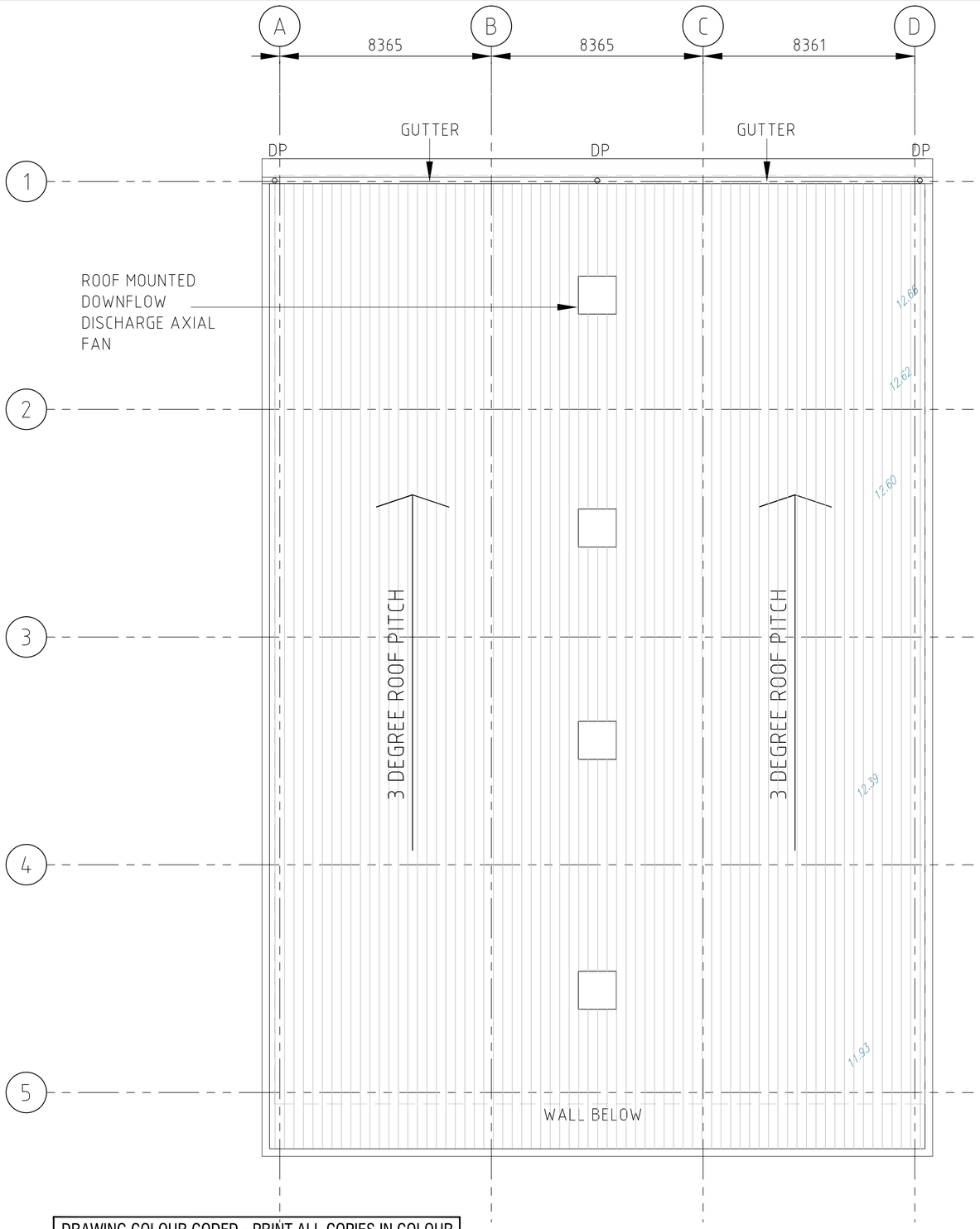
KANGY ANGY
MAIN NORTH LINE - 93.329km TO 95.300km
WAREHOUSE BUILDING
ARCHITECTURE
ELEVATIONS

FILE No. 21-066 | SHEET: 1 OF 1
STATUS: CONCEPT DESIGN ©

DRG No.	REV	VER	EDMS No.	AMD No.
512176-CCG-KEA-AR-DRG-00003	0	00	CVXXXXXXXX	A

DF 801*554

File Plotted
Plot Date & Time



DRAWING COLOUR CODED - PRINT ALL COPIES IN COLOUR

1 / - ROOF PLAN

SCALE 1 : 100

2.0 0 4.0 10.0m

SCALE 1:200

REV	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
A	ISSUED FOR SDR	NM/23.07.2021	RW/23.07.2021	HN/23.07.2021

CO-ORDINATE SYSTEM: | HEIGHT DATUM: | SCALE: 1:50

NSW GOVERNMENT | Transport for NSW

CCG ARCHITECTS
NOMINATED ARCHITECTS: DAVID COOK (5088) HISHAM NOORI (5976)
ACN 157 777 065
ARCHITECTS
LEVEL 2
5 WILSON STREET
NEWTOWN
NSW 2042
TEL (02) 9319 3077
Website: www.ccgarchitects.com.au
Email: projects@ccgarchitects.com.au

DRAWN	YOSWARIS DAWONG	30.11.21
DESIGNED	NABEEL MARCUS	30.11.21
DRG CHECK	NABEEL MARCUS	30.11.21
DESIGN CHECK	ROBERT WILLOUGHBY	30.11.21
APPROVED	HISHAM NOORI	30.11.21

ARCHITECTURE

KANGY ANGY

MAIN NORTH LINE - 93.329km TO 95.300km

WAREHOUSE BUILDING

ARCHITECTURE

ROOF PLAN

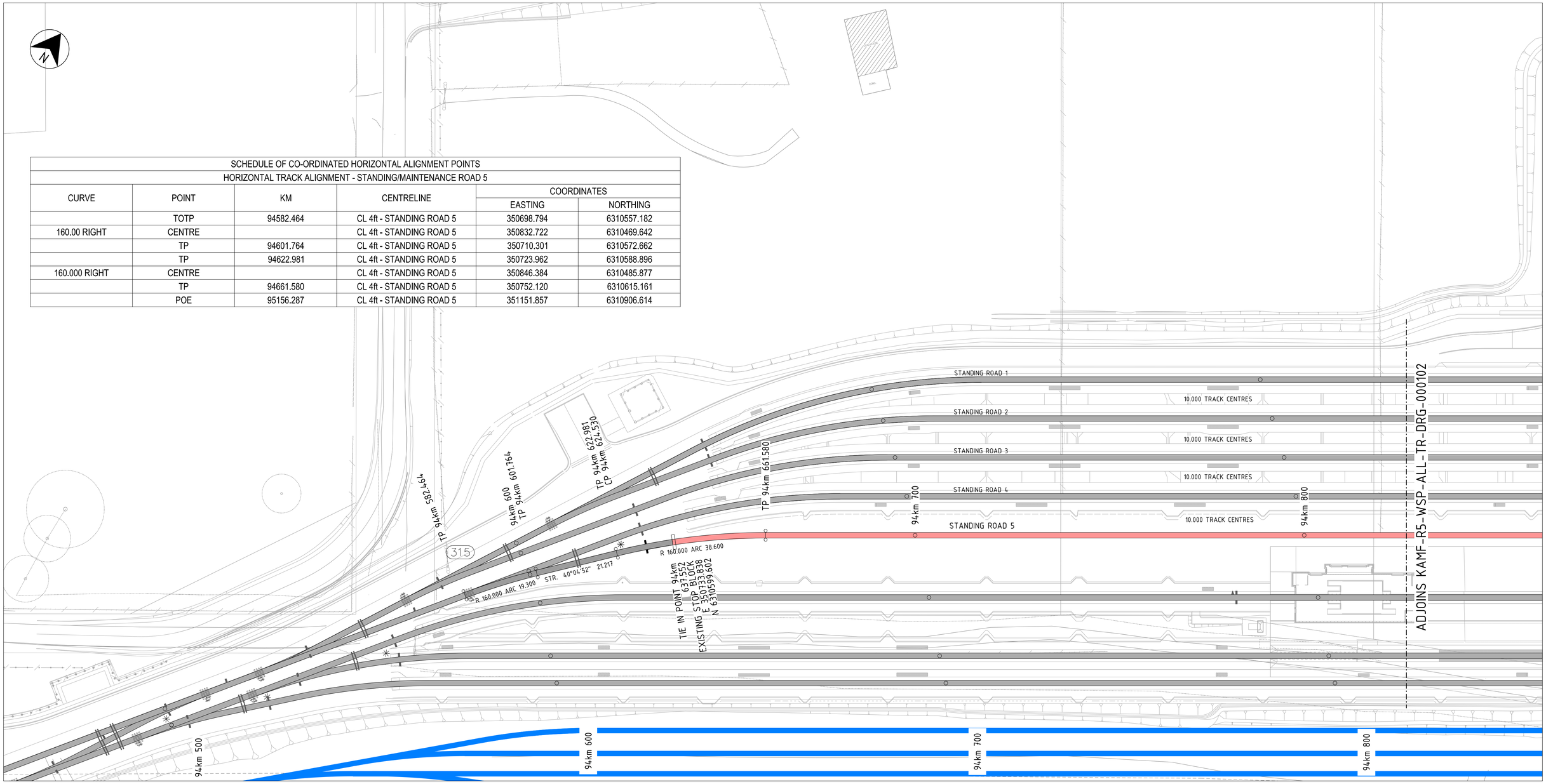
FILE No. 21-066				SHEET: 1 OF 1	
STATUS: CONCEPT DESIGN					©
DRG No. 512176-CCG-SYD02-AR-DRG-00004	REV 0	VER 00	EDMS No. CVXXXXXXX	AMD No. A	

DF 801*554

File Plotted

Plot Date & Time

SCHEDULE OF CO-ORDINATED HORIZONTAL ALIGNMENT POINTS					
HORIZONTAL TRACK ALIGNMENT - STANDING/MAINTENANCE ROAD 5					
CURVE	POINT	KM	CENTRELINE	COORDINATES	
				EASTING	NORTHING
	TOTP	94582.464	CL 4ft - STANDING ROAD 5	350698.794	6310557.182
160.00 RIGHT	CENTRE		CL 4ft - STANDING ROAD 5	350832.722	6310469.642
	TP	94601.764	CL 4ft - STANDING ROAD 5	350710.301	6310572.662
	TP	94622.981	CL 4ft - STANDING ROAD 5	350723.962	6310588.896
160.000 RIGHT	CENTRE		CL 4ft - STANDING ROAD 5	350846.384	6310485.877
	TP	94661.580	CL 4ft - STANDING ROAD 5	350752.120	6310615.161
	POE	95156.287	CL 4ft - STANDING ROAD 5	351151.857	6310906.614

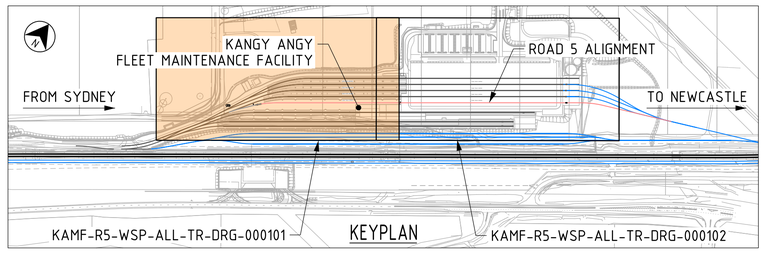


LEGEND

- DESIGN ALIGNMENT
- EXISTING TRACK ALIGNMENT
- FUTURE ALIGNMENT
- CLEARANCE POINT
- LAST LONG BEARER
- POINTS MACHINE
- FRICTION BUFFER STOP
- 110A TURNOUT POINTS NUMBER
- INSULATED RAIL JOINT/S (INDICATIVE)

NOTES:

1. CLEARANCE POINTS BASED ON NARROW ELECTRIC ROLLING STOCK BOGIE CENTRES AND MEDIUM ELECTRIC ROLLING STOCK WIDTH IN ACCORDANCE WITH AMB STANDARDS ESC215.
2. ALL CLEARANCE POINT CHAINAGES REPORTED TO THE THROUGH ROUTE OF THE TURNOUT.
3. FOR VERTICAL ALIGNMENT REFER TO DRAWING KAMF-R5-WSP-ALL-TR-DRG-000151.
4. FOR GENERAL NOTES REFER TO DRAWING KAMF-R5-WSP-ALL-TR-DRG-000002.
5. FOR TRACKFORM DETAILS REFER TO DRAWING KAMF-R5-WSP-ALL-TR-DRG-000161.



DRAWING COLOUR CODED - PRINT ALL COPIES IN COLOUR

0 10 20 30 40 50
METRES 1 TO 500

AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
1	SYSTEM DEFINITION REVIEW	A.Z. 01.06.22	B.MQ. 01.06.22	D.C. 01.06.22

CO-ORDINATE SYSTEM: MGA94, Z56 | HEIGHT DATUM: A.H.D. | SCALE: N/A

NSW GOVERNMENT Transport for NSW

wsp

WSP

DRAWN	J.DJUKANOVIC	01.06.22
DESIGNED	A.ZHANG	01.06.22
DRG CHECK	D.COLLISON	01.06.22
DESIGN CHECK	D.COLLISON	01.06.22
APPROVED	B.MCQUEEN	01.06.22

KANGY ANGY

MAIN NORTH LINE - 93.329km to 95.300km

KANGY ANGY MAINTENANCE FACILITY - ROAD 5

PERMANENT WAY

LAYOUT PLAN

FILE No. | SHEET: 1 OF 2 | A1

STATUS: SYSTEM DEFINITION REVIEW ©

DRG No. KAMF-R5-WSP-ALL-TR-DRG-000101 | 1 | EDMS No.

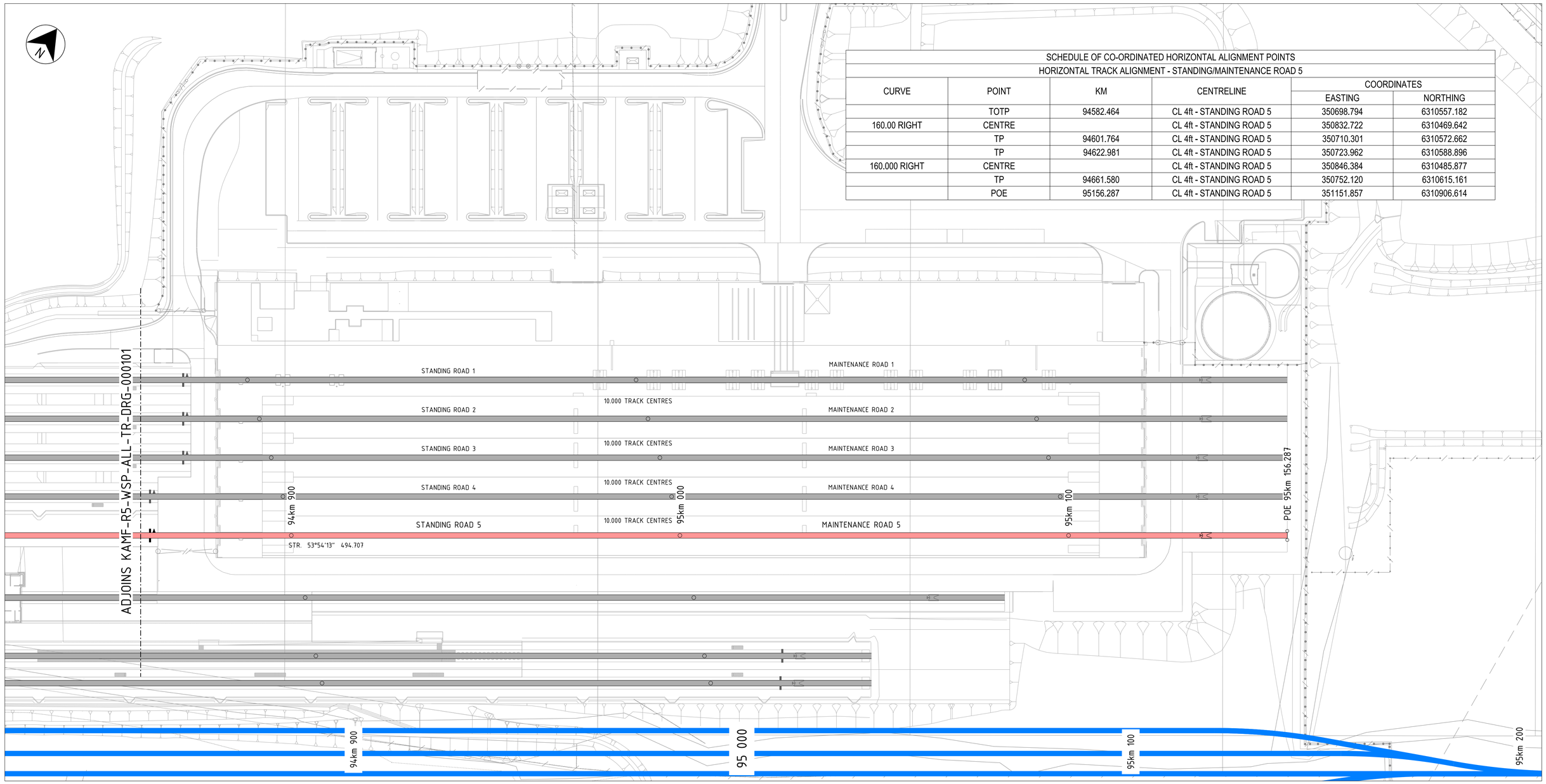
DF 841*594

File Plotted pw://wsp-aus-pw.bentley.com:wsp-aus-pw-19/Documents/PP130669-Kangy Angy Depot/04#0-Delivery/R5/TR-Track/02-Drawings/KAMF-R5-WSP-ALL-TR-DRG-000101

Plot Date & Time 1/06/2022 4:14:18 PM

Plotted by Djukanovic,I

SCHEDULE OF CO-ORDINATED HORIZONTAL ALIGNMENT POINTS					
HORIZONTAL TRACK ALIGNMENT - STANDING/MAINTENANCE ROAD 5					
CURVE	POINT	KM	CENTRELINE	COORDINATES	
				EASTING	NORTHING
	TOTP	94582.464	CL 4ft - STANDING ROAD 5	350698.794	6310557.182
160.00 RIGHT	CENTRE		CL 4ft - STANDING ROAD 5	350832.722	6310469.642
	TP	94601.764	CL 4ft - STANDING ROAD 5	350710.301	6310572.662
	TP	94622.981	CL 4ft - STANDING ROAD 5	350723.962	6310588.896
160.000 RIGHT	CENTRE		CL 4ft - STANDING ROAD 5	350846.384	6310485.877
	TP	94661.580	CL 4ft - STANDING ROAD 5	350752.120	6310615.161
	POE	95156.287	CL 4ft - STANDING ROAD 5	351151.857	6310906.614

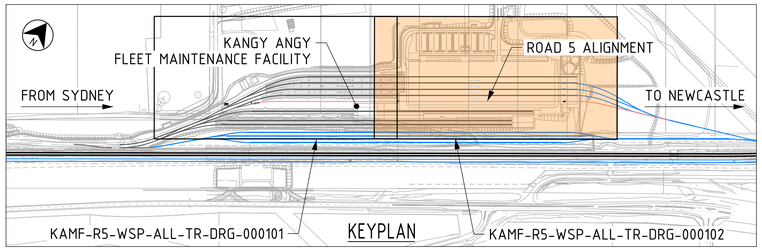


LEGEND

- DESIGN ALIGNMENT
- EXISTING TRACK ALIGNMENT
- FUTURE ALIGNMENT
- CLEARANCE POINT
- LAST LONG BEARER
- POINTS MACHINE
- FRICTION BUFFER STOP
- 110A TURNOUT POINTS NUMBER
- INSULATED RAIL JOINT/S (INDICATIVE)

NOTES:

1. CLEARANCE POINTS BASED ON NARROW ELECTRIC ROLLING STOCK BOGIE CENTRES AND MEDIUM ELECTRIC ROLLING STOCK WIDTH IN ACCORDANCE WITH AMB STANDARDS ESC215.
2. ALL CLEARANCE POINT CHAINAGES REPORTED TO THE THROUGH ROUTE OF THE TURNOUT.
3. FOR VERTICAL ALIGNMENT REFER TO DRAWING KAMF-R5-WSP-ALL-TR-DRG-000151.
4. FOR GENERAL NOTES REFER TO DRAWING KAMF-R5-WSP-ALL-TR-DRG-000002.
5. FOR TRACKFORM DETAILS REFER TO DRAWING KAMF-R5-WSP-ALL-TR-DRG-000161.



DRAWING COLOUR CODED - PRINT ALL COPIES IN COLOUR

0 10 20 30 40 50
METRES 1 TO 500

AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
1	SYSTEM DEFINITION REVIEW	A.Z. 01.06.22	B.MQ. 01.06.22	D.C. 01.06.22

CO-ORDINATE SYSTEM: MGA94, Z56 | HEIGHT DATUM: A.H.D. | SCALE: N/A

NSW GOVERNMENT Transport for NSW

wsp

wsp

DRAWN	J.DJUKANOVIC	01.06.22
DESIGNED	A.ZHANG	01.06.22
DRG CHECK	D.COLLISON	01.06.22
DESIGN CHECK	D.COLLISON	01.06.22
APPROVED	B.MCQUEEN	01.06.22

KANGY ANGY

MAIN NORTH LINE - 93.329km to 95.300km

KANGY ANGY MAINTENANCE FACILITY - ROAD 5 PERMANENT WAY

LAYOUT PLAN

FILE No. | SHEET: 2 OF 2 | A1

STATUS: SYSTEM DEFINITION REVIEW ©

DRG No. KAMF-R5-WSP-ALL-TR-DRG-000102 | 1 | EDMS No.

DF 841*594

File Plotted pw://wsp-aus-pw.bentley.com:wsp-aus-pw-19/Documents/PP130669-Kangy Angy Depot/0449-Delivery/R5/TR-Track/02-Drawings/KAMF-R5-WSP-ALL-TR-DRG-000102

Plot Date & Time 1/06/2022 4:14:25 PM

Plotted by DjukanovicJ

TANGENTIAL TURNOUT DETAILS

TURNOUT GEOMETRY									CROSSING DETAILS				
POINTS No.	BASE TYPE	TOTAL LENGTH TOTP to TOEP	T/O LENGTH Pts to Theo Pt	T/O RATE	T/O ANGLE	M/L GEOMETRY	T/O GEOMETRY	DESCRIPTION	CATALOGUE No.	XING RATE	MIN. TYPE	RAIL(kg/m)	REFERENCE
305	160:6.6	24.105	20.939	1 in 6.6	8.615648°	STRAIGHT	R160	STANDARD LH	T160C	1 in 7.433	COMPOUND	AS60HH	CV0479038
307A	160:8.25	24.644	21.058	1 in 8.25	6.911227°	STRAIGHT	R160/STR	STANDARD LH	T160S	1 in 8.25	COMPOUND	AS60HH	CV0479039
307B	160:8.25	24.644	21.058	1 in 8.25	6.911227°	STRAIGHT	R160/STR	STANDARD LH	T160S	1 in 8.25	COMPOUND	AS60HH	CV0479039
315	160:8.25	24.644	21.058	1 in 8.25	6.911227°	STRAIGHT	R160/STR	STANDARD RH	T160S	1 in 8.25	COMPOUND	AS60HH	CV0479039

SCHEDULE OF CO-ORDINATED HORIZONTAL ALIGNMENT POINTS - STANDING\MAINTENANCE ROAD 5

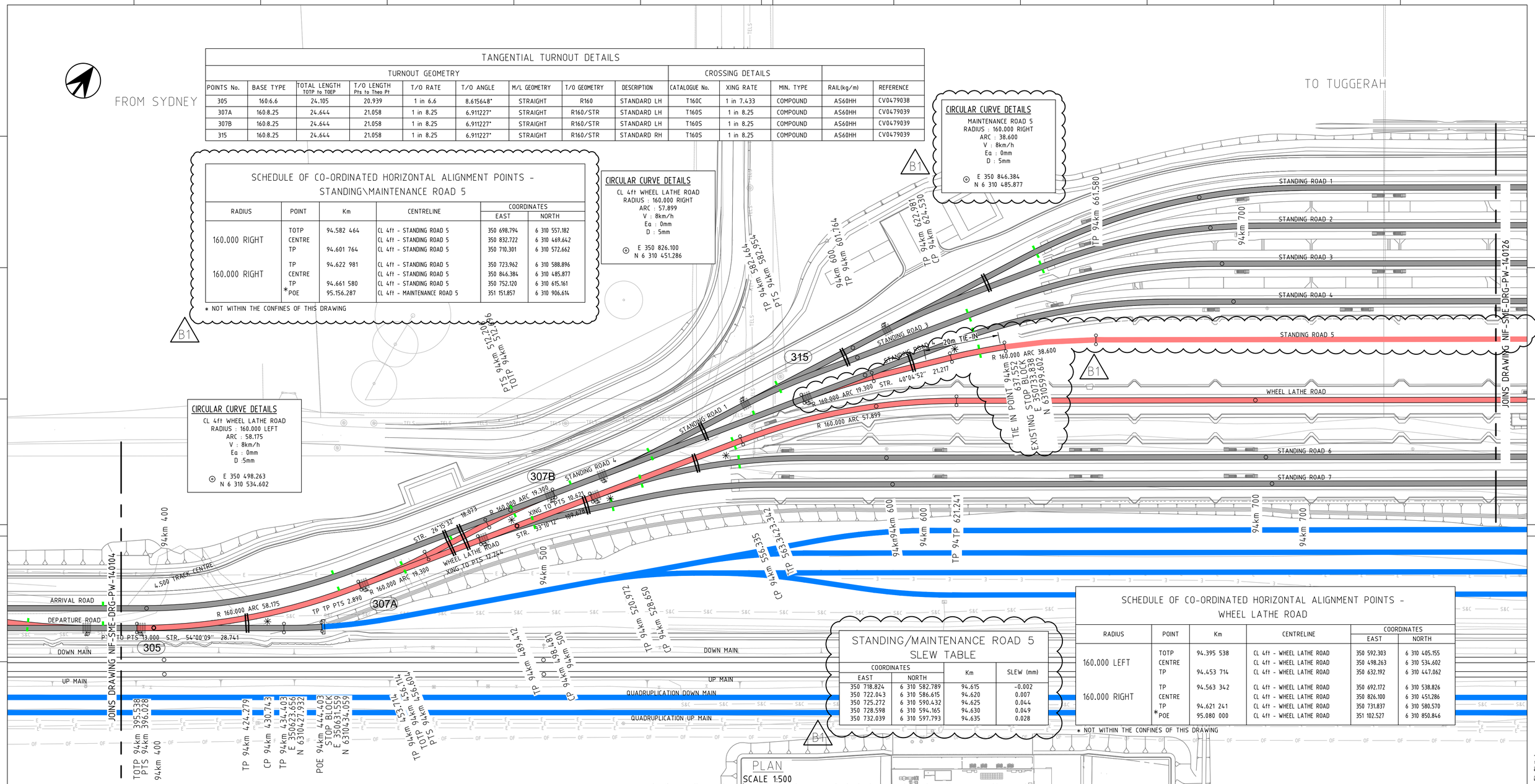
RADIUS	POINT	Km	CENTRELINE	COORDINATES EAST	COORDINATES NORTH
160.000 RIGHT	TOTP	94.582 464	CL 4ft - STANDING ROAD 5	350 698.794	6 310 557.182
	CENTRE		CL 4ft - STANDING ROAD 5	350 832.722	6 310 469.642
	TP	94.601 764	CL 4ft - STANDING ROAD 5	350 710.301	6 310 572.662
160.000 RIGHT	TP	94.622 981	CL 4ft - STANDING ROAD 5	350 723.962	6 310 588.896
	CENTRE		CL 4ft - STANDING ROAD 5	350 846.384	6 310 485.877
	TP	94.661 580	CL 4ft - STANDING ROAD 5	350 752.120	6 310 615.161
	*POE	95.156.287	CL 4ft - MAINTENANCE ROAD 5	351 151.857	6 310 906.614

* NOT WITHIN THE CONFINES OF THIS DRAWING

CIRCULAR CURVE DETAILS
CL 4ft WHEEL LATHE ROAD
RADIUS : 160.000 RIGHT
ARC : 57.899
V : 8km/h
Eq : 0mm
D : 5mm
E 350 826.100
N 6 310 451.286

CIRCULAR CURVE DETAILS
MAINTENANCE ROAD 5
RADIUS : 160.000 RIGHT
ARC : 38.600
V : 8km/h
Eq : 0mm
D : 5mm
E 350 846.384
N 6 310 485.877

CIRCULAR CURVE DETAILS
CL 4ft WHEEL LATHE ROAD
RADIUS : 160.000 LEFT
ARC : 58.175
V : 8km/h
Eq : 0mm
D :5mm
E 350 498.263
N 6 310 534.602



SCHEDULE OF CO-ORDINATED HORIZONTAL ALIGNMENT POINTS - WHEEL LATHE ROAD

RADIUS	POINT	Km	CENTRELINE	COORDINATES EAST	COORDINATES NORTH
160.000 LEFT	TOTP	94.395 538	CL 4ft - WHEEL LATHE ROAD	350 592.303	6 310 405.155
	CENTRE		CL 4ft - WHEEL LATHE ROAD	350 498.263	6 310 534.602
	TP	94.453 714	CL 4ft - WHEEL LATHE ROAD	350 632.192	6 310 447.062
160.000 RIGHT	TP	94.563 342	CL 4ft - WHEEL LATHE ROAD	350 692.172	6 310 538.826
	CENTRE		CL 4ft - WHEEL LATHE ROAD	350 826.100	6 310 451.286
	TP	94.621 241	CL 4ft - WHEEL LATHE ROAD	350 731.837	6 310 580.570
	*POE	95.080 000	CL 4ft - WHEEL LATHE ROAD	351 102.527	6 310 850.846

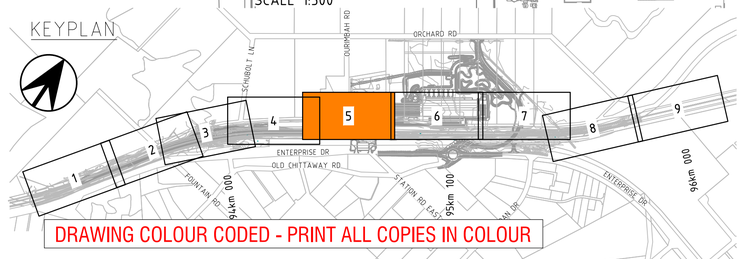
* NOT WITHIN THE CONFINES OF THIS DRAWING

STANDING/MAINTENANCE ROAD 5 SLEW TABLE

COORDINATES EAST	COORDINATES NORTH	Km	SLEW (mm)
350 718.824	6 310 582.789	94.615	-0.002
350 722.043	6 310 586.615	94.620	0.007
350 725.272	6 310 590.432	94.625	0.044
350 728.598	6 310 594.165	94.630	0.049
350 732.039	6 310 597.793	94.635	0.028

PLAN
SCALE 1:500

KEYPLAN



DRAWING COLOUR CODED - PRINT ALL COPIES IN COLOUR

LEGEND

- TRACK ALIGNMENT
- TRACK ALIGNMENT (DOCUMENTED ON OTHER DRAWINGS)
- EXISTING TRACK ALIGNMENT
- FUTURE ALIGNMENT
- CLEARANCE POINT
- LAST LONG BEARER
- OVERHEAD WIRE STRUCTURES (INDICATIVE)
- INSULATED RAIL JOINT/S (INDICATIVE)
- 110A TURNOUT POINTS NUMBER
- POINTS MACHINE
- FRICTION BUFFER STOP
- MANUAL DERAILER

TRACKFORM
- DIRECT FIXATION TRACKFORM
- EMBEDDED TRACKFORM
- PEDESTAL TRACKFORM
- BALLASTED TRACKFORM

NOTES
1. CLEARANCE POINTS BASED ON NARROW ELECTRIC ROLLING STOCK BOGIE CENTRES AND MEDIUM ELECTRIC (AND/DR SUB-MEDIUM ELECTRIC, PENDING ASA) ROLLING STOCK WIDTH IN ACCORDANCE WITH ASA STANDARD ESC215.
2. ALL CLEARANCE POINT CHAINAGES REPORTED TO THE THROUGH ROUTE OF THE TURNOUT.
3. FOR VERTICAL ALIGNMENT DRAWINGS REFER TO DRAWING KAMF-R5-WSP-ALL-TR-DRG-698873.
4. FUTURE ALIGNMENTS INDICATIVE ONLY.
5. FOR GENERAL NOTES REFER DRAWING KAMF-R5-WSP-ALL-TR-DRG-698842.
6. FOR TRACKFORM DETAILS REFER DRAWING KAMF-R5-WSP-ALL-TR-DRG-698878.
7. POSITIVE HORIZONTAL SLEW VALUES REPRESENT A TRACK SLEW TO THE RIGHT OF THE SURVEYED ALIGNMENT, AND A NEGATIVE VALUE REPRESENTS A TRACK SLEW TO THE LEFT OF THE SURVEYED ALIGNMENT (FACING INCREASING KILOMETRAGE)

5 0 5 10 15m
1:500 FULL SIZE A1

B1	PRELIMINARY DESIGN REVIEW	A.Z/19.08.22	M.C/19.08.22	D.C/19.08.22
B0	AS BUILT	M.G/02.07.20	J.Y/02.07.20	T.J/02.07.20
A0	APPROVED FOR CONSTRUCTION	M.G/22.01.19	G.W/22.01.19	S.D/22.01.19
AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE

CO-ORDINATE SYSTEM: MGA | HEIGHT DATUM: A.H.D. | SCALE: 1:500

NSW GOVERNMENT Transport for NSW

WSP

WSP TRACK

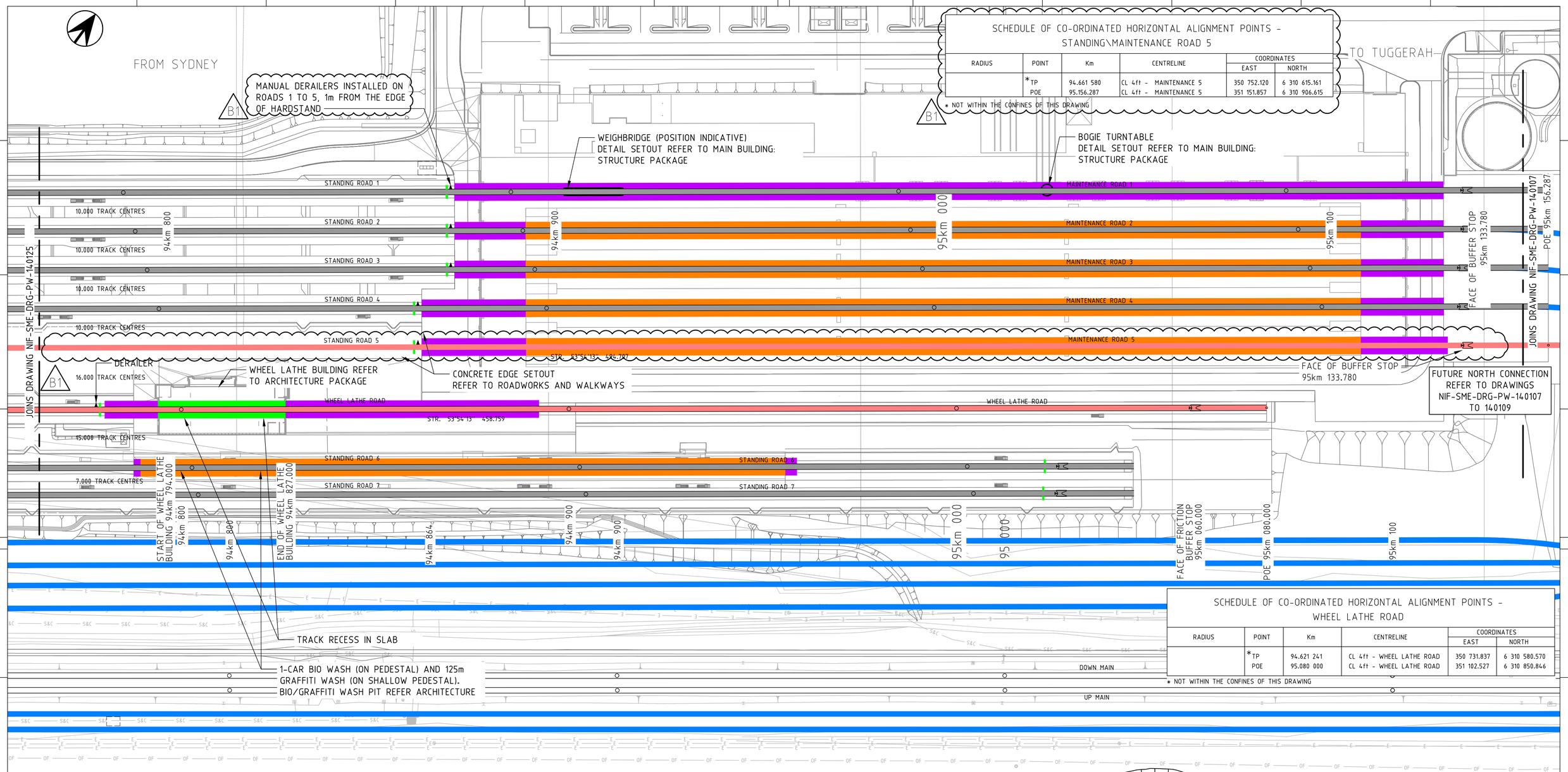
DRAWN	J.DJUKANOVIC	19.08.22
DESIGNED	A.ZHANG	19.08.22
DRG CHECK	D.COLLISON	19.08.22
DESIGN CHECK	D.COLLISON	19.08.22
APPROVED	J.POVEY	19.08.22

KANGY ANGY
MAIN NORTH LINE - 93.329KM TO 95.300KM
NEW INTERCITY FLEET MAINTENANCE FACILITY SITE WIDE PERMANENT WAY
PLAN - MAINTENANCE RD 5 & WHEEL LATHE RD

FILE No. KAMF-R5-WSP-ALL-TR-DRG-698855 | SHEET: 1 OF 1 | A1
STATUS: PRELIMINARY DESIGN REVIEW ©
DRG No. KAMF-R5-WSP-ALL-TR-DRG-698855 | 1 | EDMS No. CV0698855 | B

DF 841*594

File Plotted tbDocFullName
Plot Date & Time $$$$$$$YYTIME$$$$$$
Plotted by $USERNAMES



SCHEDULE OF CO-ORDINATED HORIZONTAL ALIGNMENT POINTS - STANDING\MAINTENANCE ROAD 5

RADIUS	POINT	Km	CENTRELINE	COORDINATES EAST	COORDINATES NORTH
	*TP	94.661 580	CL 4ft - MAINTENANCE 5	350 752.120	6 310 615.161
	POE	95.156.287	CL 4ft - MAINTENANCE 5	351 151.857	6 310 906.615

* NOT WITHIN THE CONFINES OF THIS DRAWING

SCHEDULE OF CO-ORDINATED HORIZONTAL ALIGNMENT POINTS - WHEEL LATHE ROAD

RADIUS	POINT	Km	CENTRELINE	COORDINATES EAST	COORDINATES NORTH
	*TP	94.621 241	CL 4ft - WHEEL LATHE ROAD	350 731.837	6 310 580.570
	POE	95.080 000	CL 4ft - WHEEL LATHE ROAD	351 102.527	6 310 850.846

* NOT WITHIN THE CONFINES OF THIS DRAWING

LEGEND

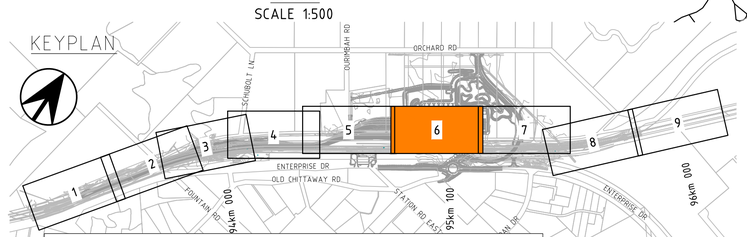
- TRACK ALIGNMENT
- TRACK ALIGNMENT (DOCUMENTED ON OTHER DRAWINGS)
- EXISTING TRACK ALIGNMENT
- FUTURE ALIGNMENT
- CLEARANCE POINT
- LAST LONG BEARER
- OVERHEAD WIRE STRUCTURES (INDICATIVE)
- INSULATED RAIL JOINT/S (INDICATIVE)
- 110A TURNOUT POINTS NUMBER
- POINTS MACHINE
- FRICTION BUFFER STOP
- MANUAL DERAILER

TRACKFORM

- DIRECT FIXATION TRACKFORM
- EMBEDDED TRACKFORM
- PEDESTAL TRACKFORM
- BALLASTED TRACKFORM

PLAN
SCALE 1:500

KEYPLAN



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NOTES

1. CLEARANCE POINTS BASED ON NARROW ELECTRIC ROLLING STOCK BOGIE CENTRES AND MEDIUM ELECTRIC (AND/DR SUB-MEDIUM ELECTRIC, PENDING ASA) ROLLING STOCK WIDTH IN ACCORDANCE WITH ASA STANDARD ESC215.
2. ALL CLEARANCE POINT CHAINAGES REPORTED TO THE THROUGH ROUTE OF THE TURNOUT.
3. FOR VERTICAL ALIGNMENT DRAWINGS REFER TO DRAWING KAMF-R5-WSP-ALL-TR-DRG-698873.
4. FUTURE ALIGNMENTS INDICATIVE ONLY.
5. FOR GENERAL NOTES REFER DRAWING KAMF-R5-WSP-ALL-TR-DRG-698842.
6. FOR TRACKFORM DETAILS REFER DRAWING KAMF-R5-WSP-ALL-TR-DRG-698878.
7. POSITIVE HORIZONTAL SLEW VALUES REPRESENT A TRACK SLEW TO THE RIGHT OF THE SURVEYED ALIGNMENT, AND A NEGATIVE VALUE REPRESENTS A TRACK SLEW TO THE LEFT OF THE SURVEYED ALIGNMENT (FACING INCREASING KILOMETRAGE)

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A0	APPROVED FOR CONSTRUCTION	M.G/22.01.19	G.W/22.01.19	S.D/22.01.19

CO-ORDINATE SYSTEM: MGA | HEIGHT DATUM: A.H.D. | SCALE: 1:500

NSW GOVERNMENT Transport for NSW

wsp

WSP TRACK

DRAWN	J.DJUKANOVIC	19.08.22
DESIGNED	A.ZHANG	19.08.22
DRG CHECK	D.COLLISON	19.08.22
DESIGN CHECK	D.COLLISON	19.08.22
APPROVED	J.POVEY	19.08.22

KANGY ANGY

MAIN NORTH LINE - 93.329KM TO 95.300KM
NEW INTERCITY FLEET MAINTENANCE FACILITY
SITE WIDE PERMANENT WAY
PLAN - MAINTENANCE RD 5 & WHEEL LATHE RD

FILE No. KAMF-R5-WSP-ALL-TR-DRG-698856 | SHEET: 1 OF 1 | A1
STATUS: PRELIMINARY DESIGN REVIEW ©
DRG No. KAMF-R5-WSP-ALL-TR-DRG-698856 | 1 | EDMS No. CV0698856 | B

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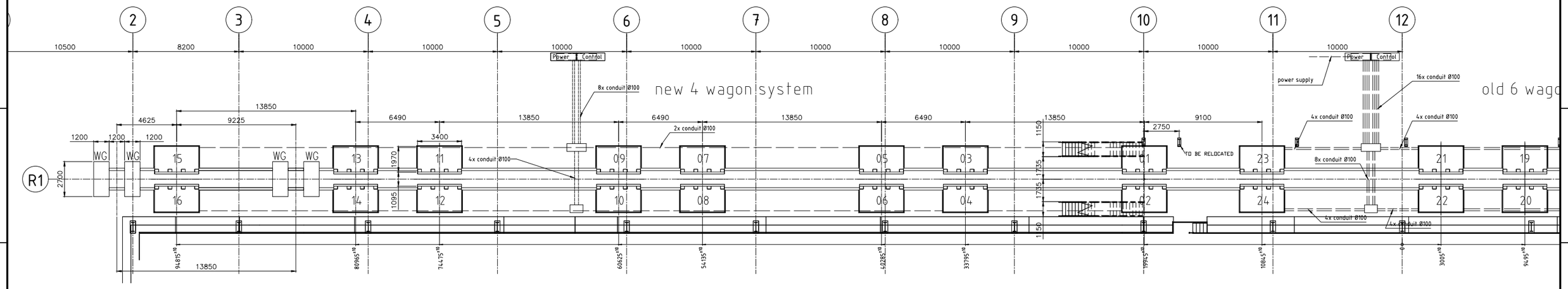

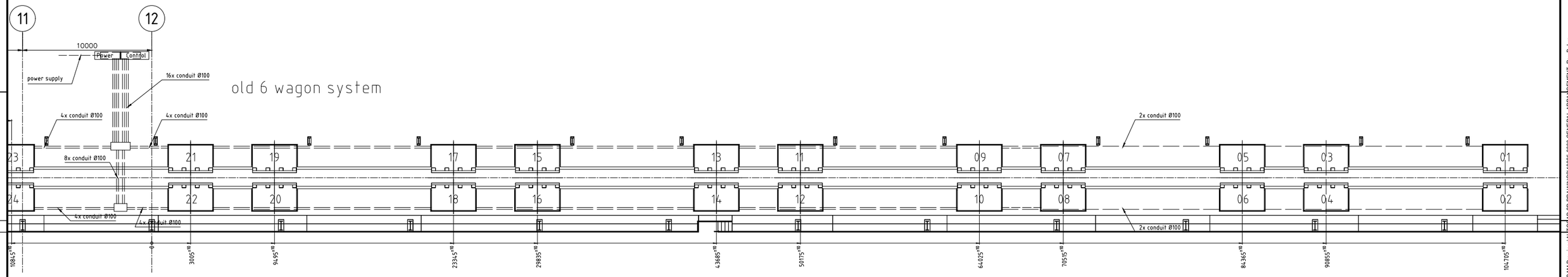

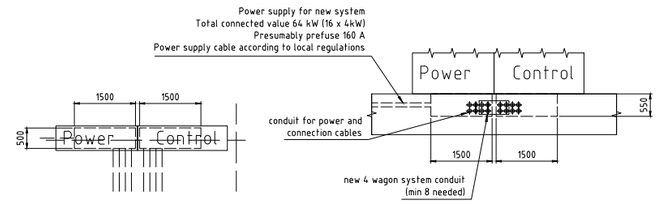

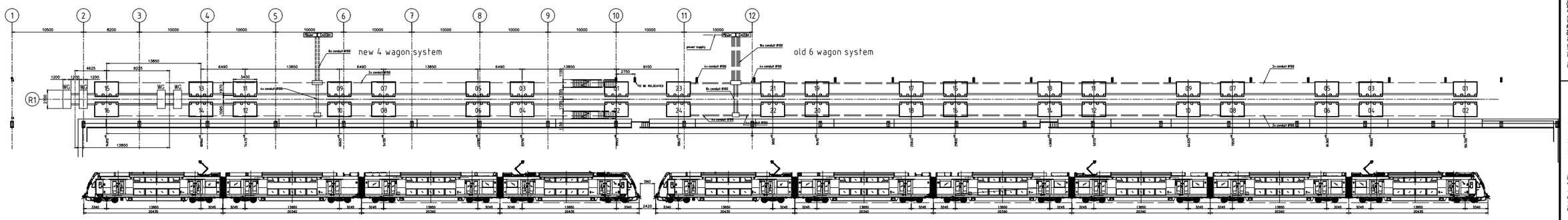

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A	FOR APPROVAL	KK/04.05.22	KK/04.05.22	JLS/04.05.22

CO-ORDINATE SYSTEM: MGA | HEIGHT DATUM: A.H.D | SCALE: AS SHOWN

NSW GOVERNMENT Transport for NSW

SAM Technology Engineers

DRAWN	KK	04.05.22
DESIGNED	KK	04.05.22
DRG CHECK	KK	04.05.22
DESIGN CHECK	JLS	04.05.22
APPROVED	JLS	04.05.22

KANGY ANGY

MAIN NORTH LINE - 94.865km

NEW INTERCITY FLEET MAINTENANCE FACILITY
MAIN FACILITY BUILDING - ROAD1 EXTENSION

GENERAL ARRANGEMENT

FILE No. 10025 | SHEET: 1 OF 1 | A1

STATUS: FOR APPROVAL | ©

DRG No. 10025-0000 | 0 | EDMS No. XXXXX | B

DF 801*554

ASA STANDARD DRAWING SHEET Ver 2.0

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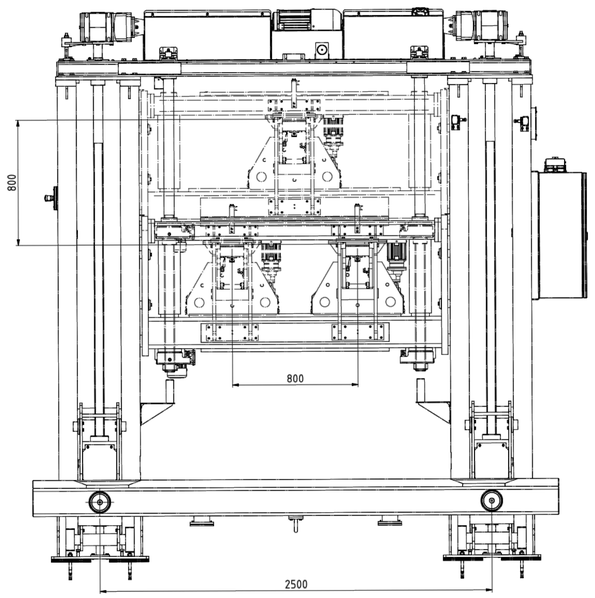

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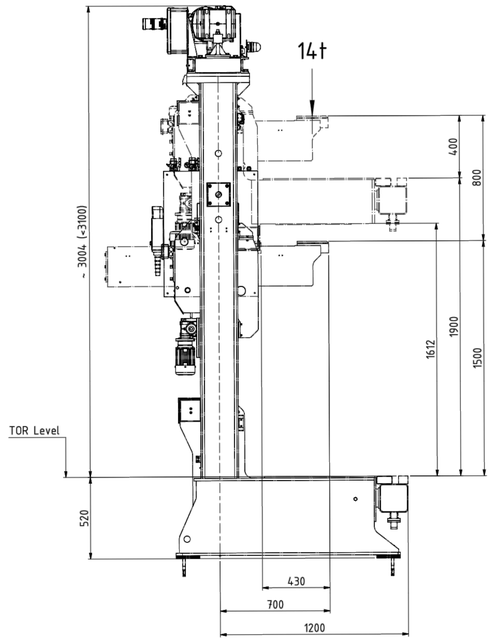

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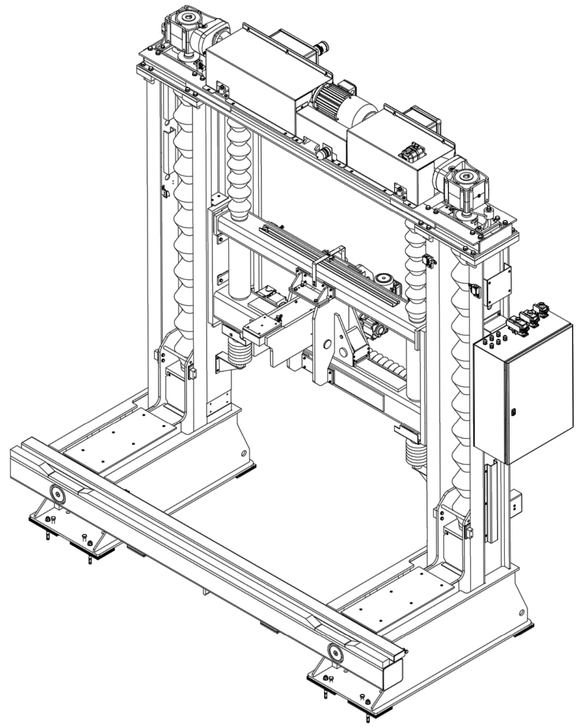

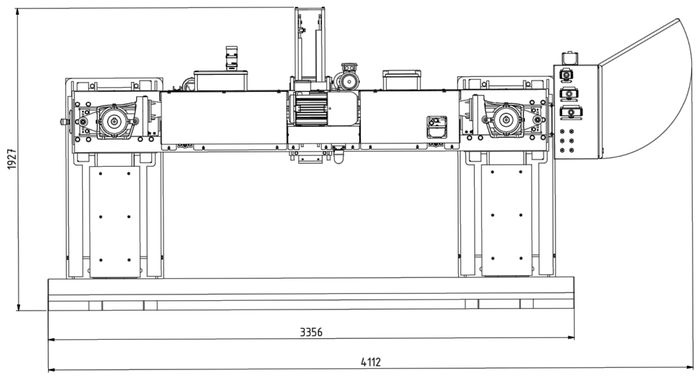

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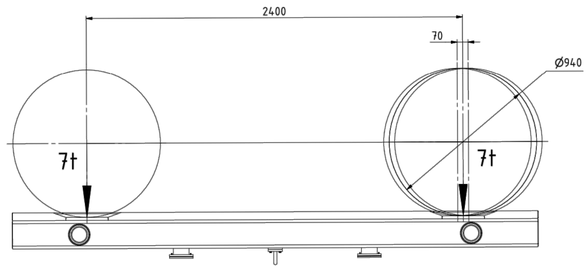

Unterschrift & Firmenstempel für Freigabe
please stamp & sign for approval

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Gepr.	11.04.2022	Alex		A1

PFAFF verkehrstechnik

Geändert am	Geändert von
A	
B	
C	
D	
E	
F	
G	

Train lifting system 28t
SAM - Kangy Angy 2 Project
General drawing

Rohmaß:	Norm:	Behandlung:	Blatt
Werkstoff:	Gewicht: 8759,53 kg	Materialzeugnis:	1 /1
Maße ohne Toleranzangabe nach DIN ISO 2768-mK			

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AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE

CO-ORDINATE SYSTEM: | HEIGHT DATUM: | SCALE: NTS

NSW GOVERNMENT Transport for NSW

ELECTRICAL CONTRACTORS

AEO REVIEW ELECTRICAL

DRAWN
DESIGNED
DRG CHECK
DESIGN CHECK
APPROVED

KANGY ANGY

MAIN NORTH LINE - 94.865KM

NEW INTERCITY FLEET MAINTENANCE FACILITY
TRAIN LIFITING SYSTEM JACK 2

GENERAL LAYOUT DRAWING

FILE No. 4064730-10-10	SHEET: 1 OF 1	A1
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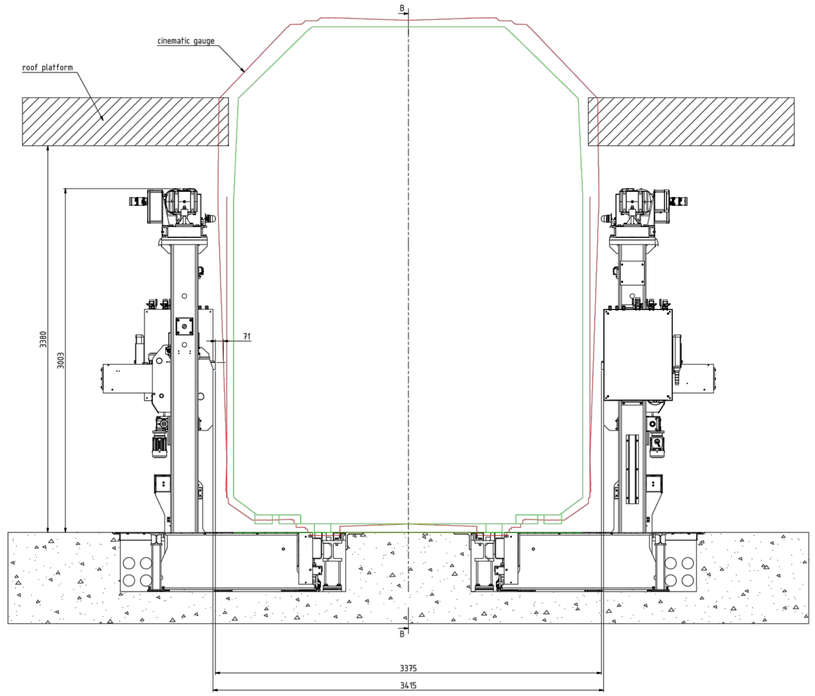

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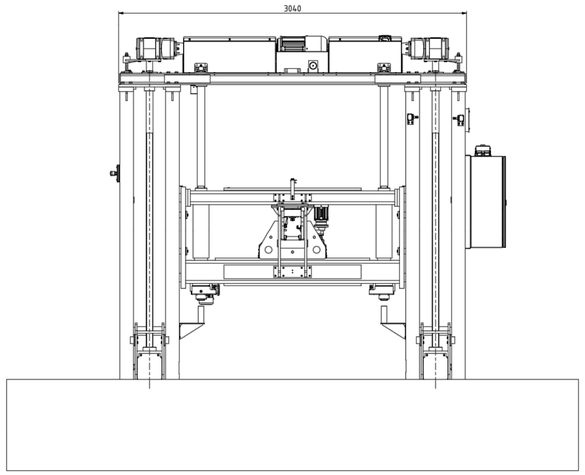

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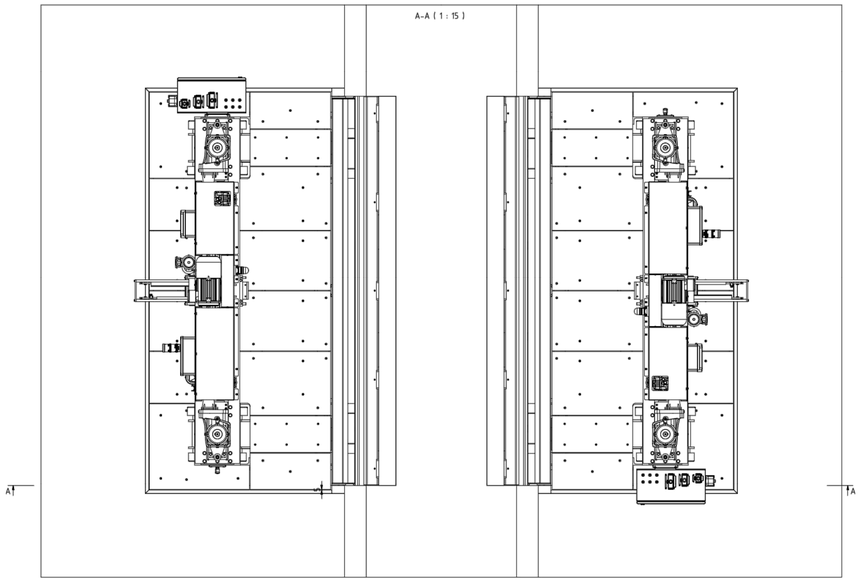

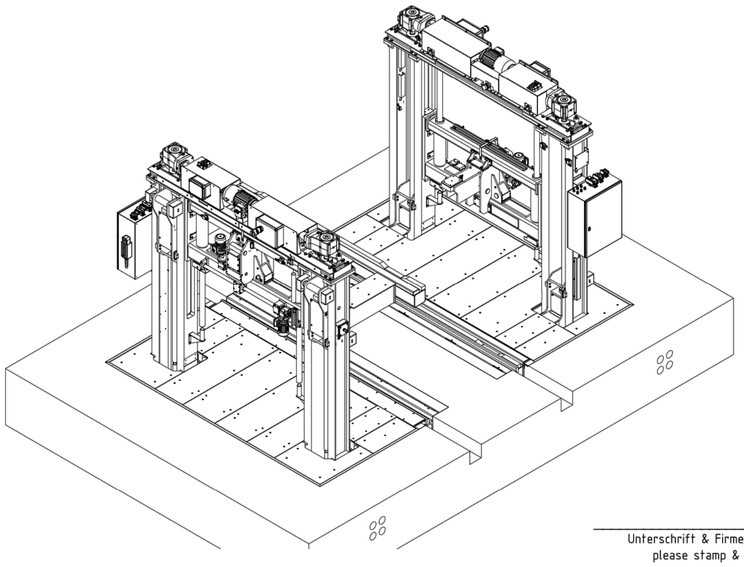

Unterschrift & Firmenstempel für Freigabe
please stamp & sign for approval

sam Technology Engineers

STAHL-BAU verbindetechnik	Datum	Name	Maßstab	Z.Nr: 4064730-10-11
	Bear: 11.04.2022	Schmidbauer	1 : 15	V/0506 Rev A
	Gepr: 11.04.2022	Alex		A4

Train lifting system 28t
SAM - Kangy Angy 2 Project
General system drawing

Änderungen	Datum	Name	Benennung
Normbezeichnung		Gewicht: 3318KLB1 kg	Materialbezeichnung
Maße ohne Toleranzangabe nach DIN ISO 2768-mK			

Blatt 1 / 1

A0	PRELIMINARY DESIGN REVIEW	JC / 26/05/2022	MC/26/05/2022	PS/26/05/2022
AMD	DESCRIPTION	DESIGNER SIGN./DATE	VERIFIED SIGN./DATE	APPROVED SIGN./DATE
CO-ORDINATE SYSTEM:	HEIGHT DATUM:	SCALE: NTS		

NSW GOVERNMENT Transport for NSW

ELECTRICAL CONTRACTORS

DRAWN
DESIGNED
DRG CHECK
DESIGN CHECK
APPROVED

AEO REVIEW ELECTRICAL

KANGY ANGY

MAIN NORTH LINE - 94.865KM

NEW INTERCITY FLEET MAINTENANCE FACILITY
TRAIN LIFITING SYSTEM JACK 2

GENERAL SYSTEM DRAWING

FILE No. 4064730-10-11	SHEET: 1 OF 1	A1
STATUS: PRELIMINARY DESIGN REVIEW		©
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Plotted by JAYESH.CHAVAN

A&A STANDARD DRAWING SHEET Ver 2.0

Appendix E: AHIMS Search

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : Kangy Angy Maintenance Fa

Client Service ID : 712221

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
45-3-4534	[redacted]	GDA	[redacted]	[redacted]	[redacted]	Open site	Valid	Artefact : -		
	Contact	Recorders	Artefact - Cultural Heritage Management - Pyrmont,Ms.Alyce Haast					Permits		
45-3-1146	[redacted]	AGD	[redacted]	[redacted]	[redacted]	Open site	Valid	Artefact : -	Open Camp Site	308,98461
	Contact	Recorders	Len Dyall					Permits		
45-3-4017	[redacted]	GDA	[redacted]	[redacted]	[redacted]	Open site	Partially Destroyed	Artefact : -		
	Contact	Recorders	Artefact - Cultural Heritage Management - Pyrmont,Artefact - Cultural Heritage Ma:					Permits	4199	
45-6-2338	[redacted]	AGD	[redacted]	[redacted]	[redacted]	Open site	Valid	Artefact : -	Open Camp Site	2267,98461
	Contact	Recorders	Mr.Matthew Barber					Permits		

**** Site Status**

Valid - The site has been recorded and accepted onto the system as valid

Destroyed - The site has been completely impacted or harmed usually as consequence of permit activity but sometimes also after natural events. There is nothing left of the site on the ground but proponents should proceed with caution.

Partially Destroyed - The site has been only partially impacted or harmed usually as consequence of permit activity but sometimes also after natural events. There might be parts or sections of the original site still present on the ground

Not a site - The site has been originally entered and accepted onto AH MS as a valid site but after further investigations it was decided it is NOT an aboriginal site. Impact of this type of site does not require permit but Heritage NSW should be notified

Report generated by AHIMS Web Service on 26/08/2022 for Alicia Rijke for the following area at Lat, Long From : -33.34, 151.385 - Lat, Long To : -33.3221, 151.4159. Number of Aboriginal sites and Aboriginal objects found is 4

Appendix F: Ecological Constraints Assessment

UGL

September 2022

Mariyung Fleet Maintenance Facility

Ecological Constraints Assessment

Question today
Imagine tomorrow
Create for the future

Mariyung Fleet Maintenance Facility
Ecological Constraints Assessment

UGL

WSP
Level 3, 51-55 Bolton St
Newcastle NSW 2300
PO Box 1162
Newcastle NSW 2300

Tel: +61 2 4929 8300
Fax: +61 2 4929 8382
wsp.com

Rev	Date	Details
A	8/09/2022	Draft
B	13/09/2022	Final

	Name	date	signature
Prepared by:	Allan Richardson	13/09/2022	
Reviewed by:	Nathan Cooper	13/09/2022	Nathan C
Approved by:	Matthew O'Leary	13/09/2022	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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1 Introduction

UGL are currently managing the operation of Transport for NSW's (TfNSW) Mariyung Fleet Maintenance Facility at Kangy Angy on the Central Coast of NSW (the facility). The facility is currently in operation, however there is limited area outside of the main building for the storage of maintenance equipment and materials, and a need exists to install additional power infrastructure.

To fulfil the short fall in storage space, an area for the erection of a warehouse has been proposed, and two areas are proposed to be utilised as laydown areas for incoming goods and materials. Furthermore, an area of the existing carpark adjacent to existing power infrastructure has been allocated for the additional power capabilities.

Due to the existence of vegetation at the proposed warehouse location, surrounding both proposed laydown areas, and occurring in gardens where new power linkages to the facility will traverse, WSP ecologists were engaged to identify the nature of associated vegetation.

2 Methodology

2.1 Preliminary investigations and desktop assessment

WSP ecologists have surveyed and assessed the local ecology occurring within and associated with the facility since early 2016, including ongoing monitoring for threatened amphibians. The following information was interrogated as part of the desktop assessment:

- Mariyung Fleet Maintenance Facility Project: Review of Environmental Factors (WSP | Parsons Brinckerhoff, 2016a)
- Mariyung Fleet Maintenance Facility Biodiversity Assessment Report (WSP | Parsons Brinckerhoff, 2016b)
- Mariyung Fleet Maintenance Facility Species Impact Statement (WSP | Parsons Brinckerhoff, 2016c)
- Mariyung Fleet Maintenance Facility Additional Species Impact Statement (WSP, 2017)
- Threatened Amphibian Baseline Condition Monitoring Report (WSP, 2018)
- Threatened Amphibian Monitoring Report – Year 2 (WSP, 2019)
- Threatened Amphibian Monitoring Report – Year 3 (WSP, 2020)
- Threatened Amphibian Monitoring Report – Year 4 (WSP, 2021)
- Threatened Amphibian Monitoring Report – Year 5 (WSP, 2022)
- Database searches as outlined in Table 2.1.

Table 2.1 Database searches completed

Database	Search date	Area searched	Reference
BioNet Atlas	17/08/2022	10 km radius of the facility	(Department of Planning and Environment, 2022a)
PlantNet	17/08/2022	10 km radius of the facility	(Royal Botanic Gardens, 2022)
Protected Matters Search Tool	17/08/2022	10 km radius of the facility	(Department of Climate Change Energy the Environment and Water, 2022a)

The key ecological risks associated with the facility include the following threatened ecological communities and species.

- ***Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*** – listed as an Endangered Ecological community under the NSW *Biodiversity Conservation Act 2016* (BC Act).
- ***Mahony's Toadlet (Uperoleia mahonyi)*** – a small frog using coastal sandy wetlands in NSW – listed as Endangered under the NSW BC Act.
- ***Wallum Froglet (Crinia tinnula)*** – a small frog using coastal wetlands with more acidic substrates – listed as Vulnerable under the NSW BC Act.
- ***Swift Parrot (Lathamus discolor)*** – a nomadic blossom foraging Parrot (uses mature Swamp Sclerophyll Forest for foraging) – listed as Endangered under the NSW BC Act and listed as Critically Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

— ***Regent Honeyeater (Anthochaera phrygia)*** – a nomadic blossom foraging Honeyeater (uses mature Swamp Sclerophyll Forest for foraging) – listed as Critically Endangered under the NSW BC Act and listed as Critically Endangered under the Commonwealth EPBC Act.

— ***Biconvex Paperbark (Melaleuca biconvexa)*** – a native shrubby tree growing in floodplain contexts and often associated with Swamp Sclerophyll Forests – listed as Vulnerable under the NSW BC Act and listed as Vulnerable under the Commonwealth EPBC Act.

2.2 Field Surveys

The study area was inspected during daylight hours by two WSP ecologists on 16 August 2022. The field survey sought primarily to identify key ecological constraints by assessing the extent and condition of vegetation and fauna habitat, especially for threatened species and ecological communities.

2.2.1.1 Weather Conditions

Surveys were conducted under cool, but dry and gusty, weather conditions on 16 August 2022 (Table 2.2).

Table 2.2 Weather conditions

Date	Min. Temp. Deg. C	Max. Temp. Deg. C	Rain (mm)	Max wind gust (km/hr- direction)
16/08/2022	9.6	18.7	0	30-W

Source: (Bureau of Meteorology, 2022): Gosford (all weather station: 061425).

2.2.1.2 Flora Survey

WSP ecologists investigated the area proposed for new infrastructure and land-use allocations, taking into account topographic context, land-use history and using Biodiversity Assessment Method (BAM 2020) survey methodologies to identify the nature of onsite vegetation (Figure 2.1). A species list of plants was generated to determine the mix of native and exotic plants and to determine if onsite vegetation was consistent with native Plant Community Types (PCT's) occurring locally (Appendix B).

2.2.1.3 Fauna Survey

Fauna habitat assessments were undertaken during the course of vegetation investigations and were the primary assessment tools in assessing whether the study area might contain habitats with the potential for supporting threatened fauna species. Fauna habitat characteristics assessed included:

— structure and floristics of the canopy, understorey and ground vegetation, including the presence of flowering and fruiting trees providing potential foraging resources

— presence of hollow-bearing trees providing roosting and breeding habitat for arboreal mammals, birds and reptiles

— presence of the ground cover vegetation, leaf litter, rock outcrops and fallen timber and potential to provide protection for ground-dwelling mammals, reptiles and amphibians

— presence of waterways (ephemeral or permanent) and water bodies.

