Appendix E - Acoustic Report

METRONET Stage 1: Morley-Ellenbrook Line

Whiteman Park Station Acoustic Design Report

MEL-MLCX-AR-RPT-00034

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A	2021-09-17	Issued for Information	A Deivasigamani	L Zoontjens	

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A	2021-09-17	Issued for Information	-	-
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Table of contents

Tables

Figures

1. Executive Summary

This document discusses noise and vibration levels expected with operation of the proposed Whiteman Park Station and the extent to which those levels comply with applicable statutory and project requirements.

On the basis of the assessment undertaken it is concluded that:

- Overall environmental rail noise levels, when assessed at nearby potential noise sensitive premises are expected to comply with applicable state noise regulations and planning policy. Rail vibration levels are expected to be compliant with recommended levels.
- Noise from car parking areas, local vehicle traffic and bus movements will increase significantly in the area from current conditions but are expected to remain compliant with relevant state policies.
- Design of the station plant and facilities such as mechanical services, public address and crowding areas to meet applicable environmental noise regulations may be achieved through conventional / industry standard design approaches and therefore is not anticipated to require specialist design input.

Acknowledgement of Country

MELconnx acknowledges the Whadjuk People of the Noongar Nation as the Traditional Custodians of the land and waters on which the Morley-Ellenbrook Line Project is located. We pay our respect to their Elders, both past and present and thank them for their continuing connection to the country, culture and community.

2. Project overview

2.1 METRONET Vision and Objectives

As Perth's single largest investment in public transport, METRONET will transform the way people commute and connect. It will create jobs and business opportunities and stimulate local communities and economic development to assist communities to thrive. The METRONET vision is for a well-connected Perth with more transport, housing and employment choices.

In delivering METRONET, the WA Government has considered peoples' requirements for work, living and recreation within future urban centres with a train station at the heart.

The objectives are to:

- Support economic growth with better connected businesses and greater access to jobs
- Deliver infrastructure that promotes easy and accessible travel and lifestyle options
- Create communities that have a sense of belonging and support Perth's growth and prosperity
- Plan for Perth's future growth by making the best use of our resources and funding
- Lead a cultural shift in the way government, private sector and industry work together to achieve integrated land use and transport solutions for the future of Perth.

2.2 Morley-Ellenbrook Line overview

As Perth grows, so does the need for rail infrastructure and METRONET is a critical element of the State Government's infrastructure agenda. The Morley-Ellenbrook Line (MEL) Project will improve connectivity between the north east metropolitan area and the rest of the city and unlock economic development in these local community areas.

Figure 1: Morley-Ellenbrook Line © METRONET

The Public Transport Authority (PTA) is the lead agency delivering the MEL Project, with Main Roads WA (MRWA) undertaking some enabling works.

2.2.1 Project features

Transport infrastructure works for the Project include:

- A 21km rail line spurring from the Midland Line east of Bayswater Station, travelling north in the Tonkin Highway median, east through land north of Marshall Road and north on the western side of New Lord Street into Ellenbrook
- Stations at Morley, Noranda, Malaga, Whiteman Park and Ellenbrook with future-proofing for a station at Bennett Springs East
- Parking and bus interchanges/facilities at stations
- Significant grade separations at key road crossings
- Underpasses to allow the rail line to enter and exit the Tonkin Highway median
- Principal shared paths for walking and cycling access along the rail line
- Track and associated infrastructure to connect to the existing Midland Line
- Road and bridge reconfiguration works
- Integration across the packages of works and other nearby projects.

2.2.2 General scope of works

The Project's general scope of works includes the design and delivery of rail infrastructure and ancillary works to support operational passenger rail between Bayswater and Ellenbrook, including stations with inter-modal bus and rail with parking and associated road works at Bayswater, Morley, Noranda, Malaga, Whiteman Park and Ellenbrook stations.

The Project activities include all investigation, design, approvals, construction, testing and commissioning, Entry Into Service (EIS), training and operational readiness required to incorporate the new railway to Ellenbrook, and tie into the existing network including the associated road, utilities and other required works to interface with adjacent works and contracts. This will include bulk earthworks and retaining structures, grade separations, roads and drainage.

The design and delivery of the main works package for the Project is broken into three distinct stages:

- Alliance Development Stage
- Project Alliance Reference Design Stage
- Project Alliance Delivery Stage (Detailed Design through to Project close-out).

Figure 2: Architect's Impression of Whiteman Park Station © MELconnx

2.2.3 Key Project Objectives, Key Compliance Objectives and Critical Success Factors

The PTA and MELconnx's single Non-Owner Participant (NOP) Laing O'Rourke Construction Australia Pty Ltd, have formed an integrated, collaborative Project Alliance to successfully deliver rail infrastructure that reflects our absolute commitment to achieving the Project Objectives and delivering positive outcomes for the State.

The following image demonstrates how we have mapped each Key Project Objective in the Project Alliance Agreement (PAA) against the Critical Success Factors to achieve best-for-project outcomes, underpinned by the Key Compliance Objectives.

Key Project Objectives	Critical Success Factors for Successful Project Delivery (abbreviated)
Implementation of a robust, cooperative team culture.	• Development of a culture that results in all Participants developing behavioural values and driving principles to achieve Alliance goals and project objectives • Longevity and stability of key Alliance personnel i.e. Alliance Manager, ALT and AMT.
Timely delivery of Works to achieve project milestones in accordance with agreed program.	• Development of a final proposal with a sufficiently developed design and accurate TOC • Subsequent cash flow management and financial forecasting, scheduling and value-earned calculation and determination • Implementation of PTA mandated systems i.e. TeamBinder, Primavera P6, TILOS and a finance system accepting the PTA's cost breakdown structure • Timely completion of design, construction and commissioning through to practical completion • Timely progress towards construction milestones and completion of close-out to achieve final asset acceptance compliance.
Inclusion of processes that embrace/promote open tendering and promotion of work package development that encourages/ enables second and third tier tendering. **Compliance with WAIPs.**	• For professional service providers, implement a proven and mature supply-chain engagement process, including tender review, contract award and project integration. Ensure that it offers opportunity and security of payment relative to services delivered in an effort to achieve best-for-project outcomes • For material suppliers and other subcontract service providers, implement a proven and mature supply-chain engagement process, including tender review, contract award and project integration that offers opportunity and security of payment relative to service delivered • Proven and mature supply-chain engagement process for labour hire services, compliant with industrial and safety laws, maintained employee standards/conditions and security of employee payments • Ability to develop contracts and terms and conditions in the spirit of the Alliance values and principles , appropriate and commensurate with the size, complexity and value of packages in accordance with industry best practice.
Optimisation of operational and whole of life costs.	• Sustainability considerations and outcomes for the whole of life of the works.
Ensuring appropriate consultation/integration with stakeholders and community.	• Constant and effective engagement with relevant stakeholders, particularly utilities/services, Main Roads, third party asset owners and relevant unions • Effective management of PTA interfaces and PTA contractors • Constant/effective engagement with the PTA in design reviews, work planning and possessions/shutdowns.
Providing passengers with safe and secure services and facilities.	• Compliance with ONSR requirements • Completed rail line, stations and bus transfer infrastructure are able to deal successfully with the movement of people, including the disabled.
Minimising disruption to current and anticipated rail operations.	• Minimise impact on public transport services disruption • Liaison and interaction with PTA rail operations personnel tasked with determining network closures, to confirm available network shutdowns and implement contingency plans • Effective management of interfaces with others in heavily constrained areas • Effective management/staging of works to reflect staged/constrained site access • Effective management of existing rail infrastructure asset protection.
Recognising the State's desired industrial relations objectives.	• Develop a project-specific Industrial Relations Management Plan based on a proven and successful industrial relations approach that delivers a collaborative worksite, genuine collective agreement, making good faith in negotiations and dispute resolution, and respect for trade union rights of entry.

Key Compliance Objectives (abbreviated)				
Compliance with all Statutory requirements and State Government policy requirements for construction work.	Compliance with the SWTC.	Protecting and minimising disruption to all existing facilities, infrastructure, properties or public utility services.	Meeting all obligations to impacted stakeholders and demonstrating genuine sensitivity.	Compliance with all environmental conditions and minimise adverse environmental impact.

Figure 3: Key Project Objectives, Critical Success Factors and Key Compliance Objectives

2.3 Alliance vision and delivery approach

The MEL Project will be delivered under an alliance contract to support the management of project and stakeholder interfaces and to mitigate project risks. A collaborative alliance approach will see the Works carried out in a cooperative, coordinated and efficient manner in compliance with the Alliance Principles.

MELconnx understands that the successful delivery of the Project is critically linked to meeting the PTA's Key Project Objectives. These objectives have shaped our vision for the Project that is around delivering a high-quality product and creating exceptional value-for-money. We are committed to a no-blame culture and to the prompt and mutual resolution of any issues that may arise.

During the AD Stage, representatives from both the PTA and MELconnx participated in an interactive workshop to begin the process of developing a suitable Alliance Vision for the Project (refer Figure 4 below for workshop outcomes).

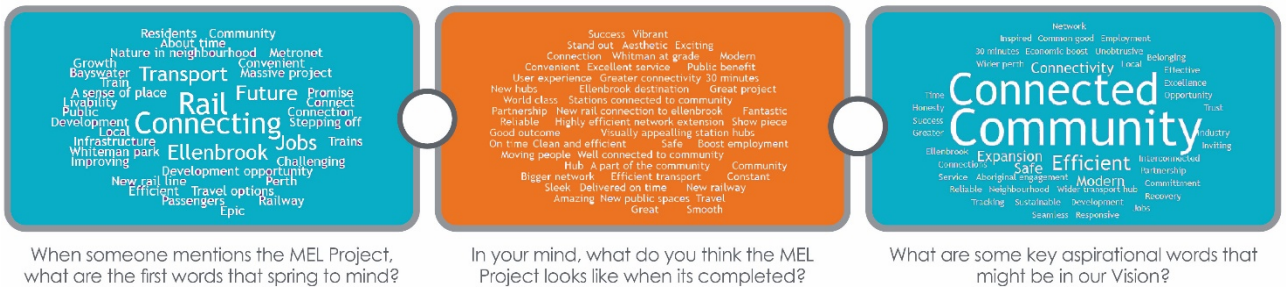


Figure 4: AD Stage Alliance Vision Development Outcomes (developed with the PTA)

The Alliance Foundation workshop was held on 11/11/2020 and the results of this workshop generated the basis for the Vision, Purpose, Values and Behaviours Commitment Statements represented here.

