Noise and Vibration Impact Assessment

Unanderra Station Upgrade
Unanderra, NSW.

Prepared for: Pitt&Sherry Operations Pty Ltd
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Muller Acoustic Consulting

Document Information

Noise and Vibration Impact Assessment

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been engaged by Pitt&Sherry Operations Pty Ltd (Pitt&Sherry) on behalf of Transport for NSW (TfNSW) to complete a Noise and Vibration Impact Assessment (NVIA) for the proposed Unanderra Station Upgrade at Unanderra, NSW (the 'Proposal').

This report presents the results, findings and recommendations of the NVIA and has been prepared to accompany the Review of Environmental Factors (REF) being prepared by Pitt&Sherry.

1.1 Scope of the Assessment

The NVIA scope of work included:

- identifying the potentially most affected receivers within the area of influence to the Proposal;
- determining the rating background levels (RBLs) to establish the construction noise management levels (NMLs) and project noise trigger levels (PNTLs) for the Proposal site;
- undertaking a quantitative assessment of noise and vibration from proposed construction activities and operational noise;
- assessment of potential impacts associated with construction noise and vibration; operational noise and sleep disturbance aspects of the Proposal against the relevant noise goals;
- providing recommendations (to be implemented by TfNSW to manage impacts) for feasible and reasonable noise and vibration mitigation and management measures, and monitoring options, where NMLs or vibration objectives may be exceeded; and
- preparing a NVIA summarising the findings and recommendations of the assessment.

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

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2 Proposal Description

2.1 Proposal Location

Unanderra Station is located at Berkeley Road, Unanderra on the South Coast of NSW. Unanderra Station is on the South Coast Line approximately 5km south west of the Wollongong Central Business District (CBD).

2.2 Proposal Overview

The Proposal involves an upgrade of Unanderra Station as part of the Transport Access Program which would improve accessibility and amenities for customers. The Proposal would include the following key elements:

- installation of three new lifts connecting to the existing footbridge, with canopies for weather protection at the lift landings;
- modifications to the existing footbridge including regrading of the deck and replacement of stair treads and handrails;
- construction of elevated walkways between the new lifts and the footbridge;
- platform modifications including minor platform regrading and line marking of boarding assistance zones on Platform 1 and 2 and relocation of two benches;
- modification of the existing station building layout for the provision of a new family accessible toilet and a new staff unisex ambulant toilet a Station Services Equipment Room (SSER) and store room;
- provision of an accessible kiss and ride on Berkeley Road (east) with a new access path to the station entrance including new kerb ramps;
- provision of an accessible kiss and ride on Berkeley Road (west) including a widened footpath and a kerb ramp;
- conversion of the existing non-compliant DDA parking spaces on Berkeley Road (west of station) into three accessible parking spaces with a shared zone; and
- provision of accessible footpaths on Berkeley Road (west) between the station entrance, kiss and ride, bus zone and accessible parking spaces

The preferred option drawings illustrating the Proposal are provided in **Appendix B**.

2.3 Identification of Sensitive Receivers

The existing acoustic environment is described as urban/industrial interface with light industrial premises located to the east of the Proposal site and commercial and residential areas located to the west. The dominant noise sources in the locality include road traffic noise from the Princes Highway, rail noise from the passage of trains on the South Coast Line, industrial noise and general urban hum.

A review of aerial photographs identifies numerous receivers in the locality of the Proposal site. The level of affectation for each receiver is influenced by the activity that is being completed and the distance and exposure of each receiver to the Proposal site.

The locality plan identifying potentially affected receivers is provided in **Figure 1**.

2.3.1 Residential Receivers

The residential receivers have been grouped into catchments based on the residential street that they are located in (see **Table 1**).

Table 1 Residential Receiver Locations

Street Name	Distance from Proposal	Street Name	Distance from Proposal
Princes Highway (North)[1]	150m	Cummins Street	420m
Tannery Street	150m	Tresnan Street	440m
Central Road	170m	Hurt Parade	440m
Tallegalla Street	230m	Factory Road	470m
Victoria Street	250m	Princes Highway (South)[2]	500m
Albert Street	250m	Maynes Parade	520m
Grace Street	290m	Cook Street	530m
Blackman Parade	290m	Lindsay Street	580m
Fraser Street	350m	Beveles Street	580m
Normandie Place	400m	McPhail Street	630m

Note 1: Residential receivers located on Princes Highway north of the Proposal site.

Note 2: Residential receivers located on Princes Highway south of the Proposal site between Factory Road and Farmborough Road.

2.3.2 Other Sensitive Land Uses

Other, non-residential land uses in the locality of the Proposal are provided in **Table 2**.

Table 2 Other Receiver Types

Type	Description	Address	Distance from Proposal
Active Recreation	Unanderra Park	Central Road	350m
Commercial	Coleman's Group	111 Princes Highway	20m
	Carlons Caravans	105 Princes Highway	30m
	IMB, Transpire Hair, Glaser Insurance, Newsagency	102-112 Princes Highway	65m
	Soto Engineers, Unanderra Thai	113-133 Princes Highway	80m
	Caltex Service Station	86 Princes Highway	75m
	Caltex Service Station	1 Tannery Street	95m
	Autopro, Wynstan, Unanderra Pharmacy	29-33 Central Road	100m
	KFC	74-78 Princes Highway	100m
	Steam Heads, Domino's, Guardian Pharmacy	114-130 Princes Highway	120m
Educational	St Pius Primary School	Hargreaves Street	450m
Industrial	Light Industrial	249 Berkeley Road	75m
	Light Industrial	245-247 Berkeley Road	125m
	Light Industrial	238-246 Berkeley Road	135m
Medical Centre	Medical and Dental Centre	102 Princes Highway	60m
	Unanderra Family Doctors	104 Central Road	160m
Place of Worship	The Immaculate Conception Church	48-50 Princes Highway	210m

FIGURE 1

PROPOSAL LOCATION

MAC191000-04

Unanderra Station Upgrade

KEY

- Proposal Site
- Compound Site
- Laydown Area

Receiver Types

- Residential
- Commercial
- Industrial
- Place of Worship
- Medical Facility
- Education Institute
- Active Recreation

0 60 120 180 240 300 m

N

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3 Noise Policy and Guidelines

3.1 Guidelines and Standards

This NVIA has been completed in general accordance with the following key policy and guidelines:

- NSW Government – Transport for NSW (TfNSW) Construction Noise and Vibration Strategy (CNVS), Version 4.1 dated May 2019;
- NSW Department of Environment and Conservation – NSW Environmental Noise Management – Assessing Vibration: A Technical Guideline (the NSW Vibration Guideline), February 2006;
- NSW Department of Environment and Climate Change – NSW Interim Construction Noise Guideline (ICNG), July 2009; and
- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPI), 2017.

The assessment has also considered and applied the following standards where relevant:

- Australian Standard AS 2436–2010 (R2016) (AS 2436) – Guide to Noise and Vibration Control on Construction, Demolition and Maintenance sites;
- Australian Standard AS 1055:2018 (AS 1055) – Description and Measurement of Environmental Noise;
- Australian Standard AS IEC 60942-2004 (AS 60942) – Electroacoustics – Sound Calibrators.
- Australian Standard AS/NZS IEC 61672:2019 (AS 61672) – Electro Acoustics - Sound Level Meters Specifications Monitoring;
- German Institute for Standardisation – DIN 4150 (1999-02) Part 3 (DIN4150-3) – Structural Vibration - Effects of Vibration on Structures;
- British Standard BS7385: Part 2-1993 (BS 7385) - Evaluation and Measurement for Vibration in Buildings — Part 2 – Guide to Damage Levels from Ground-borne Vibration, dated 1993; and
- British Standard BS 6472 (1992) Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz).

3.2 Construction Noise and Vibration Strategy

The assessment and management of noise from construction work is completed with reference to the TfNSW (2019) Construction Noise and Vibration Strategy (CNVS). This strategy provides the methodology by which noise and vibration from TfNSW construction projects are assessed and mitigation measures identified and applied.

The key objectives of the strategy are to:

1. Provide a consistent process for evaluating the construction and vibration impacts from TfNSW projects by providing simple and detailed assessment methods, with a clear pathway to identifying the best approach for each project;

2. Provide clarity on level of assessment required for construction noise and vibration before and during construction activities;

3. Encourage organisations to undertake construction works during standard construction hours where feasible and reasonable to do so. Where out of hours works (OOHW) are required, providing a hierarchy of preferred working hours and procedure for mitigating and managing impacts from these works;

4. Ensure proactive consultation with the community and other stakeholders, to facilitate effective project delivery with balanced stakeholder impacts;

5. Implement reasonable and feasible noise and vibration mitigation measures on all projects that take into consideration the time of works and the likely extent and duration of impact;

6. Verify noise assessments undertaken during the EIA stage prior to construction commencing to ensure that any changes to the project's design, scope, construction method or the mitigation measures proposed in the EIA are re-evaluated and any additional (or changes to the) mitigation measures are identified; and

7. Monitor the implementation and effectiveness of the project's noise and vibration mitigation measures.

3.3 Interim Construction Noise Guideline

The assessment and management of noise from construction work is completed with reference to the Interim Construction Noise Guideline (ICNG). The ICNG is specifically aimed at managing noise from construction work regulated by the EPA and is used to assist in setting statutory conditions in licences or other regulatory instruments. The types of construction regulated by the EPA under the POEO Act (1997), include construction, maintenance and renewal activities carried out by a public authority, such as road upgrades as described in Schedule 1 of the POEO Act.

The ICNG sets out procedures to identify and address the impact of construction noise on residences and other sensitive land uses. This section provides a summary of noise objectives that are applicable to the assessment.

The ICNG provides two methodologies for the assessment of construction noise emissions:

- Quantitative, which is suited to major construction projects with typical durations of more than three weeks; or
- Qualitative, which is suited to short term infrastructure maintenance (for projects with a typical duration of less than three weeks).

The methodology for a quantitative assessment requires a more complex approach, involving noise emission predictions from construction activities to the relevant assessment locations, whilst the qualitative assessment methodology is a more simplified approach that relies more on noise management strategies.

This report has adopted a quantitative assessment approach. The assessment includes identification of potentially affected assessment locations, description of activities involved in the Proposal, derivation of the construction noise criteria for standard and out of hours (OOH) periods, quantification of potential noise impacts at receivers and, provides management and mitigation recommendations.

3.3.1 Construction Hours

Table 3 summaries the ICNG recommended standard and out of hours periods for construction. Note, although not mandatory, strong justification is required to work outside of normal construction hours.

Table 3 Recommended Hours for Construction

Hour Commencing	12 AM	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM
Monday	OOH Period 2							Standard Hours											OOH Period 1					OOH Period 2
Tuesday																								
Wednesday																								
Thursday																								
Friday																								
Saturday																								
Sunday									OOH Period 1										OOH Period 2					
Public Holiday																								

3.3.2 Out of Hours Construction

The ICNG suggests that any request to vary the hours of standard construction activities shall be:

- considered on a case by case basis or activity-specific basis;
- accompanied by details of the nature and need for activities to be undertaken during the varied construction hours; and
- accompanied by written evidence that activities undertaken during the varied construction hours are strongly justified; appropriate consultation with potentially affected receivers and notification of the relevant regulatory authorities has occurred; and all practicable and reasonable mitigation measures will be put in place.

Out of Hours (OOH) periods are divided into two categories generally representing evening and night periods and cover the hours listed below:

- **OOH Period 1 (evening/low risk period):** Monday to Friday – 6pm to 10pm, Saturdays – 1pm to 6pm, Sundays/Public Holidays – 8am to 6pm.
- **OOH Period 2 (night/medium to high risk period):** Monday to Friday – 10pm to 7am, Saturdays/Sundays/Public Holidays – 6pm to 7am (8am on Sunday mornings and Public Holidays).

3.3.3 Construction Noise Management Levels

Table 4 reproduces the ICNG Noise Management Level (NML) for residential receivers. The NML is determined by adding 10dB (standard hours) or 5dB (OOH) to the Rating Background Level (RBL) for each specific assessment period. **Table 5** reproduces the ICNG management levels for other receiver types.

Table 4 ICNG Residential Management Levels

Time of Day	Noise Management Level $LA_{eq(15min)}$[1]	How to Apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays.	Noise affected RBL + 10dB.	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq(15min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA.	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: • times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences. • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours.	Noise affected RBL + 5dB.	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dBA above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

Note 1: The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the construction NML for noise assessment purposes and is the median of the ABL's.

Table 5 Noise Management Levels for Other Noise Sensitive Receivers		
Land use	Where objective applies	Noise Management Level $LA_{eq(15min)}$[1]
Classrooms at schools and other educational institutions	Internal noise level	45dB
Hospital wards and operating theatres	Internal noise level	45dB
Places of worship	Internal noise level	45dB
Active recreation areas	External noise level	65dB
Passive recreation areas	External noise level	60dB
Commercial premises	External noise level	70dB
Industrial premises	External noise level	75dB

Note 1: Noise management levels apply when receiver areas are in use only.

Where the predicted or measured $LA_{eq(15min)}$ noise level is greater than the NML, the proponent should apply all feasible and reasonable work practices to meet the relevant NML. Following the implementation of standard mitigation measures, where residual noise impacts occur, additional mitigation measures should be implemented.

3.3.4 Construction Sleep Disturbance

Section 4.3 of the ICNG states that a sleep disturbance assessment is required where construction activities are planned to occur for more than two consecutive nights. Given that construction activities may occur during out of hours periods, an assessment of sleep disturbance is provided in **Section 7.4**.

3.4 Construction Vibration

The CNVS provides guidance on minimum working distances from sensitive receivers for typical items of vibration intensive plant (see **Table 6**). The minimum distances are quoted for both "cosmetic" damage in accordance with British Standard BS7385.2-1993 Evaluation of measurement for vibration in buildings Part 2, and human comfort in accordance with the Department of Environment and Conservation (2006) Assessing Vibration: a technical guideline. The minimum working distances for cosmetic damage must be complied with at all times, unless otherwise approved by TfNSW. For detailed vibration criteria see **Appendix C**.

Table 6 Minimum Working Distances for Vibratory Plant (m)			
Plant item	Rating / Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration guideline)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5m	15m to 20m
	< 100 kN (Typically 2-4 tonnes)	6m	20m
	< 200 kN (Typically 4-6 tonnes)	12m	40m
	< 300 kN (Typically 7-13 tonnes)	15m	100m
	> 300 kN (Typically 13-18 tonnes)	20m	100m
	> 300 kN (> 18 tonnes)	25m	100m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2m	7m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7m	23m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22m	73m
Vibratory Pile Driver	Sheet piles	2m to 20m	20m
Pile Boring	≤ 800 mm	2m (nominal)	N/A
Piling Rig - Hammer	12t down force	15m	50m
Jackhammer	Hand held	1m (nominal)	Avoid contact with structure

Note: Source, CNVG (Roads and Maritime, 2016).

Note: More stringent conditions may apply to heritage or other sensitive structures.

The minimum working distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. Vibration monitoring is recommended to confirm the minimum working distances at specific sites.

It is understood that the Proposal would not require the use of highly vibration intensive plant such as vibratory pile drivers, large vibratory rollers or large hydraulic hammers. Nevertheless, activities such as piling works for lift shaft foundations may result in unwanted vibration.

A review of aerial photography indicates that the nearest commercial receiver to the location of lift shafts is about 20m. Where highly vibration intensive plant are used for the formation of the lift shafts, the construction vibration mitigation measures provided in **Section 9.1** should be implemented. It is noted that there are no residential receivers located within 100m of the Proposal site, hence, human exposure to vibration is anticipated to be minimal.

3.5 Construction Road Traffic Noise

The NSW EPA's Road Noise Policy (RNP) recommends that any increase in the total traffic noise level should be limited to 2dB above that of the corresponding 'without constriction' scenario. Construction of the Proposal would generate heavy vehicle movements through the transport of construction equipment and materials to the site, and light vehicle movements associated with workers and smaller deliveries. Access to the Proposal site would typically be via:

- Princes Highway – Arterial road; and
- Five Islands Road, Glastonbury Avenue, Berkeley Road – Collector roads.