Legend

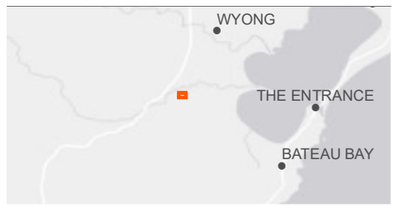
- Main North railway
- Site features
- Study area
- Conservation reserve

Survey effort

- Plot (10m x 40m)
- Plot (20m x 20m)

Native landscape plantings

- Planted native vegetation



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Scale ratio correct when printed at A3

1:1,500 Date: 7/09/2022

Data sources: - DCS, Geoscience Australia, Nearmap 2022

3 Existing environment

3.1 Vegetation types

The four areas requiring repurposing are in areas previously disturbed during the facilities construction and are situated on unnaturally elevated and imported substrates. Whilst the vegetation varied across the four repurposing sites, they were all consistent as miscellaneous ecosystems – native landscape plantings. No extant native vegetation occurred in the study area. A list of plant species recorded during the survey is contained in (Appendix B).

3.1.1 Study area 1

3.1.1.1 Warehouse site

The warehouse site occurs adjacent to the north-eastern corner of the main facility building (Figure 2.1). This area is characterised by deep and elevated imported substrates covered with planted natives and competing exotic plants (Photo 3.1). Although native plants dominated the site, due to the lack of substrates consistent with the Swamp Sclerophyll threatened ecological community (TEC), the planted elements consistent with Swamp Sclerophyll Forest are not consistent with definitions of the Swamp Sclerophyll TEC as defined in the community's Final Determination (NSW Scientific Committee, 2004, NSW Threatened Species Scientific Committee, 2011).

The erection of a warehouse at this location would displace the existing planted vegetation. A total of five *Eucalyptus robusta* (Swamp Mahogany) stems were recorded in a single 20m x 20m plot (Figure 2.1), which extrapolates to approximately 125 stems per hectare (Table A.1). All plant stems observed in the study area were less than 5cm in diameter at breast height (DBH) and less than 2.5m in height. Percent cover and abundance estimates for all growth forms are provided in Table 3.1 and Table A.1. In addition, BAM attribute 1m x 1m percent cover plots are presented in Table 3.2 and Table A.1.

Table 3.1 Percent cover of growth forms (20m x 20m BAM plot)

Attribute	Native species growth form						Exotic species	Total
	Trees	Shrubs	Grass	Forb	Fern	Other		
Number of species	1	8	9	11	0	3	13	45
Percent cover	0.5	5.55	11.6	2.9	0	0.4	1.7	22.65

Table 3.2 Percent cover BAM attributes (1m x 1m plots)

Cover	Litter	Bare ground	Cryptograms	Rock
Percent cover	7	2.5	<1	<1

Percent cover averaged from five 1m x 1m sub-plots.

Photo 3.1 Proposed warehouse location within study area 1 showing exotic grassy establishment amongst native landscape plantings

Photo 3.2 The southeast laydown area showing the open imported substrates at this location

3.1.1.2 Southeast laydown area

The southeast laydown area occurs in study area 1, to the southwest of the warehouse site between the western extremity of planted vegetation and the eastern end of the most southerly rail infrastructure. The area is bounded by regrowth vegetation to its south and east but is otherwise completely removed of vegetation. The laydown area will skirt vegetation to its east, due to the sloping nature of the ground profile not being ideal for materials storage and vegetation to its south, due to its potential for flooding (Photo 3.2).

3.1.2 Study area 2

Study area 2 occurs adjacent to the Northern Triangle conservation area and was previously used as a car park during the facility's construction (Figure 2.1). For the most part, the study area's imported substrates are devoid of vegetation, but at its edges exotic plants have colonised the open edges of its substrates. Where the study area abuts the Northern Triangle conservation area some natural regrowth of native plants has spread into the weed dominated areas from the adjoining Swamp Sclerophyll vegetation. On the southern boundary, a drainage channel has been constructed adjacent to Redgate Road and plantings of native plants consistent with those naturally occurring within Swamp Sclerophyll dominated conservation areas have been made (Photo 3.3). Due to the lack of substrates consistent with the Swamp Sclerophyll TEC, the planted elements consistent with Swamp Sclerophyll Forest are not consistent with the TEC. The study area is to be used as a laydown site for goods and there is opportunity to avoid planted Swamp Sclerophyll vegetation types.

Three tree stems, comprising one *Eucalyptus robusta*, one *Glochidion ferdinandi* (Cheese Tree) and one *Acacia maidenii* (Maiden's Wattle), were recorded in a single 10m x 40m plot (Figure 2.1), which extrapolates to approximately 75 stems per hectare. All plant stems observed in the study area were less than 5cm DBH and less than 2.5m in height. Percent cover and abundance estimates for all growth forms are provided in Table 3.3 and Table A.2. In addition, BAM attribute 1m x 1m percent cover plots are presented in Table 3.4 and Table A.2.

Table 3.3 Percent cover of growth forms (20m x 20m BAM plot)

Attribute	Native species growth form						Exotic species	Total
	Trees	Shrubs	Grass	Forb	Fern	Other		
Number of species	3	11	8	11	1	2	21	57
Percent cover	0.4	8	14	4.1	0.1	0.3	8.4	35.3

Table 3.4 Percent cover BAM attributes (1m x 1m plots)

Cover	Litter	Bare ground	Cryptograms	Rock
Percent cover	5.4	8	<1	<1

Percent cover averaged from five 1m x 1m sub plots.

Photo 3.3 Study area 2 with the car park area showing in the open central section, the Northern Triangle conservation area vegetation on the far right, planted Swamp Sclerophyll vegetation on the far left, and exotic plants colonising the edges of the open area either side of the open fill material.

3.1.3 Study area 3

Study area 3 consisted of the additional power supply infrastructure to be located adjacent to existing power infrastructure in the north-western carpark area (Photo 3.4). Power cabling will traverse the existing carpark area and walking pathways, and trenching may cross through landscape plantings along the edge of the main facility building (Photo 3.5). Native landscape plantings in the gardens associated with the general area that required cables are similar to those found in local TEC habitats, but substrates and extent of vegetation in the gardens do not conform to those consistent with the TEC.

Photo 3.4 The nature of the new infrastructure and its proposed location

Photo 3.5 Power cabling connection point with the main facility building

3.2 Plant species recorded

A total of 72 plant species were recorded within the study areas, of which 49 were native (68%) and 23 were exotic (32%).

Of the 23 exotic species recorded, two are listed as Priority Weeds under the NSW *Biosecurity Act 2015* (Biosecurity Act) for the Greater Sydney region, which includes the Central Coast. Both species are also listed as Weeds of National Significance (WONS) (Table 3.5). Under the Biosecurity Act, land managers are required to follow the regional and non-regional duties which have been allocated to each Priority Weed.

Table 3.5 Priority Weeds recorded in the study area

Scientific name	Common name	WONS
Rubus fructicosus	Blackberry	Yes
Senecio madagascariensis	Fireweed	Yes

4 Conservational significance and ecological constraints

Conservational significance mapping of the study area was undertaken to identify potential areas that would minimise impacts on ecological constraints that occur. The level of conservational significance has been ranked based on the ecological attributes outlined in Table 4.1. Mapping of ecological constraints within the study area is provided in Figure 4.1. A discussion of each ecological constraint rank within the study area is provided below.

Table 4.1 Ecological constraints ranking within the study area

Conservational significance ranking	Ecological attribute
High	Threatened ecological communities (i.e., Swamp Sclerophyll Forest TEC)
	Areas of potential habitat for threatened fauna species
	Designated conservation reserves
Moderate	Non-threatened native vegetation that provides high to moderate quality habitat for potential threatened species and wildlife connectivity
Low	Disturbed land
	Non-native vegetation
	Areas previously subject to planning approval for development impact

4.1 High ecological constraints

There were no high ecological constraints associated with the study area.

However, areas of high ecological constraint occur in proximity to the study area and are commensurate with conservation reserves (exclusion zones) excised from the facility's construction footprint to minimise impacts to threatened biodiversity. Conservation reserves retain areas of Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions TEC and habitat for threatened flora and fauna species, including (but not limited to) Biconvex Paperbark, Mahony's Toadlet, Wallum Froglet, Regent Honeyeater and Swift Parrot.

4.2 Moderate ecological constraints

There were no moderate ecological constraints associated with the study area.

4.3 Low ecological constraints

Low ecological constraint is associated with native landscape plantings. The native landscape plantings have been assigned as a low constraint rank due to their young age cohort, high disturbance levels and lack of floristic structure. In addition, these areas were previously approved for construction related impact under Part 5 of the NSW *Environmental Planning and Assessment Act 1979* and the Commonwealth EPBC Act.

Legend

- Main North railway
- Site features
- Study area

Conservation significance

- High biodiversity constraint
- Low biodiversity constraint

0 25 50 Meters

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

1:1,500 Date: 13/09/2022

Data sources: - DCS, Geoscience Australia, Nearmap 2022

5 Conclusion

UGL currently manage the operation of the Mariyung Fleet Maintenance Facility at Kangy Angy. The facility is currently in operation, however there is limited area outside of the main building for the storage of maintenance equipment and materials, and a need exists to install additional power infrastructure. To fulfil the short fall in storage space, an area for the erection of a warehouse has been proposed, and two areas are proposed to be utilised as laydown areas for incoming goods and materials. Furthermore, an area of the existing carpark adjacent to existing power infrastructure has been allocated for the additional power capabilities.

This ecological constraint assessment comprises the findings of the desktop investigation and field survey completed to identify the broad-scale distribution of biodiversity attributes and their associated values and constraints within the study area.

Four locations proposed for repurposing were visited to determine if threatened flora and fauna species, TECs, or endangered populations might be impacted by the repurposing of the sites. The sites included:

- the previous construction carpark area in the north of the site, proposed for repurposing as a laydown area
- an area of native landscape plantings adjacent to the northeast corner of the main facility building, to be repurposed as the location of a warehouse to store equipment and materials
- an open area of bare imported substrate south-west of the warehouse location, to be repurposed as a material laydown area
- a section of existing carpark, sidewalk and garden, to be repurposed for additional electrical infrastructure and associated trenching for cabling into the main facility building.

While native landscape plantings associated with three of the proposed repurposing areas are commensurate with plants that are consistent with those occurring in Swamp Sclerophyll TEC, the elevated and imported nature of substrates within these sites do not conform to substrate types or water dominated habitats consistent with the descriptions of Swamp Sclerophyll TEC within the community's Final Determination. No habitat that is suitable for supporting local threatened flora and fauna species or populations was observed within the proposed repurposing areas, due to the young age cohort of plants within the areas, and the lack of specific micro-habitats preferred by local threatened species. Furthermore, the four repurposing areas fall within areas within the facility lands that have previously been approved for the removal of native vegetation and do not fall within areas that were specifically set aside for conservation purposes. Therefore, there are no significant ecological constraints preventing the repurposing of the four sites assessed.

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revenue, loss of opportunity to earn profit, loss of production, loss of contract, increased operational costs, loss of business opportunity, site depredation costs, business interruption or economic loss) of any kind whatsoever, suffered on incurred by a third party.

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Appendix A

Biodiversity Assessment Method Plot Data

Table A.1 Biodiversity Assessment Method data – warehouse site (study area 1)

Species	Cover	Abundance	Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	High Threat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
			45	32	1	8	9	11	0	3	13	5
			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
			22.65	20.95	0.5	5.55	11.6	2.9	0	0.4	1.7	0.7
Centella asiatica	0.1	100	Forb					0.1				
Hydrocotyle sibthorpioides	0.1	10	Forb					0.1				
Livistona australis	0.2	2	Other							0.2		
Cirsium vulgare	0.1	1	Exotic								0.1	
Conyza sumatrensis	0.1	60	Exotic								0.1	
Gamochaeta calviceps	0.1	50	Exotic								0.1	
Ozothamnus diosmifolius	0.25	5	Shrub			0.25						
Senecio madagascarensis	0.1	50	Exotic High Threat									0.1
Sonchus oleraceus	0.1	35	Exotic								0.1	
Baumea articulata	0.1	4	Grass				0.1					
Cyperus eragrostis	0.1	20	Exotic High Threat									0.1
Cyperus polystachyos	0.1	30	Grass				0.1					
Gahnia clarkei	3	35	Grass				3					
Schoenus apogon	0.2	100	Grass				0.2					
Hardenbergia violacea	0.1	6	Other							0.1		
Kennedia rubicunda	0.1	30	Other							0.1		
Pultenaea retusa	0.1	3	Shrub			0.1						
Trifolium repens	0.2	50	Exotic								0.1	
Acacia irrorata subsp. Irrorata	0.2	2	Shrub			0.2						
Acacia longifolia subsp. Longifolia	4	80	Shrub			4						
Acacia ulicifolia	0.1	1	Shrub			0.1						

Easting	-33.33102
Northing	151.4007
Orientation	SE (130)
Plot size	20 x 20
BAM Attributes 20x20m plot	
Stem classes	
80+	0
50-79	0
30-49	0
20-29	0
10-19	0
5-9	0
<5	5
Hollows	0
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	7
Bare Ground (%)	2.5
Cryptogram (%)	<1
Rock (%)	<1

Goodenia hederacea	0.1	15	Forb					0.1				
Gonocarpus micranthus	0.1	20	Forb					0.1				
Gonocarpus teucrioides	0.1	5	Forb					0.1				
Juncus mollis	7	300	Grass				7					
Lomandra longifolia	0.5	25	Grass				0.1					
Eucalyptus robusta	0.5	5	Tree	0.5								
Leptospermum polygalifolium	0.5	6	Shrub			0.5						
Melaleuca ericifolia	0.2	1	Shrub			0.2						
Melaleuca linariifolia	0.2	1	Shrub			0.2						
Oxalis perennans	0.1	1	Forb					0.1				
Philydrum lanuginosum	0.1	1	Forb					0.1				
Dianella caerulea var. producta	1	100	Forb					1				
Andropogon virginicus	0.2	20	Exotic High Threat									0.2
Axonopus fissifolius	0.2	30	Exotic High Threat									0.2
Cynodon dactylon	0.1	50	Grass				0.1					
Paspalum urvillei	0.2	20	Exotic							0.2		
Setaria parviflora	0.1	20	Exotic							0.1		
Themeda triandra	0.5	35	Grass				0.5					
Baloskion tetraphyllum	0.1	1	Grass				0.1					
Rubus fruticosus agg.	0.1	1	Exotic High Threat									0.1
Verbena bonariensis	0.1	10	Exotic							0.1		
Lilaeopsis polyantha	1	1000	Forb					1				
Villarsia exaltata	0.1	1	Forb					0.1				
Drosera spatulata	0.1	1	Forb					0.1				

Table A.2 Biodiversity Assessment Method data – carpark laydown site (study area 2)

Species	Cover	Abundance	Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	High Threat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
			57	36	3	11	8	11	1	2	21	5
			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
			35.3	26.9	0.4	8	14	4.1	0.1	0.3	8.4	1.2
Centella asiatica	0.1	100	Forb					0.1				
Cyclospermum leptophyllum	0.1	2	Exotic								0.1	
Hydrocotyle sibthorpioides	0.1	10	Forb					0.1				
Aster Subulatus	0.1	20	Exotic								0.1	
Centipeda minima	0.1	1	Forb					0.1				
Conyza sumatrensis	0.2	100	Exotic								0.2	
Gamochaeta calviceps	0.2	45	Exotic								0.2	
Hypochaeris radicata	0.5	200	Exotic								0.5	
Ozothamnus diosmifolius	0.2	10	Shrub			0.2						
Senecio madagascarensis	0.1	50	Exotic High Threat									0.1
Sonchus oleraceus	0.1	20	Exotic								0.1	
Cardamine hirsuta	0.1	1	Exotic								0.1	
Cyperus eragrostis	0.2	40	Exotic High Threat									0.2
Gahnia clarkei	8	67	Grass				8					
Glochidion ferdinandi	0.1	1	Tree		0.1							
Kennedia rubicunda	0.2	30	Other							0.2		
Trifolium repens	0.1	10	Exotic								0.1	
Acacia irrorata subsp. irrorata	0.2	5	Shrub			0.2						
Acacia longifolia subsp. longifolia	6	200	Shrub			6						
Acacia maidenii	0.1	1	Tree		0.1							
Acacia suaveolens	0.1	1	Shrub			0.1						

Latitude	-33.329123
Longitude	151.400168
Orientation	E (100)
Plot size	10 x 40
BAM Attributes 10x40m plot	
Stem classes	
80+	0
50-79	0
30-49	0
20-29	0
10-19	0
5-9	0
<5	3
Hollows	0
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	5.4
Bare Ground (%)	8
Cryptogram (%)	<1
Rock (%)	<1

Acacia ulicifolia	0.2	30	Shrub		0.2						
Goodenia hederacea	1	500	Forb				1				
Gonocarpus micranthus	0.2	250	Forb				0.2				
Juncus mollis	0.1	5	Grass			0.1					
Juncus usitatus	0.2	20	Grass			0.2					
Cassytha glabella	0.1	1	Other					0.1			
Lobelia purpurascens	0.1	25	Forb				0.1				
Lomandra longifolia	0.2	15	Grass			0.2					
Sida rhombifolia	0.1	2	Exotic						0.1		
Callistemon salignus	0.2	2	Shrub		0.2						
Eucalyptus robusta	0.2	1	Tree	0.2							
Leptospermum polygalifolium	0.2	3	Shrub		0.2						
Melaleuca linariifolia	0.2	1	Shrub		0.2						
Melaleuca sieberi	0.2	1	Shrub		0.2						
Melaleuca styphelioides	0.3	3	Shrub		0.3						
Philydrum lanuginosum	0.1	3	Forb				0.1				
Dianella caerulea var. producta	0.2	10	Forb				0.2				
Plantago lanceolata	0.1	2	Exotic						0.1		
Andropogon virginicus	0.5	50	Exotic High Threat							0.5	
Cenchrus clandestinus	0.1	10	Exotic						0.1		
Chloris gayana	0.2	20	Exotic High Threat							0.2	
Cynodon dactylon	5	200	Grass			5					
Entolasia stricta	0.1	1	Grass			0.1					
Hemarthria uncinata	0.2	50	Grass			0.2					
Paspalum dilatatum	0.2	20	Exotic Hight Threat							0.2	
Paspalum urvillei	5	60	Exotic						5		
Setaria parviflora	0.1	1	Exotic						0.1		
Themeda triandra	0.2	20	Grass			0.2					
Lysimachia arvensis	0.1	1	Exotic						0.1		

Banksia spinulosa	0.2	2	Shrub	0.2			
Selaginella uliginosa	0.1	10	Fern			0.1	
Verbena bonariensis	0.2	50	Exotic				0.2
Viola hederacea	0.1	15	Forb		0.1		
Lilaeopsis polyantha	2	2500	Forb		2		
Villarsia exaltata	0.1	2	Forb		0.1		
Panicum maximum	0.1	5	Exotic				0.1

Appendix B

Plant species recorded

Table B.1 Plant species recorded

Family name	Scientific name	Common name	EPBC Act	BC Act	Native
Apiaceae	*Centella asiatica*				Native
Apiaceae	*Cyclospermum leptophyllum*	Slender Celery			Exotic
Apiaceae	*Lilaeopsis polyantha*	Lilaeopsis			Native
Araliaceae	*Hydrocotyle sibthorpioides*				Native
Arecaceae	*Livistona australis*	Cabbage Fan Palm			Native
Asteraceae	*Aster Subulatus*				Exotic
Asteraceae	*Centipeda minima*	Spreading Sneezeweed			Native
Asteraceae	*Cirsium vulgare*	Spear Thistle			Exotic
Asteraceae	*Conyza sumatrensis*				Exotic
Asteracae	*Gamochaeta calviceps*	Cudweed			Exotic
Asteracae	*Hypochaeris radicata*	Catsear			Exotic
Asteraceae	*Ozothamnus diosmifolius*	White Dogwood			Native
Asteraceae	*Senecio madagascariensis*	Fireweed			Exotic
Asteraceae	*Sonchus oleraceus*	Common Sowthistle			Exotic
Brassicaceae	*Cardamine hirsuta*				Exotic
Cyperaceae	*Machaerina articulata*	Jointed Twig-rush			Native
Cyperaceae	*Cyperus eragrostis*	Umbrella Sedge			Exotic
Cyperaceae	*Cyperus polystachyos*	Bunchy Flat sedge			Native
Cyperaceae	*Gahnia clarkei*				Native
Cyperaceae	*Schoenus apogon*				Native
Droseraceae	*Drosera spatulata*				Native
Euphorbiaceae	*Glochidion ferdinandi*	Cheese Tree			Native
Fabaceae (Faboideae)	*Hardenbergia violacea*	Purple Coral Pea			Native
Fabaceae (Faboideae)	*Kennedia rubicunda*	Red Kennedy Pea			Native
Fabaceae (Faboideae)	*Pultenaea retusa*	Noteched Bush-pea			Native
Fabaceae (Faboideae)	*Trifolium repens*	White Clover			Native
Fabaceae (Mimosoideae)	*Acacia irrorata subsp. irrorata*	Green Wattle			Native
Fabaceae (Mimosoideae)	*Acacia longifolia subsp. longifolia*	Sydney Golden Wattle			Native
Fabaceae (Mimosoideae)	*Acacia maidenii*	Maiden's Wattle			Native

Family name	Scientific name	Common name	EPBC Act	BC Act	Native
Fabaceae (Mimosoideae)	*Acacia suaveolens*	Sweet Wattle			Native
Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses			Native
Goodeniaceae	*Goodenia heteracea*				Native
Haloragaceae	*Gonocarpus micranthus*	Creeping Raspwort			Native
Haloragaceae	*Gonocarpus teucrioides*				Native
Juncaceae	*Juncus mollis*				Native
Juncaceae	*Juncus usitatus*				Native
Lauraceae	*Cassytha glabella*				Native
Lobeliaceae	*Lobelia purpurascens*				Native
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush			Native
Malvaceae	*Sida rhombifolia*	Paddys Lucerne			Exotic
Menyanthaceae	*Liparophyllum exaltatum*				Native
Myrtaceae	*Callistemon salignus*				Native
Myrtaceae	*Eucalyptus robusta*	Swamp Mahogany			Native
Myrtaceae	*Leptospermum polygalifolium*				Native
Myrtaceae	*Melaleuca ericifolia*	Swamp Paperbark			Native
Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark			Native
Myrtaceae	*Melaleuca sieberi*				Native
Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea Tree			Native
Oxalidaceae	*Oxalis perennans*				Native
Philydraceae	*Philydrum lanuginosum*	Woolly Waterlily			Native
Phormiaceae	*Dianella caerulea var. producta*				Native
Plantaginaceae	*Plantago lanceolata*	Lambs Tongues			Exotic
Poaceae	*Andropogon virginicus*	Whisky Grass			Exotic
Poaceae	*Axonopus fissifolius*	Narrow-leafed Carpet Grass			Exotic
Poaceae	*Cenchrus clandestinus*	Kikuyu Grass			Exotic
Poaceae	*Chloris gayana*	Rhodes Grass			Exotic
Poaceae	*Cynodon dactylon*	Couch			Native
Poaceae	*Entolasia stricta*	Wiry Panic			Native
Poaceae	*Hemarthria uncinata*				Native

Family name	Scientific name	Common name	EPBC Act	BC Act	Native
Poaceae	*Panicum maximum*	Guinea Grass			Exotic
Poaceae	*Paspalidium distans*	Guinea Grass			Native
Poaceae	*Paspalum dilatatum*				Exotic
Poaceae	*Paspalum urvillei*	Vasey Grass			Exotic
Poaceae	*Setaria parviflora*				Exotic
Poaceae	*Themeda triandra*	Kangaroo Grass			Native
Primulaceae	*Lysimachia arvensis*	Scarlet Pimpernel			Exotic
Proteaceae	*Banksia spinulosa*	Hairpin Banksia			Native
Restionaceae	*Baloskion tetraphyllum*				Native
Rosaceae	*Rubus fruticosus agg.*	Blackberry Complex			Exotic
Selaginellaceae	*Selaginella uliginosa*				Native
Verbenaceae	*Verbena bonariensis*				Exotic
Violaceae	*Viola hederacea*	Ivy-leaved Violet			Native

Appendix C

Threatened biodiversity

C1 Threatened ecological communities

No TECs listed under the BC Act or the EPBC Act were recorded in the study area.

Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, which is listed as Endangered under the BC Act, occurs in association with conservation zones outside the study area (Figure 2.1). This plant community type is also likely to be consistent with the Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland community, which is listed as Endangered under the EPBC Act (Department of Agriculture Water and the Environment, 2021).

This community occurs naturally on floodplain topographies often inundated by water, due to the preference of its plant species for areas subject to wet substrates. The substrates on which the proposed works are located all occur on deep layers of imported fill to reduce the risk of flooding. Therefore, native vegetation occurring at each of the four locations are landscape plantings and have not developed through natural regrowth and do not adhere to the definition of the TEC (NSW Scientific Committee, 2004, NSW Threatened Species Scientific Committee, 2011, Department of Agriculture Water and the Environment, 2021), as the substrates are not consistent with the descriptions of the contexts in which the TEC occurs.

C2 Threatened fauna

Background investigations identified 83 threatened fauna species potentially occurring in the study area locality (10 kilometre radius of the facility), including 45 birds, 20 mammals, nine amphibians, three reptiles and six fish (Appendix D). No threatened species of animal were recorded in the study area during the field survey, and none are considered to have potential habitat therein.

Although habitats in the study area are considered unsuitable for threatened fauna species habitation, several species were key ecological risks associated with the facility, including Mahony's Toadlet, Wallum Froglet, Swift Parrot and Regent Honeyeater. Ecological considerations for each of these species with respect to habitat availability in the study area is provided below.

C2.1 Mahony's Toadlet

Mahony's Toadlet occurs in wet habitats on sandy substrates, such as occur in conservation areas associated with the facility. They use elevated sandy substrates to burrow into during periods of torpor and ponds with sandy bases for breeding purposes. The species was observed calling from an elevated sandy location on the site as a single individual during pre-development habitat surveys. No individuals have been located on site apart from the original observation and ongoing monitoring targeting the species has not located the species on site, despite the species' activity at known locations elsewhere to confirm conditions suitable for activity. The substrates associated with the repurposing areas do not contain substrates that are suitable for Mahony's Toadlet to burrow into or hold water for breeding purposes. Therefore, the repurposing areas do not contain habitat suitable for Mahony's Toadlet.

C2.2 Wallum Froglet

The Wallum Froglet occurs in coastal wetlands often with acidic substrates, preferring sedgelands and wet heathlands. The species has been recorded twice in the "Rail" conservation area and twice to the south of the "Central B" conservation area prior to development. The species has not been detected on site during monitoring post-development of the site. The elevated substrates that do not hold surface water that are associated with the repurposing areas do not contain habitats that are suitable for the Wallum Froglet. Therefore, the repurposing areas do not contain habitat suitable for Wallum Froglet.

C2.3 Swift Parrot and Regent Honeyeater

Both the Swift Parrot and Regent Honeyeater have potential to occur locally, due to their occasional dependence upon the blossom of Swamp Mahogany (*Eucalyptus robusta*) in coastal habitats on the Central Coast. Although, some of the repurposing sites have Swamp Mahogany individuals growing on them or associated with them, those individuals are small and not of sufficient age to produce blossom. Therefore, the repurposing sites do not contain potential habitat for the Swift Parrot and Regent Honeyeater.

C3 Threatened flora

Background investigations identified 41 threatened flora species listed under the NSW BC Act and/ or EPBC Act as being known to occur or considered likely to occur within the locality of the study area (Appendix E). No threatened flora species were recorded during survey, and none have been assessed as having potential habitat in the study area.

One threatened species, *Melaleuca biconvexa* (Biconvex Paperbark), which is listed as Vulnerable under the NSW BC Act and Commonwealth EPBC Act, is known from conservation reserves associated with the facility. Accordingly, Biconvex Paperbark is considered below.

C3.1 Biconvex Paperbark

The Biconvex Paperbark occurs naturally in floodplain habitats often inundated by water, due to its preference for areas subject to wet substrates. The substrates on which the proposed works are located all occur on deep layers of imported fill to reduce the risk of flooding. Therefore, there is no suitable natural habitats at the repurposing sites for the Biconvex Paperbark and no individuals were observed at any of the surveyed sites.

C4 Migratory species

Migratory species are protected under international agreements to which Australia are a signatory, including JAMBA, CAMBA, RoKAMBA and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Migratory species are considered MNES and are protected under the EPBC Act.

Based on the Commonwealth EPBC Protected Matters Search Tool and other desktop database searches, 36 terrestrial and wetland migratory species have been recorded, have habitat, or are predicated to occur within the wider locality of the study area (Appendix D). Of these, the White-throated Needletail may occur locally on rare occasions because it is an aerial species, roaming widely on a season basis. However, there is no habitat in the study area that migratory species are dependent upon for their life-cycles. No migratory species were recorded opportunistically in the study area during the field survey.

Appendix D

Threatened fauna likelihood of occurrence

Table D.1 Threatened fauna likelihood of occurrence assessment

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Fish (6)							
Epinephelus daemelii	Black Rockcod, Black Cod, Saddled Rockcod	V	-	V	The Black Rockcod is found in warm temperate and subtropical parts of the south-western Pacific. Adult Black Rockcod can grow to 2 m in length and at least 80 kg in weight, but it is more common to see smaller fish (up to 1m/30kg).	PMST	Low – no suitable habitat identified in the study area.
Hippocampus whitei	White's Seahorse, Crowned Seahorse, Sydney Seahorse	E, M	-	E	The White's Seahorse is considered to be endemic to the waters of southern Queensland (Hervey Bay) to Sussex Inlet NSW where it can be found occurring in coastal embayments and estuaries. It is known to occur from depths of 1 m to 18 m. Habitats that are considered important habitat for the White's Seahorse include natural habitats such as sponge gardens, seagrass meadows and soft corals. It is also known to use artificial habitats such as protective swimming net enclosures and jetty pylons.	PMST	Low – no suitable habitat identified in the study area.
Macquaria australasica	Macquarie Perch	E	-	E	Macquarie Perch are found in the Murray-Darling Basin (particularly upstream reaches) of the Lachlan, Murrumbidgee and Murray rivers, and parts of south-eastern coastal NSW, including the Hawkesbury/Nepean and Shoalhaven catchments. Macquarie Perch are found in both river and lake habitats; especially the upper reaches of rivers and their tributaries. It prefers clear water and deep, rocky holes with lots of cover. As well as aquatic vegetation, additional cover may comprise of large boulders, debris and overhanging banks. Spawning occurs just above riffles (shallow running water).	PMST	Low – no suitable habitat identified in the study area.
Prototroctes maraena	Australian Grayling	V	-	E	The Australian Grayling is diadromous, spending part of its lifecycle in freshwater and at least part of the larval and/or juvenile stages in coastal seas. Adults (including pre spawning and spawning adults) inhabit cool, clear, freshwater streams with gravel substrate and areas alternating between pools and riffle zones.	PMST	Low – no suitable habitat identified in the study area.
Seriolella brama	Blue Warehou	CD	-	-	Blue warehou are a bentho-pelagic species that inhabits continental shelf and slope waters. Adults can be found at depths from 50-300 metres. Blue warehou are a schooling fish and usually aggregate close to the sea bed. Juveniles can sometimes be found schooling close to the surface in estuaries, often in association with jellyfish.	PMST	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Thunnus maccoyii	Southern Bluefin Tuna	CD	-	E	Southern Bluefin Tuna are highly migratory pelagic fish. In Australian waters they range from northern NSW around southern Australia to northwestern Australia. They tend to form large surface schools in offshore waters off southern Australia at certain times of the year. Southern Bluefin Tuna are found in oceanic waters normally on the seaward side of the continental shelf. They belong to the family Scombridae which also includes tuna, mackerel, bonito and wahoo. Worldwide the species is considered a single population. Southern Bluefin Tuna spawn at only one location in the tropical waters between Java and north-west Australia.	PMST	Low – no suitable habitat identified in the study area.
Amphibians (9)							
Crinia tinnula	Wallum Froglet	-	V	-	Occurs along the coastal margin from Litabella National Park in south east QLD to Kurnell in Sydney. Occurs in a wide range of habitat particularly with acidic swamps on coastal sand plains. Typically occur in sedgelands and wet heathlands. Can also be found along drainage lines within other vegetation communities and disturbed areas and occasionally in swamp sclerophyll forests. Breed in swamps with permanent water as well as shallow ephemeral pools and drainage ditches. Shelter under leaf litter, vegetation, other debris or in burrows of other species. Shelter sites are often wet or very damp and often located near the waters edge.	BioNet (3 records)	Low – no suitable habitat identified in the study area.
Heleioporus australiacus	Giant Burrowing Frog	V	V	-	Found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based. Spends more than 95% of its time in non-breeding habitat in areas up to 300m from breeding sites. Whilst in non-breeding habitat it burrows below the soil surface or in the leaf litter. Breeding habitat of this species is generally soaks or pools within first or second order streams. Species is dependent on hanging swamps on the top of sandstone plateaus and deeply dissected gullies that occur as erosion features in the Sydney Basin.	PMST	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Litoria aurea	Green and Golden Bell Frog	V	E1	-	Distributed from NSW north coast near Brunswick Heads, southwards along NSW coast to Victoria where it extends into east Gippsland. Inhabits marshes, dams and stream-sides, particularly those containing bulrushes or spikerushes. Optimum habitat includes waterbodies that are unshaded, free of predatory fish such as Plague Minnow (Gambusia holbrooki), have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas.	BioNet, PMST (7 records)	Low – no suitable habitat identified in the study area.
Litoria brevipalmata	Green-thighed Frog	-	V	-	Distribution in isolated localities along the coast and ranges of NSW from north of Wollongong to south-east Queensland. Occurs in habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain. Prefers wetter forests in the south of its range but extends into drier forests in northern NSW and southern QLD. Thought to forage in leaf-litter.	BioNet (8 records)	Low – no suitable habitat identified in the study area.
Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	V	V	-	Has a distribution that includes the plateaus and eastern slopes of the Great Dividing Range from Watagan State Forest (90 km north of Sydney) south to Buchan in Victoria. The majority of records are from within the Sydney Basin Bioregion with only scattered records south to the Victorian border and this species has not been recorded in southern NSW within the last decade. Records are isolated and tend to be at high altitude. This species breeds in the upper reaches of permanent streams and in perched swamps. Non-breeding habitat is heath-based forests and woodlands where it shelters under leaf litter and low vegetation, and hunts for invertebrate prey either in shrubs or on the ground.	PMST	Low – no suitable habitat identified in the study area.
Mixophyes balbus	Stuttering Frog, Southern Barred Frog	V	E1	-	Stuttering Frogs occur along the east coast of Australia from southern Qld to north-eastern Victoria. Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor.	BioNet, PMST (23 records)	Low – no suitable habitat identified in the study area.
Mixophyes iteratus	Giant Barred Frog, Southern Barred Frog	E	E1	-	Giant Barred Frogs forage and live amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000m. They breed around shallow, flowing rocky streams from late spring to summer. Females lay eggs onto moist creek banks or rocks above water level, from where tadpoles drop into the water when hatched.	PMST	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Pseudophryne australis	Red-crowned Toadlet	-	V	-	The Red-crowned Toadlet has a restricted distribution. It is confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains. Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. Shelters under rocks and amongst masses of dense vegetation or thick piles of leaf litter. Breeding congregations occur in dense vegetation and debris beside ephemeral creeks and gutters. Red-crowned Toadlets have not been recorded breeding in waters that are even mildly polluted or with a pH outside the range 5.5 to 6.5. Red-crowned Toadlets are quite a localised species that appear to be largely restricted to the immediate vicinity of suitable breeding habitat. Red-crowned Toadlets are usually found as small colonies scattered along ridges coinciding with the positions of suitable refuges near breeding sites.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Uperoleia mahonyi	Mahony's Toadlet	-	E1	-	Recorded almost exclusively on a substrate of leached (highly nutrient impoverished) white sand and is commonly associated with acid paperbark swamps. The typically occur in wallum heath, swamp mahogany-paperbark swamp forest, heath shrubland and Sydney red gum woodland. During non-breeding periods the species has been recorded up to 400m from standing water within intact native vegetation. This species seeks shelter by burrowing into the sandy substrate. Rocks, logs and leaf litter may also be used for shelter.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Reptiles (3)							
Hoplocephalus bungaroides	Broad-headed Snake	V	E1	-	The Broad-headed Snake is largely confined to Triassic and Permian sandstones. Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges. Moves from the sandstone rocks to shelters in hollows in large trees within 200m of escarpments in summer.	PMST	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Hoplocephalus bitorquatus	Pale-headed Snake	-	V	-	A patchy distribution from north-east Queensland to the north-eastern quarter of NSW. In NSW it has historically been recorded from as far west as Mungindi and Quambone on the Darling Riverine Plains, across the north west slopes, and from the north coast from Queensland to Sydney. A small number of historical records are known for the New England Tablelands from Glenn Innes and Tenterfield; however, the majority of records appear to be from sites of relatively lower elevation. Although the Pale-headed snake distribution is very cryptic, it now appears to have contracted to a patchy and fragmented distribution. The Pale-headed Snake is a highly cryptic species that can spend weeks at a time hidden in tree hollows. Found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest. In drier environments, it appears to favour habitats close to riparian areas. Shelter during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Hoplocephalus stephensii	Stephen's Banded Snake	-	V	-	Found in coastal areas from Gosford district to southern QLD. Arboreal snake usually encountered in the wetter sclerophyll or rainforests which occur within its range.	BioNet (2 records)	Low – no suitable habitat identified in the study area.
Birds (68 including migratory species)							
Actitis hypoleucos	Common Sandpiper	M	-	-	The Common Sandpiper frequents a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity. It is mostly encountered along muddy margins or rocky shores and rarely on mudflats. It has been recorded in estuaries and deltas of streams, banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. The muddy margins utilised by the species are often narrow, and may be steep. The species is often associated with mangroves, and sometimes found in areas of mud littered with rocks or snags. Roost sites are typically on rocks or in roots or branches of vegetation, especially mangroves. The species is known to perch on posts, jetties, moored boats and other artificial structures, and to sometimes rest on mud or 'loaf' on rocks.	PMST	Low – no suitable habitat identified in the study area.
Arenaria interpres	Ruddy Turnstone	M	-	-	Occurs at beaches and coasts with exposed rock, stony or shell beaches, mudflats, exposed reefs, and wave platforms	PMST	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Anthochaera phrygia (syn. Xanthomyza phrygia)	Regent Honeyeater	CE	CE	-	Inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. It inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. It feeds mainly on the nectar from a relatively small number of eucalypts that produce high volumes of nectar. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany.	BioNet, PMST (8 records)	Low – no suitable habitat identified in the study area.
Ardenna carneipes	Flesh-footed Shearwater	M	V	-	Ranges throughout the Pacific and Indian Oceans. There are two main breeding areas in the world: one in the South West Pacific includes Lord Howe Island and New Zealand; the other along the coast of Western Australia.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Botaurus poiciloptilus	Australasian Bittern	E	E1	-	Australasian Bitterns are widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha spp.*) and spikerushes (*Eleocharis spp.*). Feeding platforms may be constructed over deeper water from reeds trampled by the bird; platforms are often littered with prey remains. Breeding occurs in summer from October to January; nests are built in secluded places in densely-vegetated wetlands on a platform of reeds.	BioNet, PMST (1 record)	Low – no suitable habitat identified in the study area.
Burhinus grallarius	Bush Stone-Curlew	-	E1	-	The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range. Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Largely nocturnal, being especially active on moonlit nights.	BioNet (7 records)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Calidris acuminata	Sharp-tailed Sandpiper	M	-	-	Occurs in a variety of habitats: tidal mudflat, mangrove swamps, saltmarshes, shallow fresh, brackish, salt inland swamps and lakes; flooded and irrigated paddocks, sewage farms and commercial saltfields.	PMST	Low – no suitable habitat identified in the study area.
Calidris alba	Sanderling	M	-	-	Occur along the NSW coast, with occasional inland sightings. Often found on low beaches of firm sand, near reefs and inlets, along tidal mudflats and bare open coastal lagoons; individuals are rarely recorded in near-coastal wetlands. Roosts on bare sand, behind clumps of beach-cast kelp or in coastal dunes. Breeding occurs in the Northern Hemisphere.	PMST	Low – no suitable habitat identified in the study area.
Calidris canutus	Red Knot	E, M	-	-	In NSW the Red Knot mainly occurs in small numbers on intertidal mudflats, estuaries, bays, inlets, lagoons, harbours and sandflats and sandy beaches of sheltered coasts. It is occasionally found on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms and is a rare visitor to terrestrial saline wetlands and freshwater swamps.	BioNet, PMST (6 records)	None – no suitable habitat occurs within the study area or its wider locality.
Calidris ferruginea	Curlew Sandpiper	CE, M	E1	-	Occurs in inter-tidal mudflats of estuaries, lagoons, mangrove channels and also around lakes, dams, floodwaters and flooded saltbush surrounding inland lakes.	BioNet, PMST (10 records)	Low – no suitable habitat identified in the study area.
Calidris melanotos	Pectoral Sandpiper	M	-	-	In Australasia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species frequents coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. It is usually found in coastal or near coastal habitat but occasionally further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. It has also been recorded in swamp overgrown with lignum. They forage in shallow water or soft mud at the edge of wetlands.	PMST	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Calidris ruficollis	Red-necked Stint	M	-	-	Distributed along most of the Australian coastline with large densities on the Victorian and Tasmanian coasts. The Red-necked Stint has been recorded in all coastal regions and found inland in all states when conditions are suitable. Mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores. Occasionally they have been recorded on exposed or ocean beaches, and sometimes on stony or rocky shores, reefs or shoals. They also occur in saltworks and sewage farms; saltmarsh; ephemeral or permanent shallow wetlands near the coast or inland, including lagoons, lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats.	PMST	Low – no suitable habitat identified in the study area.
Calidris tenuirostris	Great Knot	CE, M	V	-	In NSW, the species has been recorded at scattered sites along the coast down to about Narooma. It has also been observed inland at Tullakool, Armidale, Gilgandra and Griffith. Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms. Migrates to Australia from late August to early September, although juveniles may not arrive until October-November. Most birds return north in March and April, however some individuals may stay over winter in Australia.	BioNet, PMST (1 record)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Callocephalon fimbriatum	Gang-gang Cockatoo	-	V	-	The Gang-gang Cockatoo is distributed from southern Victoria through south- and central-eastern New South Wales. In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the Australian Capital Territory. It is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee. In spring and summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In autumn and winter, the species often moves to lower altitudes in drier more open eucalypt forests and woodlands, particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas. May also occur in sub-alpine Snow Gum (*Eucalyptus pauciflora*) woodland and occasionally in temperate rainforests. Favours old growth forest and woodland attributes for nesting and roosting. Nests are located in hollows that are 10 cm in diameter or larger and at least 9 m above the ground in eucalypts.	BioNet, PMST (3 records)	Low – no suitable habitat identified in the study area.
Calyptorhynchus lathami	Glossy Black-Cockatoo	-	V	-	The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak (*Allocasuarina littoralis*) and Forest Sheoak (*A. torulosa*) are important foods. Inland populations feed on a wide range of sheoaks, including Drooping Sheoak, *Allocasuarina diminuta*, and *A. gymnathera*. Belah is also utilised and may be a critical food source for some populations. In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak, but also recorded in open woodlands dominated by Belah (*Casuarina cristata*). Feeds almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina species*), shredding the cones with the massive bill. Dependent on large hollow-bearing eucalypts for nest sites.	BioNet, PMST (22 records)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Charadrius leschenaultii	Greater Sand-Plover	V, M	V	-	Almost entirely restricted to coastal areas in NSW, mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks. Roosts during high tide on sandy beaches and rocky shores; begin foraging activity on wet ground at low tide, usually away from the edge of the water.	BioNet, PMST (1 record)	Low – no suitable habitat identified in the study area.
Charadrius mongolus	Lesser Sand Plover	E, M	V	-	The Lesser Sand-Plover is widespread in coastal regions. Usually found in coastal littoral and estuarine environments. It inhabits large intertidal sandflats or mudflats in sheltered bays, harbours and estuaries, and occasionally sandy ocean beaches, coral reefs, wave-cut rock platforms and rocky outcrops.	PMST	Low – no suitable habitat identified in the study area.
Chthonicola sagittata (syn. Pyrrholaemus sagittatus)	Speckled Warbler	-	V	-	The Speckled Warbler has a patchy distribution throughout south-eastern Queensland, the eastern half of NSW and into Victoria, as far west as the Grampians. The species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast. There has been a decline in population density throughout its range, with the decline exceeding 40% where no vegetation remnants larger than 100ha survive. Lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Cuculus optatus	Oriental Cuckoo	M	-	-	A non-breeding migrant to Australia, it often inhabits rainforest, vine thickets, wet sclerophyll forest and open woodland and sometimes occurs in mangroves, wooded swamps and as vagrants in gardens. The population trend appears to be stable.	PMST	Low – no suitable habitat identified in the study area.
Daphoenositta chrysoptera	Varied Sittella	-	V	-	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy.	BioNet (7 records)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Ephippiorhynchus asiaticus	Black-necked Stork	-	E1	-	Widespread in coastal and subcoastal northern and eastern Australia, south to central-eastern NSW. Mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands.	BioNet (21 records)	Low – no suitable habitat identified in the study area.
Erythrotriorchis radiatus	Red Goshawk	V	CE	-	Lives in coastal and sub-coastal tall open forests and woodlands, tropical savannas traversed by wooded or forested rivers and along edges of rainforest. Nests are only built in trees taller than 20 meters which occur within 1 kilometre of a watercourse or wetland. Has a home range of 200 square kilometres and hunts for medium to large birds in open forests and gallery forest.	PMST	Low – no suitable habitat identified in the study area.
Falco hypoleucos	Grey Falcon	-	E1	-	Sparsely distributed in NSW, chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range. The breeding range has contracted since the 1950s with most breeding now confined to arid parts of the range. There are possibly less than 5000 individuals left. Population trends are unclear, though it is believed to be extinct in areas with more than 500mm rainfall in NSW. Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey.	PMST	Low – no suitable habitat identified in the study area.
Falco subniger	Black Falcon	-	V	-	Widely, but sparsely, distributed in New South Wales, mostly occurring woodland, shrubland and grassland in the arid and semi-arid zones, especially wooded watercourses and agricultural land with scattered remnant trees. It is usually associated with streams or wetlands, visiting them in search of prey and often using standing dead trees as lookout posts. Habitat selection is generally influenced more by prey densities than by specific aspects of habitat floristics or condition, although in agricultural landscapes it tends to nest in healthy, riparian woodland remnants with a diverse avi-fauna.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Gallinago hardwickii	Latham's Snipe	M	-	-	Latham's Snipe is a non-breeding visitor to south-eastern Australia. This species occurs in permanent and ephemeral wetlands up to 2000m above sea-level. They usually inhabit open, freshwater wetlands with low, dense vegetation.	PMST	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Gallinago megala	Swinhoe's Snipe	M	-	-	During the non-breeding season, occurs at the edges of wetlands, such as wet paddy fields, swamps and freshwater streams. The species is also known to occur in grasslands, drier cultivated areas (including crops of rapeseed and wheat) and market gardens. Habitat includes the dense clumps of grass and rushes round the edges of fresh and brackish wetlands. This includes swamps, billabongs, river pools, small streams and sewage ponds. They are also found in drying claypans and inundated plains pitted with crab holes.	PMST	Low – no suitable habitat identified in the study area.
Gallinago stenura	Pin-tailed Snipe	M	-	-	During non-breeding period, occurs most often in or at the edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grasses/sedges or other vegetation. The species is also found in drier, more open wetlands such as claypans in more arid parts of species' range. It is also commonly seen at sewage ponds; not normally in saline or inter-tidal wetlands.	PMST	Low – no suitable habitat identified in the study area.
Glossopsitta pusilla	Little Lorikeet	-	V	-	The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs. Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species. Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards.	BioNet (5 records)	Low – no suitable habitat identified in the study area.
Grantiella picta	Painted Honeyeater	V	V	-	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits Boree/ Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*) and Box-Gum Woodlands and Box-Ironbark Forests (Oliver et al., 2003). A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema.	BioNet, PMST (1 record)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Haematopus longirostris	Pied Oystercatcher	-	E1	-	The species is distributed around the entire Australian coastline, although it is most common in coastal Tasmania and parts of Victoria, such as Corner Inlet. In NSW the species is thinly scattered along the entire coast, with fewer than 200 breeding pairs estimated to occur in the State. 'Pied' Oystercatchers are occasionally recorded on Lord Howe island but it is uncertain which species is involved.	BioNet (4 records)	Low – no suitable habitat identified in the study area.
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	V	-	The White-bellied Sea-eagle is distributed around the Australian coastline, including Tasmania, and well inland along rivers and wetlands of the Murray Darling Basin. In New South Wales it is widespread along the east coast, and along all major inland rivers and waterways. Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea. Occurs at sites near the sea or sea-shore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, and forest (including rainforest). Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as ‘guard roosts’. Feed mainly on fish and freshwater turtles, but also waterbirds, reptiles, mammals and carrion.	BioNet (36 records)	Low – no suitable habitat identified in the study area.
Hieraaetus morphnoides	Little Eagle	-	V	-	The Little Eagle is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW. Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter. Preys on birds, reptiles and mammals, occasionally adding large insects and carrion.	BioNet (3 records)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Hirundapus caudacutus	White-throated Needletail	V, M	-	-	Widespread in eastern and south-eastern Australia. In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains. It is almost exclusively aerial, from heights of less than 1 m up to more than 1000 m above the ground. Because they are aerial, it has been stated that conventional habitat descriptions are inapplicable, but there are, nevertheless, certain preferences exhibited by the species. Although they occur over most types of habitat, they are probably recorded most often above wooded areas, including open forest and rainforest, and may also fly between trees or in clearings, below the canopy, but they are less commonly recorded flying above woodland. They also commonly occur over heathland, but less often over treeless areas, such as grassland or swamps. When flying above farmland, they are more often recorded above partly cleared pasture, plantations or remnant vegetation at the edge of paddocks. In coastal areas, they are sometimes seen flying over sandy beaches or mudflats and often around coastal cliffs and other areas with prominent updraughts, such as ridges and sand-dunes.	BioNet, PMST (13 records)	Low – no suitable habitat identified in the study area.
Irediparra gallinacea	Comb-crested Jacana	-	V	-	The Comb-crested Jacana occurs on freshwater wetlands in northern and eastern Australia, mainly in coastal and subcoastal regions, from the north-eastern Kimberley Division of Western Australia to Cape York Peninsula then south along the east coast to the Hunter region of NSW, with stragglers recorded in south-eastern NSW (possibly in response to unfavourable conditions further north). Inhabit permanent freshwater wetlands, either still or slow-flowing, with a good surface cover of floating vegetation, especially water-lilies, or fringing and aquatic vegetation. The nest is a platform or shallow cup of vegetable material, though eggs sometimes laid directly onto a large leaf with no nest built. Comb-crested Jacanas are dispersive, moving about in response to the condition of wetlands, and occasionally turn up well beyond normal range.	BioNet (2 records)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Ixobrychus flavicollis	Black Bittern	-	V	-	The Black Bittern has a wide distribution, from southern NSW north to Cape York and along the north coast to the Kimberley region. The species also occurs in the south-west of Western Australia. In NSW, records of the species are scattered along the east coast, with individuals rarely being recorded south of Sydney or inland. Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves. Feeds on frogs, reptiles, fish and invertebrates, including snails, dragonflies, shrimps and crayfish, with most feeding done at dusk and at night.	BioNet (14 records)	Low – no suitable habitat identified in the study area.
Lathamus discolor	Swift Parrot	CE	E1	-	Breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW mostly occurs on the coast and south west slopes. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum Corymbia maculata, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Inland Grey Box *E. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis*.	BioNet, PMST (6 records)	Low – no suitable habitat identified in the study area.
Limosa lapponica baueri	Bar-tailed Godwit	V, M	-	-	The Bar-tailed Godwit (both subspecies combined) has been recorded in the coastal areas of all Australian states. It is widespread in the Torres Strait and along the east and south-east coasts of Queensland, NSW and Victoria. The migratory Bar-tailed Godwit (western Alaskan) does not breed in Australia. Occurs mainly in coastal habitats in coastal habitats which include large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It also has been recorded in coastal sewage farms and saltworks, saltlakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms and coral reef-flats.	PMST	Low – no suitable habitat identified in the study area.
Limosa limosa	Black-tailed Godwit	M	V		Occurs in coastal mudflats, sandbars, shores of estuaries, salt marsh and sewage ponds	PMST	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Lophoictinia isura	Square-tailed Kite	-	V	-	The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast, arriving in September and leaving by March. Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. In arid north-western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland. Is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage.	BioNet (2 records)	Low – no suitable habitat identified in the study area.
Monarcha melanopsis	Black-faced Monarch	M	-	-	The Black-faced Monarch is widespread in eastern Australia. Mainly occurs in rainforest ecosystems although it can be found in gullies in mountain areas or coastal foothills, softwood scrub dominated by Brigalow (*Acacia harpophylla*), coastal scrub dominated by Coast Banksia (*Banksia integrifolia*) and Southern Mahogany.	PMST	Low – no suitable habitat identified in the study area.
Motacilla flava	Yellow Wagtail	M	-	-	Non-breeding habitat only: mostly well-watered open grasslands and the fringes of wetlands. Roosts in mangroves and other dense vegetation.	PMST	Low – no suitable habitat identified in the study area.
Myiagra cyanoleuca	Satin Flycatcher	M	-	-	The Satin Flycatcher is widespread in eastern Australia. Satin Flycatchers inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests.	PMST	Low – no suitable habitat identified in the study area.
Numenius madagascariensis	Eastern Curlew	CE, M	-	-	Inhabits coastal estuaries, mangroves, mud flats and sand pits. It is a migratory shorebird which generally inhabits sea and lake shore mud flats, deltas and similar areas, where it forages for crabs and other crustaceans, clam worms and other annelids, molluscs, insects and other invertebrates. Its migration route ranges from its wintering grounds in Australia to its breeding grounds in northern China, Korea and Russia.	PMST	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Numenius minutus	Little Curlew	M	-	-	On passage the species shows a preference for foraging and resting in swampy meadows near lakes and along river valleys. It overwinters on dry inland grassland, bare cultivation, dry mudflats and coastal plains of black soil with scattered shallow pools of freshwater, swamps, lakes or flooded ground. It shows a preference for short grass swards of less than 20 cm tall, and occasionally occurs in dry saltmarshes, coastal swamps, mudflats or sandflats in estuaries, or on the beaches of sheltered coasts.	PMST	Low – no suitable habitat identified in the study area.
Numenius phaeopus	Whimbrel	M	-	-	Migrates to Taiwan, Philippines, PNG, and a race breeding in NE Siberia is found on the north and south-eastern coastlines of Australia. Juveniles arrive to Australia from spring to early summer. Usually only juveniles remain in Australia but very occasionally adults in breeding plumage may be seen in Australian winters	PMST	Low – no suitable habitat identified in the study area.
Pluvialis fulva	Pacific Golden Plover	M	-	-	Prefers sandy, muddy or rocky shores, estuaries and lagoons, reefs, saltmarsh, and or short grass in paddocks and crops. The species is usually coastal, including offshore islands; rarely far inland. Often observed on beaches and mudflats, sandflats and occasionally rock shelves, or where these substrates intermingle; harbours, estuaries and lagoons.	PMST	Low – no suitable habitat identified in the study area.
Pluvialis squatarola	Grey Plover	M	-	-	In non-breeding grounds in Australia, Grey Plovers occur almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, or on reefs within muddy lagoons. They also occur around terrestrial wetlands such as near-coastal lakes and swamps, or salt-lakes. The species is also very occasionally recorded further inland, where they occur around wetlands or salt-lakes (Marchant & Higgins 1993). They usually forage on large areas of exposed mudflats and beaches and occasionally in pasture and on muddy margins of inland wetlands. They usually roost in sandy areas, such as on unvegetated sandbanks or sand-spits on sheltered beaches or other sheltered environments.	PMST	Low – no suitable habitat identified in the study area.
Pterodroma leucoptera leucoptera	Gould's Petrel	E	V	-	Breeds on both Cabbage Tree Island, 1.4 km offshore from Port Stephens and on nearby Boondelbah island. The range and feeding areas of non-breeding petrels are unknown. The first arrival of Gould's petrel on cabbage tree Island occurs from mid to late September.	BioNet, PMST (1 record)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Pterodroma neglecta neglecta	Kermadec Petrel	V	V	-	Ranges over subtropical and tropical waters of the South Pacific. Balls Pyramid (near Lord Howe Island) and Phillip Island (near Norfolk Island) are the only known breeding sites in Australian waters.	BioNet, PMST (2 records)	Low – no suitable habitat identified in the study area.
Ninox connivens	Barking Owl	-	V	-	The Barking Owl is found throughout continental Australia except for the central arid regions. Although common in parts of northern Australia, the species has declined greatly in southern Australia and now occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains and in some northeast coastal and escarpment forests. Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey on these fertile riparian soils. Preferentially hunts small arboreal mammals such as Squirrel Gliders and Common Ringtail Possums, but when loss of tree hollows decreases these prey populations the owl becomes more reliant on birds, invertebrates and terrestrial mammals such as rodents and rabbits. Requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 hectares, with 2000 hectares being more typical in NSW habitats.	BioNet (1 record)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Ninox strenua	Powerful Owl	-	V	-	The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered records on the western slopes and plains suggesting occupancy prior to land clearing. Now at low densities throughout most of its eastern range, rare along the Murray River and former inland populations. It inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. It requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine *Syncarpia glomulifera*, Black She-oak *Allocasuarina littoralis*, Blackwood *Acacia melanoxylon*, Rough-barked Apple *Angophora floribunda*, Cherry Ballart *Exocarpus cupressiformis* and a number of eucalypt species. The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider.	BioNet (49 records)	Low – no suitable habitat identified in the study area.
Numenius madagascariensis	Eastern Curlew	CE, M	-	-	Inhabits coastal estuaries, mangroves, mud flats and sand pits. It is a migratory shorebird which generally inhabits sea and lake shore mud flats, deltas and similar areas, where it forages for crabs and other crustaceans, clam worms and other annelids, molluscs, insects and other invertebrates. Its migration route ranges from its wintering grounds in Australia to its breeding grounds in northern China, Korea and Russia.	BioNet, PMST (2 records)	Low – no suitable habitat identified in the study area.
Pandion cristatus (syn. P. haliaetus)	Eastern Osprey	M	V	-	Eastern Ospreys are found right around the Australian coastline, except for Victoria and Tasmania. They are common around the northern coast, especially on rocky shorelines, islands and reefs. The species is uncommon to rare or absent from closely settled parts of south-eastern Australia. There are a handful of records from inland areas. Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water.	BioNet (2 records)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Petroica phoenicea	Flame Robin	-	V	-	In NSW the Flame Robin breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats. In winter lives in dry forests, open woodlands and in pastures and native grasslands, with or without scattered trees. In winter, occasionally seen in heathland or other shrublands in coastal areas. Occasionally occurs in temperate rainforest, and also in herb fields, heathlands, shrublands and sedgelands at high altitudes. The Flame Robin forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other woody debris. The robin builds an open cup nest of plant fibres and cobweb, which is often near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Ptilinopus magnificus	Wompoo Fruit-Dove	-	V	-	Occurs in rainforests, monsoon forests, adjacent eucalypt forests, fruiting trees on scrubby creeks or in open country.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Ptilinopus superbus	Superb Fruit-Dove	-	V	-	The Superb Fruit-dove occurs principally from north-eastern in Queensland to north-eastern NSW. It is much less common further south, where it is largely confined to pockets of suitable habitat as far south as Moruya. There are records of vagrants as far south as eastern Victoria and Tasmania. Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees. Part of the population is migratory or nomadic.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Rhipidura rufifrons	Rufous Fantail	M	-	-	The Rufous Fantail occurs in coastal and near coastal districts of northern and eastern Australia. In east and south-east Australia, this species mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood, Mountain Grey Gum, Narrow-leaved Peppermint, Mountain Ash, Alpine Ash, Blackbutt or Red Mahogany; usually with a dense shrubby understorey often including ferns. They also occur in subtropical and temperate rainforests; for example near Bega in south-east NSW, where they are recorded in temperate Lilly Pilly rainforest, with Grey Myrtle, Sassafras and Sweet Pittosporum subdominants.	PMST	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Rostratula australis (syn. R. benghalensis)	Australian Painted Snipe (Painted Snipe)	E	E1	-	The Australian Painted Snipe is restricted to Australia. Most records are from the south east, particularly the Murray Darling Basin, with scattered records across northern Australia and historical records from around the Perth region in Western Australia. In NSW many records are from the Murray-Darling Basin including the Paroo wetlands, Lake Cowal, Macquarie Marshes, Fivebough Swamp and more recently, swamps near Balldale and Wanganella. Other important locations with recent records include wetlands on the Hawkesbury River and the Clarence and lower Hunter Valleys. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	PMST	Low – no suitable habitat identified in the study area.
Sternula albifrons	Little Tern	M	E1	-	Migrating from eastern Asia, the Little Tern is found on the north, east and south-east Australian coasts, from Shark Bay in Western Australia to the Gulf of St Vincent in South Australia. In NSW, it arrives from September to November, occurring mainly north of Sydney, with smaller numbers found south to Victoria. It breeds in spring and summer along the entire east coast from Tasmania to northern Queensland, and is seen until May, with only occasional birds seen in winter months. Almost exclusively coastal, preferring sheltered environments; however may occur several kilometres from the sea in harbours, inlets and rivers (with occasional offshore islands or coral cay records). Nests in small, scattered colonies in low dunes or on sandy beaches just above high tide mark near estuary mouths or adjacent to coastal lakes and islands.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Sternula nereis nereis	Australian Fairy Tern	V	-	-	Within Australia, the Fairy Tern occurs along the coasts of Victoria, Tasmania, South Australia and Western Australia; occurring as far north as the Dampier Archipelago near Karratha. The subspecies has been known from New South Wales (NSW) in the past, but it is unknown if it persists there. The Fairy Tern (Australian) nests on sheltered sandy beaches, spits and banks above the high tide line and below vegetation. The subspecies has been found in embayments of a variety of habitats including offshore, estuarine or lacustrine (lake) islands, wetlands and mainland coastline.	PMST	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Stictonetta naevosa	Freckled Duck	-	V	-	The Freckled Duck is found primarily in south-eastern and south-western Australia, occurring as a vagrant elsewhere. It breeds in large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina. The duck is forced to disperse during extensive inland droughts when wetlands in the Murray River basin provide important habitat. The species may also occur as far as coastal NSW and Victoria during such times. Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Symposiarchus trivirgatus	Spectacled Monarch	M	-	-	Inhabits dense rainforests and moist eucalypt forests of eastern and north-eastern Australia, the Spectacled Monarch sometimes also inhabits mangroves and other densely vegetated habitats.	PMST	Low – no suitable habitat identified in the study area.
Tringa brevipes	Grey-tailed Tattler	M	-	-	It is often found on sheltered coasts with reefs, rock platforms or with intertidal mudflats. It is also found at intertidal rocky, coral or stony reefs, platforms and islets that are exposed at low tide. It has also been found in embayments, estuaries and coastal lagoons, especially fringed with mangroves. It is rarely seen on open beaches and occasionally found around near-coastal wetlands, such as lagoons, lakes and ponds in sewage farms and saltworks. Inland records for the species are rare. The species forages in shallow water, hard intertidal substrates, rock pools, intertidal mudflats, mangroves, banks of seaweed and among rocks and coral rubble, over which water may surge. The species roosts in mangroves, dense stands of shrubs, snags, rocks, beaches, reefs, artificial structures (sea walls, oyster racks), occasionally in near-coastal saltworks and sewage ponds and rarely on sandy beaches or sand banks.	PMST	Low – no suitable habitat identified in the study area.
Tringa nebularia	Common Greenshank	M	-	-	Occurs in a range of inland and coastal environments. Inland, it occurs in both permanent and temporary wetlands, billabongs, swamps, lakes floodplains, sewage farms, saltworks ponds, flooded irrigated crops. On the coast, it occurs in sheltered estuaries and bays with extensive mudflats, mangrove swamps, muddy shallows of harbours and lagoons, occasionally rocky tidal ledges. It generally prefers wet and flooded mud and clay rather than sand.	PMST	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Tringa stagnatilis	Marsh Sandpiper	M	-	-	Occurs in coastal and inland wetlands (salt or fresh water), estuarine and mangrove mudflats, beaches, shallow or swamps, lakes, billabongs, temporary floodwaters, sewage farms and saltworks ponds.	PMST	Low – no suitable habitat identified in the study area.
Tyto novaehollandiae novaehollandiae	Masked Owl (southern mainland)	-	V	-	Extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. There is no seasonal variation in its distribution. Lives in dry eucalypt forests and woodlands from sea level to 1100 m. A forest owl, but often hunts along the edges of forests, including roadsides. The typical diet consists of tree-dwelling and ground mammals, especially rats. Pairs have a large home-range of 500 to 1000 hectares.	BioNet (9 records)	Low – no suitable habitat identified in the study area.
Tyto tenebricosa	Sooty Owl	-	V	-	Occupies the easternmost one-eighth of NSW, occurring on the coast, coastal escarpment and eastern tablelands. Territories are occupied permanently. Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. Roosts by day in the hollow of a tall forest tree or in heavy vegetation; hunts by night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum (*Pseudocheirus peregrinus*) or Sugar Glider (*Petaurus breviceps*). Nests in very large tree-hollows.	BioNet (34 records)	Low – no suitable habitat identified in the study area.
Xenus cinereus	Terek Sandpiper	M	V	-	A rare migrant to the eastern and southern Australian coasts, being most common in northern Australia, and extending its distribution south to the NSW coast in the east. The two main sites for the species in NSW are the Richmond River estuary and the Hunter River estuary. The latter has been identified as nationally and internationally important for the species.	BioNet (2 records)	Low – no suitable habitat identified in the study area.
Mammals (20)							

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Cercartetus nanus	Eastern Pygmy-possum	-	V	-	The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extents from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes. Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	-	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years. Found in well-timbered areas containing gullies.	PMST	Low – no suitable habitat identified in the study area.
Dasyurus maculatus	Spotted-Tailed Quoll	E	V	-	Found in eastern NSW, eastern Victoria, south-east and north-eastern Queensland, and Tasmania. Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den sites. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares. Are known to traverse their home ranges along densely vegetated creeklines.	BioNet, PMST (10 records)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Falsistrellus tasmaniensis	Eastern False Pipistrelle	-	V	-	The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania. Prefers moist habitats, with trees taller than 20 m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	BioNet (16 records)	Low – no suitable habitat identified in the study area.
Miniopterus australis	Little Bent-winged Bat	-	V	-	Found along east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW. Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. Only five nursery sites /maternity colonies are known in Australia.	BioNet (38 records)	Low – no suitable habitat identified in the study area.
Miniopterus schreibersii oceanensis	Large Bent-winged Bat	-	V	-	Eastern Bentwing-bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Populations disperse within about 300 km range of maternity caves. Hunt in forested areas, catching moths and other flying insects above the tree tops.	BioNet (49 records)	Low – no suitable habitat identified in the study area.
Micronomus norfolkensis	Eastern Coast Free-tail Bat	-	V	-	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures.	BioNet (23 records)	Low – no suitable habitat identified in the study area.
Myotis macropus	Southern Myotis, Large-footed Myotis	-	V	-	The Southern Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers. Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface.	BioNet (10 records)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Petauroides volans	Greater Glider	V	V	-	The Greater Glider has a restricted distribution in eastern Australia, from the Windsor Tableland in north Queensland to central Victoria, with an elevated range from sea level to 1200m above sea level. The species is largely restricted to eucalypt forests and woodlands, feeds exclusively on eucalypt leaves, buds, flowers and mistletoe. It is found in abundance in montane eucalypt forest with relatively old trees and an abundance of hollows. It also favours forests with a diversity of eucalypts to cater for seasonal variation in food abundance.	BioNet, PMST (2 records)	Low – no suitable habitat identified in the study area.
Petaurus australis	Yellow-bellied Glider	V	V	-	The Yellow-bellied Glider is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. Extract sap by incising (or biting into) the trunks and branches of favoured food trees, often leaving a distinctive 'V'-shaped scar. Very mobile and occupy large home ranges between 20 to 85 ha to encompass dispersed and seasonally variable food resources.	BioNet, PMST (72 records)	Low – no suitable habitat identified in the study area.
Petaurus norfolcensis	Squirrel Glider	-	V	-	The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria. Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey. Require abundant tree hollows for refuge and nest sites. Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein.	BioNet (22 records)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1	-	The range of the Brush-tailed Rock-wallaby extends from south-east Queensland to the Grampians in western Victoria, roughly following the line of the Great Dividing Range. However the distribution of the species across its original range has declined significantly in the west and south and has become more fragmented. In NSW they occur from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit. Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night. Highly territorial and have strong site fidelity with an average home range size of about 15 ha.	PMST	Low – no suitable habitat identified in the study area.
Phascolarctos cinereus	Koala	E	E1	-	The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. It was briefly historically abundant in the 1890s in the Bega District on the south coast of NSW, although not elsewhere, but it now occurs in sparse and possibly disjunct populations. Koalas are also known from several sites on the southern tablelands. Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. Some preferred species include Forest Red Gum, Grey Gum. In coastal areas, Tallowwood and Swamp Mahogany are important food species, while in inland areas White Box, Bimble Box and River Red Gum are favoured. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size.	BioNet, PMST (5 records)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Phoniscus papuensis	Golden-tipped Bat	-	V	-	The Golden-tipped Bat is distributed along the east coast of Australia in scattered locations from Cape York Peninsula in Queensland to south of Eden in southern NSW. It has recently been trapped just inside the Victorian border. It also occurs in New Guinea. Found in rainforest and adjacent wet and dry sclerophyll forest up to 1000m. Also recorded in tall open forest, Casuarina-dominated riparian forest and coastal Melaleuca forests. Roost mainly in rainforest gullies on small first- and second-order streams in usually abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests modified with an access hole on the underside. Bats may also roost under thick moss on tree trunks, in tree hollows, dense foliage and epiphytes.	BioNet (9 records)	Low – no suitable habitat identified in the study area.
Potorous tridactylus tridactylus	Long-nosed Potoroo (northern)	V	V	-	The long-nosed potoroo is found on the south-eastern coast of Australia, from Queensland to eastern Victoria and Tasmania, including some of the Bass Strait islands. There are geographically isolated populations in western Victoria. In NSW it is generally restricted to coastal heaths and forests east of the Great Dividing Range, with an annual rainfall exceeding 760 mm. Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. The fruit-bodies of hypogeous (underground-fruiting) fungi are a large component of the diet of the Long-nosed Potoroo. They also eat roots, tubers, insects and their larvae and other soft-bodied animals in the soil.	BioNet, PMST (2 records)	Low – no suitable habitat identified in the study area.
Pseudomys novaehollandiae	New Holland Mouse	V	V	-	The New Holland Mouse has a fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Genetic evidence indicates that the New Holland Mouse once formed a single continuous population on mainland Australia and the distribution of recent subfossils further suggest that the species has undergone a large range contraction since European settlement. Total population size of mature individuals is now estimated to be less than 10,000 individuals although, given the number of sites from which the species is known to have disappeared between 1999 and 2009, it is likely that the species' distribution is actually smaller than current estimates. Known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes.	BioNet, PMST (1 record)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	-	Grey-headed Flying-foxes are generally found within 200km of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia. Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Can travel up to 50km from the camp to forage; commuting distances are more often <20km. Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines.	BioNet, PMST (60 records)	Low – no suitable habitat identified in the study area.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	-	V	-	The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia. In the most southerly part of its range - most of Victoria, south-western NSW and adjacent South Australia - it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes. Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.	BioNet (2 records)	Low – no suitable habitat identified in the study area.
Scoteanax rueppellii	Greater Broad-nosed Bat	-	V	-	The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however, does not occur at altitudes above 500m. Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3-6m.	BioNet (15 records)	Low – no suitable habitat identified in the study area.