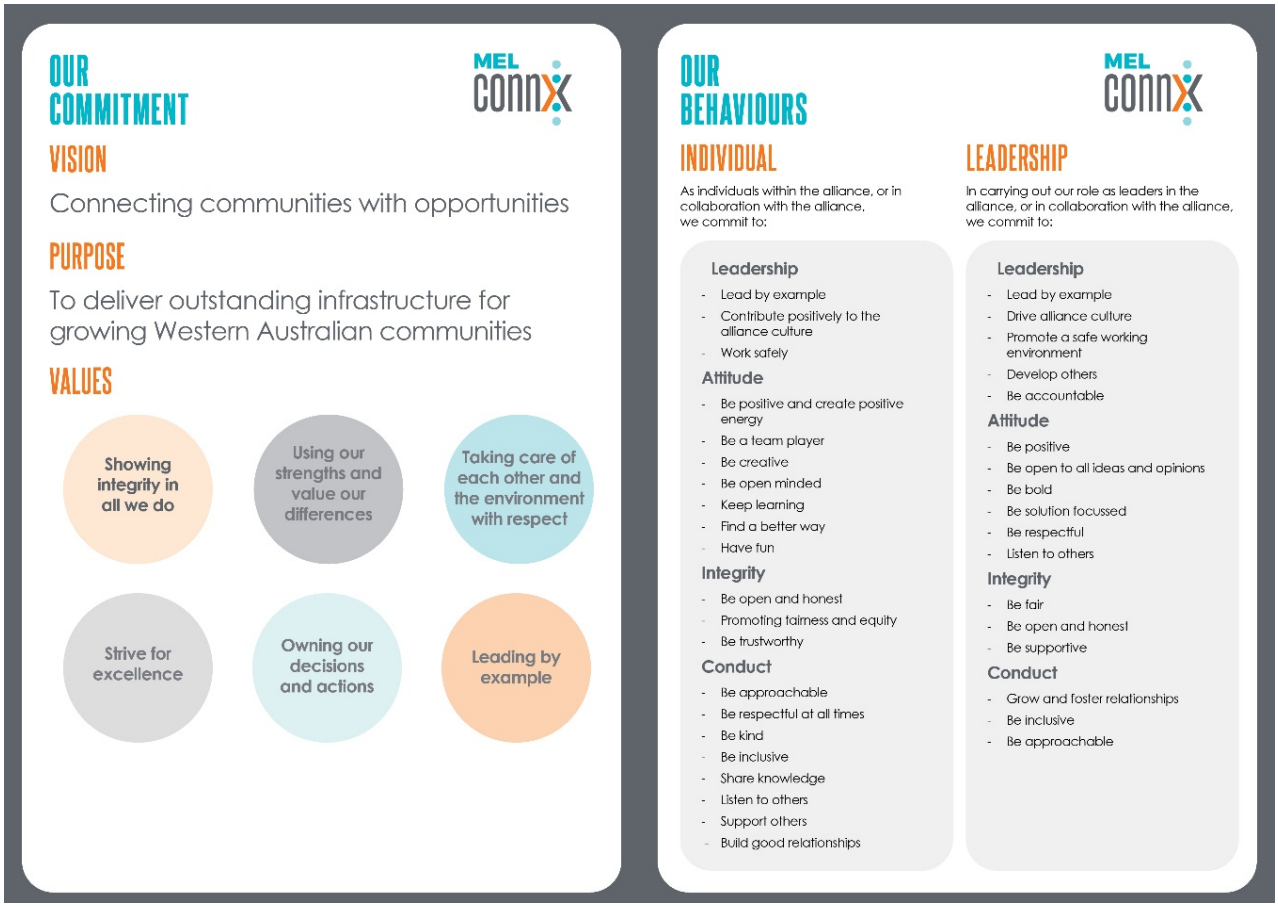


Figure 5: MELconnx Alliance Vision, Purpose and Values

2.4 Purpose of the Report

Whiteman Park Station is proposed as a key station where all trains will slow down and stop at the station (no non-stop 'through' traffic).

The project will also involve the construction of car parks, bus and car drop off points and pedestrian facilities, the operation of which may involve a change in noise levels at nearby residential and other sensitive locations.

This document discusses noise and vibration levels expected with operation of the proposed Whiteman Park Train Station and the extent to which those levels comply with applicable statutory and project requirements.

This Design Report identifies any interdependencies between each Design Package and how those dependencies have been accommodated within the document. The Design Report describes the relationship between each of the Package(s) engineering lifecycle and the assurance gates throughout the Project.

2.5 Changes Since Previous Design Submission

2.5.1 Alliance Development Stage to Reference Design Stage

Not applicable at this Design Stage.

2.5.2 Reference Design to Interim Detailed Design

Not applicable at this Design Stage.

2.5.3 Interim Detailed Design to Final Detailed Design

Not applicable at this Design Stage.

2.5.4 IFC Design Finalisation

Not applicable at this Design Stage.

3. Design Description

3.1 Scope of this Design Package

The scope of this Design Package is outlined as follows.

- A schedule of recommended controls where required to be considered and reviewed for design optimisation and design/statutory planning approval within the packages is described in Section 3.3.

The details of the future masterplan (i.e. buildings in the vicinity of the station and car park) are currently unknown, and hence they cannot be assessed in detail at this stage. The indicative future development masterplan show that the future sensitive uses may be in the order of 125 m from the station bus loops and transformers located to the east of Drumpellier Drive. It is anticipated that compliance with the Noise Regulations can be achieved via careful unit orientations and shielding (such as screens and enclosures) where necessary. Detailed impacts and mitigation measures (if required) to this future development will be assessed once more details are available during the course of the design.

3.2 Design Description

The following subsections discuss the key project noise and vibration issues assessed in further detail.

3.2.1 Rail operations

Treatments to the railway sections involved at Whiteman Park Station are considered not required. Speeds in the immediate vicinity of the station are too low for rolling noise levels to be above State Planning Policy 5.4 (SPP5.4) targets that may be assessable at nearby development.

Note that compliance with SPP5.4 does not prevent community complaint. Subjectively, residents in the area may notice noise from low speed rail movements and the braking system air release as trains depart. Train air conditioning systems may also be noticeable on unusually hot days. These noise emissions are modelled to be within SPP5.4 targets.

Given the expected speeds in the immediate vicinity of the station, vibration levels are predicted to be within recommended criteria applicable at anticipated future development sites nearby. See Section 4.8.8 for further information.

3.2.2 Station and associated infrastructure

Asphaltic or bitumen-based road and vehicle parking surfaces should be used instead of smooth concrete or heavily painted surfaces which can result in strong sound reflections and tyre squeal under cornering.

Speed bumps or sudden changes in road level (e.g. loose gutters, expansion control joints) should be avoided. Traffic can however be managed via gradual gradient pedestrian crossings (such as wombat crossings) if required.

From Section 5.2 it can be seen that noise impacts at adjacent future development areas from road vehicles can be managed to levels compliant with applicable criteria.

On the basis of a screening assessment of proposed public address systems (Section 4.8.1) and likely crowd noise (Section 4.8.2), compliance with relevant assigned noise levels is expected.

With regards to internal reverberation levels, the station platform is expected to comply with SWTC requirements, on the basis of hard diffusive internal walls and the open style ceiling and roof system which provides significant access to open air. The concourse area is relatively enclosed and is recommended to have absorptive finishes to achieve the recommended reverberation levels due to the fairly enclosed nature of the space below the platform and viaducts – refer Section 4.8.1.

3.2.3 Electrical transformer noise

The transformer located just north-east of the proposed bus loop and is more than 100 metres from the future development and is more than 250 m from existing residential premises. Based on expected loading and sound power levels for transformers, it is predicted that noise emissions will be compliant with applicable noise regulations.

3.2.4 Mechanical noise

A basic screening assessment is provided in Appendix E which considers the minimum distance to potential future noise sensitive development and the proposed mechanical plant and equipment.

Given the equipment comprises small enclosed fan coil units and domestic level air conditioning outdoor condensers, compliance with applicable noise regulations is predicted.

3.2.5 Local road traffic and new roundabouts

Local road vehicle traffic noise may vary due to the introduction of the proposed train station but is not assessable within the criteria outlined.

3.3 Relationship with other Design Packages

The relationship and/or reliance of this design package on other MEL design packages is derived from the N2 Matrix and is outlined in the Table below.

Relationship with other Design Packages	Description/Title	Interface Elements	Integration Strategy
E018	Line wide - Permanent Way and Stabling & Track – Transit Space & Structure /Ballast Interface	Trackform Rail web dampers Under ballast matting	Confirm trackform Review rail web damper options

E016	LW Urban Design - Urban Design - Architecture	Noise walls	Confirm spatial inputs and coordinate implementation of recommended treatments
E017	Linewide Urban Design - Landscape	Noise walls	Confirm spatial inputs and coordinate implementation of recommended treatments
E010	Whiteman Park Precinct – Urban Design – Architecture	Noise walls	Confirm spatial inputs and coordinate implementation of recommended treatments
E098	Whiteman Park Precinct Civil - Fencing and Gates, Retaining Walls & Minor Structures, Noise Walls	Noise walls	Confirm spatial inputs and coordinate implementation of recommended treatments
E102	Whiteman Park Station – Electrical - Lighting & LV & Comms & Security	Electrical plant noise emissions	Confirm inputs and coordinate implementation of any recommended treatments
E105	Whiteman Park Station – Mechanical and BMSC	Mechanical plant noise emissions	Confirm inputs and coordinate implementation of any recommended treatments

3.4 External Interfaces

The relationship and/or reliance of this design package on external interfaces and details of integration strategies are outlined in the Table below.

Item	External Party	Interface Elements	Integration Strategy
	N/A		

4. Design Inputs

4.1 Project Design Requirements

The following design inputs, loads combinations, standards and other key design inputs have been used in preparation of this report;

4.1.1 Environmental noise regulations

Refer to Section 4.5.1 below.