It is noted that the access route from Five Islands Road along Glastonbury Avenue and Berkeley Road is principally used for industrial traffic, with no residential receivers located along the route. Therefore, no construction road traffic noise impacts are likely to occur.

For residential receivers adjacent to the Princes Highway, to achieve an increase in road traffic noise levels of 2dB, total traffic volumes would need to increase by about 60%. Due to the high existing traffic volumes along the Princes Highway, it is unlikely that the generation of road traffic during the construction works would result in traffic noise impacts. Hence, no further assessment is required.

3.6 Operational Noise

Noise levels associated with the operation of railway stations are assessed in accordance with the provisions of the NSW EPA's Noise Policy for Industry (NPI). The NPI indicates that the Project Noise Trigger Levels (PNTL), are the lower value of the Project Intrusiveness Noise Level (PINL) and the Project Amenity Noise Level (PANL). The PINL aims to limit the degree of change a new noise source introduces to an existing environment while the PANL aims to limit continuing increases in noise levels from all industrial noise sources.

The proposed station upgrades would not result in an increase in rail operations on the South Coast Line and would not affect operational noise levels. It is anticipated that station upgrades to the PA system would have a net beneficial effect, with noise levels at nearby residential receivers anticipated to be lower than present. It is understood that current PA system uses few speakers in a central location at a higher level, while the new system would employ a greater number of directional speakers at a lower level to target particular areas on the platform.

Therefore, it is expected that operational noise levels would be the same or lower than current levels and hence, no further assessment is required.

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4 Existing Environment

4.1 Background Noise Environment

Due to the COVID-19 travel and social distancing restrictions, background noise monitoring was unable to be undertaken at the Proposal site. In lieu of site-specific data, historic background noise monitoring data has been used to quantify the existing noise environment. The data was sourced from the Environmental Noise Assessment (publicly available) for a service station at 41-43 Princes Highway, Unanderra, NSW (Marshall Day Acoustics, 2014 Ref: Rp 001 2014353SY). The historic monitoring was completed in August to September 2014 at 20 Hurt Parade, Unanderra, NSW adjacent to the Princes Highway. This location is considered representative of the background noise levels for receivers in the vicinity of the Proposal site being of similar offset to the railway and Princes Highway.

The results of the unattended noise monitoring are presented in **Table 7**. The measured noise levels were used to determine the Rating Background Level (RBL) for the assessment during the day, evening and night periods in accordance with the NPI.

Table 7 Background Noise Levels

Location	Rating Background Level, dB LA90(period)			Ambient Level, dB LAeq(period)		
	Day	Evening	Night	Day	Evening	Night
Hurt Parade	54	52	38	58	57	52

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

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5 Noise Assessment Criteria

5.1 Construction Noise

Noise Management Levels (NMLs) for construction activities have been developed for receivers during standard construction hours and out of hours periods and are summarised in **Table 8**.

Table 8 Noise Management Levels

Location	Assessment Period	RBL, dBA	NML dB $LA_{eq(15min)}$	
			Noise Affected	Highly Noise Affected
Residential receivers	Day (Standard Hours)	54	64 (RBL+10dBA)	75
	Evening (OOH1)	52	57 (RBL+5dBA)	75
	Night (OOH2)	38	43 (RBL+5dBA)	75
Commercial Receivers	When in use	N/A	70 (external)	75
Industrial Receivers	When in use		75 (external)	N/A
School classrooms	When in use		45 (internal)	75
Medical Facilities	When in Use		45 (internal)	75
Places of Worship	When in use		40 (internal)	75
Active recreation areas	When in use		65 (external)	75

5.2 Maximum Noise Trigger Levels

The potential for sleep disturbance from maximum noise level events from a project during the night-time period needs to be considered. The NPI considers sleep disturbance to be both awakenings and disturbance to sleep stages.

Where night-time noise levels from a development/premises at a residential location exceed the following criteria, a detailed maximum noise level event assessment should be undertaken:

- $LA_{eq(15min)}$ 40dB or the prevailing RBL plus 5dBA, whichever is the greater, and/or
- LA_{max} 52dB or the prevailing RBL plus 15dBA, whichever is the greater.

A detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period.

Other factors that may be important in assessing the impacts on sleep disturbance include:

- how often the events would occur;
- the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the development;
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods); and
- current understanding of effects of maximum noise level events at night.

The maximum trigger levels shown in **Table 9** are based on night-time RBLs and trigger values as per Section 2.5 of the NPI.

Table 9 Maximum Noise Level Assessment Trigger Levels – Residential Receivers

$LA_{eq(15min)}$		LA_{max}	
40dB $LA_{eq(15min)}$ or RBL + 5dB		52dB LA_{max} or RBL + 15dB	
Trigger	40	Trigger	52
RBL +5dB	43	RBL +15dB	53
Highest	**43**	**Highest**	**53**

Note 1: As per Section 2.5 of the NPI, the highest of each metric are adopted as the trigger level.

6 Noise Assessment Methodology

6.1 Construction Assessment Methodology

A computer model was developed to quantify Proposal noise emissions to existing identified residential receivers for typical construction activities and operations. DGMR (iNoise, Version 2020) noise modelling software was used to quantify noise emissions from typical construction activities and operations. iNoise is a new intuitive and quality assured software for industrial noise calculations in the environment. 3D noise modelling is considered industry best practice for assessing noise emissions from projects.

The model incorporated a three-dimensional digital terrain map giving all relevant topographic information used in the modelling process. Additionally, the model uses relevant noise source data, ground type, attenuation from barrier or buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers.

The model calculation method used to predict noise levels was in accordance with ISO 9613-1 'Acoustics - Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere' and ISO 9613-2 'Acoustics - Attenuation of sound during propagation outdoors. Part 2: General method of calculation'.

The construction scenarios included in this assessment are described in Table 10.

Table 10 Construction Scenarios

Scenario	Description
S1 – Site establishment and enabling works	Establishment of environmental control measures and traffic controls Establishment of site compound Relocate services
S2 – Station entrance	Upgrade of existing pedestrian paths / kerbs Provide compliant car parking
S3 – Lift installation	Construction lift pits/foundations/lift bases Installation of lift shafts Installation of lift structures
S4 – Platform works	Platform level works Installation of tactiles
S5 – Pedestrian bridge	Regrading of pedestrian bridge and stairs Construct lift links
S6 – Station facilities and fit-out	Upgrade of station facilities Station fit-out and installation of systems

It is anticipated that the proposed works would typically be undertaken during standard construction hours. Work outside of standard hours (OOH1 and OOH2) may be required during scheduled Sydney Trains rail possessions. It is estimated that three rail possessions would be utilised to facilitate the installation of lift structures, delivery of lift equipment and regrading of the existing footbridge. In the event that each of the work stages may be carried out during OOH work periods, each of the construction scenarios have been assessed for standard, OOH1 and OOH2 periods.

At this stage of the Proposal, the detailed construction methodology is still being determined. Hence this assessment has adopted generic activities to replicate potential worst case noise emissions for each scenario. Assumed plant and equipment consistent with those to be used are listed in **Table 11**, along with each item's sound power level. It is noted that sound power levels for plant assessed in this report were sourced from MAC's noise source database, derived from first-hand measurements and industry research material. For each activity, all sources were assessed as operating simultaneously.

Table 11 Construction Scenarios & Fleet Sound Power Levels dB $LA_{eq(15min)}$

Item	SWLs	Construction Scenario					
		S1	S2	S3	S4	S5	S6
Excavator (35t)	107			✓			
Bobcat/Excavator (20t)	104	✓	✓				
Mobile Crane	105	✓				✓	✓
Tower Crane	110					✓	
Concrete/Demolition Saw[1]	117		✓		✓		
Jack Hammer[1]	118		✓		✓		
Hammer Drill	118				✓		
Hand Tools (Power)	102	✓	✓		✓	✓	✓
Piling Rig (Bored)	109			✓			
Compacting Plate	108			✓			
Concrete Agitator Truck	103		✓	✓	✓	✓	
Concrete Pump	109		✓	✓	✓	✓	
Elevated Work Platform	102					✓	✓
Lighting Tower	93			✓		✓	
Road Trucks	102	✓	✓	✓	✓	✓	✓
Light Vehicles	76	✓	✓	✓	✓	✓	✓
Total Fleet SWL		110	118	115	118	114	109
Sleep disturbance assessment (LA_{max}), Night-time periods (10pm to 7am)							
Metal Impact Noise				115			

Note 1: It is assumed that only one of concrete saw or jack hammer occurring at any one time.

7 Construction Noise Levels

Construction noise levels have been predicted at sensitive receiver locations for each of the construction scenarios described in **Table 10**. The results of the noise predictions are presented for residential receivers in **Section 7.1** (standard construction hours) and **Section 7.2** (out of hours), and for non-residential receivers in **Section 7.3**.

7.1 Residential Receivers – Standard Construction Hours

The predicted $LA_{eq(15min)}$ noise levels have been assessed against the NMLs for standard construction hours and are presented in **Table 12** as a range representing receiver locations on each residential street.

The results of the assessment demonstrate that construction noise levels are not anticipated to exceed the NML for standard construction hours during any of the assessed scenarios, which represents the trigger for the implementation of standard mitigation measures.

Table 12 Predicted Construction Noise Levels – Standard Construction Hours							
NCA	NML (dB LAeq)	Predicted Noise Levels Per Scenario, dB LAeq(15min)					
		S1	S2	S3	S4	S5	S6
Princes Highway (North)[1]	64	35-50	38-53	39-53	41-58	39-53	37-52
Tannery Street		<30-41	32-55	33-51	33-49	32-47	<30-47
Central Road		33-49	37-58	36-56	40-51	36-57	34-49
Tallegalla Street		<30-41	32-47	32-48	31-46	31-48	<30-43
Victoria Street		<30-35	33-42	33-42	33-41	35-41	<30-37
Albert Street		34-40	38-46	40-45	41-47	39-45	36-42
Grace Street		31-39	37-43	38-44	39-47	36-43	34-41
Blackman Parade		30-37	34-46	35-47	34-43	35-45	32-40
Fraser Street		35-42	39-43	39-45	41-48	39-46	37-44
Normandie Place		<30	30-34	31-34	30-34	30-34	<30-31
Cummins Street		31-39	36-45	35-45	36-45	34-46	32-41
Tresnan Street		30-36	34-43	35-42	37-42	34-42	33-39
Hurt Parade		35-40	40-45	41-46	41-46	39-46	37-43
Factory Road		<30-32	<30-37	31-38	<30-38	<30-38	<30-34
Princes Highway (South)[2]		31-37	36-42	37-42	38-43	37-43	33-39
Maynes Parade		33-39	38-45	39-44	33-44	38-45	35-41
Cook Street		37-38	42-44	43-44	43-44	43-44	39
Lindsay Street		34-39	35-45	36-45	36-44	36-45	32-41
Beveles Street		<30-36	<30-42	<30-41	<30-41	<30-42	<30-37
McPhail Street		<30-36	30-40	31-41	34-42	33-41	<30-38

Note 1: Residential receivers located on Princes Highway north of the Proposal site.

Note 2: Residential receivers located on Princes Highway south of the Proposal site between Factory Road and Farmborough Road .

Note: Exceed standard construction hours by more than 10dB requiring additional mitigation measures.

Note: Standard construction periods as defined in Section 3.3.1.

7.2 Residential Receivers – Out of Hours

The predicted $LA_{eq(15min)}$ noise levels, assessed against the noise goals for OOH work periods, are presented in **Table 13** as a range representing receiver locations on each residential street. Predicted levels exceeding the OOH NMLs, representing the trigger for the implementation of standard mitigation measures, are displayed in **bold** text.

Following the implementation of standard mitigation measures, where residual noise levels exceed the triggers for the implementation of additional mitigation measures, levels are displayed as **light blue shading** for OOH2 and **medium blue shading** for OOH1 and OOH2.

Table 13 Predicted Noise Levels – Out of Hours

NCA	NML dB LA_{eq} (OOH1/OOH2)	Predicted Noise Levels Per Scenario, dB $LA_{eq(15min)}$					
		S1	S2	S3	S4	S5	S6
Princes Highway (North)[1]		**35-50**	**38-53**	**39-53**	**41-58**	**39-53**	**37-52**
Tannery Street		<30-41	32-55	33-51	33-49	32-47	<30-47
Central Road		**33-49**	**37-58**	**36-56**	**40-51**	**36-57**	**34-49**
Tallegalla Street		<30-41	**32-47**	**32-48**	**31-46**	**31-48**	<30-43
Victoria Street		<30-35	33-42	33-42	33-41	35-41	<30-37
Albert Street		34-40	**38-46**	**40-45**	**41-47**	**39-45**	36-42
Grace Street		31-39	37-43	**38-44**	**39-47**	36-43	34-41
Blackman Parade		30-37	**34-46**	**35-47**	34-43	**35-45**	32-40
Fraser Street		35-42	39-43	**39-45**	**41-48**	**39-46**	**37-44**
Normandie Place		<30	30-34	31-34	30-34	30-34	<30-31
Cummins Street	57 / 43	31-39	**36-45**	**35-45**	**36-45**	**34-46**	32-41
Tresnan Street		30-36	34-43	35-42	37-42	34-42	33-39
Hurt Parade		35-40	**40-45**	**41-46**	**41-46**	**39-46**	37-43
Factory Road		<30-32	<30-37	31-38	<30-38	<30-38	<30-34
Princes Highway (South)[2]		31-37	36-42	37-42	38-43	37-43	33-39
Maynes Parade		33-39	**38-45**	**39-44**	**33-44**	**38-45**	35-41
Cook Street		37-38	**42-44**	**43-44**	**43-44**	**43-44**	39
Lindsay Street		34-39	**35-45**	**36-45**	**36-44**	**36-45**	32-41
Beveles Street		<30-36	<30-42	<30-41	<30-41	<30-42	<30-37
McPhail Street		<30-36	30-40	31-41	34-42	33-41	<30-38

Note 1: Residential receivers located on Princes Highway north of the Proposal site.

Note 2: Residential receivers located on Princes Highway south of the Proposal site between Factory Road and Farmborough Road.

Note: Exceed OOH P1 and P2 by more than 5dB requiring Additional Mitigation Measures.

Note: Out of Hours construction periods as defined in Section 3.3.2.

7.3 Non-Residential Receivers

The predicted $LA_{eq(15min)}$ noise emissions for non-residential receivers are presented in **Table 14**. Predicted levels exceeding the NMLs are displayed **shaded** text.

Table 14 Predicted Noise Levels – Other Receiver Types

Receiver Type	NML dB LA_{eq} (When in use)	Predicted Noise Levels Per Scenario, dB $LA_{eq(15min)}$					
		S1	S2	S3	S4	S5	S6
Commercial	70	33-64	**40-77**	**41-75**	**41-69**	**39-73**	36-66
Industrial	75	55-61	57-64	60-64	59-68	60-64	56-63
Medical Facility	55[1]	38-56	**44-69**	**44-67**	**45-64**	**43-64**	**40-60**
Educational	55[1]	38	43	44	43	43	40
Places of Worship	55[1]	50	52	54	**58**	55	53
Active Recreation	65	37	42	42	43	42	38

Note 1: External noise level allowing for 10dB loss through an open window.

The results of the assessment identify that predicted $LA_{eq(15min)}$ noise levels would exceed the relevant NMLs for commercial receivers, medical facilities and places of worship during the proposed construction scenarios. Construction noise levels are predicted to satisfy the relevant NMLs for industrial receivers, educational institutions and active recreation areas during all construction scenarios.

For commercial receivers, predicted noise levels are anticipated to exceed the NML of 70dB $LA_{eq(15min)}$ at the nearest receiver (111 Princes Highway) during station entrance upgrades (S2), lift installation (S3) and pedestrian bridge upgrades (S5), with the highest exceedances of 7dB during S2 works. It is noted that the predicted noise levels are anticipated to satisfy the NML at all other commercial receiver locations.