Scientific name	Common Name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat	Data source[4]	Likelihood of occurrence
Vespadelus troughtoni	Eastern Cave Bat	-	V	-	The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT. A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals. Occasionally found along cliff-lines in wet eucalypt forest and rainforest.	BioNet (1 record)	Low – no suitable habitat identified in the study area.

(1) Listed under the Commonwealth Environment Protection and Biodiversity Act 1999 – CD = Conservation Dependent, CE = Critically Endangered, E= Endangered, V= Vulnerable, M= Migratory, Ma=Marine

(2) Listed under the NSW Biodiversity Conservation Act 2016 – CE = Critically Endangered, E1= Endangered, E2= Endangered Population, V= Vulnerable

(3) BioNet search = Department of Planning and Environment's BioNet Atlas of NSW Wildlife (records within 10km of the study area/regional search); **PMST=** Department of Climate Change, Energy, the Environment and Water's EPBC Protected Matters Search Tool

(4) Habitat descriptions sourced from Department of Planning and Environment's Threatened Biodiversity Profile Search (Department of Planning Industry and Environment, 2022) and Department of Climate Change, Energy, the Environment and Water's Species Profile and Threats Database website (Department of Climate Change Energy the Environment and Water, 2022b) for each species.

D1 Likelihood of Occurrence

The likelihood of threatened and migratory species occurring within the study area was assessed against the criteria outlined in Table D.2. Species subject to likelihood of occurrence assessments were those identified during the desktop assessments and any additional species considered to have potential to occur in the professional opinion of the contributors to this assessment.

Table D.2 Likelihood of occurrence assessment

Likelihood of occurrence	Criteria
Recorded	The species has been previously recorded within the study area.
High	A species has a high likelihood of occurrence if it was not recorded during field surveys and fit one or more of the following criteria: — the study area is likely to contain suitable habitat, habitat types that are present in the study area are abundant and/or in good condition — important habitat elements (i.e. for breeding or important life cycle periods such as winter foraging periods) are likely to be present — the species has been recorded recently and/or frequently in similar habitat in the study area and locality — the study area is likely to support a resident population or to contain habitat that is visited by the species during regular seasonal movements or migration.
Moderate	A species has a moderate likelihood of occurrence if it was not recorded during field surveys and fit one or more of the following criteria: — the study area contains or is likely to contain potential habitat, habitat types and resources present in the study area may be poor or modified in condition — important habitat elements (i.e. for breeding or important life cycle periods such as winter foraging periods) are likely to be present — the species has not been recently recorded in similar habitat within the locality or has been recorded infrequently in the locality — the study area is unlikely to support a resident population or to contain habitat that is visited by the species during regular seasonal movements or migration but is likely to be used opportunistically on an infrequent basis during seasonal movements and/or dispersal — are cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
Low	A species has a low likelihood of occurrence if it was not recorded during field surveys and fit one or more of the following criteria: — have not been recorded previously in the study area and surrounds and for which the study area is beyond the current distribution range — rely on specific habitat types or resources that are not present in the study area — are considered locally extinct — are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.

Appendix E

Threatened flora likelihood of occurrence

Table E.1 Threatened flora species likelihood of occurrence assessment

Family	Species Name	Common Name	EPBC Act[2]	BC Act[1]	Habitat[3]	Data Source[4]	Likelihood of occurrence
Fabaceae	*Acacia bynoeana*	Bynoe's Wattle	V	E1	Bynoe's wattle is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. The species is currently known from about 30 locations, with the size of the populations at most locations being very small (1-5 plants). It has recently been found in the Colymea and Parma Creek areas west of Nowra. Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches.	PMST	Low – no suitable habitat identified in the study area.
Fabaceae	*Acacia pubescens*	Downy Wattle	V	V	Occurs on alluviums, shales and at the intergrade between shales and sandstones. Occurs in open woodland and forest, in a variety of plant communities, including Cooks River / Castlereagh Ironbark Forest, Shale/Gravel Transition Forest and Cumberland Plain Woodland.	PMST	Low – no suitable habitat identified in the study area.
Myrtaceae	*Angophora inopina*	Charmhaven Apple	V	V	Endemic to the Central Coast region of NSW. The known northern limit is near Karuah where a disjunct population occurs; to the south populations extend from Toronto to Charmhaven with the main population occurring between Charmhaven and Morisset. There is an unconfirmed record of the species near Bulahdelah. Approximately 1250 ha of occupied habitat has been mapped in the Wyong–southern Lake Macquarie area.	BioNet, PlantNet, PMST (5 records)	Low – no suitable habitat identified in the study area.
Rutaceae	*Asterolasia elegans*	–	E	E	Occurs on Hawkesbury sandstone. Can be found in sheltered forests on mid to low slopes and valleys and in areas of sheltered forest.	PMST	Low – no suitable habitat identified in the study area.
Restionaceae	*Baloskion longipes*	Dense Cord-rush	V	V	Commonly found in swamps or depressions in sandy alluvium, sometimes growing with sphagnum moss. Also occurs in swails within tall forest, and in Black Gum (*Eucalyptus aggregata*) Woodland.	PMST	Low – no suitable habitat identified in the study area.

Family	Species Name	Common Name	EPBC Act[2]	BC Act[1]	Habitat[3]	Data Source[4]	Likelihood of occurrence
Orchidaceae	*Caladenia tessellate*	Thick Lip Spider Orchid	V	E1	The Thick Lip Spider Orchid is known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Populations in Kiama and Queanbeyan are presumed extinct. It was also recorded in the Huskisson area in the 1930s. The species occurs on the coast in Victoria from east of Melbourne to almost the NSW border.	PlantNet, PMST	Low – no suitable habitat identified in the study area.
Myrtaceae	*Callistemon linearifolius*	Netted Bottle Brush	-	V	Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. Recorded in 2000 at Coalcliff in the northern Illawarra. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. The species was more widespread in the past, and there are currently only 5-6 populations remaining from the 22 populations historically recorded in the Sydney area. Three of the remaining populations are reserved in Ku-ring-gai Chase National Park, Lion Island Nature Reserve and Spectacle Island Nature Reserve. The species has also been recorded from Yengo National Park.	PlantNet	Low – no suitable habitat identified in the study area.
Orchidaceae	*Corunastylis* sp. Charmhaven	–	CE	CE	A terrestrial orchid which is known only from Charmhaven in the Wyong LGA. It occurs within low woodland to heathland with a shrubby understorey and ground layer. Dominants include Black She-oak (*Allocasuarina littoralis*), Prickly Tea-tree (*Leptospermum juniperinum*), Prickly-leaved Paperbark (*Melaleuca nodosa*), Narrow-leaved Bottlebrush (*Callistemon linearis*) and Zig-zag Bog-rush (*Schoenus brevifolius*).	PMST	Low – no suitable habitat identified in the study area.
Orchidaceae	*Cryptostylis hunteriana*	Leafless Tongue Orchid	V	V	Occurs south from the Gibraltar Range, chiefly in coastal districts but also extends on to tablelands. Grows in swamp-heath and drier forest on sandy soils on granite & sandstone. Occurs in small, localised colonies most often on the flat plains close to the coast but also known from some mountainous areas growing in moist depressions and swampy habitats.	PlantNet, PMST	Low – no suitable habitat identified in the study area.

Family	Species Name	Common Name	EPBC Act[2]	BC Act[1]	Habitat[3]	Data Source[4]	Likelihood of occurrence
Apocynaceae	*Cynanchum elegans*	White-flowered Wax Plant	E	E1	The White-flowered Wax Plant usually occurs on the edge of dry rainforest vegetation. Restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. The species has been recorded as far west as Merriwa in the upper Hunter River valley.	PMST	Low – no suitable habitat identified in the study area.
Orchidaceae	*Diuris praecox*	Rough Doubletail	V	V	Known from between Bateau Bay and Smiths Lake. Grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey. Exists as subterranean tubers most of the year. It produces leaves and flowering stems in winter.	PlantNet, PMST	Low – no suitable habitat identified in the study area.
Ericaceae	*Epacris purpurascens var. purpurascens*	–	-	V	Recorded from Gosford in the north, to Narrabeen in the east, Silverdale in the west and Avon Dam vicinity in the South. Found in a range of habitat types, most of which have a strong shale soil influence. Lifespan is recorded to be 5-20 years, requiring 2-4 years before seed is produced in the wild. Killed by fire and re-establishes from soil-stored seed.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Myrtaceae	*Eucalyptus camfieldii*	Camfield's Stringybark	V	V	Restricted distribution in a narrow band with the most northerly records in the the Raymond Terrace area south to Waterfall. Localised and scattered distribution includes sites at Norah Head (Tuggerah Lakes), Peats Ridge, Mt Colah, Elvina Bay Trail (West Head), Terrey Hills, Killara, North Head, Menai, Wattamolla and a few other sites in Royal National Park. Poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges. Occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas.	PlantNet, PMST	Low – no suitable habitat identified in the study area.
Myrtaceae	*Eucalyptus pumila*	Pokolbin Mallee	V	V	Currently known only from a single population west of Pokolbin in the Hunter Valley. Historical records also exist for Wyong and Sandy Hollow, however, has not been recorded recently in these areas.	PlantNet	Low – no suitable habitat identified in the study area.

Family	Species Name	Common Name	EPBC Act[2]	BC Act[1]	Habitat[3]	Data Source[4]	Likelihood of occurrence
Myrtaceae	*Eucalyptus oblonga*	–	–	E2	Restricted and localized, in dry sclerophyll woodland on extremely infertile sandy soils on sandstone; from Gosford to Nowra; recently found in Oxley Rivers National Park, in the northern tablelands.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Orobanchaceae	*Euphrasia arguta*	–	CE	CE	Inhabits (Nundle region) eucalypt forest with a mixed grass and shrub understorey. As with other species of *Euphrasia*, this species is semi-parasitic and attaches to the roots of other associated plants.	PMST	Low – no suitable habitat identified in the study area.
Orchidaceae	*Genoplesium baueri*	Bauer's Midge Orchid	E	E1	The species has been recorded from locations between Ulladulla and Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections have been made from those sites in recent years. Currently the species is known from just over 200 plants across 13 sites. The species has been recorded at locations now likely to be within the following conservation reserves: Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments.	PMST	Low – no suitable habitat identified in the study area.
Orchidaceae	*Genoplesium insigne*	Variable Midge Orchid	CE	CE	Recorded from four localities between Chain Valley Bay and Wyong in Wyong local government area. A small population also occurs within Lake Macquarie LGA. Known locations/populations of plants exhibit dormancy for greater than four years (likely to persist underground for greater than four years). Therefore, absence in a given year may be a 'false absence' and the plants can re-emerge once conditions are favourable (e.g. rainfall in winter and appropriate disturbance).	PlantNet, PMST	Low – no suitable habitat identified in the study area.

Family	Species Name	Common Name	EPBC Act[2]	BC Act[1]	Habitat[3]	Data Source[4]	Likelihood of occurrence
Orchidaceae	*Genoplesium plumosum*	Tallong Midge Orchid	E	CE	The Tallong Midge Orchid was originally collected at Kurnell in 1947; presumably it also occurred south of there, but it is now only known from two areas - the village of Tallong and its immediate environs, and a site in Morton National Park 8.5 km south-east of the town of Wingello. At Tallong it occurs within an area of less than two kilometres north and east of the town centre and the largest population of flowering plants that has been recorded (in 2001) is less than 300 plants. The Morton National Park site was discovered in 2001 and there were only 10 flowering plants at that time. Surveys have failed to locate any plants there since then.	PlantNet	Low – no suitable habitat identified in the study area.
Polypodiaceae	*Grammitis stenophylla*	Narrow-leaf Finger Fern	-	E1	*Grammitis stenophylla* is known from 30 locations across New South Wales. The species is known to occur in 24 conservations reserves. It is common in several areas, such as the Mount Warning Shield, the sandstone reserves of the lower Clarence, the granites of Washpool, Gibraltar and Nymbioda National Parks, and also Mt Jerusalem and Nightcap National Park. The species was also recently recorded from New England National Park. Found in moist places, usually near streams, on rocks or in trees, in rainforest and moist eucalypt forest.	PlantNet	Low – no suitable habitat identified in the study area.
Proteaceae	*Grevillea parviflora subsp. parviflora*	Small flower Grevillea	V	V	Sporadically distributed throughout the Sydney Basin with sizeable populations around Picton, Appin and Bargo (and possibly further south to the Moss Vale area) and in the Hunter in the Cessnock - Kurri Kurri area (particularly Werakata NP). Separate populations are also known from Putty to Wyong and Lake Macquarie on the Central Coast.	PlantNet	Low – no suitable habitat identified in the study area.
Proteaceae	*Grevillea shiressii*	–	V	V	Known from two populations near Gosford, on tributaries of the lower Hawkesbury River north of Sydney (Mooney Mooney Creek and Mullet Creek). Both populations occur within the Gosford Local Government Area. There is also a naturalised population at Newcastle. Grows along creek banks in wet sclerophyll forest with a moist understorey in alluvial sandy or loamy soils.	PMST	Low – no suitable habitat identified in the study area.

Family	Species Name	Common Name	EPBC Act[2]	BC Act[1]	Habitat[3]	Data Source[4]	Likelihood of occurrence
Malvaceae	*Lasiopetalum joyceae*	–	V	V	Has a restricted range occurring on lateritic to shaley ridgetops on the Hornsby Plateau south of the Hawkesbury River. It is currently known from 34 sites between Berrilee and Duffys Forest. Seventeen of these are reserved. Grows in heath on sandstone.	PMST	Low – no suitable habitat identified in the study area.
Proteaceae	*Macadamia integrifolia*	Macadamia Nut	V	–	Not known to occur naturally in the wild in NSW.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Juncaginaceae	*Maundia triglochinoides*	–	–	V	Restricted to coastal NSW and extending into southern Queensland. The current southern limit is Wyong; former sites around Sydney are now extinct. Grows in swamps, lagoons, dams, channels, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients. Flowering occurs during warmer months.	BioNet (11 records), PlantNet	Low – no suitable habitat identified in the study area.
Myrtaceae	*Melaleuca biconvexa*	Biconvex Paperbark	V	V	Biconvex Paperbark is only found in NSW, with scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north. Biconvex Paperbark generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects. Flowering occurs over just 3-4 weeks in September and October. Resprouts following fire.	BioNet, PlantNet, PMST (514 records)	Low – no suitable habitat identified in the study area.
Myrtaceae	*Melaleuca deanei*	Dean's Melaleuca	V	V	The species occurs mostly in ridgetop woodland, with only 5% of sites in heath on sandstone. Occurs in two distinct areas, in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas respectively. There are also more isolated occurrences at Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas.	PMST	Low – no suitable habitat identified in the study area.

Family	Species Name	Common Name	EPBC Act[2]	BC Act[1]	Habitat[3]	Data Source[4]	Likelihood of occurrence
Polygonaceae	*Persicaria elatior*	Tall Knotweed	V	V	*Tall Knotweed has been recorded in south-eastern NSW (Mt Dromedary (an old record), Moruya State Forest near Turlinjah, the Upper Avon River catchment north of Robertson, Bermagui, and Picton Lakes. In northern NSW it is known from Raymond Terrace (near Newcastle) and the Grafton area (Cherry Tree and Gibberagee State Forests). The species also occurs in Queensland. This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance.*	PMST	Low – no suitable habitat identified in the study area.
Proteaceae	*Persoonia hirsuta*	Hairy Geebung	E	E1	*Persoonia hirsuta* has a scattered distribution around Sydney. The species is distributed from Singleton in the north, along the east coast to Hilltop in the south west, Dombarton in the south east and the Blue Mountains to the west. *Persoonia hirsuta* has a large area of occurrence, but occurs in small populations or isolated individuals, increasing the species' fragmentation in the landscape. The Hairy Geebung is found in clayey and sandy soils in dry sclerophyll open forest, woodland and heath, primarily on the Mittagong Formation and on the upper Hawkesbury Sandstone.	PMST	Low – no suitable habitat identified in the study area.
Thymelaeaceae	*Pimelea curviflora var. curviflora*	–	V	V	A small shrub with grows to 120cm in height. Confined to the coastal area of the Sydney and Illawarra regions. Populations are known between northern Sydney and Maroota in the north-west. Occurs on shaley/lateritic soils over shale sandstone transition soils on ridgetops and upper slopes amongst woodlands. Also recorded in Illawarra Lowland Grassy Woodland habitat. Flowers in October to May.	PMST	Low – no suitable habitat identified in the study area.

Family	Species Name	Common Name	EPBC Act[2]	BC Act[1]	Habitat[3]	Data Source[4]	Likelihood of occurrence
Lamiaceae	*Prostanthera askania*	Tranquility Mintbush	E	E1	Occurs over a very restricted geographic range (of less than 12 km) in the upper reaches of creeks that flow into Tuggerah Lake or Brisbane Water within the Wyong and Gosford local government areas. Eight populations are known from the catchments of Ourimbah Creek, Narara Creek, Dog Trap Gully, Chittaway Creek and Berkeley Creek. A further two populations are known from the Erina Creek–Fires Creek catchment. The species may also have occurred in West Gosford. Occurs in moist sclerophyll forest and warm temperate rainforest communities, and the ecotone between them.	BioNet, PlantNet, PMST (195 records)	Low – no suitable habitat identified in the study area.
Lamiaceae	*Prostanthera junonis*	Somersby Mintbush	E	E1	The species is restricted to the Somersby Plateau. It occurs on both the Somersby and Sydney Town soil landscapes on gently undulating country over weathered Hawkesbury sandstone within open forest/low woodland/open scrub. It occurs in both disturbed and undisturbed sites. The dominant flowering period for this species is October to mid-December depending on weather/site conditions. The plant is very difficult to identify outside of this time.	PlantNet, PMST	Low – no suitable habitat identified in the study area.
Orchidaceae	*Rhizanthella slateri*	Eastern Australian Underground Orchid	E	V	Endangered Population. Flowers from September to November. This population is found on the northern limits of the species in the Great Lakes LGA. Little is known about the preferred habitat of this species, but apparently prefers Sclerophyll forest with a reasonably deep layer of organic litter.	PMST	Low – no suitable habitat identified in the study area.
Myrtaceae	*Rhodamnia rubescens*	Scrub Turpentine	CE	CE	Occurs in coastal districts north from Batemans Bay in New South Wales, approximately 280 km south of Sydney, to areas inland of Bundaberg in Queensland. Populations of *R. rubescens* typically occur in coastal regions and occasionally extend inland onto escarpments up to 600 m a.s.l. in areas with rainfall of 1,000-1,600 mm. Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils.	BioNet, PlantNet, PMST (67 records)	Low – no suitable habitat identified in the study area.

Family	Species Name	Common Name	EPBC Act[2]	BC Act[1]	Habitat[3]	Data Source[4]	Likelihood of occurrence
Myrtaceae	*Rhodomyrtus psidioides*	Native Guava	CE	CE	Occurs from Broken Bay, approximately 90 km north of Sydney, New South Wales, to Maryborough in Queensland. Populations are typically restricted to coastal and sub-coastal areas of low elevation however the species does occur up to c. 120 km inland in the Hunter and Clarence River catchments and along the Border Ranges in NSW. Pioneer species found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest often near creeks and drainage lines.	BioNet, PlantNet, PMST (9 records)	Low – no suitable habitat identified in the study area.
Asteraceae	*Rutidosis heterogama*	Heath Wrinklewort	V	V	Recorded from near Cessnock to Kurri Kurri with an outlying occurence at Howes Valley. On the Central Coast it is located north from Wyong to Newcastle. There are north coast populations between Wooli and Evans Head in Yuraygir and Bundjalung National Parks. It also occurs on the New England Tablelands from Torrington and Ashford south to Wandsworth south-west of Glen Innes. Grows in heath on sandy soils and moist areas in open forest and has been recorded along disturbed roadsides.	PlantNet, PMST	Low – no suitable habitat identified in the study area.
Fabaceae (Caesalpinioideae)	*Senna acclinis*	Rainforest Cassia	-	E1	Occurs in coastal districts and adjacent tablelands of NSW from the Illawarra in NSW to Queensland. Grows on the margins of subtropical, littoral and dry rainforests. Often found as a gap phase shrub. Flowering occurs in spring and summer and the fruit is ripe in summer and autumn. Primarily pollinated by a variety of bees.	BioNet (1 record)	Low – no suitable habitat identified in the study area.
Myrtaceae	*Syzygium paniculatum*	Magenta Lilly Pilly	V	E1	The Magenta Lilly Pilly is found only in NSW, in a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest. On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.	BioNet, PlantNet, PMST (14 records)	Low – no suitable habitat identified in the study area.

Family	Species Name	Common Name	EPBC Act[2]	BC Act[1]	Habitat[3]	Data Source[4]	Likelihood of occurrence
Elaeocarpaceae	*Tetratheca juncea*	Black-eyed Susan	V	V	Confined to the northern portion of the Sydney Basin bioregion and the southern portion of the North Coast bioregion in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock. It is usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover. However, it has also been recorded in heathland and moist forest. The majority of populations occur on low nutrient soils associated with the Awaba Soil Landscape.	PlantNet, PMST	Low – no suitable habitat identified in the study area.
Orchidaceae	*Thelymitra adorata*	Wyong Sun Orchid	CE	CE	Currently known from several local government areas (LGA) within the Central Coast Council region of New South Wales. These include but are not limited to the LGAs of Wyong, Warnervale and Wyongah. Also recorded in the southern portion of Lake Macquarie City Council area. A number of sites where the species occurs are subject to past and ongoing disturbance, including sites on the edges of roads that contain a mixture of native and introduced species in the understorey, though competition with invasive introduced species is a threat. At Wyong (Pacific Hwy) the species occurs as the only native amongst an array of exotic species, where weedy grasses dominate.	PlantNet, PMST	Low – no suitable habitat identified in the study area.
Santalaceae	*Thesium australe*	Austral Toadflax	V	V	Found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. Grows in association with *Themeda triandra* and (less frequently) with *Poa* spp.	PMST	Low – no suitable habitat identified in the study area.

(1) Listed as Vulnerable (V), Endangered (E1), Endangered populations (E2) or Critically Endangered (CE) under the *Biodiversity Conservation Act 2016* (BC Act).

(2) Listed as Vulnerable (V), Endangered (E), Critically Endangered (CE) or Migratory (M) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

(3) Habitat profiles sourced from each species Department of Planning and Environment's online species profile (Department of Planning and Environment, 2022b) and Department of Climate Change, Energy, the Environment and Water's Species Profile and Threats Database (Department of Climate Change Energy the Environment and Water, 2022b).

(4) Data source: PMST = DCCEEW EPBC Protected Matters Search Tool; BioNet Search = DPEs BioNet Atlas of NSW Wildlife. PlantNet = NSW Flora online spatial search.

Appendix G: Noise Assessments

The TfNSW Construction Noise Estimator Tool is only suitable for simple noise assessment as detailed in Section 4.1 of the TfNSW Construction Noise & Vibration Strategy. To determine if the tool can be used, complete the questions below:

-	Description of construction site locality	Kangy Angy Maintenance Facility
-	Brief description of construction scenario to be assessed	Enabling works OUTSIDE maintenance facility (Road 5)
-	User Name and Company	UGL
-	Assessment Date	30 June 2022

	Question	User Input	Feedback/Instructions
1	When will work be completed?	Standard Hours	Yes, the Construction Noise Estimator Tool can be used.
2	How long will it take to complete the construction works?	Less than 6-weeks	Yes, the Construction Noise Estimator Tool can be used.
3a	Is vibration intensive equipment to be used within 100m of sensitive receivers? (Section 5.3)	No	Continue to Question 4; the Construction Noise Estimator can be used.
3b	Continue to Question 4		
4	Will the work exceed construction traffic noise objectives (increase traffic noise by 2dBA over 'without construction' levels) and/or sleep disturbance objectives (Activities with LA_{max} in exceedance of 15dBA over RBL in Period 2 at the nearest receiver)?	No	The Construction Noise Estimator Tool can be used.

	User Input
	Calculated Value
	High Noise Plant/Equipment

This spreadsheet is used to calculate the cumulative sound power level when multiple plants/equipment are used
Equipment that generates noise with special audible characteristics (including intensive vibration) are highlighed in orange.

Note: The predictions provided by this Noise Estimator Tool will generate the worst case scenario for construction activities. For more accurate predictions it may be suitable to divide each work stage or work shift into separate estimates or engage a suitably qualified person such as an acoustic consultant to prepare a Detailed Assessment.

Total number of plant/equipment to be used	**11**
Cumulative Sound Power Level, SWL (dBA)	**119**
SWL with Special Audible Characteristics Correction (dBA)	**124**

Use whole numbers only. Include all equipment that will be used for a minimum of 15-minutes.

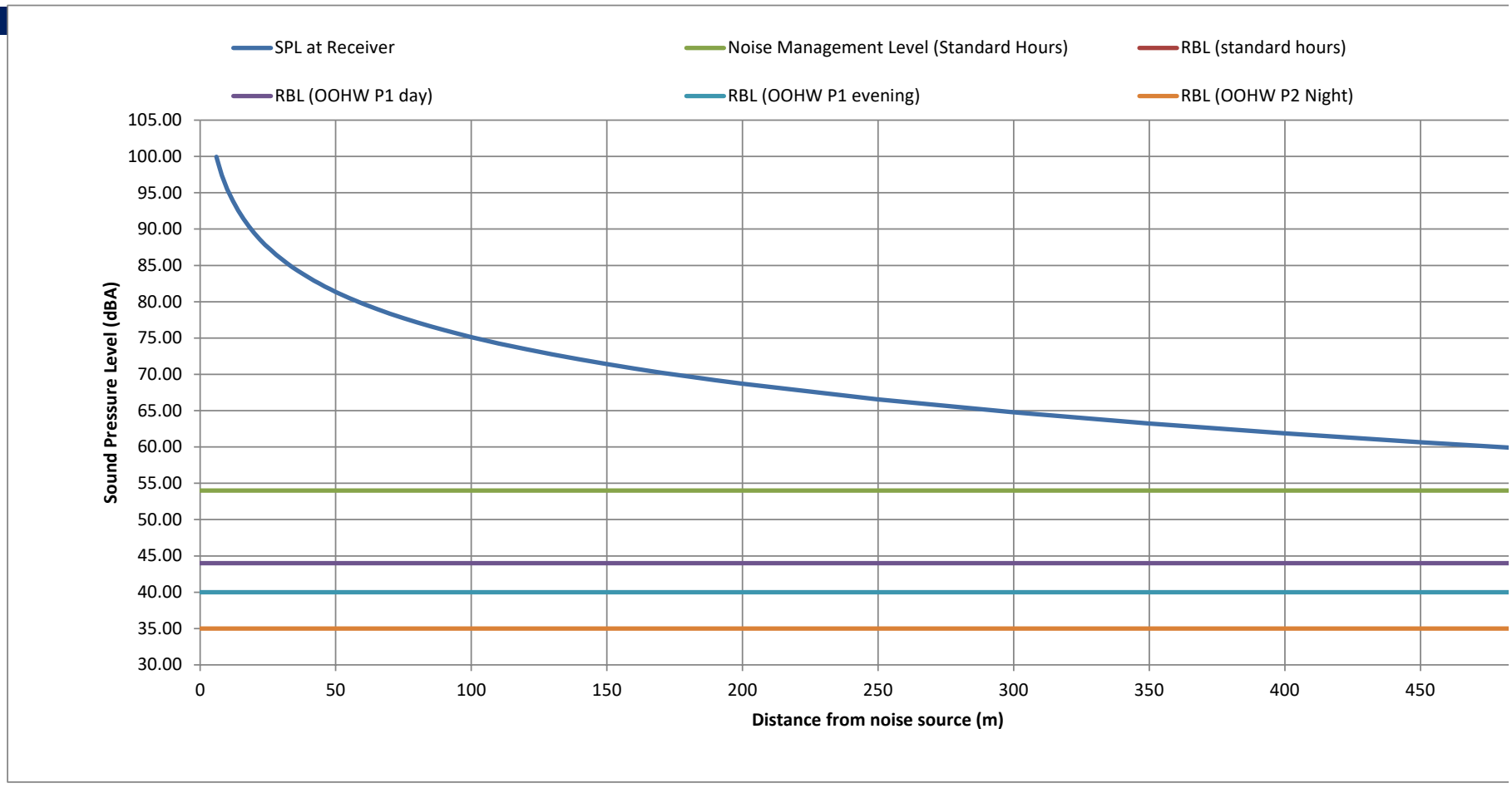
Plant / Equipment	SWL, LA_{eq} (dBA)	No. of plant / equipment to be used	Sound energy' level	Plant Cum. SWL (dBA)
Air Compressor	102			0
Asphalt Truck & Sprayer	106			0
Auger/Drill Rig	105			0
Angle grinder (small - up to 7 inch)	109			0
Backhoe 108 dBA	111			0
Chainsaw 96	114			0
Compressor	109			0
Concrete Pump 106	109			0
Concrete saw/corer 115	118			0
Concrete Truck / Agitator 106	**109**	1	79432823472	**109**
Concrete Vibrator 102	113			0
D9 Dozer 118 dBA	116			0
D10 Dozer	121			0
Daymakers (4 Aspects) 77	98			0
Elevated Work Platform 97	**95**	1	3162277660	**95**
Excavator (3 tonne) 84	90	1	1000000000	**90**
Excavator (6 tonne) 92	95			0
Excavator (10 tonne) 94	**100**	2	20000000000	**103**
Excavator (20 tonne) 105	105			0
Excavator (30 tonne) 110	110			0
Excavator (40 tonne) 115	115			0
Excavator (large) + rock breaker 121	122			0
Excavator hammer 10 T 112	118			0
Flatbed truck 100	108			0
Flood Lights	90			0
Franna - Crane	98			0
Generator - Diesel /Petrol	103			0
Generator - Attenuated	92			0
Grader/Scraper	113			0
Grinder	**109**	1	79432823472	**109**
Hammer Drill 108	116			0
Hand Tools (powered)	**102**	2	31697863849	**105**
Impact drill	116			0
Impact wrench	111			0
Jackhammer	**113**	2	3.99052E+11	**116**
Line Marking Plant 104	108			0
Loader - Front End/Telehander	112			0
Mobile Crane (20 tonne) 99	108			0
Mobile Crane (60 tonne) 100	108			0
Mobile crane (all terrain)	110			0
Mobile crane truck / HIAB (12 tonne) 98	108			0
Mobile Crane (Franna) 99	98			0
Pad Foot Roller 109	109			0
Pavement Profiler	117			0
Paving machine (Asphalt) 104	114			0
Pile Driver (Vibratory)	121			0
Piling Rig (Bored) 108	112			0
Piling Rig (Impact)	134			0
Rail Regulator/Tamper	98			0
Rail Saw	107			0
Roller (non vibratory) 110 dBA	**110**	1	1E+11	**110**
Semi tralier 106	103			0
Scissor Lift	98			0
Skidsteer Loader 1/2 T	107			0
Skidsteer Loader 1 T	110			0
Sucker Truck/Road Sweeper	109			0
Tipper truck (Single) 97	108			0
Tipper truck with dog 97	108			0
Truck (10 tonne)	103			0
Truck (Semi trailer) 106	103			0
Dump truck	110			0
Tub Grinder/Mulcher	116			0
Tunnel boring machine 111 dBA	111			0
Ute/4WD 98 dBA	103			0
Vacuum Truck/Sweeper	109			0
Vibratory Roller 114 dBA	109			0
Wacker rammer 106	106			0
Water Tanker (8000 litre) 98	107			0
Welding Equipment (Thermit)	110			0
	76			0
Other:				0
Other:				0

Noise Estimate Results

	Sound Power Level (dBA)	Distance (m)	Sound Pressure Level (dBA)	Air Attenuation (dBA) Day and Evening	Air Attenuation (dBA) Night	Additional Attenuation (hoarding etc) (dBA)[1]	Predicted Noise level (SPL dBA LAeq) Day and Evening	Predicted Noise level (SPL dBA LAeq) Night
May to Sep	**124**	170	**70.93**	**0.69**	**0.73**	10	**60.24**	**60.20**

	Standard Hours	OOHW P1 Day	OOHW P1 Evening	OOHW P2 Night
Rating Background Level (RBL)	44	44	40	35
RBL Exceedance	**16**	**16**	**20**	**25**
Noise Management Level (NML)	54	49	45	40

May to Sep



Notes: Where the SPL line intersects with the RBL line in the graph above demonstrates the total radius (m) of impacted receivers
SPL = SWL(point) - 20log (r) - 8 - Additional Attenuation
Sound Power Level includes +5dBA adjustment for noise with special audible characteristics (if requried)

[1] Continuous, long solid barrier within the project boundary, that breaks line of sight between work area and receiver = 5dBA reduction
Enclosed, solid structure around work area/equipment = 10dBA reduction

The required mitigation measures for your activity are:

	Exceedance of RBL (dBA)															
	Standard Hours				OOHW Period 1 Day				OOHW Period 1 Evening				OOHW Period 2 - Night			
	0-20	20-30	>30	>75dBA*	5-10	10-20	20-30	>30	5-10	10-20	20-30	>30	5-10	10-20	20-30	>30
Standard Mitigation Measures (TfNSW CNVS Appendix C)	Yes					Yes					Yes				Yes	
Additional Mitigation Measures (TfNSW CNVS Appendix D)																
Periodic notification						Yes					Yes				Yes	
Verification monitoring											Yes				Yes	
Specific Notification											Yes				Yes	
Respite Offer											Yes				Yes	
Respite Period											Yes				Yes	
Duration Reduction											Yes				Yes	
Alternative Accommodation																

*** Any work above 75dBA regardless of RBL exceedance**

Assessment Summary

Site Locality	
Construction Scenario	Enabling works OUTSIDE maintenance facility (Road 5)
User Name and Company	UGL
Number of Sources and SWL	11 Sources with overall SWL of 124 dBA including 5 dBA penalty for high impact noise
Receiver Distance	170 m
Barrier/enclosure attenuation	10 dBA
Assessment Date	30 June 2022

Predicted Noise Level 60 dBA 60 dBA

Period	RBL	NML	+ RBL
Standard Hours	44	54	16
OOHW Period 1 - Day	44	49	16
OOHW Period 1 - Evenin	40	45	20
OOHW Period 2 - Night	35	40	25

A map show ng the ocat on of the proposed work area (source) nearest sens t ve rece ver map sca e and north arrow should be nc uded into the no se est mator too . The map should be c ear w th a required e ements c ear y v s ble and not c uttered w th nformat on

L st of m nimum required e emnets
Landscape
Location of source
Location of receiver
Map scale
North arrow

Figure 3: Kangy Angy Maintenance Centre Aerial View

The TfNSW Construction Noise Estimator Tool is only suitable for simple noise assessment as detailed in Section 4.1 of the TfNSW Construction Noise & Vibration Strategy. To determine if the tool can be used, complete the questions below:

-	Description of construction site locality	Kangy Angy Maintenance Facility
-	Brief description of construction scenario to be assessed	Main works outside (Biowash, warehouse and Road 5)
-	User Name and Company	UGL
-	Assessment Date	30 June 2022

	Question	User Input	Feedback/Instructions
1	When will work be completed?	Standard Hours	Yes, the Construction Noise Estimator Tool can be used.
2	How long will it take to complete the construction works?	Less than 6-weeks	Yes, the Construction Noise Estimator Tool can be used.
3a	Is vibration intensive equipment to be used within 100m of sensitive receivers? (Section 5.3)	No	Continue to Question 4; the Construction Noise Estimator can be used.
3b	Continue to Question 4		
4	Will the work exceed construction traffic noise objectives (increase traffic noise by 2dBA over 'without construction' levels) and/or sleep disturbance objectives (Activities with LA_{max} in exceedance of 15dBA over RBL in Period 2 at the nearest receiver)?	No	The Construction Noise Estimator Tool can be used.

	User Input
	Calculated Value
	High Noise Plant/Equipment

This spreadsheet is used to calculate the cumulative sound power level when multiple plants/equipment are used
Equipment that generates noise with special audible characteristics (including intensive vibration) are highlighed in orange.

Note: The predictions provided by this Noise Estimator Tool will generate the worst case scenario for construction activities. For more accurate predictions it may be suitable to divide each work stage or work shift into separate estimates or engage a suitably qualified person such as an acoustic consultant to prepare a Detailed Assessment.

Total number of plant/equipment to be used	**11**
Cumulative Sound Power Level, SWL (dBA)	**119**
SWL with Special Audible Characteristics Correction (dBA)	**124**

Use whole numbers only. Include all equipment that will be used for a minimum of 15-minutes.

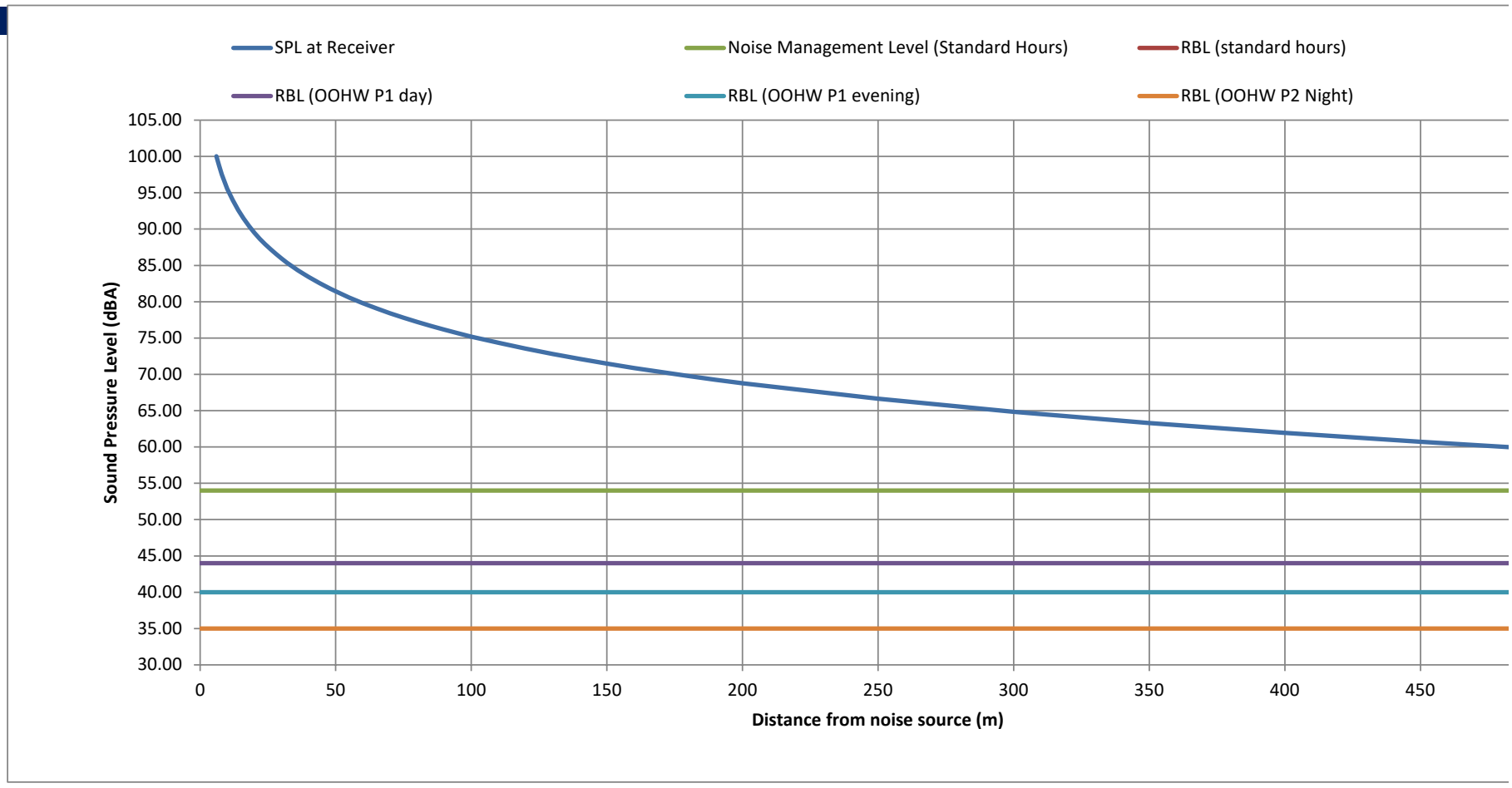
Plant / Equipment	SWL, LA_{eq} (dBA)	No. of plant / equipment to be used	Sound energy' level	Plant Cum. SWL (dBA)
Air Compressor	102			0
Asphalt Truck & Sprayer	106			0
Auger/Drill Rig	105			0
Angle grinder (small - up to 7 inch)	109			0
Backhoe 108 dBA	111			0
Chainsaw 96	114			0
Compressor	109			0
Concrete Pump 106	109			0
Concrete saw/corer 115	118			0
Concrete Truck / Agitator 106	**109**	2	1.58866E+11	**112**
Concrete Vibrator 102	113			0
D9 Dozer 118 dBA	116			0
D10 Dozer	121			0
Daymakers (4 Aspects) 77	98			0
Elevated Work Platform 97	95			0
Excavator (3 tonne) 84	90			0
Excavator (6 tonne) 92	95			0
Excavator (10 tonne) 94	**100**	2	20000000000	**103**
Excavator (20 tonne) 105	105			0
Excavator (30 tonne) 110	110			0
Excavator (40 tonne) 115	115			0
Excavator (large) + rock breaker 121	122			0
Excavator hammer 10 T 112	118			0
Flatbed truck 100	108			0
Flood Lights	90			0
Franna - Crane	98			0
Generator - Diesel /Petrol	103			0
Generator - Attenuated	92			0
Grader/Scraper	113			0
Grinder	**109**	1	79432823472	**109**
Hammer Drill 108	116			0
Hand Tools (powered)	**102**	1	15848931925	**102**
Impact drill	116			0
Impact wrench	**111**	1	1.25893E+11	**111**
Jackhammer	**113**	1	1.99526E+11	**113**
Line Marking Plant 104	108			0
Loader - Front End/Telehander	112			0
Mobile Crane (20 tonne) 99	108			0
Mobile Crane (60 tonne) 100	108			0
Mobile crane (all terrain)	110			0
Mobile crane truck / HIAB (12 tonne) 98	108			0
Mobile Crane (Franna) 99	**98**	1	6309573445	**98**
Pad Foot Roller 109	109			0
Pavement Profiler	117			0
Paving machine (Asphalt) 104	114			0
Pile Driver (Vibratory)	121			0
Piling Rig (Bored) 108	112			0
Piling Rig (Impact)	134			0
Rail Regulator/Tamper	98			0
Rail Saw	107			0
Roller (non vibratory) 110 dBA	**110**	1	1E+11	**110**
Semi tralier 106	103			0
Scissor Lift	98			0
Skidsteer Loader 1/2 T	107			0
Skidsteer Loader 1 T	110			0
Sucker Truck/Road Sweeper	109			0
Tipper truck (Single) 97	108			0
Tipper truck with dog 97	108			0
Truck (10 tonne)	**103**	1	19952623150	**103**
Truck (Semi trailer) 106	103			0
Dump truck	110			0
Tub Grinder/Mulcher	116			0
Tunnel boring machine 111 dBA	111			0
Ute/4WD 98 dBA	103			0
Vacuum Truck/Sweeper	109			0
Vibratory Roller 114 dBA	109			0
Wacker rammer 106	106			0
Water Tanker (8000 litre) 98	107			0
Welding Equipment (Thermit)	110			0
	76			0
Other:				0
Other:				0

Noise Estimate Results

	Sound Power Level (dBA)	Distance (m)	Sound Pressure Level (dBA)	Air Attenuation (dBA) Day and Evening	Air Attenuation (dBA) Night	Additional Attenuation (hoarding etc) (dBA)[1]	Predicted Noise level (SPL dBA LAeq) Day and Evening	Predicted Noise level (SPL dBA LAeq) Night
May to Sep	**124**	170	**71.00**	**0.69**	**0.73**	10	**60.31**	**60.27**

	Standard Hours	OOHW P1 Day	OOHW P1 Evening	OOHW P2 Night
Rating Background Level (RBL)	44	44	40	35
RBL Exceedance	**16**	**16**	**20**	**25**
Noise Management Level (NML)	54	49	45	40

May to Sep



Notes: Where the SPL line intersects with the RBL line in the graph above demonstrates the total radius (m) of impacted receivers
SPL = SWL(point) - 20log (r) - 8 - Additional Attenuation
Sound Power Level includes +5dBA adjustment for noise with special audible characteristics (if requried)

[1] Continuous, long solid barrier within the project boundary, that breaks line of sight between work area and receiver = 5dBA reduction
Enclosed, solid structure around work area/equipment = 10dBA reduction

The required mitigation measures for your activity are:

	Exceedance of RBL (dBA)															
	Standard Hours				OOHW Period 1 Day				OOHW Period 1 Evening				OOHW Period 2 - Night			
	0-20	20-30	>30	>75dBA*	5-10	10-20	20-30	>30	5-10	10-20	20-30	>30	5-10	10-20	20-30	>30
Standard Mitigation Measures (TfNSW CNVS Appendix C)	Yes					Yes					Yes				Yes	
Additional Mitigation Measures (TfNSW CNVS Appendix D)																
Periodic notification						Yes					Yes				Yes	
Verification monitoring											Yes				Yes	
Specific Notification											Yes				Yes	
Respite Offer											Yes				Yes	
Respite Period											Yes				Yes	
Duration Reduction											Yes				Yes	
Alternative Accommodation																

*** Any work above 75dBA regardless of RBL exceedance**

Assessment Summary

Site Locality	
Construction Scenario	Main works outside (Biowash, warehouse and Road 5)
User Name and Company	UGL
Number of Sources and SWL	11 Sources with overall SWL of 124 dBA including 5 dBA penalty for high impact noise
Receiver Distance	170 m
Barrier/enclosure attenuation	10 dBA
Assessment Date	30 June 2022

Predicted Noise Level		60 dBA	60 dBA
Period	**RBL**	**NML**	**+ RBL**
Standard Hours	44	54	16
OOHW Period 1 - Day	44	49	16
OOHW Period 1 - Evenin	40	45	20
OOHW Period 2 - Night	35	40	25

A map show ng the ocat on of the proposed work area (source) nearest sens t ve rece ver map sca e and north arrow should be nc uded into the no se est mator too . The map should be c ear w th a required e ements c ear y v s ble and not c uttered w th nformat on

L st of m nimum required e emnets
Landscape
Location of source
Location of receiver
Map scale
North arrow

Figure 3: Kangy Angy Maintenance Centre Aerial View

The TfNSW Construction Noise Estimator Tool is only suitable for simple noise assessment as detailed in Section 4.1 of the TfNSW Construction Noise & Vibration Strategy. To determine if the tool can be used, complete the questions below:

-	Description of construction site locality	Kangy Angy Maintenance Facility
-	Brief description of construction scenario to be assessed	Enabling Works Inside Maintenance Facility
-	User Name and Company	UGL
-	Assessment Date	30 June 2022

	Question	User Input	Feedback/Instructions
1	When will work be completed?	Standard Hours	Yes, the Construction Noise Estimator Tool can be used.
2	How long will it take to complete the construction works?	Less than 6-weeks	Yes, the Construction Noise Estimator Tool can be used.
3a	Is vibration intensive equipment to be used within 100m of sensitive receivers? (Section 5.3)	No	Continue to Question 4; the Construction Noise Estimator can be used.
3b	Continue to Question 4		
4	Will the work exceed construction traffic noise objectives (increase traffic noise by 2dBA over 'without construction' levels) and/or sleep disturbance objectives (Activities with LA_{max} in exceedance of 15dBA over RBL in Period 2 at the nearest receiver)?	No	The Construction Noise Estimator Tool can be used.

	User Input
	Calculated Value
	High Noise Plant/Equipment

This spreadsheet is used to calculate the cumulative sound power level when multiple plants/equipment are used
Equipment that generates noise with special audible characteristics (including intensive vibration) are highlighed in orange.

Note: The predictions provided by this Noise Estimator Tool will generate the worst case scenario for construction activities. For more accurate predictions it may be suitable to divide each work stage or work shift into separate estimates or engage a suitably qualified person such as an acoustic consultant to prepare a Detailed Assessment.

Total number of plant/equipment to be used	**8**
Cumulative Sound Power Level, SWL (dBA)	**118**
SWL with Special Audible Characteristics Correction (dBA)	**123**

Use whole numbers only. Include all equipment that will be used for a minimum of 15-minutes.

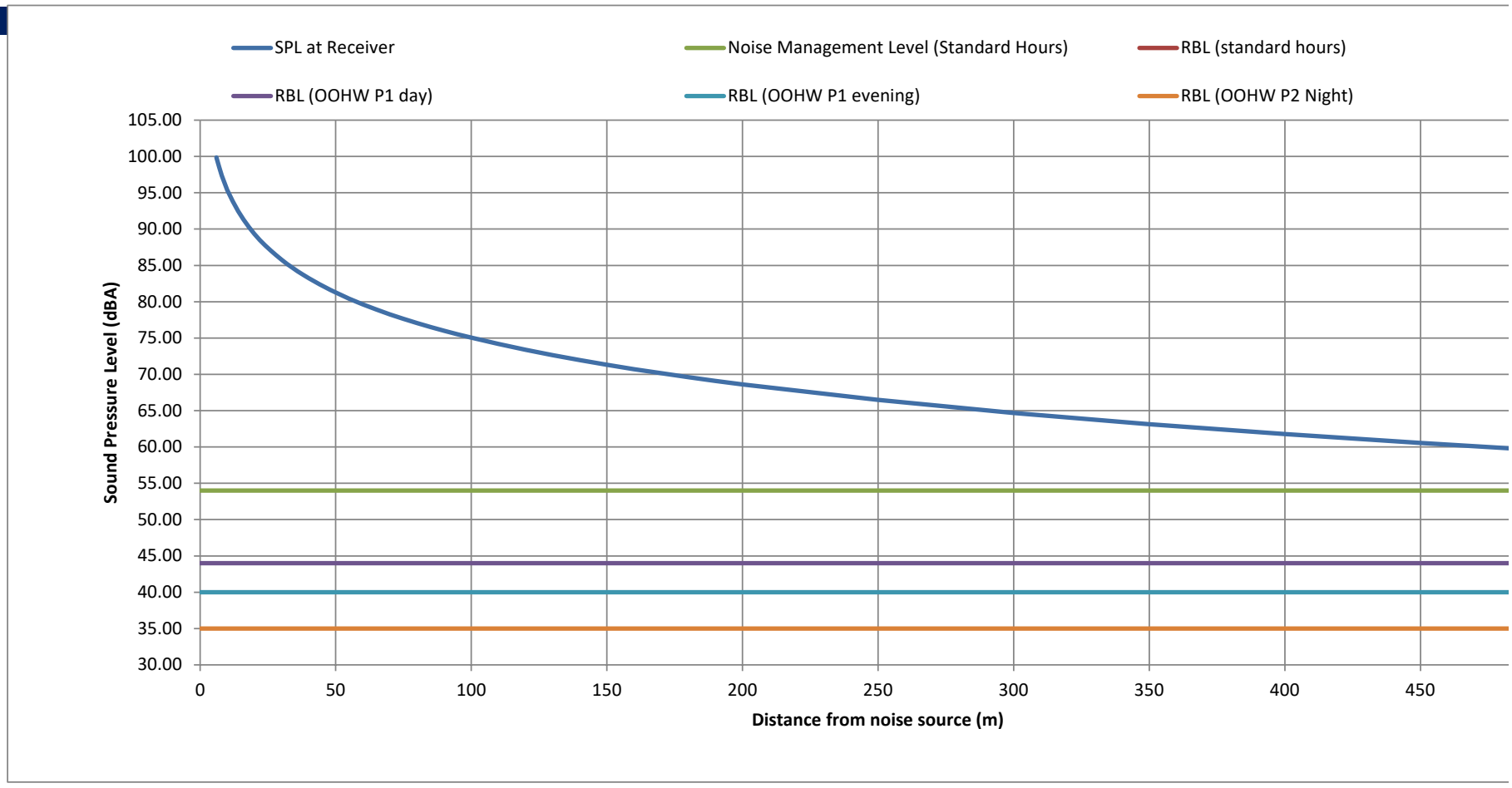
Plant / Equipment	SWL, LA_{eq} (dBA)	No. of plant / equipment to be used	Sound energy' level	Plant Cum. SWL (dBA)
Air Compressor	102			0
Asphalt Truck & Sprayer	106			0
Auger/Drill Rig	105			0
Angle grinder (small - up to 7 inch)	109			0
Backhoe 108 dBA	111			0
Chainsaw 96	114			0
Compressor	109			0
Concrete Pump 106	109			0
Concrete saw/corer 115	118			0
Concrete Truck / Agitator 106	**109**	1	79432823472	**109**
Concrete Vibrator 102	113			0
D9 Dozer 118 dBA	116			0
D10 Dozer	121			0
Daymakers (4 Aspects) 77	98			0
Elevated Work Platform 97	95			0
Excavator (3 tonne) 84	90			0
Excavator (6 tonne) 92	95			0
Excavator (10 tonne) 94	**100**	1	10000000000	**100**
Excavator (20 tonne) 105	105			0
Excavator (30 tonne) 110	110			0
Excavator (40 tonne) 115	115			0
Excavator (large) + rock breaker 121	122			0
Excavator hammer 10 T 112	118			0
Flatbed truck 100	108			0
Flood Lights	90			0
Franna - Crane	98			0
Generator - Diesel /Petrol	103			0
Generator - Attenuated	92			0
Grader/Scraper	113			0
Grinder	**109**	1	79432823472	**109**
Hammer Drill 108	116			0
Hand Tools (powered)	**102**	2	31697863849	**105**
Impact drill	116			0
Impact wrench	111			0
Jackhammer	**113**	2	3.99052E+11	**116**
Line Marking Plant 104	108			0
Loader - Front End/Telehander	112			0
Mobile Crane (20 tonne) 99	108			0
Mobile Crane (60 tonne) 100	108			0
Mobile crane (all terrain)	110			0
Mobile crane truck / HIAB (12 tonne) 98	108			0
Mobile Crane (Franna) 99	98			0
Pad Foot Roller 109	109			0
Pavement Profiler	117			0
Paving machine (Asphalt) 104	114			0
Pile Driver (Vibratory)	121			0
Piling Rig (Bored) 108	112			0
Piling Rig (Impact)	134			0
Rail Regulator/Tamper	98			0
Rail Saw	107			0
Roller (non vibratory) 110 dBA	**110**	1	1E+11	**110**
Semi tralier 106	103			0
Scissor Lift	98			0
Skidsteer Loader 1/2 T	107			0
Skidsteer Loader 1 T	110			0
Sucker Truck/Road Sweeper	109			0
Tipper truck (Single) 97	108			0
Tipper truck with dog 97	108			0
Truck (10 tonne)	103			0
Truck (Semi trailer) 106	103			0
Dump truck	110			0
Tub Grinder/Mulcher	116			0
Tunnel boring machine 111 dBA	111			0
Ute/4WD 98 dBA	103			0
Vacuum Truck/Sweeper	109			0
Vibratory Roller 114 dBA	109			0
Wacker rammer 106	106			0
Water Tanker (8000 litre) 98	107			0
Welding Equipment (Thermit)	110			0
	76			0
Other:				0
Other:				0

Noise Estimate Results

	Sound Power Level (dBA)	Distance (m)	Sound Pressure Level (dBA)	Air Attenuation (dBA) Day and Evening	Air Attenuation (dBA) Night	Additional Attenuation (hoarding etc) (dBA)[1]	Predicted Noise level (SPL dBA LAeq) Day and Evening	Predicted Noise level (SPL dBA LAeq) Night
May to Sep	**123**	180	**70.34**	**0.73**	**0.77**	15	**54.61**	**54.57**

	Standard Hours	OOHW P1 Day	OOHW P1 Evening	OOHW P2 Night
Rating Background Level (RBL)	44	44	40	35
RBL Exceedance	11	11	15	20
Noise Management Level (NML)	54	49	45	40

May to Sep



Notes: Where the SPL line intersects with the RBL line in the graph above demonstrates the total radius (m) of impacted receivers
SPL = SWL(point) - 20log (r) - 8 - Additional Attenuation
Sound Power Level includes +5dBA adjustment for noise with special audible characteristics (if requried)

[1] Continuous, long solid barrier within the project boundary, that breaks line of sight between work area and receiver = 5dBA reduction
Enclosed, solid structure around work area/equipment = 10dBA reduction

The required mitigation measures for your activity are:

	Exceedance of RBL (dBA)															
	Standard Hours				OOHW Period 1 Day				OOHW Period 1 Evening				OOHW Period 2 - Night			
	0-20	20-30	>30	>75dBA*	5-10	10-20	20-30	>30	5-10	10-20	20-30	>30	5-10	10-20	20-30	>30
Standard Mitigation Measures (TfNSW CNVS Appendix C)	Yes					Yes				Yes					Yes	
Additional Mitigation Measures (TfNSW CNVS Appendix D)																
Periodic notification						Yes				Yes					Yes	
Verification monitoring															Yes	
Specific Notification															Yes	
Respite Offer															Yes	
Respite Period										Yes					Yes	
Duration Reduction										Yes					Yes	
Alternative Accommodation																

*** Any work above 75dBA regardless of RBL exceedance**

Assessment Summary

Site Locality	
Construction Scenario	Enabling Works Inside Maintenance Facility
User Name and Company	UGL
Number of Sources and SWL	8 Sources with overall SWL of 123 dBA including 5 dBA penalty for high impact noise
Receiver Distance	180 m
Barrier/enclosure attenuation	15 dBA
Assessment Date	30 June 2022

Predicted Noise Level	55 dBA	55 dBA

Period	RBL	NML	+ RBL
Standard Hours	44	54	11
OOHW Period 1 - Day	44	49	11
OOHW Period 1 - Evenin	40	45	15
OOHW Period 2 - Night	35	40	20

A map show ng the ocat on of the proposed work area (source) nearest sens t ve rece ver map sca e and north arrow should be nc uded into the no se est mator too . The map should be c ear w th a required e ements c ear y v s ble and not c uttered w th nformat on

L st of m nimum required e emnets
Landscape
Location of source
Location of receiver
Map scale
North arrow

Figure 3: Kangy Angy Maintenance Centre Aerial View

The TfNSW Construction Noise Estimator Tool is only suitable for simple noise assessment as detailed in Section 4.1 of the TfNSW Construction Noise & Vibration Strategy. To determine if the tool can be used, complete the questions below:

-	Description of construction site locality	Kangy Angy Maintenance Facility
-	Brief description of construction scenario to be assessed	Main Works Inside Maintenance Facility
-	User Name and Company	UGL
-	Assessment Date	30 June 2022

	Question	User Input	Feedback/Instructions
1	When will work be completed?	Standard Hours	Yes, the Construction Noise Estimator Tool can be used.
2	How long will it take to complete the construction works?	Less than 6-weeks	Yes, the Construction Noise Estimator Tool can be used.
3a	Is vibration intensive equipment to be used within 100m of sensitive receivers? (Section 5.3)	No	Continue to Question 4; the Construction Noise Estimator can be used.
3b	Continue to Question 4		
4	Will the work exceed construction traffic noise objectives (increase traffic noise by 2dBA over 'without construction' levels) and/or sleep disturbance objectives (Activities with LA_{max} in exceedance of 15dBA over RBL in Period 2 at the nearest receiver)?	No	The Construction Noise Estimator Tool can be used.

	User Input
	Calculated Value
	High Noise Plant/Equipment

This spreadsheet is used to calculate the cumulative sound power level when multiple plants/equipment are used
Equipment that generates noise with special audible characteristics (including intensive vibration) are highlighed in orange.

Note: The predictions provided by this Noise Estimator Tool will generate the worst case scenario for construction activities. For more accurate predictions it may be suitable to divide each work stage or work shift into separate estimates or engage a suitably qualified person such as an acoustic consultant to prepare a Detailed Assessment.

Total number of plant/equipment to be used	**7**
Cumulative Sound Power Level, SWL (dBA)	**116**
SWL with Special Audible Characteristics Correction (dBA)	**121**

Use whole numbers only. Include all equipment that will be used for a minimum of 15-minutes.

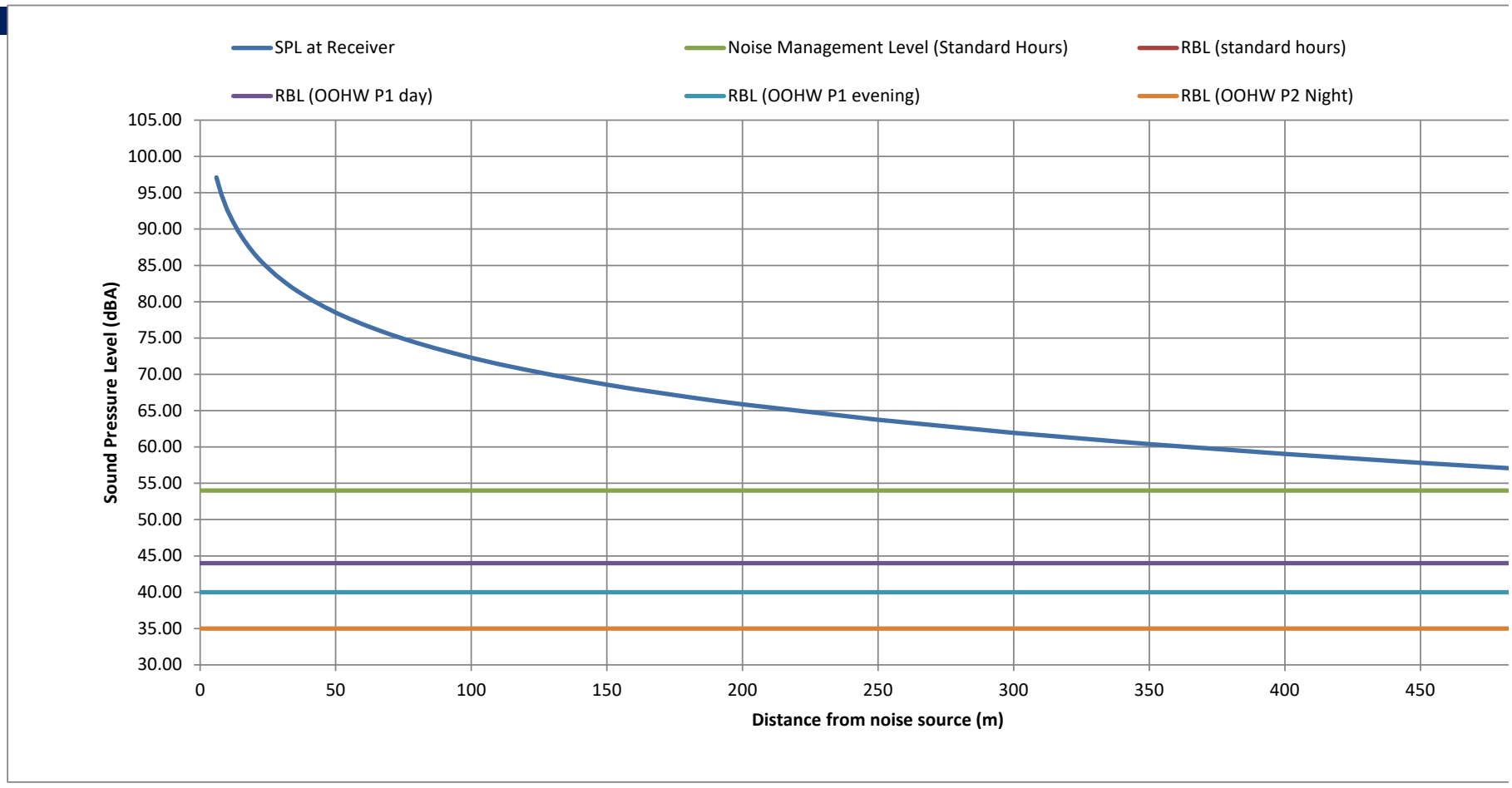
Plant / Equipment	SWL, LA_{eq} (dBA)	No. of plant / equipment to be used	Sound energy' level	Plant Cum. SWL (dBA)
Air Compressor	102			0
Asphalt Truck & Sprayer	106			0
Auger/Drill Rig	**105**	1	31622776602	**105**
Angle grinder (small - up to 7 inch)	109			0
Backhoe 108 dBA	111			0
Chainsaw 96	114			0
Compressor	109			0
Concrete Pump 106	109			0
Concrete saw/corer 115	118			0
Concrete Truck / Agitator 106	109			0
Concrete Vibrator 102	113			0
D9 Dozer 118 dBA	116			0
D10 Dozer	121			0
Daymakers (4 Aspects) 77	98			0
Elevated Work Platform 97	**95**	1	3162277660	**95**
Excavator (3 tonne) 84	90			0
Excavator (6 tonne) 92	95			0
Excavator (10 tonne) 94	100			0
Excavator (20 tonne) 105	105			0
Excavator (30 tonne) 110	110			0
Excavator (40 tonne) 115	115			0
Excavator (large) + rock breaker 121	122			0
Excavator hammer 10 T 112	118			0
Flatbed truck 100	108			0
Flood Lights	90			0
Franna - Crane	98			0
Generator - Diesel /Petrol	103			0
Generator - Attenuated	92			0
Grader/Scraper	113			0
Grinder	**109**	1	79432823472	**109**
Hammer Drill 108	116			0
Hand Tools (powered)	**102**	2	31697863849	**105**
Impact drill	116			0
Impact wrench	**111**	1	1.25893E+11	**111**
Jackhammer	113			0
Line Marking Plant 104	108			0
Loader - Front End/Telehander	112			0
Mobile Crane (20 tonne) 99	108			0
Mobile Crane (60 tonne) 100	108			0
Mobile crane (all terrain)	110			0
Mobile crane truck / HIAB (12 tonne) 98	108			0
Mobile Crane (Franna) 99	98			0
Pad Foot Roller 109	109			0
Pavement Profiler	117			0
Paving machine (Asphalt) 104	114			0
Pile Driver (Vibratory)	121			0
Piling Rig (Bored) 108	112			0
Piling Rig (Impact)	134			0
Rail Regulator/Tamper	98			0
Rail Saw	107			0
Roller (non vibratory) 110 dBA	110			0
Semi tralier 106	103			0
Scissor Lift	98			0
Skidsteer Loader 1/2 T	107			0
Skidsteer Loader 1 T	110			0
Sucker Truck/Road Sweeper	109			0
Tipper truck (Single) 97	108			0
Tipper truck with dog 97	108			0
Truck (10 tonne)	103			0
Truck (Semi trailer) 106	103			0
Dump truck	110			0
Tub Grinder/Mulcher	116			0
Tunnel boring machine 111 dBA	111			0
Ute/4WD 98 dBA	103			0
Vacuum Truck/Sweeper	109			0
Vibratory Roller 114 dBA	109			0
Wacker rammer 106	106			0
Water Tanker (8000 litre) 98	107			0
Welding Equipment (Thermit)	110	1	1E+11	**110**
	76			0
Other:				0
Other:				0

Noise Estimate Results

	Sound Power Level (dBA)	Distance (m)	Sound Pressure Level (dBA)	Air Attenuation (dBA) Day and Evening	Air Attenuation (dBA) Night	Additional Attenuation (hoarding etc) (dBA)[1]	Predicted Noise level (SPL dBA LAeq) Day and Evening	Predicted Noise level (SPL dBA LAeq) Night
May to Sep	**121**	180	**67.60**	**0.73**	**0.77**	15	**51.87**	**51.83**

	Standard Hours	OOHW P1 Day	OOHW P1 Evening	OOHW P2 Night
Rating Background Level (RBL)	44	44	40	35
RBL Exceedance	8	8	12	17
Noise Management Level (NML)	54	49	45	40

May to Sep



Notes: Where the SPL line intersects with the RBL line in the graph above demonstrates the total radius (m) of impacted receivers
SPL = SWL(point) - 20log (r) - 8 - Additional Attenuation
Sound Power Level includes +5dBA adjustment for noise with special audible characteristics (if requried)

[1] Continuous, long solid barrier within the project boundary, that breaks line of sight between work area and receiver = 5dBA reduction
Enclosed, solid structure around work area/equipment = 10dBA reduction

The required mitigation measures for your activity are:

	Exceedance of RBL (dBA)															
	Standard Hours				OOHW Period 1 Day				OOHW Period 1 Evening				OOHW Period 2 - Night			
	0-20	20-30	>30	>75dBA*	5-10	10-20	20-30	>30	5-10	10-20	20-30	>30	5-10	10-20	20-30	>30
Standard Mitigation Measures (TfNSW CNVS Appendix C)	Yes				Yes					Yes				Yes		
Additional Mitigation Measures (TfNSW CNVS Appendix D)																
Periodic notification										Yes				Yes		
Verification monitoring														Yes		
Specific Notification														Yes		
Respite Offer														Yes		
Respite Period										Yes				Yes		
Duration Reduction										Yes				Yes		
Alternative Accommodation																

*** Any work above 75dBA regardless of RBL exceedance**

Assessment Summary

Site Locality	
Construction Scenario	Main Works Inside Maintenance Facility
User Name and Company	UGL
Number of Sources and SWL	7 Sources with overall SWL of 121 dBA including 5 dBA penalty for high impact noise
Receiver Distance	180 m
Barrier/enclosure attenuation	15 dBA
Assessment Date	30 June 2022

Predicted Noise Level 52 dBA 52 dBA

Period	RBL	NML	+ RBL
Standard Hours	44	54	8
OOHW Period 1 - Day	44	49	8
OOHW Period 1 - Evenin	40	45	12
OOHW Period 2 - Night	35	40	17

A map show ng the ocat on of the proposed work area (source) nearest sens t ve rece ver map sca e and north arrow should be nc uded into the no se est mator too . The map should be c ear w th a required e ements c ear y v s ble and not c uttered w th nformat on

L st of m nimum required e emnets
Landscape
Location of source
Location of receiver
Map scale
North arrow

Figure 3: Kangy Angy Maintenance Centre Aerial View

UGL Pty Limited

Kangy Angy Maintenance Facility Road 5, Warehouse and Graffiti Removal

PDR Design Report, Graffiti Wash Facility - Noise Modelling Assessment

November 2022

Confidential

Question today
Imagine tomorrow
Create for the future

Kangy Angy Maintenance Facility
Road 5, Warehouse and Graffiti Removal
PDR Design Report, Graffiti Wash Facility - Noise Modelling Assessment

UGL Pty Limited

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Fax: +61 2 4929 8382
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Rev	Date	Details
Rev A	15/08/2022	PDR Submission
Rev 1	24/10/2022	Addressing PDR comments
Rev 2	02/11/2022	Addressing Department comments
Rev 3	24/10/2022	Addressing PDR comments
Rev 3	24/10/2022	Addressing PDR comments

	Name	date	signature
Prepared by:	S Henley	24/11//2022	
Reviewed by:	B Ison	24/11/2022	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

Table of contents

1 Project background

1.1 Introduction

UGL Pty Limited proposes to construct a Graffiti Removal Facility as part of continued upgrades to the New Intercity Fleet Maintenance Facility (NIF MF), located at Kangy Angy, NSW. The facility's purpose will be to remove graffiti from trains through use of electric and diesel-powered high-pressure washing hoses.