4.1.2 SWTC Requirements

Refer to Section 4.5.3 below.

4.1.3 Operational Scenarios

Normal operations are expected to result in 74 train movements per day (6am to 10pm) and 16 movements per night (10pm to 6am) at the Whiteman Park Station.

The “PTA Concept Train Operating Plan” described as being within Book 5 of the SWTC could not be accessed. In lieu of this information, these volumes are used from the Reference Design.

4.1.4 Stations and Infrastructure

Stations and infrastructure have been assessed on the basis of supplied drawings to date and 16 buses per hour typical day scenario.

We note that the design of each station utilises natural ventilation strategies, with significant openings at roof level throughout the station.

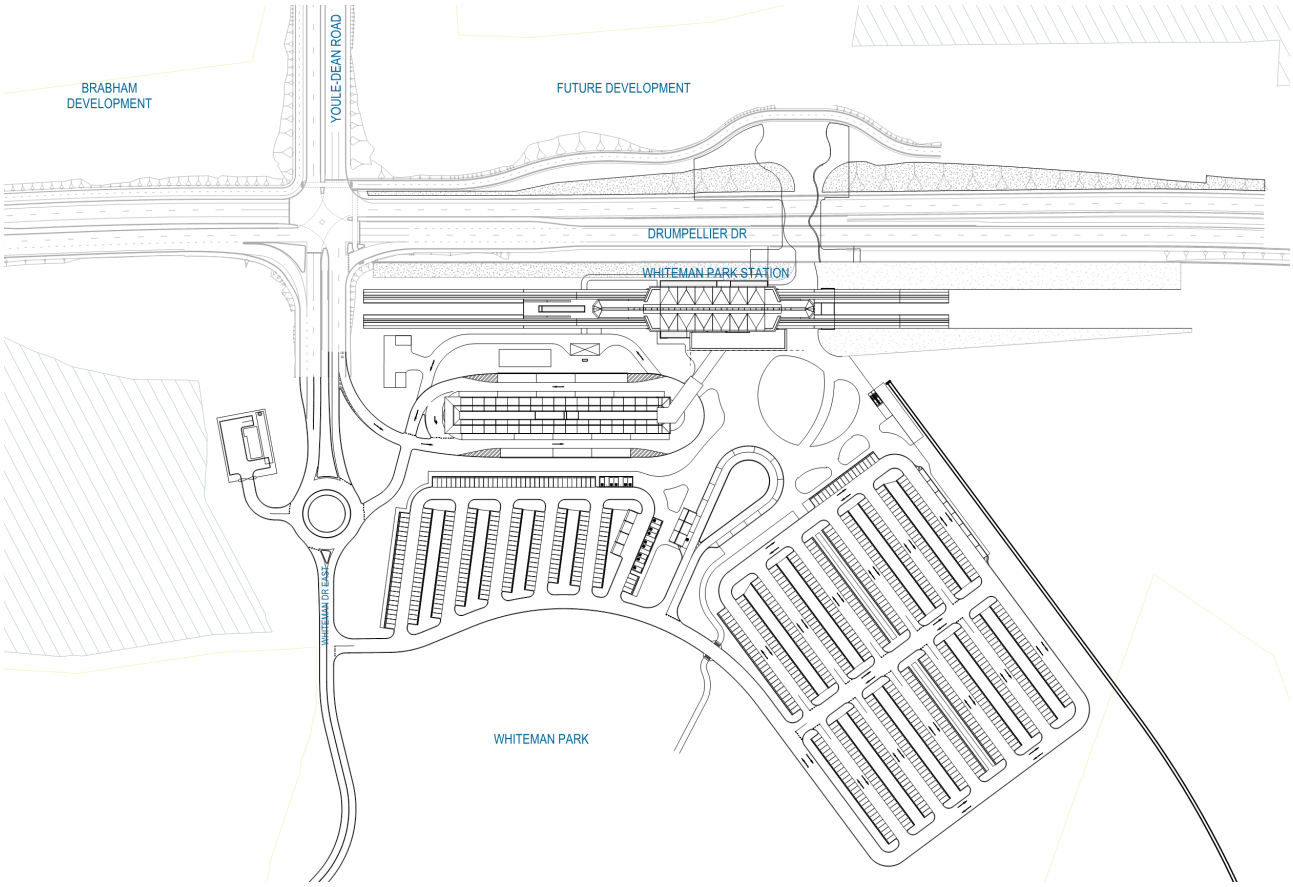


Figure 6: Extract of architectural overview plan 25-A-289-AR0011_A02 indicating site locality.

4.1.5 Electrical transformers

From the supplied drawings, it can be seen that the transformers associated with the station are approximately 100 metres from future development (East of Drumpellier Drive) and more than 250 m from existing residential properties. By inspection of the likely transformer sound power level / loading and the proposed screening elements, compliance with the relevant assigned noise levels is expected.

4.1.6 Electrical pumps

From the supplied drawings, it can be seen that the pumps within the station precinct are approximately 100 metres from future development (East of Drumpellier Drive) and more than 250 m from existing residential properties. By inspection of the likely pump sound power level / loading and the proposed screening elements, compliance with the relevant assigned noise levels is expected.

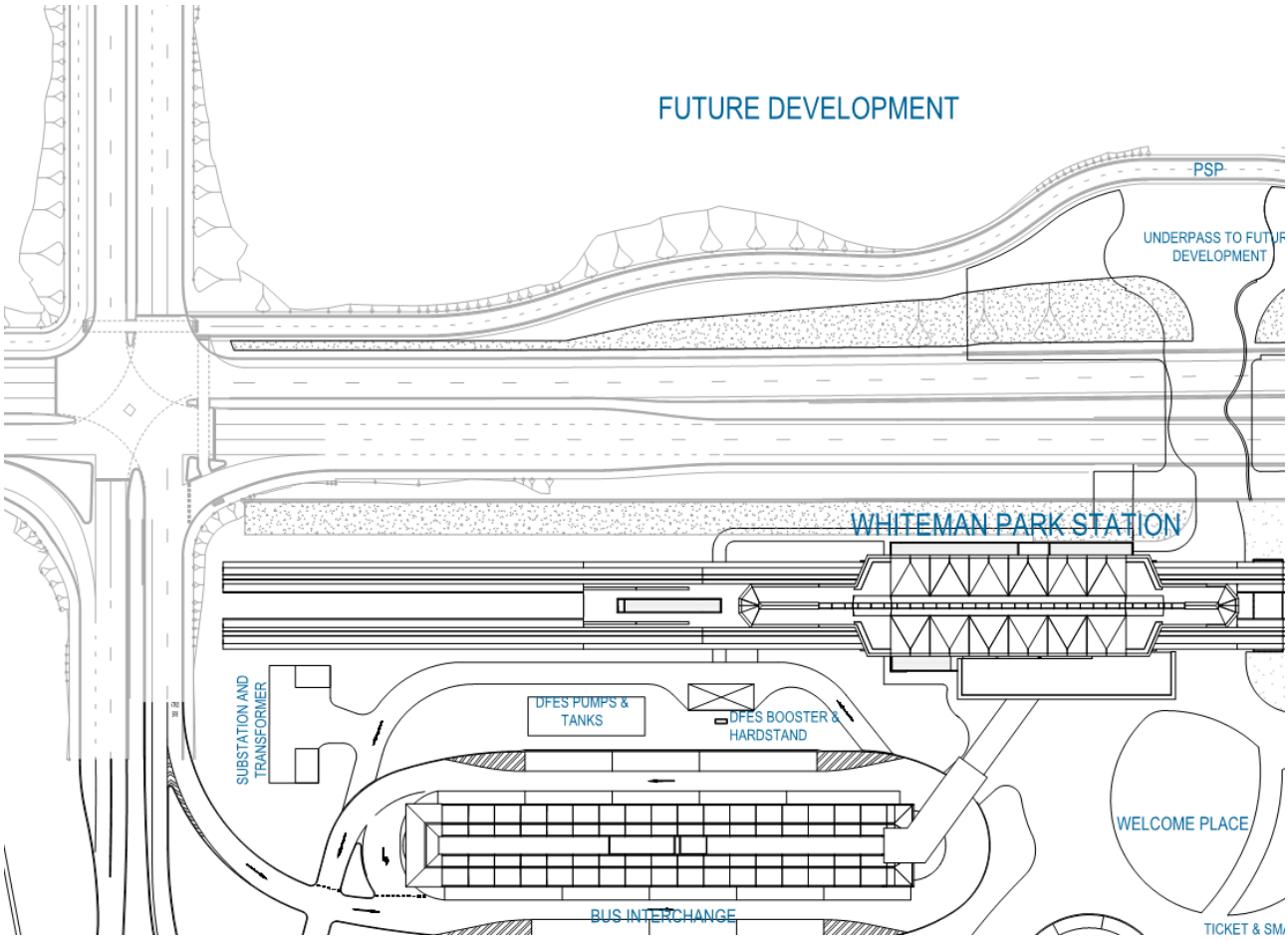


Figure 7: Extract of architectural plan 25-A-289-AR0013_A02

4.1.7 Mechanical outdoor plant

Drawings 25-A-289-ME0008 to -ME0013 indicate that the outdoor mechanical plant comprise condenser units. Based on rooms served, each would have capacities the order of 6 kW or less (similar to domestic residential air conditioning systems). These units, assessed in cumulative terms, are considered compliant with the assigned noise levels defined in Section 4.5.1 at the nearest noise sensitive premises.

4.2 Design Software Used for this Package

Computer software used to develop this package is outlined in the Table below.

Reference	Supplier	Usage
MS Office 2013	Microsoft Inc. (with proprietary SLR code)	Calculation of in-car noise levels Calculation of 3D receiver distances Calculation of 1D vibration propagation Consolidation and presentation of results 1D propagation / noise analyses
SoundPLAN v8.1	SoundPLAN GmbH	Calculation of site wide airborne noise emissions according to prescribed standards

4.3 Applicable Codes and Standards

Applicable standards, codes and guidelines to this design package (at time of project commencement) including identification of specific provisions, criteria and classifications are provided in the Table below.