For medical facilities, predicted noise levels are anticipated to exceed the internal NML of 45dB $LA_{eq(15min)}$ at Centre Health Unanderra located at 11/102 Princes Highway during each of the construction stages, with the highest exceedances of 14dB during S2 works. It is noted that the assessment assumed that the medical centre has direct frontage to the Princes Highway with exposure to the Proposal site. Where the medical centre is located at the rear of the building with no frontage to the Princes Highway, predicted noise levels are anticipated to marginally exceed the NML during S2 (3dB), S3 (2dB) and S5 (3dB).

For places of worship, the predicted noise levels are anticipated to exceed the internal NML of 45dB $LA_{eq(15min)}$ at the Immaculate Conception Catholic Church located at 48-50 Princes Highway by up to 3dB during platform regrading works (S4). Construction noise emissions are predicted to satisfy the NML for all other construction scenarios.

7.4 Maximum Noise Trigger Level Assessment

Out of hours construction activities occurring during the night time have the potential to generate noise emissions that may cause sleep disturbance at receivers in proximity to the construction work.

Noise modelling quantified the levels from maximum night time events from the near point of each construction activity to each assessed receiver. Modelling adopted a sound power level of 115dB LA_{max} to represent emissions from transient sources such as metallic impacts from equipment.

Modelling identified that maximum emissions have the potential to exceed to maximum noise trigger level at the nearest assessed residential receivers on Central Road and Tannery Street. Therefore, it is recommended that the Proposal proactively manages night time noise emissions and implement reasonable and feasible noise control strategies to minimise and where possible, eliminate the occurrence of sleep disturbance within the surrounding locality.

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8 Discussion of Construction Noise Assessment

Noise emissions at residential receiver locations are predicted to be below the trigger level for the implementation of standard mitigation measures for all scenarios during standard construction hours. During OOH1, construction noise levels are predicted to exceed the trigger level for the implementation of standard mitigation measures by up to 1dB at 102 Central Road during station entrance upgrades (S2) and 89 Princes Highway during platform works (S4).

Predicted noise levels during OOH2 are anticipated to exceed the trigger level for the implementation of standard mitigation measures for residential receivers during each construction scenario. Therefore, feasible and reasonable standard mitigation measures are recommended for works undertaken during the OOH2 work period. It is noted that construction noise levels would not exceed the highly noise affected NML of 75dBA at any residential receiver locations.

Following the implementation of standard mitigation measures for works undertaken during OOH2, residual noise impacts above the NML are anticipated for nearby residential receivers during construction scenarios S2 to S5. Therefore, additional mitigation measures apply for works conducted during OOH2.

The propagation of noise from the site is largely influenced by the shielding of buildings and structures within and adjacent to the Proposal site. The affected distances discussed below are indicative of the maximum affectation distance and not the distance within which all receivers are potentially impacted.

For detailed mapping of the affected areas, noise contours for each modelled scenario are presented in Appendix D.

8.1 Scenario S1 – Site Establishment and Enabling Works

The results of the predictive modelling indicate that residential receivers located within 320m of the Proposal site may experience noise levels above the NML for construction works undertaken during OOH2. The highest exceedance of the NML (up to 7dB) is predicted for the residential dwelling at 89 Princes Highway to the north of the Proposal site. Construction noise levels are anticipated to satisfy the NMLs at all residential receiver locations for works undertaken during standard construction hours and OOH1 work periods.

Following the implementation of standard mitigation measures, predicted noise levels are not anticipated to exceed the trigger level for the implementation of additional mitigation measures (AMMs) during OOH2.

Table 15 presents a summary of the predicted noise level exceedances and affected distances for site establishment and clearing works during each of the construction periods.

Table 15 Affected Distances for Site Establishment and Enabling Works

Construction Period	Highest Exceedance above NML (dB)	NML		AMM Trigger Level	
		Affected Distance	Impacted Receivers	Affected Distance	Impacted Receivers
Standard	N/A	N/A	N/A	N/A	N/A
OOH Period 1	N/A	N/A	N/A	N/A	N/A
OOH Period 2	7	320m	<10	N/A	N/A

8.2 Scenario S2 – Station Entrance

The results of the predictive modelling indicate that residential receivers located within 675m of the Proposal site may experience noise levels above the NML for construction works undertaken during OOH2. The highest exceedances of the NML (up to 15dB) are predicted for the residential unit building at 102 Central Road to the north west of the Proposal site. Construction noise levels are anticipated to satisfy the NMLs at all residential receiver locations for works undertaken during standard construction hours and OOH1 work periods.

Following the implementation of standard mitigation measures, residual noise levels are anticipated to exceed the trigger level for the implementation of AMMs for receivers located within approximately 250m during OOH2.

Table 16 presents a summary of the predicted noise level exceedances and affected distances for piling and earthworks during each of the construction periods.

Table 16 Affected Distances for Station Entrance

Construction Period	Highest Exceedance above NML (dB)	NML		AMM Trigger Level	
		Affected Distance	Impacted Receivers	Affected Distance	Impacted Receivers
Standard	N/A	N/A	N/A	N/A	N/A
OOH Period 1	N/A	N/A	N/A	N/A	N/A
OOH Period 2	14	675m	<50	250m	<5

8.3 Scenario S3 – Lift Installation

The results of the predictive modelling indicate that residential receivers located within 660m of the Proposal site may experience noise levels above the NML for construction works undertaken during OOH2. The highest exceedances of the NML (up to 13dB) are predicted for the residential unit building at 102 Central Road to the north west of the Proposal site. Construction noise levels are anticipated to satisfy the NMLs at all residential receiver locations for works undertaken during standard construction hours and OOH1 work periods.

Following the implementation of standard mitigation measures, residual noise levels are anticipated to exceed the trigger level for the implementation of AMMs for receivers located within approximately 220m during OOH2.

Table 17 presents a summary of the predicted noise level exceedances and affected distances for parking and footpath upgrade works during each of the construction periods.

Table 17 Affected Distances for Lift Installation

Construction Period	Highest Exceedance above NML (dB)	NML		AMM Trigger Level	
		Affected Distance	Impacted Receivers	Affected Distance	Impacted Receivers
Standard	N/A	N/A	N/A	N/A	N/A
OOH Period 1	N/A	N/A	N/A	N/A	N/A
OOH Period 2	13	660m	<50	220m	~5

8.4 Scenario S4 – Platform Works (Regrading/Tactiles)

The results of the predictive modelling indicate that residential receivers located within 700m of the Proposal site may experience construction noise levels above the NML for works undertaken during OOH2. The highest exceedance of the NML (up to 15dB) is predicted at the residential receiver located at 89 Princes Highway to the north of the Proposal site. Construction noise levels are anticipated to satisfy the NMLs at all residential receiver locations for works undertaken during standard construction hours and OOH1 work periods.

Following the implementation of standard mitigation measures, residual noise levels are anticipated to exceed the trigger level for the implementation of AMMs for receivers located within approximately 220m during OOH2.

Table 18 presents a summary of the predicted noise level exceedances and affected distances for the construction of the pedestrian bridge and associated works during each of the construction periods.

Table 18 Affected Distances for Platform Works (Regrading)

Construction Period	Highest Exceedance above NML (dB)	NML		AMM Trigger Level	
		Affected Distance	Impacted Receivers	Affected Distance	Impacted Receivers
Standard	N/A	N/A	N/A	N/A	N/A
OOH Period 1	N/A	N/A	N/A	N/A	N/A
OOH Period 2	15	700m	<75	220m	<5

8.5 Scenario S5 – Pedestrian Bridge

The results of the predictive modelling indicate that residential receivers located within 650m of the Proposal site may experience noise levels above the NML for construction works undertaken during OOH2. The highest exceedances of the NML (up to 14dB) are predicted for the residential unit building at 102 Central Road to the north west of the Proposal site. Construction noise levels are anticipated to satisfy the NMLs at all residential receiver locations for works undertaken during standard construction hours and OOH1 work periods.

Following the implementation of standard mitigation measures, residual noise levels are anticipated to exceed the trigger level for the implementation of AMMs for receivers located within approximately 260m during OOH2.

Table 19 presents a summary of the predicted noise level exceedances and affected distances for the construction and fit out of station buildings during each of the construction periods.

Table 19 Affected Distances for Pedestrian Bridge

Construction Period	Highest Exceedance above NML (dB)	NML		AMM Trigger Level	
		Affected Distance	Impacted Receivers	Affected Distance	Impacted Receivers
Standard	N/A	N/A	N/A	N/A	N/A
OOH Period 1	N/A	N/A	N/A	N/A	N/A
OOH Period 2	14	650m	<50	260m	<5

8.6 Scenario S6 – Station Facilities and Fit-out

The results of the predictive modelling indicate that residential receivers located within 360m of the Proposal site may experience noise levels above the NML for construction works undertaken during OOH2. The highest exceedance of the NML (up to 9dB) is predicted at the residential receiver located at 89 Princes Highway to the north of the Proposal site. Construction noise levels are anticipated to satisfy the NMLs at all residential receiver locations for works undertaken during standard construction hours and OOH1 work periods.

Following the implementation of standard mitigation measures, residual noise levels are not anticipated to exceed the trigger level for the implementation of AMMs for any residential receiver locations during OOH2.

Table 20 presents a summary of the predicted noise level exceedances and affected distances for the platform level works during each of the construction periods.

Table 20 Affected Distances for Station Facilities and Fit-out

Construction Period	Highest Exceedance above NML (dB)	NML		AMM Trigger Level	
		Affected Distance	Impacted Receivers	Affected Distance	Impacted Receivers
Standard	N/A	N/A	N/A	N/A	N/A
OOH Period 1	N/A	N/A	N/A	N/A	N/A
OOH Period 2	9	360	<5	N/A	N/A

9 Construction Mitigation Measures

9.1 Standard Mitigation Measures

The CNVS outline noise management and mitigation measures to minimise the noise and vibration impacts from construction activities on nearby sensitive receivers. The standard mitigation measures as per the CNVS are reproduced in **Table 21**.

Table 21 Standard Mitigation Measures

Action Required	Details
	Management Measures
Implementation of any project specific mitigation measures required	In addition to the measures set out in this table, any project specific mitigation measures identified in the EIA documentation (e.g. REF, submissions or representations report) or approval or licence conditions must be implemented.
Implement stakeholder consultation measures	Periodic notification (monthly letterbox drop and website notification) detailing all upcoming construction activities delivered to sensitive receivers at least 7 days prior to commencement of relevant works. In addition to Periodic Notification, the following strategies may be adopted on a case-by-case basis: ▪ Project Specific Website ▪ Project Infoline ▪ Construction Response Line ▪ Email Distribution List ▪ Web-based Surveys ▪ Social Media ▪ Community and Stakeholder Meetings and ▪ Community Based Forums (if required by approval conditions).
Register of noise and vibration sensitive receivers	A register of most affected noise and vibration sensitive receivers (NVSRs) would be kept on site. The register would include the following details for each NVSR: ▪ Address of receiver ▪ Category of receiver (e.g. Residential, Commercial etc.) ▪ Contact name and phone number. The register may be included as part of the Project's Community Liaison Plan or similar document and maintained in accordance with the requirements of this plan.
Construction hours and scheduling	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating noise with special audible characteristics and/or vibration levels should be scheduled during less sensitive time periods
Construction respite period	Noise with special audible characteristics and vibration generating activities (including jack and rock hammering, sheet and pile driving, rock breaking and

Table 21 Standard Mitigation Measures	
Action Required	Details
	Management Measures
	vibratory rolling) may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block. 'Continuous' includes any period during which there is less than a 1 hour respite between ceasing and recommencing any of the work. No more than two consecutive nights of noise with special audible characteristics and/or vibration generating work may be undertaken in the same NCA over any 7-day period, unless otherwise approved by the relevant authority.
Site inductions	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: ▪ All relevant project specific and standard noise and vibration mitigation measures ▪ Relevant licence and approval conditions ▪ Permissible hours of work ▪ Any limitations on noise generating activities with special audible characteristics ▪ Location of nearest sensitive receivers ▪ Construction employee parking areas ▪ Designated loading/unloading areas and procedures ▪ Site opening/closing times (including deliveries) ▪ Environmental incident procedures.
Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors. No excessive revving of plant and vehicle engines. Controlled release of compressed air.
Monitoring	A noise monitoring program should be carried out for the duration of works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Attended vibration measurements shall be undertaken at all buildings within 25 m of vibration generating activities when these activities commence to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update CEMP	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Building condition surveys	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to major project construction activities with the potential to cause property damage.

Table 21 Standard Mitigation Measures	
Action Required	Details
Management Measures	
Standard Source Mitigation Measures	
Plan worksites and activities to minimise noise and vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Equipment selection	Use quieter and less vibration emitting construction methods where feasible and reasonable, see APPENDIX C of the guideline. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits.
Maximum noise levels	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the allowable noise levels in APPENDIX C of the guideline.
Rental plant and equipment	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the allowable noise levels in APPENDIX C of the guideline.
Use and siting of plant	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers.
Non-tonal reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work, including delivery vehicles.
Minimise disturbance arising from delivery of goods to construction sites	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
Construction related traffic	Schedule and route vehicle movements away from sensitive receivers and during less sensitive times. Limit the speed of vehicles and avoid the use of engine compression brakes. Maximise on-site storage capacity to reduce the need for truck movements during sensitive times.
Silencers on mobile plant	Where possible reduce noise from mobile plant through additional fittings including: Residential grade mufflers Damped hammers such as “City” Model Rammer Hammers Air Parking brake engagement is silenced.

Table 21 Standard Mitigation Measures	
Action Required	Details
Management Measures	
Prefabrication of materials off-site	Where practicable, pre-fabricate and/or prepare materials off-site to reduce noise with special audible characteristics occurring on site. Materials can then be delivered to site for installation.
Engine compression brakes	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained original equipment manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.
Standard Path Mitigation Measures	
Shield stationary noise sources such as pumps, compressors, fans etc	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix F of AS 2436: 1981 lists materials suitable for shielding
Shield sensitive receivers from noise activities	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

9.2 Additional Mitigation Measures

Where construction noise levels are predicted to exceed the NMLs after the application of the standard mitigation measures, additional mitigation measures should be implemented where reasonable and feasible.

The TfNSW CNVS V4.1 outlines a range of Additional Mitigation Measures (AMM) which are recommended to manage the potential residual impacts. The AMMs to be applied are outlined in Table 22.