As the operational noise of these hoses have the potential to impact noise-sensitive receivers in the surrounding environment, UGL has asked WSP to perform a noise assessment of the proposed facility to determine the extent to which the proposal will impact nearby receivers, and whether these impacts comply with the nominated project criteria.

An assessment of potential construction noise impacts has been carried out by UGL and is provided in UGL design report (NIF-150494-RCN-EM-000121).

1.2 Description of project

The proposed Graffiti Removal Facility has dimensions of approximately 30 m length, 8.0 width and 8.3 meter height, with a sloped roof in the North-West direction and sits on an existing slab. The ends of the structure are open for train access.

The longitudinal walls of the building are proposed to consist of 9mm Fibre Cement (FC) wallboard internally and Colorbond™ Steel on the external side of the facility wall. The roof of the facility is proposed to only consist of a mix of steel and translucent sheet roofing without any other noise-insulating material.

Two operational scenarios have been considered in this report, these are:

- Scenario 1: 2 x HP Diesel hoses / compressors operating simultaneously
- Scenario 2: 1 x HP Diesel hose / compressors and 1 electric hose / compressors operating simultaneously

One of these scenarios is proposed to operate at any time within the Facility.

The Graffiti Removal Facility is proposed as an open shed to house the graffiti removal activities. No equipment and control room are required, and the shed would be naturally ventilated via the two open ends.

1.3 Sensitive receivers

The Maintenance Facility is surrounded by a variety of receivers, with semi-rural residential receivers located to the north-west and south of the facility and a light industrial area to the East. The Main North Rail Line runs parallel to the maintenance facility.

Nearest receivers to the Graffiti Removal Facility are located to the south along Enterprise Drive and to the north on Ourimbah Road. Sensitive receivers along Buckton and Orchard Roads are less susceptible due to an existing 6m noise barrier along the northern boundary of the site, flanking the Western section of the Maintenance Facility, as well as screening provided by the maintenance facility itself.

Acoustic impacts at the 19 noise-sensitive receivers within 500m of the Graffiti shed were assessed.

1.4 Noise criteria

1.4.1 Maximum predicted noise levels

Noise impacts from the facility were originally assessed in the New Intercity Fleet Maintenance Facility D&C Project Operational Noise and Vibration Review, Renzo Tonin and Associates (2019) (ONVR). This assessment found that noise levels were likely to exceed the Project Specific Noise Limits (PSNL) at many receivers, and as such these properties qualified for At Property acoustic treatments. Following this treatment, noise levels should comply with the maximum predicted noise impacts outlined in this document.

As such, for each receiver assessed in this document, the $L_{Aeq,\ 15min}$ operational noise goal for the Graffiti Removal Facility was set as the maximum of PSNL and the maximum predicted noise level for normal operations of the maintenance facility. These noise levels, as well as the consequent Graffiti Removal Facility Noise Limit for each receiver, are shown in Table 1.1 below.

Table 1.1 PSNLs & Maximum Predicted Noise Levels

Receiver	Project Specific Noise Limit[1] ($L_{eq\ 15\ minute}$ dBA)		Maximum predicted noise level – ONVR[1] ($L_{eq\ 15\ minute}$ dBA)		Graffiti Removal Facility noise goal ($L_{eq\ 15\ minute}$ dBA)	
	Day	Night	Day	Night	Day	Night
R12 - 19 Ourimbah Road	49	40	53	53	**53**	**53**
R13 - 50 Orchard Road, Kangy Angy	49	40	48	49	**49**	**49**
R14 - 54 Orchard Road, Kangy Angy	49	40	46	48	**49**	**48**
R15 - 62 Orchard Road, Kangy Angy	49	40	47	48	**49**	**48**
R16 - 72 Orchard Road, Kangy Angy	49	40	45	47	**49**	**47**
R17 - 80 Orchard Road, Kangy Angy	49	40	44	47	**49**	**47**
R31 - 12 Ourimbah Road, Kangy Angy	49	40	49	50	**49**	**50**
R34 - 170 Old Chittaway Road	54	40	58	58	**58**	**58**
R35 - 150 Old Chittaway Road	54	40	56	57	**56**	**57**
R36 - 130 Old Chittaway Road, Fountaindale	54	40	53	55	**54**	**55**
R37 - 141 Old Chittaway Road, Fountaindale	54	40	50	52	**54**	**52**
R38 - 127 Old Chittaway Road, Fountaindale	54	40	50	52	**54**	**52**
R44 - 149 Old Chittaway Road, Fountaindale	54	40	52	54	**54**	**54**
R45 - 165 Old Chittaway Road, Fountaindale	54	40	53	54	**54**	**54**
R47 - 11 Station Road, Fountaindale	54	40	50	52	**54**	**52**
R48 - 16 Station Road, Fountaindale	54	40	50	53	**54**	**53**
R57 - 157 Old Chittaway Road, Fountaindale	54	40	49	52	**54**	**52**
R118 - 53 Orchard Rd(Acquired)	49	51	51	50	**51**	**51**
R137 - 64 Turpentine Road, Kangy Angy	49	49	49	40	**49**	**49**

(1) Source: Operational Noise and Vibration Review (ONVR) (Renzo Tonin, 12 August 2019)

1.4.2 Corrections for annoying noise

Where a noise source contains certain characteristics such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise of the same sound level. In accordance with Fact Sheet C of the Noise Policy for Industry, a correction factor is applied to the measured noise levels before comparison with the noise standards to account for the additional annoyance caused by these modifying factors.

With reference to the attended noise monitoring results outlined in Table 1.2, both high pressure hose systems produce relatively flat frequency spectrum and are not subject to low frequency of tonal corrections.

The operation of the high pressure hoses is unknown and is likely to be dependent upon the job at hand and specific to each operator, however at times the equipment may be considered to be intermittent. This is defined as where the noise level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5 dB(A); for example, when the equipment cycles on and off.

When the high pressure hose operate sin the absence of other on site noise sources, it is likely to generate intermittent noise, however during operations at the time of the maximum predicted noise level, those operations would be the dominant noise source and operation of the graffiti wash facility would not generate intermittent noise. These corrections have been considered in the following assessment.

1.5 Work Health Safety Regulations

It is a requirement of the Work Health and Safety Regulations 2017 that: "*a person conducting a business or undertaking at a workplace must ensure that the noise that a worker is exposed to at the workplace does not exceed the exposure standard for noise*" (Work Health and Safety Regulations 2017, Section 4.1 Clause 57).

The exposure standard for noise is:

- $L_{Aeq(8hour)}$ of 85 dB, or
- L_{Cpeak} of 140 dB.

Measured at the position of the person's ear, without taking into account any protection which may be provided to the person by personal hearing protectors.

The first criterion of $L_{Aeq(8hour)}$ 85 dB relates to the total amount of noise energy a person is exposed to during a typical 8 hour working day. It specifies that a person should not be exposed to more sound energy than that produced by a constant noise level of 85 dBA for eight hours. At higher sound pressure levels, the exposure limit is reached in a shorter time. For example, it takes only 4 hours to reach the allowable limit when exposed to a continuous noise level of 88 dBA. Where workplaces exceed these criteria, employers are required to reduce noise exposure and minimise the risk of hearing loss.

The second criterion of L_{Cpeak} 140 dB relates to short term impulsive noise sources (such as loud bangs) and is an extremely high level of noise and is close to the threshold of pain. Even very brief exposure to noise at this level may cause hearing loss.

AS1269 also provides guidance for determining the equivalent daily noise exposure for shifts longer than 8 hours.

1.6 Previous studies

On the 13 September 2021, WSP attended the Kangy Angy facility to carry out attended noise monitoring of the proposed graffiti wash system equipment. These monitored noise levels were used for a preliminary assessment of the likely impact of operational noise from the operations. It is noted that this assessment assumed the operation of a single high pressure unit at an external location (ie without the Graffiti Removal Facility). This assessment was detailed in the

New Intercity Fleet – Kangy Angy Maintenance Facility – Graffiti wash noise monitoring and mitigation (Memo), WSP (PS126565-ACG-MEM-Rev0, September 2021).

The modelling and assessment were based on assessments and inputs detailed in the *Operational Noise and Vibration Review* (ONVR) (Renzo Tonin, 12 August 2019), and *Variation 043 – Additional Operational Noise Modelling* (AONM) (WSP, 24/02/2020) for the facility.

Monitoring was carried out using a SVAN 958 Sound Level Meter (SLM). This unit is in calibration, and this calibration was confirmed in the field before and after the measurements to ensure no drift had occurred.

The measured sound pressure level (SPL) and modelled sound power level (SWL) are outlined in Table 1.2.

Table 1.2 High pressure hose and compressor measured and modelled sound pressure/power levels

Equipment	Measured Octave Band Centre Frequency, Hz							Measured SPL, dBA	Modelled SWL, dBA
	63	125	250	500	1K	2K	4K		
Diesel high-pressure hose and compressor	91	93	86	85	85	85	81	90.7 at 2 meters	104.7
Electric high-pressure hose and compressor	68	69	68	72	71	69	66	75.5 at 2 metres	89.5

The operational noise model for the site was updated to include the measured SWLs for each item. Modelling was undertaken using the CONCAWE noise prediction method within SoundPLAN 8.2 noise modelling software. In order that a representative worst case scenario is assessed, the modelling assumptions for the high-pressure washing systems assumed the operation of a diesel high-pressure hose and compressor operating continuously over a 15-minute period at the southern end of the wheel lathe building.

The predicted noise levels at the worst-case representative receivers for the high pressure washing system are tabulated in Table 1.3.

Table 1.3 Predicted noise levels – high pressure hose and compressor scenario

Receiver	Predicted noise level – High pressure only ($L_{eq\ 15\ minute}$ dBA)	Predicted noise level - ONVR ($L_{eq\ 15\ minute}$ dBA)		Increase in Predicted noise level over ONVR ($L_{eq\ 15\ minute}$ dBA)
	Diesel	Arrival (night)	Departure (night)	Diesel
R34 - 170 Old Chittaway Road	48	56	57	0
R12 - 19 Ourimbah Road	37	53	53	0

The graffiti wash system was not predicted to increase the operational noise levels above the maximum predicted operational noise level (arrival and departure) assessed in the ONVR at the nearest sensitive receivers.

However, the memo found that although compliance with site criteria is likely, the operation of the diesel system is expected to be audible at properties on Chittaway Road and as such may be cause annoyance at these locations, particularly during the absence of other on site noise sources.

The memo stated that construction of the Graffiti Removal Facility will provide additional screening to properties north and south of the facility and as such, further reduce these noise levels.

2 Noise assessment

2.1 Noise modelling methodology

Operational noise impacts have been predicted using the original noise model utilised in the ONVR. This model was prepared in SoundPLAN 8.2, implemented the CONCAWE calculation method. The use of SoundPLAN and the CONCAWE prediction methodology are widely applied in Australia for the prediction of noise from operational works.

A three-dimensional representation of the physical environment within the proposal site was produced utilising the SoundPLAN noise prediction software. Modelling inputs included ground elevation, locations of sensitive receivers and the noise-generating facility, as well as any other inputs affecting the noise environment, such as the buildings surrounding the proposal.

Model inputs are presented in Table 2.1. The model was based on the latest design and considered noise sources, façade materials, receivers and the effect of distance, ground topography, atmospheric attenuation and obstacles such as barriers and buildings. Further high level technical inputs for the noise model are presented within the ONVR.

The noise generated by equipment inside the facility and the level of reverberation and noise mitigation provided by the facades of the facility were incorporated into an industrial building within the noise model. Two operational scenarios were detailed by UGL, the operation of two diesel hoses or the operation of one electric hose and one diesel. The following inputs were implemented for the Graffiti Wash Facility noise model.

Table 2.1 Noise modelling inputs

Parameter	**Source / Level**					
Building design drawings	*KAMF-WB-WSP-ALL-DRG-0000022 (21-066)*					
Noise sources	Scenario 1: 2 x HP Diesel hoses / compressors operating simultaneously (refer Table 1.2) Scenario 2: 1 x HP Diesel hose / compressors and 1 electric hose / compressors operating simultaneously (refer Table 1.2)					
Frequency (Hz)	**125**	**200**	**500**	**1000**	**2000**	**4000**
Absorption coefficient (9mm fibre cement)	0.04	0.05	0.06	0.08	0.04	0.06
Absorption coefficient (Steel sheeting)	0.13	0.09	0.08	0.09	0.11	0.11
Transmission loss (9mm fibre cement) dB	15	28	40	48	54	53
Transmission loss (Steel sheeting) dB	10	14	19	24	29	34
Resultant façade noise transmission						
North and south facades dB(A)	92.7	81.9	62.8	53.3	47.9	48.5
Ends of building dB(A)	Open					
Roof dB(A)	97.9	96.1	84.0	77.5	73.1	67.7

2.2 Noise modelling results

The results of the operational noise modelling have been compared to the day / night noise goals calculated in Section 1.4 for representative noise sensitive receivers and are presented below in Table 2.2. For each of the 2 scenarios, Table 2.2 lists two values:

1 The scenario with no other simultaneous noise sources

2 The scenario occurring simultaneously with a train arrival or departure

Noise results for each scenario alone are presented graphically in Figure 2.1 and Figure 2.2.

Table 2.2 Predicted Noise Levels from Graffiti Removal Facility operational noise at representative noise-sensitive receivers

Receiver	Project Noise Limit $L_{eq\ 15\ minute}$ dBA	Scenario 1		Scenario 2	
		PROJECT Predicted Noise Level [1] $L_{eq\ 15\ minute}$ dBA	TOTAL maximum predicted site noise level $L_{eq\ 15\ minute}$ dBA	PROJECT Predicted Noise Level [1] $L_{eq\ 15\ minute}$ dBA	TOTAL maximum predicted site noise level $L_{eq\ 15\ minute}$ dBA
	Day/Night	Day / Night	Day/Night	Day/Night	Day / Night
R12 - 19 Ourimbah Road	53	48	53	47	53
R13 - 50 Orchard Road, Kangy Angy	49	46	**50**	44	49
R14 - 54 Orchard Road, Kangy Angy	48	36	48	33	48
R15 - 62 Orchard Road, Kangy Angy	48	36	48	34	48
R16 - 72 Orchard Road, Kangy Angy	47	36	47	33	47
R17 - 80 Orchard Road, Kangy Angy	47	35	47	32	47
R31 - 12 Ourimbah Road, Kangy Angy	50	46	50	44	50
R34 - 170 Old Chittaway Road	58	56	**59**	54	**59**
R35 - 150 Old Chittaway Road	57	48	57	46	57
R36 - 130 Old Chittaway Road	55	45	55	43	55
R37 - 141 Old Chittaway Road	52	43	52	41	52
R38 - 127 Old Chittaway Road	52	43	52	41	52
R44 - 149 Old Chittaway Road	54	46	54	44	54
R45 - 165 Old Chittaway Road	54	49	54	47	54

(1) Including 5dB penalty for potentially impulsive noise

(2) **BOLD** indicates a potential exceedance of AONM Maximum predicted noise levels

2.3 Discussion

The results of noise modelling outlined in Table 2.2 shows that operation of the graffiti wash facility is predicted to comply at all receiver locations during normal operations. These results are presented graphically in Figure 2.1 and Figure 2.2.

However the results also show that where the facility operates at the same time as the Maximum predicted noise scenario outlined in the AONM (train arrival or departures), marginal exceedances may be predicted at up to 2 properties for Scenario 1 (2x HP diesel hoses) and 1 property for Scenario 2 (1x HP diesel hose and 1x HP electric hose). These

exceedances are minor (approximately 1dB). It is generally accepted that an increase of less than 2dB is considered unnoticeable by most people. Given the infrequent nature of these events coinciding, an increase of this magnitude is considered acceptable.

Although these impacts are minor, noise mitigation measures are provided in Section 3 in the event the client wishes to pursue these measures.

Figure 2.1 Predicted noise levels – Scenario 1 (2 x HP Diesel hoses / compressors operating simultaneously)

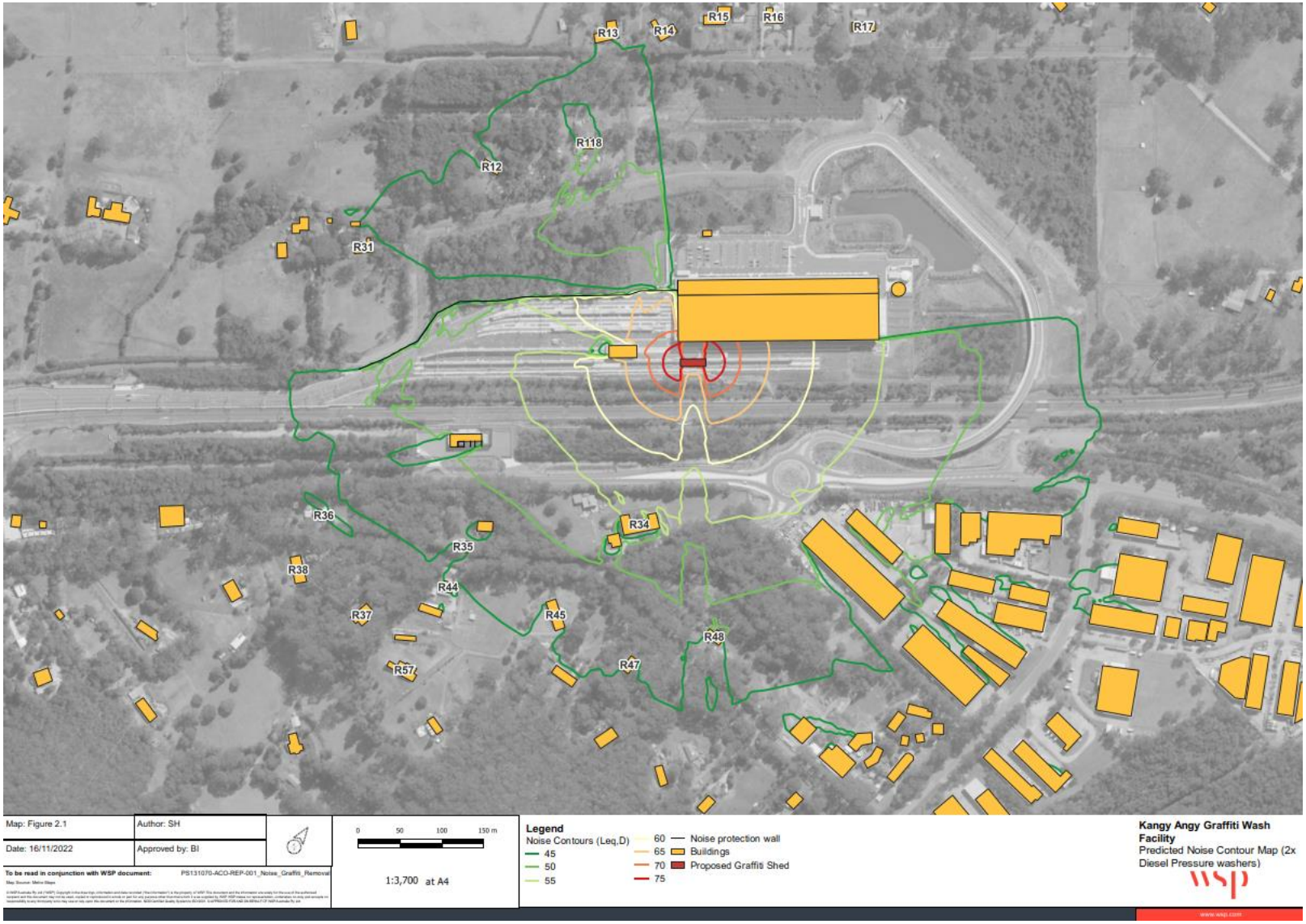
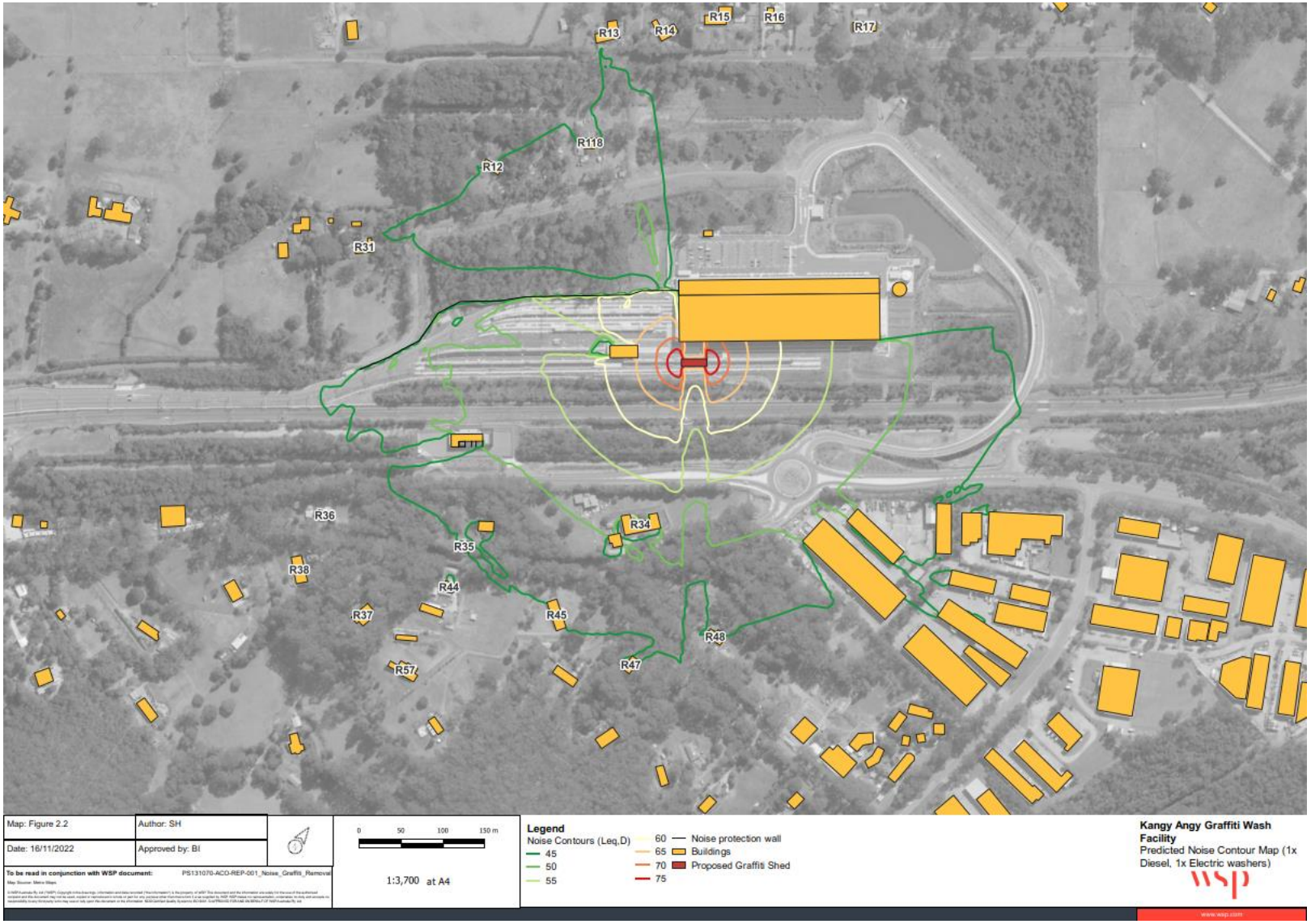


Figure 2.2 1 x HP Diesel hose / compressors and 1 electric hose / compressors operating simultaneously



2.4 OHS assessment

The attended noise monitoring results outlined in Table 1.2 show that operation of the diesel high pressure hose and compressor may exposure workers to noise levels in excess of the OHS noise management levels outlined in Section 1.5. Operation of the electric high pressure hose is expected to generate acceptable noise levels.

As such the following noise management controls should be considered in order to comply with Work Health and Safety Regulations 2011:

- Signage to be erected and clearly visible requiring that hearing protection be worn by all persons who enter/are working in the vicinity of the diesel high pressure hose
- Turn off noisy plant when not in use.
- Rosters designed so that as few personnel as possible are exposed to noisy operations
- Hearing tests are provided every two years for workers frequently employed in the graffiti shed
- Consideration is given to potential ototoxic interactions with chemical substances used within the Graffiti shed

3 Noise mitigation and management

Due to the potential for total operational noise levels to marginally exceed the maximum predicted project noise levels during the graffiti removal activities, a consideration of mitigation strategies to reduce the likely noise impact has been carried out.

From an acoustic perspective, possible strategies to mitigate noise are typically investigated in the following order (decreasing preference):

1. Land use planning and provision of appropriate buffer distances
2. Noise control at the noise source
3. Noise control along the noise transfer path
4. Noise control at the receiver.

The following sections outline the assessments that have been undertaken during this study to determine the potential effectiveness of a range of noise management and mitigation measures.

3.1.1 Noise control at the source (Operational controls)

The noise assessment has found that where operation of the facility coincides with the period of maximum predicted noise (train arrival / departure scenario), noise levels may marginally exceed the project criteria. The following operational controls may be considered and should be adopted where reasonable and feasible:

- The consideration of using only electric high pressure hoses. This will result in a significant reduction in noise impacts from graffiti removal operations (approximately 10-15dB). It is understood that diesel high pressure hose use may be required in some situations.
- The halting of graffiti removal operations using diesel high pressure hoses during periods where trains are arriving or departing from the maintenance facility at night. Use of the electric high pressure hoses could continue during these periods. Where this control is adopted, potential cumulative noise impacts would not occur, and predicted noise levels would comply at all locations.

Where either of these strategies are adopted, noise levels are predicted to comply with the project criteria.

3.1.2 Noise control along the transfer path (Noise screening)

The potential effectiveness of a short barrier at either end of the facility was also considered.

A 5m long noise screen at 4m in height was considered to be a reasonable and effective barrier configuration. This screen was positioned within the noise model from the south-west corner of the facility parallel to the train tracks.

The installation of this barrier was found to decrease noise from the facility at southern receivers by a small margin (< 2 dBA), however was also found to marginally increase noise levels by up to 2dB at properties to the north of the maintenance facility due to reflection.

While the selection of non-reflective barrier material may be investigated in order to reduce noise levels to the north, given the marginal nature of the predicted exceedances, and the minimal reductions provided by the barrier, the option of a noise barrier has not been investigated further and one or both of the operational noise control outlined in Section 3.1.1 are recommended.

3.1.3 Noise control at the receiver

Subsequent to the complete consideration of all source and pathway feasible and reasonable noise mitigation measures (as discussed in the preceding subsections), the NPfI allows for receiver property treatment to be considered for any residual noise impacts. The NPfI stated that receiver-based treatment is typically only applicable for isolated residences

in rural areas and may include upgrade of various construction elements of the dwellings and voluntary property acquisition.

In accordance with NPfI, a residual noise impact is defined as '*receivers with exceedances of the project noise trigger levels under the best-achievable acoustic outcome from a development*'. Residual noise impacts are identified after all source and pathway feasible and reasonable noise mitigation measures have been considered. Fact sheet F of the NPfI describes reasonable and feasible measures as:

> *A feasible mitigation measure is a noise mitigation measure that can be engineered and is practical to build and/or implement, given project constraints such as safety, maintenance and reliability requirements. It may also include options such as amending operational practices (for example, changing a noisy operation to a less-sensitive period or location) to achieve noise reduction.*
>
> *Selecting reasonable measures from those that are feasible involves judging whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the mitigation measure.*

The currently predicted residual noise impacts show an infrequent exceedance of approximately 1dB, occurring where graffiti removal operation coincide with the arrival or departure of trains from the site. The significance of residual noise impacts in accordance with NPfI and the possible associated level of receiver-based treatment they receive are summarised in Table 3.1.

Table 3.1 Significance of residual noise impacts – NPfI

If the predicted noise level minus the project noise trigger level is:	And the total cumulative industrial noise level is:	Then the significance of residual noise level is:
≤ 2 dB	Not applicable	Negligible
≥ 3 but ≤ 5 dB	> recommended amenity noise level, but the increase in total cumulative industrial noise level resulting from the development is less than or equal to 1 dB	Marginal
≥ 3 but ≤ 5 dB	> recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is more than 1 dB	Moderate
> 5 dB	> recommended amenity noise level	Significant

This shows that where all reasonable and feasible noise mitigation options have been investigated, an exceedance of less than 2dB is considered negligible and no further mitigation is justified.

4 Conclusion

UGL has commissioned WSP to provide a noise assessment of a proposed Graffiti Removal Facility at the Kangy Angy NIF MF to determine the extent to which the proposal will impact nearby receivers.

Operational noise goals for the 24 most noise-sensitive receivers were determined from the previously established noise limits and predicted noise levels of the NIF MF defined in the ONVR. Noise levels associated with the two assessed scenarios were modelled and noise impacts from the operation of the facility were assessed.

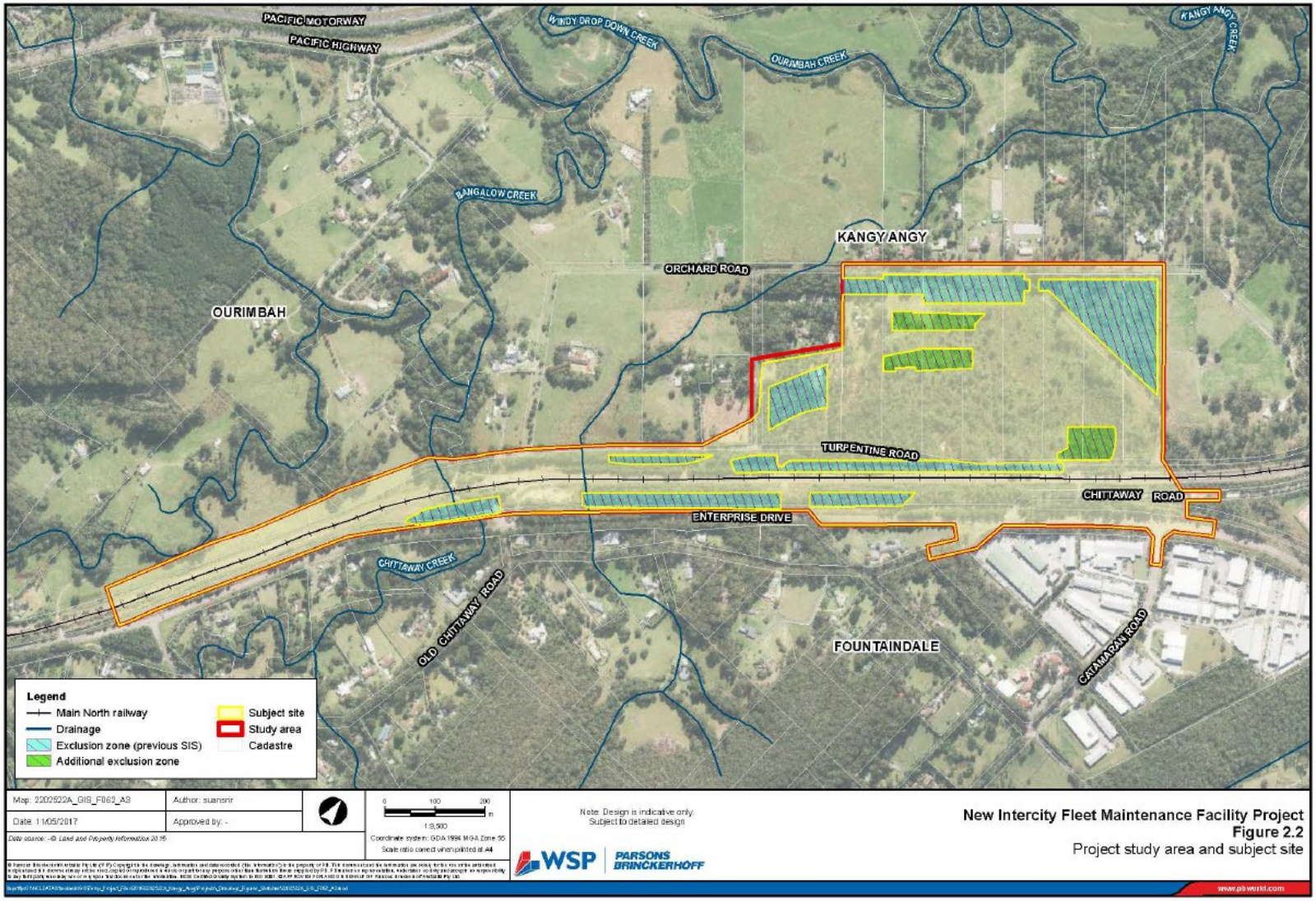
It was predicted that operational noise from the Graffiti Removal Facility alone would be less than the predicted maximum noise levels for the facility, however that total noise level during train arrival or departure may increase by a small margin, resulting in marginal (1 dBA) exceedances at up to 2 properties. This increase is expected to be infrequent and not to be noticeable to most receivers.

The installation of barriers was not found to be effective at reducing noise levels, however options for operational controls have been provided for consideration by UGL.

References

- *New Intercity Fleet Maintenance Facility D&C Project Operational Noise and Vibration Review, Renzo Tonin and Associates (2019)*
- *New Intercity Fleet – Kangy Angy Maintenance Facility – Graffiti wash noise monitoring and mitigation (Memo), WSP (2022)*

Appendix H: Ecological Exclusion Zones (source Mariyung MF REF)



Appendix I: ONVR, Rev 11, (12/4/21)

MEMO

New Intercity Fleet Maintenance Facility Operational Noise and Vibration Review – Revision 11 (dated 12/4/21)

This memo has been prepared to amend the Operational Noise and Vibration Review (ONVR) (from Revision 10 to 11) to enable the temporary washing of the NIF trains on the graffiti & biowash road. The need for the washing of the trains during the evening and night periods on the graffiti and biowash road has occurred as a result delays to the commissioning the train wash arising from COVID-19.

Section 6.13 of the ONVR outlines the assumptions / noise mitigation measures in relation to the operation of the external graffiti and biowash road. Due to the predicted noise impacts of this heavy duty cleaning on the external road, a management measure was included to limit the operation of this activity to daytime period (i.e. 7am-6pm).

COVID-19 has impacted the commissioning of the train wash as a result of the international borders being closed, and the relevant specialists from Spain have been unable to enter the country. The sides of the trains are able to be washed within the enclosed train wash, with the front and back of the trains proposed to be washed on the external graffiti & biowash road (road 7).

The below sets out the existing operational assumptions listed in the ONVR Section 6.13 (in *italics*), with an additional assumption / mitigation measure included in **bold**.

1. *Bio-wash and graffiti removal, and heavy duty external cleaning are to take place in a dedicated area on Road 6. This will be undertaken by contractors with portable equipment. Cleaning activities take place anywhere around the standing train.*

2. *Bio-wash and graffiti removal, and heavy duty external cleaning will take place only during the daytime period (7:00 am to 6:00 pm).*

3. *APPENDIX C outlines the noise sources and modelling assumptions for the bio-wash and graffiti removal, and heavy duty external cleaning activities. However, as the cleaning will be undertaken by cleaning contractors, the typical equipment could vary. As such, typical noise source levels have been modelled, but noise limits for the equipment are provided in the mitigation and management measures to control noise impacts.*

4. **General train cleaning to take place on the bio-wash and graffiti road during the evening and night periods (6pm-7am) from 12 April 2021 to 30 April 2022 or until the train wash is fully commissioned (whichever is sooner). Cleaning activities to take place would utilise two water pressure gurneys with maximum sound power level of 101dBA (per gurney). No heavy duty external cleaning to take place during the evening or night periods.**

Additional text (in **bold**) has been included in Table 1 (Operations) in relation to external cleaning/ bio-wash.

- *Limit to day period (7am to 6pm)* **for heavy duty cleaning. The front and back of trains are to be washed during the evening and night periods (6pm-7am) from 12 April 2021 to 30 April 2022, or until the train wash final commissioning is complete (whichever is sooner).**

RENZO TONIN & ASSOCIATES
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NEW INTERCITY FLEET MAINTENANCE FACILITY D&C PROJECT

Operational Noise and Vibration Review

12 August 2019

John Holland Pty Ltd

NIF-RTA-RPT-NA-250001(r10) NIF Maintenance Facility - Noise Vibration Assessment - ONVR (Final).docx

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aaac Association of Australian Acoustical Consultants

Document details

Detail	Reference
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Prepared for:	John Holland Pty Ltd (JH)
Attention:	Peter Addlem / Allister Maskery

Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Reviewed / Authorised
16/8/2018	Preliminary draft	Internal #7	-	ALe/PK	PK	-
20/8/2018	Draft	0	1	ALe/PK	PK	PK
27/2/2019	Final draft	2	3	ALe	PK	PK
22/3/2019	Final draft (TfNSW comments) – minor updates	-	4	ALe	PK	-
23/04/2019	Final (TfNSW comments) – minor updates	5	6	ALe	PK	PK
29/05/2019	Minor updates	-	7	ALe	PK	PK
02/07/2019	Minor updates	-	8	ALe	PK	PK
03/07/2019	Minor updates	-	9	ALe	PK	PK
12/08/2019	Minor updates - receivers	-	10	ALe	PK	PK

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1 Introduction

Renzo Tonin & Associates (RT&A) is engaged by John Holland Pty Ltd (JH) to conduct a noise and vibration assessment of and provide noise mitigation design advice for the New Intercity Fleet Maintenance Facility Design and Construct (D&C) Project NIF MF at Kangy Angy, NSW.

This report addresses the overall environmental operational noise emissions from the NIF MF onto noise sensitive receivers surrounding the site and the acoustic design of on-site and off-site noise mitigation measures with recommended management measures.

This report outlines the following:

- Conformance with Environmental and Design requirements, including:
  - Relevant Conditions of Approval, and
  - Relevant Combined Submissions Report requirements
- Land Use Survey
- Project specific operational noise criteria
- Noise assessment methodology and procedures, including:
  - Pertinent design information
  - Operational noise modelling inputs and assumptions, including noise data and assumed conservative (but realistic reasonable worst case) operational procedures
- Design outcomes, including:
  - Details of reasonable and feasible noise and vibration mitigation and management measures that have been incorporated into the design
  - Predicted operational noise and vibration impacts at project assessment receivers

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Project conditions of approval and requirements

The TfNSW's New Intercity Fleet Maintenance Facility Project – Determination Report (August 2017) sets out Conditions of Approval (CoA) in its Appendix F, pertaining to the determination under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act), which must also be read in conjunction with the final management measures in the TfNSW's Combined Submissions Report (August 2017).

The CoA relating to noise and vibration are reproduced below in Table 2-1. Only conditions relevant to the operations of the facility are included.

Table 2-1: Noise and Vibration - Conditions of Approval for Project

CoA No.	CoA Details	Reference in this document
21	**Noise Impact on Educational Facilities** Potentially affected pre-schools, schools, universities and any other affected permanent educational institutions shall be consulted in relation to noise mitigation measures to identify any noise sensitive periods (e.g. exam periods). As much as reasonably practicable noise intensive construction works in the vicinity of affected educational buildings are to be minimised.	Section 3.2, 4, 5 & 7
22	**Operational Noise and Vibration Levels** Operational noise levels ($L_{Aeq\ (15\ minute)}$) from the facility are to comply with the requirements of the Industrial Noise Policy (EPA, 2000) at surrounding residential receivers of the maintenance facility for daytime, evening and night-time periods. Operational noise levels ($LA_{1\ (60\ second)}$) from horn testing, brake testing and the train movement warning system are not to exceed the Rating Background Level by more than 15 dBA ($L_{A1\ (60\ second)} \leq$ RBL + 15 dBA) at surrounding residential receivers of the maintenance facility for evening (6pm-10pm) and night-time (10pm-7am) periods. Operation of the new rail turn outs are to comply with the requirements of the NSW Rail Infrastructure Noise Guideline (EPA, 2013). Augmentation of track infrastructure on the Main North Line to provide access to and from the maintenance facility is to include a provision with the aim of installing turnouts which avoid the generation of impulsive noise (e.g. use of 'swing nose' turnouts).	Section 4 & 5
23	**Operational Noise and Vibration Review** Prior to commencement of laying of rail track, construction of the maintenance building or the construction of physical noise mitigation structures, an Operational Noise and Vibration Review (ONVR) shall be prepared to confirm the final physical mitigation measures for operational noise and vibration that would be implemented to satisfy the requirements of Condition 22.	This document

CoA No.	CoA Details	Reference in this document
	The ONVR shall be prepared in consultation with Sydney Trains (where relevant), NSW Train Link and other relevant stakeholders. The ONVR shall: a) examine all reasonable and feasible noise and vibration mitigation measures consistent with Rail Infrastructure Noise Guideline (EPA, 2013) and Industrial Noise Policy (EPA, 2000) b) identify specific physical and other mitigation measures for controlling noise and vibration at the source and at the receiver (if relevant) including location, type and timing of implementation of the proposed operational noise and vibration mitigation measures c) seek feedback from directly affected receivers on the final mitigation measures proposed in the review. A copy of the ONVR shall be submitted to the EMR for review and endorsement. The EMR is to be given a minimum period of 7 days to review and endorse the ONVR. Following receipt of the EMR's endorsement, the ONVR shall be submitted to the ADEM for approval, at least one month prior to commencement of laying of rail track, construction of the maintenance building or the construction of physical noise mitigation structures (or such time as is otherwise agreed to by the ADEM). The approved physical mitigation measures are to be installed prior to the commencement of operations, unless otherwise agreed by the ADEM.	
24	**Operational Noise Compliance Monitoring** In order to validate compliance with the requirements of Condition 22 and performance of operational noise mitigation measures identified in the ONVR, monitoring shall be undertaken within three months of commencement of operation. The noise and vibration monitoring shall be undertaken to confirm compliance with the predicted noise and vibration levels. Should the results of monitoring identify exceedances of the operational noise levels identified in Condition 22, predicted noise and vibration levels, additional reasonable and feasible mitigation measures would be implemented in consultation with the affected property owners, to the satisfaction of the ADEM.	Post-opening noise compliance monitoring
25	**Warning Sounds** Warning sounds associated with the movements of rolling stock shall only occur in emergency traffic or pedestrian safety situations but not as part of normal operations of the Project. Testing of warning sounds on rolling stock shall only be undertaken wholly within the Maintenance Building.	See Section 6 and Appendix C
26	**Maintenance Building Materials** The Maintenance Building is to be designed and constructed to achieve a sound insulation performance of at least 26dB Rw (weighted sound reduction index). In the event this would not achieve compliance with the requirements of Condition 22, additional noise mitigation measures are to be provided to ensure that compliance with the requirements of Condition 22.	See Section 6.8.3

The environmental management measures from the Combined Submissions Report which relate to noise and vibration are reproduced below in Table 2-2.

Table 2-2: Noise and Vibration - Management and Mitigation Measures: Combined Submissions Report August 2017

ID No.	Environmental Management Measure	Reference in this document
B.1	When additional details are available for substations and other mechanical plant, they would be assessed and designed so that overall noise emission of the Project with all mobile and fixed noise sources does not exceed the environmental noise objectives of the Project.	See Sections 4, 5 and 7

ID No.	Environmental Management Measure	Reference in this document
B.2	Noise mitigation for sources such as shunt vehicles; vehicle movement alarm systems; mechanical plant (including backup generator(s)) and PA systems would be addressed during the detailed design to ensure they meet the environmental noise objectives of the Project.	See Sections 5 and 7 and Appendix C
B.3	An acoustic enclosure or insulation for the substation would be considered during the detailed design so as to meet the relevant environmental noise objectives.	See Section 7 and Appendix C
B.4	Alternative systems would be investigated for vehicle movement alarms, such as the use of visual alarms.	See Section 7 and 8.3
B.5	The design and suitability of noise barriers would be determined where required. Noise barriers have been considered to reduce noise levels from train arrivals and departures in addition to standing trains. The final height and locations of any proposed barriers would be subject to further investigation. Currently proposed barriers for consideration include (refer to Figure 6-1 of the Noise and Vibration Impact Assessment): • A barrier of approximately five metres high above the track along the standing tracks south of the maintenance shed. The side of the barrier facing the noise sources would be acoustically absorptive or the barrier should include a combination of a vegetated earth berm and barrier. • A barrier to the full height of the train wash building which extends to fully block line of sight from the train wash exit to 26 Turpentine Road. Where noise barriers are considered to be the preferred treatment method, they would be required to be constructed so as to be solid and continuous with no gaps between the ground and barrier and between barrier panels. The barriers would be constructed of a material with a surface density of at least 12 kilograms per square metre	See Section 7 and Appendix D
B.6	The adoption of any proposed treatments measures at the source of residential receivers would be considered (such as architectural upgrades).	See Section 7 and 8.4
B.7	Further assessment of the potential noise impacts associated with the proposed track cross overs should be undertaken using detailed analysis techniques, such as computer aided modelling, in order to confirm the extent of any trigger level exceedance and appropriate mitigation measures. This would be undertaken as part of the Operational Noise and Vibration Review for the Project. Mitigation measures which would be considered to mitigate any exceedances would include: • Use of different types of turnouts which provide additional noise damping • Localised barrier screening in the vicinity of the turn outs • At-property treatments for affected receivers (where required).	See Section 8 and refer to ONVR once prepared

3 Noise sensitive receivers

Surrounding the site, 146 receiver locations were identified and assessed. The locations are presented in APPENDIX B. The noise criteria for these receivers were derived in the REF NVIA, with additional receivers and updates for receiver identification reviewed and adopted in this assessment.

3.1 Overview of receivers

A land use survey has been undertaken to confirm the location of all sensitive receivers that are potentially impacted by noise and vibration from the NIF MF.

Specifically, the following information is provided:

- A detailed land use survey is required to identify potentially critical areas that are sensitive to operational noise and vibration impacts, having regard to the type of land use.
- The land use survey identifying the land use category and the associated operational noise and vibration criteria at all sensitive receivers potentially impacted by the project.

Receivers were identified via a range of methods described below:

- A Cadastral Boundary layer, identifying the property boundaries of all parcels of land within the project area was provided from REF design.
- The most recent aerial photography from NearMap was utilised to locate buildings on each parcel of land. For the airborne noise modelling, the aerial imagery along with the REF noise model was utilised to digitise the buildings and locate them within the three-dimensional GIS database and noise modelling software. These software suites were utilised to determine the number of floor levels for each building and the approximate building heights.
- Additional land use information was sourced from the REF NVIA, and supplementary reports.

3.2 Receiver types

The following land use categories (receiver types) have been identified within the project area:

- Residential (RES)
- Childcare centres (CCC)
- Commercial and industrial facilities (COM)
- Education facilities (EDU) (as required by CoA 21)

Maps showing the receiver locations, the receiver identification and land uses surrounding the NIF MF are presented in APPENDIX B. A list of the identified assessment receivers applicable to the project are also provided in APPENDIX B. The table provides a summary of the following information:

- Receiver identification number
- Address
- Land Use (Receiver Type)
- Noise catchment area (NCA) reference
- Applicable Operational noise criteria

Predicted noise levels for each location are presented in APPENDIX D.

3.2.1 Noise Catchment Areas (NCAs)

For the purpose of assessing noise, the residential areas surrounding the NIF MF have been divided into Noise Catchment Areas (NCAs) in line with the REF NVIA, which describe areas of similar topographical and acoustic features. APPENDIX B presents the nominated NCAs used in the noise design along with other noise sensitive receivers that have been identified in the land use survey.

4 Noise and vibration requirements

In accordance with the CoA requirements, noise requirements were derived in accordance with the NSW Industrial Noise Policy (INP), and in accordance with the criteria established as part of the REF process.

4.1 Operational noise

4.1.1 Industrial Noise Policy (NSW INP)

In accordance with the CoA requirements, the assessment of noise emissions from the operations of the facility are undertaken in terms of the NSW Industrial Noise Policy (INP) (EPA, 2000), as per Section 1.5 and Appendix 3 of the NSW Rail Infrastructure Noise Guideline (RING) (EPA, 2013). This applies to noise generating activities within the project boundary, that are not for public use (eg. public roads). Noise criteria in accordance with the INP were derived in the REF NVIA.

The INP assessment has two components:

- Controlling intrusive noise impacts in the short-term for residences; and
- Maintaining noise level amenity for particular land uses for residences and other land uses.

4.1.1.1 Intrusive noise criteria

The INP's intrusiveness criteria are applicable to residential premises only. According to the INP, the intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor) does not exceed the background noise level measured in the absence of the source by more than 5 dB(A).

The intrusiveness criterion is summarised as follows:

- $L_{Aeq,15minute} \leq$ Rating Background Level (RBL) plus 5dB

This noise level is assessed over a 15-minute assessment period. This is based upon a 'reasonable' worst case 15-minute set of operations. It is generally accepted that the assessment of noise impacts should consider the noise impact that occurs 90% of the time. For example, if a noise event or set of concurrent noise events only occur for 3 or less 15-minute periods of the 9 hour night period (10pm to 7am) then it could be considered a non-typical or irregular event/s, and not be considered as part of the 'reasonable' worst case 15-minute assessment scenario. However, if the noise event or set of concurrent noise events occur more frequently than this it would be considered as part of the 'reasonable' worst case 15-minute assessment.

Furthermore, the INP also comments on atypical scenarios in its Section 7.6:

From time to time, managing noise at the source may require a short-term increase in noise beyond the level approved. Such situations may include:

- *running-in new equipment*
- *abnormal operations due to unforeseen breakdown or maintenance requirements*
- *occasional needs to move heavy equipment to new locations on site.*

Mitigation strategies are often impractical for such short-term and infrequent events.

4.1.1.2 Amenity noise criteria

The INP's amenity criteria are designed to maintain noise level amenity for particular land uses, including residential and other land uses. The INP recommends base acceptable noise levels for various receivers, including residential, commercial, industrial receivers and other sensitive receivers in Table 2.1 of the INP. Noise from new sources need to be designed such that the cumulative effect does not produce levels that would significantly exceed the criteria.

Table 4-1: INP Amenity Criteria - Recommended L_{Aeq} noise levels from industrial noise sources [NSW INP Table 2.1]

Type of receiver	Indicative Noise Amenity Area	Time of day	Recommended $L_{Aeq(Period)}$ noise level	
			Acceptable	Recommended maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Urban/Industrial Interface - for existing situations only	Day	65	70
		Evening	55	60
		Night	50	55
School classrooms - internal	All	Noisiest 1 hour period when in use	35	40
Hospital ward	All	Noisiest 1 hour period		
- internal			35	40
- external			50	55
Place of worship - internal	All	When in use	40	45
Area specifically reserved for passive recreation (e.g. National Park)	All	When in use	50	55
Active recreation area (e.g. school playground, golf course)	All	When in use	55	60

Type of receiver	Indicative Noise Amenity Area	Time of day	Recommended $L_{Aeq(Period)}$ noise level	
			Acceptable	Recommended maximum
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Note:
Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
The LAeq index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

Table 2.2 of the INP sets out modifications to be applied to acceptable amenity noise levels where existing levels of industrial noise are significant in the area. This INP table is reproduced below as Table 4-2 of this report.

Table 4-2: Modification to Acceptable Noise Level (ANL)* to account for existing level of industrial noise [NSW INP Table 2.2]

Total Existing L_{Aeq} noise level from Industrial Noise Sources	Maximum L_{Aeq} noise level for noise from new sources alone, dB(A)
≥ Acceptable noise level plus 2	If existing noise level is likely to decrease in future: acceptable noise level minus 10 If existing noise level is unlikely to decrease in future: existing noise level minus 10
Acceptable noise level plus 1	Acceptable noise level minus 8
Acceptable noise level	Acceptable noise level minus 8
Acceptable noise level minus 1	Acceptable noise level minus 6
Acceptable noise level minus 2	Acceptable noise level minus 4
Acceptable noise level minus 3	Acceptable noise level minus 3
Acceptable noise level minus 4	Acceptable noise level minus 2
Acceptable noise level minus 5	Acceptable noise level minus 2
Acceptable noise level minus 6	Acceptable noise level minus 1
< Acceptable noise level minus 6	Acceptable noise level

* ANL = recommended acceptable LAeq noise level for the specific receiver, area and time of day from Table 2.1 (INP)

4.1.1.3 Modifying factors

Table 4.1 of the INP sets out modifying factors which are applicable to noise sources that have characteristics that are particularly distinguishable and potentially more annoying than generally steady and broadband industrial noise. This table is reproduced in Table 4-3 below.

Table 4-3: Modifying Factor Corrections (Table 4.1 NSW INP)

Factor	Assessment/ measurement	When to apply	Correction1	Comments
Tonal noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: —5 dB or more if the centre frequency of the band containing the tone is above 400 Hz —8 dB or more if the centre frequency of the band containing the tone is 160 to 400 Hz inclusive —15 dB or more if the centre frequency of the band containing the tone is below 160 Hz	5 dB2	Narrow-band frequency analysis may be required to precisely detect occurrence
Low frequency noise	Measurement of C-weighted and A-weighted level	Measure/assess C- and A- weighted levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more	5 dB2	C-weighting is designed to be more responsive to low-frequency noise
Impulsive noise	A-weighted fast response and impulse response	If difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB	Apply difference in measured levels as the correction, up to a maximum of 5 dB.	Characterised by a short rise time of 35 milliseconds (ms) and decay time of 1.5 s
Intermittent noise	Subjectively assessed	Level varies by more than 5 dB	5 dB	Adjustment to be applied for night-time only.
Duration	Single-event noise duration may range from 1.5min to 2.5hr	One event in any 24-hour period	0 to –20 dB(A)	The acceptable noise level may be increased by an adjustment depending on duration of noise. (See Table 4.2)
Maximum adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10 dB(A)2 (excluding duration correction)	

Notes:

1.Corrections to be added to the measured or predicted levels.

2.Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range.

See definitions in Section 4.2 NSW INP

Where the character of the facility noise is assessed as particularly annoying (i.e. if it has an inherently tonal, low frequency, impulsive or is intermittent at night), then an adjustment is to be added to penalise the noise for its potential increase in annoyance. The INP provides definitive procedures for determining whether a penalty or adjustment should be applied as set out in Table 4-3 above.

Noise from the typical activities and operations likely to occur in the facility have been reviewed and the subject noise emissions with the designed mitigations implemented, would not likely require the application of modifying factor corrections.

4.1.2 Sleep disturbance criteria

The NSW EPA has made the following policy statement, for assessments in accordance the EPA INP, with respect to sleep disturbance as part of the INP Application Notes (December 2010):

> *Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.*
>
> *Research on sleep disturbance is reviewed in the NSW Road Noise Policy. This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.*
>
> *From the research, the EPA recognised that the current sleep disturbance criterion of an LA1, (1 minute) not exceeding the LA90, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, the EPA will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.*
>
> *The detailed analysis should cover the maximum noise level or LA1, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy. Other factors that may be important in assessing the extent of impacts on sleep include:*
>
> - *how often high noise events will occur*
> - *time of day (normally between 10pm and 7am)*
> - *whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).*
>
> *The LA1, (1 minute) descriptor is meant to represent a maximum noise level measured under 'fast' time response. The EPA will accept analysis based on either LA1, (1 minute) or LA, (Max).*
>
> *Source: http://www.epa.nsw.gov.au/noise/applicnotesindustnoise.htm*

In summary, the sleep disturbance criteria of $L_{A1,1min} \leq L_{A90,15min}$ + 15 dB(A) is to be used for initial assessment. The L_{Amax} descriptor may be used as an alternative to the $L_{A1,1min}$. It is noted that the background L_{A90} noise level used for establishing the sleep disturbance criteria includes all background noise including noise from the project.

Where the background noise level is very low, this may result in a limit which is unnecessarily strict. Therefore, where the screening limit L_{A90} + 15 is less than 55 dB(A) outside, a value of 55 dB(A) would be

appropriate to ensure the internal noise level does not exceed 45dB(A), on the assumption that there is a 10 dB(A) outside-to-inside noise loss through an open window (see INP, p17). Where windows are likely to remain closed on the basis of adequate ventilation that meets the Building Code of Australia's ventilation requirements, then outside noise levels can be greater than 65 dB(A), on the assumption that there is a minimum 20 dB(A) outside-to-inside noise loss through a closed window.

All sleep disturbance impacts associated with activities other than those described in Section 4.1.3, such as brake cylinder pressure venting noise, have been assessed to determine if the impacts exceed the awakening reaction level of 65 dB(A) externally at residential receiver locations.

4.1.3 Horn testing, brake testing and the train movement warning systems

Specific criteria for the horn testing, brake testing and the train movement warning system have been specified in the conditions of approval (CoA 22). This has been taken to include the noise emission from the Ground-based warning system (GBWS) and Depot Protection System (DPS) which are to be installed within the facility. This requirement states:

> *Operational noise levels (LA1 (60 second)) from horn testing, brake testing and the train movement warning system are not to exceed the Rating Background Level by more than 15 dBA (LA1 (60 second) ≤ RBL + 15 dBA) at surrounding residential receivers of the maintenance facility for evening (6pm-10pm) and night-time (10pm-7am) periods.*

As such, for these specific items, instead of achieving the sleep disturbance requirement outlined in Section 4.1.2 for the night period only (10 pm to 7 am), these noise impacts will be limited to:

- $L_{A1,1min}$ noise events will not exceed RBL + 15 dB(A) facility for evening (6 pm-10 pm) and night-time (10 pm-7 am) periods

4.1.4 Application of INP and sleep disturbance criteria to facility

Operational noise emissions from the facility have been assessed in terms of the intrusive noise criteria, presented in Table 4-4 below. This is because due to the variable, intermittent and non-continuous nature of the key noise sources (eg. train movements and positioning, cleaning and maintenance activities etc), and the small difference between the EPA's INP intrusive noise criteria and amenity noise criteria for the key receiver areas (NCA2 & NCA 3), the $L_{Aeq,15min}$ intrusive period is found to be the more stringent of the two criteria during the critical night period, see Section 4.1.4.1.

Intrusive criterion at the residential receivers has been derived based upon four noise catchment areas (NCA), determined from the unattended noise logging undertaken in the REF NVIA. Each residential receiver has been allocated an NCA from which to determine the background noise levels, and the appropriate intrusive noise criteria. NCAs and receiver locations are presented in APPENDIX B.

Table 4-4: Application of INP and Sleep Disturbance Noise Criteria, dB(A)

Noise catchment area (NCA)	INP Intrusiveness criteria $L_{Aeq,15min}$, dB(A)			Amenity criteria $L_{Aeq,period}$, dB(A)			Sleep Disturbance $L_{A1,1min}$ (or L_{Amax}), dB(A)	
	Day 7am – 6pm	Evening 6pm - 10pm	Night 10pm – 7am	Day 7am – 6pm	Evening 6pm – 10pm	Night 10pm – 7am	Initial Screening Level $L_{A90(15min)}$ + 15	Awakening reaction level
NCA1	50	50	**48**[1]	55	45	40[2]	58	**65**
NCA2	49	45	**40**[1]	53	42	40[2]	50	**65**
NCA3	54	49	**40**[1]	55	40	38[2]	50	**65**
NCA4	52	52	**50**[1]	55	37	37[2]	60	**65**

Notes:

1. The night time period is found to be the determining period in terms of noise impacts and noise mitigation design, so is assessed herein for the majority of the environmental noise design requirements.

4.1.4.1 Amenity criteria applicability

Due to the varying nature of the NIF MF facility noise source, where trains move in or out, or are only turned on for relatively small periods of time, the reduction in overall noise level between the reasonable worst case 15-minute period, and the overall day, evening or night assessment period will be such that the intrusive criteria is the controlling design criteria, and by achieving the intrusive criteria requirements, the amenity noise levels will also be achieved.

Even for relatively constant noise sources, it is typically found that there is a 2-3 dB(A) reduction in noise level from a source at the receiver, when the $L_{Aeq\ 15\text{-}minute}$ level is compared to the $L_{Aeq\ period}$ noise level. This is supported by the intrusiveness to amenity noise level conversion in the EPA Noise Policy for Industry (NPfI, EPA 2017) which is the EPA policy document which recently superseded the INP, however the INP is used in this assessment as it is specifically nominated in the Conditions of Approval for this project.

The NPfI states:

> *To standardise the time periods for the intrusiveness and amenity noise levels, this policy assumes that the $L_{Aeq,15minute}$ will be taken to be equal to the $L_{Aeq,\ period}$ + 3 decibels (dB), unless robust evidence is provided for an alternative approach for the particular project being considered.*

4.1.5 Project specific noise levels (PSNL)

A summary of the operational noise criteria that have been used to assess noise emissions from the NIF MF is presented in Table 4-5.

Table 4-5: Project specific noise levels (PSNL)

Operational noise assessment	INP			Horn testing, brake testing and the train movement warning systems (CoA 22)		Sleep Disturbance[1]	
Descriptor	$L_{Aeq,15min}$, dB(A)			$L_{A1,1min}$, dB(A)		$L_{A1,1min}$, dB(A)	
Noise catchment area (NCA)	Day 7am – 6pm	Evening 6pm – 10pm	Night 10pm – 7am	Evening 6pm – 10pm	Night 10pm – 7am	Screening Level $L_{A90(15min)}$ + 15dB(A)	Awakening reaction level
NCA1	50	50	**48**[1]	60	**58**	58	**65**
NCA2	49	45	**40**[1]	55	**50**	50	**65**
NCA3	54	49	**40**[1]	59	**50**	50	**65**
NCA4	52	52	**50**[1]	63	**60**	60	**65**

Notes:

1. The night time period is found to be the determining period in terms of noise impacts and noise mitigation design, so is assessed herein for the majority of the environmental noise design requirements.
2. Sleep disturbance only applies to the night period (10pm – 7am)

4.2 Vibration

Vibration requirements were derived in the REF NVIA for operational activities.

Operational vibration was reviewed and considered insignificant due to the large distance offset from the facilities to sensitive receivers and it does not require further assessment.

4.3 Road traffic noise objectives (outside to project site)

Off-site road traffic noise was assessed in the REF NVIA against the requirements of the NSW Road Noise Policy (RNP).

The new access road to Orchard Road off Enterprise Drive, and the modification works on Enterprise Drive which falls within the project works are public roads. As such, these have been assessed against the requirements of the NSW Road Noise Policy (RNP) as per the REF NVIA.

As defined in the REF NVIA, the project assessment criteria are presented in Table 4-6. These levels apply cumulatively for all road traffic noise impacts at the nearby sensitive receivers.

Table 4-6: Road traffic noise (outside the facility) assessment criteria

Assessment Period	Day criteria (7am – 10pm) $L_{Aeq, Worst 1 hour}$	Night criteria (10pm – 7am) $L_{Aeq, Worst 1 hour}$	Relative increase
New access road (local road) and additional traffic on Enterprise Drive (sub-arterial)[1]	55	50	Development increases existing L_{Aeq} road traffic noise levels by 2 dB or more

Notes 1. As per the REF NVIA, to conservatively assess the additional traffic on Enterprise Drive (sub-arterial road), the worst-case 1 hour has also been assessed against, in place of the 15 hour day / 9 hour night periods

4.4 Rail noise objectives (outside the project site)

The NSW 'Rail Infrastructure Noise Guideline' (RING 2013) provides guidance in relation to the prediction and assessment of railway noise from new and upgraded railway projects.

The purpose of the guideline is to ensure noise and vibration impacts associated with railway developments are evaluated in a consistent and transparent manner. This is achieved by specifying noise and vibration trigger levels to protect the community from the adverse effects of noise and vibration. If the noise assessment identifies that the trigger levels are likely to be exceeded, the assessment is required to outline feasible and reasonable noise mitigation measures that could be implemented to ameliorate the predicted impacts.

The RING guideline provides airborne noise trigger levels that address both an increase in rail noise due to rail infrastructure projects and absolute levels of rail noise. The project involves the installation of four turnouts on the main line. Since all trains on the Main North Lines will operate through one or more of these turnouts (three turnouts on Down Line and one turnout on Up line), noise levels may increase compared with existing operations.

As the Main North Line is an existing railway corridor, the applicable noise trigger levels are based on the "redevelopment of an existing rail line" levels in RING. As such the noise trigger levels for redeveloped rail lines are applicable for this assessment and are shown in Table 4-7 and Table 4-8.

For residential receivers, the noise trigger levels for absolute levels of rail noise have two components:

- L_{Aeq}, which addresses the average level of train noise over the day or night period; and
- L_{Amax}, which addresses the maximum noise level from train pass-by events. The L_{Amax} noise parameter is based on the 95th percentile passby level (1 in 20 trains can exceed the 95th percentile level).

For other noise-sensitive land uses, only L_{Aeq} is applied, as the focus is on speech interference and providing adequate acoustic protection to conduct the activities associated with those land uses.

According to RING, the noise trigger levels apply both immediately after operations commence and for projected traffic volumes at an indicative period (ten years or similar) into the future to represent the expected future level of rail traffic usage. However, for this assessment, noise level predictions are made with and without the proposed turnouts. Any potential noise level differences which result from timetable changes, traffic mix changes or speed changes over a 10-year timeframe are not within the scope of this assessment and are independent of the noise level change associated with the additional turnouts.

The noise trigger levels refer to noise from rail transportation only and do not include ambient noise from other non-railway noise sources.

Table 4-7: Airborne rail traffic noise trigger levels for residential land uses (adapted from RING)

Type of development	Daytime noise trigger levels, dB(A) (7am to 10pm)	Night-time noise trigger levels, dB(A) (10pm to 7am)	Comment
Redevelopment of existing rail line	Development increases existing $L_{Aeq(period)}$[1] rail noise levels by 2 dB or more, or existing L_{Amax} rail noise levels by 3 dB or more **and**		These numbers represent external levels of noise that trigger the need for an assessment of potential noise mitigation measures to reduce noise levels from a rail infrastructure project
	Predicted rail noise levels exceed: 65 $L_{Aeq(15hour)}$ 85 L_{Amax}	Predicted rail noise levels exceed: 60 $L_{Aeq(9hour)}$ 85 L_{Amax}	

Note – 1. $L_{Aeq(period)}$ means $L_{Aeq(15h)}$ for the day-time period and $L_{Aeq(9h)}$ for the night-time period

Table 4-8: Airborne rail traffic noise trigger levels for sensitive land uses other than residential (adapted from RING)

Type of development	Sensitive land use	New rail line development, noise trigger levels, dB(A)
Redeveloped rail line	Schools, educational institutions and child care centres	45 $L_{Aeq(1hour)\ internal}$
Redeveloped rail line	Places of worship	45 $L_{Aeq(1hour)}$ internal
Redeveloped rail line	Hospital wards	40 $L_{Aeq(1hour)}$ internal
Redeveloped rail line	Hospitals other uses	65 $L_{Aeq(1hour)}$ external
Redeveloped rail line	Open space – passive use (e.g. parkland, bush reserves)	65 $L_{Aeq(15hour)}$ external
Redeveloped rail line	Open space – active use (e.g. sports field, golf course)	65 $L_{Aeq(15hour)}$ external

The noise trigger levels represent external levels except where otherwise stated. Noise levels at residences are assessed 1 metre in front of the most affected building facade. Where only free-field measurements can be made, the measured noise level is corrected [generally by +2.5 dB(A)] to account for the facade reflection effect.