Reference	Description/Title	Compliance (Specific Provisions, Criteria and Classifications)
Australian and Other Standards and Guidelines		
CR NOI TSI	Technical specification for interoperability relating to the subsystem 'rolling stock – noise' of the trans-European conventional rail system, adopted by the Commission Decision 2011/229/EU, April 2011	Referenced for typical wheel-rail roughness assumptions
SPP5.4	State Planning Policy No. 5.4 Road and Rail Noise 2019	Compliance criteria
EPNR	Western Australia Environmental Protection (Noise) Regulations 1997	Compliance criteria
AS 2670.1	Evaluation of human exposure to whole-body vibration - General requirements	Reference for assessment method
AS 2670.2	Evaluation of human exposure to whole-body vibration - Continuous and shock-induced vibration in buildings (1 to 80 Hz)	Referenced for criteria comparison
ISO GUIDE 98-3	Uncertainty of measurement — Part 3:Guide to the expression of uncertainty in measurement (GUM:1995)	Referenced for uncertainty estimation
ISO 2631-1:1997	Mechanical vibration and shock - Evaluation of human exposure to whole-body vibration - Part 1: General requirements.	Reference for assessment method
AS ISO 2631.2:2014	Mechanical vibration and shock - Evaluation of human exposure to whole-body vibration - Vibration in buildings (1 Hz to 80 Hz).	Compliant
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc, 2011 ASHRAE Handbook - Heating, Ventilating, and Air-Conditioning APPLICATIONS - SI Edition, Atlanta GA http://www.ashrae.org	Referenced for typical HVAC installation and operations
FTA	C.E. Hanson, D.A. Towers, and L.D. Meister 2006, Transit Noise and Vibration Impact Assessment, Office of Planning and Environment, Federal Transit Administration, Report FTA-VA-90-1003-06, Washington DC	Referenced for vibration assessment method
Nord2000	Jonasson HG, Storeheier S. Nord 2000. New Nordic prediction method for rail traffic noise [Internet]. 2001. (SP Rapport).	Rail noise modelling algorithm adopted
Green Star	Green Star Design and As-built Requirements for Railway Stations (v1.1)	Partially compliant (within the scope of this report)
ISCA	Infrastructure Sustainability Council of Australia (ISv2.0) Design and As Built	General reference
PTA Standards and Specifications		

Reference	Description/Title	Compliance (Specific Provisions, Criteria and Classifications)

4.4 Reference Information

The project specific reference information and reports that have been used as inputs into the development of the detailed design are included in the table below.

Document Reference	Description/Title	Revision
25-A-289-AR0001 to -AR0127	E010 Whiteman Park Station - Urban Design - Architecture	A, A01, A02
25-A-289-EG0101 to -EG0168	E0102 Whiteman Park Station - Electrical - Lighting & LV & Comms & Security	A, A01, A02
25-A-289-ME0001 to -ME0017	E105 Whiteman Park Station – Mechanical and BMSC	A, A01, A02
	MEL - MLCX – WHITEMAN PARK STATION - COMMUNICATIONS - EASE ACOUSTIC MODEL - SHEET 01	A
	MEL - MLCX - WHITEMAN PARK STATION - COMMUNICATIONS - EASE ACOUSTIC MODEL - SHEET 02	A
	MEL - MLCX - WHITEMAN PARK STATION - COMMUNICATIONS - EASE ACOUSTIC MODEL - SHEET 03	A
GCOR-LOR-LW-00096	Track Inputs for Noise Modelling	02-Jun-2021 13:10 AWST
GCOR-LOR-PW-00193	Design data for SLR noise modelling	07-May-2021 19:02 AWST
GCOR-LOR-PW-00166	MELconnx CAD issue to SLR	30-Apr-2021 09:42 AWST
GCOR-LOR-LW-00047	Latest WIP rail strings	19-Apr-2021 11:51 AWST
GCOR-LOR-PW-00128	Update to Health Safety Environmental Management System	06-Apr-2021 15:56 AWST
GCOR-LOR-PW-00071	Aerial Imagry (sic)	01-Apr-2021 15:48 AWST
GCOR-LOR-PW-00067	Project AD Design Information On ASite	23-Feb-2021 11:16 AWST
(TBA)	<Architectural and Civil Drawing packages>	
	Baseline Noise and Vibration Measurements (SLR Consulting)	(in preparation)

4.5 Design Criteria

The design criteria utilised in the development of this report are outlined below.

4.5.1 Environmental Noise Regulations

Environmental noise emissions (excluding trains and some emissions from road vehicles) from various premises to nearby noise receiving premises are covered by legislation in the form of the *Western Australia Environmental Protection (Noise) Regulations 1997,* which operate under the *Environmental Protection Act 1986*. For this project, these regulations apply to stations and ancillary operational equipment, and specifically do not apply to narrow gauge trains.

To achieve compliance, received noise levels at nearby premises including noise sensitive premises (for example, residential, commercial and industrial premises) are not to exceed specified noise limits in the form of assigned noise levels. The Act gives state authorities powers to order financial penalties and closure of plant that are in excess of assigned noise levels through a formal investigation process. There are methods within the Regulations by which assets found to be producing excessive noise be managed on an ongoing basis in consultation with the Department of Water and Environment Regulation (DWER), say through noise management plans and/or alternative criteria, however at its core of any such agreement is that the proponent will exercise all reasonable and practicable measures to minimise noise.

The assigned noise levels, as shown in Table 1, vary for each noise sensitive receiver, as they are determined from consideration of Influencing Factors (IF) which takes into account the amount of commercial, industrial and road transport infrastructure within specific distances to the receiving noise sensitive premises.

Table 1 Table of Assigned Noise Levels, dB

Part of premises receiving noise	Time of day	LA10	LA1	LAmax
Noise Sensitive premises at locations within 15 metres of a building directly associated with a noise sensitive use	0700 to 1900 hours Monday to Saturday	45 + IF	55 + IF	65 + IF
	0900 to 1900 hours Sunday and public holidays	40 + IF	50 + IF	65 + IF
	1900 to 2200 hours all days	40 + IF	50 + IF	55 + IF
	2200 hours on any day to 0700 Monday to Saturday and 0900 hours Sunday and public holidays	35 + IF	45 + IF	55 + IF
Noise Sensitive premises at locations further than 15 metres from a building directly associated with a noise sensitive use.	All hours	60	75	80
Commercial premises	All hours	60	75	80
Industrial and utility premises	All hours	65	80	90

Regulation 7 of the *Environmental Protection (Noise) Regulations 1997* requires that, if noise emitted from any premises when received at any other premises cannot reasonably be free of intrusive characteristics of tonality, modulation and impulsiveness, then a series of adjustments must be added to the emitted levels (measured or calculated) and the adjusted level must comply with the assigned level. The adjustments are detailed in Table 2 and are further defined in Regulation 9(1) of the *Environmental Protection (Noise) Regulations 1997*.

Note that the following adjustments (Table 2) generally apply to fixed plant and infrastructure only.

Table 2 Table of adjustments for intrusive characteristics

Application	Where tone(s) are present	Where modulation is present	Where impulsiveness is present
Adjustment where noise emission is not music (These adjustments are cumulative to a maximum of 15 dB)	+5dB	+5dB	+10dB

Tones are defined in Regulation 9(1) as being present where the difference between the A weighted sound pressure level in any one third octave band and the arithmetic average of the A-weighted sound pressure levels in the two adjacent one third octave bands is greater than 3dB in terms of $L_{Aeq,T}$ where the time period T is greater than 10% of the representative assessment period, or greater than 8dB at any time when the sound pressure levels are determined as LAS levels.

Modulation is defined as a variation in the emission of noise that —

- is more than 3 dB L_{AF} or is more than 3 dB L_{AF} in any one third octave band;
- is present for at least 10% of the representative assessment period; and
- is regular, cyclic and audible.

Impulsiveness is defined as present where the difference between L_{Apeak} and L_{ASmax} is more than 15dB when determined for a single representative event.

During the assessment process the above adjustments have been applied to relevant noise sources, taking into account specific intrusive characteristics of these noise sources based on SLR's in-house noise database. It is unlikely that modulation or impulsiveness characteristics would apply to PTA fixed assets being typically electrical power transformers or air handling plant

4.5.2 SPP5.4

SWTC 13.6.1-3 states that

The Alliance must design and construct the operating passenger railway and any associated noise mitigation controls to meet the requirements of "State Planning Policy No. 5.4 Road and Rail Noise (SPP 5.4)" (WAPC, 2019).

The Alliance must design and construct the operating passenger railway to ensure that the LAmax applicable to the 95th percentile train passby event is 80 dB or less at buildings with a noise sensitive use located on noise sensitive premises.

The table below outlines the adopted noise objective levels in regard to airborne noise during road and rail operations. Noise mitigation must be provided where the noise level is above these targets

Table 3 SPP5.4 criteria

Metric	Application	Value(s)	Notes
Period average noise levels	**Major upgrade of existing railway** *Applied where emissions from MID and FAL lines are considered significant (Bayswater area)*	$L_{Aeq,day}$ 60 dB	SPP5.4
		$L_{Aeq,night}$ 55 dB	
	New railway *(All other locations)*	$L_{Aeq,day}$ 55 dB	
		$L_{Aeq,night}$ 50 dB	
Maximum noise levels	**Line wide**	L_{Amax} 80 dB	95th percentile. SWTC

These objectives are assessed outdoors, 1 metre from the main building on a lot associated with a noise sensitive usage. Consistent with SPP5.4, the criteria are assessed

- Only at premises that are occupied or designed for occupation or use for residential purposes (including dwellings, residential buildings or short-stay accommodation), caravan parks, camping grounds, educational establishments, child care premises, hospital, nursing home, corrective institution; or place of worship (Note that this excludes recreational parks, commercial and industrial premises along the alignment – results will be determined for these locations, but mitigation would not be recommended); and
- at all floor levels where identified from surveys, noting that sufficient mitigation (in the context of the targets) may not reasonable or practicable at higher floors.

4.5.3 Stations and Associated Infrastructure

Section 13.7 of Book 5 of the SWTC details the noise and vibration Technical Criteria requirements for the design and operation of the station and associated infrastructure, and includes the following statements:

The Alliance must address noise and vibration impacts associated with station noise impacts, inclusive of any new road infrastructure to service the stations, to surrounding sensitive receivers, occupational health and amenity for PTA staff and patrons.