Table 22 Additional Mitigation Measures		
Measure	Description	Abbreviation
Periodic Notification	For each I&S project, a notification entitled 'Project Update' or 'Construction Update' is produced and distributed to stakeholders via letterbox drop and distributed to the project postal and/or email mailing lists. The same information will be published on the TfNSW website (www.transport.nsw.gov.au). Periodic notifications provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage, inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on stakeholders . The approval conditions for projects specify requirements for notification to sensitive receivers where works may impact on them. Content and length are determined on a project-by-project basis and must be approved by TfNSW prior to distribution. Most projects distribute notifications on a monthly basis. Each notification is graphically designed within a branded template. In certain circumstances media advertising may also be used to supplement Periodic Notifications, where considered effective. Periodic Notification may be advised by the I&S Community Engagement Team in cases where AMMs are not triggered, for example where community impacts extend beyond noise and vibration (traffic, light spill, parking etc). In these circumstances the I&S Community Engagement Team will determine the community engagement strategy on a case-by-case basis.	PN
Verification Monitoring	Verification monitoring of noise and/or vibration during construction may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one receiver has been identified). Monitoring can be in the form of either unattended logging (i.e. for vibration provided there is an immediate feedback mechanism such as SMS capabilities) or operator attended surveys (i.e. for specific periods of construction noise). The purpose of monitoring is to confirm that: ▪ construction noise and vibration from the project are consistent with the predictions in the noise assessment ▪ mitigation and management of construction noise and vibration is appropriate for receivers affected by the works. Where noise monitoring finds that the actual noise levels exceed those predicted in the noise assessment then immediate refinement of mitigation measures may be required and the CNVIS amended.	V
Specific Notification	Specific notifications are in the form of a personalised letter or phone call to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. Alternatively (or in addition to), communications representatives from the contractor would visit identified	SN

Table 22 Additional Mitigation Measures		
Measure	Description	Abbreviation
	stakeholders at least 48 hours ahead of potentially disturbing construction activities and provide an individual briefing. ▪ Letters may be letterbox dropped or hand distributed ▪ Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and their specific needs ▪ Individual briefings are used to inform stakeholders about the impacts of noisy activities and mitigation measures that will be implemented. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project. Specific notifications are used to support periodic notifications, or to advertise unscheduled works and must be approved by TfNSW prior to implementation/distribution.	
Respite Offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact. The offer could comprise pre-purchased movie tickets, bowling activities, meal vouchers or similar offer. This measure is determined on a case-by-case basis, and may not be applicable to all I&S projects.	RO
Alternative Accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts. Alternative accommodation will be determined on a case-by-case basis and should provide a like-for-like replacement for permanent residents, including provisions for pets, where reasonable and feasible.	AA
Alternative Constriction Methodology	Where the vibration assessment identifies that the proposed construction method has a high risk of causing structural damage to buildings near the works, the proponent will need to consider alternative construction options that achieve compliance with the VMLs for building damage. For example, replace large rock breaker with smaller rock breakers or rock saws.	AC
Respite Period	OOHW during evening and night periods will be restricted so that receivers are impacted for no more than 3 consecutive evenings and no more than 2 consecutive nights in the same NCA in any one week. A minimum respite period of 4 evenings/5 nights shall be implemented between periods of consecutive evening and/or night works. Strong justification must be provided where it is not reasonable and feasible to implement these period restrictions (e.g. to minimise impacts to rail operations), and approval must be given by TfNSW through the OOHW Approval Protocol. Note; this management measure does not apply to OOHW Period 1 – Days	RP
Duration Reduction	Where Respite Periods (see management measure above) are considered to be counterproductive to reducing noise and vibration impacts to the community it may be beneficial to increase the number of consecutive evenings and/or nights	DR

Table 22 Additional Mitigation Measures		
Measure	Description	Abbreviation
	through Duration Reduction to minimise the duration of the activity. This measure is determined on a project-by-project basis, and may not be applicable to all I&S projects. Impacted receivers must be consulted and evidence of community support for the Duration Reduction must be provided as justification for the Duration Reduction. A community engagement strategy must be agreed with and implemented in consultation with I&S Community Engagement Representatives.	

The triggers for the implementation of the AMMs are reproduced in **Table 23**.

Table 23 Triggers for Additional Mitigation Measures - Airborne Noise				
Time period	Receiver Perception	dB above RBL	dB above NML	AMMs
Standard	Noticeable	5 – 10	0	--
	Clearly Audible	>10 – 20	<10	--
	Moderately Intrusive	>20 – 30	>10 – 20	PN, V
	Highly Intrusive	>30	>20	PN, V
	> 75dBA HNA	n/a	n/a	PN, V, SN
OOH Period 1	Noticeable	5 – 10	<5	
	Clearly Audible	>10 – 20	5 - 15	PN
	Moderately Intrusive	>20 – 30	>15 – 25	PN, V, SN, RO
	Highly Intrusive	>30	>25	PN, V, SN, RO, RP#, DR#
OOH Period 2	Noticeable	5 – 10	<5	PN
	Clearly Audible	>10 – 20	5 - 15	PN, V
	Moderately Intrusive	>20 – 30	>15 – 25	PN, V, SN, RO, RP, DR
	Highly Intrusive	>30	>25	PN, V, SN, AA, RP, DR

Notes: PN = Project Notification; SN = Specific Notification, individual briefings, or phone call; V = Verification monitoring; DR = Duration Reduction; RP = Respite Period; RO = Project specific Respite Offer; AA = Alternative Accommodation.

Respite periods and duration reduction are not applicable when works are carried out during OOH Period 1 Day only (i.e. Saturday 6am-7am & 1pm-6pm, Sundays / Public Holidays 8am-6pm).

Construction noise management zones have been mapped to identify the receivers where residual noise levels are anticipated to exceed the AMM trigger levels. The noise management zones are provided for lift installation works, considered to be the activity likely to impact the greatest number of receivers, for OOH2 (**Figure 2**).

It is noted that the predicted noise levels during standard construction hours and OOH1 construction periods are below the AMM trigger levels at all receiver locations, hence, it is expected that following the implementation of standard mitigation measures, the AMM trigger levels would be met for all construction scenarios.

FIGURE 2

Construction AMMs for OOH2

MAC191000-04

Unanderra Station Upgrade

KEY

Proposal Site

AMM Category

- Noticeable
- Clearly Audible
- Moderately Intrusive
- Highly Intrusive

0 60 120 180 240 300 m

N

MAC Muller Acoustic Consulting

10 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has been engaged by Pitt&Sherry Operations Pty Ltd on behalf of Transport for NSW (TfNSW) to complete a Noise and Vibration Assessment for the proposed Unanderra Station Upgrade, Unanderra, NSW.

The results of the assessment demonstrate that construction noise levels are anticipated to be below the relevant NMLs for residential receivers for all works undertaken during standard construction hours. During OOH1, construction noise levels are predicted to exceed the trigger level for the implementation of standard mitigation measures by up to 1dB at 102 Central Road during station entrance upgrades (S2) and 89 Princes Highway during platform works (S4).

For works undertaken during Out of Hours Period 2, construction noise levels are expected to exceed the NML for all construction scenarios, and trigger the implementation of additional mitigation measures for station entrance upgrades (S2), lift installation (S3), platform regrading (S4) and pedestrian bridge upgrades (S5). Accordingly, the NVIA provides prescriptive reasonable and feasible recommendations that can be implemented to reduce noise impacts to the community. Notwithstanding, noise levels are predicted to satisfy the highly noise affected criteria of 75dB $LA_{eq(15min)}$, at all assessed receivers.

In summary, it is recommended that during construction, noise control and management measures provided in this report are adopted to minimise impacts to receiver catchments during Out of Hours Period 2.

Construction activities occurring during Out of Hours Period 2 have the potential to generate noise emissions above the maximum noise trigger levels for sleep disturbance at the nearest receivers on Central Road and Tannery Street. Therefore, the Proposal will actively manage and minimise transient noise events.

It is understood that the Proposal would not require the use of highly vibration intensive plant such as vibratory pile drivers, large vibratory rollers or large hydraulic hammers. However, where vibration intensive works are undertaken within 25m of any sensitive receivers, standard mitigation measures will be implemented. It is noted that there are no residential receivers located within 100m of the Proposal site, hence, human exposure to vibration is anticipated to be minimal.

Construction road traffic (noise and vibration) impacts from the Proposal are not anticipated due to the relatively low number of additional vehicles on the public road network.

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Appendix A – Glossary of Terms

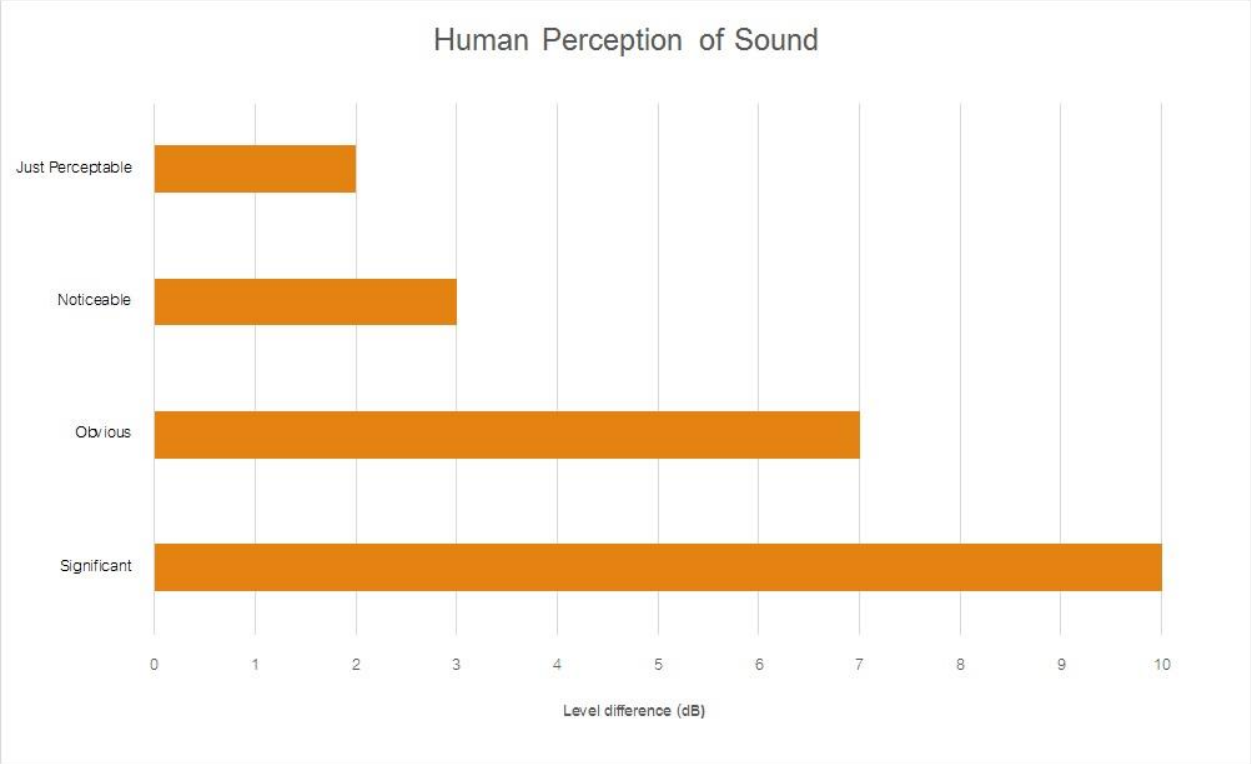
Table A1 provides a number of technical terms have been used in this report.

Table A1 Glossary of Terms	
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured LA90 statistical noise levels.
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by: = 10.log10 (W/Wo) Where: W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA	
Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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Appendix B – Proposal Design Plans

LEGEND

- ABP — ASSISTED BOARDING POINT RAMP
- ABP — PROPOSED ASSISTED BOARDING POINT RAMP
- PROPOSED LIFT ACCESS POINT
- HLP — EMERGENCY HELP POINT
- 3.3m SETBACK
- TO BE DEMOLISHED
- CENTER LINE OF TRACK
- ACCESSIBLE PATH
- LIFT ACCESS ZONE
- WHEELCHAIR WAITING AREA
- EXISTING PLATFORM TGSI
- NEW WORK

1. PROPOSED FAT DOOR (850mm CLEAR)
2. PROPOSED INTERNAL WALL
3. EXISTING UNISEX TOILET AND COMMS ROOM TO BE CONVERTED TO SSER
4. EXISTING TICKET WINDOW (NOT OPERATIONAL) GLASS TO BE OPAQUE
5. EXISTING STAFF TOILET TO BE CONVERTED TO FAT
6. PROPOSED STAFF TOILET TO BE UNISEX AMBULANT TOILET

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EX.COL	EXISTING COLUMN
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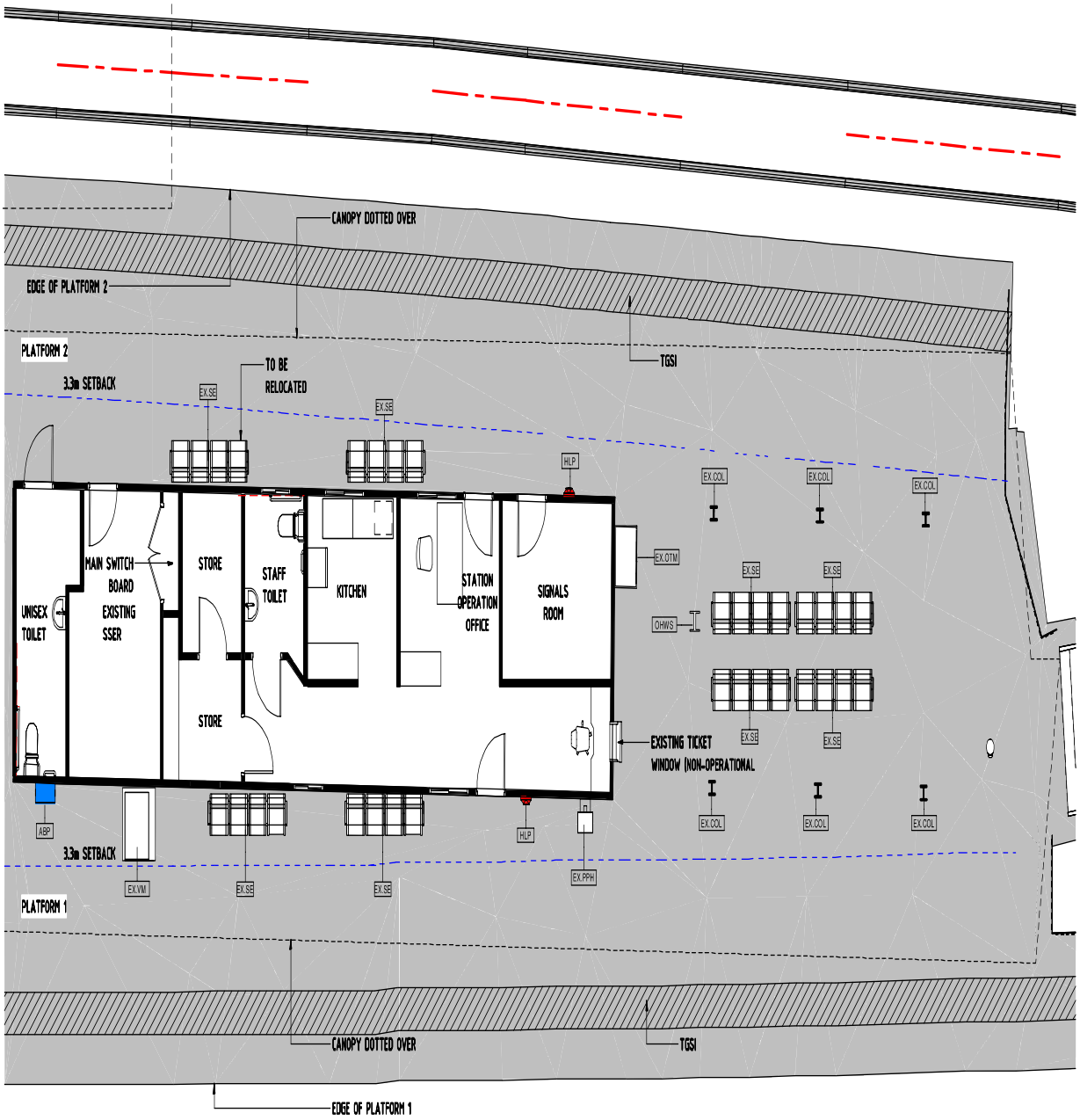
FNE	PROPOSED FENCE
GL-01	LIFT SHAFT GLAZING
HLP	EMERGENCY HELP POINT
HR	PROPOSED HANDRAIL
LIFT	PROPOSED LIFT
LVR	ALUMINIUM LOUVER
MRS	METAL ROOF SHEETING
OHWS	OVERHEAD WIRE SUPPORT STAUNCHION
SCN	WEATHER PROTECTION SCREEN
SE	PROPOSED SEATING
STR	PROPOSED STAIR
TGSI	TACTILE GROUND SURFACE INDICATORS



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SCALES AT A1 SIZE DRAWING

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F	UPDATED SCOPING DESIGN ISSUE FOR REVIEW	VS-30/10/18	NJ-30/10/18	
E	UPDATED SCOPING DESIGN ISSUE FOR REVIEW	VS-29/10/18	NJ-29/10/18	
D	UPDATED SCOPING DESIGN ISSUE FOR REVIEW	VS-24/10/18	NJ-24/10/18	
C	DRAFT SCOPING DESIGN ISSUE FOR REVIEW	VS-19/10/18	NJ-19/10/18	
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UNANDERRA STATION