4.5 Building acoustics

4.5.1 Building envelope requirements

In addition to the noise criteria outline in the Conditions of Approval (CoA) 22, CoA 26 notes a requirement that the maintenance building facade is to achieve a minimum acoustic transmission loss, as shown in Table 4-9.

Table 4-9: CoA - Maintenance Building Materials requirements

26	**Maintenance Building Materials** The Maintenance Building is to be designed and constructed to achieve a sound insulation performance of at least 26dB Rw (weighted sound reduction index). In the event this would not achieve compliance with the requirements of Condition 22, additional noise mitigation measures are to be provided to ensure that compliance with the requirements of Condition 22.

Further clarification and commitments were adopted in the combined submissions report by TfNSW in the response, Section 4.8.1 *Peer review of noise and vibration assessment* Table 4.5, Item 15.

Table 4-10: CoA - Maintenance Building Materials requirements

Item	Technical paper section	Comment	Peer review comment	Transport for NSW response
Item 15	6.6.3	Rw26 requirements from the shed.	All doors and windows to be acoustically rated as well. Is there internal absorption treatment proposed to reduce reverberation time.	The Noise and Vibration Impact Assessment specifies the maintenance building would achieve the sound insulation rating, this would include windows, doors and any other apertures for ventilation. Specific construction materials for the maintenance building would be addressed as part of detailed design and could include reverberation control, where required.

4.5.2 Internal noise levels and reverberation times

Acoustic criteria specific to the design of the NIF MF administration building and other occupied noise sensitive spaces of the NIF MF is not outlined in the Condition of Approval. Nonetheless, the recommended design criteria for the administration and office areas of the maintenance building have been derived to be consistent with similar projects and are consistent with the recommended upper noise levels and reverberation times set out in the Australian/New Zealand Standard AS/NZS 2107:2016 "*Acoustics – Recommended design sound levels and reverberation times for building interiors*".

The design documentation incorporates these recommended internal noise levels and reverberation times, and this assessment accounts for these in the noise emission modelling to neighbours.

4.5.2.1 Internal noise levels

Limiting of internal noise levels have been used to control noise emissions from noise sources within buildings across the project.

4.5.2.2 Reverberation control

A measure of a room's degree of acoustic 'liveliness' or 'deadness' is through the measurement of the room's 'reverberation'. In layman terms, reverberation is the build-up of sound within a room due to sound reflecting from the surfaces in a room. Reverberation time is a measure of how long it takes for a burst of sound to decay 60 dB and is given the abbreviation of RT60.

A 'lively' room has many hard and reflective surfaces whereby sound can reflect off and lose little energy. A 'dead' room has soft finishes, which absorb sound, and approaches the conditions found in an open outdoor area. All things being equal, a noise source in a 'lively' room can in practice be up to approximately 5-7 dB(A) louder than in a 'dead' or 'quiet' room.

Reverberation control is necessary for two important noise emission reasons:

1. A noise source will generate greater sound pressure levels in a reverberant space because the sound energy takes longer to decay.
2. Excessive reverberation may influence other acoustic sources (eg PA system, DPS and GBWS Systems) to be higher in level in order for them to be fit for purpose.

Therefore, it is important when designing 'quiet' spaces that the surface area of sound absorptive finishes is maximised. The use of sound absorptive materials has been used to control noise emission from noise sources within buildings across the project.

4.5.2.3 Ground based warning system, Pubic Address (PA) system and Depot Protection System (DPS)

The design of the GBWS, PA and DPS system is undertaken by others. Noise emission from these systems have been reviewed as part of the noise emissions from normal operations, covered in Section 4.1.

Other performance requirements for the PA and DPS system are covered within the Works Brief, such as the speech transmission index (STI) requirements. It is understood that these levels have been updated in agreement with TfNSW.

The works brief also covers the internal Occupant Warning system, as part of the fire detection system which has minimum and maximum noise levels that are to be achieved. The design of these elements is undertaken by others. As the use of this system is undertaken during emergency situations, it does not form part of the normal noise emissions from the operations of the site.

5 Assessment methodologies

The noise assessment of this design review has been based upon the SoundPlan 7.4 model developed for the REF by WSP/PB, which was updated by RT&A.

The assessed operational scenarios, assumptions and noise sources are outlined in Section 6 and APPENDIX C. For noise producing plant items at the facility that are not listed in APPENDIX C, they have not been identified as operating at the facility during reasonable worst case operations, and it is assumed that they do not contribute to the overall noise emission of the site.

5.1.1 Environmental noise predictions

The noise emission requirements for the NIF MF consider the overall facility and include all components that would operate during a reasonable worst assessment period during all periods of operation.

Modelling and assessment of airborne noise impacts from the project were determined by modelling the noise sources, receiver locations, topographical features, and possible noise mitigation measures using SoundPlan Version 8.0, based upon the noise model developed for the REF by WSP/PB. The model uses the worst-case prevailing meteorological conditions, see Section 5.1.2, using the CONCAWE noise prediction method.

The noise modelling algorithms were used to calculate the contribution of each noise source at each identified sensitive receiver location and to predict the total noise from the site for the various reasonable worst-case scenarios developed for the project.

The noise prediction model considers:

- Location of noise sources and sensitive receiver locations;
- Height of sources and receivers referenced to 2 metre digital ground contours within the site and outside the site area;
- Noise source levels of individual plant, equipment and internal building noise levels;
- Separation distances between sources and receivers;
- Ground type between sources and receivers (mixed soft/ hard);
- Attenuation from barriers (natural terrain and purpose built); and
- Atmospheric losses and meteorological conditions.

Predicted noise emissions are based on the sources and assumptions in APPENDIX C, and ensure that cumulative noise impact from activities that could occur simultaneously within the NIF MF has been taken into account. Results of noise predictions are presented in APPENDIX D, incorporating all noise mitigation and management design measures contained in this report.

Shielding from adjacent trains is not accounted for in the noise model, based upon a review of the modelling results, which showed a negligible difference [approximately <0.5dB(A)]. This is due to the relative height of the nearby receivers to the standing yard.

No additional factors of safety have been incorporated into the predicted results due to the conservative nature of the assessment scenarios.

5.1.2 Meteorological conditions

In accordance with the INP, the noise assessment considers the effects of adverse meteorological conditions such as wind and temperature inversions.

The analysis for likely occurrence frequency of temperature inversions and wind effects was carried in accordance with the INP.

Meteorological results have been taken from the Gosford automatic meteorological station. A review of 2015, 2016 and 2017 was undertaken to determine typical years. Meteorological conditions representative for the assessment have been reviewed to determine the prevailing wind and temperature inversion conditions. The analyses of the meteorological conditions are summarised as:

- The prevailing wind conditions around the NIF MF project were evaluated using the NEWA program for 2017 wind data, to determine the prevailing assessment wind speed and direction to be considered in the noise assessment, as defined by the NSW INP. The results showed that noise enhancing wind speeds between 0.5 m/s to 3 m/s in all directions during all seasons occur less than 10% of the day and evening period, and approximately up to 11% during the night period considering all directions. These occurrence frequencies do not exceed the minimum 30% occurrence which deems the meteorological condition as prevailing in accordance with the INP. As such, noise enhancement as a result of source to receiver wind is not considered a feature of the area in accordance with the INP.
- During the night-time period at the NIF MF temperature inversion conditions were calculated based upon the sigma-theta method referred to in Part E4 of Appendix E to the NSW INP. Based upon this method the temperature inversions (Stability Class F) occurred for over 30% of the winter month night time periods, as over the 2015 to 2017 period the occurrence of temperature inversions ranged between 37% to 41%.

On the basis of the assessment the following noise enhancing adverse meteorological effects were included in the noise modelling design conditions, in accordance with the INP requirements.

Table 5-1: Design assessment prevailing adverse meteorological conditions

Assessment period	Assessment meteorological condition	
	Pasquill-Gifford stability class	Source-to-receiver wind
Day (7am – 6pm)	Class D	0 m/s
Evening (6pm – 10pm)	Class F	0 m/s[1]
Night (10pm – 7am)	Class F	0 m/s[1]

Notes: 1. No drainage winds due to the elevation of the nearby receivers

5.1.3 Noise generation within buildings

Noise generation within buildings, including the Maintenance building, Wheel Lathe, and Train Wash were modelled within CadnaR 3D noise modelling software prior to being incorporated into the SoundPlan environmental noise model.

5.1.4 Mainline rail noise and wheel/rail noise sources

SoundPLAN Version 8.0 was used to calculate railway noise emission for wheel/rail noise sources for the project both on the Main North Line and within the project where required. The Nordic Rail Traffic Noise Prediction Method (Kilde 1984) was adopted, consistent with the noise prediction methods described in the RING and was applied where the wheel/rail noise may contribute to the overall noise emissions. The noise predictions take into account the inputs outlined in Table 5-2.

Noise levels have been predicted using the inputs provided by JH and the assumptions presented in Table 5-2. Track features such as turnouts have the potential to generate increased wheel-rail noise as the vehicles traverse the discontinuity in the rail line. The noise modelling includes a correction for the relevant sections of track (see Table 5-2).

Table 5-2: Summary of operational rail noise modelling inputs

Input parameters	Input assumptions
Noise modelling software:	SoundPLAN 'Rail Noise Module' – Version 8.0
Noise model Standard:	Nordic Rail Noise Prediction Method (1984) (Kilde Rep 130) predicts the LAeq and LAmax noise levels in accordance with the IGANRIP
Reference noise levels:	In the noise model, corrections to the base Nordic inputs are required for the source noise levels to correlate with the above. The source levels adopted in the noise modelling are: *RING comparison assessment for mainline turnouts* Assessment train type reference: K-Set Reference condition = 15m, 80 km/h $L_{Amax, 95\%}$ = 85 dB(A), L_{AE} = 88.6 dB(A) for 6-car train Reference: TfNSW Rail Noise Database (Version 1.0) *INP assessment (Arrivals and departures)* - Reference condition = 7.5m, 80 km/h NIF design limits: L_{Amax} = 83 dB(A), $L_{pAeq,TP}$ = 80 dB(A) for 10-car train NIF design noise levels: L_{Amax} = 80.5 dB(A), $L_{pAeq,TP}$ = 79.5 dB(A) for 10-car train NIF design noise levels reference: NIF 'Noise Prediction Report' (Doc. No. REDE207532, Rev. No. 5, 2 January 2019)
Rail traffic volumes:	*RING comparison assessment for mainline turnouts* - The comparison scenario assumes 4 trains per hour on both the up and down lines during the more stringent night-time period. *Arrivals and departures* – See Section 6.4 and APPENDIX C
Train speeds:	*RING comparison assessment for mainline turnouts* - Train speeds have been modelled at 80km/h and 145km/h, which are respectively based upon the potential average speeds and current maximum speeds along this section of the Main North Line. *INP assessment (Arrivals and departures)* – up to 70km/h at the Main North Line to stationary at the standing points, Train Wash on arrival, Departure Signal on departure.
Track alignment:	The centre line of each track was used as the source object in the noise model. Five metre increments were made along the 3D CAD file provided by JH and then inserted into the model as a railway line source.
Source height:	The source object in SoundPLAN is equal to the top of rail height. The Nordic Rail Noise Prediction Method 1984 sets the emission height to 0.5 m above the source object in SoundPLAN.
Ground topography:	2 m topographic data provided by the project's design team was used. SoundPLAN triangulates the data to create a Digital Ground Model (DGM).
Receiver heights:	1.5 m above floor level of each receiver building for each relevant floor level. The ground floor is assumed to be 0.5 m above local ground level and each building level assumed to be 3 m high.
Air and ground absorption:	Detailed within the Nordic Rail Traffic Noise Prediction Method 1984 and SoundPLAN Rail Noise Module. Soft ground is assumed in the noise model predictions.
Buildings:	Existing dwellings and buildings are included in the noise model.
Facade correction:	*RING comparison assessment for mainline turnouts* - Predicted noise levels at buildings are inclusive of facade reflections, in accordance with RING. *INP assessment (Arrivals and departures)* - No correction applied, assessment has been undertaken to the INP applicable external assessment location.
Rail surface discontinuities:	No correction applied. Assumed that insulated joints and welded joints are well maintained.
Rail Roughness assumptions	Rail roughness levels consistent with the requirements of ISO 3095-2013 (International Stanadards, 2013) and ISO 3381-2005 (International Standards, 2005) are assumed, representing smooth track suitable for type testing.
Turnouts and crossovers:	Correction for conventional turnout is based on the Nordic Rail Noise Prediction Method 1984; 6 dB(A) is added to L_{Amax} and LAE reference noise levels over a track length of 10 m.

6 Noise assessment design review

6.1 Overview

The following activities located within the maintenance facility are the key activities that could generate noise as part of normal operations:

- 9 standing roads which could accommodate train preparation, departure, arrival, presentation (internal cleaning) and stabling modes
- Maintenance activities within the maintenance facility building and associated external plant and equipment operations
- Mechanical plant and equipment associated with the administration building
- Train movements along the arrival and departure roads
- Train wash activities
- Wheel lathe activities
- Bio-wash and graffiti removal operations
- Traction substation operations
- Car park activities for maintenance and administration works
- Vehicle deliveries

Vibration emissions from the activities within the facility with respect to impacts to neighbouring sensitive receivers have been reviewed as insignificant and do not warrant further assessment.

Key assumptions for the design of noise mitigation measures were:

- Physical noise mitigation measures at the noise source or as part of the building fabric are constructed as advised and documented, to minimise noise break-out and emission to noise sensitive receivers.
- Physical noise mitigation measures in the form of noise barriers have been designed to minimise noise impacts and limit the number of noise sensitive receivers where the noise criteria are exceeded during the day and evening period. This will ensure that the acoustic amenity of outdoor areas is protected during the time periods that these areas are most likely to be used.
- Residual noise impacts will be addressed through the implementation of at-property noise mitigation treatment to ensure that the acoustic amenity of indoor areas is protected, in particular during the critical and night period.
- The day-to-day adherence by staff to the operations and procedures assumed for management of noise within the NIF MF outlined in this noise assessment.

The main constraints for the design of noise mitigation measures were:

- Close proximity of some noise sensitive receivers to the NIF MF.
- Typically, low background noise levels for the area surrounding the NIF MF, particularly for the late arrivals and early morning operations (night assessment period).
- Inability to build a noise barrier along the access roads, and south-east side of the NIF MF due to flooding issues, physical proximity limitations from the Main North Line, and the elevated location of the noise sensitive receivers relative to the NIF MF.

The noise and vibration sources associated with normal operations of the NIF MF cover a range of noise assessments and noise generating activities. The details of the operational noise sources, design elements and design assumptions in this are outlined in the following table.

Table 6-1: Details of the operational noise sources, design elements and design assumptions

Assessment / Element	Section
Rail noise (external to facility)	
Turnouts located on the Main North Line	Section 7.1
Operational activities	
Trains in standing area including preparation for service, arrival and departure movements and internal cleaning	Section 6.2.1, 6.2.2, 6.2.3
Warning alarms, ground borne warning systems, depot protection systems, public address systems	Section 6.2.4, 6.2.5
Maintenance and cleaning activities within the maintenance building	Section 6.2.6
Train wash plant	Section 6.2.8
Wheel reprofiling using an underfloor wheel lathe (UFWL)	Section 6.2.9
Mechanical equipment serving the Administration/Maintenance building	Section 6.2.6
Bio-wash and graffiti removal external cleaning	Section 6.2.11
Ancillary buildings, including the sewer decant facility and rain water pump house	Section 6.2.12
Road traffic generation and carpark and delivery activities	Section 6.2.7
Electrical equipment, including traction substation	Section 6.2.10
Road traffic noise (external to facility)	
Road traffic noise level changes from the Enterprise Drive road modifications and new bridge.	Section 6.2.7

Presented in Table 6-2 are the reference maintenance facility building drawings used for the design advice in this report.

Table 6-2: Assessment reference design packages

Drawings reference	Date	Revision
Maintenance Facility Building Package 20.1 - CDR	07/08/2018	D
Site Wide Package - CDR	24/07/2018	C
Mechanical Services CDR Interim Draft Issue Package	29/05/2018	B
Design Package 16.4 – Ground Based Warning System – CDR Resubmission	-	E

Drawings reference	Date	Revision
Design Package 16.5 – Depot Protection System	-	-
Design Package 21 – Traction Substation	14/8/2018	C
Design Package 22 – Train Wash	14/8/2018	C
Design Package 22 – Wheel Lathe Building	14/8/2018	D
Design Package 22 – Bio-wash/Graffiti	23/7/2018	C
Design Package 23 – Site Entry Buildings - CDR	24/7/2018	C

Presented in Table 6-3 are the reference maintenance facility building drawings used for the design advice in this report.

Table 6-3: Assessment reference documents

Reference document	Reference No.	Date	Revision
Works Brief (Exhibit B)	5510859_14	19 December 2016	14
Exhibit B Annexure C - Clarifications	5514434_1	-	-
Business Operational Requirements Document (BOR)	4608829_3	8 October 2015	3.0
Concept of Operations (CoOps)	4889032	April 2016	1.2
Determination Report	5339920	August 2017	1.0
Conditions of Approval (Determination Report Appendix F)	5339920	August 2017	1.0
Combined Submissions Report [including Supplementary noise and vibration assessment (SNVA)]	NIF MFP Combined Submissions Report	24 August 2017	0
Maintenance Concept for NIF Maintenance Services Specification (MSS)	ENG/R-0223/SCH.2333 / DAR no. UGL-MSS-OT-0001-8	27 June 2018	H
Review of Environmental Factor's (REF) noise and vibration impact assessment (NVIA)	WSP/PB Project ACG1522100	16 May 2016	3
Supplementary Review of Environmental Factor's (REF) noise and vibration impact assessment (NVIA)			
Hyundai Rotem New Intercity Fleet 'Noise Prediction Report'	Doc. No. REDE207532	2 January 2019	5

6.2 Operational noise sources, design elements and design assumptions overview

This section of the report describes the operational noise sources, assumptions, incorporated mitigation and management measures to control noise emissions for the noise generating activities across the project.

Each of the major buildings or areas of activity across the entire site have been reviewed, and details of the assumptions or requirements for each of the following components are described herein. This information has been provided in the following break-down:

- Operational assumptions and design elements
- Operations and noise sources

- Internal noise levels and reverberation control
- Building envelope

Noise emission from the NIF MF will vary depending on the time of day on the basis of train movements and operations, loads on mechanical equipment, and types of activities such as cleaning, maintenance and wheel lathe operation.

Reasonable worst-case operating scenarios for each activity has been established for the range of assessment time periods and key operational variations, which are detailed in this section, and further details are provided in APPENDIX C. APPENDIX C summarises the operational assumptions that have formed part of the noise mitigation design.

Table 7-5 in Section 7.2.1 then sets out the reasonable worst-case set of concurrent activities that could occur across the site to assess the cumulative noise impacts. Where these operations do not actually occur concurrently, the noise levels at some receivers will be less than those predicted.

For noise producing plant items at the facility not identified in this section and APPENDIX C, it is assumed that they do not contribute to the overall noise emission from the site or can be sufficiently mitigated to not contribute to the overall noise. Operational scenario information has been provided by the project documentation, JH, Rail Connect and TfNSW.

6.3 Rolling stock

6.3.1 Assumptions

Noise from trains within the NIF MF will predominately relate to auxiliary systems on the train, including HVAC, SIV and air compressors. Air compressors will typically operate only intermittently, however, could operate while in operation. Below is a description of modelling input operational assumptions pertaining to trains:

1. Operation of the HVAC system in regard to cooling, venting and heating is based on Hyundai Rotem noise prediction report, prepared on behalf of the operator, RailConnect, on the New Intercity Fleet (NIF) trains entitled 'Noise Prediction Report' (Doc. No. REDE207532, Rev. No. 5, 2 January 2019) (NIF rolling stock noise prediction report), as presented in Table 6-4.

   TfNSW has advised that the ONVR is to assume that the standing trains are at “maximum operating condition” for the ONVR noise emission assessment. Additionally, TfNSW has advised that it should be assumed that 4 compressors on each train could be running during the train morning preparation and departure.

   This is a conservative assumption, and once the facility is operating the actual train operating condition could vary from this based upon local conditions, and the operating condition of the train could also vary for an arriving train at night compared to a train in preparation in the early morning.

2. Speed of trains are assumed to be the following average speeds:
   a. Within the standing yard is limited to 8 km/h and along after each of the standing points.
   b. Through the train wash the train will move at 3.5 km/h, pausing for periods in the case that a complete wash is being undertaken.
   c. Trains could wait for up to approximately 5 minutes at the entrance to the train wash upon arrival at the facility, and up to approximately 5 minutes upon departing the facility at the signal between the standing yard and train wash, located approximately 120 m NE of the train wash.
3. Upon arrival at the facility, trains will be required to dump/vent the brake compressed air once the train is stopped and the key removed. This is a significant noise event and is much louder than normal brake tests. The NIF fleet do not have additional mitigation measures incorporated into the brake vent pipework to mitigate this noise source. It is recommended feasible and reasonable mitigation or management measures are investigated for this noise source once the actual noise level and its range across the NIF fleet is known in order to minimise sleep disturbance impacts and achieve the $L_{A1,1min}$ requirements during the night period.
4. APPENDIX C outlines the noise sources and modelling assumptions for the rolling stock.

6.3.2 $L_{Aeq\ 15\text{-}minute}$ noise sources

The rolling stock noise levels are based upon the Hyundai Rotem noise prediction report, prepared on behalf of the operator, RailConnect, on the New Intercity Fleet (NIF) trains entitled 'Noise Prediction Report' (Doc. No. REDE207532, Rev. No. 5, 2 January 2019) (NIF rolling stock noise prediction report). The NIF rolling stock noise prediction report predicts that the NIF trains will meet the ASA Standard T-HR-RS-00100-ST RSU 100 (RSU 100) noise specifications, and provides predicted noise levels, which have been used to develop a calibrated model of the stationary and slow-moving trains.

Presented in Table 6-4 are the reference values presented in the NIF rolling stock noise prediction report which have been used in the noise modelling.

Table 6-4: Summary of sound power levels for key rolling stock noise generating items, dB(A)

Operating condition	HVAC	Compressor	Static Inverter (SIV)
Presentation	84.3	-	83.3
Normal	86.3	88.7	83.3
Maximum	90.3	88.7	83.3

Table 6-5 presents the assumed number and location of noise sources per train.

Table 6-5: Summary of assumed rolling stock noise generating items

Operating condition	HVAC[1]	Compressor[1,2]	Static Inverter (SIV)/APU[3]
Presentation	2 per car = 20 per 10 car train on top of train	Not operating	3 per 6 car train 2 per 4 car train On top of train
Normal	2 per car = 20 per 10 car train on top of train	4 operating for 10 Car train. Located at the end of adjoined 6 car and 4 car trains. Underneath train	3 per 6 car train 2 per 4 car train On top of train
Maximum	2 per car = 20 per 10 car train on top of train	4 operating for 10 Car train. Located at the end of adjoined 6 car and 4 car trains. Underneath train	3 per 6 car train 2 per 4 car train On top of train

Notes: 1. Based upon NIF rolling stock noise prediction report, Doc. No. REDE207532, Rev. No. 5, 2 January 2019, and NIF layout information provided by TfNSW

2. NIF rolling stock noise prediction report notes 2 compressors could run during maximum operation conditions, while under exceptional or emergency circumstances 4 compressors could run. TfNSW has advised to use 4 compressors in operation as this may occur during the trains starting up procedure.

3. VVVF inverters do not have a forced ventilation system, so the stationary noise is negligible.

Preparation noise levels have been based upon noise levels similar to current Sydney Trains Waratah A-Sets, such as the door testing operations.

6.3.3 $L_{A1,1min}$ noise sources

For **brake testing** within the yard, Table 3 of the NIF rolling stock noise prediction report identifies the external noise limits during moving tests for the NIF trains, which includes braking tests based upon RSU 100. The braking test noise source level is based upon both the RSU 100 requirement of 82 dB(A) L_{pAFmax} at 7.5m, and similar attended noise measurements undertaken by RT&A. A braking noise source (either braking activity or brake testing noises) sound power level (SWL) of 108 dB(A) has been modelled.

During **brake air venting/exhausting** the noise source levels can be significantly [> 15dB(A)] higher than the normal RSU 100 brake test noise levels. In consultation with TfNSW, the brake air venting/exhausting noise source levels for the NIF are based upon estimates from measurements undertaken at the Auburn Maintenance Facility, June 2018, which showed that this noise source could be up to 128 dB(A) $L_{A1\ 1\ minute}$ SWL on other trains within the Sydney Trains fleet. The $L_{A1,\ 1\ minute}$ and $L_{Aeq\ 15\text{-}minute}$ noise source levels are presented in Table 6-15. These noise levels during the preparation procedure have also been captured, based upon noise level similar to current Sydney Trains Waratah A-Sets.

Horn testing will not form part of normal operations within the yard but could occur in emergency traffic situation or pedestrian safety situations as per Condition of Approval 25 and testing of warning sounds on rolling stock shall only be undertaken wholly within the Maintenance Building with all maintenance building doors closed.

On the access road, the wheel-to-rail noise from the **trains entering or exiting the facility** at speeds above 40 km/h could result in high $L_{A1,1min}$ noise events, and so maximum train wheel-to-rail noise levels when the train is within the project boundary have been assessed against the INP sleep disturbance levels (Section 4.1.2).

The **train service brakes** will be required to operate during both the arrival and departure activities, and so these have been modelled to assess the potential for sleep disturbance impacts as trains arrive or depart from the facility.

6.4 Access road

6.4.1 Overall assumptions

1. Up to 2 trains could either arrive or depart the facility within a 15-minute period, day, evening or night. This is a conservative assumption as only up to 2 Long and 1 Short NIF train are expected to arrive between 7:00pm and 2:00am (CoOps 7.1.3).
2. Up to 16 train movements in and out of the facility could occur in a 24 hour period (CoOps 7.1.3).
3. To reduce potential increases in noise due to the wheel-rail interface such as flanging or wheel squeal, consideration will be given to the installation of rail lubrication systems (where required) as part of the development of the wheel-rail maintenance strategy.
4. It is assumed the HVAC and auxiliary systems will be operating in worst-case mode throughout a train arrival or departure, with up to 4 compressors running (LNIF).
5. Trains would not vent/dump the brake compressed air at any location along the access road.

6.4.2 Arrival assumptions

1. On arrival the trains exit the Main North Line at 70 km/h.
2. On arrival, the trains will slow down from the Main North Line departure point to then stop prior to the train wash.
3. A train could be required to pause with auxiliary systems running for prior to the train wash for up to 5 minutes.
4. The train will then move through the train wash at 3.5km/h, without pause in the case of a quick wash or in the case of a complete wash with pauses to wash the train front, rear and intercab areas.
5. The train will then move into the facility at up to 8 km/h to then stop either within the standing yard or move into the maintenance facility building.

6.4.3 Departure assumptions

1. On departure, trains will move at up to 8 km/h to the signal point prior to the train wash.
2. At the signal point the train could be required to pause with auxiliary systems running for up to 5 minutes.
3. From the signal point the train will then accelerate to reach 70 km/h when entering the Main North Line.

6.5 Standing yard

6.5.1 Assumptions

1. Up to 4 Long NIF trains could be standing in the yard operating at any of 9 locations, including Roads 1 to 4, Wheel Lathe Road, or up to two trains in Roads 6 or 7 in either the southern or northern locations. This is based upon the requirement that up to 2 Long and 1 Short NIF could enter service (0400 - 0700) (CoOps 7.1.3).
2. For trains standing in the yard, trains would be powered down, except during the necessary presentation services.
3. One additional train, separate from the up to 3 trains that could be preparing could be in operation, with HVAC and auxiliary systems running (worst case operations).
4. Train preparation for service could occur from 4:00am (CoOps 7.1.3), and at the worst case there could be 3 trains preparing in the same 15 minute period. There could be approximately a 20 minute gap between train preparations. However, TfNSW has advised that we are to assume for the ONVR modelling that 2 trains could depart in a 15-minute period. Preparation of the train could take up to 30 minutes per train and is based upon the train preparation procedure (Section 13.5.2, MainCpts (Rev H)), which involves:
   a. Access and activate the trailing, lead and lead (trailing) cabs, including:
      - Operation of air compressor
      - Operation of HVAC (likely presentation by ventilation mode could vary)
      - Operation of static inverters (SIV) & auxiliary systems
   b. Run automated/ facilitated serviceability tests, including electrical systems and brake tests (noise levels similar to other Sydney Trains Waratah A-Sets, as details for the NIF trains were not available).

   Noise emissions from the train preparation activities rely on the final train design and train preparation procedure, and so the assumed operating noise sources are either in accordance with the NIF rolling stock noise prediction report, and where this information is not included it has been based upon similar to Sydney Train Waratah A-Set trains, as recommended by TfNSW. These assumed noise levels are included in APPENDIX C.

5. Once trains are prepared and ready for departure systems will remain on idle with all auxiliary systems running (modelling assumption is worst case operational mode).
6. APPENDIX C outlines the noise sources and modelling assumptions for the standing yard.

6.5.2 Mitigation and management measures

6.5.2.1 Noise barrier review

A review of potential noise barriers has been undertaken with consideration of Review of Environmental Factor's noise and vibration impact assessment (REF NVIA) undertaken by WSP/PB (WSP/PB Project ACG1522100, Issue 3, dated 16 May 2016) for TfNSW.

A noise barrier review was conducted early on as part of the initial design process to determine which barriers were reasonable and feasible to proceed with into detailed analysis and design. This review process took into consideration:

- noise source details (eg noise spectra and heights)
- limitations with topography surrounding the site and large distances between noise sources and receivers (both reduce noise barrier benefits)
- large range of standing train locations
- cumulative noise impacts
- use of alternative noise mitigation measures in lieu of noise barriers (eg acoustic improvement of train wash building)
- urban design requirements
- importantly the flooding requirements and constraints on site

Presented in Table 6-6 is a summary of the noise barrier options that have been considered during the design development process, with comments on their feasibility and reasonableness with regards to this project.

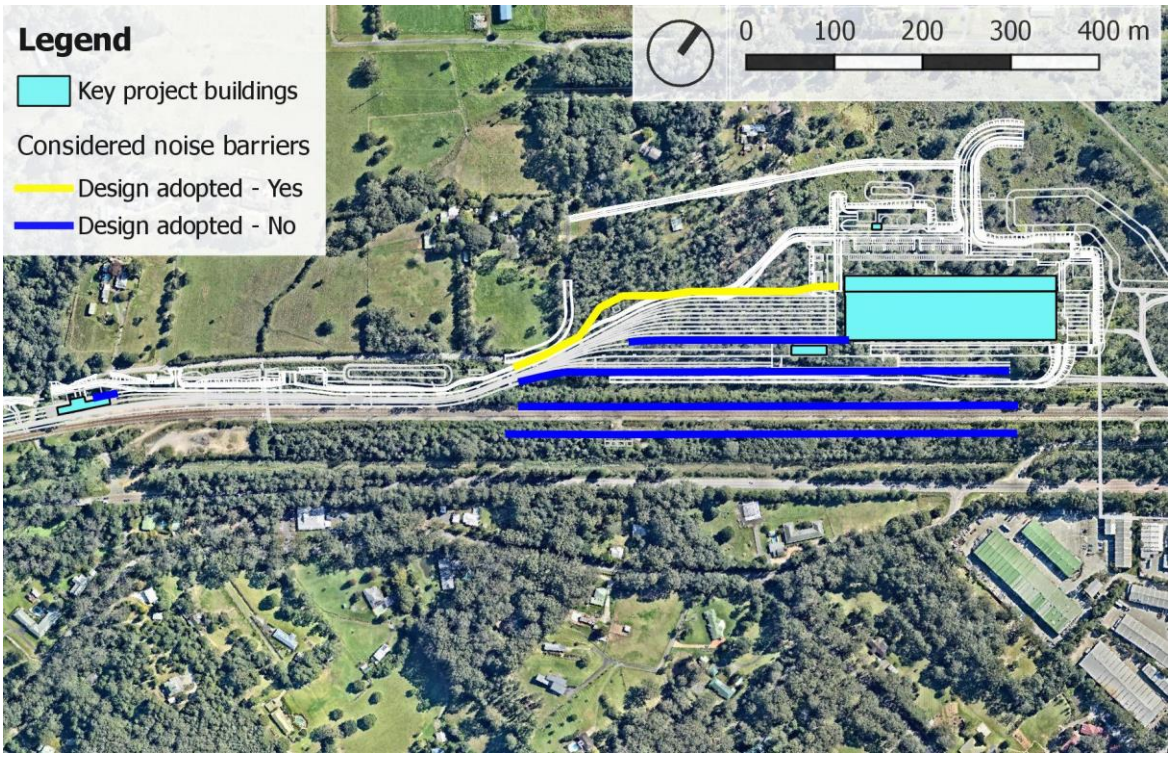
Table 6-6: Summary of noise barrier options for NIF MF

Noise barrier	Estimated noise benefit	Comments on feasibility/ reasonableness	Design result
North-west side of the standing yard	5 to 15 dB reduction in L_{Aeq} and L_{Amax} noise levels to receivers located to the north and west of site	Reasonable cost with limited operational impact. Reasonable cost and visual impact. Reasonable noise reduction for receivers located north and west of site which is reduced during temperature inversions. See Section 6.5.2.2	Option adopted

Noise barrier	Estimated noise benefit	Comments on feasibility/ reasonableness	Design result
Acoustic shed over standing yard	15+ dB reduction in L_{Aeq} and L_{Amax} noise levels to all receivers to the north, east and west	High cost of construction; high visual impact and operational limitations. High level of noise reduction.	Option not feasible or reasonable
Train wash noise barrier (REF NVIA)	Minimal benefit to only one of two receivers	Reasonable cost and limited operational impact. Greater acoustic reductions and for more receivers can be gained by at-building mitigation into the train wash design to minimise blower fan noise break-out. See Section 6.10	Alternative in-building mitigation strategy adopted
Arrival and departure rail road barrier	Minimal benefit under adverse meteorological conditions to all receivers	High cost of construction; limited level of noise reduction to distant receivers under adverse meteorological conditions; receivers already exposed to existing rail noise. TfNSW have advised, during REF process, that it is not feasible to construct noise barriers along the arrival / departure rail road due to drainage and flooding risk.	Option not feasible or reasonable
Stabling yard – site boundary / external barrier South-East Side	Marginal to negligible benefit, reduced under adverse meteorological conditions to receivers to the south-east	1. The REF's NVIA (Section 6.6.6) prepared by WSP dated 16/05/16, describes that due to constraints from the Main North Line a noise barrier along the south-eastern side of the facility was not feasible for protection of the noise sensitive receivers located generally south of the facility. This was confirmed during detailed design. 2. Minimal effectiveness of a barrier in this location in terms of noise reduction and number of properties that benefit overall, because the land topography slopes up from the facility towards the south, and is especially apparent when trains are in north-western parts of the standing yard, particularly during temperature inversions. See Section 5.1.2.	Option not feasible or reasonable
Stabling yard – internal barrier South-East Side	Low to marginal benefit, reduced under adverse meteorological conditions to receivers to the south-east	Between Road 5 and the Wheel Lathe there is insufficient room to provide a suitable and effective noise barrier. South of Road 7, a drainage swale runs parallel to the track for its full length, so a noise wall here would prevent suitable drainage. Locating a noise barrier closer to the Main North Line would place it in the retained vegetation area (i.e. the "Exclusion Zone"), which is not feasible. Furthermore, the above options would result in internal operational constraints imposed within the facility as a result of such a noise barrier, rendering it not feasible.	Option not feasible

The locations of the reviewed barrier options are presented in Figure 6-1.

Figure 6-1 New Intercity Fleet (NIF) Maintenance Facility (MF) noise barrier options



6.5.2.2 Adopted noise barrier

The adopted noise barrier was then taken forward in the design process for detailed analysis, and further reviewed to determine the optimum barrier height.

The noise barrier height analysis was undertaken with the aim of achieving the requirements of the INP with the use of feasible and reasonable noise barriers.

A sensitivity analysis of noise barrier heights versus noise levels was conducted as part of the design process to determine the optimal height and length from the recommended noise barrier in the REF from 5m. This analysis took into consideration –

- Noise sources (L_{Aeq} noise emissions and L_{A1} noise events)
- The range of standing train locations
- The cumulative noise impacts and required mitigations (eg. arrival and departures)
- Length of barrier
- Height of barrier
- Urban design requirements
- Flooding requirements

Key outcomes from the sensitivity analysis found –

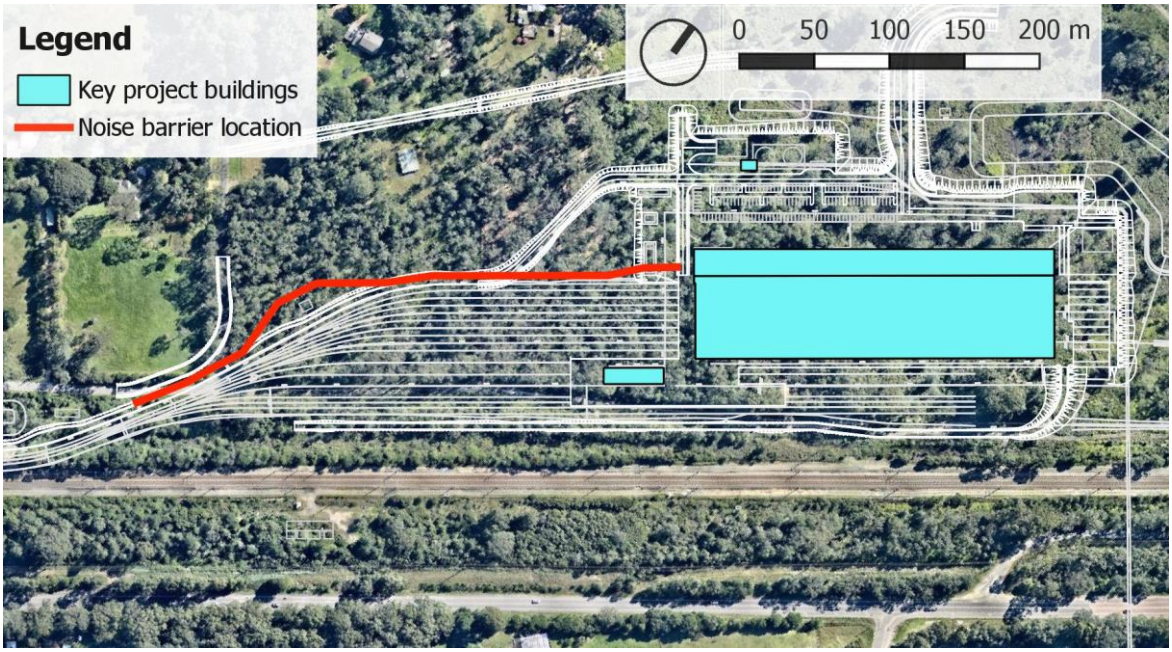
- 6 m high noise barrier would reduce the $L_{A1,1min}$ noise events impacts to within the RBL+15dB(A) requirements at the receivers to the north and west of the project.
- The length of the barrier was extended from 300 m to 390 m further south from the project than the REF noise barrier, to protect receivers to the NW of the project.

A noise barrier along the north-west side of the stabling yard, approx. 390m long is recommended. As presented in Table 6-7 and Figure 6-2.

Table 6-7: Adopted noise barrier details

Description	Approx. Length (m)	Height Above Local Ground (m)	Height Above Top of Rail (m)	Purpose of Noise Barrier
Noise wall along north/north-west side of standing yard	390	6.5	6	Protects 10 key properties to the N and NW of the standing yard

Figure 6-2 New Intercity Fleet (NIF) Maintenance Facility (MF) north-west noise barrier



This location and extent are similar to the REF proposed noise barrier. The REF proposed a 5m high noise barrier, however a detailed design review has been undertaken. A design review was undertaken to assess the reasonable and feasible height for the barrier which determined the following:

- An initial cost -v- noise benefit analysis found that a 7m-8m high noise barrier would be an optimum height for this location. However, the design team conducted a more detailed cost-comparison and found that a **6m high noise barrier** in combination with at-property noise mitigation measures gave the optimum value solution.
- A 6m high noise barrier is also considered more suitable for the area to satisfy a number of factors including the urban design perspective. This height is based upon the standing yard and barrier base level being at 13.5m, which is 1m higher than at the REF stage, and the 6m height is measurable from the top of rail of the adjacent stabling yard track. The relative top height of the barrier is to be maintained for the whole barrier length.

Key design elements of the noise barrier include -

- The gate of the noise barrier will be constructed to continue the noise wall at a height of 6m, up to the maintenance building in order to prevent creating a gap in the barrier and the noise to break-out and will include acoustic design elements to minimise break-out around the bottom of the gate and the gate edges.
- The noise barrier drainage would utilise pits and pipes in order to prevent the requirement for gaps or holes in the noise wall compromising the acoustic performance.

6.5.2.3 Other considered noise barriers

REF NVIA – Train wash noise barrier

The design did not incorporate a noise barrier adjacent to the train wash, and instead control of noise emission from train wash operations is achieved through an acoustically improved design of the train wash itself (refer Section 6.10 for details). The noise impacts on the closest receivers to the north of the arrival road are dominated by the train services (eg AC, static inverters, compressors) when the train moves through the train wash, and so the proposed small length of barrier controlling noise break-out from the train wash only would not have assisted in minimising noise impacts at nearby receivers. Controlling noise break-out of the jet blowers noise from both ends of the train wash building is a more acoustically efficient and effective solution, and so was adopted by the project.

Arrival and Departure rail road

Noise impacts from trains entering and exiting the facility along the arrival / departure rail road, and standing at the train wash entrance or departure signal location, were modelled to exceed the INP's noise criteria at nearby receivers. TfNSW have advised, during REF process, that it is not feasible to construct noise barriers along the arrival / departure rail road due to drainage and flooding risk. As such, these were deemed not feasible and have not been considered further. Instead of a noise barrier, properties found to exceed the project's noise criteria are identified and recommended for consideration of at-property treatment to control noise impacts.

Stabling yard – South-East Side (internal or boundary / external)

Section 6.6.6 of the REF's NVIA (prepared by WSP dated 16/05/16), describes that due to constraints from the Main North Line a noise barrier along the south-eastern side of the facility was not feasible for protection of the noise sensitive receivers located generally south of the facility. This was confirmed during detailed design.

Similarly, consideration of potential internal noise barriers proved to have insufficient room to provide suitable and effective noise barriers; a drainage swale running parallel to the track would provide drainage constraints and locating a noise barrier closer to the Main North Line would place it in the retained vegetation area (i.e. the "Exclusion Zone"), which are all considered not feasible.

Furthermore, a review of potential noise barrier options as shown in Figure 6-1 was conducted early in the design process and found that the effectiveness of such noise barriers are limited, because receiver locations to the south-east are elevated compared to the stabling yard. This is especially apparent when trains are in the northern parts of the stabling yard.

As such, this has not been considered further, and properties found to exceed the project's noise criteria are identified and recommended for consideration of at-property treatment to control noise impacts.

6.5.3 Standing yard operations

The preferred standing locations where possible, are the following roads to be used in order of preference for standing trains or train preparations early in the morning (eg. first train to depart or last train to arrive should be positioned in the most preferred location). These preferences are to be incorporated in the operational management plan for the site.

Table 6-8: Train standing/preparation location order of preference for noise purposes

Noise preference order	Road
1	Road 1
2	Road 2
3	Road 3
4	Road Wheel Lathe
5	Road 4
6	Road 6(N)
7	Road 7(N)
8	Future Road 5
9	Road 6(S)
10	Road 7(S)

Consideration to the location of standing trains should be included in the operational management plan to both maximise the preferred location for noise, in addition to maximising the shielding of stationary trains from standing yard noise sources for receivers to the south-west. This would include:

1. Locating standing trains in Road 7 (North) where possible, to aid with shielding for receivers to the south-west
2. Where trains will be standing in the yard, and not departing until the day period (after 7am), then the train can be used if located at the nearest road directly SW of a train which is to depart during the 5am to 7am period)

6.5.4 Train operational state management

The INP aims to protect the external amenity of residential receivers, and as such the treatment of residual noise impact by at-property treatments does not assist with this aim. As part of the site operational environmental management plan (OEMP), once a better understanding of the actual noise levels across the site is understood following the commencement of operations, the various noise levels for the standing train and the required train operating states should be reviewed to determine if further noise mitigation and management measures would be feasible and reasonable. This would include:

1. Quantify the noise level for the different train operating states of the standing trains

2. Implement a management approach to maximise the use of quieter train operating states during the various times trains are in the standing yard with due consideration given to the times of day when receivers are more sensitive to noise (eg. night).

6.6 Warning Alarms / Ground-borne warning system (GBWS)

The movement of trains within a yard and maintenance facilities area is generally governed by Sydney Trains Operators Specific Procedure (OSP) 16 which requires drivers to "Sound the train whistle to warn persons that the train is about to move". It also requires drivers to carry out an inching movement to "*warn persons on or near the train that a movement is about to take place*" - this is relevant for persons who may be alongside the train. Using a train horn as a means to alert persons within the yard area of the facility of an imminent train movement would result in a breach of the CoA LA1,1min noise requirements.

As per the CoA, train horns will not be used within the open yard area unless used for emergency situations (CoA No.25). The use of a train horn is permitted in an emergency situation as this is not a recurring and assessable event. In order to satisfy the safety aspects of alerting persons within the vicinity of an imminent train movement a Ground Based Warning System (GBWS) is to be implemented as the control to replace the requirement for a driver sounding the whistle before any train movement.

6.6.1 Standing yard

Outside the shed, within the standing yard, TfNSW has selected the option to proceed with a Ground Based Warning System (GBWS). This is designed by others and will contribute to the overall noise emissions from the site, so it has been included in this noise assessment.

The installed movement alarm was designed by others so that the noise emissions from the system do not exceed the following noise requirements:

- $L_{Aeq\ 15\ minute}$ - The GBWS does not exceed 3dB(A) below the relevant PSNL (Table 4-5), based upon assuming that the site is contributing a noise level from all operations equivalent to the PSNL. This is for the $L_{Aeq\ 15\ minute}$ assessment at the nearest residential receiver. This is on the basis that the train movement warning system would not increase the site noise emissions by more than 2 dB(A).
- $L_{A1\ 1\ minute}$ - The train movement warning system does not exceed the night RBL+ 15 dB(A) noise requirement during the evening and night periods at the nearest residential receivers.

Notwithstanding the above, as the noise sources for the GBWS are typically short noise events (eg. 5 second intermittent warning sounding), the critical design requirement for this is $L_{A1,1min} \leq$ RBL + 15 dB(A), as per CoA 22.

Along with the above environmental noise requirements, the GBWS and DPS will also need to achieve simultaneously the human factors requirements relevant to the safe operation of the facility.

6.6.1.1 Assumptions

The scenarios for assessment of noise emissions from the GBWS/DPS for normal operations of the NIF MF are presented in Table 6-9. Each of the roads presented in Table 6-9 assumes that other roads are not operating concurrently.

Table 6-9: Summary GBWS/DPS assumed operations within the NIF MF

Operation/activity	Noise sources (duration of noise source/15 minute period)	Location	D[1]	E[1]	N[1]
GBWS/DPS					
Train movement from yard	1. Road 1-4 - 20 Speakers (10 either side of road) with movement (5 seconds) 2. Road 6 - 39 Speakers (18 Nth side/21 Sth Side of road) with movement (5 seconds) 3. Road 7 - 42 Speakers (21 either side of road) with movement (5 seconds)	Zone 1-4 (Road 1-4) Zone 6&7 (Road 6&7)	✓	✓	✓
Trains departing/entering main building from yard	1. Speakers either side of road in the yard with movement (5 seconds) 2. Internal DPS on road within the building operating (5-Secs on/5-Sec off during a train entry/departure)[2]	Zone 1-4 + Zone 13 (internal) (Road 1-4 + Main Building door either end of building)	✓	✓	✓
Wheel lathe operation	1. 18 Speakers with movement (5 seconds) 2. Two movements in 15-minutes (ie. total of 10 seconds of warning noise in 15-minutes)	Zone 5 (Wheel Lathe Road)	✓	✓	✓

Notes:
1. D=Daytime 7.00 am to 6.00 pm; E=Evening 6.00 pm to 10.00 pm; N=Night-time 10.00 pm to 7.00 am
2. It is assumed that the DPS achieve the noise level limits at the maintenance facility external doors presented in the Main Building Design report (NIF-RTA-RPT-NA-200001 (Rev B), dated 29/05/2019) presented in Table 4-14 and 4-15. These noise levels can be achieved with operating durations that vary from that assumed, which may be required as part of commissioning process refinements.

Other key assessment assumptions were:

1. The proposed speakers are 15W TOA CS-154, which are rated at 97 dB @ 1m @ 1W, which means that the maximum sound level of each speaker is 109 dB @ 1m. The speaker directivity for all frequencies used in the noise modelling is based upon this speaker and the provided data.

2. All external speakers within each zone will operate concurrently and with the same sound power level. Any time delays between speakers are considered negligible for the purposes of assessing noise emissions.

3. The GBWS and DPS would use a “pink” noise spectrum (equal power per octave band), as this is the most effective method to take advantage of the speaker directivity, considering both receivers within the standing yard and the nearby residential receivers. The speakers would use a frequency filtered sound source (ie. use “pink” noise from 500Hz and above) to reduce low frequency noise emission to neighbours, as low frequency noise propagates further than high

frequency noise. The speakers would be rotated to maximise the effectiveness of directivity of the speakers (facing downwards and towards the north-east in the direction of the Maintenance Building) to achieve both the human factors limits and the environmental noise emission goals.

4. The GBWS speaker signal in the yard will be a 5 second noise signal, chirping on/off at a rate between 2Hz and 4Hz. Within the maintenance building, the DPS will operate with this same noise signal, for an extended period of time during a train entry or exit movement into the maintenance building.

5. It is assumed that there is one train movement in a 15-minute period, except for the Wheel Lathe road, where there may be two movements.

6. The location, orientation and height of all other speakers are as per those presented in Appendix C5, as per the relevant design package (see Table 6-2). All yard speakers are generally facing north-east in the direction of the Maintenance Building with the only exception of the southern-most speaker in each road, which faces south-west along the walkway.

6.6.1.2 Mitigation and management measures

The design of the GBWS has controlled noise emissions through:

1. Limiting the maximum sound levels at the speakers (see Table 6-10)

2. Using the directivity of the speakers and pointing the speakers in a direction to minimise noise impacts on nearby residential receivers, along with filtering the audible warning sound to maximise the speaker directivity

3. Lowering the speaker height

Based upon the assessment of noise emissions, the sound level limits presented in Table 6-10 are required for the speakers operating along each road to achieve noise emission goals at neighbours while also aiming to achieve human factors requirements within the yard. By limiting the GBWS sound levels to these maximums, along with operating in accordance with the assumptions outlined in Section 6.6.1.1, the GBWS was designed to achieve the noise emission requirements outlined in Section 4.1.3 at all receivers. The only exception is for R34, where this was not possible due to other competing design factors such as human factors. An exceedance of up to 4 dB(A) is predicted for this location. However, the following points are noted:

1. Exceedances are only predicted for the operation of the GBWS for Road 6 (up to 3 dB(A) exceedance) & Road 7 (up to 4 dB(A) exceedance), during the night period.

2. When a train is located in Road 6 or 7 during the operation of the GBWS, additional shielding may result in shielding of the GBWS, and a lower noise level at the residence.

3. As per the recommendations in Section 6.5.3, these GBWS noise impacts at this residence can be minimised through the management of standing trains to avoid minimise early morning operations from Roads 6 & 7.

4. This R34 property is also being treated for general noise emissions from the site.

Table 6-10: Standing yard GBWS maximum speaker sound levels

Speaker Zone	Maximum sound pressure level at 1m from speaker, dB(A)		
	Day	Evening	Night
Road 1[1]	107	99	92
Road 2[1]	107	99	92
Road 3[1]	107	99	92
Road 4[1]	107	99	92
Road Wheel Lathe	103	98	91
Road 6	103	95	91
Road 7	103	95	91

Notes:

1. Daytime = 7am to 6pm
2. Evening = 6pm to 10pm
3. Night = 10pm to 7am
4. Roads 1 to 4 consider that the DPS will also be sounding concurrently within the Main Building with only that door open.

Final limiting noise levels will be subject to noise monitoring verification.

6.6.2 Maintenance Shed

The **depot protection system (DPS) train movement warning alarm** within the shed will be provided by the internal PA system and has been designed to control internal noise levels breaking-out of the maintenance shed during train movements, through control of the noise levels of individual speakers and their locations. This DPS train movement warning alarm will sound for an extended period during the movement of a train entering or exiting the maintenance building to/from outside in the yard. To avoid the alarm having tonal noise impacts on nearby receivers, the alarm will be broadband in nature.

Tonal audible warning alarms are often found to cause considerable annoyance to nearby noise sensitive receivers due to their tonal and intrusive nature of their noise character, as it often differs in character from the ambient noise environment. Tonal alarms can be more audible over greater distances than a broadband-type noise, which tends to be masked by background noise levels more easily and is less discernible. Broadband alarms used on construction sites, for example, have been demonstrated to reduce noise complaints from the surrounding community.

Complaints at similar maintenance facilities have resulted from the use of warning alarms within maintenance sheds signalling the arrival or departure of trains from the buildings.

Other options for movement alarms include implementing a 'spotter' and/or visual alarms such as flashing lights, combined with the use of broadband-type audible alarms. Some audible warning alarms

also incorporate features such as an internal feedback system for them to automatically adjust the sound output relative to the background noise levels, and alarm/alarm speakers that direct the sound to the area where persons may be potentially at risk and reducing the noise emission in other directions so that the noise does not propagate in all directions equally.

The above issues have provided guidance to the design of the method of warning of a train arrival or departure. The installed movement alarm has been designed not to exceed the noise limits presented in Table 6-11. These noise limits have been determined on the following basis:

- $L_{Aeq\ 15\ minute}$ - The GBWS and DPS does not exceed 3 dB(A) below the relevant PSNL (Table 4-5), based upon assuming that the site is contributing a noise level from all operations equivalent to the PSNL. This is for the $L_{Aeq\ 15\ minute}$ assessment at the nearest residential receiver. This is on the basis that the train movement warning system would not increase the site noise emissions by more than 2 dB(A).
- $L_{A1\ 1\ minute}$ - The train movement warning system does not exceed the night RBL+ 15 dB(A) noise requirement during the evening and night periods at the nearest residential receivers.
- The noise levels presented in Table 6-11 are based upon each train door being 27m^2 at the opening, given that the warning alarms are likely to be used during times when trains are about to exit the maintenance facility building. Assumed that a single door either end of the maintenance building is open (likely to occur during a train entry/exit movement into/from the maintenance building) with other doors closed (as required during evening and night periods).

Table 6-11: Depot protection system (DPS) train movement warning noise level limits

Requirement location	Noise level limits, dB(A)	
	$L_{Aeq,15min}$	$L_{A1,1min}$
Maintenance facility building's access doors (open) (single door either end of building)	66	84
All other maintenance facility building's facades	77	90

During commissioning and testing, the above movement warning system design noise limits may need to be reviewed on a reasonable and feasible basis, in consultation with TfNSW, in order for the train movement warning system to also achieve other technical requirements within the maintenance facility.

6.7 Public Address (PA) System

The intended use of the Public Address (PA) system is for coverage of the standing roads, administration area and around the maintenance building, for the purpose of security and any safety and/ or evacuation purposes which might occur in the yard. The public announcement (PA) system is being designed to meet the Works Brief Section 4.36.18 requirements. As such, the PA system is being designed to minimise noise impacts (nuisance overspill noise) at nearby receivers, by using measures such as speaker selection and placement, combined with upper noise limits. The design is to ensure that

the PA sound does not significantly increase the cumulative noise impacts at nearby receivers and achieves the operational noise requirements set out in Section 4.1.

6.7.1 Standing yard

The PA system outside the maintenance building, within the standing yard, carpark and external to the maintenance building, has been assessed for noise emissions to neighbours. As the noise sources for the PA system are typically short duration noise events (eg. up to 30 second events), the critical design requirement for this is $L_{A1,1min} \leq$ RBL + 15 dB(A), as per CoA 22.

The installed PA system is not to exceed the noise levels presented in Table 6-12 at the nominated locations. These noise limits have been determined on the basis:

- $L_{Aeq\ 15\ minute}$ - The PA system does not exceed 3dB(A) below the relevant PSNL (Table 4-5), based upon assuming that the site is contributing a noise level from all operations equivalent to the PSNL. This is for the $L_{Aeq\ 15\ minute}$ assessment at the nearest residential receiver. This is on the basis that the train movement warning system would not increase the site noise emissions by more than 2 dB(A).
- $L_{A1\ 1\ minute}$ - The PA system does not exceed the night RBL+ 15 dB(A) noise requirement during the evening and night periods at the nearest residential receivers.

Along with the above noise requirements, the PA system will also need to achieve simultaneously any human factors requirements and the speech transmission index (STI) requirements.

6.7.1.1 Assumptions

It is assumed that PA announcements would typically occur for up to 30 seconds in a 15 minute period.

The location, orientation and height of all other speakers are as per those presented in Appendix C5, as per the relevant design package (see Table 6-2). All yard speakers are generally facing north-east in the direction of the Maintenance Building with the only exception of the southern-most speaker in each road, which faces south-west along the walkway.

6.7.1.2 Mitigation and management measures

The PA system design aims to achieve the noise emission requirements by limiting the maximum sound levels at the speakers, considering the location and the direction that each speaker is pointing.

The design of the PA system controls noise emissions by limiting the maximum sound levels at the speakers (see Table 6-12).

It is recommended that the PA system is restricted so that it is not used during the night period externally for normal facility operations, due to the lower background noise levels and more stringent night-time environmental noise emission goals. Emergency situations do not apply for these noise emission requirements.

Based upon an assessment of noise emissions, the maximum speaker sound levels presented in Table 6-12 are required to achieve noise emission requirements at the nearby receivers. These noise levels would be subject to verification via noise measurements during the compliance stage, to modify the limiting speaker level to achieve the requirements if they vary from the below.

Table 6-12: Standing yard PA system maximum speaker noise levels

Speaker Zone	Maximum sound pressure level at 1m from speaker, dB(A)		
	Day	Evening	Night
Road 1	102	97	
Road 2	102	97	
Road 3	102	97	
Road 4	102	97	
Road Wheel Lathe	100	96	No typical usage
Road 6	96	93	
Road 7	96	93	
Carpark	94	90	
Building North (Zone 15)	108	104	

Notes:

1. Daytime = 7:00am to 6:00pm
2. Evening = 6:00pm to 10:00pm
3. Night = 10:00pm to 7:00am
4. The maximum noise levels are based upon 30 seconds of PA announcements in a 15 minute period.
5. These noise levels assume that multiple zones do not sound simultaneously or within the same 15 minute period.

6.7.2 Maintenance building

The **PA system** <u>within</u> the maintenance building could result in noise impacts to nearby sensitive receivers if noise breaks out via the open or closed building doors, or via the maintenance building's facades. In order to achieve the requirements of CoA 22, the installed PA system is not to exceed the noise limits presented in Table 6-13. These noise limits have been determined on the following basis:

- The noise levels presented in Table 6-13 are based upon each train access door being 27m^2 at the opening. Assumed that a single door either end of the building could be open (likely to occur during a train entry/exit movement into/from the maintenance building) with other doors closed (as required during evening and night periods).

Table 6-13: PA system noise level limits

Maintenance facility building's doors position	Noise level limits, dB(A)		Requirement location
	$L_{Aeq,15min}$	$L_{A1,1min}$	
Open (single door either end of building)	66	84	Maintenance facility building access doors
	77	90	All other maintenance facility building facades
Closed	80	93	Maintenance facility building access doors
	77	90	All other maintenance facility building facades

During commissioning and testing, the above PA system design noise limits may need to be reviewed on a reasonable and feasible basis, in consultation with TfNSW, in order for the PA system to also achieve the other technical requirements (eg. speech transmission index) within the maintenance building.

6.8 Maintenance building

6.8.1 Assumptions

Section 6.1.4 of the CoOps provides a summary of the maintenance and related activities that will take place at the NIF MF. This outlines that Level 1 through to Level 3 maintenance activities (planned heavy component changes), in addition to testing and commissioning activities (Level 0), could take place within the NIF MF.

As such, noise measurements at Auburn Maintenance Facility (MF) were used to determine the suitable internal design noise levels of the facility. The Auburn MF provides Level 0 to Level 2 maintenance activities, and Level 3 component exchange activities, in line with the activities that will take place at the NIF MF.

Some component exchange operations (eg. HVAC) currently take place at Auburn MF, while others such as bogie changes can be provided, but are currently performed in Cardiff. Noise sources associated with these operations that would not have been captured in the noise measurements (eg. component moving, installation works) have been considered, and information on the train lift system and the associated noise generating items (eg. alarms) have been received and those items will be designed and/or adjusted by their manufacturer so that they account for the project's noise emission requirements.

Auburn MF is currently servicing 3 train fleets and so is a busy maintenance facility. The upper 10th percentile of measured noise levels were used to determine suitable internal design noise levels for the NIF MF. As such, the noise generated by the Level 0 to Level 3 maintenance activities (planned heavy component changes) as required in Section 6.1.4 of the CoOps, have been considered in the building envelope design.

Other heavy maintenance works such as significant periods of loud metal work type activities (> 108dB(A) SWL) required for other Level 3 maintenance are not expected to take place regularly and so have not been included in the assessments herein. Loud maintenance activities such as rattle guns and grinding, up to source noise levels of 108 dB(A) at typical locations within the shed (ie. not adjacent to the doors) have been included.

The following operational assumptions have been made in this assessment:

1. The Maintenance building includes:
    a. Four maintenance roads (with space for a future fifth road) including one for a train lift (Road 1).
    b. Train lift (Road 1).
    c. Overhead gantry crane over the lifting roads for A/C, or large items (3.2 tonne electric gantry cranes).
    d. Overhead gantry crane in the bogie delivery (12.5 tonne electric gantry crane) area for unloading bogies and large items.
    e. Workshop/storage area –
        i. Paint-workshop, general workshop
        ii. Storage areas (chemicals/oil/heavy materials/battery/waste)
    f. Mobile plant and equipment (eg. forklifts)
    g. Delivery area activities
2. The NIF MF will provide Level 1 through to Level 3 maintenance activities (planned heavy component changes), in addition to testing and commissioning (Level 0) activities (CoOps 6.1.4), including:
    a. Level 1 maintenance consists of minor repairs, interior cleaning, toilet decanting, tanking of water, exterior washing and correction of vandalism and graffiti.
    b. Level 2 maintenance includes planned 30 to 60 day routine maintenance examinations
    c. Level 3 maintenance, including the exchange of major components such as bogies, couplers, gangways, compressors etc.
    d. Other heavy maintenance works such as significant periods of machining, grinding, and loud metal work type activities required for other Level 3 maintenance are not expected to take place regularly and so have not been included in the assessments. Should other maintenance activities (eg. heavy maintenance with significant noise generating activities such as extended metal working/grinding etc. (> source SWL 108dB(A)) be changed from the current operations in the maintenance area in the future, the noise management and mitigation measures for these activities will require review.
    e. Deliveries may be required during the day, evening and night periods.

3. The Maintenance building will be ventilated using assisted natural ventilation. These features have been incorporated into the noise model and form part of the acoustic design.
4. Heating and cooling to specific work areas will also be provided with the mechanical equipment located in dedicated plantrooms of the administration and maintenance building.
5. Internal noise levels within the NIF MF are based upon the upper 10th percentile of measured noise levels undertaken within the Auburn Maintenance Facility, which were used to determine suitable internal design noise levels for the NIF MF.
6. No on-site back-up diesel generator is required, but access locations are provided, as such they are not a typical noise source.
7. APPENDIX C outlines the noise sources and modelling assumptions for the Maintenance building.

6.8.2 Internal noise levels

Internal noise levels within the maintenance building's maintenance area have been based upon long term noise logging undertaken by Renzo Tonin & Associates between 23 May 2018 and 6 June 2018 at another similar facility. It is understood that the maintenance activities at the Reliance Rail Auburn Maintenance Centre (Auburn MF) at Auburn, NSW will be very similar to the NIF MF at Kangy Angy. These noise measurements are summarised in the technical memorandum reference:*TJ265-02D05 (r1) Noise monitoring*, dated 19 June 2018.

The two locations of the unattended noise monitoring were near the entry/exit doors of the facility, one was located along the spare maintenance road, and one was located on the high-level walkways. A summary of the key noise monitoring results is presented in Table 6-14.

Over the course of the monitoring period the underlying "background noise" (L_{A90}) was controlled by train HVAC in operation. While the ambient noise levels (L_{Aeq}) were influenced both by the train HVAC and the high noise events inside the facility such as the maintenance activities (occasional hand tools, voices, tool drops and usage, etc.), speaker tests, train noise events when entering facility (brake squeals, compressor releases etc.) and the train movement warning sirens. These high noise events were loud enough and frequent enough to dominate the average ambient (L_{Aeq}) noise levels, over the top of the train HVAC. Meaning that even though the train HVAC controlled the background noise levels (L_{A90}), other maintenance activities controlled the design noise levels (L_{Aeq}) within the maintenance building. These high noise events also drove the L_{Amax} and L_{A1} noise levels within the space.

As such, even if there are variations between the Waratah and Oscar train HVAC system noise levels that were measured at Auburn MF and the final NIF HVAC systems, the background noise levels controlled by the train HVAC systems measured at Auburn MF were between 10-15 dB(A) below the L_{Aeq} noise levels, and so it was other high noise events, and not the train HVAC, which control the design noise levels.

The other activities that were observed taking place at Auburn MF as part of daily operations at the facility which were captured in the noise monitoring, were the use of overhead gantry cranes and fork lift activities.

Table 6-14: Auburn Maintenance Centre – Unattended noise monitoring summary

Monitoring period	Location	L_{A90}[2]	L_{Aeq}[3,6] (Average)	L_{Aeq}[3,7] (10th percentile)	L_{A1}[4,6] (Average)	L_{A1}[4,7] (10th percentile)	L_{Amax}[5,6] (Average)	L_{Amax}[5,7] (10th percentile)
Day[1]								
	L1	56	72	72	83	83	102	100
	L2	59	68	71	78	81	90	95
	L3	55	70	74	82	84	98	99
	L4	50	64	66	74	77	86	88
Evening[1]								
	L1	55	73	73	86	86	98	102
	L2	58	70	73	80	83	90	95
	L3	55	74	75	86	86	100	101
	L4	52	67	68	78	83	87	91
Night[1]								
	L1	55	70	72	81	82	94	99
	L2	58	70	73	80	84	89	93
	L3	54	70	73	82	83	97	99
	L4	51	69	70	81	84	87	91

Notes:
1. Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
2. LA90 "background noise levels" processed in accordance with the Industrial Noise Policy (EPA, 2000)
3. The LAeq index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
4. The LA1 index corresponds to the measured level of noise that is exceeded for 1% of the measurement period of 15-minutes.
5. The LAmax index corresponds to the maximum measured level of noise over the measurement period of 15-minutes.
6. Levels are based upon a logarithmic average of the individual LAeq, LA1 or LAmax,15 minute periods, and overall monitoring period values.
7. Levels are based upon the 10th percentile of the individual LAeq, LA1 or LAmax,15 minute periods, and logarithmic average of the overall monitoring period values.

Based upon attended noise measurements and known sources and distances during the unattended noise monitoring, measure noise levels and calculated sound power levels for key noise generating items are presented in Table 6-15.

Table 6-15: Maintenance facility key noise generating items

Item being measured	Measurement distance, m	Measured noise level, $L_{Aeq(t)}$, dB(A)	Converted to a sound pressure level at the nearest facade, dB(A)	Calculated Sound Power Level (source level), dB(A)
Movements siren[1]	7	95	94	119
Compressed Air Release (Mid Train) [1]	3	102	88	118
Compressed Air Release from brakes when turned off (Front of train) [2]	7	99 - 104 $_{LAFmax}$[3]	92 - 96 $_{LA1,1minute}$	123 - 128 $_{LA1,1minute}$[6]
	7	88 - 95 $_{LAeq(t)}$[4,5]	81 - 88 $_{LAeq,15minute}$	93 - 98 $_{LAeq,15minute}$[6]

Notes: 1. Attended noise measurement

2. Noise level from unattended noise measurements and sound power level calculated from known distance to train noise generating component over a sample of 7 trains.

3. This is the LAmax of the noise measurement of the brake release/venting

4. Duration of brake air release/venting ranged from 5 seconds to 22 seconds.

5. No penalty has been applied to the 15-minute assessment period at the receiver from the brake release, considering these are individual events over the entire assessment period.

6. These upper brake noise levels have been used to model trains within the standing yard when they dump/vent the brake compressed air.

Reasonable worst-case operational scenarios have been used to assess noise emissions from the maintenance facility building and recommended acoustic treatments to elements of the building.

6.8.3 Building facades

Based upon the analysis of these noise measurements the design internal noise levels presented in Table 6-16 have been assumed to be impinging on the facade of the building.