[..] Noise and Vibration Criteria for Impacts to Surrounding Sensitive Premises at Stations and associated infrastructure (eg. car parks, plant rooms etc.) must be designed to comply with the requirements of the Environmental Protection (Noise) Regulations 1997 (WA).

[..] The Alliance shall determine the noise criteria for impacts from Station entry roads and grade separations and design roads and any associated noise mitigation controls to meet the requirements of Western Australia State Planning Policy No 5.4, Road and Rail Noise 2019.

4.5.3.1 Ambient Noise Levels within Passenger Station Areas

Section 13.7.1 of the SWTC defines acceptable noise levels via the following table, as defined in AS 1055.1:1997 and assessed according to AS/NZS 2107:2000. In accordance with the SWTC it is proposed to follow this the 2000 version of AS/NZS 2107 and not the more recent 2016 version.

Table 4 Ambient noise level criteria

Area	Scenario	Minimum acceptable noise level (dB)	Maximum acceptable noise level (dB)
Ticket sales area	Building services and plant	-	L_{Aeq} 45
General office areas	Building services and plant	-	L_{Aeq} 45
Staff crib rooms	Building services and plant	-	L_{Aeq} 45
Public waiting areas, kiosks	Building services and plant	-	L_{Aeq} 45
Toilets and amenities	Building services and plant	L_{Aeq} 45	L_{Aeq} 55
Parking and waste storage areas	Building services and plant	-	L_{Aeq} 65
Platforms, at any position within 1.5m of platform edge or centreline (whichever is closer to track), and more than 8 metres from Portals	Stationary trains, auxiliary equipment operating as normal	-	L_{Aeq} 70
	Moving trains	-	L_{ASmax} 80
	Building services and plant (ventilation, escalators, etc.)	-	L_{Aeq} 55

	Emergency smoke fan systems	-	L_{Aeq} 85
Plantrooms	Building services and plant	-	L_{Aeq} 85
All other areas	All	-	Table 1, AS/NZS 2107:2000 'Satisfactory' values plus 5dB

Section 13.7.1 of the SWTC also states that

For enclosed rooms containing plant, equipment and electrical power Assets, noise levels must be assessed at no less than 1 metre from any item of equipment; and noise levels from mechanical ventilation systems serving the room must not exceed L_{Aeq} 65dB.

The criteria listed above in this section do not apply to systems or components operating in emergency mode. In this situation, noise generated by the systems or their components must comply with AS 1670.4 and AS 1668.1, and not exceed levels that affect speech intelligibility in egress paths, evacuation assembly areas, or operational or emergency control rooms or areas.

4.5.3.2 Noise and Vibration Ingress into Passenger Station Areas

Section 13.7.2 of the SWTC states that the Alliance shall comply with the following requirements:

External noise ingress from all associated road and rail traffic sources controlled according to the requirements of the WAPC State Planning Policy No 5.4 Road and Rail Noise (SPP 5.4) 2019.

Floor vibration levels within publicly accessible areas from plant, equipment or external sources not exceed $L_{v, RMS,1s}$ 112dB.

4.5.3.3 Reverberation within Passenger Station Areas

Section 13.7.3 of the SWTC states that the Alliance shall comply with the following requirements:

Within platform areas, the spatial average reverberation time (RT60) values for the full octave bands with centre frequencies 500Hz and 1kHz not exceed 1.3 seconds for the scenario where 100 patrons are present, or 1.6 seconds when empty.

At all other areas, spatial average reverberation time (RT60) values for the full octave bands with centre frequencies 500Hz and 1 kHz be in accordance with AS/NZS 2107:2000 given the usage of each space.

4.5.3.4 Public Address Systems within Passenger Station Areas

Section 13.7.4 of the SWTC states that:

The Alliance must ensure that the PA systems achieve the minimum sound level and speech intelligibility requirements of clause 4.3.4 and 4.3.6 of AS 1670.4 for all representative locations, environmental conditions and passenger levels

External noise ingress from adjacent road traffic sources must be assessed and considered when designing and constructing all stations to ensure that the public address systems within passenger station Areas achieve the minimum sound level and speech intelligibility requirements of clause 4.3.4 and 4.3.6 of AS 1670.4 for all representative locations, environmental conditions and passenger levels.

4.5.3.5 Acoustic Sound Insulation within Passenger Station Areas

Section 13.7.5 of the SWTC states that:

Airborne sound insulation targets are given in terms of the weighted level difference, Dw between two spaces. The Alliance must ensure that design complies with the following general in-situ airborne sound insulation targets:

- *Dw ≥ 35dB between normally occupied enclosed spaces.*
- *Dw ≥ 28dB between normally occupied spaces where the common partition includes a door.*

The following table presents criteria that supersede these general requirements for specific occupied spaces. Where two different space types are adjacent to one another, the Alliance must ensure that the more onerous target applies.

Table 5 Vibration criteria (SWTC Book 5 Table 31: Airborne Sound Insulation Requirements)

	Space Type / Occupancy	Minimum Weighted Sound Level Difference, Dw, dB
Between normally occupied back of house offices and crib rooms	Generally	40
	Where the common partition at the interface includes a door	30
Toilets and amenities to nearby public areas	Generally	42
	Where the common partition at the interface includes a door	25
	Where the common partition at the interface has no door	16

SWTC 13.7.5 also states that

Where receiving spaces are not fully enclosed, the closest point of assessment must be at least 4 metres from the nearest door or window or the nearest scheduled seating position, whichever is closest.

Noise from hydraulic services associated with toilet amenities (e.g. flushing) must not be audible in any other publicly accessible area.

Noise from hand dryers within toilets and amenities should not be audible at any position more than 2 metres from the entrance, and must not be audible at any commercial retail or patron seating areas.

4.6 Design Life

Not applicable.

4.7 Durability Requirements

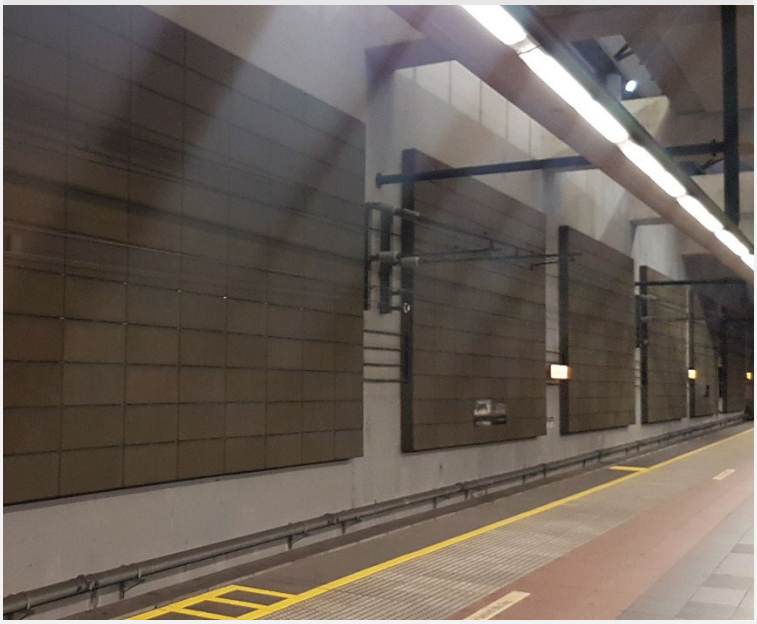
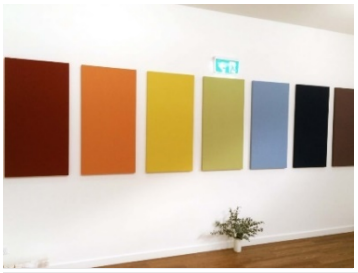
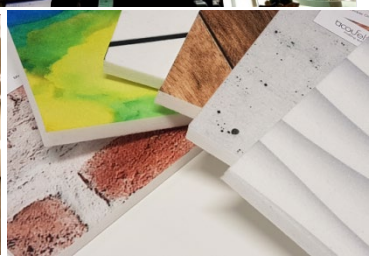
Not applicable.

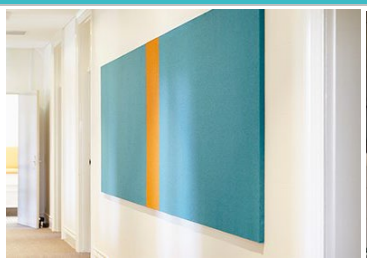
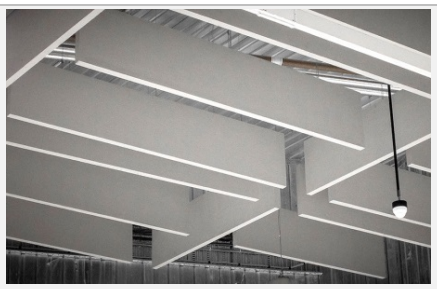
4.8 Specialist Technical Inputs

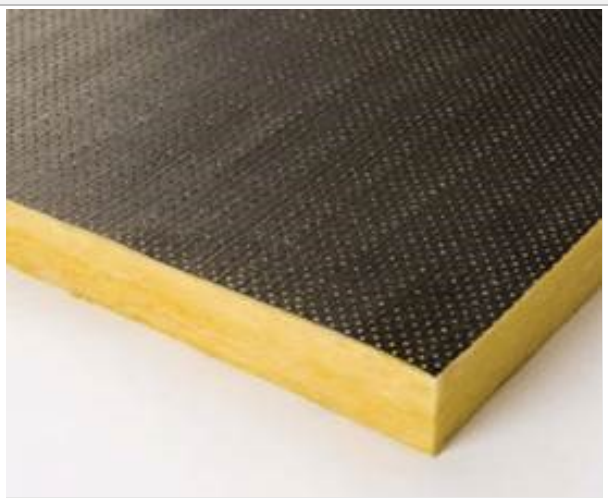
4.8.1 Reverberation

The concourse at the Whiteman Park Station is fairly enclosed with station buildings abutting on sides and the platform and viaducts above the concourse. The reverberation times have to be controlled within the concourse spaces in accordance with Section 4.5.3.3. Based on the volume of concourse, the reverberation times are recommended to be 1.2 – 1.4 seconds.