SOUTH COAST LINE 88.199KM TO 88.354KM

ARCHITECTURAL

STATION BUILDING PLAN_EXISTING

MAC Matter Acoustic Consulting

FILE No. 150105 | SHEET: 3 OF 15 | A1

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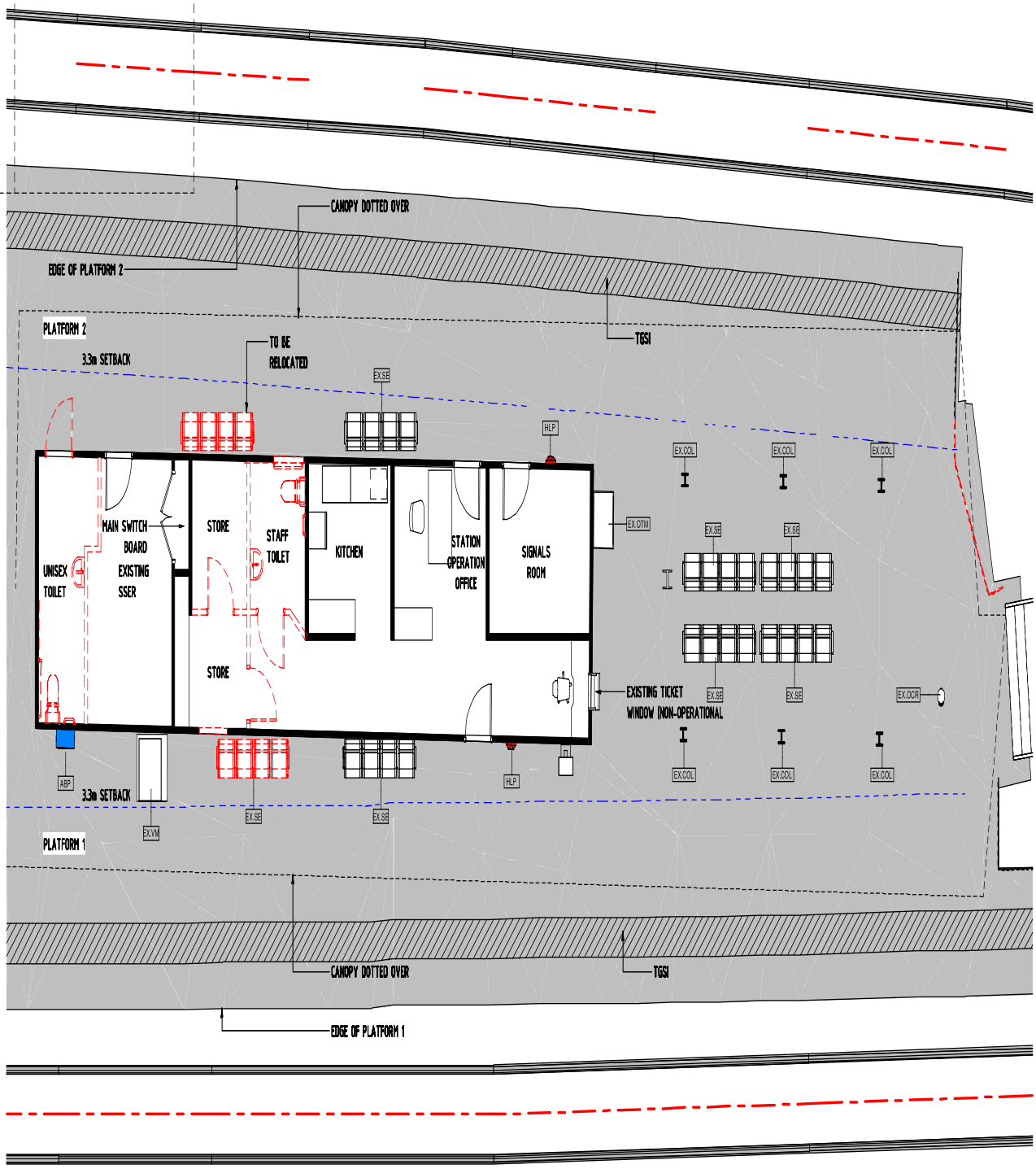

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UNANDERRA STATION

SOUTH COAST LINE 88.199KM TO 88.354KM

ARCHITECTURAL

STATION BUILDING PLAN_DEMOLITION

MAC Master Acoustic Consulting

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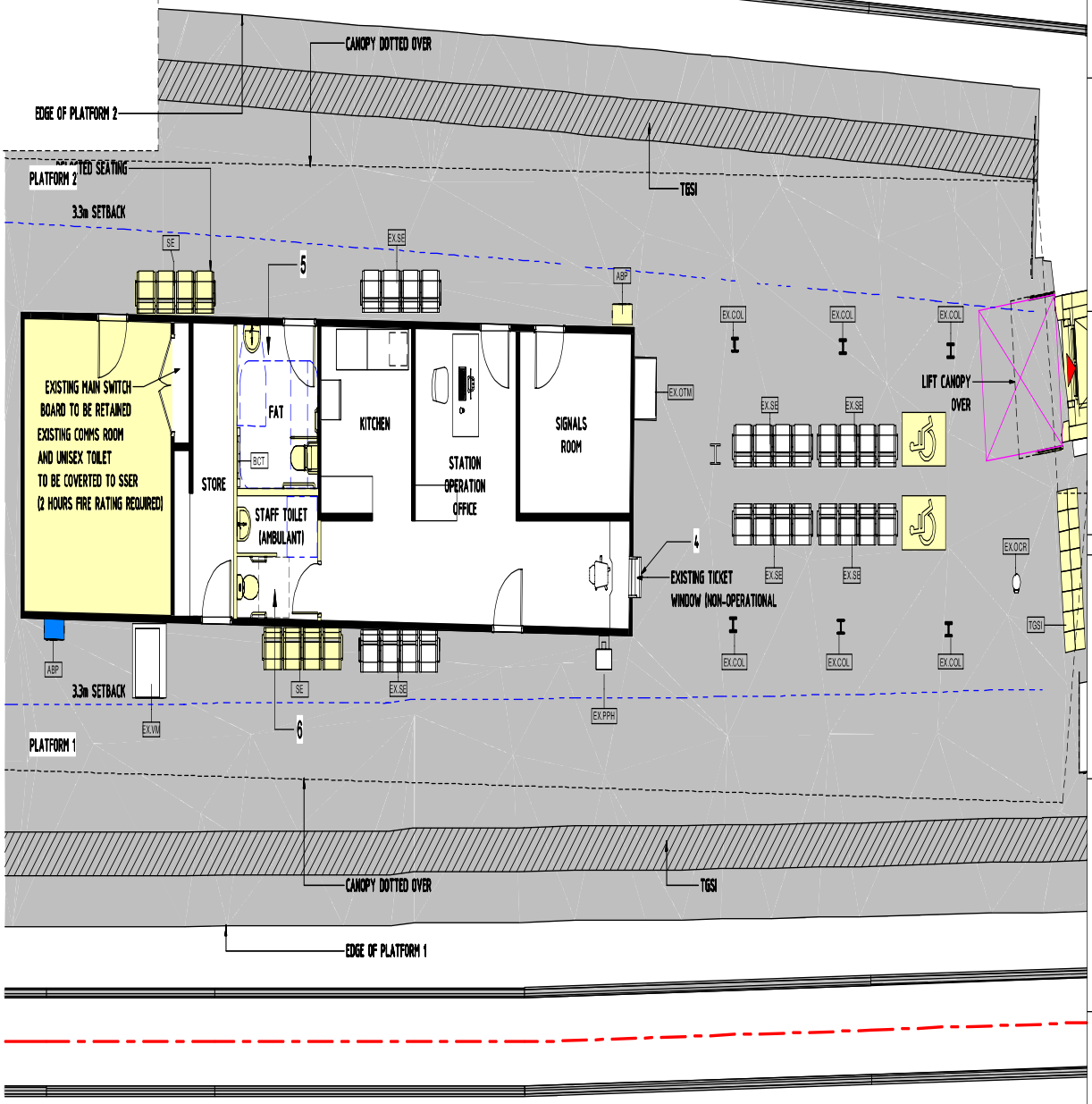

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DESIGN CHECK	NIGEL JUSTINS	19/10/2018
APPROVED	Approver	19/10/2018

UNANDERRA STATION

SOUTH COAST LINE 88.198KM TO 88.354KM

ARCHITECTURAL

STATION BUILDING PLAN_PROPOSED

MAC Marshall Acoustic Consulting

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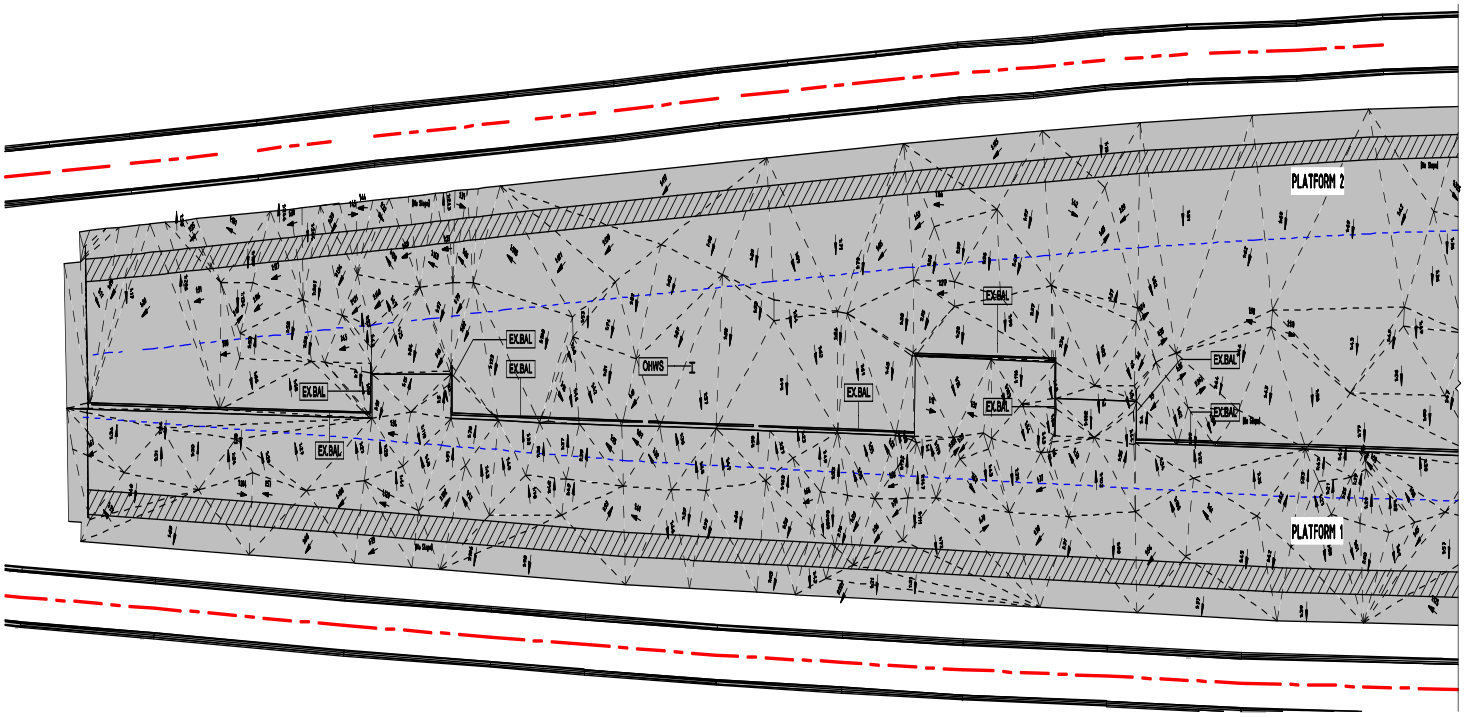

01_PLATFORM REGRADING STUDY_PART 1

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1 G01

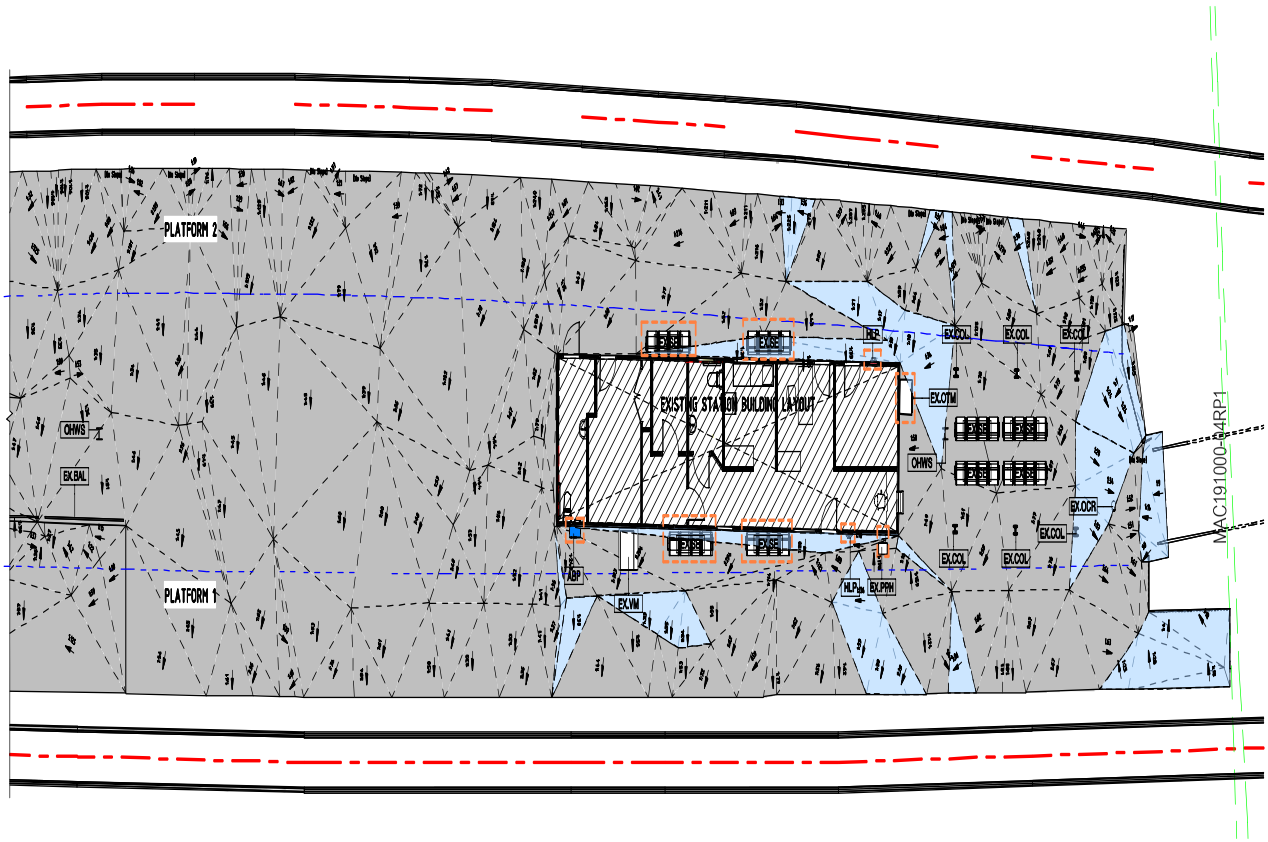
LEGEND

- 1:20X — EXISTING PLATFORM CROSSFALL
- PLATFORM SURFACE TO BE REGRADED TO MAX. 1:40
- ITEMS AFFECTED BY REGRADING
- 3.3m SETBACK
- CENTER LINE OF TRACK
- EXISTING PLATFORM SURFACE
- PROPOSED WORK
- EXISTING PLATFORM TGSI

NOTES

1. ADDITIONAL SURVEY WORK REQUIRED TO ACCURATELY CONFIRM EXTENT OF AREAS TO BE REGRADED.
2. HORIZONTAL AND DIAGONAL CLEARANCES TO BE CHECKED DUE TO CURVATURE AND CAMBER OF TRACK.
3. RAISED COPING EDGE TO INCORPORATE COPING TILE.