The assessment design noise levels are based upon the 10th percentile of the $L_{Aeq,15min}$ and $L_{A1,1min}$ measured noise levels over the measurement period and are presented in Table 6-16.

Table 6-16: Maintenance facility building maintenance area facade design noise levels

Internal facade element	Design noise level $L_{Aeq,15min}$, dB(A)	Design noise level $L_{A1,1min}$, dB(A)
North	75	96
West (high level – windows/louvres)	75	-
West (low level – administrative building)	74	-
South	75	96
East	75	-
Roof	74	-

CoA 26 requires that the maintenance shed building envelope is designed and constructed to achieve a sound insulation performance of at least Rw 26. CoA 22 is unclear as to what is strictly required, as it is unclear as to respect of openings or doors.

Compliance with the minimum Rw 26 performance is achieved without considering major louvres and openings. For some building elements and openings, it is not feasible or reasonable for Rw 26 to be achieved.

Assessing the building envelope design, the majority of building envelope elements achieves this the Rw 26 requirement, while the composite transmission loss of all building envelope elements achieves on 1 dB less than this as presented in Table 6-18, reduced only due to the performance of major louvres and openings. With the louvres and openings accounted for, a composite transmission loss of Rw 25 is achieved.

CoA 26 requires that in the case the Rw 26 is not achieved, noise emissions achieve the requirements of CoA 22.

The relative increases of noise levels from the facility are presented in Table 6-17 which demonstrates that the noise emissions from the shed alone is significantly below the CoA 22 requirements, and even if the rest of the site is contributing the allowed noise levels presented in CoA 22, the change in noise levels from the maintenance facility building at nearby receivers would be negligible.

As such, even though the composite transmission loss of the building envelope does not achieve the overall Rw 26 required by CoA 26, the selected building element constructions have been selected so that noise emission to nearby receivers from the maintenance facility building both achieve the noise criteria individually, and negligibly contribute to noise levels at nearby receivers and so achieves the requirements of CoA 22. As such, this demonstrates that the building envelope achieves the intent of CoA 26.

Table 6-17: Maintenance facility building envelope acoustic performance review: Predicted noise levels at nearby receivers, dB(A)

Receiver	Address	Night design criteria $L_{eq\ 15min}$,	Maintenance shed contribution (Doors Closed)	Increase due to maintenance shed if rest of facility is at criteria	Standing road preparation (Roads 2 3 & 4) (Presentation HVAC)	Increase due to maintenance shed	Standing road preparation (Roads 2, 3 & 4) (Normal HVAC)	Increase due to maintenance shed
R12	19 Ourimbah Road	40	31	0.5	45	0.2	47	0.1
R13	50 Orchard Road	40	30	0.4	42	0.3	44	0.2
R14	54 Orchard Road	40	31	0.5	41	0.4	43	0.2
R15	62 Orchard Road	40	32	0.6	43	0.3	45	0.2
R16	72 Orchard Road	40	32	0.6	42	0.4	43	0.3
R17	80 Orchard Road	40	31	0.5	41	0.4	42	0.3
R19	106 Orchard Road	40	27	0.2	37	0.4	38	0.3
R21	15 Schubolt Road	40	22	0.1	37	0.1	39	0.1

Receiver	Address	Night design criteria $L_{eq\ 15min}$,	Maintenance shed contribution (Doors Closed)	Increase due to maintenance shed if rest of facility is at criteria	Standing road preparation (Roads 2 3 & 4) (Presentation HVAC)	Increase due to maintenance shed	Standing road preparation (Roads 2, 3 & 4) (Normal HVAC)	Increase due to maintenance shed
R34	170 Old Chittaway Rd	40	34	1.0	48	0.2	50	0.1
R35	150 Old Chittaway Rd	40	27	0.2	46	0.1	48	0.0

Notes: 1. Predicted noise levels are based upon the assumptions in Section 6.8 and APPENDIX C., which includes including the main doors closed.

In summary, whilst Rw 26 cannot be achieved at all areas of the building, overall the noise levels negligibly contribute to noise levels at nearby receivers and so achieves the requirements of CoA 22 at surrounding residential receivers.

Table 6-18: Recommended building envelope minimum sound transmission loss

Internal space	Facade	Facade element	Recommended minimum sound transmission loss, dB (octave band, Hz)								Assumed construction material	Area, m²	Composite transmission loss calculation (✓=included in calculation)	
			Rw	63	125	250	500	1000	2000	4000			With openings	Openings excluded
Maintenance area	South	Main Doors	Rw 25	16	20	24	20	23	38	19	Jewers Doors (Swift SEW)	138	✓	✓
		Main door overhead wiring opening	-	-	-	-	-	-	-	-	5 openings, each maximum 0.6m²	3	✓	-
		Facade	Rw 26	14	18	22	24	21	32	42	Kingspan 100mm KS1000AWP	394	✓	✓
	East	Facade	Rw 26	8	12	15	22	32	35	30	Danpalon 16mm/100mm/16mm	2053	✓	✓
		Louvres	Rw 21	6	4	9	18	26	25	23	Hudson 600 Chevron	483	✓	-
	North	Facade	Rw 26	14	18	22	24	21	32	42	Kingspan 100mm KS1000AWP	394	✓	✓
		Main Doors	Rw 25	16	20	24	20	23	38	19	Jewers Doors (Swift SEW)	138	✓	✓
		Main door overhead wiring opening	-	-	-	-	-	-	-	-	5 openings, each maximum 0.6m²	3	✓	-
	West	Facade	Rw 26	14	18	22	24	21	32	42	Kingspan 100mm KS1000AWP	1143	✓	✓
		Louvres	Rw 21	6	4	9	18	26	25	23	Hudson 600 Chevron	130	✓	-
		Roller Doors	Rw 28	18	22	26	22	25	40	21	Braselmann Roller Door 1 roller shutter 1.100 D (1.25 mm steel+65kg/m³ poly)	92	✓	✓
		Windows	Rw 26	8	12	15	22	32	35	30	Double glazed unit	70	✓	✓
	Roof	Roof	Rw 26	14	18	22	24	21	32	42	Kingspan 100mm KS1000RW	16475	✓	✓
		Skylight	Rw 26	10	12	12	22	32	37	39	Kingspan KS1000DLTR PLUS 0.8	1932	✓	✓
		Roof vent	Rw 20	5	5	7	17	25	27	28	Airocle 4 Series lined roof ventilator	836	✓	-
											Composite transmission loss (Rw)		**25**	**26**

6.8.4 Mitigation and management measures

6.8.4.1 Reverberation control

To reduce noise build-up within the maintenance building, and the resulting noise emission to nearby sensitive receivers, acoustic absorption in the form of acoustic panels will be installed over the maintenance areas. This will assist to further reduce the noise emission via the building envelope. The acoustic panels and baffles are proposed to be installed on internal surfaces of the building envelope and will also be added to available locations along the high-level roads/walkways, if required. The final locations of the acoustic absorption panels and baffles will be installed with consideration to the limitations of other services (eg. lighting, fire and smoke, etc.).

Acoustic absorption panels and baffles will be constructed from material with a minimum NRC 0.8, and achieve the octave band acoustic absorption levels presented Table 6-19. Suitable acoustic absorption material is Whisper FR 60mm (3 layers, 20mm) or other product of equivalent acoustic performance or as approved by the project's acoustic consultant.

The selection of all reverberation control elements outlined in this section have been made for acoustic purposes only. The appropriate usage and placement of these materials for non-acoustic purposes (ie. fire) are the responsibility of the appropriate other disciplines.

Acoustic absorption panels and baffles will be evenly distributed over the roof area. The total minimum installed area of acoustic absorption area will be approximately 5,000 m^2.

Where panels are installed on the internal surface of the roof or walls, then then the area of absorption is as per the sum of all the panel sizes. This includes if the panel is offset from the adjacent internal surface. Where this is installed as an acoustic baffle however, located away from any other surfaces, and both sides of the baffle are clearly exposed to the internal space, then this counts as approximately two surfaces (ie. 4m^2 baffle equates to 8m^2 of absorption), because the baffles utilise both faces for absorption providing an efficient method of introducing the required acoustic absorption.

Table 6-19: Maintenance building acoustic panels and baffles minimum installed acoustic absorption

Item	Acoustic absorption coefficient per octave band, Hz						NRC
	125	250	500	1000	2000	4000	
Maintenance area acoustic baffle/panel Minimum area of absorption 5000m^2	0.2	0.8	0.8	0.9	0.8	0.8	**0.8**

Design Package 16.2 (Depot Protection System) may require additional/different absorption during the commissioning process in order to achieve the technical acoustic requirements (eg. speech transmission index), or to achieve the agreed levels set by TfNSW. This minimum coverage area may increase during design refinement/commissioning and optimisation in conjunction with the public announcement (PA) system design.

6.8.4.2 Specific activities noise

The following mitigation and management measures apply to all maintenance activities within the maintenance area.

6.8.4.2.1 Maintenance activities and train operations

- All doors of the maintenance building, including northern workshop/storage roller doors, are to be closed when there are trains inside and/or any significant noise generating maintenance activities are taking place during the evening (6pm to 10pm) and night (10pm to 7am) periods. This will control noise emissions from maintenance activities, including speaker tests, gantry crane operations, mobile plant and equipment (ie. forklifts) and other general maintenance activities (occasional hand tools, voices, tool drops and usage, etc.).
- However, because it is not usual operational practice at similar facilities to close the main train access doors and the operators may prefer doors to be open for ventilation and comfort reasons, management measures will need to be developed and incorporated into the operational management plans of the facility to control noise emissions when the doors are open. These would include, but not be limited to:
  - Identification of activities restricted from taking place (generally or in specific locations) while the doors are open.
  - Procedures for how significant noise generating activities that could take place when the doors are open can be identified and appropriate management or mitigation measures developed.
  - Procedures for verifying that noise emissions from the main building are meeting requirements when the doors are open.

  These management measures are required to be in place to manage noise emissions so that noise levels do not exceed requirements at nearby noise sensitive receivers when the doors are open during the evening and night periods. Management measures are required to be in place to manage noise emissions so that noise levels do not significantly exceed requirements at nearby noise sensitive receivers during evening and night periods.
- During evening (6pm to 10pm) and night (10pm to 7am) periods, the maintenance building's doors are required to be closed prior to the train compressor releases/brake pipe venting releases. This is required to achieve the evening and night $L_{A1,1min}$ noise emission requirements.

- As per Condition of Approval 25, rolling stock horn testing (town or country) is not included in the assessment or design of the maintenance facility building, as per the TfNSW combined submission response:

  > *"The potential impacts from the use of horns are to be considered in the operational noise management plan in consideration of the potential environmental noise impacts. Management and mitigation measure AC.1 identifies that the Operational Noise and Vibration Review would be developed to meet the environmental noise objectives for the Project and would include consideration of alternative methodologies for horns, warning signals and horn testing at the facility. This would include the recommendation that horns are not to be used at the maintenance facility and that a ground based warning system is used instead of yard horns."*

  As per Condition of Approval 25, it is recommended that horns are not to be used at the maintenance facility and that a ground based warning system (GBWS) is used instead of yard horns. Operational controls are in place to stop the use of the horn to signal movement (i.e. GBWS), therefore the use of a train horn will only be in emergency situations. Should there be any uncommon operation of a train horn, it would only occur within the maintenance facility building with all doors closed. This management measure will be incorporated into the operational management plans of the facility to control noise emissions.

- Overhead gantry cranes are electric powered and will operate without alarms/sirens. They do not exceed noise requirements at the nearby residential receivers, with consideration of simultaneous maintenance activities.

- Bogie turntable will operate without an alarm/siren as part of its normal operations and will have a maximum noise level of 75dB(A) at 1m when in full operation. Given its infrequent use, the short duration of events and consideration of other simultaneous maintenance activities, the bogie turntable will not contribute to the overall noise emissions at neighbours.

- All mobile plant and equipment (ie. forklifts) that are permanently based at the facility and require reversing warning alarms, are to be fitted with non-tonal reversing beepers (or an equivalent

mechanism). The use of ambient sensitive alarms that adjust output relative to the ambient noise level will be considered.

6.8.4.2.2 Forklift operations

- Forklifts that are to operate externally of the facility shall be selected so they operate with an average sound power level of no greater than 92dB(A) (ie. an electric or low noise gas forklift) and are fitted with a broadband reversing alarm.
- Where forklift operations occur during the night period, noise emissions are predicted to potentially exceed the $L_{A1\ 1\ minute}$ sleep disturbance requirements and the $L_{Aeq\ 15\text{-}minute}$ requirements. As such, forklift activities are to be managed and restricted during the night period as follows:
  - Only one forklift is to operate externally at any one time.
  - Forklift activities on the NW side of the maintenance building are to be restricted to near (within 30m) the loading docks and moving between the loading docks. Forklifts cannot operate throughout the carpark area during the night period.
  - Feasible and reasonable management measures are to be adopted to prevent potential sleep disturbance noise impacts when forklift is to operate at either of the NW loading docks, or if the forklift operates between the maintenance shed and the wheel lathe building. In these areas, measures to prevent high noise events from metal-on-metal bangs or dropping of goods or equipment (ie. lowering onto rubber matting, etc.) are to be investigated and implemented.

6.8.4.2.3 Loading dock activities and bogie deliveries –

During the evening and night periods could result in exceedances of the PSNL at nearby noise sensitive receivers. As such, restrictions on the evening and night deliveries are required, as outlined in APPENDIX C. In addition to the restrictions outlined in APPENDIX C, the following management measures would be adopted.

- Where feasible and reasonable external deliveries and off-loading activities are to be scheduled to the daytime (7am to 6pm) period.
- Where feasible and reasonable, loading dock activities taking place during the evening and night will be undertaken within the maintenance building with the facade doors/windows closed, and the door will remain closed as much as feasible during the daytime period.
- Deliveries during the evening and night period are permitted only in accordance with the assumptions outlined in APPENDIX C.
- The operational procedures at the Security Building for entry/exit methods for deliveries are to set up so that they minimise idling time at the security gate. This is to include consideration of the following at a minimum:

  - Developing an operational procedure that advises the maintenance building personnel that a delivery vehicle has arrived, so that it is ready for the delivery vehicle to enter minimising external idling time, during the night time period (10pm to 7am).
  - Installing a sign on the entry road which advises trucks are not permitted to stop between Orchard Road and the Security Gate.
  - Review the evening/night delivery procedure once operations commence, to determine and implement noise reduction/minimisation procedures.
- The following operational management measures would also be adopted:
  - Management of deliveries is to form part of the site operational management plan.
  - Regular foreseen deliveries to the maintenance facility are to be scheduled to occur between 7am and 6pm.
  - Where deliveries are foreseen but are required to take place during the evening (6pm to 10pm) or night (10pm to 7am) period due to specific external reasons (ie. oversized loads under escort, road restrictions for loads) then they are to be prioritised to the evening where possible, and the night only as last resort.
  - The above do not apply under emergency or under exceptional circumstances.
  - Where possible, movements are to be coordinated so that they do not overlap with known personnel change over times.

6.8.4.2.4 Train lift system

(a) Assumed noise levels and operations

As part of the train lift system located in Road 1 there is the potential for two sets of warning alarms to sound when the train lift system is in use:

1. A single loud alarm horn (with associated flashing lights and buzzers) indicating the commencement of a lifting/lowering operation of a group of bogie lifters. It is assumed that this alarm will only sound for approximately 2 seconds during a train lift procedure.

2. A warning buzzer (with associated flashing lights) on each bogie lifter. This is signalling all the time the specific Bogie Lifter is operated. It is assumed that this alarm will sound throughout the train lift procedure.

As part of planned heavy component changes maintenance activities, the train lift system could be in use day, evening or night.

(b) Required noise levels

During use of the train lift system, the operational noise management plan will incorporate requirements so that the external doors are closed while the train lift procedure is taking place during the evening or night periods.

These warning alarms are being selected or adjusted in order to achieve the levels presented in Table 6-20.

Table 6-20: Train lift system noise level limits

Maintenance facility building's doors position	Noise level limits, dB(A)		Design operational location
	Sound Power Level	Sound Pressure Level at 1m	
Train lift single loud alarm horn	116	108	Centre of shed (110m to either external door) See Note 1 & 2
Train lift bogie lifter warning buzzer	85	77	Located at each bogie along Road 1. Assume there are 24 buzzers in operation (6 car train) simultaneously See Note 3

Notes
1. If the train lift alarm is shifted from the centre of the building toward either end of the building, then the allowable sound power/pressure limits will decrease.
2. This assumes the buzzer duration does not occur for longer than 2 seconds in 15-minutes
3. This assumes that the buzzer may be required to stay on for up to 15-minutes

6.8.4.3 Services noise

Specified recommendations and mitigation measures have been provided to the project team based upon the mechanical, electrical and hydraulic services design and plant and equipment selections, and incorporated into the respective designs with the aim of achieving the requirements outlined in Section 4.5.2.

The plant and equipment selections for the basis of this report and associated noise level data for the NIF MF are presented in the noise and vibration design in APPENDIX C.

6.9 Car park and traffic generation

Car parking and traffic generation requirements and assumed operations are outlined in Table 6-21 below.

Table 6-21: Employment type mode share and parking provision estimates

Vehicle movements	Day (7am – 10pm)		Night (10pm-7am)		Assumptions
Vehicle type	**Light**	**Heavy**	**Light**	**Heavy**	
RC Staff (maintenance) Shift 1	24	-	24	-	Arrive 6-7am, Depart 5-6pm
RC Staff (maintenance) Shift 2	31	-	31	-	Arrive 6-7pm, Depart 5-6am
RC Staff (admin)	70	-	-	-	Arrive 7-8am, Depart 5-6pm, 35 staff
NSW Trains	42	-	-	-	Arrive 7-8am, Depart 4-5pm
Deliveries	30	8	-	8	15 light, 4 heavy deliveries (day), 4 deliveries (night), see Section 6.8.4.2
Visitors	20				10 daytime visitors
Total per day/night	**196**	**8**	**76**	**8**	
Worst case 1 Hour	**59**	**6**	**28**	**2**	Distributed over worst 1 hour
Worst case 15-minute	**20**	**4**	**15**	**1**	Distributed over worst 15 min

As the facility is security controlled, and vehicles are required to pass through security, heavy vehicles will be required to stop, and so associated braking noises have been modelled.

6.10 Train Wash Plant

6.10.1 Assumptions

The following operational assumptions have been made in this assessment:

1. The bi-direction train wash plant could be used for any train that enters or exists the facility, and as such could occur anytime between 5:00am through to 2:00am, 7 days per week.
2. The train moving speed through the train wash is limited to 3.5km/h, with the train stopping for periods as the rear and front cabin ends of the trains are washed and in the middle where two sets are coupled to form a Long NIF train.

3. There are two potential washing cycles for the trains, being either a quick wash or a complete wash. The durations of these wash cycles are shown in Table 6-22.

Table 6-22: Train wash duration and procedure assumptions

Single train operation	Duration (seconds)	Notes
Quick wash (without front, rear and intercabs)		
Moving train	260	205m train moving at 3.5km/h
Stationary train	-	
Total[1]	**260**	**4 minutes 20 seconds**
Complete wash (including front, rear and intercabs)		
Moving train	**260**	205m train moving at 3.5km/h
Stationary train	**410**	Long NIF pauses for front, rear and intercab washing
Total[1]	**670**	**11 minutes 10 seconds**

Notes
1. Train wash jet blower will be in operation for the duration of the moving train period but will not operate during the stationary train periods.
2. Timing rounded to nearest 10 seconds.

4. The train wash jet blower is the key noise source within the train wash building and will be in operation for the duration of a quick wash but will not operate when the train is stationary during a complete wash. Only the blower at the exit of the train wash will be in operation during the process.

5. As there are two potential wash cycles for trains to use, the noise impacts from both scenarios have been reviewed, and the worst case included in the reasonable worst-case operational assessment presented in Section 7.2. As the key noise source during the arrival process is from the train HVAC and systems operating on a stationary or slow-moving train, the wash cycle operation that has been included in the assessment is for two trains in a 15-minute period, each undertaking a quick wash.

6. APPENDIX C outlines the noise sources and modelling assumptions for the Train Wash building.

6.10.2 Internal noise levels

Attended noise measurements of the train wash and wheel lathe at the Reliance Rail Auburn Maintenance Centre (Auburn MF) at Auburn, NSW were undertaken by Renzo Tonin & Associates on 23 May 2018 and 6 June 2018, in order to determine reasonable worst-case operational noise emissions from the train wash. These scenarios have also been used to recommend noise control treatments and management measures to mitigate noise emissions.

The train wash jet blowers proposed for the NIF MF are very similar to the equipment and operations at the Auburn MF, and as such are considered suitable for the purpose of designing noise mitigation measures for the NIF MF. Jet-blower noise levels were confirmed to achieve similar or less noise levels than those measured at Auburn MF.

It is understood that the jet blowers will operate for the extent of time that the train is within the train wash, and only the car at the end of the train set when departing will be in operation during the washing procedure.

A summary of the key noise monitoring results is presented in Table 6-23. Based upon attended noise measurements and known noise sources and distances, noise source levels for the wheel lathe building and the train wash building have been validated and used for the design of the relevant buildings.

Table 6-23: Reliance Rail Auburn Maintenance Centre (Auburn MF) key noise measurements

Item being measured	Measured noise level[1], $L_{Aeq(t)}$ dB(A)	Measurement distance, m	Calculated Sound Power Level[2], dB(A) re 1pW
Train Wash			
Train Wash in operation	55	107	103[4]
Jet Blower in operation	89	5	106[3,5]

Notes: 1. Attended noise measurement
2. Sound power calculation considered both distance from noise source and the internal space
3. Sound power for a single jet blower, two were operating during the measurement
4. Sound power of the wash opening
5. Further information has been received from the train wash contractor, determining that the blower noise level achieves this assumed noise level.

Other mechanical services noise sources such as fans and condenser units have been provided by the mechanical contractor and included in the noise emissions modelling.

6.10.3 Mitigation and management design elements

Noise levels at the nearest receivers from the train wash building as the train passes through are a combination of the train wash building, specifically the jet blowers in operation and slow-moving train going through the train wash. The design of the train wash building is based upon the train moving through the train wash at 3.5km/h, and the train HVACs operating in normal mode.

Due to length restrictions of the train wash building, the location in the building of the AWD (Automatic Wheel Detection) and the Turpentine Bridge at either ends of the train wash building, the amount of additional acoustic mitigation of the jet blowers was restricted.

The REF recommended a barrier at the eastern end of the train wash, however this would only protect an individual receiver. As the jet blower noise could not be mitigated directly at source, acoustic mitigation in the form of acoustic absorption to be installed for the length of the train wash from the blowers to each of the train wash building's openings has been incorporated. In addition, the building has been redesigned so that the blowers are located as far as possible within the train building and away from the openings at the two ends, so as to maximise the noise attenuation from acoustic absorption lining. This provides a better noise reduction solution than an external noise barrier, as it reduces noise breakout from the train wash at either end and reduces noise impacts at multiple receivers, which is not the case with a barrier that would protect only a single receiver.

A maximum distance of 6.5 m from each jet blower to the train wash opening was achieved at each end of the train wash. The internal walls and roof of 8m lengths at both ends of the train wash building are then lined with acoustic absorption to reduce the noise breakout via the openings.

With consideration of the physical restrictions, the noise mitigation design aims to ensure that the noise contribution from the train wash building in operation (eg. jet blowers) does not noticeably increase the overall noise level [less than 2 dB(A) increase] at nearby residential receivers under normal and worst-case train HVAC operation modes.

6.10.3.1 Building envelope

The train wash building envelope will be constructed with building elements that achieve the minimum acoustic sound transmission loss performances presented in Table 6-24.

Table 6-24: Train Wash Building - building envelope minimum sound transmission loss

Internal space	Facade	Facade element	Recommended minimum sound transmission loss, dB, per octave band, Hz								Assumed construction material
			Rw	63	125	250	500	1000	2000	4000	
Train Wash	East	Facade	Rw 26	14	18	22	24	21	32	42	Kingspan 100mm KS1000AWP
		Opening	-	-	-	-	-	-	-	-	Maximum 35m^2
	North	Facade	Rw 26	14	18	22	24	21	32	42	Kingspan 100mm KS1000AWP
	West	Facade	Rw 26	14	18	22	24	21	32	42	Kingspan 100mm KS1000AWP
		Opening	-	-	-	-	-	-	-	-	Maximum 35m^2
	South	Facade	Rw 21	10	13	14	18	22	24	22	Danpalon 16mm
	Roof	Roof	Rw 26	14	18	22	24	21	32	42	Kingspan 100mm KS1000RW
		Ventilators (x6)	Rw 13	9	5	8	11	14	13	11	Acoustic Turbo-Base LBA-600
Pump Room	All	Facade	Rw 26	14	18	22	24	21	32	42	Kingspan 100mm KS1000AWP
	West	Door	Rw 24	-	-	-	-	-	-	-	Solid core door
	West	Roller Door	Rw 11	1	3	6	8	11	12	14	Standard roller door
	North	Louvre (N)	-	-	-	-	-	-	-	-	Architectural louvre
	South	Louvre (S)	-	-	-	-	-	-	-	-	Architectural louvre
	Roof	Roof	Rw 26	14	18	22	24	21	32	42	Kingspan 100mm KS1000RW

Roof ventilations are to be acoustically lined with 50 mm internal acoustic insulation for a minimum of 0.8 m plus an acoustic insulation lined damper, that achieves a minimum Rw 13, such as Acoustic Turbo-Base LBA-600 or acoustical equivalent.

6.10.3.2 Internal noise levels

1. Jet blowers are located no closer than 6.5m from the nearest main openings of the train wash.

2. The **train wash bay** will have installed acoustic absorption (minimum NRC 0.8) around each of the jet blower bays, extending over the entire jet blower bay through to the nearest train wash main opening, totalling a minimum of 8 m in length from each end of the train wash building. This acoustic absorption is to extend for both walls, and the roof over this area, as shown in Figure 6-3 and Figure 6-4 . The acoustic absorption will be Whisper FR 60mm (3 layers, 20mm) or other product of equivalent acoustic performance.

3. The acoustic absorption is being installed at both ends of the train wash building as the train wash is required to be used bidirectionally, as noted in TfNSW Clarifications REQ_BORD_210.

Figure 6-3 Extent of acoustic absorption within the train wash (PLAN)

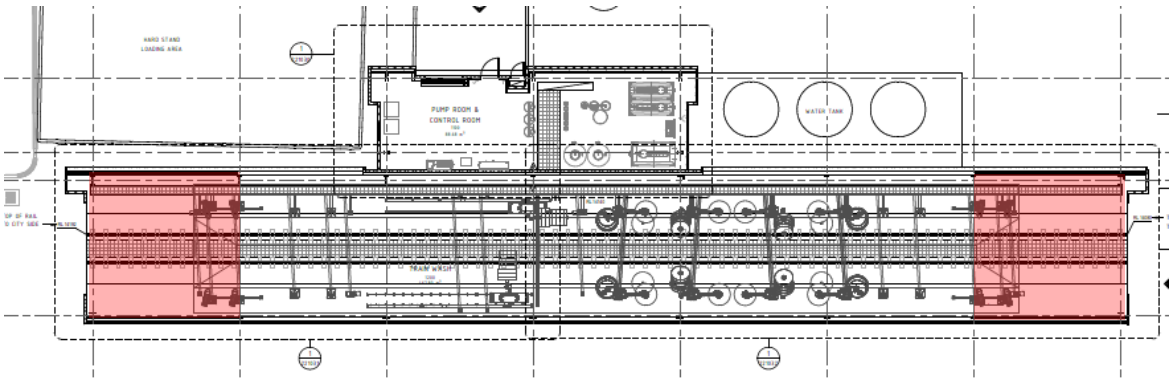
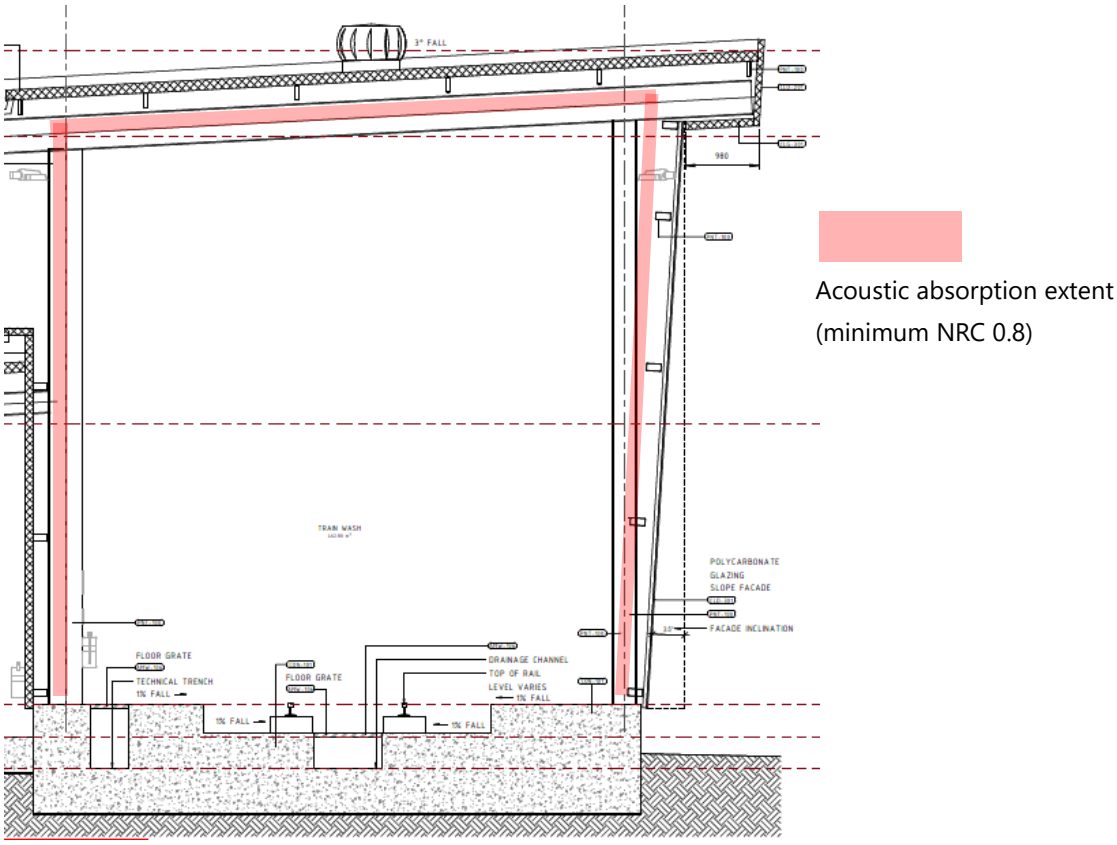


Figure 6-4 Extent of acoustic absorption within the train wash (SECTION)



6.10.3.3 Pump room and control room (Room 1100)

The plant and equipment within the pump and control room are being refined, and any additional acoustic requirements to control noise emission from the pump room will be reviewed at that stage. Design elements minimum acoustics requirements are:

1. External entry door is to be solid core.

2. Louvres in the pump and control room are being reviewed, but do not require further mitigation measures with an internal noise level of 75 dB(A).

6.11 Wheel lathe building

6.11.1 Assumptions

Noise emissions from the wheel lathe building are to be controlled to the nearby residential receivers, with consideration of cumulative impacts from the rest of the other nearby noise generating activities. Noise emissions have been assessed during the night period (10.00pm to 7.00am), as required by BOR 4.2.2.

The wheel lathe will have a dedicated Ground Borne Warning System (GBWS) to signal when the train is about to move or moving. The noise impacts from the GBWS are being detailed in per Section 6.6.

The following operations assumptions are included in this assessment:

1. An underfloor wheel lathe will be installed within the Wheel Lathe building.
2. The wheel lathe could operate up to 8 hours per day, 7 days a week.
3. The wheel lathe will not operate during the night period (10:00pm to 7:00am).
4. The train is not operational during the lathing process and the train is moved using an electric train shunter.
5. A water treatment plant is to be located on the northern side of the wheel lathe building.
6. APPENDIX C outlines the noise sources and modelling assumptions for the Wheel Lathe.

6.11.2 Internal noise levels and source levels

Attended noise measurements of the wheel lathe at the Reliance Rail Auburn Maintenance Centre (Auburn MF) at Auburn, NSW were undertaken by Renzo Tonin & Associates on 23 May 2018 and 6 June 2018, in order to determine reasonable worst-case operational scenarios to assess noise emissions from the wheel lathe operations. These scenarios have also been used to recommend noise control treatments and management measures to mitigate noise emissions.

It is understood that the wheel lathe proposed for the NIF MF is very similar to the equipment and operations at the Auburn MF, and as such is considered suitable for the purpose of designing noise mitigation measures for the NIF MF.

A summary of the key noise monitoring results is presented in Table 6-25. Based upon attended noise measurements and known noise sources and distances, noise source levels for the wheel lathe building and the train wash building have been validated and used for the design of the relevant buildings.

Table 6-25: Reliance Rail Auburn Maintenance Centre (Auburn MF) key noise measurements

Item being measured	Measured noise level[1], $L_{Aeq(t)}$ dB(A)	Measurement distance, m	Calculated Sound Power Level[2], dB(A) re 1pW
Wheel Lathe			
At wheel lathe facade during machining operations	75	5[3]	96[4]
West end of the wheel lathe building	72	8[3]	96[4]
East end of the wheel lathe building	65	25[3]	96[4]

Notes: 1. Attended noise measurement
2. Sound power calculation considered both distance from noise source and the internal space
3. Distance from wheel lathe machine
4. Calibrated sound power of the wheel lathe machine in the pit, based upon the range of attended measurements

Noise levels were based upon information provided by the design team, and the design has been based upon the calculated sound power levels presented in Table 6-26.

Table 6-26: Modelled noise source levels

Noise source	Modelled Sound Power Level, dB(A)[2]	Notes
Wheel lathe building[2]		
Wheel lathe machine	Table 6-25	-
Electric shunt vehicle	78	Electric shunt vehicle is to not exceed 70 dB(A) at 1m
Water treatment plant/Plant room	6 pumps each 78 dB(A)	See Section 6.11.3.4 for details of the maximum installed unit noise level

Notes: 1. Associated train movement noise impacts are included in the NIF MF site-wide report
2. No train noise is associated with the wheel lath operations

Other mechanical services noise sources such as fans and condenser units have been provided by the mechanical contractor and included in the noise emissions modelling.

6.11.3 Mitigation and management design elements

6.11.3.1 Building envelope

The wheel lathe building envelope is to be constructed with elements that achieve the minimum acoustic sound transmission loss performance presented in Table 6-27. It is assumed that these elements are in place and doors closed to control noise emissions during typical operations of the wheel lathe.

Table 6-27: Wheel Lathe Building - building envelope minimum sound transmission loss

Internal space	Facade	Facade element	Recommended minimum sound transmission loss, dB, per octave band, Hz								Assumed construction material
			Rw	63	125	250	500	1000	2000	4000	
Wheel lathe	NE	Facade	Rw 26	14	18	22	24	21	33	45	Kingspan 100mm KS1000AWP
		Opening	-	-	-	-	-	-	-	-	Maximum 25m^2 Roller Door (assumed open when wheel lathe is in operation)
	NW (Main area)	Facade	Rw 26	14	18	22	24	21	33	45	Kingspan 100mm KS1000AWP
		Roller Door 1	Rw 11	1	3	6	8	11	12	14	Standard roller door
		Roller Door 2	Rw 11	1	3	6	8	11	12	14	Standard roller door
	NW Water Treatment Plant (WTP)	WTP Roller Door 1	Rw 20	6	12	14	17	21	21	20	Acoustic rated roller door
		WTP Roller Door 2	Rw 20	6	12	14	17	21	21	20	Acoustic rated roller door
		Facade	Rw 26	14	18	22	24	21	33	45	Kingspan 100mm KS1000AWP
		Opening NE	-	-	-	-	-	-	-	-	Maximum 3m^2
		Opening SW	-	-	-	-	-	-	-	-	Maximum 3m^2
		Roof	Rw 26	15	19	23	23	21	39	47	Kingspan 100mm KS1000RW
	SW	Facade	Rw 26	14	18	22	24	21	33	45	Kingspan 100mm KS1000AWP
		Opening	-	-	-	-	-	-	-	-	Maximum 25m^2 Roller Door (assumed open when wheel lathe is in operation)
	SE	Facade	Rw 21	10	13	14	18	22	24	22	Danpalon 16mm
	Roof	Roof	Rw 26	15	19	23	23	21	39	47	Kingspan 100mm KS1000RW
		Ventilator (x 2)	-	-	-	-	-	-	-	-	Roof ventilator

6.11.3.2 Internal room acoustics

1. **Wheel lathe building** requires acoustic absorption to be installed over a minimum of 40% of the ceiling area and the top of the north-western wall, extending from the roof level downwards approximately 2-3 m, totalling a minimum area of 220 m^2. This is to be evenly distributed over these areas and exposed to the internal space. A suitable material is Whisper FR 60mm (3 layers, 20mm) or other product of equivalent acoustic performance or as approved by the project's acoustic consultant.

2. **Wheel lathe pit** will require acoustic absorption (minimum NRC 0.7) to be installed over a minimum 70% of the exposed walls of the wheel lathe pit. Suitable acoustic absorption material is 50mm Pyrotek Reapor (NRC 0.95) or other product of equivalent acoustic performance or as approved by the project's acoustic consultant.

6.11.3.3 Warning Alarms - Ground based warning system (GBWS)

The wheel lathe Ground Based Warning System (GBWS) will contribute to the overall noise emissions from the site. Refer to Section 6.6 which addresses GBWS noise, its management and mitigation.

6.11.3.4 Water treatment plant and plant room

Located on the northern façade of the wheel lathe building, the water treatment plant will be within a dedicated plantroom space. Noise from the plant will be limited to a combined **overall sound power level** of all components during reasonable worst-case operations of **86 dB(A), which assumes 6 pumps each operating at 78 dB(A) sound power level.**

6.12 Traction substation building

6.12.1 Assumptions

The following sets out operational assumptions used in this assessment:

1. The traction substation building equipment operate 24 hours per day, 7 days per week.

2. For acoustic design purposes the only environmental noise emission sources identified for this building are the transformers and reactor.

3. Other components such as harmonic filters, switches and other components are either installed within the traction substation or do not generate significant noise. Noise emission from these items therefore has not been included in the noise model.

4. Transformers can result in tonal noise impacts at the nearby receiver, typically at either the 100Hz or 200Hz third-octave bands. In absence of third-octave band noise level data available from the manufacturer's specifications, it has been assumed that a tonal penalty could apply at the nearest residential receiver. The noise source spectrum is based upon a typical transformer spectrum measured by RT&A.

5. Noise emission from circuit breakers has not been included in the operational noise assessment as they occur under fault conditions, which are highly irregular and infrequent events.

6. APPENDIX C outlines the noise sources and modelling assumptions for the traction substation building.

6.12.2 Noise source levels

Transformer noise levels were based upon information provided by the design team, and the design has been based upon the calculated sound power levels presented in Table 6-28.

Table 6-28: Modelled noise source levels

Noise source	Modelled Sound Power Level, dB(A)[2]	Notes
Traction substation		
Power transformers (3MVA 66kV/11kV)	90	Based upon 68 dBA at 1m from the radiating surface of the transformer. Dimensions 4m (H) (Main Body 2.5m) x 3.7m (W) x 4.7m (L)
Rectifier Transformer (5.35MVA 66kV/600/600V)	65	At Rated Voltage & Rated Current 2 transformers in substation, one primary and one standby
DC Reactor	Not considered	Advised no noise as no magnetic core

Notes: 1. Associated train movement noise impacts are included in the NIF MF site-wide report
2. No train noise is associated with the wheel lath operations

Other mechanical services noise sources such as fans and condenser units have been provided by the mechanical contractor and included in the noise emissions modelling.

6.12.3 Mitigation and management design elements

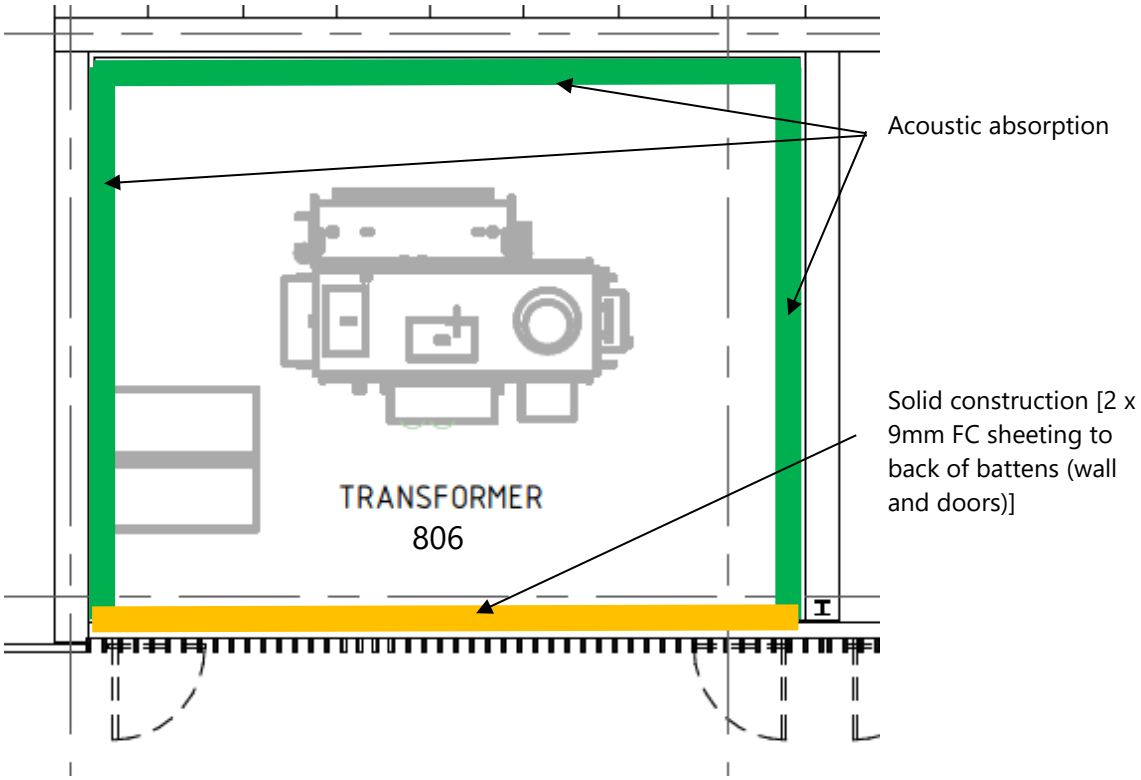
To control noise emission from the traction substation the following design elements have been included in the design, as shown in Figure 6-5:

1. **Transformer Bay 806** contains the power transformers (3MVA 66kV/11kV). Acoustic absorption material (minimum NRC 0.8) will be installed to extend within the transformer bay for a minimum 2.5 m above the transformer bay floor to the underside of the traction substation building roof level of the transformer bay. Suitable acoustic absorption material is 50mm Pyrotek Reapor (NRC 0.95) or other product of equivalent acoustic performance or as approved by the project's acoustic consultant.

2. In **Transformer Bay 806** the south-east wall of the bay will be of solid construction, without gaps. This is will extend from ground level to no less than 4.5m above external ground level and the top of the solid construction will end no less than 2 m above the main body of the transformer (ie. main transformer tank). The minimum transmission loss of this barrier is to be Rw 35, such as

2 layers of 9mm fibre cement (FC) sheeting (minimum individual sheet surface density 14 kg/m^2). This treatment will be applied to the access doors to the transformer bay. Doors will only have a threshold gap no larger than 10 mm.

Figure 6-5 Minimum acoustic treatment for Transformer Bay (806)



6.13 Bio-wash and graffiti removal external cleaning

6.13.1 Assumptions

Bio-wash and graffiti removal external cleaning is located in a dedicated area on Road. It is understood This activity will be undertaken by personnel with portable equipment and could occur anywhere around the standing train.

Standing trains in the yard have the potential to exceed the daytime project noise goals at the nearest receivers. As such, the noise emissions from the bio-wash and graffiti removal external cleaning activities have been assessed so that when they take place, they will not significantly increase [by more than 2 dB(A)] the noise levels at the nearest receivers, when noise emissions from the site are at the daytime project noise goals. In the case that overall noise impacts from the site are higher than the project noise goals, then any increase as a result of the bio-wash and graffiti removal external cleaning activities will be less than predicted.

It is predicted that if high-pressure washing activities with a sound power level greater than 101 dB(A), this will increase the site noise emissions by greater than 2 dB(A) above the daytime project noise goals at the nearest receivers, if the site noise emissions are at the daytime project noise goals. As such,

further mitigation and management is required if the high-pressure washing activities are higher than this sound power level.

The following sets out operational assumptions used in this assessment:

1. Bio-wash and graffiti removal, and heavy duty external cleaning are to take place in a dedicated area on Road 6. This will be undertaken by contractors with portable equipment. Cleaning activities take place anywhere around the standing train.
2. Bio-wash and graffiti removal, and heavy duty external cleaning will take place only during the daytime period (7:00 am to 6:00 pm).
3. APPENDIX C outlines the noise sources and modelling assumptions for the bio-wash and graffiti removal, and heavy duty external cleaning activities. However, as the cleaning will be undertaken by cleaning contractors, the typical equipment could vary. As such, typical noise source levels have been modelled, but noise limits for the equipment are provided in the mitigation and management measures to control noise impacts.

6.13.2 Noise source levels

Bio-wash and graffiti removal activity noise levels were based upon information provided by the design team, and the design has been based upon the calculated sound power levels presented in Table 6-29

Table 6-29: Modelled noise source levels

Noise source	Modelled Sound Power Level, dB(A)[2]	Notes
Sewer Decant		
High pressure cleaning equipment	101	-
Standing train		See Section 6.3

Notes: 1. Associated train noise impacts are included in the NIF MF site-wide report

6.13.3 Mitigation and management design elements

To control noise emission from the bio-wash and graffiti removal external cleaning operations contractors are to select high-pressure cleaning systems (including any associated generators or compressors) which cumulatively achieve maximum sound power levels or sound pressure levels at 1 m when in use, as presented in Table 6-30. Cumulatively includes consideration of multiple operators washing simultaneously, and any other associated noise producing equipment/plant.

Limiting the noise level at source is the preferred method, however this may not be possible for cleaning contractors due to the required pressure washer systems. As such, where the cleaning contractors cannot provide equipment that achieve the maximum required sound power level without additional mitigation, then noise measurements to confirm noise impacts from cleaning activities are to be undertaken.

Where cleaning activities are identified to exceed or cause an overall exceedance of the noise requirements at nearby residential receivers, feasible and reasonable mitigation measures, such as alternative equipment or mitigated equipment along with management of activities in areas with the highest noise impacts, are to be adopted.

Table 6-30: External cleaning and bio-wash – maximum equipment noise levels

Cleaning setup	Maximum equipment sound power levels, dB(A) re 1pW	Maximum sound pressure level at 1 m, dB(A)
Worst case cleaning operations	101[1]	93[1]

Notes: 1. This includes all noise sources associated with the cleaning activity, ie. machine plus the water jet interaction with the train noise, for all simultaneous operators.

6.14 Ancillary buildings (Security building, sewer decant facility, rainwater pump house)

6.14.1 Assumptions

The following sets out operational assumptions used in this assessment:

1. The **sewer decant facility** and **rain water pump house** equipment could operate 24 hours per day, 7 days per week.
2. The mechanical equipment that operate associated with the use of the **security building** could operate 24 hours per day, 7 days per week.
3. Single basin pumps are to be located at each of the two basins within the facility. These could operate 24 hours per day, 7 days per week.
4. An electric/diesel pump for the fire sprinkler system will be located within the **rain water pump house**. This pump will operate only in emergencies and will be tested no more frequently than a monthly basis.
5. APPENDIX C outlines the noise sources and modelling assumptions for theses ancillary buildings.

6.14.2 Noise source levels

Sewer decant facility, and rainwater pump house noise levels were based upon information provided by the design team, and the design has been based upon the calculated sound power levels presented in Table 6-31.

Table 6-31: Key modelled noise source levels

Noise source	Modelled Sound Power Level, dB(A)[2]	Notes
Sewer Decant		
Vacuum Pump	89	Based upon a Mink Claw Vacuum Pump MM 1252 AV. Located within the building.
Rainwater pump house		
Rainwater pump	75	Based upon a Lowara 5.5kW pump. Two will potentially operate. Located within the building.
Retention basin pumps		
Retention basin pump No. 1	< 70	Located within the acoustic enclosure, with a cast iron lid with no holes/openings.
Retention basin pump No. 2	< 70	Located within the enclosure, with a cast iron lid with no holes/openings.

Other mechanical services noise sources such as fans and condenser units have been provided by the mechanical contractor and included in the noise emissions modelling.

6.14.3 Mitigation and management design elements

1. This sewer pump is located within a dedicated **sewer decant facility** building, with façade elements that achieve a minimum Rw26.
2. All louvre/ventilation openings for the **sewer decant facility** building are pointed away from the nearby residential receivers.
3. Each retention basin pump is to be located within a dedicated enclosure with a cast iron lid with no holes/openings, which will significantly reduce the pump noise emissions.
4. Mechanical services noise sources such as condenser units and fans for all the ancillary buildings have been selected or mitigated to achieve noise level requirements at nearby receivers.
5. The fire sprinkler system pump is not part of typical operations. The fire sprinkler system pump will be located within the **rain water pump house**. It is to be tested during daytime only (7am to 6pm). This is on the basis that testing occurs no more frequently than once per month. Furthermore, the fire sprinkler system pump exhaust is to be fitted with a residential grade exhaust silencer.

7 Noise and vibration design outcomes

7.1 Mainline turnout-out noise

In accordance with CoA 22, the proposed augmentation of track infrastructure on the Main North Line to provide access to and from the maintenance facility is to avoid the generation of impulsive noise. As such, impacts relating to impulsive (or maximum) noise associated with the proposed new rail turnouts, have been assessed in accordance with the RING.

As part of the Combined Submission Report for the NIF MF (WSP, Revision 0, dated 24 August 2017), WSP undertook a supplementary noise and vibration assessment (WSP review) which assessed the noise impacts of the new crossover and turnout points from trains using the Main North line. This assessment presented a number of rail noise measurements that were undertaken in vicinity of the proposed turnouts, and also a preliminary assessment of the potential increase in rail noise levels as a result of the turnouts. The assessment recommended:

"…that more detailed analysis techniques, such as computer aided modelling, be commissioned in order to confirm the extent of any trigger level exceedance."

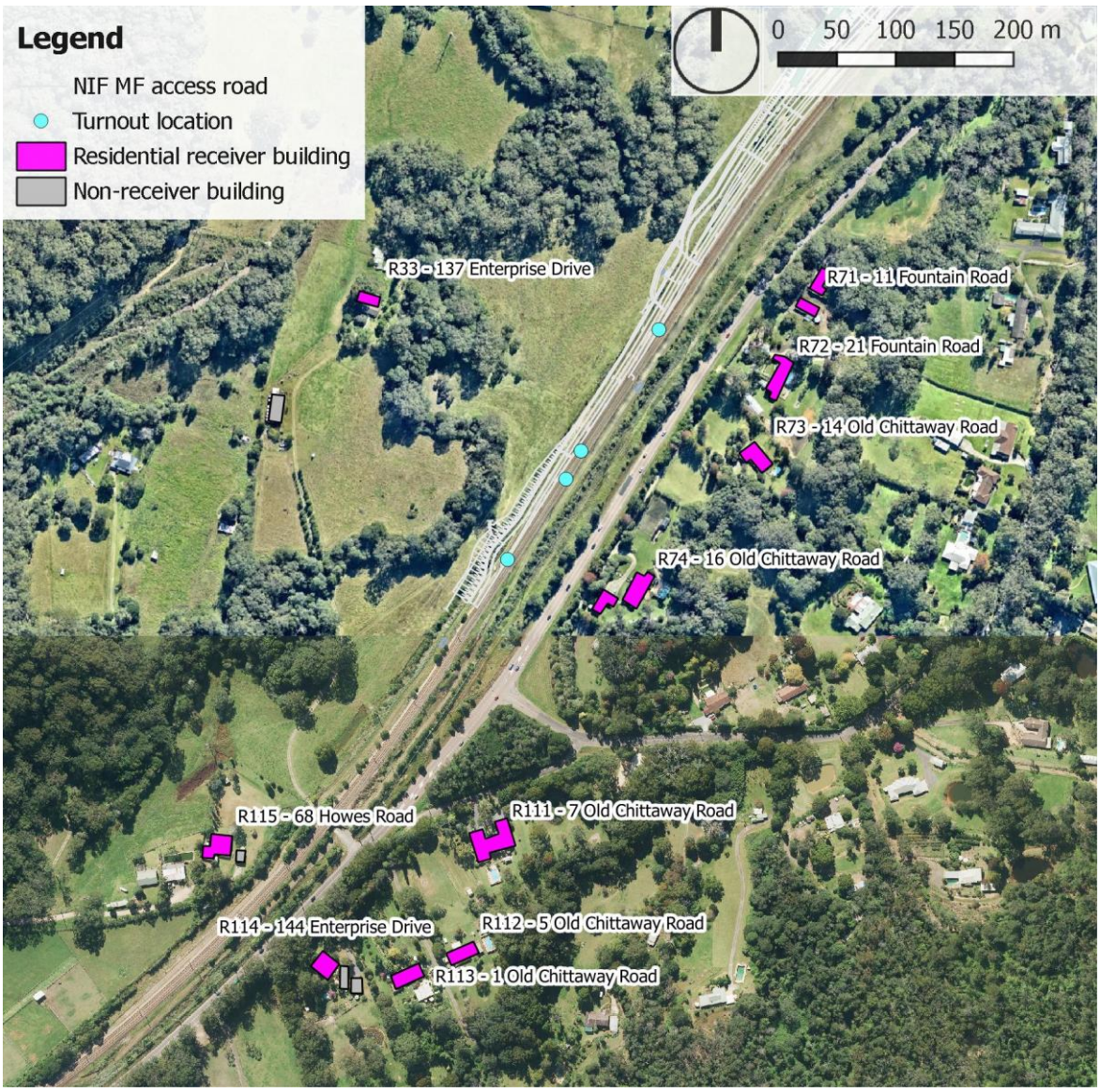
This section of the report outlines this assessment.

7.1.1 Assessment

Four standard turnouts are to be installed on the main line approximately 2.8 km north of Ourimbah Station. The closest receivers to the turnout locations are the residences along Enterprise Drive, Fountaindale approximately 80 m from the Main North Line.

The location of the proposed rail turnouts and the nearest residential receivers are presented in Figure 7-1.

Figure 7-1 New Intercity Fleet (NIF) Maintenance Facility (MF) Main North Line turnouts and nearby receiver locations



7.1.2 Noise levels

The measurements that were undertaken in the WSP review have been normalised to the standard conditions referenced in the TfNSW Rail Noise Database (RNDB) (Version 1.0) of 80 km/h at 15 m, based upon the measurement duration and train speed specified in the WSP review. These are presented in Table 7-1, and compared with the RNDB noise levels for the measured trains.

Only the passenger train noise levels are compared in this assessment, as this provides a conservative assessment and assumes that all rail noise is generated by wheel-rail noise and potentially affected by the proposed turnouts. In practice, diesel engine and exhaust noise from locomotives (unaffected by turnout noise) may also be a significant noise source in this project area. In this case, the change in overall noise levels would be lower than presented in this report. As such, freight trains have been excluded.

Table 7-1: Comparison of WSP review and RNDB rail noise levels

	WSP review Measured noise level @ 28m, dB(A)[1]	Normalised noise level for reference conditions of 80km/h @ 15m, dB(A)	RNDB noise levels 80km/h @ 15m, dB(A)	Difference between WSP review and RNDB noise levels at standard reference conditions, dB(A)
L_{AE}[2]				
H-set (Oscar)	88.8	88.3	85.6	-2.7
K-Set	87.4	87.2	88.6	1.4
$L_{Amax, 95\%}$[3]				
H-set (Oscar)	84.8	85.6	86.0	0.4
K-Set	84.9	85.6	85.0	-0.6

Notes:

1. The train speeds for these measurements ranged, refer to the WSP review. For the H-set (Oscar) at measurements were at 115 km/h except for one measurement at 100 km/h. For the K-Sets the range all measurements were at 115 km/h except for one measurement at 100 km/h and two at 90 km/h.
2. Based upon the log average of the 3 H-set (Oscar) measurements, and 12 K-Set measurements respectively pass-by measurements.
3. Based upon the 95th percentile of the 3 H-set (Oscar) measurements, and 12 K-Set measurements respectively.

As shown in Table 7-1, the normalised noise levels show that the passenger train measurements in the WSP review were within 1.5 dB(A) of the RNDB noise levels for 3 of the 4 results. The only exception is for the L_{AE} H-set (Oscar) noise measurements, for which there were only 3 measurements undertaken and a large 12 dB(A) range in the WSP measurement results. As such, the detailed assessment undertaken in this report is based upon the RNDB noise levels, which are supported by the measurements undertaken in the WSP review.

7.1.3 Predicted airborne noise levels

To compare directly the influence of the introduction of the turnout to the noise levels at the nearby receivers, noise levels have been predicted with and without a standard turnout for a passenger train case study and assessed against the RING noise trigger levels. This has been undertaken for the range of potential Main North Line train speeds from 80 km/h up to the maximum speed of 145 km/h to assess the impact over the range of potential train speeds.

To provide a conservative assessment, all rail noise is assumed to be from wheel-rail noise and potentially affected by turnout noise. In practice, diesel engine and exhaust noise from locomotives (unaffected by turnout noise) may also be a significant noise source in this project area. In this case, the change in overall noise levels would be lower than presented in this report.

Noise levels have been predicted at the nearest 10 noise-sensitive receivers near the proposed turnout locations, also assessed in the WSP review, for train speeds of 80 km/h and 145 km/h. Based on the modelling assumptions presented in Section 5.1.4.

- Table 7-2 shows the predicted increase in L_{Aeq} noise levels (to 1 decimal place) is up to 1.0 dB(A) at the nearest receivers for train speeds of 145 km/h. For train speeds of 80 km/h, the predicted

increase in L_{Aeq} noise levels (to 1 decimal place) is up to 1.1 dB(A) at the nearest receivers. Both these predicted increases are well below the 2 dB(A) allowance in RING.

- Table 7-3 shows the predicted increase in L_{Amax} noise levels (to 1 decimal place) is up to 1.8 dB(A) at the nearest receivers for train speeds of both 80 km/h and 145 km/h. Both these predicted increases are well below the 3 dB(A) allowance in RING.

Overall noise levels are also shown in Table 7-2 (for L_{Aeq}) and Table 7-3 (for $L_{Amax,95\%}$). However, the overall noise predictions are indicative as they do not represent the noise variation for each train type, operating speed and passenger/freight timetables. As noted earlier, this does not influence the change in wheel-rail noise associated with the proposed turnouts which are independent of such factors.

Table 7-2: Predicted noise levels, $L_{Aeq(night)}$ dB(A), compared to the RING trigger levels

Assessment speed	Receiver	Without standard turnout	With standard turnout	Standard turnout generated noise increase, dB(A)	Exceedance of RING absolute noise trigger level	Exceedance of RING increase trigger level
80 km/h	R33 – 137 Enterprise Drive	49	50	0.8	No	No
	R71 - 11 Fountain Road	53	54	0.4	No	No
	R72 - 14 Old Chittaway Road	52	53	0.9	No	No
	R73 - 16 Old Chittaway Road	54	55	1.1	No	No
	R74 - 21 Old Chittaway Road	54	54	0.7	No	No
	R111 – 7 Old Chittaway Road	53	53	0.1	No	No
	R112 – 5 Old Chittaway Road	52	52	0.1	No	No
	R113 – 1 Old Chittaway Road	52	52	0.1	No	No
	R114 – 144 Enterprise Drive	55	55	0.1	No	No
	R115 – 68 Howes Road	61	61	0	Yes	No
145 km/h	R33 – 137 Enterprise Drive	55	56	0.8	No	No
	R71 - 11 Fountain Road	59	60	0.4	No	No
	R72 - 14 Old Chittaway Road	58	59	0.9	No	No
	R73 - 16 Old Chittaway Road	60	61	1	Yes	No
	R74 - 21 Old Chittaway Road	60	60	0.6	No	No
	R111 – 7 Old Chittaway Road	59	59	0.1	No	No
	R112 – 5 Old Chittaway Road	58	58	0.1	No	No
	R113 – 1 Old Chittaway Road	58	58	0	No	No
	R114 – 144 Enterprise Drive	61	61	0.1	Yes	No
	R115 – 68 Howes Road	67	67	0	Yes	No

Table 7-3: Predicted noise levels, $L_{Amax,95\%}$ dB(A), compared to the RING trigger levels

Assessment speed	Receiver	Without standard turnout	With standard turnout	Standard turnout generated noise increase, dB(A)	Exceedance of RING absolute noise trigger level	Exceedance of RING increase trigger level
80 km/h	R33 – 137 Enterprise Drive	68	70	1.8	No	No
	R71 - 11 Fountain Road	74	75	0.1	No	No
	R72 - 14 Old Chittaway Road	73	74	1.3	No	No
	R73 - 16 Old Chittaway Road	75	77	1.3	No	No
	R74 - 21 Old Chittaway Road	75	76	1.3	No	No
	R111 – 7 Old Chittaway Road	75	75	0	No	No
	R112 – 5 Old Chittaway Road	73	73	0	No	No
	R113 – 1 Old Chittaway Road	74	74	0	No	No
	R114 – 144 Enterprise Drive	76	76	0	No	No
	R115 – 68 Howes Road	83	83	0	No	No
145 km/h	R33 – 137 Enterprise Drive	76	78	1.8	No	No
	R71 - 11 Fountain Road	82	82	0.1	No	No
	R72 - 14 Old Chittaway Road	81	82	1.3	No	No
	R73 - 16 Old Chittaway Road	83	85	1.3	No	No
	R74 - 21 Old Chittaway Road	83	84	1.4	No	No
	R111 – 7 Old Chittaway Road	83	83	0	No	No
	R112 – 5 Old Chittaway Road	81	81	0	No	No
	R113 – 1 Old Chittaway Road	82	82	0	No	No
	R114 – 144 Enterprise Drive	84	84	0	No	No
	R115 – 68 Howes Road	91	91	0	Yes	No

The predicted noise levels as a direct result of the introduction of the standard turnout are below the RING noise trigger levels at the nearest residential locations to the proposed turnouts for the range of potential Main North Line train speeds from 80 km/h up to the maximum speed of 145 km/h.

As such, even though a change in the future fleet mix operating along the Main North Line may result in an exceedance of the RING trigger levels, the results presented in Table 7-2 and Table 7-3 show that even if the RING trigger noise levels are exceeded, the comparison shows this will not be a direct result of the standard turnouts, and any exceedance of the trigger levels along the Main Line will not be isolated to this location.

Care needs to be undertaken during installation to ensure that the turnouts are aligned correctly. This will minimise the potential for excessive impulsive noise being generated and will be in line with the turnout noise level assumptions. Poor alignment could result in an increase in impulsive noise.

As such, if properly installed and maintained, the noise level changes associated with the proposed standard turnouts is predicted to be less than the RING noise increase allowances at the nearest

sensitive receivers. Consideration of mitigation measures to ameliorate rail noise impacts as a direct result of the turnouts is not required, such as the installation of swing nose turnouts.

7.2 NIF MF operations predicted noise levels and assessment

7.2.1 Reasonable and feasible design measures

A range of noise mitigation measures have been considered as part of the noise mitigation design to protect noise sensitive receivers surrounding the NIF MF.

The preferred noise mitigation treatment option is at-source noise mitigation, such as building treatments, architectural attenuation measures, train subsystem noise control or changes to work practises. Treatment 'at-source' reduces the level of noise before it even leaves the site, lowering the overall level of noise potentially generated by the NIF MF, thus reducing the need for further noise mitigation measures. The applicable mitigation and management measures for each element of the project are outlined in the Section 6.2.

The next preferred noise mitigation treatment option is 'between source and receiver', such as strategic placement of buildings or noise barriers. This mitigation option reduces the level of noise before it leaves the facility, thus reducing the noise impact in areas surrounding the facility. The offset to these mitigation measures is that there may be some visual impact or limitations on land use as a result. The key noise barrier that is incorporated into the design is included in Section 6.5.2.2.

With all reasonable and feasible implementation of these two categories of acoustic mitigation implemented and exhausted, there are still residual exceedances at some receivers. As outlined in the REF NVIA, noise mitigation at receiver properties should then be considered in order to mitigate these residual exceedances. Properties identified with residual exceedances are proposed to have individual property treatments implemented.

Table 7-4 below summarises the key noise mitigation options that considered across the project during the design development of all fixed facilities requiring noise mitigation, with comments on their feasibility and reasonableness with regard to this project.

Table 7-4: Summary of noise mitigation options for NIF MF

Noise mitigation option	Estimated noise benefit	Comments on feasibility/ reasonableness	Design result
At source			
Acoustic treatment of plant room/s and Administration /Maintenance building facades	5 to 15 dB(A) reduction in L_{Aeq} noise levels based on base design.	Reasonable cost, limited operational impact. Further improvements to the adopted design of the Maintenance building are not beneficial due to noise emission controlled through door openings or standing yard noise impacts, and compliance is achieved with doors closed,	Option adopted

Noise mitigation option	Estimated noise benefit	Comments on feasibility/ reasonableness	Design result
Absorptive lining of underside of roof and / or walls to reduce noise build up within the internal spaces and the subsequent noise emission.	Up to 5 dB(A) reduction in L_{Aeq} noise levels	Reasonable cost, limited operational impact. Maintenance building – Feasible and beneficial Wheel Lathe– Feasible and beneficial Substation transformer bay– Feasible and beneficial Train wash – Feasible and beneficial	Option adopted
Train wash – shifting the jet-blowers further inside the train wash, and internal acoustic absorption from blower to opening	Up to 15 dB(A) reduction in L_{Aeq} noise levels	Reasonable cost, limited operational impact. Physical limitations either end of train wash prevent further attenuation. Noise benefits controlled by cumulative impacts with associated moving and standing train.	Option adopted
No horn testing within standing yard.	Minimum 40 dB(A) reduction in L_{Amax} noise levels at 100 m from the standing yard	Operational requirement, as both deed and CoA requirement	Option adopted
Noise reduction of train auxiliary systems.	Up to 5-6 dB(A) reduction in L_{Aeq} noise levels	Option to be included where feasible and practicable as part of normal operations.	Option not currently adopted
Reduction of number of simultaneous standing trains	Up to 4 dB(A) if reduced trains reduced from 3 to 1 train	Overly restrictive on operations of the facility for normal operations.	Option not reasonable
Preferred standing locations	Up to 5 dB(A) if trains are located in most preferred locations compared with least preferred	Option to be included where feasible and practicable as part of normal operations.	Option adopted
Deliveries with heavy vehicles and the external loading and unloading associated with the workshop restricted to daytime periods.	5-10 dB(A) reduction in $L_{Aeq,15min}$ noise levels to residential receivers to the north on Orchard Road. This provides benefits both from $L_{Aeq,15min}$ levels and $L_{A1,1min}$ sleep disturbance impacts on heavy vehicle arrivals.	This would typically be included where feasible and practicable, as part of normal operations, exceptions being for oversized loads.	Option adopted
Between source and receiver			
Strategic use of preferred standing locations	5 to 10 dB(A) reduction in L_{Aeq} and L_{A1} noise levels by using if trains are located in most preferred locations compared with least preferred. This maximises the benefits of the northern noise wall and the Maintenance Building structure for shielding.	Option to be included where feasible and practicable as part of normal operations.	Option adopted
390m long and 6m high noise wall along north-west side of the standing yard	5 to 15 dB(A) reduction in L_{Aeq} and L_{Amax} noise levels to receivers located the north and west of site.	Reasonable cost with limited operational impact. Reasonable cost and visual impact. Reasonable noise reduction for receivers located north and west of site which is reduced during temperature inversions. See Section 6.5.2.2	Option adopted

Noise mitigation option	Estimated noise benefit	Comments on feasibility/ reasonableness	Design result
Noise barrier along the south-west edge of the power transformer bay in the traction substation	5 to 10 dB(A) reduction in L_{Aeq} noise levels	Reasonable cost, limited operational impact.	Option adopted
At Property Treatment (at receiver)			
At-property treatment of existing dwellings	Up to 15+ dB(A) reduction is achievable in L_{Aeq} and L_{Amax} noise levels, depending on design requirements	Usually more cost-effective than installing noise barriers where receivers are well spaced apart. Will be used for residual treatment where site noise mitigation measures, such as noise barriers, have reached practical acoustic and engineering limits. Does not reduce noise levels outdoors.	Option adopted

7.2.2 Operational noise impact results

The assessment has modelled the cumulative noise impacts including all design elements that are outlined in Section 6.2.

The assessment reviews four critical time periods -

1) Daytime

2) Evening

3) Night (arrivals in late evening)

4) Night (preparation and departures in early morning)

Four scenarios have been assessed for each critical time period, with overall 18 scenarios modelled. 14 of these scenarios have trains either in the standing yard and either departing or arriving, which are the key noise generating activities within the NIF MF.

The assessment scenarios assume in a reasonable worst-case, up to four trains could be operating within the standing yard (Section 6.5). Trains could be located in a range of configurations within the yard. As such, a sensitivity analysis of train locations was undertaken, and key design configurations were selected for the reasonable worst-case, which are outlined in Table 7-5.

The rolling stock can operate in three operating conditions (Presentation/Normal/Maximum) as shown in Section 6.3, and all assessments has been undertaken assuming the maximum operating condition, decided in consultation with TfNSW. Taking a conservative approach to best manage noise impacts at the nearby sensitive receivers, the residual noise impacts which are identified and require consideration of at-property noise treatment are based upon the maximum operating condition.