It is anticipated that these recommendations can be achieved through the suitable installation of 600 m^2 of absorptive finishes achieving a minimum Noise Reduction Coefficient (NRC) 0.80, or Class A or B according to EN ISO 11654. The following table provides various examples of such products.

Name	Image (Source), link	Description
Quietstone Standard **or** **Pyrotek Reapor**		Porous recycled glass material designed primarily for direct fixing to walls and ceilings. Non-toxic, non-flammable and not affected by moisture. Non fibrous material. Can be cleaned with a high pressure hose. Classified Class A according to EN ISO 11654 (50 mm+) Used in various Perth train stations already (Elizabeth Quay, Joondalup etc.) Main downside is risk of friable silica dust when broken / handled.
Acoufelt	    https://acoufelt.com/products/panels/	Can be self-adhesive backed (Direct fix) or mechanically fixed Can be ordered with hi resolution image print Low resistance to damage EN ISO 11654 Class C (α_w 0.70-0.75) or better 25 to 100 mm thick polyester with fabric facing Non-toxic, Non-allergenic,Non-irritant
Pyrotek Echohush	  https://www.pyroteknc.com/products/echohush/echohush-board/	EN ISO 11654 Class C (α_w 0.70-0.75) or better 25 to 100 mm thick polyester with fabric facing Direct fix installation Recyclable, various colour options Can be used to pin / Velcro items on Non-toxic, Non-allergenic, Non-irritant

Name	Image (Source), link	Description
CSR Martini DECO Quiet Panel	  http://www.csrmartini.com.au/products/decorative-acoustic-products	Effectively equivalent to Pyrotek Echohush
Stratocell Whisper FR	 http://www.soundblock.com.au/sound-absorbers/stratocell-whisper	EN ISO 11654 Class C (α_w 0.70-0.75) or better 25 to 100 mm thick Polyethylene foam (unpainted) Lightweight and easily cut into shapes, affix to walls or hang
Asona Triton	 http://www.asona.co.nz/	EN ISO 11654 Class B (α_w 0.80-0.85) 25 to 100 mm thick glass fibre with fabric facing Direct fix installation Recyclable, various colour options
Renhurst RenAcoustic Baffles	 http://renhurst.com/renacoustic-baffles/	EN ISO 11654 Class C (α_w 0.70-0.75) or better Rigid fibreglass core and a fine textured fleece Lightweight with various suspension options
Himmel Ecophon Solo Panels	  https://www.himmel.com.au/product-listing/2016/07/13/ecophon-solo-panels	Suspended colour panels Likely limited extent due to ceiling fan / air movement needs Glass fibre reinforced for rigidity

Name	Image (Source), link	Description
Stratocell Whisper	 www.soundblock.com.au/sound-absorbers/stratocell-whisper	Claimed to be resilient to water and humidity Flame retardant and/or Group 1 fire rating. Claimed self-extinguishing material (Class B2) to DIN 4101 series Light weight and non-corrosive. Easy to fix and fasten, pinned or glued Sheet size is 2400 x 1200 x 50mm thick Classified Class A according to EN ISO 11654
32-48 kg/m^3 glasswool or mineral fibre faced with glass fabric	 www.bradfordinsulation.com.au/	Manufactured by spinning molten glass, containing up to 80% recycled material, into fine fibres which are then bonded together using a thermosetting resin. Typical density of 48 to 60 kg/m^3. Non-flammable, non-toxic material which is not affected by moisture. Typically installed in perforated sheet metal enclosures with an additional spun bonded cloth film to protect from dust and moisture. Industrial product with relatively long product life.

With the control of reverberation, it is anticipated that the PA intelligibility requirements can be achieved through careful speaker system design within the concourse, as discussed in the following subsection.

4.8.2 Public Address (PA) Systems

The public address system will need to be designed to be sufficiently audible (involving both sound level and speech intelligibility) to meet relevant provisions of Australia Standard 1670.4, Fire Detection, Warning, Control and Intercom Systems - System Design, Installation and Commissioning - Sound Systems and Intercom Systems for Emergency Purposes (AS 1670.4) such that patrons can be advised in case of emergencies.

By inspection of each station arrangement and distancing to the nearest residential receivers (screening assessment), it can be seen that there is a range of sound levels which can meet both the minimum sound level limit requirements of AS 1670.4 and the maximum noise level limits listed.

An active PA system which regulates speaker volume depending on actual ambient sound level conditions to maintain intelligibility is recommended for the Whiteman Park Station.

The PA system is currently designed by the communications designer, and the detailed results of compliance will be published as the project progresses.

4.8.3 Crowd / Patron Noise

Average crowd and patron noise levels in the context of the design criteria and other environmental noise sources are considered insignificant.

The arrangement of the station has passenger waiting areas on the platform, busway waiting areas and pick up points at distances over 100 metres from potential sensitive premises and/or generously spaced open environments.

Providing this level of distance separation and low crowd densities is expected to ensure that any sustained crowd / patron noise levels (conversations, walking) as individually L_{Aeq} 60dB @ 1 metre and therefore below L_{Aeq} 30dB @ 40 metres will be at a cumulative level that is inaudible at nearby residential locations against other background environmental noise.

4.8.4 Vehicle Car Parking

EU Parking Area Noise 2007[1] guidelines have been used to provide an indicative level of noise emissions on surrounding areas.

- Vehicle movement rate for P&R facilities over 15 km from CBD. A vehicle entering or exiting a parking bay is one movement, so the same vehicle arriving and departing on the same day completes two movements.
  - 0.30 per hour per parking bay (6am to 10pm).
  - 0.10 per hour per parking bay (10pm to 6am).
- Random fill across all parking lots.[2]
- Impulse correction K_I 4dB.
- L_{w0} 63dB (standardised vehicle sound power level).

4.8.5 Bus movements

Bus vehicles have been modelled using Nord2000 methodologies with the following parameters:

- Bus movements of up to 4 buses per stand per hour during the day (up to 40 buses/hour in total), and 0.5 bus per stand per hour during the night (up to 5 buses/hour in total) has been assumed for the assessment.
- Changes in level from arriving / idling / departure at stations (as assessed at nearest noise sensitive location) have been determined insignificant and not modelled. Publicly accessible road sections beyond the loop or its intersections are not included.
- Ground class F (compacted dense ground).
- Category 2a vehicles (up to 12.5m length and 2 axles, e.g. Volgren OC500LE), approximately L_{Amax} 75dB, L_{AE} 78dB at 7.5m and 35km/hr.
- Traffic case F (35km/hr max).

[1] Bayer, Landesamt für Umwelt 2007, Parking Area Noise - Recommendations for the Calculation of Sound Emissions of Parking Areas, Motorcar Centers and Bus Stations as well as of Multi-Storey Car Parks and Underground Car Parks, Bayerisches Landesamt für Umwelt, Parkplatzlärmstudie 6, Aufl., August 2007.
[2] Random fill assumed in the absence of a specific car parking traffic analysis. Fill patterns in practice may vary due to proximity to train station, and presence of ticketed parking and/or reserved parking.

- Asphalt concrete surface, any increases in noise level due to gradients was included on the basis of the ground topography provided.

4.8.6 Kiss and Ride

Car movements have been modelled using Nord2000 methodologies with the following parameters:

- Movements of up to 40 vehicles per hour during the day, and up to 10 vehicles per hour during the night has been assumed for the assessment.
- Changes in level from arriving / idling / departure at stations (as assessed at nearest noise sensitive location) have been determined insignificant and not modelled. Publicly accessible road sections beyond the loop or its intersections are not included.
- Ground class F (compacted dense ground).
- Category 1 vehicles approximately L_{AE} 78dB at 7.5m and 40km/hr.
- Traffic case F (40km/hr max).
- Asphalt concrete surface, any increases in noise level due to gradients was included on the basis of the ground topography provided.

4.8.7 Noise Propagation Effects

4.8.7.1 Path Attenuation Factors

Outside the rail reserve, the environmental factors relevant to noise propagation were modelled as follows:

- Topography dataset of existing conditions for the assessment area was sourced from Landgate and adapted to the provided alignment in 3D dwg format.
- Given the relatively short propagation distances, weather conditions for each time period were considered neutral, with 20°C ambient temperature and no prevailing wind or temperature gradient effects.
- Existing noise barrier and fence heights and locations were reviewed with necessary corrections being made to reflect their realistic existing conditions. The modelling was then carried out on the basis that these fences and barriers are acoustically solid, i.e. they perform as effective noise barriers, being of suitable construction to sufficiently reduce noise transmission.

4.8.7.2 Air Attenuation and Diffraction

The propagation of railway noise from source to nearby sensitive areas has been estimated using industry standard numerical code that has been validated through field measurements.

- 'N2k': The Nord2000 Rail prediction method is an update to the Kilde formulation based on advancements in the late 1990s. The main benefit comes from the fact that the N2k methodology calculates in terms of one-third octave bands, rather than a single number to represent all frequencies. This is critical in regards to the design of noise walls, because their effectiveness is strongly frequency dependent – the difference in noise reduction at higher frequencies is vastly different compared to low frequencies.
- The ISO 9613 Industrial Prediction Model has been used for predicting noise from stationary assets with noise sources including sirens and bells. Various weather conditions can be taken into account in this modelling algorithm.

Stationary noise sources are modelled according to the parameters outlined in the following Table.

Parameter	Day period	Night period
Wind speed	Nil (ISO 9613, C_{met} = 0dB)	Nil (ISO 9613, C_{met} = 0dB)
Temperature inversion lapse rate	Nil (ISO 9613)	Nil (ISO 9613)
Temperature	20°C	15°C

Relative humidity	50%	50%
Mean barometric pressure	1013hPa	1013hPa

These sources are generally those assessed under the Regulations, such as crowd noise, public address systems, fixed mechanical plant and idling buses not on public roads.

4.8.7.3 Ground absorption

The table below summarises the ground absorption rates modelled.