KEY	DESCRIPTION
ABP	ASSISTED BOARDING POINT
BCT	BABY CHANGE TABLE
CAN	PROPOSED CANOPY
COL	PROPOSED COLUMN
EX.BAL	EXISTING BALUSTRADE
EX.COL	EXISTING COLUMN
EX.FNE	EXISTING FENCE
EX.OCR	EXISTING OPAL CARD READER
EX.OTM	EXISTING OPAL TOP UP MACHINE
EX.PPH	EXISTING PAYPHONE
EX.SE	EXISTING SEAT
EX.VM	EXISTING VENDING MACHINE
FNE	PROPOSED FENCE
GL-01	LIFT SHAFT GLAZING
HLP	EMERGENCY HELP POINT
HR	PROPOSED HANDRAIL
LIFT	PROPOSED LIFT
LVR	ALUMINIUM LOUVER
MRS	METAL ROOF SHEETING
OHWS	OVERHEAD WIRE SUPPORT STAUNCHION
SCN	WEATHER PROTECTION SCREEN
SE	PROPOSED SEATING
STR	PROPOSED STAIR
TGSI	TACTILE GROUND SURFACE INDICATORS



01_PLATFORM REGRADING STUDY_PART 2

SCALE: 1 : 100@A1

2 G01

DRAWING COLOUR CODED - PRINT ALL COPIES IN COLOUR

NOTES:

1. ALL LEVELS AND DIMENSIONS SHOWN SUBJECT TO DETAILED SURVEY.
2. RLs INDICATED ARE BASED ON POINT CLOUD SURVEY.
3. REFER TO LIFTRONIC DRAWINGS FOR DETAILED REQUIREMENTS AND SETOUT OF 17 PERSON LIFT.
4. ALL WORKS TO COMPLY WITH AS1428.1 AND AS1428.2 INCLUDING BUT NOT LIMITED TO
   - RAMP GRADIENTS TO MAX 1:14
   - ACCESSIBLE CAR PARK SPACE CROSS FALL MAX 1:33
   - FOOTBRIDGE AND ACCESSIBLE PATHWAYS CROSS FALL MAX 1:40
5. NOT ALL KNOWN UNDERGROUND SERVICES ARE SHOWN

SCALES AT A1 SIZE DRAWING

1:100 @ A1 0 1 2 3 4 5 m

AMD	DESCRIPTION	DESIGNER INITIAL / DATE	VERIFIED INITIAL / DATE	APPROVED INITIAL / DATE
G	FINAL FINAL SCOPING DESIGN SUBMISSION	VS-10/12/18	NJ-10/12/18	
F	FINAL SCOPING DESIGN ISSUE FOR SUBMISSION	VS-30/11/18	NJ-30/11/18	
E	FINAL SCOPING DESIGN ISSUE FOR REVIEW	VS-28/11/18	NJ-28/11/18	
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C	UPDATED SCOPING DESIGN ISSUE FOR REVIEW	VS-29/10/18	NJ-29/10/18	
B	UPDATED SCOPING DESIGN ISSUE FOR REVIEW	VS-24/10/18	NJ-24/10/18	
A	DRAFT SCOPING DESIGN ISSUE FOR REVIEW	VS-19/10/18	NJ-19/10/18	

CO-ORDINATE SYSTEM:MGA Zone 56 HEIGHT DATUM: A.H.D. SCALE: 1 : 100 @ A1

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ARCHITECTUS AR

DRAWN	VINCE SHEN	19/10/2018
DESIGNED	VINCE SHEN	19/10/2018
DRG CHECK	NIGEL JUSTINS	19/10/2018
DESIGN CHECK	NIGEL JUSTINS	19/10/2018
APPROVED	Approver	19/10/2018

UNANDERRA STATION

SOUTH COAST LINE 88.199KM TO 88.354KM

ARCHITECTURAL

PLATFORM REGRADING STUDY

MAC Master Acoustic Consulting

FILE No. 150105 SHEET: 6 OF 15 A1

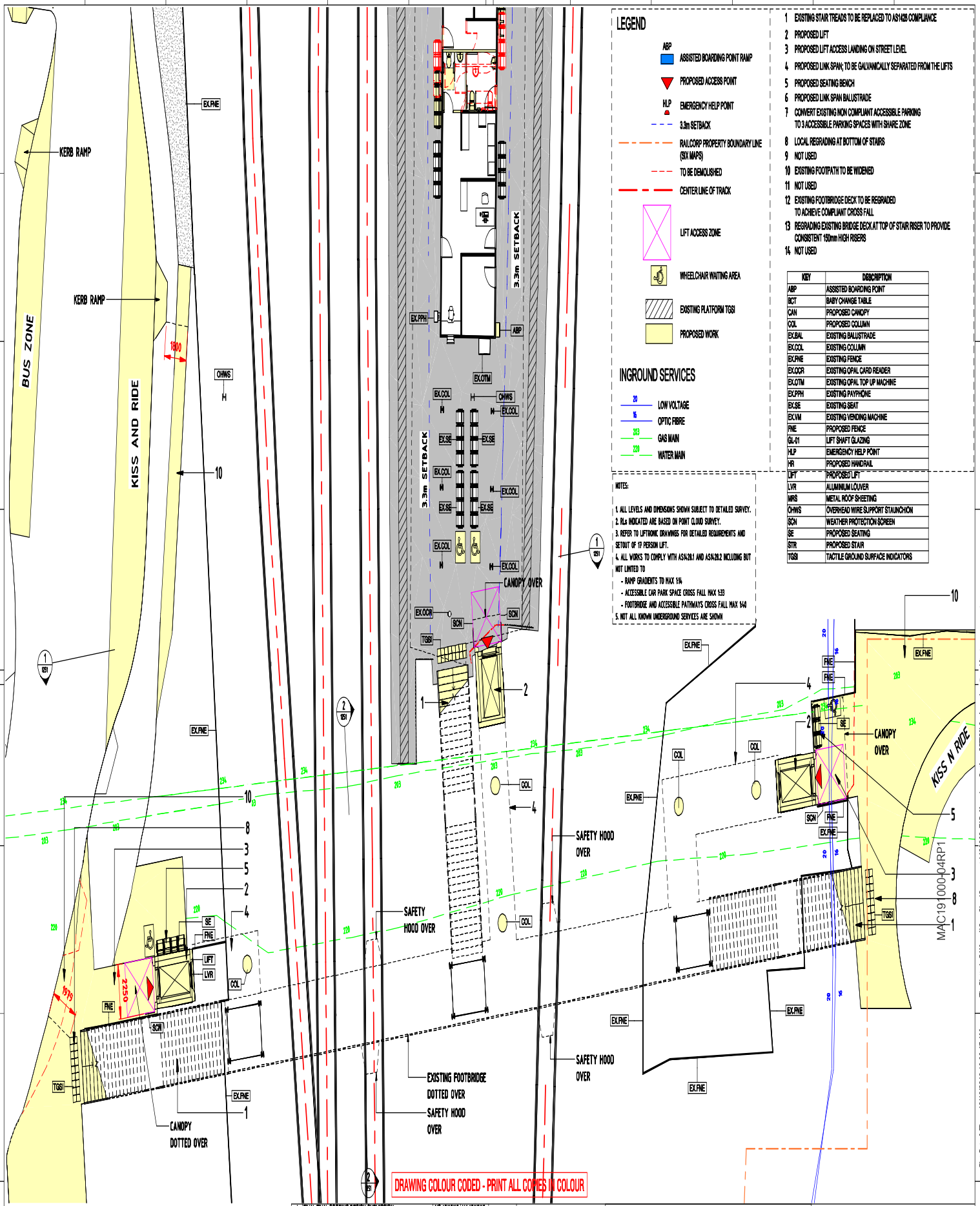
STATUS: SCOPING DESIGN

DRG No. TAP-UNAN-150105-AR-DRAW-0011 G

EDMS No.

File Plotted C:\Users\VinceShen\Documents\150002_TAP_Unanderra Station_OPTION 2_vince.shen@architectus.com.au.rvt

Plot Date & Time 19/12/2018 10:33:05 AM



LEGEND

- ABP — ASSISTED BOARDING POINT RAMP
- PROPOSED ACCESS POINT
- HLP — EMERGENCY HELP POINT
- 3.3m SETBACK
- RAILCORP PROPERTY BOUNDARY LINE (SIX MAPS)
- TO BE DEMOLISHED
- CENTER LINE OF TRACK
- LIFT ACCESS ZONE
- WHEELCHAIR WAITING AREA
- EXISTING PLATFORM TGSI
- PROPOSED WORK

INGROUND SERVICES

- 20 — LOW VOLTAGE
- 16 — OPTIC FIBRE
- 203 — GAS MAIN
- 220 — WATER MAIN

1 EXISTING STAIR TREADS TO BE REPLACED TO AS1428 COMPLIANCE
2 PROPOSED LIFT
3 PROPOSED LIFT ACCESS LANDING ON STREET LEVEL
4 PROPOSED LINK SPAN; TO BE GALVANICALLY SEPARATED FROM THE LIFTS
5 PROPOSED SEATING BENCH
6 PROPOSED LINK SPAN BALUSTRADE
7 CONVERT EXISTING NON COMPLIANT ACCESSIBLE PARKING TO 3 ACCESSIBLE PARKING SPACES WITH SHARE ZONE
8 LOCAL REGRADING AT BOTTOM OF STAIRS
9 NOT USED
10 EXISTING FOOTPATH TO BE WIDENED
11 NOT USED
12 EXISTING FOOTBRIDGE DECK TO BE REGRADED TO ACHIEVE COMPLIANT CROSS FALL
13 REGRADING EXISTING BRIDGE DECK AT TOP OF STAIR RISER TO PROVIDE CONSISTENT 150mm HIGH RISERS
14 NOT USED

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EX.PPH	EXISTING PAYPHONE
EX.SE	EXISTING SEAT
EX.VM	EXISTING VENDING MACHINE
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HR	PROPOSED HANDRAIL
LIFT	PROPOSED LIFT
LVR	ALUMINIUM LOUVER
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SCN	WEATHER PROTECTION SCREEN
SE	PROPOSED SEATING
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TGSI	TACTILE GROUND SURFACE INDICATORS

NOTES:

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   - FOOTBRIDGE AND ACCESSIBLE PATHWAYS CROSS FALL MAX 1:40
5. NOT ALL KNOWN UNDERGROUND SERVICES ARE SHOWN

SCALES AT A1 SIZE DRAWING

1:100 @ A1 0 1 2 3 4 5 m

AMD	DESCRIPTION	DESIGNER INITIAL / DATE	VERIFIED INITIAL / DATE	APPROVED INITIAL / DATE
J	FINAL FINAL SCOPING DESIGN SUBMISSION	VS-10/12/18	NJ-10/12/18	
H	FINAL SCOPING DESIGN ISSUE FOR SUBMISSION	VS-30/11/18	NJ-30/11/18	
G	FINAL SCOPING DESIGN ISSUE FOR REVIEW	VS-20/11/18	NJ-20/11/18	
F	UPDATED SCOPING DESIGN ISSUE FOR REVIEW	VS-30/10/18	NJ-30/10/18	
E	UPDATED SCOPING DESIGN ISSUE FOR REVIEW	VS-29/10/18	NJ-29/10/18	
D	UPDATED SCOPING DESIGN ISSUE FOR REVIEW	VS-24/10/18	NJ-24/10/18	
C	DRAFT SCOPING DESIGN ISSUE FOR REVIEW	VS-19/10/18	NJ-19/10/18	
B	UPDATED OPTION 2A SKETCH DESIGN ISSUE FOR REVIEW	VS-05/10/18	NJ-05/10/18	
A	OPTION 2A SKETCH DESIGN ISSUE FOR REVIEW	VS-11/09/18	NJ-11/09/18	

CO-ORDINATE SYSTEM:MGA Zone 56 | HEIGHT DATUM: A.H.D. | SCALE: 1 : 100 @ A1

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DESIGNED	VINCE SHEN	19/10/2018
DRG CHECK	NIGEL JUSTINS	19/10/2018
DESIGN CHECK	NIGEL JUSTINS	19/10/2018
APPROVED	Approver	19/10/2018

UNANDERRA STATION

SOUTH COAST LINE 88.199KM TO 88.354KM

ARCHITECTURAL PLATFORM LEVEL PLAN

MAC Matter Acoustic Consulting

FILE No. 150105 | SHEET: 8 OF 15 | A1

STATUS: SCOPING DESIGN

DRG No. TAP-UNAN-150105 -AR-DRAW-1101 | J | EDMS No.

Plot Date & Time 10/12/2018 10:35:15 AM

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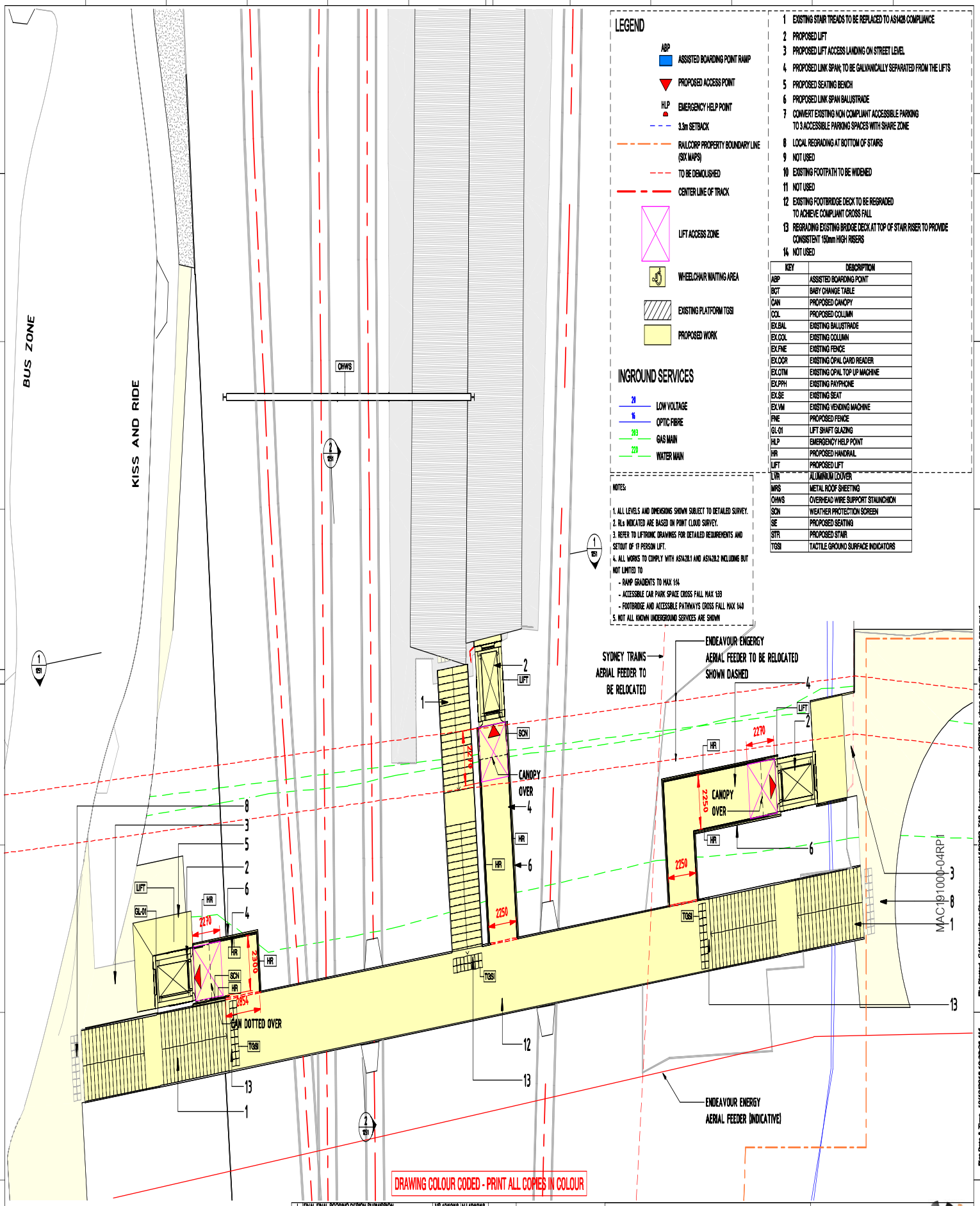