The above standing yard and access road activities have been modelled occurring concurrently with the other general noise generating buildings/activities that occur within the facility. The operating assumptions for each of the various activities across the NIF MF are included in APPENDIX C.

The assessed scenarios are presented in Table 7-5 where a "✓" is shown, this operation/activity is included in the modelling, and where "-" in shown this operation/activity has not been included in the model.

Table 7-5: Design assessment - concurrent operation/activity modelling scenarios Day & Evening (All scenarios assessed train HVAC @ Maximum operating conditions)

Operation/activity modelled	Scn 1	Scn 2	Scn 3	Scn 4	Scn 5	Scn 6	Scn 7	Scn 8	Scn 9
Assessment period	Daytime operations (7 am to 6 pm)					Evening arrival (6 pm to 10 pm)			
Access Track	No standing/ arriving trains	Arrival (via Train wash)				No standing/ arriving trains	Arrival (via Train wash)		
Standing yard train locations		Arrive Road 4/6(S) Stand Road 2/3	Arrive Road 3/4 Stand Road 6(S)/7(S)	Arrive Road 6(S)/7(N) Stand Road 3/4	Depart Road 6(S)/7(S) Prep Road 3/4		Arrive Road 4/6(S) Stand Road 2/3	Arrive Road 3/4 Stand Road 6(S)/7(S)	Arrive Road 6(S)/7(N) Stand Road 3/4
Arrival via Train Wash		✓ (Note 1)	✓ (Note 1)	✓ (Note 1)	-		✓ (Note 1)	✓ (Note 1)	✓ (Note 1)
Departure		-	-	-	✓ (Note 2)		-	-	-
Standing train - ROAD 1		-	-	-	-		-	-	-
Standing train - ROAD 2		✓	-	-	-		✓	-	-
Standing train - ROAD 3		✓	- (Note 1)	✓	✓		✓	- (Note 1)	✓
Standing train - ROAD 4		- (Note 1)	✓ (Note 1)	✓	✓		- (Note 1)	✓ (Note 1)	✓
Standing train - WL Rd		-	-	-	-		-	-	-
Standing train - ROAD 6 (South)		✓ (Note 1)	✓	-	- (Note 3)		✓ (Note 1)	✓	-
Standing train - ROAD 6 (North)		-		- (Note 1)	-		-		- (Note 1)
Standing train - ROAD 7 (South)		-	✓	-	✓ (Note 3)		-	✓	-
Standing train - ROAD 7 (North)		-	-	✓ (Note 1)			-	-	✓
Admin/Maintenance Building	✓	✓	✓	✓	✓	✓[5]	✓[6]	✓[6]	✓[5]
Wheel Lathe	✓	✓	✓	✓	✓	✓	✓	✓	✓
External Cleaning / Bio-wash	✓	✓	✓	✓	✓	-	-	-	-
Carpark	✓	✓	✓	✓	✓	✓	✓	✓	✓
Deliveries	✓	✓	✓	✓	✓	✓[4]	✓[4]	✓[4]	✓[4]
Ancillary/Security buildings	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sewer Decant Building	✓	✓	✓	✓	✓	✓	✓	✓	✓
Traction Substation	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes

1. **Reasonable worst case 15-minutes - ARRIVAL - Train 1,** Arrive from MNL to train wash =1min, Pause at train wash = up to 5min, Wash train = 4min, Move to yard = 5min, Train stop/dump/vent air in your or within maintenance building. **Train 2 (arrive @ ~ 9min following first train),** Arrive=1min, Pause at train wash = up to 5min, Wash train = 4min
2. **Reasonable worst case 15-minutes - DEPARTURE - Train 1,** Leave/GWBS, Move to signal=4min, Pause at signal = up to 5min, Depart = 1min, **Train 2,** Stand/Prep=up to10min, Leave/GWBS, Move to signal=4min, Pause at signal = up to 5 min, Depart from signal to MNL = 1min
3. For trains that depart the facility, the corresponding road GBWS signal will be sounded.
4. See Section 6.8.4.2 for details of deliveries during the evening and night
5. Modelled with doors closed
6. Modelled with a single door open for 15-minutes, both north and south ends open on arrival.

Table 7-6: Design assessment - concurrent operation/activity modelling scenarios (All scenarios assessed train HVAC @ Maximum operating conditions)

Operation/activity modelled	Scn 10	Scn 11	Scn 12	Scn 13	Scn 14	Scn 15	Scn 16	Scn 17	Scn 18
Assessment period	Night arrival (10 pm to 2 am)			Morning departure (4 am to 7 am)					
Access Track	No standing/ arriving trains	Arrival (via Train wash)		No standing/ arriving trains	Departure				
Standing yard train locations		Arrive Road 3/4 Stand Road 6(S)/7(S)	Arrive Road 6(N)/7(N) Stand Road 3/4		Depart Road 3/4 Prep Road 6(S)/7(S)	Depart Road 6(S)/7(S) Prep Road 3/4	Prep/Stand Road 2/3/4/6(S)	Prep/Stand Road 3/4/ 6(S)/7(S)	Prep/Stand Road 3/4/6(N)/7(N)
Arrival via Train Wash	-	✓ (Note 1)	✓ (Note 1)	-	-	-	-	-	-
Departure	-	-	-	-	✓ (Note 2)	✓ (Note 2)	-	-	-
Standing train - ROAD 1		-	-	-	-	-	-	-	-
Standing train - ROAD 2		-	-	-	-		✓	-	-
Standing train - ROAD 3		- (Note 1)	✓	-	- (Note 3)	✓	✓	✓	✓
Standing train - ROAD 4		✓ (Note 1)	✓	-	✓ (Note 3)	✓	✓	✓	✓
Standing train - WL Rd		-	-	-	-	-	-	-	-
Standing train - ROAD 6 (South)		✓	-	-	✓	- (Note 3)	✓	✓	-
Standing train - ROAD 6 (North)	-	-	- (Note 1)	-	-	-	-	-	✓
Standing train - ROAD 7 (South)	-	✓	-	-	✓	✓ (Note 3)	-	✓	-
Standing train - ROAD 7 (North)		-	✓ (Note 1)				-	-	✓
Admin/Maintenance Building	✓[5]	✓[6]	✓[5]	✓[5]	✓[6]	✓[5]	✓[5]	✓[5]	✓[5]
Wheel Lathe	-	-	-	-	-	-	-	-	-
External Cleaning / Bio-wash	-	-	-			-	-	-	-
Carpark	✓	✓	✓	✓	✓	✓	✓	✓	✓
Deliveries	✓[4]	✓[4]	✓[4]	✓[4]	✓[4]	✓[4]	✓[4]	✓[4]	✓[4]
Ancillary/Security buildings	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sewer Decant Building	✓	✓	✓	✓	✓	✓	✓	✓	✓
Traction Substation	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes

1. **Reasonable worst case 15-minutes - ARRIVAL - Train 1,** Arrive from MNL to train wash =1min, Pause at train wash = up to 5min, Wash train = 4min, Move to yard = 5min, Train stop/dump/vent air in your or within maintenance building. **Train 2 (arrive @ ~ 9min following first train),** Arrive=1min, Pause at train wash = up to 5min, Wash train = 4min
2. **Reasonable worst case 15-minutes - DEPARTURE - Train 1,** Leave/GWBS, Move to signal=4min, Pause at signal = up to 5min, Depart = 1min, **Train 2,** Stand/Prep=up to10min, Leave/GWBS, Move to signal=4min, Pause at signal = up to 5 min, Depart from signal to MNL = 1min
3. For trains that depart the facility, the corresponding road GBWS signal will be sounded.
4. See Section 6.8.4.2 for details of deliveries during the evening and night
5. Modelled with doors closed
6. Modelled with a single door open for 15-minutes, both north and south ends open on arrival.

Table D1 in APPENDIX D presents a summary of the predicted $L_{Aeq\ 15\text{-}minute}$ noise levels for the various operating scenarios assessed outlined above. Table D2 presents the $L_{A1\ 1minute}$ predicted noise impacts.

In all cases, the primary contributors to predicted exceedances are noise sources not readily controlled through design of the buildings associated with the NIF MF, such as trains in the standing area, trains on the access road arriving or departing the facility and trains standing along the access road.

7.2.3 Maximum noise level assessment

7.2.3.1 Horn testing, brake testing and the train movement warning systems

Noise levels generated by the short term noise events from the horn testing within the building, brake maintenance testing and the train movement warning systems, which include the PA systems, GBWS, and the depot protection system (DPS) within the maintenance building, have been assessed against the $L_{A1,1min}$ noise event requirements of RBL + 15 dB(A) facility for evening (6 pm-10 pm) and night-time (10 pm-7 am) periods.

High noise level events such as the brake maintenance tests or the sounding of the GBWS conducted during preparation prior to departure have been predicted based on the worst-case yard activities, primarily during preparation activities during the night period.

The noise barrier height has been designed to mitigate the main sources of sleep disturbance for receivers to the north and north west of the facility. However, to the south-east there is the potential for noise levels during these activities to exceed the sleep disturbance screening levels, and the $L_{A1,1min}$ noise requirements set in the CoA.

The GBWS and PA system have been designed with the aim of achieving the $L_{A1,1min}$ noise event requirement of RBL + 15 dB(A).

Table D1 in APPENDIX D presents a summary of the predicted noise levels for the various operating scenarios assessed and outlined in APPENDIX D.

7.2.3.2 Sleep Disturbance assessment

Noise levels generated by the short term noise events from all other sources not included in Section 7.2.3.1 have been assessed in accordance with the REF NVIA and submission clarification requirements, and the INP Application Notes, to control noise events to below $L_{A1,1min}$ noise level of 65dB(A) as per Table 4-4.

These noise events include –

- Dumping/venting the compressed air from the brake system when the trains are turned off
- During preparation tests
- Noise events within the maintenance facility (when the maintenance building doors are open during a train movement)

- Braking requirements along the access road (eg. stopping at train wash or departure signal, or as part of train wash movements)
- Wheel/rail noise on arrival and departure from the facility

Table D1 in APPENDIX D presents a summary of the predicted noise levels for the various operating scenarios assessed and outlined in APPENDIX D.

7.3 Residual noise impacts

Residual noise impacts have been identified where there is exceedance of the criteria after all reasonable and feasible noise mitigation measures have been incorporated.

As outlined in Section 7.2, the assessment has included each of the three train operating conditions to illustrate the differences between them, however, as a conservative approach in order to best manage noise impacts at the nearby sensitive receivers, the residual noise impacts which are identified and require consideration of at-property noise mitigation treatment are based upon the maximum operating condition.

As sensitive receivers are predicted to be residually impacted, it is recommended that properties identified to exceed the $L_{Aeq,15min}$ and $L_{A1,1min}$ project criteria should be considered for additional investigation of at property treatment.

In accordance with the project requirements outlined in the CoA and the REF NVIA, the project is to adopt a feasible and reasonable approach for the noise mitigation design, combining both physical noise mitigation and noise management measures, as follows:

Physical noise mitigation

Physical noise mitigation measures in the form of building designs and orientation, selection of low noise and acoustically treated mechanical equipment, broadband and ambient noise sensing alarms within the Maintenance building and mitigation to equipment areas where required.

Once potential implementation has been exhausted ↓

Noise management measures

Noise emission from the NIF MF will be managed through operational measures such as restricting heavy vehicle movements during the evening and night time period, limiting the opening of the maintenance building main doors, and no use of yard horns during movement of trains.

Once potential implementation has been exhausted ↓

At-property treatment

Any residual noise impacts (including sleep disturbance impacts) will be addressed through at-property noise mitigation treatment to ensure that the acoustic amenity of indoor areas is protected, in particular during the critical night periods.

At-property treatment may comprise:

- Property boundary fencing or other external screen walls
- Fresh air ventilation systems that allow existing windows and doors to remain closed
- Sealing of wall vents
- Upgrading window and door seals, and/or
- Upgraded windows and glazing and solid core doors on the exposed facades of masonry structures only. Upgrading of windows and doors typically provides negligible acoustic benefit for light-weight framed structures.

Table 7-7 summarises the noise mitigation options to achieve the operational noise goals. The recommendations are based on the information available and the noise level reductions assumed for each treatment option are based on conservative estimates. At-property treatments are likely to be either Option A, B, C or D.

Table 7-7: At-property noise mitigation options

Noise mitigation option	Noise reduction to achieve external criteria	At-property noise mitigation treatment description
NR	0	At property treatment not required
A	1 to 5 dB(A)	Property boundary fencing or other external screen walls; and/ or Install fresh air mechanical ventilation to affected rooms, such as - • Fresh air mechanical ventilation, for example where air-conditioning exists at the property or preferred by property owner; or • Air-conditioning with separate fresh air mechanical ventilation. The above is dependent on advice from air-conditioning / mechanical ventilation contractor for rooms requiring windows/doors to be closed for noise mitigation. See Note 1 & 2
B	6 to 10 dB(A)	In addition to the above: Replace existing weather seals with acoustic seals on windows and doors (eg Q-Lon seals from Schlegel)
C	11 to 15 dB(A)	In addition to the above: Replace existing glazing with thicker laminated glazing. (See Note 3)
D	Greater than 15 dB(A)	Treatments A + B + install secondary window, fitted with acoustic seals, to inner side of existing windows (see Note 3)

Notes
1. If internal noise goals can only be achieved with windows closed, then mechanical ventilation should be considered to ensure fresh airflow inside the dwelling so to meet the requirements of the Building Code of Australia.
2. It is important to ensure that mechanical ventilation does not provide a new noise leakage path into the dwelling and does not create a noise nuisance to neighbouring residential premises.
3. These upgrades are only suitable for masonry type buildings. It is unlikely that this degree of upgrade would provide noticeable benefits to light framed structures with no acoustic insulation in the walls.

Given that the above details are unique for each dwelling, the level of at-property treatment for affected receivers would be subject to review following detailed site inspections of individual properties to confirm floorplans and the current state of the dwellings prior to implementation of any treatments, such as existing noise treatments, or constraints on the implementation of property treatment.

Noise modelling has revealed that for the current design and operational assumptions, the project achieves compliance with the project noise objectives set out in Section 4.1 for all locations with the exception the number of properties presented in Table 7-8, under worst case train operating condition.

Table 7-8: Summary of number of properties with residual exceedances under various operating conditions

Operating condition for standing and arriving trains	Maximum
Number of properties with residual exceedances	**68**

Table 7-9 identifies all dwellings for consideration of at-property treatment under the conservative worst-case train operating condition scenario. These properties are also presented on a map in APPENDIX E. The properties to be considered for at-property treatment will be further reviewed if further mitigation or management measures for key noise sources are adopted.

Table 7-9: Consideration for at-property noise mitigation treatment

NCA	Receiver No.	Address	Noise reduction required, dB(A)	Potential noise mitigation option
NCA2	R12	19 Ourimbah Road, Kangy Angy	13	Option C
NCA2	R13	50 Orchard Road, Kangy Angy	9	Option B
NCA2	R14	54 Orchard Road, Kangy Angy	8	Option B
NCA2	R15	62 Orchard Road, Kangy Angy	8	Option B
NCA2	R16	72 Orchard Road, Kangy Angy	7	Option B
NCA2	R17	80 Orchard Road, Kangy Angy	7	Option B
NCA2	R18	92 Orchard Road, Kangy Angy	3	Option A
NCA2	R19	106 Orchard Road, Kangy Angy	2	Option A
NCA2	R20	84 Orchard Road, Kangy Angy	4	Option A
NCA2	R21	15 Schubolt Road, Kangy Angy	10	Option B
NCA2	R22	16 Schubolt Road, Kangy Angy	9	Option B
NCA2	R23	26 Turpentine Road, Kangy Angy	15	Option C
NCA2	R24	16 Turpentine Road, Kangy Angy	13	Option C
NCA2	R25	56 Bridge Street, Ourimbah	10	Option B
NCA2	R26	2 Orchard Road, Kangy Angy	4	Option A
NCA2	R27	8 Orchard Road, Kangy Angy	2	Option A
NCA2	R31	12 Ourimbah Road, Kangy Angy	10	Option B
NCA2	R32	52 Howes Road, Ourimbah	2	Option A
NCA3	R33	137 Enterprise Drive, Ourimbah	6	Option B
NCA3	R34	170 Old Chittaway Road, Fountaindale	18	Option D
NCA3	R35	150 Old Chittaway Road	17	Option D
NCA3	R36	130 Old Chittaway Road, Fountaindale	15	Option C
NCA3	R37	141 Old Chittaway Road, Fountaindale	12	Option C
NCA3	R38	127 Old Chittaway Road, Fountaindale	12	Option C

NCA	Receiver No.	Address	Noise reduction required, dB(A)	Potential noise mitigation option
NCA3	R39	121 Old Chittaway Road, Fountaindale	9	Option B
NCA3	R40	107 Old Chittaway Road, Fountaindale	9	Option B
NCA3	R41	103 Old Chittaway Road, Fountaindale	9	Option B
NCA3	R43	86 Old Chittaway Road, Fountaindale	9	Option B
NCA3	R44	149 Old Chittaway Road, Fountaindale	14	Option C
NCA3	R45	165 Old Chittaway Road, Fountaindale	14	Option C
NCA3	R46	3 Station Road East, Fountaindale	11	Option C
NCA3	R47	11 Station Road East, Fountaindale	12	Option C
NCA3	R48	16 Station Road East, Fountaindale	13	Option C
NCA3	R49	7 Station Road East, Fountaindale	9	Option B
NCA3	R50	23 Station Road East, Fountaindale	7	Option B
NCA3	R51	27 Station Road East, Fountaindale	6	Option B
NCA3	R52	35 Station Road East, Fountaindale	5	Option A
NCA3	R57	157 Old Chittaway Road, Fountaindale	12	Option C
NCA3	R58	161 Old Chittaway Road, Fountaindale	10	Option B
NCA3	R59	89 Old Chittaway Road, Fountaindale	7	Option B
NCA3	R60	105 Old Chittaway Road, Fountaindale	6	Option B
NCA3	R61	125 Old Chittaway Road, Fountaindale	1	Option A
NCA3	R70	96 Old Chittaway Road, Fountaindale	12	Option C
NCA3	R71	11 Fountain Road, Fountaindale	14	Option C
NCA3	R72	21 Fountain Road, Fountaindale	12	Option C
NCA3	R73	14 Old Chittaway Road, Fountaindale	10	Option B
NCA3	R74	16 Old Chittaway Road, Fountaindale	9	Option B
NCA3	R75	78 Old Chittaway Road, Fountaindale	10	Option B
NCA3	R76	64 Old Chittaway Road, Fountaindale	6	Option B
NCA3	R77	60 Old Chittaway Road, Fountaindale	6	Option B
NCA3	R78	58 Old Chittaway Road, Fountaindale	5	Option A
NCA3	R79	46 Old Chittaway Road, Fountaindale	4	Option A
NCA3	R80	32 Old Chittaway Road, Fountaindale	3	Option A
NCA3	R81	26 Old Chittaway Road, Fountaindale	4	Option A
NCA3	R111	7 Old Chittaway Road, Fountaindale	2	Option A
NCA2	R118	53 Orchard Rd, Kangy Angy (Acquired)	11	Option C
NCA3	R120	75 Old Chittaway Road, Fountaindale	6	Option B
NCA3	R121	73 Old Chittaway Road, Fountaindale	4	Option A
NCA3	R122	65 Old Chittaway Road, Fountaindale	5	Option A
NCA3	R123	57 Old Chittaway Road, Fountaindale	3	Option A
NCA3	R124	53 Old Chittaway Road, Fountaindale	2	Option A
NCA3	R125	49 Old Chittaway Road, Fountaindale	2	Option A
NCA3	R126	47 Old Chittaway Road, Fountaindale	1	Option A

NCA	Receiver No.	Address	Noise reduction required, dB(A)	Potential noise mitigation option
NCA3	R128	41 Old Chittaway Road, Fountaindale	2	Option A
NCA3	R129	39 Old Chittaway Road, Fountaindale	1	Option A
NCA3	R130	37 Old Chittaway Road, Fountaindale	2	Option A
NCA2	R137	64 Turpentine Road, Kangy Angy	10	Option B
NCA3	R146	83 Old Chittaway Road, Fountaindale	8	Option B

Notes 1. This receiver has been acquired by TfNSW

It is reiterated that for the purpose of this assessment, selected treatment options indicated in Table 7-9 for each affected property are based on general information available and on conservative estimates of noise level reductions that can be expected for each treatment option.

7.3.1 Operational noise management

As the site has residual exceedances of the project noise goals following the implementation of feasible and reasonable mitigation measures, it is important the site can review and incorporate opportunities to reduce noise emissions over the facility's life time.

As part of the site Operational Environmental Management Plan, not only should reviewing the site noise emissions against the site noise levels and the predicted levels in this ONVR be incorporated, there should also be regular reviews of on-site noise mitigation and management practices to incorporate and capture opportunities for reductions of site noise emissions with considerations of at minimum the following:

- Review of noise reduction opportunities during changes or refinements of site noise generating activities
- Reviewing noise levels of plant, equipment and activities, during both ongoing compliance checks and in response to complaints
- Improvements in Best Management Practice (BMP), as defined in the INP
- Improvements in Best Available Technology Economically Achievable (BATEA), as defined in the INP

7.4 Future operations

The design has provided for spatial allowance should future stabling be proposed at the facility (Works Brief 3.19), however future noise mitigation measures have not been allowed for as this does not form part of the project's scope.

With future train stabling proposed to take place between Road 7 and the Main North Line (BOR 4.2.4), it is likely that noise impacts will increase at nearby receivers, especially to the south-east of the site.

Any future operations such as stabling activities would be subject to a future planning approval, and noise mitigation and management measures are to be reviewed at this stage.

Any future noise mitigation and management measures should take into consideration the final noise levels from the site, and approach noise mitigation and management measures considering the limitations outlined in this assessment.

7.5 Road traffic noise (external to facility)

As outlined in Section 4.3, off-site road traffic noise is against the requirements of the NSW Road Noise Policy (RNP). The new access road to Orchard Road off Enterprise Drive, and the modification works on Enterprise Drive which falls within the project works are public roads. As such, these have been assessed against the requirements of the NSW Road Noise Policy (RNP) as per the REF NVIA.

For the assessment it has been assumed that -

- Along Enterprise Drive, the design speed is 80 km/h, with the introduction of a roundabout, and zones which slow down the traffic either side of the round-about.
- The bridge speed advisor sign will indicate 45km/h, however, as a conservative assessment it has been assumed that vehicle could travel at 60km/h over the new bridge and access road.
- Existing traffic counts along Enterprise Drive have been based upon the REF NVIA
- The project will generate traffic numbers as per Table 6-21 in Section 6.9
- For a conservative assessment, it has been assumed that project traffic could all travel along Enterprise Drive from either the north or south.

The United States Federal Highways Administration's (US FHWA) road traffic noise prediction model was used to predict traffic noise at the facade of the nearest affected residences. Like other prediction models, the FHWA method arrives at a predicted noise level through a series of adjustments to a reference sound level. The source sound levels used in this project to model traffic noise levels are contained within the calculation algorithms of the US FHWA noise model. Furthermore, the model was verified and calibrated using the long-term noise monitoring results obtained for this project.

This model is commonly used for traffic noise predictions, especially in areas where other models are not suited due to intermittent or non-free flowing traffic conditions, such as along the new bridge and Enterprise Drive.

The noise prediction model takes into account:

- traffic volume and heavy vehicle forecasts
- vehicle speed

- location of the noise sources on the roads
- the differing source heights of cars and trucks
- relative levels and angles of view of the road from the receiver's position

Predicted road traffic noise levels generated by NIF MF traffic added to the existing and new roads at the residential facade at the key receivers on Enterprise Drive and Orchard Road are presented in Table 7-10.

Table 7-10: Predicted road traffic noise levels

	Receiver	Criteria $L_{Aeq\ 1\ hour}$, dB(A)	Predicted existing noise level $L_{Aeq\ 1\ hour}$, dB(A)	Predicted future noise level $L_{Aeq\ 1\ hour}$, dB(A)	Relative increase, dB(A)
	Daytime				
R15	62 Orchard Road	55 & >2dB(A) increase	44	45	0.6
R16	72 Orchard Road		44	45	0.8
R17	80 Orchard Road		45	46	1.4
R18	92 Orchard Road		46	46	0.5
R19	106 Orchard Road		47	48	0.8
R20	84 Orchard Road		42	44	1.2
R34	170 Old Chittaway Road		66	66	0.3
R82	139 Orchard Road		53	54	0.5
	Night				
R15	62 Orchard Road	50 & >2dB(A) increase	37	38	1.2
R16	72 Orchard Road		37	38	1.4
R17	80 Orchard Road		38	40	2.0
R18	92 Orchard Road		38	40	1.6
R19	106 Orchard Road		40	42	1.5
R20	84 Orchard Road		35	37	1.7
R34	170 Old Chittaway Road		59	60	0.8
R82	139 Orchard Road		46	47	1.1

Receiver R34 is predicted to have high road traffic noise levels. This property is identified for at-property treatment for operational noise reasons, which will also assist in mitigating road traffic noise impacts.

As such, the predicted road traffic impacts from the additional traffic generated by the project are not expected to exceed the RNP objectives set out in Section 4.3 at sensitive receivers nearby to the project.

8 Conclusion

This Operational Noise & Vibration Review report presents the noise and vibration assessment for emissions across the NIF MF project, and how the project is addressing the requirements outlined in the Conditions of Approval and the measures described in the Combined Submissions Report.

All feasible and reasonable measures have been adopted and incorporated into the design to minimise noise and vibration impacts on nearby sensitive receivers and achieve requirements outlined in the Conditions of Approval and the measures described in the Combined Submissions Report. The main mitigation and management measures which will be incorporated are:

- 390m long 6m high noise barrier along the north/north-west side of standing yard
- Building envelope and openings mitigation and management along with internal noise source control implemented in the Maintenance Building, Train Wash building, Wheel Lathe building, Traction Substation and ancillary buildings.
- Reverberation control incorporated into the building designs to minimise noise emissions for the Maintenance Building, Train Wash building and Wheel Lathe building.
- Noise source limitations and restrictions to be implemented into the train movement warning systems, PA speaker systems throughout the facility in addition to the bio-wash and graffiti removal operations.

At source and between noise source and receiver mitigation and management measures have not removed all residual noise impacts, and as such, at-property treatments have been recommended in order to achieve the project's requirements at 68 residential properties.

Further reviews following consultation with community and TfNSW will review and update all feasible and reasonable mitigation or management measures that can be incorporated into the project to reduce residual noise impacts.

References

1. Exhibit B – Works Brief (New Intercity Fleet Maintenance Facility), Contract Number: ISD-15-4811, Revision 314 dated 19 December 2016, ref. 5510859_14, Transport for NSW
2. Business Operational Requirements (BOR), Version 3.0, dated 8 October 2015, ref. 4608829_3, Transport for NSW
3. New Intercity Fleet Maintenance Facility Concept of Operations, Version 1.2 dated April 2016, ref. 4889032, Transport for NSW
4. NIFMF, Review of Environmental Factor Mitigation Measures, Contract Mitigation Measures (TfNSW).
5. Conditions of Approval, New Intercity Fleet Maintenance Facility Project – Determination Report, dated August 2017, ref. 5339920, Transport for NSW
6. Combined Submissions Report, New Intercity Fleet Maintenance Facility Project, 24 August 2017, NIF MFP Combined Submissions Report, Transport for NSW
7. Australian/New Zealand Standard AS/NZS 2107 Acoustics – Recommended design sound levels and reverberation times for building interiors (Standards Australia, 2016)
8. Australian Standard AS2822 - 1985 Acoustics - Methods of assessing and predicting speech privacy and speech intelligibility, (Standards Australia, 1985)
9. Australian/New Zealand Standard AS/NZS 1668.1:2015 "The use of ventilation and air conditioning in buildings, Part 1: Fire and smoke control in buildings" (Standards Australia, 2015)
10. Hyundai Rotem. New Intercity Fleet 'Noise Prediction Report', Doc. No. REDE20753, dated 2 January 2019, Revision 5

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Absorption Coefficient α	The absorption coefficient of a material, usually measured for each octave or third-octave band and ranging between zero and one. For example, a value of 0.85 for an octave band means that 85% of the sound energy within that octave band is absorbed on coming into contact with the material. Conversely, a low value below about 0.1 means the material is acoustically reflective.
Adverse weather	Weather effects that enhance noise (particularly wind and temperature inversions) occurring at a site for a significant period of time. In the NSW INP this occurs when wind occurs for more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of nights in winter.
Air-borne noise	Noise which is fundamentally transmitted by way of the air and can be attenuated by the use of barriers and walls placed physically between the noise source and receiver.
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Amenity	A desirable or useful feature or facility of a building or place.
AS	Australian Standard
Assessment period	The time period in which an assessment is made. e.g. Day 7am-10pm & Night 10pm-7am.
Assessment Point	A location at which a noise or vibration measurement is taken or estimated.
Attenuation	The reduction in the level of sound or vibration.
Audible Range	The limits of frequency which are audible or heard as sound. The normal hearing in young adults detects ranges from 20 Hz to 20 kHz, although some people can detect sound with frequencies outside these limits.
A-weighting	A filter applied to the sound recording made by a microphone to approximate the response of the human ear.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the LA90 noise level if measured as an overall level or an L90 noise level when measured in octave or third-octave bands.
Barrier (Noise)	A natural or constructed physical barrier which impedes the propagation of sound and includes fences, walls, earth mounds or berms and buildings.
Berm	Earth or overburden mound.
Buffer	An area of land between a source and a noise-sensitive receiver and may be an open space or a noise-tolerant land use.
Bund	A bund is an embankment or wall of brick, stone, concrete or other impervious material, which may form part or all of the perimeter of a compound.
BS	British Standard

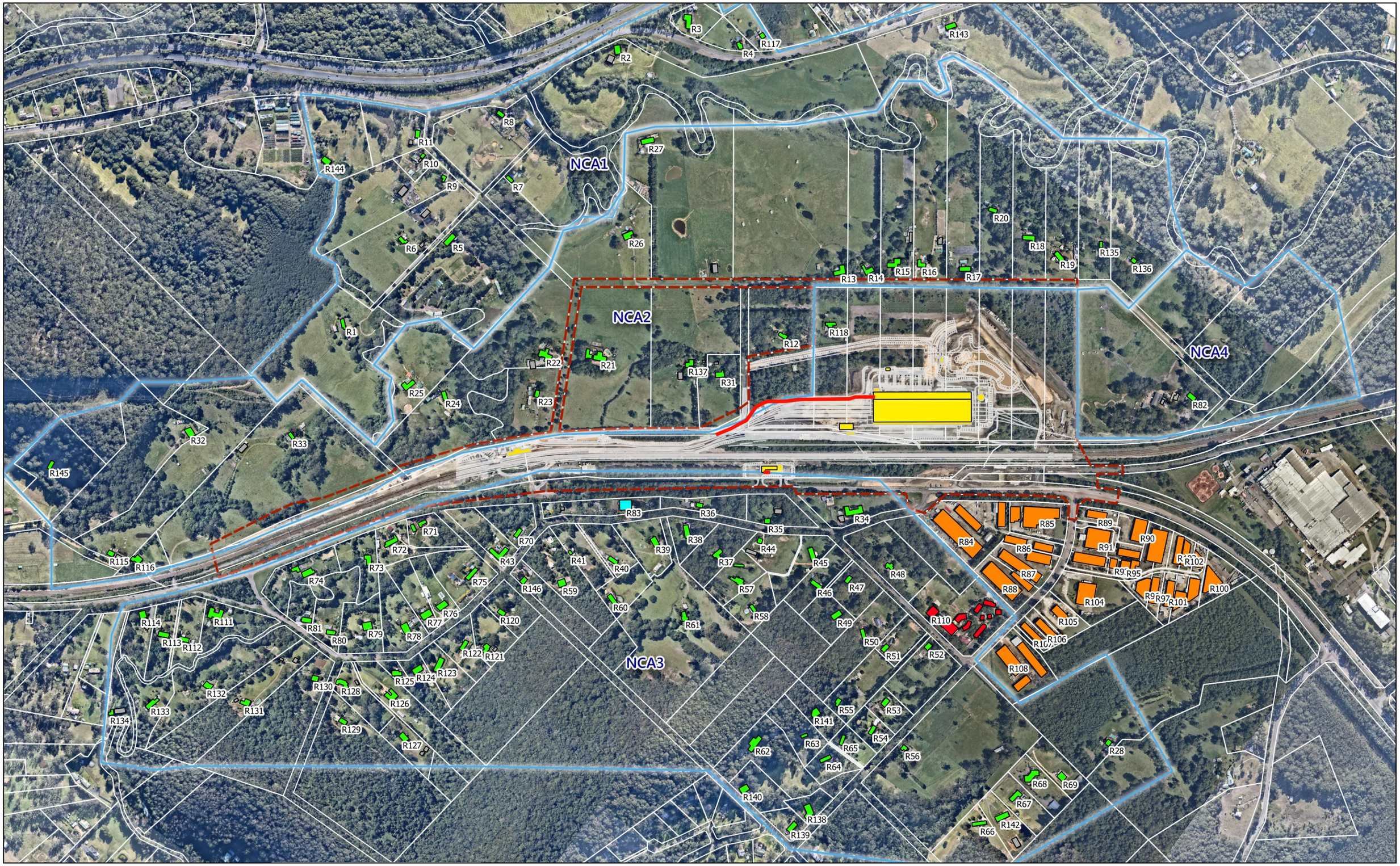
Decibel [dB]	The units of sound measurement. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear, defined as 20 micro Pascal 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 110dB Operating a chainsaw or jackhammer 120dB Deafening
dB(A)	A-weighted decibel. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies. The dB(C) level is not widely used but has some applications.
Diffraction	The distortion of sound waves caused when passing tangentially around solid objects.
DIN	German Standard
ECRTN	Environmental Criteria for Road Traffic Noise, NSW, 1999
EPA	Environment Protection Authority
Field Test	A test of the sound insulation performance in-situ. See also 'Laboratory Test' The sound insulation performance between building spaces can be measured by conducting a field test, for example, early during the construction stage or on completion. A field test is conducted in a non-ideal acoustic environment. It is generally not possible to measure the performance of an individual building element accurately as the results can be affected by numerous field conditions.
Fluctuating Noise	Noise that varies continuously to an appreciable extent over the period of observation.
Free-field	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Ground-borne noise	Vibration propagated through the ground and then radiated as noise by vibrating building elements such as wall and floor surfaces. This noise is more noticeable in rooms that are well insulated from other airborne noise. An example would be vibration transmitted from an underground rail line radiating as sound in a bedroom of a building located above.
Habitable Area	Includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room, home theatre and sunroom. Excludes a bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, photographic darkroom, clothes drying room, and other spaces of a specialised nature occupied neither frequently nor for extended periods.
Heavy Vehicle	A truck, transporter or other vehicle with a gross weight above a specified level (for example: over 8 tonnes).
IGANRIP	Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects, NSW DEC 2007

Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
INP	NSW Industrial Noise Policy, EPA 1999
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
Intrusive noise	Refers to noise that intrudes above the background level by more than 5 dB(A).
ISEPP	State Environmental Planning Policy (Infrastructure), NSW, 2007
ISEPP Guideline	Development Near Rail Corridors and Busy Roads - Interim Guideline, NSW Department of Planning, December 2008
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L10(1hr)	The L10 level measured over a 1 hour period.
L10(18hr)	The arithmetic average of the L10(1hr) levels for the 18 hour period between 6am and 12 midnight on a normal working day.
L90	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq or Leq	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time, which would produce the same energy as a fluctuating sound level. When A-weighted, this is written as the LAeq.
LAeq(1hr)	The LAeq noise level for a one-hour period. In the context of the NSW EPA's Road Noise Policy it represents the highest tenth percentile hourly A-weighted Leq during the period 7am to 10pm, or 10pm to 7am (whichever is relevant).
LAeq(8hr)	The LAeq noise level for the period 10pm to 6am.
LAeq(9hr)	The LAeq noise level for the period 10pm to 7am.
LAeq(15hr)	The LAeq noise level for the period 7am to 10pm.
LAeq (24hr)	The LAeq noise level during a 24 hour period, usually from midnight to midnight.
Lmax	The maximum sound pressure level measured over a given period. When A-weighted, this is usually written as the LAmax.
Lmin	The minimum sound pressure level measured over a given period. When A-weighted, this is usually written as the LAmin.
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on. That is, the sound of 85 dB is four times or 400% the loudness of a sound of 65 dB.
Microphone	An electro-acoustic transducer which receives an acoustic signal and delivers a corresponding electric signal.
NCA	Noise Catchment Area. An area of study within which the noise environment is substantially constant.
Noise	Unwanted sound
Pre-construction	Work in respect of the proposed project that includes design, survey, acquisitions, fencing, investigative drilling or excavation, building/road dilapidation surveys, minor clearing (except where threatened species, populations or ecological communities would be affected), establishing ancillary facilities such as site compounds, or other relevant activities determined to have minimal environmental impact (e.g. minor access roads).
Reflection	Sound wave reflected from a solid object obscuring its path.
RING	Rail Infrastructure Noise Guideline, NSW, May 2013

RMS	Root Mean Square value representing the average value of a signal.
Rw	Weighted Sound Reduction Index A measure of the sound insulation performance of a building element. It is measured in very controlled conditions in a laboratory. The term supersedes the value STC which was used in older versions of the Building Code of Australa. Rw is measured and calculated using the procedure in ISO 717-1. The related field measurement is the DnT,w. The higher the value the better the acoustic performance of the building element.
R'w	Weighted Apparent Sound Reduction Index. As for Rw but measured in-situ and therefore subject to the inherent accuracies involved in such a measurement. The higher the value the better the acoustic performance of the building element.
RNP	Road Noise Policy, NSW, March 2011
Sabine	A measure of the total acoustic absorption provided by a material. It is the product of the Absorption Coefficient (alpha) and the surface area of the material (m2). For example, a material with alpha = 0.65 and a surface area of 8.2m2 would have 0.65 x 8.2 = 5.33 Sabine. Sabine is usually calculated for each individual octave band (or third-octave).
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy by conversion to thermal energy.
Sound Insulation	Sound insulation refers to the ability of a construction or building element to limit noise transmission through the building element. The sound insulation of a material can be described by the Rw and the sound insulation between two rooms can be described by the DnT,w.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 pico watt.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone referenced to 20 mico Pascal.
Spoil	Soil or materials arising from excavation activities.
STC	Sound Transmission Class A measure of the sound insulation performance of a building element. It is measured in controlled conditions in a laboratory. The term has been superseded by Rw.
Structure-borne Noise	Audible noise generated by vibration induced in the ground and/or a structure. Vibration can be generated by impact or by solid contact with a vibrating machine. Structure-borne noise cannot be attenuated by barriers or walls but requires the isolation of the vibration source itself. This can be achieved using a resilient element placed between the vibration source and its support such as rubber, neoprene or springs or by physical separation (using an air gap for example). Examples of structure-borne noise include the noise of trains in underground tunnels heard to a listener above the ground, the sound of footsteps on the floor above a listener and the sound of a lift car passing in a shaft. See also 'Impact Noise'.
Tonal Noise	Sound containing a prominent frequency and characterised by a definite pitch.

Transmission Loss	The sound level difference between one room or area and another, usually of sound transmitted through an intervening partition or wall. Also the vibration level difference between one point and another. For example, if the sound level on one side of a wall is 100dB and 65dB on the other side, it is said that the transmission loss of the wall is 35dB. If the transmission loss is normalised or standardised, it then becomes the Rw or R'w or DnT,w.

APPENDIX B Noise Catchment Areas and Receiver Locations



Receiver building type

- Residential
- Commercial
- Childcare
- Non-receiver
- Education

50 0 50 100 150 200 m

Client:
John Holland Pty Ltd

Project:
New Intercity Fleet
Maintenance Facility D&C

Description:
Noise assessment receivers and Noise Catchment Areas (NCAs)

RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

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Date: 09.08.2019
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APPENDIX C Noise and vibration design inputs and requirements, management measures, architecural acoustic elements and noise sources

Table C1: Operations

				Reasonable worst case 15-minute period				
				Day	Evening	Night	Night	Night (Early morning)
Operation/activity modelled	**Area**	**Operation**	**Details / Source location2**	**7am 6pm**	**6pm-10pm**	**10pm-2am**	**2am to 4am**	**4am to 7am**
Arrival via Train Wash	Access road	Train arriving	• Arrive between 1900 - 0200, could be 2x LNIF + 1 SNIF in this time period (CoOps 7.1.3) • Assumed 2 LNIF (10 car, 205m train) movements could take place in 15 minute period • HVAC + systems operating could be at **WORST CASE** condition throughout the arrival period • Trains could apply service brakes along the route • Train compressors (4 compressors for LNIF) could operate at any time during arrival • Trains leave the Main North Line at 70km/h then slow to stationary prior to Train Wash Road • Main North Line (MNL) to Train Wash - Train travelling from 70km/h exit speed at MNL to stationary at Train Wash Road • Train could be stationary with systems running (**HVAC+systems=WORST CASE**) at the Train Wash entrance for up to **5 minutes** • Train does not vent/exhaust the brake cylinder pressure when stopped at train wash. • All trains could travel through train wash • Trains travelling through the train wash, move at up to 3.5km/h, and will complete either quick wash without pauses or a complete with pauses to wash the front/rear of each train (eg. 3 pauses for LNIF). • Train wash location to Yard - Train travelling at slow speed (average 8km/h)	2 trains	2 trains	2 trains	0	0
Arrival via Train Wash	Train Wash	Train wash plant	• In use day, evening or night 7 days/ week • NIF or Oscar can be washed (BOR 4.51.2 (j)) • Train moves at 3.5km/h through train wash plant (Works Brief 4.51.2) • Train arrivals could take place up until 2:00am, 7 days/ week. Night operations possible. (CoOps 7.1.3.2)	2 trains	2 trains	2 trains	-	-
Standing train	Standing Yard	Train arrival noise sources	• Train will vent/exhaust the brake cylinder pressure once train is stopped in the standing yard (or within the maintainance shed) when train key removed. All brake cylinders will vent simultaneously (4 compressors for LNIF). • 4 trains (LNIF) can be standing with HVAC+systems (**WORST CASE**) operational at full load in a 15 minute period in the yard. • Trains could be standing at any of 9 locations, including Roads 1 to 4, Wheel Lathe Road, or up to two trains in Roads 6 or 7 in either the southern or northern locations. • 4 compressors operational for LNIF • Each compressor can vent/exhaust the brake cylinder pressure (4 compressors for LNIF) • Compressor/Brake venting noise source located on bottom of train (0.5m above track), behind front/rear cab. • No blow-off silencers fitted (noise source levels similar to current Sydney Train fleet, 4th generation trains) • Up to 2 trains could vent/exhaust the brake cylinder pressure in 15-minutes. • For modelling purposes, assumed that for worst case for LAeq 15minute period trains would enter and stop at Road 4 and Road 6(S) • Train could stand in yard with HVAC + systems operating could be at WORST CASE condition for 15-minutes upon arrival	2 trains	2 trains	2 trains	-	-
Departure	Access road	Train departing	• Departure between 0400 - 0700, could be 2x LNIF + 1 SNIF in this time period (CoOps) • Assumed 2 LNIF (10 car, 205m train) movements could take place in 15 minute period • HVAC + systems operating could be at WORST CASE condition • Yard to Signal Point - Train travelling at slow speed (average 8km/h) • Train does not vent/exhaust the brake cylinder pressure when stopped at the first signal point prior to the train wash, or at any point along the access road. • Train could be stationary with systems on (HVAC=Worst Case) at the first signal point prior to the Train Wash location on depature for 5 minutes • Trains could apply service brakes along the route • Train compressor (4 compressors for LNIF) could operate at any time during departure	2 trains	2 trains	-	-	2 trains
Standing train	Standing Yard	Train preparation OR Train arrival and standing (internal cleaning)	• 4 Trains (LNIF) could be located operational on standing roads in a 15-minute period • Trains could be standing at any of 9 locations, including Roads 1 to 4, Wheel Lathe Road, or up to two trains in Roads 6 or 7 in either the southern or northern locations. • Train preparation activities could commences approx. 1 hour prior to departure. • 3 Trains (LNIF) can be preparing in a 15 minute period • Preparation period is maximum 30 minutes (Section 13.5.2, MainCpts (Rev H)) • Train could remain idle with HVAC+systems (**WORST CASE**) operational at full load for 1 hour. • 2 Long and 1 Short NIF will enter service (0400 - 0700) (NIF CoOps) • Train preparation procedure tests are similar to current fleet levels. Source levels based upon current Sydney Trains 4th generation fleet (A-Set). • Up to 2 trains could be performin train preparation test in a 15-minute period. • HVAC + systems operating could be at WORST CASE condition • Design assumes all aux systems are on at full load. • All compressors assumed operational for full 15-minutes (4 compressors for LNIF) (but could be typically on 5min for first 15min)	3 trains	3 trains	3 trains	-	3 trains
Standing train	Standing Yard	GBWS/DPS/Horn sounding	• Provided for emergency use only. Not used for standard operations. • Depot Protection System and Ground Borne Warning System (GBWS) used to signal train movements. • Up to 2 activations of the GBWS in a 15-minute period {critical during Night (10pm to 7am)}	2	2	2	2	2
External Cleaning/Bio-Wash	Graffiti and Biocleaning (Road 6)	Cleaning activities	• Limit to day period (7am to 6pm) • Undertaken using portable equipment and could occur anywhere around the standing train at the dedicated cleaning area on Road 6. • Worst case noise impact would be when cleaning activities take place at ground level, activities within the pit would be of similar noise level and so would be shielded by pit walls/train. • Train could be standing with HVAC (normal) {as unoccupied} + systems operational at full load in a 15 minute period	1	-	-	-	-
Wheel Lathe	Wheel lathe building/road	Under floor wheel lathe (UFWL) (8 hours per day)	• Could be used up to 8 hours per day, 7 days • Operations would be limited to 7am to 10pm • Train HVAC + systems are not operational during the lathing process, and is moved by an electric train shunter. • Wheel Lathe specification: the noise level emitted from the Wheel Lathe under all working conditions shall not exceed 80 dB(A) when measured at a level of 1.5 m above floor level and at any point 3 m away from the Wheel Lathe • Adjoined water treatment plant could operate during the night period (10pm to 7am)	1	1	1	-	1
Wheel Lathe	Wheel lathe building/road	Locomotive Train Shunter	• Electric Locomotive Train Shunter will not exceed 70dB(A) @ 1m in operation	1	1	1	-	1
Maintenance/Admin Building	Maintenance/Admin Building	Train status	• 4 roads could be occupied • Train standing with HVAC operating • Main train doors & loading dock doors open during the day period (7am to 6pm), otherwise doors closed during all other times except during train entry/egress.	4 trains	4 trains	4 trains	4 trains	4 trains
Maintenance/Admin Building	Maintenance/Admin Building	Maintenance Activities	• Assumed main train doors and loading dock doors remain closed wherever practical for noise management. • Assumed maintenance shed doors can remain open, only if low-internal noise level are achieved at the doors from internal activities. • Level 1/2 or Level 3 (component exchange) activities could take place. • Loud activities such as rattle guns, grinding or train door system testing could take place day, evening or night. This assumes typical locations within the maintenance facility adjacent to trains, and with typical numbers of equipment/activities operating simultaneously. • Shed façade designed so that typical noise levels do not exceed the following values at the facade - 1) LAeq-15minute noise levels do not exceed 75dB(A) 2) LA1-1minute noise levels do not exceed 94dB(A) • Any uncommon operation of a train horn is to be undertaken within the maintenance facility building with all facade doors closed. This applies for day, evening and night periods.	All	All	All	All	All

				Reasonable worst case 15-minute period				
				Day	Evening	Night	Night	Night (Early morning)
Operation/activity modelled	**Area**	**Operation**	**Details / Source location2**	**7am 6pm**	**6pm-10pm**	**10pm-2am**	**2am to 4am**	**4am to 7am**
Maintenance/Admin Building	Maintenance/Admin Building	Train movements	• 1 train movement into/out of shed in 15-minute period {Critical for night period (10pm-7am)} • Train door could be open **for the entire 15-minute assessment period** during the entry of exit movement {Critical for night period (10pm-7am)} • During train entry/egress, assumed that a single door where train is entering/existing is opened. All other doors are assumed closed during typical movement. • Door at both ends of maintenance shed will open during a train entering event. • Main train doors remain closed wherever practical for noise management. • Deport protection system (DPS), within the Maintenance Shed, will operate via speaker system to alert of train movement, using broadband alert noise signal. - Ambient noise sensing to be used to vary speaker noise level. - Noise level from DPS at nearby receivers will be designed so that not more than 15dB(A) above ambient noise level at nearby residential receivers. - DPS is designed to sound for 25 seconds (5-second on/5-second off) while train arriving/ departing shed during one movement. This duration may be required to vary as part of the commissioning refinement process. The DPS will be achieve the noise levels at the maintenance building envelope as specified in Section 6.6.2 which take into account both the instanteous noise level and the duration of the altert tone.	1	1	1	1	1
Maintenance/Admin Building	Maintenance/Admin Building	Mobile plant - Internal - General	Mobile Plant/equipment - Forklifts - To be selected with an operating Sound Power Level (SWL) of no more than 97dB(A) LAeq. - All on-site mobile plant are assumed to be fitted with broadband reverse alarms (quackers)	1	1	1	1	1
Maintenance/Admin Building	Maintenance/Admin Building	Train Lifting Equipment (TLE)	• Train Lift system located on ROAD 1 • Assumed 1 lift could operate throughout a 15 min period • Train Lift System warning alarms will operate as per detailed in Section 6.2.6 of the ONVR • Assumed maintenance building external train doors are closed during during a train lift operation.	1	1	1	1	1
Maintenance/Admin Building	Maintenance/Admin Building	Workshop/General - Lifting	• Cranes (electric) - 3.2 tonne gantry cranes located over each of Road 1 to Road 4. - 12.5 tonne gantry crane located in Bogie Delivery Area. - Flashing light warning only, no alarm siren • Gantry cranes and bogie turntable will operate without an alarm/siren as part of normal operations.	1	1	1	1	1
Maintenance/Admin Building	Maintenance/Admin Building	Mechanical services	All administration and mechanical plant items could be in operation 24/7	All	All	All	All	All
Maintenance/Admin Building	External	Mobile plant - External - General	Mobile Plant/equipment - Mobile plant/equipment could operate throughout the facility day/evening/night. - Restrictions on the area of operation, how equipment operate, and maximum noise levels from equipment are detailed in the ONVR. Specific retrictions are required for both the evening (6pm to 10pm) and night (10pm to 7am) periods.	1	1	Restricted	Restricted	Restricted
Ancillary/Security buildings	1. Sewer Decant Facility Building 2. Rainwater Pump Building 3. Security building	Plant and equipment	All auxiliary plant and equipment items could be in operation 24/7	All	All	All	All	All
Ancillary/Security buildings	-	Emergency plant/equipment	• No on-site back-up diesel generator is required, but access locations are provided, as such they are not a typical noise source. • Emergency fire pump would be located within the dedicated Rain Water Pump building. This would operate only during emergencies. Testing could take place with a frequency no shorter than monthly, and would be tested for short periods during the daytime only (7am - 6pm).	-	-	-	-	-
Car park	Car park	Car park	• Light vehicles arriving or departing car park will operate as per detailed in Section 6.2.7 of the ONVR	20	20	15	15	15
Deliveries + external loading	External to Maintenance Building loading docks	Loading dock truck	Loading dock sources identified below: • One truck (semi-trailer) movements in 15-minute period - External movements between gate and Maintenance building • Truck parks outside loading dock areas. Loading dock doors open. • Unloading via forklift externally, and forklift move in/out of maintenance building	1	-	-	-	-
Deliveries (unloading in shed)	Maintenance Building loading docks	Loading dock truck	Trucks can take place during the evening and night if: **EVENING AND NIGHT (Assumptions/operational management measures)** 1. Security and entry/exit procedures are efficient (eg. assumed maximum 2 min idle time at gate). Trucks move directly into the shed, with no extended idling time outside (eg. maximum 1 min at shed). 2. Coordinate deliveries so that they does not overlap with known change over times. 3. Unloading activities are to not take place outside during evening and night. Unloading activities are to take place within the designated loading docks. 4. Unloading activities would typically take 2-2.5 hours 5. Management measures are to be implemented so that trucks do not to stop between Orchard Road and the Security Gate. 6. Assumes truck does not enter and leave in the same 15-minute period. 7. Loading dock roller door is to remain closed during the evening and night, unless trucks are entering/exiting. 8. Only exceptions to Item 7 may be where the truck cannot fit within the loading dock. For deliveries where the truck will not fit within the loading dock, these are to be scheduled to occur during the day period where feasible and reasonable. If required to take place at night, the truck is to be turned off during the unloading operations, and unloading activities should incorporate management measures to minimise metal-on-metal bangs (ie. chain drops, etc.). **EVENING AND NIGHT Delivery limitations -** **EVENING (6pm-10pm)** - Limited to 2 trucks per evening period. Maximum 2 truck movements (ie. one truck in and out) in 1 hour period. Maximum 1 movement per 15-minute period. **NIGHT (10pm - 7am)** - Limited to 4 trucks per night period. Maximum 2 truck movements (ie. one truck in and out) in 1 hour period. Maximum 1 movement per 15-minute period. .	2	See assumptions	See assumptions	See assumptions	See assumptions
Traction Substation	Traction substation	Transformers	**Traction substation external bays -** Only typical significant noise emission sources are: - Power transformers (3MVA 66kV/11kV) - Rectifier Transformer (5.35MVA 66kV/600/600V Dyn1 ONAN 3 PHASE OIL FILLED TRANSFORMER)	2x transformers	2x transformers	2x transformers	2x transformers	2x transformers

Table C2: Management

Area	Operation	Details / Source location	NOISE REQUIREMENTS
Standing yard	Train standing /preparation/arrival	Train standing/preparation location order of preference for noise purposes	As part of the OEMP, a methodology to influence the locations of trains will stand once they arrive at the facility or are planned to depart during the night period, should be incorporated to consider site noise emissions. This methodology should be based upon the train standing/preparation location order of preference for noise purposes outlined in the ONVR, or other order based supported by noise measurements.
Standing yard	Train standing /preparation/arrival	Train operational state management	Following the commencement of site operations, a review of actual noise levels during typical operations should be undertaken in order to identify key operational noise levels and activities across the sites operations. Further noise mitigation and management measures should be reviewed to determine if any additional feasible and reasonable mitiation and mangement measures should be adopted.For stanidng trains this should would include: 1.Quantify the noise level for the different train operating states of the standing trains 2.Implement a management approach to maximise the use of quieter states during the various times trains are in the standing yard.
Access track	Train movements along access track	Potential wheel-rail interface noise such as flanging or wheel squeal	To reduce potential increases in noise due to the wheel-rail interface such as flanging or wheel squeal, consideration will be given to the installation of rail lubrication systems (where required) as part of the development of the wheel-rail maintenance strategy.
Maintenance Building	Deliveries	Deliveries to the loading docks on the NW side of the Maintenance Building	Trucks can take place during the evening and night if: EVENING AND NIGHT (Assumptions/operational management measures) 1. Security and entry/exit procedures are efficient (eg. assumed maximum 2 min idle time at gate). Trucks move directly into the shed, with no extended idling time outside (eg. maximum 1 min at shed). 2. Coordinate deliveries so that they does not overlap with known change over times. 3. Unloading activities are to not take place outside during evening and night. Unloading activities are to take place within the designated loading docks. 4. Unloading activities would typically take 2-2.5 hours 5. Management measures are to be implemented so that trucks do not to stop between Orchard Road and the Security Gate. 6. Assumes truck does not enter and leave in the same 15-minute period. 7. Loading dock roller door is to remain closed during the evening and night, unless trucks are entering/exiting. 8. Only exceptions to Item 7 may be where the truck cannot fit within the loading dock. For deliveries where the truck will not fit within the loading dock, these are to be scheduled to occur during the day period where feasible and reasonable. If required to take place at night, the truck is to be turned off during the unloading operations, and unloading activities should incorporate management measures to minimise metal-on-metal bangs (ie. chain drops, etc.). EVENING AND NIGHT Delivery limitations - EVENING (6pm-10pm) - Limited to 2 trucks per evening period. Maximum 2 truck movements (ie. one truck in and out) in 1 hour period. Maximum 1 movement per 15-minute period. NIGHT (10pm - 7am) - Limited to 4 trucks per night period. Maximum 2 truck movements (ie. one truck in and out) in 1 hour period. Maximum 1 movement per 15-minute period. .
Maintenance Building	Forklift and mobile plant	Forklift/mobile plant are to be fitted with non-tonal broadband reverse alarms (quackers)	Forklift/mobile plant are to be fitted with non-tonal broadband reverse alarms (quackers)
Maintenance Building	Forklift and mobile plant	Forklift/mobile plant operating restrictions	Forklift/mobile plant are operate in the areas designated in the ONVR (Section 6.8) during the night period and associated detailed management measures.
Maintenance Building	Maintenance facility building doors	Noise emission to neighbours from open maintenance building doors, LAeq noise levels and LA1 noise events.	All doors of the maintenance facility building are to be closed when there are trains inside and/or any noise generating maintenance activities are taking place during the evening (6pm to 10pm) and night (10pm to 7am) periods. If doors are require to be opened for ventilation reasons, noise management measures are to be developed and implemented in line with in Section 6.8.2 of the ONVR to achieve noise emission requirements.
Maintenance Building	Maintenance activity noise management	Management of maintenance activity noise levels when the maintenance buidling train doors are required to be opened.	As the train doors may need to occasionally be opened for ventilation reasons, management measures will need to be developed and incorporated into the operational management plans of the facility to control noise emissions when the doors are open. These would include, but not be limited to: - Identification of activities restricted from taking place (generally or in specific locations) while the doors are open. - Procedures for how significant noise generating activities that could take place when the doors are open can be identified and appropriate management or mitigation measures developed. - Procedures for verifying that noise emissions from the main building are meeting requirements when the doors are open.
Maintenance Building	Maintenance activity noise management	High occupational/worker noise levels	Noise levels from activities within this space are likely to exceed 80dB(A). The use of these spaces by personnel are to be managed in accordance with the NSW Code of Practice for managing noise and preventing hearing loss at work (April 2016), to achieve the requirements of the WHS Act and the Work Health and Safety Regulations (the WHS Regulations).
Maintenance Building	Brake pipe venting	Noise emission from brake pipe venting within maintenance building to neighbours from open maintenance building doors, LA1 noise events.	Feasible and reasonable mitigation or management measures are to be investigated for this noise source once the actual noise level and its range across the NIF fleet is known in order to minimise sleep disturbance impacts and achieve the LA1,1min requirements during the night period.
Maintenance Building	Train horns	Noise emission from horns within maintenance building to neighbours from open maintenance building doors, LA1 noise events.	Rolling stock horns (town or country) are prohibited from being used within the facility during normal operations, and shall only occur in emergency traffic or pedestrian safety situations. Testing of warning sounds on rolling stock shall only be undertaken wholly within the Maintenance Building, with all external doors closed.
Maintenance Building	Depot protection system	Exceedance of noise emission requirements	DPS is to achieve the noise limits specified in Section 6.6 of the ONVR
Maintenance Building	PA system	Exceedance of noise emission requirements	PA system is to achieve the noise limits specified in Section 6.7 of the ONVR
Maintenance Building	Crane and machine warning sirens	Exceedance of noise emission requirements	Overhead gantry cranes are electric powered and will operate without alarms/sirens. They are unlikely to exceed noise requirements at the nearby residential receivers, with consideration of simultaneous maintenance activities.