Parameter	Value	Comments
Default	0	Hard ground
Rail reserve generally	0	Hard ground
Undeveloped sites, loose soil	0	Conservatively assuming future development / sealed surfaces
Significant road and sealed concrete surfaces	0	Conservatively 100% hard reflective
Established parks and reserves	0.6	60% sound absorptive

4.8.8 Vibration source levels

Vibration emissions from the site will be mainly controlled by rail traffic. Road vehicles will also contribute where speed humps, loose panels (e.g. gutter or pit covers) or sudden variations in road surface are introduced.

This assessment acknowledges that typical rail vibration levels in the immediate area will decrease from corresponding decreases in rail speeds when all trains pass through Whiteman Park (rather than pass through the area at or near the track section limit).

On a number of previous projects in Perth, ground vibration measurements have been carried out by SLR adjacent to surface rail track carrying passenger trains at a variety of distances from the rail centreline at each site.

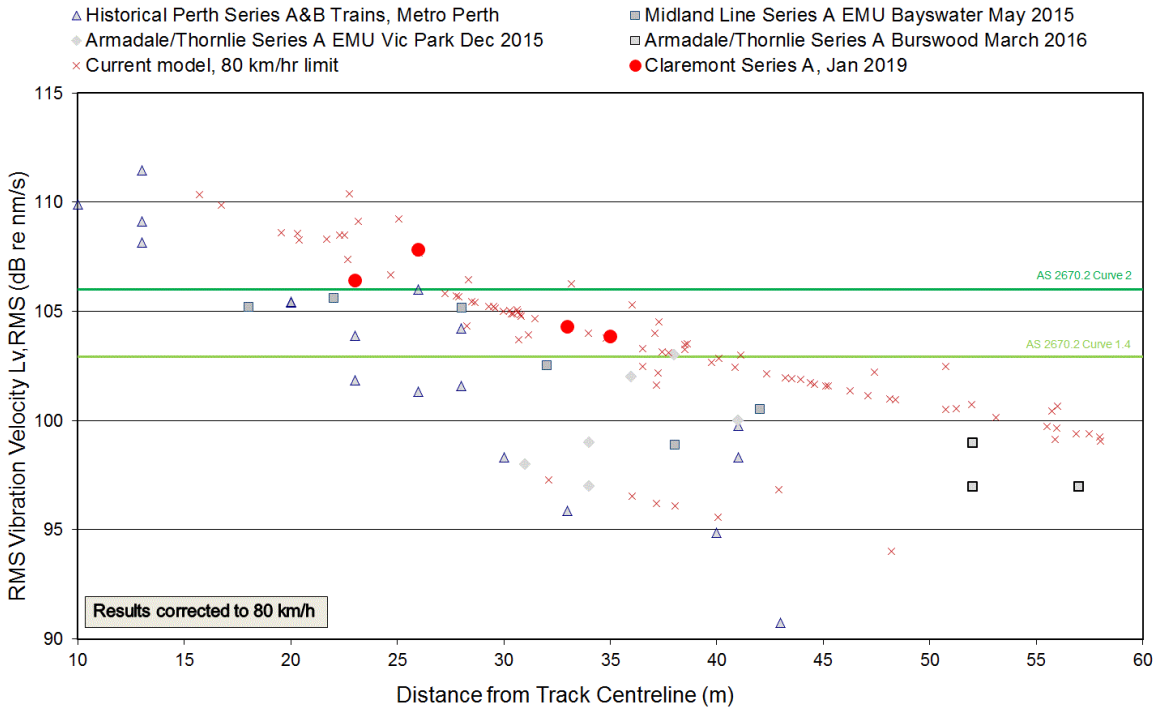


Figure 8: Measured railway vibration velocity level versus plan distance for selected Perth rolling stock at 80 km/hr

Adjusting for speeds around 40 km/hr, which would be the highest speed that could be expected in the vicinity of the station, typical vibration levels will comply with Curve 1.4 (Residential) at approximately 30m from the nearest track centreline. Curve 2 will be complied with at approximately 20m from the nearest track centreline. For reduced speeds associated with stopping trains, rail vibration levels applicable to station areas are also considered to meet the $L_{v, RMS,1s}$ 112dB requirement referenced in Section 4.5.3.2.

Actual results will vary from these estimates according to rail condition, in situ soil and terrain profiles; however even after allowing for such variation, vibration levels are expected to be compliant. Also, the rails are proposed to be over embankments and viaducts within the Whiteman Park precinct which is expected to further decrease the vibration effects at the surrounding receivers.

On the basis of the above, the project provisions for vibration mitigation may be limited to avoiding road speed humps and loose coverings for buses and heavy vehicle traffic. Where traffic speed control is required, gradual gradient pedestrian crossings (such as wombat crossings) can be implemented which is not expected to introduce noticeable noise and/or vibration increase.

4.9 Constructability Requirements

Not applicable.

4.10 Environmental & Sustainability Design Criteria

Credit 14 under Green Star Design and As-built Requirements for Railway Stations (v1.1) has four (4) points available under Acoustic Comfort. These relate to:

- 14.1 Internal Noise Levels
- 14.2 Reverberation
- 14.3 Audibility
- 14.4 Hearing Loop Coverage

The SWTC requirements for Station internal noise levels (Section 4.5.3.1) and reverberation (Section 4.5.3.3) is expected to achieve the design credits under 14.1 and 14.2 of the Green Star requirements. As-built credits are achievable via compliant post-construction measurements.

The credits for Audibility and Hearing Loop Coverage (14.3 and 14.4) are not within the scope of this Report.

The noise and vibration design requirements under ISCA are applicable line wide and are covered within the Operational Noise and Vibration Design Report (MEL-MLCX-EN-RPT-00032).

4.11 Future Proofing

Not applicable.

4.12 Value Engineering

Not applicable.

4.13 Third Party Operational Stakeholders

Not applicable.

4.14 Design Input from Stakeholders and Community Involvement Process

Not applicable.

4.15 Design Risks, Assumptions, Issues, Dependencies, Opportunities, and Constraints (RAIDOC)

Detailed of design risks, assumptions, issues, dependencies, opportunities and constraints are outlined below.

4.15.1 Design Risk Register

Design risks related to this design package are detailed in the Table below;

ID	Description	Status	Evidence of Validation
	Not applicable at this design stage		

4.15.2 Design Assumptions

Design assumptions related to this design package are detailed in the Table below;

ID	Description	Status	Evidence of Validation
	Rough / diffusive wall finishes. If walls are hard reflective, then wall extents may need to be revised.		
	Existing residential walls and noise walls relevant to the report outcomes are acoustically sound, continuous / without gaps.		
	Car parking and vehicle trafficable areas avoid the use of loose laid road coverings, e.g. openable drains and grates are positively secured with mechanical fasteners.		

	Car parking and vehicle trafficable areas avoid the use of smooth concrete surfaces, e.g. concrete surfaces are brush finished or otherwise rough such that tyres do not squeak under heavy steering.		
	Cumulative mechanical external plant noise emissions do not exceed L_{wA} 92 dB during the day and L_{wA} 83 dB at night, which is considered to be a conservative estimate of commercial split systems servicing existing outdoor train stations in Perth (up to the order of 60 kW installed capacity outdoors). This includes the effects of screening panels and station buildings.		

4.15.3 Design Issues

Design issues related to this design package are detailed in the Table below;

ID	Description	Status	Evidence of Validation
	Not applicable at this design stage		

4.15.4 Design Dependencies

Design dependencies related to this design package are detailed in the Table below;

ID	Description	Status	Evidence of Validation
	Noting Rail Systems Australia are constructing EASE models for Whiteman Park (25-A-289-EC0151, 25-A-289-EC0152, 25-A-289-EC0153) Responsibility for production of Speech Transmissibility Index (STI) contours and design of loudspeaker arrangements to be submitted as part of the various Station packages by Rail Systems Australia.		

4.15.5 Design Opportunities

Design opportunities related to this design package are detailed in the Table below;

ID	Description	Status	Evidence of Validation
	Not applicable at this design stage		

4.15.6 Design Constraints

Design constraints related to this design package are detailed in the Table below;

ID	Description	Status	Evidence of Validation
	Not applicable at this design stage		

4.16 Requests for Information (RFI)

Requests for information submitted in relation to this design package are outlined in the Table below. Copies of the RFIs are provided in Appendix W of this report.

RFI	Description/Title	Response
062 **CRFI-SLR-PW-00001**	Noise and Vibration - Baseline Measurements	Closed
063 **CRFI-SLR-PW-00002**	Noise and Vibration Assessments - Data Input Log / Requests	Closed
068 **CRFI-SLR-PW-00003**	Conversion of federated model 25-B-00-0001.4.0.IFI to AutoCAD	Closed

5. Design Outputs

5.1 Deliverables List

Not applicable.

5.2 Drawings and Models

5.2.1 Bus and car parking activities

The below figure gives an example of potential noise levels in the vicinity of the station as a result of modelled bus operations and car parking facilities according to Section 4. It can be seen that the predicted levels from car park and bus movements at the station are within the targets outlined in Section 4.5.2 to the nearest receivers, including the potential future development.