LEGEND

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INGROUND SERVICES

- 20 — LOW VOLTAGE
- 16 — OPTIC FIBRE
- 263 — GAS MAIN
- 220 — WATER MAIN

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5. PROPOSED SEATING BENCH
6. PROPOSED LINK SPAN BALUSTRADE
7. CONVERT EXISTING NON COMPLIANT ACCESSIBLE PARKING TO 3 ACCESSIBLE PARKING SPACES WITH SHARE ZONE
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DRAWING COLOUR CODED - PRINT ALL COPIES IN COLOUR

SCALES AT A1 SIZE DRAWING

1:100 @ A1 0 1 2 3 4 5

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B	UPDATED OPTION 2A SKETCH DESIGN ISSUE FOR REVIEW	VS-05/10/18	NJ-05/10/18	
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CO-ORDINATE SYSTEM:MGA Zone 56 | HEIGHT DATUM: A.H.D. | SCALE: 1 : 100 @ A1

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ARCHITECTUS AR

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DESIGNED	VINCE SHEN	19/10/2018
DRG CHECK	NIGEL JUSTINS	19/10/2018
DESIGN CHECK	NIGEL JUSTINS	19/10/2018
APPROVED	Approver	19/10/2018

UNANDERRA STATION

SOUTH COAST LINE 88.199KM TO 88.354KM

ARCHITECTURAL FOOTBRIDGE LEVEL PLAN

MAC Noise Acoustic Consulting

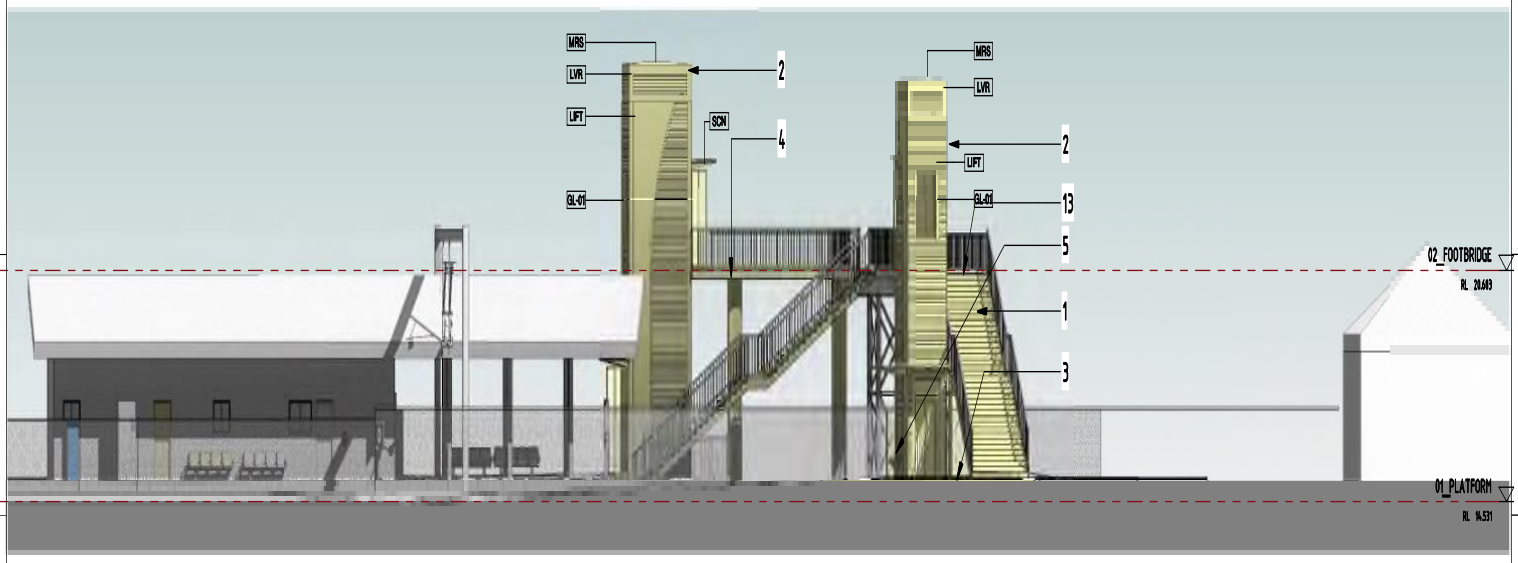
FILE No. 150105 | SHEET: 9 OF 19 | A1

STATUS: SCOPING DESIGN

DRG No. TAP-UNAN- 150105 -AR-DRAWI-1102 | J | EDMS No.

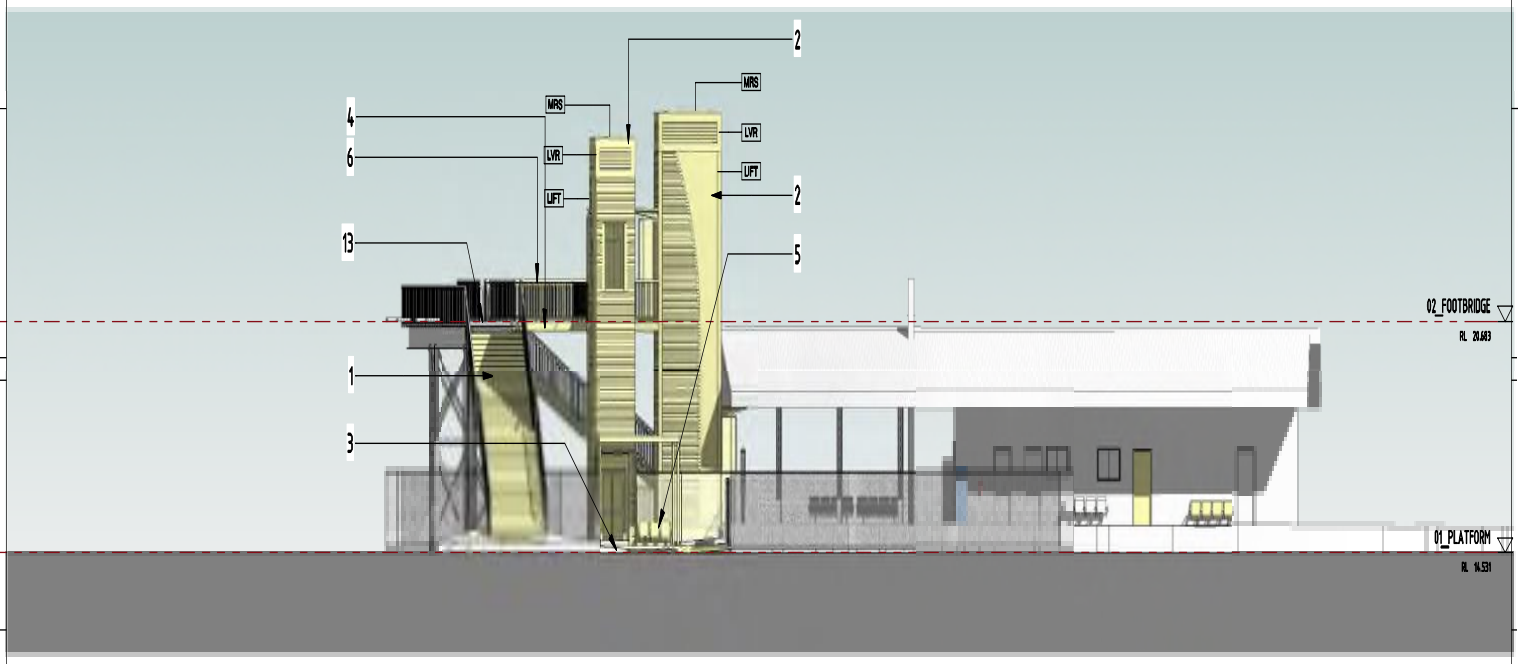
File Plotted C:\Users\VinceShen\Documents\150002_TAP_Unanderra Station_OPTION 2_vince.shen@architectus.com.au.rvt

Plot Date & Time 10/12/2018 10:33:28 AM



ELEVATION 1 (1)

SCALE: 1 : 100@A1



ELEVATION 2 (2)

SCALE: 1 : 100@A1

LEGEND

ABP — ASSISTED BOARDING POINT RAMP

PROPOSED ACCESS POINT

HLP — EMERGENCY HELP POINT

3.3m SETBACK

TO BE DEMOLISHED

PROPOSED WORK

1 EXISTING STAIR TREADS TO BE REPLACED TO AS1428 COMPLIANCE
2 PROPOSED LIFT
3 PROPOSED LIFT ACCESS LANDING ON STREET LEVEL
4 PROPOSED LINK SPAN, TO BE GALVANICALLY SEPARATED FROM THE LIFTS
5 PROPOSED SEATING BENCH
6 PROPOSED LINK SPAN BALUSTRADE
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9 NOT USED
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EX.VM	EXISTING VENDING MACHINE
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SCALES AT A1 SIZE DRAWING

1:100 @ A1 0 1 2 3 4 5 m

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CO-ORDINATE SYSTEM:MGA Zone 56 HEIGHT DATUM:A.H.D. SCALE: 1 : 100 @ A1

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ARCHITECTUS AR

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DRG CHECK	NIGEL JUSTINS	19/10/2018
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APPROVED	Approver	19/10/2018

UNANDERRA STATION

SOUTH COAST LINE 88.199KM TO 88.354KM

ARCHITECTURAL ELEVATIONS

FILE No. 150105 | SHEET: 10 OF 15 | A1

STATUS: SCOPING DESIGN | G

DRG No. TAP-UNAN-150105-AR-DRAW-1201 | G | EDMS No.

File Plotted C:\Users\VinceShen\Documents\150105_TAP_Unanderra Station_OPTION 2_vince.shen@architectus.com.au.rvt
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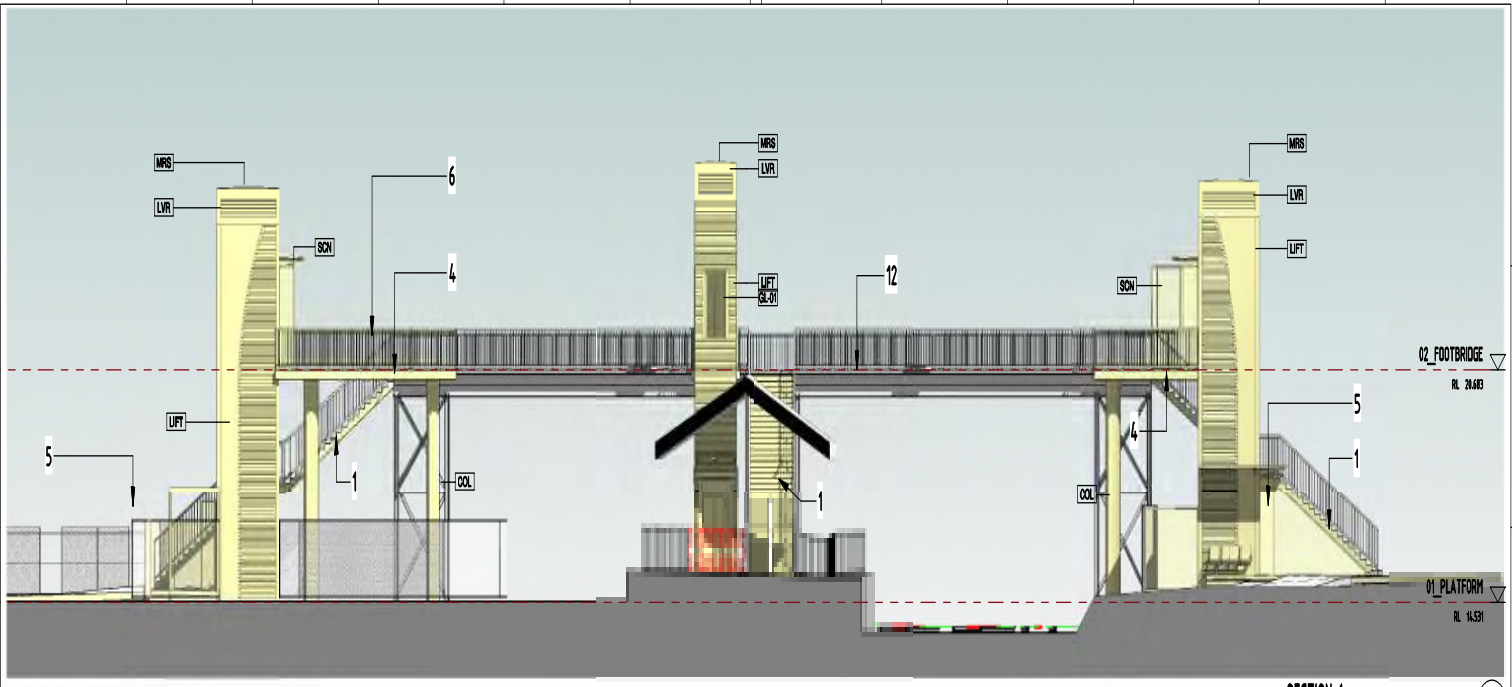
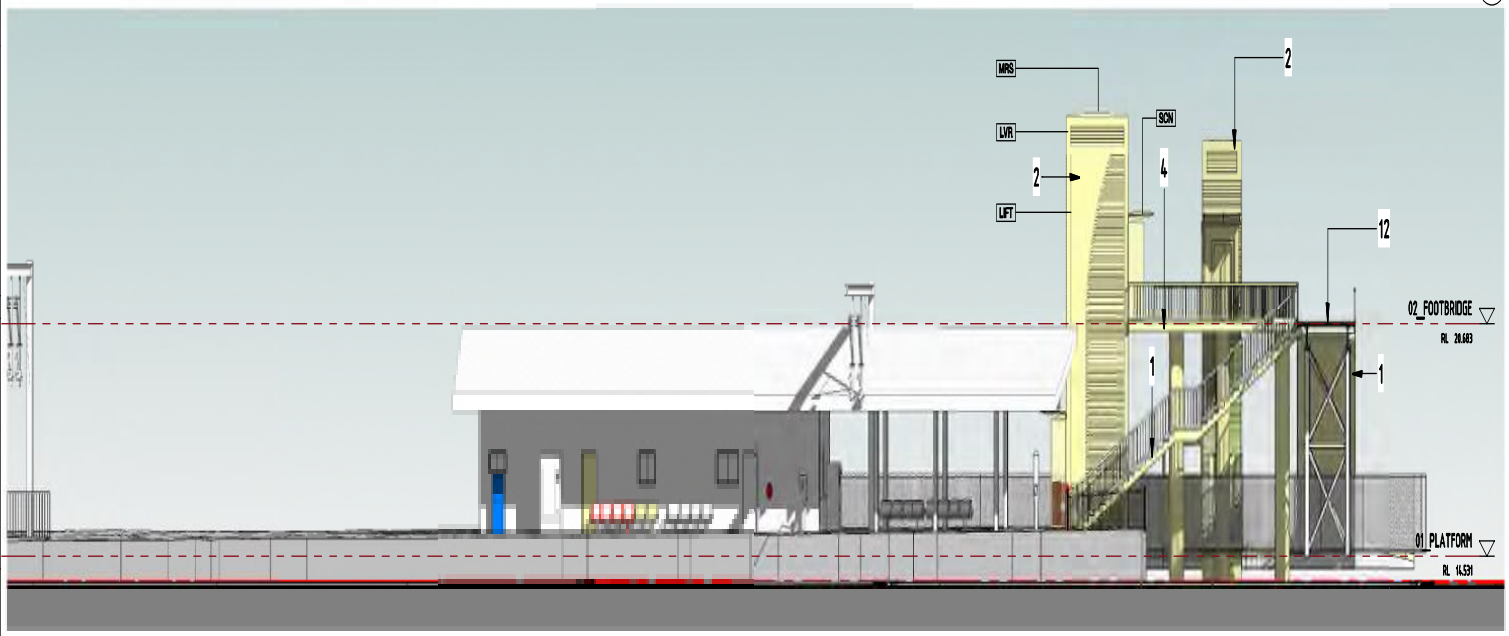