Area	Operation	Details / Source location	NOISE REQUIREMENTS
Maintenance Building	Plant Room 202	High occupational/worker noise levels	Internal noise levels within this space are likely to exceed 80dB(A). The use of these spaces by personnel are to be managed in accordance with the NSW Code of Practice for managing noise and preventing hearing loss at work (April 2016), to achieve the requirements of the WHS Act and the Work Health and Safety Regulations (the WHS Regulations).
Maintenance Building	Plant Room 311	High occupational/worker noise levels	Internal noise levels within this space are likely to exceed 80dB(A). The use of these spaces by personnel are to be managed in accordance with the NSW Code of Practice for managing noise and preventing hearing loss at work (April 2016), to achieve the requirements of the WHS Act and the Work Health and Safety Regulations (the WHS Regulations).
Rain water pump house	Fire sprinkler system pump (electric/diesel)	Noise emission during testing. Noting this pump will operate only in emergencies, and will be tested no more frequently than a monthly basis.	It to be tested during the daytime only (7am to 6pm) only. This is on the basis that testing occurs not more frequently that once per month.
Rain water pump house	Fire sprinkler system pump (electric/diesel)	High occupational/worker noise levels	Internal noise levels within this space are likely to exceed 80dB(A). The use of these spaces by personnel are to be managed in accordance with the NSW Code of Practice for managing noise and preventing hearing loss at work (April 2016), to achieve the requirements of the WHS Act and the Work Health and Safety Regulations (the WHS Regulations).
Bio-wash and graffiti removal	Bio-wash and graffiti removal	Bio-wash and graffiti removal in dedicated area in Road 6	Take place only the daytime period (7:00 am to 6:00 pm)
Bio-wash and graffiti removal	Bio-wash and graffiti removal	Bio-wash and graffiti removal in dedicated area in Road 6	Cleaning contractors are to provide equipment that achieve the maximum required sound power level, considering all activities (eg. compressor + noise of water onto the train). Where this is not possible, then noise measurements are to be undertaken to confirm noise impacts from cleaning activities at nearby receivers. Where cleaning activities are identified to exceed or cause an overall exceedance of the noise requirements at nearby residential receivers feasible and reasonable mitigation measures, such as alternative equipment or mitigated equipment along with management of activities in areas with the highest noise impacts are to be adopted.
Yard	Horn sounding (City or Town)	Emergency use only. Not used for standard operations.	Emergency use only. Not used for standard operations.
Yard	PA system	Exceedance of noise emission requirements	PA system is to operate as assumed in Section 6.7, and achieve the maximum noise levels detailed in Section 6.7
Yard	Ground based warning system (GBWS)	Exceedance of noise emission requirements	GBWS is to operate as assumed in Section 6.6, and achieve the maximum noise levels detailed in Section 6.6
Whole of site	Noise management	On-going performance	As the site has residual exceedances of the project noise goals following the implementation of feasible and reasonable mitigation measures, it is important the site reviews and uses opportunities to reduce noise emissions over the facility's life time. As part of the site Operational Environmental Management Plan, not only should reviewing the site noise emissions against the site noise levels and the predicted levels in this ONVR be incorporated, there should also be regular reviews of on-site noise mitigation and management practices to incorporate and capture opportunities for reductions of site noise emissions with considerations of at minimum the following: •Review of noise reduction opportunities during changes or refinements of site noise generating activities •Reviewing noise levels of plant, equipment and activities, during both ongoing compliance checks and in response to complaints •Improvements in Best Management Practice (BMP), as defined in the INP •Improvements in Best Available Technology Economically Achievable (BATEA), as defined in the INP

Table C3: Architectural Mitigation Measures

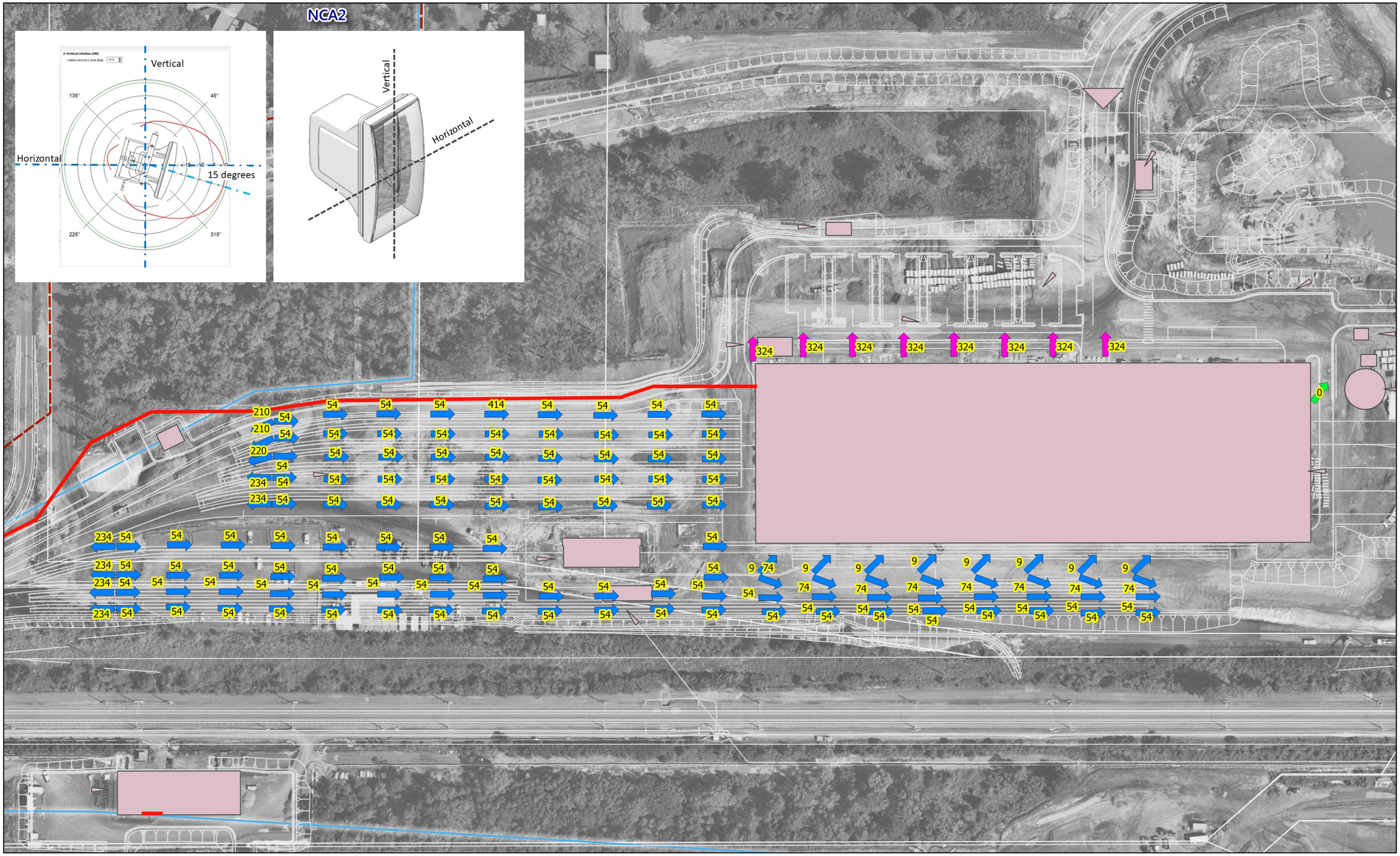
ARCH SPECIFICATION				NV Requirement				Octave band values						
Building	Room ID	Element	Element ID	Description	NRC	Transmission loss	Octave Band Values	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz
Maintenance Building	Maintenance Area	South façade	Main Doors	Jewers Doors (Swift SEW)	-	25	Transmission loss	16	20	24	20	23	38	19
Maintenance Building	Maintenance Area	South façade	Main door overhead wiring opening	5 openings, each maximum 0.25 sqm	-	-	-	-	-	-	-	-	-	-
Maintenance Building	Maintenance Area	South façade	Facade	Kingspan 100mm KS1000AWP	-	26	Transmission loss	14	18	22	24	21	33	45
Maintenance Building	Maintenance Area	East façade	Louvres	Hudson 600 Chevron	-	21	Transmission loss	6	4	9	18	26	25	23
Maintenance Building	Maintenance Area	East façade	Facade	Danpalon 16mm/100mm/16mm	-	Rw 26	Transmission loss	8	12	15	22	32	35	30
Maintenance Building	Maintenance Area	North façade	Facade	Kingspan 100mm KS1000AWP	-	Rw 26	Transmission loss	14	18	22	24	21	33	45
Maintenance Building	Maintenance Area	North façade	Main Doors	Jewers Doors (Swift SEW)	-	Rw 25	Transmission loss	16	20	24	20	23	38	19
Maintenance Building	Maintenance Area	North façade	Main door overhead wiring opening	5 openings, each maximum 0.25 sqm	-	-	-	-	-	-	-	-	-	-
Maintenance Building	Maintenance Area	West façade	Facade	Kingspan 100mm KS1000AWP	-	Rw 26	Transmission loss	14	18	22	24	21	33	45
Maintenance Building	Maintenance Area	West façade	Louvres	Hudson 600 Chevron	-	Rw 21	Transmission loss	6	4	9	18	26	25	23
Maintenance Building	Maintenance Area	West façade	Roller Doors	Braselmann Roller Door 1 roller shutter 1.100 D (1.25 mm steel+65kg/m3 poly)	-	Rw 28	Transmission loss	18	22	26	22	25	40	21
Maintenance Building	Maintenance Area	West façade	Windows	Glazed window unit	-	Rw 26	Transmission loss	8	12	15	22	32	35	30
Maintenance Building	Maintenance Area	Roof	Roof	Kingspan 100mm KS1000RW	-	Rw 26	Transmission loss	15	19	23	23	21	39	47
Maintenance Building	Maintenance Area	Roof	Skylight	Kingspan KS1000DLTR PLUS 0.8	-	Rw 26	Transmission loss	10	12	12	22	32	37	39
Maintenance Building	Maintenance Area	Roof	Roof vent	Airocle 4 Series lined roof ventilator	-	Rw 20	Transmission loss	5	5	7	17	25	27	28
Maintenance Building	Plant Room 202	Walls & ceiling	-	Cover a minimum of 70% of the wall and ceiling area with 50mm 32kg/m3 thick acoustic insulation	0.8	-	-	-	-	-	-	-	-	-
Maintenance Building	Plant Room 311	Walls & ceiling	-	Cover a minimum of 70% of the wall and ceiling area with 50mm 32kg/m3 thick acoustic insulation	0.8	-	-	-	-	-	-	-	-	-
Maintenance Building	Administration area	Caping construction	-	Kingspan 100mm KS1000RW	N/A	Rw 26	Transmission loss	15	19	23	23	21	39	47
Maintenance Building	All Administration spaces (except Lobby (201) and kitchen and meals area (234) and amenities)	Ceilings	-	CAC 40 ceiling tile	0.7	CAC 40	-	-	-	-	-	-	-	-
Maintenance Building	TfNSW meeting rooms 209 & 211	Operable wall	-	Operable wall minimum acoustic rating of Rw 50, with an above ceiling baffle.	0.7	Rw 50	-	-	-	-	-	-	-	-
Maintenance Building	TfNSW meeting rooms 209 & 211	Wall to Corridor		Full height partition required. Area above ceiling to be min 2x16mm fire rated plasterboard each side with 75mm thick 14 kg/m3 glasswool insulation in the wall cavity. The plasterboard above ceiling baffle shall extend from the top of the operable wall to the soffit. Acoustically seal all penetrations.	-	Rw 50	-	-	-	-	-	-	-	-
Maintenance Building	Plant Room 202	Door	-	50mm Solid Core Door fitted with full perimeter acoustic seals		Rw 34								
Maintenance Building	Plant Room 311	Door	-	50mm Solid Core Door fitted with full perimeter acoustic seals		Rw 34								
Maintenance Building	Multiple	Partitions, buidling envelope, services, architectural acoustic treatments and constructions		As per Main Building design report - NIF-RTA-RPT-NA-200001	-	-								
Maintenance Building	Office 1 (216)	Reverberation control	-	Acoustically absorptive panels, minimum NRC 0.7 and 4 sqm, installed on a minimum of one wall.	0.7	-	-	-	-	-	-	-	-	-
Maintenance Building	Office 2 (217)	Reverberation control	-	Acoustically absorptive panels, minimum NRC 0.7 and 4 sqm, installed on a minimum of one wall.	0.7	-	-	-	-	-	-	-	-	-
Maintenance Building	Office 3 (218)	Reverberation control	-	Acoustically absorptive panels, minimum NRC 0.7 and 4 sqm, installed on a minimum of one wall.	0.7	-	-	-	-	-	-	-	-	-
Maintenance Building	TfNSW meeting rooms 209	Reverberation control	-	Acoustically absorptive panels, minimum NRC 0.8 and 7 sqm, installed on walls.	0.8	-	-	-	-	-	-	-	-	-
Maintenance Building	TfNSW meeting rooms 211	Reverberation control	-	Acoustically absorptive panels, minimum NRC 0.8 and 7 sqm, installed on walls.	0.8	-	-	-	-	-	-	-	-	-
Maintenance Building	Conference room (Room 215)	Reverberation control	-	Acoustically absorptive panels, minimum NRC 0.8 and 8 sqm, installed on minimum 2 walls.	0.8	-	-	-	-	-	-	-	-	-
Maintenance Building	Lobby (201) and kitchen and meals area (234)	Reverberation control	-	Minimum 50mm (11 kg/m3 glasswool or polyester) installed behind the timber batten ceiling system.	0.7	-	-	-	-	-	-	-	-	-
Maintenance Building	Maintenance Area	Reverberation control	-	Minimum total installed area of exposed acoustic baffle area of 5000 sqm	0.9	-	Absorption coefficient	-	0.4	0.9	0.9	0.9	0.8	0.8
All	Acoustic Sealing Compounds	General	-	Specific gravity no less than 1.5sg										
All	Minimum plasterboard and fibre-cement sheeting surface masses	General	-	13 mm standard plasterboard - 8.4 kg/m2 13 mm fire-rated plasterboard - 10.4 kg/m2 13 mm impact-rated plasterboard - 10.4 kg/m2 13 mm moisture resistant plasterboard - 9.6 kg/m2 16 mm fire-rated plasterboard - 12.5 kg/m2 6 mm fibre-cement sheeting - 9.7 kg/m2 9 mm fibre-cement sheeting - 14.3 kg/m2										
Train Wash	Main internal space	East Facade	Facade	Kingspan 100mm KS1000AWP	-	Rw 26	Transmission loss	14	18	22	24	21	32	42
Train Wash	Main internal space	East Opening	-	Maximum 35sqm	-	-	Transmission loss	-	-	-	-	-	-	-
Train Wash	Main internal space	North Facade	Facade	Kingspan 100mm KS1000AWP	-	Rw 26	Transmission loss	14	18	22	24	21	32	42
Train Wash	Main internal space	West Facade	Facade	Kingspan 100mm KS1000AWP	-	Rw 26	Transmission loss	14	18	22	24	21	32	42
Train Wash	Main internal space	West Opening	-	Maximum 35sqm	-	-	Transmission loss	-	-	-	-	-	-	-
Train Wash	Main internal space	South Facade	Facade	Danpalon 16mm	-	Rw 21	Transmission loss	10	13	14	18	22	24	22
Train Wash	Main internal space	Roof Roof	Roof	Kingspan 100mm KS1000RW	-	Rw 26	Transmission loss	14	18	22	24	21	32	42
Train Wash	Main internal space	Roof Ventilators (x6)	Roof ventilators	Acoustic Turbo-Base LBA-600	-	Rw 13	Transmission loss	9	5	8	11	14	13	11
Train Wash	Main internal space	Reverberation control		Acoustic absorption installed along both walls and ceiling for the minimum extent of 8 m in length from each end of the train wash building.	0.8	-	Absorption coefficient	-	0.4	0.9	0.9	0.9	0.8	0.8
Train Wash - Pump Room	Pump Room	All Facade	Facade	Kingspan 100mm KS1000AWP	-	Rw 26	Transmission loss	14	18	22	24	21	32	42
Train Wash - Pump Room	Pump Room	West Door	Door	Solid core door	-	Rw 24	Transmission loss	-	-	-	-	-	-	-
Train Wash - Pump Room	Pump Room	West Roller Door	Roller Door	Standard roller door	-	Rw 11	Transmission loss	1	3	6	8	11	12	14
Train Wash - Pump Room	Pump Room	North Louvre (N)	Louvres	Architectural louvre	-	-	Transmission loss	-	-	-	-	-	-	-
Train Wash - Pump Room	Pump Room	South Louvre (S)	Louvres	Architectural louvre	-	-	Transmission loss	-	-	-	-	-	-	-
Train Wash - Pump Room	Pump Room	Roof		Kingspan 100mm KS1000RW	-	Rw 26	Transmission loss	14	18	22	24	21	32	42
Train Wash building	Multiple	Partitions, buidling envelope, services, architectural acoustic treatments and constructions		As per design report - NIF-RTA-RPT-NA-220001										
Wheel Lathe	Main internal space	NE Facade	Facade	Kingspan 100mm KS1000AWP	-	Rw 26	Transmission loss	14	18	22	24	21	33	45
Wheel Lathe	Main internal space	NE Opening	Opening	Maximum 25sqm. Roller Door (assumed open when wheel lathe is in operation)	-	-	Transmission loss	-	-	-	-	-	-	-
Wheel Lathe	Main internal space	NW (Main area) Facade	Facade	Kingspan 100mm KS1000AWP	-	Rw 26	Transmission loss	14	18	22	24	21	33	45
Wheel Lathe	Main internal space	NW (Main area) Roller Door 1	Roller Door 1	Standard roller door	-	Rw 11	Transmission loss	1	3	6	8	11	12	14
Wheel Lathe	Main internal space	NW (Main area) Roller Door 2	Roller Door 2	Standard roller door	-	Rw 11	Transmission loss	1	3	6	8	11	12	14
Wheel Lathe	Main internal space	NW WTP Roller Door 1	WTP Roller Door 1	Acoustic rated roller door	-	Rw 20	Transmission loss	6	12	14	17	21	21	20
Wheel Lathe	Water treatment plantroom	Water Treatment Plant (WTP) WTP Roller Door 2	WTP Roller Door 2	Acoustic rated roller door	-	Rw 20	Transmission loss	6	12	14	17	21	21	20
Wheel Lathe	Water treatment plantroom	Water Treatment Plant (WTP) Facade	Facade	Kingspan 100mm KS1000AWP	-	Rw 26	Transmission loss	14	18	22	24	21	33	45
Wheel Lathe	Water treatment plantroom	Water Treatment Plant (WTP) Opening NE	Opening NE	Maximum 3sqm	-	-	Transmission loss	-	-	-	-	-	-	-
Wheel Lathe	Water treatment plantroom	Water Treatment Plant (WTP) Opening SW	Opening SW	Maximum 3sqm	-	-	Transmission loss	-	-	-	-	-	-	-
Wheel Lathe	Water treatment plantroom	Water Treatment Plant (WTP) Roof	Roof	Kingspan 100mm KS1000RW	-	Rw 26	Transmission loss	15	19	23	23	21	39	47
Wheel Lathe	Main internal space	SW Facade	Facade	Kingspan 100mm KS1000AWP	-	Rw 26	Transmission loss	14	18	22	24	21	33	45
Wheel Lathe	Main internal space	SW Opening	Opening	Maximum 25sqm. Roller Door (assumed open when wheel lathe is in operation)	-	-	Transmission loss	-	-	-	-	-	-	-
Wheel Lathe	Main internal space	SE Facade	Facade	Danpalon 16mm	-	Rw 21	Transmission loss	10	13	14	18	22	24	22
Wheel Lathe	Main internal space	Roof Roof	Roof	Kingspan 100mm KS1000RW	-	Rw 26	Transmission loss	15	19	23	23	21	39	47
Wheel Lathe	Main internal space	Roof Ventilator (x 2)	Ventilator (x 2)	Roof ventilator (1 sqm)	-	-	-	-	-	-	-	-	-	-
Wheel Lathe	Main internal space	Walls and Roof (internal)	Reverberation control	Acoustic absorption installed for a minimum of 40% of the ceiling area and the top of the north-western wall, extending from the roof level downwards approximately 2-3 m, totalling a minimum area of 220 m2. This is to be evenly distributed over these areas and exposed to the internal space. Whisper FR 60mm (3 layers, 20mm) or other product of equivalent acoustic performance	0.8	-	Absorption coefficient	-	0.4	0.9	0.9	0.9	0.8	0.8
Wheel Lathe	Main internal space	Wheel lathe pit	Reverberation control	Acoustic absorption to be installed over a minimum 70% of the exposed walls of the wheel lathe pit. 50mm Pyrotek Reapor (NRC 0.95) or other product of equivalent acoustic performance	0.7	-	Absorption coefficient							
Wheel Lathe	Multiple	Partitions, buidling envelope, services, architectural acoustic treatments and constructions		As per design report - NIF-RTA-RPT-NA-220001	-	-	-							
Traction substation	Transformer Bay 806	Power transformer bay	Reverberation control	Acoustic absorption material (minimum NRC 0.8) will be installed to extend within the transformer bay for a minimum 2.5 m above the transformer bay floor to the underside of the traction substation building roof level of the transformer bay. Suitable acoustic absorption material is 50mm Pyrotek Reapor (NRC 0.95) or other product of equivalent acoustic performance or as approved by the project's acoustic consultant.	0.8	-	Absorption coefficient							
Traction substation	Transformer Bay 806	Noise barrier		Noise barrier installed along the south-east wall of the bay will be of solid construction, without gaps. This is will extend from ground level to no less than 4.5m above external ground level and the top of the solid construction will end no less than 2 m above the main body of the transformer (ie. main transformer tank). The minimum transmission loss of this barrier is to be Rw 35, such as 2 layers of 9mm fibre cement (FC) sheeting (minimum individual sheet surface density 14 kg/m2). This treatment will be applied to the access doors to the transformer bay. Doors will only have a threshold gap no larger than 10 mm.	-	Rw 35	-	-	-	-	-	-	-	-

ARCH SPECIFICATION				NV Requirement			Octave band values						
Building	Room ID	Element	Element ID	Description	NRC	Transmission loss	Octave Band Values	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz
Traction substation	Multiple	Partitions, buidling envelope, services, architectural acoustic treatments and constructions		As per design report - NIF-RTA-RPT-NA-220001	-	-	-							

SPECIFICATION DETAIL						NOISE LEVEL REQUIREMENTS	
Item/Area	Sub Item	Details	Source	Sound level description	Descriptor	Max Lp dB(A) Note 1	Maximum Lw dB(A) Note 2
Train	HVAC Maximum operating condition	2 per car, 20 per 10 car train. Located on top of train	NIF 'Noise Prediction Report' (Doc. No. REDE207532, Rev. No. 5, 2 January 2019)	External	LAeq	-	90
Train	HVAC Normal operating condition	2 per car, 20 per 10 car train. Located on top of train	NIF 'Noise Prediction Report' (Doc. No. REDE207532, Rev. No. 5, 2 January 2019)	External	LAeq	-	86
Train	HVAC Presentation operating condition	2 per car, 20 per 10 car train. Located on top of train	NIF 'Noise Prediction Report' (Doc. No. REDE207532, Rev. No. 5, 2 January 2019)	External	LAeq	-	84
Train	Compressor	4 per 10 Car train. Located at the end of adjoined 6 car and 4 car trains. Underneath train.	NIF 'Noise Prediction Report' (Doc. No. REDE207532, Rev. No. 5, 2 January 2019)	External	LAeq	-	89
Train	Static Inverter/Auxiliary Power Unit	3 per 6 car train, 2 per 4 car train, On top of train	NIF 'Noise Prediction Report' (Doc. No. REDE207532, Rev. No. 5, 2 January 2019)	External	LAeq	-	83
Train	Service brakes		NIF 'Noise Prediction Report' (Doc. No. REDE207532, Rev. No. 5, 2 January 2019)	External	LAFmax @ 7.5m	82	-
Train	Brake pipe dumping/venting when train turned off	Based upon RelianceRail Auburn measurments of existing Sydney trains	RelianceRail Auburn measurements, 06/2018	External	LAFmax	-	128
Train	Brake pipe dumping/venting when train turned off	Based upon RelianceRail Auburn measurments of existing Sydney trains.	RelianceRail Auburn measurements, 06/2018	External	LAeq, 15min	-	98
Train	Constant speed	As per ISO 3095:2013 constant speed test	NIF 'Noise Prediction Report' (Doc. No. REDE207532, Rev. No. 5, 2 January 2019)	External	LAeq, Tp @ 7.5m	79.5	-
Train	Constant speed	As per ISO 3095:2013 constant speed test	NIF 'Noise Prediction Report' (Doc. No. REDE207532, Rev. No. 5, 2 January 2019)	External	LAFmax @ 7.5m	80.5	-
Train	Door operations test	All doors open one side of train each test. Noise source level based upon single train door.	Based upon RT&A noise measurements October 2011, of A-Set (advised by TfNSW as suitable comparison train 20/2/2019)	External	LAFmax @ 1m	80	-
Train	Door operations test	All doors open one side of train each test. Noise source level based upon single train door.	Based upon RT&A noise measurements October 2011, of A-Set (advised by TfNSW as suitable comparison train 20/2/2019)	External	LAeq, 15min	-	75
Train	Vigilance testing (Driver car/Non-driver car)	Located 0.5m above ground level, on side of train	Based upon RT&A noise measurements October 2011, of A-Set (advised by TfNSW as suitable comparison train 20/2/2019)	External	LAeq, 15min	-	80/70
Train	Vigilance testing	Located 0.5m above ground level, on side of train	Based upon RT&A noise measurements October 2011, of A-Set (advised by TfNSW as suitable comparison train 20/2/2019)	External	LAFmax	-	108
Train	Emergency Brake / Park Brake (Driver car/Non-driver car)	Located 0.5m above ground level, on side of train	Based upon RT&A noise measurements October 2011, of A-Set (advised by TfNSW as suitable comparison train 20/2/2019)	External	LAeq, 15min	-	91/66
Train	Emergency Brake / Park Brake	Located 0.5m above ground level, on side of train	Based upon RT&A noise measurements October 2011, of A-Set (advised by TfNSW as suitable comparison train 20/2/2019)	External	LAFmax	-	115
Train	Automatic brake (Driver car/Non-driver car)	Located 0.5m above ground level, on side of train	Based upon RT&A noise measurements October 2011, of A-Set (advised by TfNSW as suitable comparison train 20/2/2019)	External	LAeq, 15min	-	77/67
Train	Automatic brake	Located 0.5m above ground level, on side of train	Based upon RT&A noise measurements October 2011, of A-Set (advised by TfNSW as suitable comparison train 20/2/2019)	External	LAFmax	-	108
Maintenance building	Rattle guns			External	LAeq	-	108
Maintenance building	Other loud equipment	Internal noise levels assume this maximum equipment noise level		External	LAeq	-	108
Maintenance building	Forkifts that operate externally of facility	Maximum SWL 92dB(A) (eg. electric or low noise gas forklift)	Source Example: Kalmar ECG50-90	External	LAeq	-	92
Maintenance building	Gantry crane - Crane operation			External	LAeq	-	91
Maintenance building	Bogie turntable	Maximum noise level of 75dB(A) at 1m when in full operation and no alarms / sirens	UGL Subsystem Specification, Rev J ENG/R-0218/SPN.004; RailConnect DAR No. UGL-BTE-SP-0002-9	External	LAeq @ 1m	75	-
Maintenance building	Train lift - Single loud alarm horn	Centre of shed (110m to either external door). Buzzer duration does not occur for longer than 2 seconds in 15-minutes.		External	LAFmax	-	116
Maintenance building	Train lift - Bogie lifter warning buzzer	Located at each bogie along Road 1. Assume there are 24 buzzers in operation (6 car train) simultaneously		External		-	85
Maintenance building	All mobile plant and equipment	All mobile plant and equipment (ie. forklifts) that are permanently based at the facility and require reversing warning alarms, are to be fitted with non-tonal reversing beepers (or an equivalent mechanism). The use of ambient sensitive alarms that adjust output relative to the ambient noise level should be considered		-		-	-
Maintenance building	Delviery trucks - Idle			External	LAeq		98
Maintenance building	Delviery trucks - Moving into site	Truck accelerating/moving assumed moving typically at 5km/h. Modelled as moving point source		External	LAeq		108
Train Wash	Jet Blower	1. Located within train wash, acoustic lining of train wash reduces noise emissions 2. Located no closer that 6.5m from either end of the train wash.		External		-	106
Train Wash	Pump room and control room (Room 1100)			Reverberant field	LAeq	75	-
Wheel Lathe	Train electric shunt vehicle			External	LAeq @ 1m	70	-
Wheel Lathe	Water treatment plant/Plant room - Pumps (combined sound power level)	Up to 6 pumps could be in operation within the room opeating @ 78dB(A) SWL each		External		-	86
Wheel Lathe	Wheel lathe machine			External		-	96
Substation	Power transformers	3MVA 66kV/11kV		External		-	90
Substation	Rectifier Transformer	5.35MVA 66kV/600/600V		External		-	65
Substation	DC Reactor	Advised no noise as no magnetic core and noise generation		External		-	< 65
Bio-wash and graffiti removal external cleaning	High-pressure washing activities	Based upon maximum allowed noise level for daytime operations.		External		-	101
Sewer decant facility	Vacuum Pump		Based upon Mink MM 1252 AV	External		-	89
Sewer decant facility	Rainwater pump		Based upon Lowara 5.5kW pump	External		-	75
Sewer decant facility	Exhaust fan			External		-	65
Rainwater Pumphouse	Fire sprinkler Electric/diesel pump	1. Residential grade silencer is to be installed on the exhaust system (> 25dB(A) reduction) 2. Located within a enclosed acoustically rated structure (>=Rw 24) (ie. Rain water pump house)		External		-	< 120
Rainwater Pumphouse	Exhaust fan			External		-	65
Retention basins	Basin pump No. 1 & No. 2			External		-	< 70

NOTE 1 *- At specified distance*

NOTE 2 *- For individual item only (uness specified)*



Legend

Assumed speaker location with height

- 3.5m above ground level
- 5.9m above ground level
- 10m above ground level

NOTES:

1. Speaker axis direction (bearing from north) labeled yellow and arrow pointing in the direction
2. Speaker tilt/orientation (see insert diagrams)

a. All speakers are angled down at 15 degrees from the horizontal

b. Speaker horn long dimension is vertical

Client:
John Holland Pty Ltd

50 0 50 100 150 200 m

Project:
New Intercity Fleet Maintenance Facility D&C

Noise Levels are approximate due to interpolation of contours and should be used for reference only. For information only and not for construction. This information is protected by copyright.

Description:
GBWS - Yard and carpark speaker location assumptions

RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

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Figure No: TJ265-02 6 2 2 008 (r0)
Date: 26.06.2019
Scale: 1:1500 @ A3

APPENDIX D Predicted noise levels from NIF MF operations

Table D1 (Worst case operating condition): Environmental noise predictions with adverse met conditions - LAeq 15-minute

Report ref: NIF-RTA-RPT-NA-250001(r10)

Receiver ID	NCA/ Receiver Type	Address	Day 7am 6pm PSNL Day	Day 7am 6pm OVERALL	Day 7am 6pm Scenario 1	Day 7am 6pm Scenario 2	Day 7am 6pm Scenario 3	Day 7am 6pm Scenario 4	Day 7am 6pm Scenario 5	Day 7am 6pm PSNL Day	Evening 6pm 10pm PSNL Evening	Evening 6pm 10pm OVERALL	Evening 6pm 10pm Scenario 6	Evening 6pm 10pm Scenario 7	Evening 6pm 10pm Scenario 8	Evening 6pm 10pm Scenario 9	Night 10pm 7am PSNL NIGHT	Night 10pm 7am OVERALL	Night 10pm 2am Scenario 10	Night 10pm 2am Scenario 11	Night 10pm 2am Scenario 12	Night 4am 7am Scenario 13	Night 4am 7am Scenario 14	Night 4am 7am Scenario 15	Night 4am 7am Scenario 16	Night 4am 7am Scenario 17	Night 4am 7am Scenario 18
R1	BG1	57 Bridge Street, Ourimbah	50	42	24	42	42	42	38	50	50	44	23	44	44	44	48	44	20	44	44	20	40	39	34	34	33
R2	BG1	68 Pacific Highway, Kangy Angy	50	36	27	35	36	35	35	50	50	39	24	38	39	38	48	39	23	39	38	23	38	38	36	37	34
R3	BG1	67 Pacific Highway, Kangy Angy	50	35	27	34	35	34	34	50	50	38	24	37	38	37	48	38	24	38	37	24	38	37	36	37	35
R4	BG1	79 Pacific Highway, Kangy Angy	50	36	28	35	36	35	35	50	50	39	26	38	39	38	48	39	25	39	38	25	39	38	37	38	36
R5	BG1	36 Bridge Street, Ourimbah	50	40	26	40	40	40	37	50	50	43	25	42	43	42	48	42	22	42	42	22	40	39	36	36	33
R6	BG1	43 Bridge Street, Ourimbah	50	39	25	39	39	39	37	50	50	42	24	42	42	42	48	42	21	42	42	21	39	39	35	35	33
R7	BG1	24 Bridge Street, Ourimbah	50	38	27	38	38	37	37	50	50	41	25	40	41	40	48	41	23	41	40	23	40	39	36	37	34
R8	BG1	2 Bridge Street, Ourimbah	50	35	26	35	35	35	34	50	50	39	23	38	39	38	48	39	22	39	38	22	37	37	35	36	33
R9	BG1	15 Bridge Street, Ourimbah	50	37	25	37	37	37	36	50	50	40	24	40	40	40	48	40	21	40	40	21	39	38	36	36	33
R10	BG1	11 Bridge Street, Ourimbah	50	36	23	36	36	36	34	50	50	39	23	39	39	39	48	39	20	39	39	20	37	37	34	34	32
R11	BG1	3 Bridge Street, Ourimbah	50	33	24	33	33	33	32	50	50	37	23	36	37	36	48	36	21	36	36	21	36	36	33	34	32
R12	BG2	19 Ourimbah Road, Kangy Angy	49	53	46	51	53	51	52	49	45	53	38	51	53	50	40	53	37	53	50	37	53	52	52	53	50
R13	BG2	50 Orchard Road, Kangy Angy	49	48	44	47	48	47	48	49	45	49	37	48	49	47	40	49	37	49	47	37	49	48	48	49	47
R14	BG2	54 Orchard Road, Kangy Angy	49	46	42	46	46	46	46	49	45	47	38	46	47	46	40	48	38	47	46	38	47	47	47	48	46
R15	BG2	62 Orchard Road, Kangy Angy	49	47	44	46	47	47	47	49	45	48	40	47	48	47	40	48	40	48	47	40	48	48	48	48	47
R16	BG2	72 Orchard Road, Kangy Angy	49	45	41	44	45	44	45	49	45	47	41	46	47	46	40	47	41	47	46	41	47	47	47	47	46
R17	BG2	80 Orchard Road, Kangy Angy	49	44	40	43	44	43	44	49	45	46	41	45	46	45	40	47	41	46	45	41	46	46	46	47	45
R18	BG2	92 Orchard Road, Kangy Angy	49	40	36	39	40	39	40	49	45	43	36	42	43	41	40	43	36	43	41	36	43	42	42	43	41
R19	BG2	106 Orchard Road, Kangy Angy	49	40	36	39	39	39	40	49	45	42	36	42	42	41	40	42	36	42	41	36	42	42	42	42	40
R20	BG2	84 Orchard Road, Kangy Angy	49	41	34	39	40	39	41	49	45	44	36	43	44	42	40	44	36	44	42	36	44	44	43	44	42
R21	BG2	15 Schubolt Road, Kangy Angy	49	48	35	48	48	48	48	49	45	50	32	50	50	50	40	50	28	50	50	28	50	50	44	45	43
R22	BG2	16 Schubolt Road, Kangy Angy	49	48	32	48	48	48	46	49	45	49	30	49	49	49	40	49	26	49	49	26	48	48	42	43	41
R23	BG2	26 Turpentine Road, Kangy Angy	49	54	34	54	54	54	50	49	45	55	29	55	55	55	40	55	26	55	55	26	51	50	43	43	42
R24	BG2	16 Turpentine Road, Kangy Angy	49	52	29	52	52	52	44	49	45	53	23	53	53	53	40	53	19	53	53	19	45	45	37	37	36
R25	BG2	56 Bridge Street, Ourimbah	49	49	27	49	49	49	43	49	45	50	24	50	50	50	40	50	22	50	50	22	43	43	34	34	34
R26	BG2	2 Orchard Road, Kangy Angy	49	41	33	40	41	40	41	49	45	44	29	43	44	42	40	44	27	44	42	27	43	43	40	42	39
R27	BG2	8 Orchard Road, Kangy Angy	49	39	31	38	39	38	38	49	45	42	27	41	42	40	40	42	26	42	40	26	41	41	38	39	37
R28	BG2	120 Berkeley Road, Fountaindale	49	37	33	35	35	37	36	49	45	39	24	36	36	39	40	40	23	36	39	23	37	37	37	37	40
R31	BG2	12 Ourimbah Road, Kangy Angy	49	49	41	48	48	47	49	49	45	49	36	49	49	49	40	50	34	49	49	34	50	50	48	49	47
R32	BG2	52 Howes Road, Ourimbah	49	41	22	41	41	41	37	49	45	42	19	42	42	42	40	42	17	42	42	17	38	38	31	31	30
R33	BG3	137 Enterprise Drive, Ourimbah	54	45	24	45	45	45	41	54	49	46	21	46	46	46	40	46	19	46	46	19	42	42	33	33	32
R34	BG3	170 Old Chittaway Road, Fountaindale	54	58	54	57	58	57	58	54	49	57	38	57	57	57	40	58	35	57	57	35	57	57	58	58	58
R35	BG3	150 Old Chittaway Road	54	56	47	55	56	53	55	54	49	57	38	56	57	54	40	57	37	57	54	37	57	56	57	57	54
R36	BG3	130 Old Chittaway Road, Fountaindale	54	53	43	52	53	50	53	54	49	54	34	54	54	51	40	55	33	54	51	33	55	54	53	54	50
R37	BG3	141 Old Chittaway Road, Fountaindale	54	50	41	49	50	48	50	54	49	52	32	51	52	50	40	52	31	52	50	31	52	52	52	52	49
R38	BG3	127 Old Chittaway Road, Fountaindale	54	50	41	49	50	48	50	54	49	51	32	51	51	49	40	52	31	51	49	31	52	51	50	51	48
R39	BG3	121 Old Chittaway Road, Fountaindale	54	47	31	45	45	44	47	54	49	48	23	47	48	46	40	49	22	48	46	22	49	48	44	44	40
R40	BG3	107 Old Chittaway Road, Fountaindale	54	47	31	46	46	45	47	54	49	48	26	48	48	47	40	49	26	48	47	26	49	48	44	44	42
R41	BG3	103 Old Chittaway Road, Fountaindale	54	47	33	47	47	47	47	54	49	49	26	49	49	49	40	49	25	49	49	25	48	48	42	42	40
R43	BG3	86 Old Chittaway Road, Fountaindale	54	48	23	48	48	48	44	54	49	49	21	49	49	49	40	49	20	49	49	20	45	45	35	35	33
R44	BG3	149 Old Chittaway Road, Fountaindale	54	52	44	51	52	50	52	54	49	54	34	53	54	51	40	54	33	54	51	33	54	53	54	54	51
R45	BG3	165 Old Chittaway Road, Fountaindale	54	53	47	52	53	52	53	54	49	54	34	53	54	52	40	54	33	54	52	33	54	53	54	54	53
R46	BG3	3 Station Road East, Fountaindale	54	49	44	49	49	49	49	54	49	51	32	50	51	50	40	51	31	51	50	31	51	50	51	51	50
R47	BG3	11 Station Road East, Fountaindale	54	50	45	49	49	50	50	54	49	51	33	50	50	51	40	52	32	50	51	32	50	50	51	51	52
R48	BG3	16 Station Road East, Fountaindale	54	50	46	49	49	50	50	54	49	51	33	50	50	51	40	53	32	49	51	32	50	50	51	51	53
R49	BG3	7 Station Road East, Fountaindale	54	47	42	47	47	46	47	54	49	48	30	48	48	47	40	49	29	48	47	29	48	48	49	49	48
R50	BG3	23 Station Road East, Fountaindale	54	45	40	44	43	45	44	54	49	46	29	45	43	46	40	47	28	43	46	28	43	45	46	45	47
R51	BG3	27 Station Road East, Fountaindale	54	43	39	42	41	43	42	54	49	45	27	42	40	45	40	46	26	40	45	26	40	42	44	42	46
R52	BG3	35 Station Road East, Fountaindale	54	42	38	40	39	42	40	54	49	43	26	39	36	43	40	45	25	36	43	25	36	39	40	39	45
R53	BG3	11 Manns Road, Fountaindale	54	23	18	22	22	23	22	54	49	24	13	24	23	24	40	25	12	23	24	12	23	24	24	24	25
R54	BG3	23 Manns Road, Fountaindale	54	21	17	21	21	21	21	54	49	23	11	22	22	23	40	24	11	22	23	11	22	22	22	22	24
R55	BG3	33 Station Road, Fountaindale	54	22	17	22	22	22	22	54	49	24	12	24	23	24	40	24	12	23	24	12	23	23	24	24	24
R56	BG3	22 Manns Road, Fountaindale	54	22	18	21	21	22	21	54	49	24	15	22	22	24	40	26	15	22	24	15	22	22	22	22	26
R57	BG3	157 Old Chittaway Road, Fountaindale	54	49	41	49	49	47	49	54	49	51	31	51	51	49	40	52	31	51	49	31	52	51	51	52	48
R58	BG3	161 Old Chittaway Road, Fountaindale	54	47	40	47	47	45	47	54	49	49	30	49	49	47	40	50	29	49	47	29	49	49	49	50	47
R59	BG3	89 Old Chittaway Road, Fountaindale	54	45	33	45	45	45	45	54	49	47	26	47	47	47	40	47	25	47	47	25	47	46	42	42	40
R60	BG3	105 Old Chittaway Road, Fountaindale	54	44	34	43	44	43	44	54	49	46	26	46	46	45	40	46	25	46	45	25	46	46	44	44	42
R61	BG3	125 Old Chittaway Road, Fountaindale	54	39	18	38	38	38	39	54	49	41	14	41	41	41	40	41	14	41	41	14	41	41	29	30	27
R62	BG3	39 Manns Road, Fountaindale	54	20	14	19	20	19	20	54	49	22	9	22	22	21	40	22	8	22	21	8	22	22	21	22	21
R63	BG3	12 Lorikeet Lane, Fountaindale	54	20	15	20	20	20	20	54	49	22	11	22	22	22	40	22	11	22	22	11	22	22	22	22	22
R64	BG3	6 Lorikeet Lane, Fountaindale	54	19	14	19	19	19	19	54	49	21	10	21	21	21	40	21	9	21	21	9	21	21	21	21	21
R65	BG3	9 Lorikeet Lane, Fountaindale	54	20	15	20	20	20	20	54	49	22	11	22	22	22	40	23	10	22	22	10	22	22	22	22	23
R66	BG3	48 Lillygrove Lane, Fountaindale	54	33	29	31	30	33	31	54	49	35	20	31	28	35	40	37	19	28	35	19	28	30	32	30	37
R67	BG3	36 Lillygrove Lane, Fountaindale	54	35	31	33	32	35	33	54	49	37	21	34	32	37	40	39	20	31	37	20	32	33	35	33	39
R68	BG3	32 Lillygrove Lane, Fountaindale	54	36	32	34	34	36	35	54	49	38	22	35	34	38	40	40	22	34	38	22	34	35	37	36	40
R69	BG3	28 Lillygrove Lane, Fountaindale	54	36	31	34	34	36	35	54	49	38	23	35	34	38	40	40	22	34	38	22	34	35	36	36	40
R70	BG3	96 Old Chittaway Road, Fountaindale	54	51	19	51	51	51	46	54	49	52	17	52	52	52	40	52	16	52	52	16	46	46	29	29	27
R71	BG3	11 Fountain Road, Fountaindale	54	54	29	54	54	54	47	54	49	54	23	54	54	54	40	54	22	54	54	22	48	48	39	39	38
R72	BG3	21 Fountain Road, Fountaindale	54	51	26	51	51	51	49	54	49	52	21	52	52	52	40	52	21	52	52	21	49	49	36	36	35
R73	BG3	14 Old Chittaway Road, Fountaindale	54	49	25	49	49	49	47	54	49	50	20	50	50	50	40	50	19	50	50	19	47	47	35	35	33
R74	BG3	16 Old Chittaway Road, Fountaindale	54	49	24	49	49	49	42	54	49	49	19	49	49	49	40	49	19	49	49	19	43	43	34	34	32
R75	BG3	78 Old Chittaway Road, Fountaindale	54	48	23	48	48	48	42	54	49	50	18	50	50	50	40	50	17	50	50	17	44	44	27	27	31
R76	BG3	64 Old Chittaway Road, Fountaindale	54	44	19	44	44	44	40	54	49	46	16	46	46	46	40	46	16	46	46	16	41	41	26	26	26
R77	BG3	60 Old Chittaway Road, Fountaindale	54	44	26	44	44	44	40	54	49	46	20	46	46	46	40	46	19	46	46	19	41	41	35	35	33
R78	BG3	58 Old Chittaway Road, Fountaindale	54	43	24	43	43	43	39	54	49	45	19	45	45	45	40	45	19	45	45	19	41	41	35	35	32
R79	BG3	46 Old Chittaway Road, Fountaindale	54	43	25	43	43	43	38	54	49	44	20	44	44	44	40	44	19	44	44	19	39	39	34	34	33
R80	BG3	32 Old Chittaway Road, Fountaindale	54	41	24	41	41	41	38	54	49	43	19	43	43	43	40	43	18	43	43	18	39	39	33	33	32
R81	BG3	26 Old Chittaway Road, Fountaindale	54	42	23	42	42	42	38	54	49	44	19	44	44	43	40	44	18	44	43	18	39	39	32	32	31
R82	BG4	139 Orchard Road, Kangy Angy	52	38	34	36	36	37	38	52	52	39	31	37	38	39	50	40	31	38	39	31	38	38	36	37	40
R83	CCC	98-112 Old Chittaway Road, Fountaindale	55	53	37	51	51	50	53	55	55	52	29	52	52	51	55	53	28	52	51	28	53	53	47	48	45
R84	COM	1 Co-wyn Close, Fountaindale	65	54	50	51	51	54	53	65	65	55	36	50	49	55	65	57	35	49	54	35	50	50	51	50	57
R85	COM	2 Catamaran Road, Fountaindale	65	49	45	46	46	48	49	65	65	49	35	45	45	49	65	51	35	45	49	35	45	45	45	45	51
R86	COM	4 Catamaran Road, Fountaindale	65	43	39	41	41	43	43	65	65	44	30	41	40	44	65	46	30	40	44	30	40	40	40	40	46
R87	COM	6 Catamaran Road, Fountaindale	65	47	41	43	43	47	45	65	65	48	32	42	42	48	65	51	31	42	48	31	42	42	42	42	51
R88	COM	8 Catamaran Road, Fountaindale	65	43	40	41	42	43	43	65	65	43	30	42	42	43	65	45	30	42	43	30	42	42	42	42	45
R89	COM	1 Catamaran Road, Fountaindale	65	44	40	42	42	43	44	65	65	44	32	42	42	44	65	46	32	42	44	32	42	42	42	42	46
R90	COM	3 Catamaran Road, Fountaindale	65	42	38	40	40	41	42	65	65	42	31	40	41	42	65	44	31	41	42	31	41	41	40	41	44
R91	COM	5 Catamaran Road, Fountaindale	65	45	39	42	42	43	45	65	65	45	31	43	42	45	65	47	30	42	45	30	43	43	43	43	47
R92	COM	2 Ketch Close, Fountaindale	65	39	36	38	38	38	39	65	65	39	29	39	39	38	65	40	29	39	38	29	40	38	39	39	39
R93	COM	3A Catamaran Road, Fountaindale	65	42	37	40	40	41	42	65	65	42	28	41	41	42	65	43	27	41	42	27	41	41	41	41	43
R94	COM	4 Ketch Close, Fountaindale	65	37	33	35	35	37	37	65	65	39	26	36	36	39	65	40	26	36	39	26	36	35	34	34	40
R95	COM	5 Ketch Close, Fountaindale	65	43	38	41	41	42	43	65	65	43	30	42	42	43	65	45	29	42	43	29	42	42	42	42	45
R96	COM	15 Ketch Close, Fountaindale	65	39	32	37	38	36	39	65	65	41	25	40	41	38	65	41	24	41	38	24	41	40	39	40	37
R97	COM	14 Ketch Close, Fountaindale	65	35	28	32	33	32	35	65	65	35	24	34	35	34	65	35	23	35	34	23	35	34	34	35	35
R98	COM	13 Ketch Close, Fountaindale	65	41	36	38	38	40	41	65	65	41	26	40	39	41	65	43	25	39	41	25	39	39	40	39	43
R99	COM	11 Ketch Close, Fountaindale	65	41	36	39	39	39	41	65	65	41	27	40	40	41	65	41	27	40	41	27	40	40	40	41	41
R100	COM	10 Ketch Close, Fountaindale	65	37	31	35	35	36	37	65	65	38	26	37	37	38	65	38	26	37	38	26	37	37	35	36	38
R101	COM	9 Ketch Close, Fountaindale	65	40	34	38	38	38	40	65	65	39	26	39	39	39	65	40	25	39	39	25	40	39	39	40	40
R102	COM	8 Ketch Close, Fountaindale	65	36	32	34	35	35	36	65	65	37	24	36	36	37	65	37	23	36	37	23	36	36	34	35	37
R103	COM	7 Ketch Close, Fountaindale	65	37	33	34	34	35	37	65	65	36	28	35	35	36	65	37	28	35	36	28	35	35	35	35	37
R104	COM	9 Catamaran Road, Fountaindale	65	37	32	35	35	37	37	65	65	39	27	36	36	39	65	41	27	36	39	27	36	36	35	35	41
R105	COM	11 Catamaran Road, Fountaindale	65	41	36	40	40	40	41	65	65	42	24	41	42	41	65	42	22	42	41	22	42	41	42	42	42
R106	COM	13 Catamaran Road, Fountaindale	65	36	31	34	34	36	36	65	65	38	23	35	35	38	65	40	22	35	38	22	36	36	36	35	40
R107	COM	15 Catamaran Road, Fountaindale	65	43	39	42	42	43	43	65	65	44	25	43	43	44	65	45	23	43	44	23	43	43	44	44	45
R108	COM	17 Catamaran Road, Fountaindale	65	40	35	37	37	40	39	65	65	42	27	37	36	42	65	45	26	35	42	26	36	37	38	37	45
R110	SCH	10 Catamaran Road, Fountaindale	55	45	41	42	42	45	43	55	55	46	28	41	39	46	55	48	27	39	46	27	39	41	43	41	48
R111	BG3	7 Old Chittaway Road, Fountaindale	54	41	23	41	41	41	35	54	49	42	18	42	42	42	40	42	18	42	42	18	37	37	32	32	31
R112	BG3	5 Old Chittaway Road, Fountaindale	54	38	20	38	38	38	32	54	49	40	15	40	40	40	40	40	15	40	40	15	34	34	29	29	29
R113	BG3	1 Old Chittaway Road, Fountaindale	54	37	19	37	37	36	32	54	49	38	15	38	38	38	40	38	15	38	38	15	34	34	28	28	28
R114	BG3	144 Enterprise Drive, Fountaindale	54	39	18	39	39	39	32	54	49	40	16	40	40	40	40	40	15	40	40	15	34	34	29	29	29
R115	BG2	66 Howes Road, Ourimbah	49	37	20	37	37	37	34	49	45	39	17	39	39	39	40	39	16	39	39	16	35	35	31	31	30
R116	BG2	68 Howes Road, Ourimbah	49	39	20	39	39	39	35	49	45	40	17	40	40	40	40	40	17	40	40	17	36	36	30	30	29
R117	BG1	83 Pacific Highway, Kangy Angy	50	36	29	35	36	35	35	50	50	39	26	37	39	37	48	39	25	39	37	25	38	38	37	38	36
R118	BG2	53 Orchard Rd, Kangy Angy (Acquired)	49	51	46	50	50	50	51	49	45	51	42	50	51	50	40	51	42	51	50	42	51	51	51	51	50
R120	BG3	75 Old Chittaway Road, Fountaindale	54	44	19	44	44	44	41	54	49	46	17	46	46	46	40	46	17	46	46	17	42	42	30	29	27
R121	BG3	73 Old Chittaway Road, Fountaindale	54	42	14	42	42	42	39	54	49	44	14	44	44	44	40	44	14	44	44	14	40	40	24	23	21
R122	BG3	65 Old Chittaway Road, Fountaindale	54	42	15	42	42	42	39	54	49	45	15	45	45	45	40	45	15	45	45	15	40	40	26	26	24
R123	BG3	57 Old Chittaway Road, Fountaindale	54	40	13	40	40	40	36	54	49	43	13	43	43	43	40	43	13	43	43	13	37	37	20	20	19
R124	BG3	53 Old Chittaway Road, Fountaindale	54	40	14	40	40	40	35	54	49	42	14	42	42	42	40	42	14	42	42	14	37	37	22	22	20
R125	BG3	49 Old Chittaway Road, Fountaindale	54	39	14	39	39	39	35	54	49	42	15	42	42	42	40	42	15	42	42	15	37	37	24	23	22
R126	BG3	47 Old Chittaway Road, Fountaindale	54	39	15	39	39	39	36	54	49	41	16	41	41	41	40	41	16	41	41	16	37	37	30	29	27
R127	BG3	43 Old Chittaway Road, Fountaindale	54	37	13	37	37	37	34	54	49	40	13	40	40	40	40	40	13	40	40	13	35	35	20	20	18
R128	BG3	41 Old Chittaway Road, Fountaindale	54	40	24	40	40	40	37	54	49	42	19	42	42	42	40	42	19	42	42	19	38	38	33	33	31
R129	BG3	39 Old Chittaway Road, Fountaindale	54	39	24	39	39	39	37	54	49	41	19	41	41	41	40	41	18	41	41	18	38	38	32	32	32
R130	BG3	37 Old Chittaway Road, Fountaindale	54	40	24	40	40	40	37	54	49	42	19	42	42	42	40	42	19	42	42	19	38	38	32	32	31
R131	BG3	33 Old Chittaway Road, Fountaindale	54	39	22	39	39	39	36	54	49	40	18	40	40	40	40	40	18	40	40	18	37	37	31	31	30
R132	BG3	25 Old Chittaway Road, Fountaindale	54	38	21	38	38	38	33	54	49	40	18	40	40	40	40	40	17	40	40	17	35	35	30	30	29
R133	BG3	3 Old Chittaway Road, Fountaindale	54	35	20	35	35	35	31	54	49	37	17	37	37	37	40	37	17	37	37	17	33	33	29	29	28
R134	BG3	142 Enterprise Drive Fountaindale	54	34	19	34	34	34	30	54	49	36	16	36	36	36	40	36	16	36	36	16	32	32	28	28	28
R135	BG2	110 Orchard Road, Kangy Angy	49	37	30	36	36	35	37	49	45	40	33	39	40	38	40	40	33	40	38	33	40	40	39	40	38
R136	BG2	118 Orchard Road, Kangy Angy	49	36	29	35	35	34	36	49	45	39	32	39	39	38	40	39	32	39	38	32	39	39	39	39	37
R137	BG2	64 Turpentine Road, Kangy Angy	49	49	39	48	48	47	49	49	45	50	41	50	50	49	40	50	40	50	49	40	50	50	48	49	47
R138	BG3	51 Manns Road, Fountaindale	54	18	14	18	18	17	18	54	49	21	17	21	21	21	40	21	17	21	21	17	21	21	21	21	21
R139	BG3	53 Manns Road, Fountaindale	54	17	14	17	17	17	17	54	49	21	17	21	21	21	40	21	17	21	21	17	21	21	21	21	21
R140	BG3	1 Heathcliff Close, Fountaindale	54	18	14	18	18	18	18	54	49	21	17	21	21	21	40	22	17	22	21	17	21	21	21	21	21
R141	BG3	11 Lorikeet Lane, Fountaindale	54	22	18	22	22	22	22	54	49	25	22	25	25	25	40	26	22	25	25	22	25	25	26	26	26
R142	BG3	44 Lillygrove Lane, Fountaindale	54	34	30	32	31	34	32	54	49	39	37	38	37	39	40	40	37	37	39	37	37	38	38	38	40
R143	BG1	126 Pacific Highway, Kangy Angy	50	34	27	33	34	33	34	50	50	38	29	37	38	37	48	38	29	38	36	29	38	37	37	37	36
R144	BG1	274 Pacific Highway, Ourimbah	50	34	22	34	34	34	32	50	50	38	25	38	38	37	48	38	24	38	37	24	35	35	32	33	30
R145	BG2	48 Howes Road, Ourimbah	49	27	12	27	27	27	20	49	45	28	15	28	28	28	40	28	15	28	28	15	21	21	17	17	17
R146	BG3	83 Old Chittaway Road, Fountaindale	54	46	28	46	46	46	44	54	49	48	30	48	48	48	40	48	30	48	48	30	46	46	40	40	37

LEGEND

Predicted level of exceedance, dB(A)

1 to 5	🟦
6 to 10	🟩
11 to 15	🟧
16 to 20	🟨

Table D2: Environmental noise predictions with adverse met conditions - LA1 1minute

Report ref: NIF-RTA-RPT-NA-250001(r10)

Receiver ID	NCA/ Receiver Type	Address	Evening 6pm-10pm PSNL RBL + 15dB A Cor 22	Evening 6pm-10pm GRNN/OPS	Evening 6pm-10pm Yards/balcony/outdoor living area/amenity area/building facade - open	Evening 6pm-10pm Yards/balcony/outdoor living area/amenity area/building facade - open	Night 10pm-7am PSNL RBL + 15dB A Cor 22	Night 10pm-7am GRNN/OPS	Night 10pm-7am Yards/balcony/outdoor living area/amenity area/building facade - open	Night 10pm-7am Yards/balcony/outdoor living area/amenity area/building facade - open	Night 10pm-7am PSNL Awaiting assessment 55 dB A	Night 10pm-7am OVERALL	Night 10pm-7am Mechanical noise building clause 5.4.2	Night 10pm-7am Transmission	Night 10pm-7am Transmission	Night 10pm-7am Mechanical noise building clause 5.4.2 (open)	Night 10pm-7am Mechanical noise building clause 5.4.2 (open)
R1	BG1	57 Bridge Street, Murrimbah	60	38	42	44	58	32	42	44	65	58	< 30	58	50	42	44
R2	BG1	68 Pacific Highway, Kangy Angy	60	32	40	48	58	< 30	40	48	65	48	< 30	48	40	40	48
R3	BG1	67 Pacific Highway, Kangy Angy	60	32	42	47	58	< 30	42	47	65	47	< 30	44	39	42	47
R4	BG1	79 Pacific Highway, Kangy Angy	60	32	43	47	58	< 30	43	47	65	49	< 30	49	42	43	47
R5	BG1	36 Bridge Street, Murrimbah	60	39	43	48	58	32	43	48	65	52	< 30	52	45	43	48
R6	BG1	43 Bridge Street, Murrimbah	60	39	44	47	58	32	44	47	65	55	< 30	55	47	44	47
R7	BG1	24 Bridge Street, Murrimbah	60	38	39	51	58	31	39	51	65	51	< 30	51	43	39	51
R8	BG1	2 Bridge Street, Murrimbah	60	35	37	51	58	< 30	37	51	65	51	< 30	47	39	37	51
R9	BG1	15 Bridge Street, Murrimbah	60	37	38	50	58	< 30	38	50	65	50	< 30	50	43	38	50
R10	BG1	11 Bridge Street, Murrimbah	60	36	37	48	58	< 30	37	48	65	48	< 30	47	40	37	48
R11	BG1	3 Bridge Street, Murrimbah	60	35	36	48	58	< 30	36	48	65	48	< 30	44	36	36	48
R12	BG2	19 Murrimbah Road, Kangy Angy	55	49	60	61	50	45	60	61	65	61	34	50	50	60	61
R13	BG2	50 Orchard Road, Kangy Angy	55	44	61	58	50	43	61	58	65	61	< 30	44	43	61	58
R14	BG2	54 Orchard Road, Kangy Angy	55	43	62	57	50	42	62	57	65	62	< 30	44	41	62	57
R15	BG2	62 Orchard Road, Kangy Angy	55	47	58	59	50	44	58	59	65	59	< 30	43	39	58	59
R16	BG2	72 Orchard Road, Kangy Angy	55	48	55	56	50	43	55	56	65	56	< 30	45	42	55	56
R17	BG2	80 Orchard Road, Kangy Angy	55	50	54	57	50	43	54	57	65	57	< 30	41	40	54	57
R18	BG2	92 Orchard Road, Kangy Angy	55	49	49	56	50	42	49	56	65	56	32	48	48	49	56
R19	BG2	108 Orchard Road, Kangy Angy	55	49	48	53	50	42	48	53	65	53	32	48	48	48	53
R20	BG2	84 Orchard Road, Kangy Angy	55	47	53	56	50	40	53	56	65	56	30	47	47	53	56
R21	BG2	15 Schubolt Road, Kangy Angy	55	49	52	55	50	42	52	55	65	55	< 30	51	53	52	55
R22	BG2	16 Schubolt Road, Kangy Angy	55	46	49	52	50	39	49	52	65	53	< 30	51	53	49	52
R23	BG2	26 Turpentine Road, Kangy Angy	55	47	50	52	50	40	50	52	65	57	< 30	57	56	50	52
R24	BG2	16 Turpentine Road, Kangy Angy	55	47	45	47	50	40	45	47	65	59	< 30	59	52	45	47
R25	BG2	56 Bridge Street, Murrimbah	55	31	38	46	50	34	38	46	65	63	< 30	63	56	38	46
R26	BG2	2 Orchard Road, Kangy Angy	55	40	44	51	50	33	44	51	65	51	< 30	50	42	44	51
R27	BG2	8 Orchard Road, Kangy Angy	55	35	42	48	50	31	42	48	65	48	< 30	48	42	42	48
R28	BG2	120 Berkeley Road, Fountaindale	55	41	54	57	50	39	54	57	65	57	< 30	38	38	54	57
R31	BG2	12 Murrimbah Road, Kangy Angy	55	52	54	58	50	45	54	58	65	58	33	56	56	54	58
R32	BG2	52 Howes Road, Murrimbah	55	35	39	41	50	< 30	39	41	65	58	< 30	58	50	39	41
R33	BG3	137 Enterprise Drive, Murrimbah	59	38	41	43	50	32	41	43	65	63	< 30	63	55	41	43
R34	BG3	170 Old Chittaway Road, Fountaindale	59	57	74	74	50	54	74	74	65	74	41	57	57	74	74
R35	BG3	150 Old Chittaway Road, Fountaindale	59	51	74	74	50	46	74	74	65	74	34	52	53	74	74
R36	BG3	130 Old Chittaway Road, Fountaindale	59	52	68	71	50	48	68	71	65	71	33	50	54	68	71
R37	BG3	141 Old Chittaway Road, Fountaindale	59	47	68	69	50	42	68	69	65	69	31	48	49	68	69
R38	BG3	127 Old Chittaway Road, Fountaindale	59	48	66	67	50	44	66	67	65	67	31	52	51	66	67
R39	BG3	121 Old Chittaway Road, Fountaindale	59	47	62	62	50	42	62	62	65	62	< 30	50	51	62	62
R40	BG3	107 Old Chittaway Road, Fountaindale	59	45	59	58	50	40	59	58	65	59	< 30	49	51	59	58
R41	BG3	103 Old Chittaway Road, Fountaindale	59	44	56	55	50	39	56	55	65	56	< 30	53	50	56	55
R43	BG3	86 Old Chittaway Road, Fountaindale	59	40	52	48	50	37	52	48	65	58	< 30	58	51	52	48
R44	BG3	149 Old Chittaway Road, Fountaindale	59	48	70	70	50	43	70	70	65	70	33	49	49	70	70
R45	BG3	165 Old Chittaway Road, Fountaindale	59	50	70	69	50	46	70	69	65	70	36	52	52	70	69
R46	BG3	3 Station Road East, Fountaindale	59	48	67	67	50	43	67	67	65	67	33	49	49	67	67
R47	BG3	11 Station Road East, Fountaindale	59	49	68	67	50	44	68	67	65	68	34	50	50	68	67
R48	BG3	16 Station Road East, Fountaindale	59	50	68	68	50	47	68	68	65	68	< 30	45	43	68	68
R49	BG3	7 Station Road East, Fountaindale	59	46	66	64	50	40	66	64	65	66	31	47	47	66	64
R50	BG3	23 Station Road East, Fountaindale	59	45	64	63	50	39	64	63	65	64	< 30	44	44	64	63
R51	BG3	27 Station Road East, Fountaindale	59	42	63	63	50	37	63	63	65	63	< 30	39	34	63	63
R52	BG3	35 Station Road East, Fountaindale	59	40	60	63	50	38	60	63	65	63	< 30	39	38	60	63
R53	BG3	11 Manns Road, Fountaindale	59	< 30	42	43	50	< 30	42	43	65	43	< 30	< 30	< 30	42	43
R54	BG3	23 Manns Road, Fountaindale	59	< 30	40	40	50	< 30	40	40	65	40	< 30	< 30	< 30	40	40
R55	BG3	33 Station Road, Fountaindale	59	< 30	41	40	50	< 30	41	40	65	41	< 30	< 30	< 30	41	40
R56	BG3	22 Manns Road, Fountaindale	59	< 30	41	45	50	< 30	41	45	65	45	< 30	< 30	< 30	41	45
R57	BG3	157 Old Chittaway Road, Fountaindale	59	47	68	69	50	41	68	69	65	69	31	47	47	68	69
R58	BG3	161 Old Chittaway Road, Fountaindale	59	44	66	66	50	39	66	66	65	66	< 30	51	45	66	66
R59	BG3	89 Old Chittaway Road, Fountaindale	59	43	56	55	50	38	56	55	65	56	< 30	53	47	56	55
R60	BG3	105 Old Chittaway Road, Fountaindale	59	43	59	59	50	38	59	59	65	59	< 30	46	45	59	59
R61	BG3	125 Old Chittaway Road, Fountaindale	59	< 30	47	48	50	< 30	47	48	65	48	< 30	42	43	47	48
R62	BG3	39 Manns Road, Fountaindale	59	< 30	38	38	50	< 30	38	38	65	38	< 30	< 30	< 30	38	38
R63	BG3	12 Lorikeet Lane, Fountaindale	59	< 30	39	39	50	< 30	39	39	65	39	< 30	< 30	< 30	39	39
R64	BG3	6 Lorikeet Lane, Fountaindale	59	< 30	39	38	50	< 30	39	38	65	39	< 30	< 30	< 30	39	38
R65	BG3	9 Lorikeet Lane, Fountaindale	59	< 30	39	39	50	< 30	39	38	65	39	< 30	< 30	< 30	39	38
R66	BG3	48 Lillygrove Lane, Fountaindale	59	32	53	57	50	30	53	57	65	57	< 30	33	32	53	57
R67	BG3	36 Lillygrove Lane, Fountaindale	59	36	53	58	50	33	53	58	65	58	< 30	36	36	53	58
R68	BG3	32 Lillygrove Lane, Fountaindale	59	39	53	59	50	35	53	59	65	59	< 30	38	38	53	59
R69	BG3	28 Lillygrove Lane, Fountaindale	59	39	53	59	50	36	53	59	65	59	< 30	37	37	53	59
R70	BG3	96 Old Chittaway Road, Fountaindale	59	32	39	40	50	< 30	39	40	65	56	< 30	56	53	39	40
R71	BG3	11 Fountain Road, Fountaindale	59	43	49	50	50	37	49	50	65	64	< 30	64	59	49	50
R72	BG3	21 Fountain Road, Fountaindale	59	40	45	46	50	33	45	46	65	70	< 30	63	45	45	46
R73	BG3	14 Old Chittaway Road, Fountaindale	59	39	44	45	50	32	44	45	65	68	< 30	68	61	44	45
R74	BG3	16 Old Chittaway Road, Fountaindale	59	37	43	44	50	31	43	44	65	63	< 30	63	56	43	44
R75	BG3	78 Old Chittaway Road, Fountaindale	59	40	37	42	50	34	37	42	65	53	< 30	52	53	37	42
R76	BG3	64 Old Chittaway Road, Fountaindale	59	39	41	38	50	33	41	38	65	60	< 30	60	51	41	38
R77	BG3	60 Old Chittaway Road, Fountaindale	59	38	49	47	50	33	49	47	65	56	< 30	56	50	49	47
R78	BG3	58 Old Chittaway Road, Fountaindale	59	38	49	46	50	32	49	46	65	54	< 30	54	50	49	46
R79	BG3	46 Old Chittaway Road, Fountaindale	59	37	45	45	50	32	45	45	65	58	< 30	58	49	45	45
R80	BG3	32 Old Chittaway Road, Fountaindale	59	36	44	44	50	31	44	44	65	59	< 30	59	50	44	44
R81	BG3	26 Old Chittaway Road, Fountaindale	59	36	42	43	50	< 30	42	43	65	58	< 30	58	50	42	43
R82	BG4	138 Orchard Road, Kangy Angy	62	45	44	50	60	45	44	50	65	50	< 30	44	44	44	50
R83	CCC	98-112 Old Chittaway Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R84	COM	1 Co-wyn Close, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R85	COM	2 Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R86	COM	4 Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R87	COM	6 Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R88	COM	8 Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R89	COM	1 Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R90	COM	3 Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R91	COM	5 Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R92	COM	2 Katch Close, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R93	COM	3A Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R94	COM	4 Katch Close, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R95	COM	5 Katch Close, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R96	COM	15 Katch Close, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R97	COM	14 Katch Close, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R98	COM	13 Katch Close, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R99	COM	11 Katch Close, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R100	COM	10 Katch Close, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R101	COM	9 Katch Close, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R102	COM	8 Katch Close, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R103	COM	7 Katch Close, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R104	COM	9 Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R105	COM	11 Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R106	COM	13 Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R107	COM	15 Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R108	COM	17 Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R110	SCH	10 Catamaran Road, Fountaindale	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	-	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
R111	BG3	7 Old Chittaway Road, Fountaindale	59	37	42	43	50	31	42	43	65	54	< 30	54	47	42	43
R112	BG3	5 Old Chittaway Road, Fountaindale	59	33	40	40	50	< 30	40	40	65	53	< 30	53	45	40	40
R113	BG3	1 Old Chittaway Road, Fountaindale	59	32	39	40	50	< 30	39	40	65	52	< 30	52	44	39	40
R114	BG3	144 Enterprise Drive, Fountaindale	59	33	39	39	50	< 30	39	39	65	52	< 30	52	45	39	39
R115	BG2	66 Howes Road, Murrimbah	55	35	39	41	50	< 30	39	41	65	53	< 30	53	46	39	41
R116	BG2	68 Howes Road, Murrimbah	55	35	40	40	50	< 30	40	40	65	55	< 30	55	47	40	40
R117	BG1	83 Pacific Highway, Kangy Angy	60	32	46	47	58	< 30	46	47	65	47	< 30	46	39	46	47
R118	BG2	53 Orchard Rd, Kangy Angy (Acquired)	55	47	60	59	50	46	60	59	65	60	33	48	48	60	59
R120	BG3	75 Old Chittaway Road, Fountaindale	59	31	50	43	50	32	50	43	65	57	< 30	57	51	50	43
R121	BG3	73 Old Chittaway Road, Fountaindale	59	< 30	44	40	50	< 30	44	40	65	58	< 30	58	50	44	40
R122	BG3	65 Old Chittaway Road, Fountaindale	59	< 30	46	39	50	< 30	46	39	65	58	< 30	58	50	46	39
R123	BG3	57 Old Chittaway Road, Fountaindale	59	< 30	36	31	50	< 30	36	31	65	50	< 30	50	46	36	31
R124	BG3	53 Old Chittaway Road, Fountaindale	59	< 30	37	34	50	< 30	37	34	65	49	< 30	49	46	37	34
R125	BG3	49 Old Chittaway Road, Fountaindale	59	< 30	46	34	50	< 30	46	34	65	56	< 30	56	47	46	34
R126	BG3	47 Old Chittaway Road, Fountaindale	59	33	48	39	50	< 30	48	39	65	57	< 30	57	47	48	39
R127	BG3	43 Old Chittaway Road, Fountaindale	59	< 30	34	32	50	< 30	34	32	65	52	< 30	52	44	34	32
R128	BG3	41 Old Chittaway Road, Fountaindale	59	35	47	45	50	< 30	47	45	65	51	< 30	51	48	47	45
R129	BG3	39 Old Chittaway Road, Fountaindale	59	34	47	45	50	< 30	47	45	65	55	< 30	55	49	47	45
R130	BG3	37 Old Chittaway Road, Fountaindale	59	35	46	44	50	< 30	46	44	65	57	< 30	57	49	46	44
R131	BG3	33 Old Chittaway Road, Fountaindale	59	33	45	42	50	< 30	45	42	65	56	< 30	56	48	45	42
R132	BG3	25 Old Chittaway Road, Fountaindale	59	33	41	41	50	< 30	41	41	65	51	< 30	51	45	41	41
R133	BG3	3 Old Chittaway Road, Fountaindale	59	32	40	40	50	< 30	40	40	65	49	< 30	49	42	40	40
R134	BG3	142 Enterprise Drive Fountaindale	59	31	39	39	50	< 30	39	39	65	51	< 30	51	42	39	39
R135	BG2	110 Orchard Road, Kangy Angy	55	40	43	51	50	47	43	51	65	51	39	39	39	43	51
R136	BG2	118 Orchard Road, Kangy Angy	55	40	43	49	50	47	43	49	65	49	37	37	37	43	49
R137	BG2	64 Turpentine Road, Kangy Angy	55	44	55	58	50	51	55	58	65	58	53	53	54	55	58
R138	BG3	51 Manns Road, Fountaindale	59	< 30	37	36	50	< 30	37	36	65	37	35	35	35	37	36
R139	BG3	53 Manns Road, Fountaindale	59	< 30	36	36	50	< 30	36	36	65	36	34	34	34	36	36
R140	BG3	1 Heathcliff Close, Fountaindale	59	< 30	36	36	50	< 30	36	36	65	36	34	34	34	36	36
R141	BG3	11 Lorikeet Lane, Fountaindale	59	< 30	41	40	50	< 30	41	40	65	41	38	38	38	41	40
R142	BG3	44 Lillygrove Lane, Fountaindale	59	32	57	57	50	37	57	57	65	57	57	57	57	57	57
R143	BG1	126 Pacific Highway, Kangy Angy	60	30	48	46	58	34	48	46	65	48	46	46	46	48	46
R144	BG1	274 Pacific Highway, Murrimbah	60	< 30	37	45	58	35	37	45	65	47	< 30	47	40	37	45
R145	BG2	48 Howes Road, Murrimbah	55	< 30	22	23	50	< 30	22	23	65	42	< 30	42	33	22	23
R146	BG3	83 Old Chittaway Road, Fountaindale	59	36	54	52	50	43	54	52	65	58	43	58	51	54	52

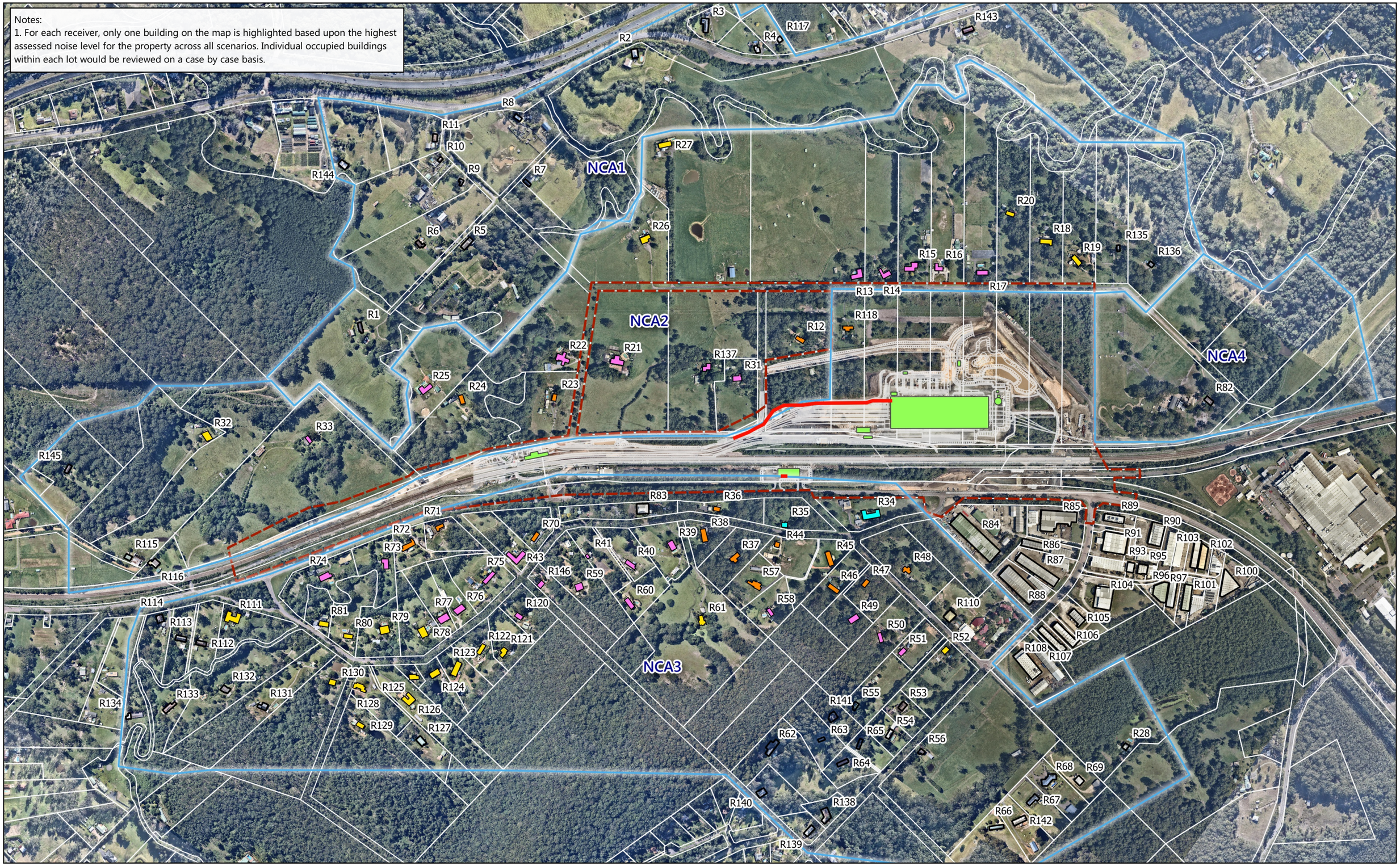
LEGEND

Predicted level of exceedance, dB(A)

1 to 5	
6 to 10	
11 to 15	
16 to 20	

APPENDIX E Summary of residual noise exceedances

Notes:
1. For each receiver, only one building on the map is highlighted based upon the highest assessed noise level for the property across all scenarios. Individual occupied buildings within each lot would be reviewed on a case by case basis.



Legend

- Noise catchment area (NCA) boundary
- Property boundary
- Project noise barrier
- Project boundary
- Project building

Predicted level of exceedance, dB(A) LAeq 15 minute [count]

- 1 -5 [22]
- 6 - 10 [28]
- 11 - 15 [16]
- 16 - 20 [2]
- Comply [69]

Client:
John Holland Pty Ltd

Project:
New Intercity Fleet
Maintenance Facility D&C

Description:
Operational Noise & Vibration Review
Summary of residual exceedances - ONVR (r10)

50 0 50 100 150 200 m

Noise Levels are approximate due to interpolation of contours and should be used for reference only. For information only and not for construction. This information is protected by copyright.

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Date: 09.08.2019
Scale: 1:8500 @ A3