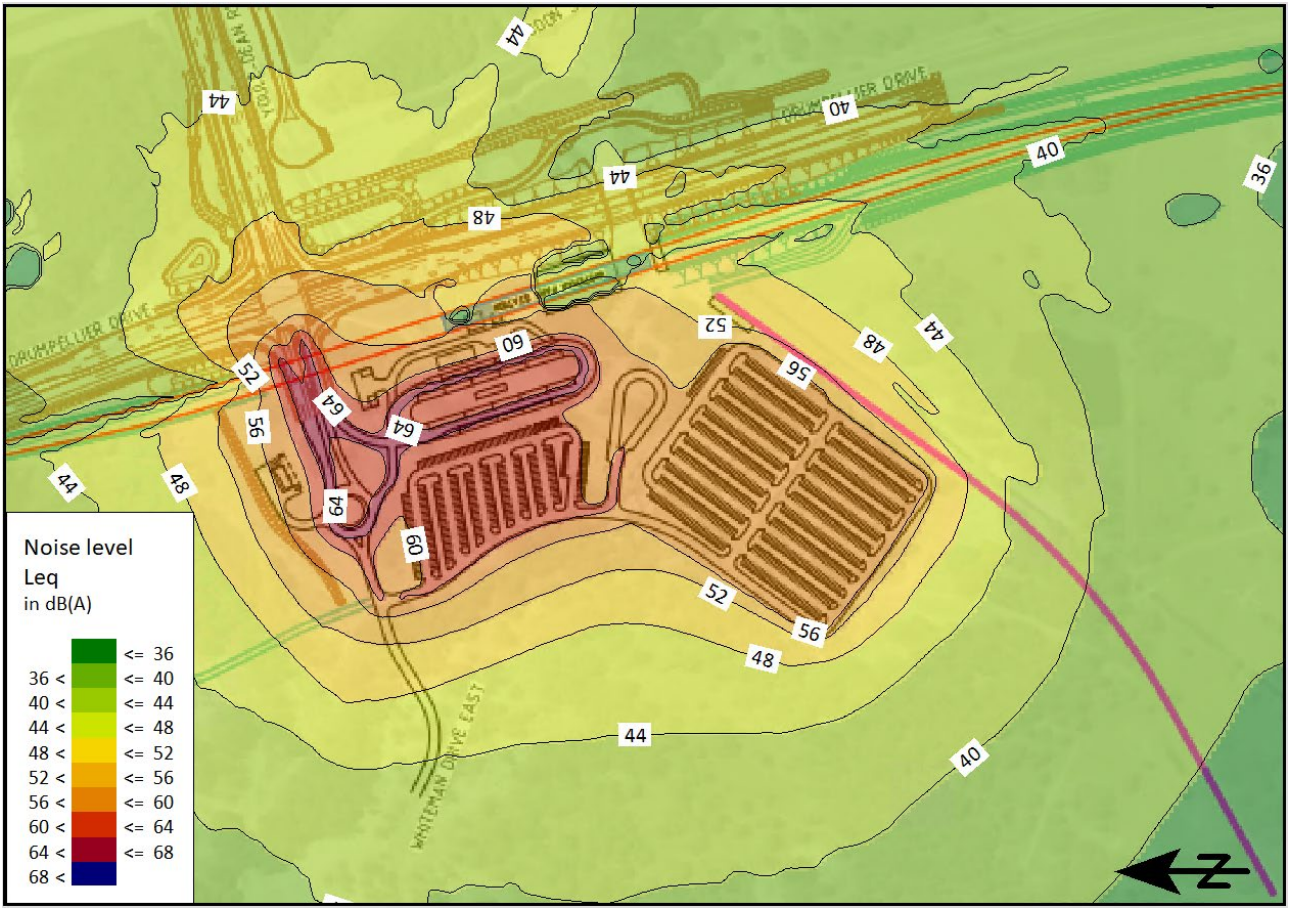


Figure 9: Indicative distribution in airborne noise from station, bus and car parking areas for comparison with L_{Aeq} day criteria

5.3 Specifications

Not applicable at this design stage.

5.4 Standard Reference Drawings

Not applicable.

5.5 System Coordination Drawings and Models

Not applicable.

5.6 Type Approvals

Not applicable.

5.7 Calculations

Not applicable.

5.8 Schedules

Not applicable.

6. Competence for Design

Not applicable at this Design Stage.

7. Design Reviews and Certification

7.1 Interdisciplinary Design Check (IDC) Review

Not applicable at this Design Stage.

7.2 IDC Certificate

Not applicable at this Design Stage.

7.3 Design Verification

Not applicable at this Design Stage.

7.4 Independent Verification

Not applicable at this Design Stage.

7.5 BCA

Not applicable at this Design Stage.

7.6 DDA

Not applicable at this Design Stage.

7.7 PTA Design Submission Reviews.

Not applicable at this Design Stage.

8. Design Compliance

The demonstration of compliance with the requirements of the Project Definition Documents, including any non-conformances of concessions is summarised on the following sections.

8.1 Standards & Guidelines

See Section 4.3.

8.2 SWTC

Not applicable at this Design Stage.

8.3 Planning & Environmental Approvals

Not applicable at this Design Stage.

8.4 Third Party Requirements

Not applicable at this Design Stage.

8.5 Deviation Register

Not applicable at this Design Stage.

8.6 Non-Compliances Register

Not applicable at this Design Stage.

9. External Interface Work Packages

9.1 Project Interface Control Plan

Not applicable at this Design Stage.

10. Effects of the Works

Not applicable.

11. Safety in Design

11.1 Overview

Not applicable.

11.2 Systems Safety Assurance Plan.

Not applicable.

11.3 Compliance with Safety Assurance Plan

Not applicable.

11.4 Safety Analysis

Not applicable.

11.5 Safety Argument

Not applicable.

11.6 Hazard Analysis

Not applicable.

11.7 Satisfaction of Safety Integrity Level Targets

11.8 Satisfaction of GSN Requirements

Not applicable.

11.9 Management of Safety Requirements

Not applicable.

11.10 Transfer of Residual Risks and Safety Related Operational Conditions

Not applicable.

11.11 Safety Assurance Statement

Not applicable.

12. Systems Engineering

12.1 Sub-system Allocation

Not applicable.

12.2 Requirements Management

Not applicable.

12.3 Engineering Assurance Summary

Not applicable.

13. Sustainability in Design

Not applicable.

14. Testing & Commissioning Requirements

Not applicable.

14.1 ITP's

Not applicable.

14.2 Hold Points

Not applicable.

14.3 Witness Points

Not applicable.

15. Human Factors

Not applicable.

16. Reliability, Availability and Maintainability (RAM)

16.1 General RAM Provisions

Not applicable.

16.2 RAM Targets

Not applicable.

17. Construction Methodology

17.1 Construction Methods

Not applicable.

17.2 Operational Staging

Not applicable.

17.3 Works in Track Occupancies

Not applicable.

18. Asset Maintenance Strategy

Not applicable.

18.1 RTO Assets

18.2 Other Assets

Not applicable.

19. Asset Operations Strategy

The following operational strategy has been assumed in this design package:

19.1 Normal Modes of Operations

19.2 Degraded Modes of Operations

20. Decommissioning Strategy

Not applicable.

20.1 Capability to Modify

20.2 Decommissioning Strategy

21. Project Actions Register

A list of outstanding issues and assumptions that may affect the design are outlined in the Table below.

ID	Outstanding Issues	Potential Effect	Status
	Final arrangement of loudspeakers / PA systems	Increased noise emissions	
	Land use of future development	Noise sensitive premises within the indicated future development may introduce additional receivers closer to the station and car park areas. Refer to Section 5.2.1 above for comment in this regard.	

Appendix E: Calculations

strutt

Job No.	Job Title			
675.30045	MEL D			
Date Created	By	Date Revised	Rev	Sheet
15 Sep 2021	LZ	15 Sep 2021	2	3
Date Reviewed	By	Review Type	Review Status	

Whiteman Park Mechanical Noise Emissions - Screening Calc (ISO9613)

Item / Description		Rating/Broadband/Input Rating	dB	dB(A)	Octave Band Centre Frequency, Hz 31.5	63	125	250	500	1k	2k	4k	8k
Source levels / inputs													
Empirical Air-Cooled Condenser Lw	Conservative power level	60.0 kW		92.0 (A)		96	96	93	90	86	83	80	72
Day reduced duty				0.0									
Evening emission level, total				92.0 (A)		96	96	93	90	86	83	80	72
Separation distance from station centre		200.0 m											
Air temp		20.0											
Environmental losses	For distances r >> source dimension ds												
Point Source Propagation Loss		200.0 m	3.0 dB		-53.9	-53.9	-53.9	-53.9	-53.9	-53.9	-53.9	-53.9	-53.9
Atmospheric Attenuation - Theory: ISO		200 m	20 °C	RH 70%		0.0	-0.1	-0.2	-0.6	-1.0	-1.8	-4.6	-15.3
Ground Attenuation, Theory: ISO 9613.2, Source Zone Ground 50% Soft Ground, Mi		200.0 m	1.0 m	1.5 m		4.9	1.4	-4.9	-4.3	1.1	2.4	2.4	2.4
Assume no barriers, wall reflection or screening effects													
Received level outdoors, night	LAeq			37 (A)		46.8	43.3	33.8	31.1	32.0	29.5	23.7	5.0
Residential night time target (EPNR)	6 dB transport factor			**51 (A)**									
Excess on target (level of compliance)				(14.3)									
	Forecast level of compliance is more than design uncertainty												

Figure E10: Mechanical paint noise emissions screening calc, Whiteman Park, day period

strutt

Job No.	Job Title			
675.30045	MEL D			
Date Created	By	Date Revised	Rev	Sheet
15 Sep 2021	LZ	15 Sep 2021	2	1
Date Reviewed	By	Review Type	Review Status	

Whiteman Park Mechanical Noise Emissions - Screening Calc (ISO9613)

Item / Description		Rating/Broadband/Input Rating	dB	dB(A)	Octave Band Centre Frequency, Hz 31.5	63	125	250	500	1k	2k	4k	8k
Source levels / inputs													
Empirical Air-Cooled Condenser Lw	Conservative power level	60.0 kW		92.0 (A)		96	96	93	90	86	83	80	72
Evening reduced duty				-9.0									
Evening emission level, total				83.0 (A)		87	87	84	81	77	74	71	63
Separation distance from station centre		200.0 m											
Air temp		20.0											
Environmental losses	For distances r >> source dimension ds												
Point Source Propagation Loss		200.0 m	3.0 dB		-53.9	-53.9	-53.9	-53.9	-53.9	-53.9	-53.9	-53.9	-53.9
Atmospheric Attenuation - Theory: ISO		200 m	20 °C	RH 70%		0.0	-0.1	-0.2	-0.6	-1.0	-1.8	-4.6	-15.3
Ground Attenuation, Theory: ISO 9613.2, Source Zone Ground 50% Soft Ground, Mi		200.0 m	1.0 m	1.5 m		4.9	1.4	-4.9	-4.3	1.1	2.4	2.4	2.4
Assume no barriers, wall reflection or screening effects													
Received level outdoors, night	LAeq			28 (A)		37.8	34.3	24.8	22.1	23.0	20.5	14.7	-4.0
Residential night time target (EPNR)	6 dB transport factor			**41 (A)**									
Excess on target (level of compliance)				(13.3)									
	Forecast level of compliance is more than design uncertainty												

Figure E11: Mechanical paint noise emissions screening calc, Whiteman Park, night period