SECTION 1

SCALE: 1 : 100@A1



SECTION 2

SCALE: 1 : 100@A1

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10. EXISTING FOOTPATH TO BE WIDENED
11. NOT USED
12. EXISTING FOOTBRIDGE DECK TO BE REGRADED TO ACHIEVE COMPLIANT CROSS FALL
13. REGRADING EXISTING BRIDGE DECK AT TOP OF STAIR RISER TO PROVIDE CONSISTENT 150mm HIGH RISERS
14. NOT USED

DRAWING COLOUR CODED - PRINT ALL COPIES IN COLOUR

NOTES:

1. ALL LEVELS AND DIMENSIONS SHOWN SUBJECT TO DETAILED SURVEY.
2. RLs INDICATED ARE BASED ON POINT CLOUD SURVEY.
3. REFER TO LIFTRONIC DRAWINGS FOR DETAILED REQUIREMENTS AND SETOUT OF 17 PERSON LIFT.
4. ALL WORKS TO COMPLY WITH AS1428.1 AND AS1428.2 INCLUDING BUT NOT LIMITED TO
   - RAMP GRADIENTS TO MAX 1%
   - ACCESSIBLE CAR PARK SPACE CROSS FALL MAX 1:33
   - FOOTBRIDGE AND ACCESSIBLE PATHWAYS CROSS FALL MAX 1:40
5. NOT ALL KNOWN UNDERGROUND SERVICES ARE SHOWN

SCALES AT A1 SIZE DRAWING

1:100 @ A1 0 1 2 3 4 5 m

AMD	DESCRIPTION	DESIGNER INITIAL / DATE	VERIFIED INITIAL / DATE	APPROVED INITIAL / DATE
J	FINAL FINAL SCOPING DESIGN SUBMISSION	VS-10/12/18	NJ-10/12/18	
H	FINAL SCOPING DESIGN ISSUE FOR SUBMISSION	VS-30/11/18	NJ-30/11/18	
G	FINAL SCOPING DESIGN ISSUE FOR REVIEW	VS-28/11/18	NJ-28/11/18	
F	UPDATED SCOPING DESIGN ISSUE FOR REVIEW	VS-30/10/18	NJ-30/10/18	
E	UPDATED SCOPING DESIGN ISSUE FOR REVIEW	VS-29/10/18	NJ-29/10/18	
D	UPDATED SCOPING DESIGN ISSUE FOR REVIEW	VS-24/10/18	NJ-24/10/18	
C	DRAFT SCOPING DESIGN ISSUE FOR REVIEW	VS-19/10/18	NJ-19/10/18	
B	UPDATED OPTION 2A SKETCH DESIGN ISSUE FOR REVIEW	VS-05/10/18	NJ-05/10/18	
A	OPTION 2A SKETCH DESIGN ISSUE FOR REVIEW	VS-11/09/18	NJ-11/09/18	

CO-ORDINATE SYSTEM:MGA Zone 56 HEIGHT DATUM: A.H.D. SCALE: 1 : 100 @ A1

NSW GOVERNMENT Transport for NSW

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architectus

ARCHITECTUS AR

DRAWN	VINCE SHEN	19/10/2018
DESIGNED	VINCE SHEN	19/10/2018
DRG CHECK	NIGEL JUSTINS	19/10/2018
DESIGN CHECK	NIGEL JUSTINS	19/10/2018
APPROVED	Approver	19/10/2018

UNANDERRA STATION

SOUTH COAST LINE 88.199KM TO 88.354KM

ARCHITECTURAL SECTIONS

FILE No. 150105	SHEET: 11 OF 15	A1
STATUS: SCOPING DESIGN		©
DRG No. TAP-UNAN-150105-AR-DRAW-1251	J	EDMS No.

DF 80 *204

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Plot Date & Time 10/12/2018 10:35:57 AM

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Appendix C – Vibration Criteria

C Construction Vibration

C1. Cosmetic Damage Criteria

British Standard BS 7385:Part 2-1993 “Evaluation and measurement for vibration in buildings Part 2”, gives guidance on the levels of vibration which building structures could be damaged. BS7385 also takes into consideration the frequency of the vibration which is critical when assessing the likelihood of building damage.

Guide values are set for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are considered to result in a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

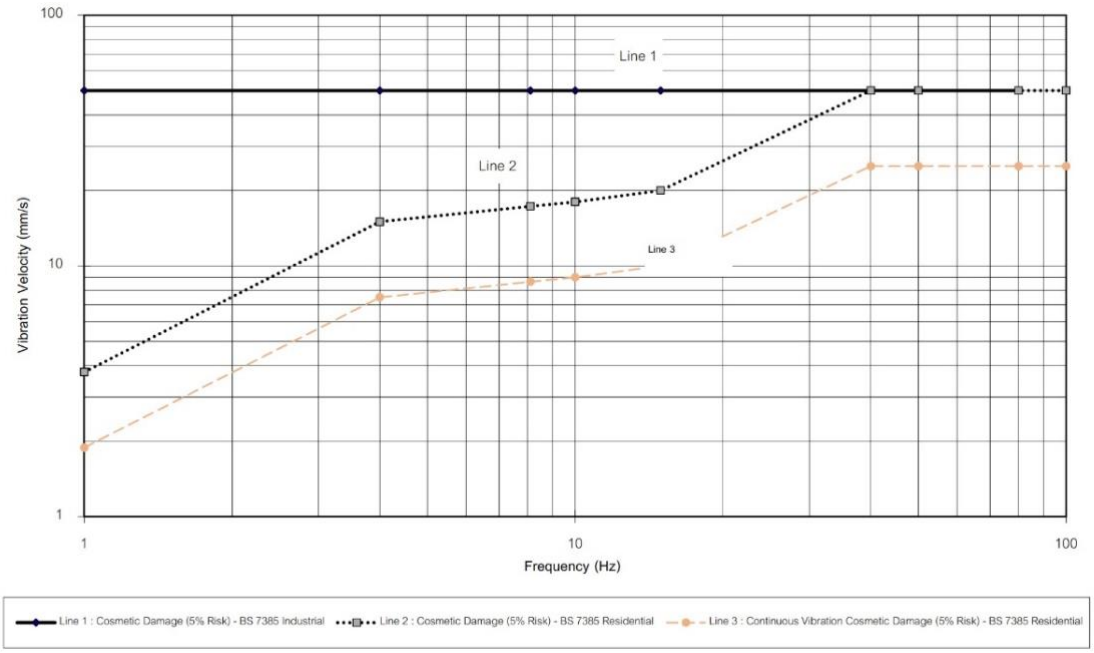
The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and heavy commercial/industrial buildings are presented in **Table C1**, with a visual representation presented in **Figure C1**.

Where sources of continuous vibration may give rise to dynamic magnification due to resonance, the values provided in **Table B1** should be reduced by 50%. This is especially the case with respect to Peak Particle Velocity (PPV) at lower frequencies.

Table C1 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Figure C1– Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage



Sources of vibration, which are considered in the standard, include blasting (carried out during mineral extractions or construction excavation), demolition, piling, ground treatments (compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

To assess the likelihood of cosmetic damage due to vibration, BS 7385 specifies that vibration levels should be obtained from a monitoring position situated at the base of the building and the maximum level of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the criteria curves presented in **Figure C1**.

C2. Human Comfort – Assessing Vibration a Technical Guideline

Humans are far more sensitive to vibration than is commonly realised and may detect vibration levels which are well below levels that may cause damage to buildings or structures. Assessing vibration: a technical guideline was published in February of 2006 by the DECC and is based on guidelines contained in BS 6472 – 1992, Evaluation of human exposure to vibration in buildings (1-80 Hz) and provides guidance on assessing vibration against human comfort.

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to

building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended the operator negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the guideline provides examples of the three vibration types and has been reproduced in **Table C2**.

Table C2 Examples of types of vibration (from Table 2.1 of the guideline)

Continuous Vibration	Impulsive Vibration	Intermittent Vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery)	Infrequent: Activities that create up to three distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990)	Trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

C2.1 Continuous Vibration

Appendix C of the guideline outlines acceptable criteria for human exposure to continuous vibration (1-80Hz), the criteria are dependent on both the time of activity (usually daytime or night-time) and the occupied place being assessed. **Table C3** reproduces the preferred and maximum criteria relating to measured peak velocity.

Table C3 Criteria for Exposure to Continuous Vibration

Place	Time	Peak Velocity (mm/s)	
		Preferred	Maximum
Critical working Areas (e.g. hospital operating theatres, precision laboratories)	Day or Night	0.14	0.28
Residences	Day	0.28	0.56
	Night	0.20	0.40
Offices	Day or Night	0.56	1.1
Workshops	Day or Night	1.1	2.2

Note: rms velocity (mm/s) and vibration velocity value (dB re 10^{-9} mm/s) values given for most critical frequency >8Hz assuming sinusoidal motion.

C2.2 Intermittent Vibration

Intermittent vibration (as defined in Section 2.1 of the guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time.

Intermittent vibration is representative of activities such as impact hammering, rolling or general excavation work (such as an excavator tracking).

Section 2.4 of the Guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted rms (root mean square) acceleration levels over the frequency range 1 Hz to 80 Hz. To calculate VDV the following formula (refer section 2.4.1 of the guideline) was used:

$$VDV = \left[\int_0^T a^4(t)dt \right]^{0.25}$$

Where VDV is the vibration dose value in $m/s_{1.75}$, a (t) is the frequency-weighted rms of acceleration in m/s2 and T is the total period of the day (in seconds) during which vibration may occur.

The Acceptable Vibration Dose Values (VDV) for Intermittent Vibration is reproduced in **Table C4**.

Table C4 Acceptable Vibration Dose Values (VDV) for Intermittent Vibration

Location	Daytime		Night-time	
	Preferred Value, $m/s_{1.75}$	Maximum Value, $m/s_{1.75}$	Preferred Value, $m/s_{1.75}$	Maximum Value, $m/s_{1.75}$
Critical Areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Note: Daytime is 7am to 10pm and Night-time is 10pm to 7am

Note: These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The guideline states that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

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Appendix D – Construction Noise Contours

FIGURE D1

Noise Contours - Scenario 1

MAC191000-04

Unanderra Station Upgrade

KEY

Proposal Site

NML

- OOH2
- OOH1
- Standard
- HNA

0 60 120 180 240 300 m

N

MAC

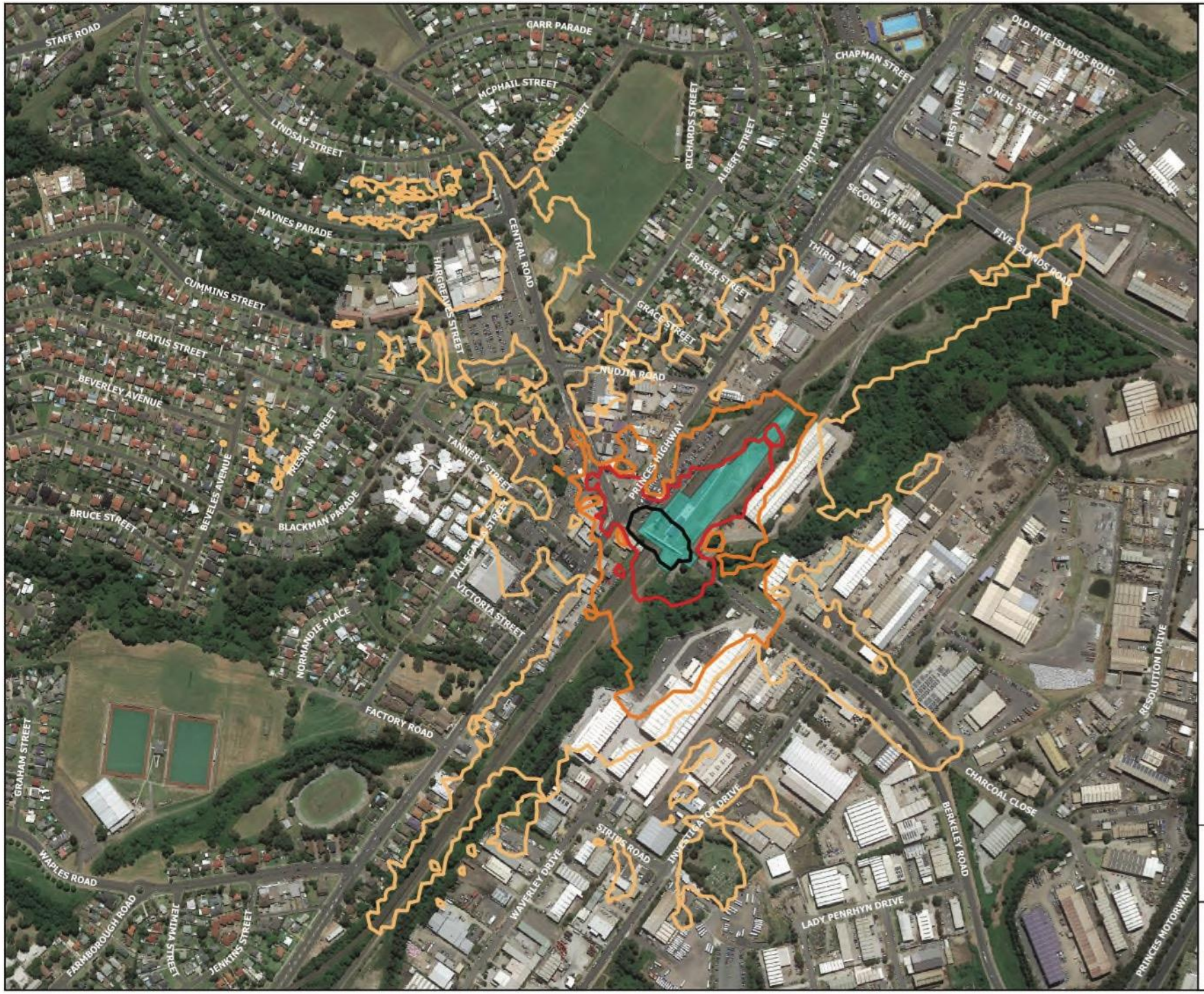

FIGURE D2

Noise Contours - Scenario 2

MAC191000-04

Unanderra Station Upgrade

KEY

Proposal Site

NML

- OOH2
- OOH1
- Standard
- HNA

0 60 120 180 240 300 m

N

MAC

FIGURE D3

Noise Contours - Scenario 3

MAC191000-04

Unanderra Station Upgrade

KEY

Proposal Site

NML

- OOH2
- OOH1
- Standard
- HNA

0 60 120 180 240 300 m

N

MAC

FIGURE D4

Noise Contours - Scenario 4

MAC191000-04

Unanderra Station Upgrade

KEY

Proposal Site

NML

- OOH2
- OOH1
- Standard
- HNA

0 60 120 180 240 300 m

N

MAC

FIGURE D5

Noise Contours - Scenario 5

MAC191000-04

Unanderra Station Upgrade

KEY

Proposal Site

NML

OOH2

OOH1

Standard

HNA

0 60 120 180 240 300 m

N

MAC

FIGURE D6

Noise Contours - Scenario 6

MAC191000-04

Unanderra Station Upgrade

KEY

Proposal Site

NML

- OOH2
- OOH1
- Standard
- HNA

0 60 120 180 240 300 m

N

MAC

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