EES Inquiry - Melbourne Metro Rail Project

Expert Evidence Statement of James Hargreaves

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1. Name and address

James Hargreaves
Meinhardt
c/o Level 11, 501 Swanston St
Melbourne VIC 3000

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2. Qualifications and experience

(a) I have a Bachelor Degree in Engineering (Civil) (Hons) from the Queensland University of Technology, and currently hold the position of Senior Consultant, Structures at Meinhardt.

(b) I have over nine years' experience as a consultant in structural engineering.

(c) My Curriculum Vitae is included in Attachment A.

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3. Statement of the Expert's Area of Expertise

I have over the period of my career dealt with varying ground conditions across the country across WA, QLD, VIC and NSW. In particular to the Melbourne Metro Rail Project I have spent the last 5 years designing, documenting and providing construction advice for foundation systems found along the varying geology of the route of the rail alignment.

In previous years I was engaged as an employee of Meinhardt by the Building Commission - Victoria (now Victorian Building Authority) to investigate foundation failures in the western suburbs and provide technical advice.

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4. Statement of the other significant contributors of the report.

Rennie Darmanin – Discipline Leader – Structures (Aust) & Project Director

- Fellow of the Institute of Engineers Australia (admitted to Corporate Membership in 1986) as a Chartered Professional Engineer
- Bachelor of Engineering (Honours) University of Melbourne 1981
- Registered Professional Engineer with the National Professional Engineers Register (NPER3) Civil College, Institute of Engineers Australia, Membership no. 64039
- Registered Building Practitioner with the Building Practitioners Board Victoria, Civil Engineer, Registration No. EC-1127
- Registered Building Practitioner with the Building Control Tasmania Accreditation number CC5226 J, Category Engineer-Civil – Unrestricted
- Member of the College of Structural Engineers, Institute of Engineers Australia
- Member of the College of Civil Engineers, Institute of Engineers Australia
- Past Member (Associate) of the Australian Institute of Project Managers
- Member of the Australian Steel Institute
- Member of the Concrete Institute of Australia

Rennie has wide ranging experience gained through his work on medium and high rise commercial developments, health and aged care facilities, recreation facilities, defence projects, education facilities, institutional, industrial and infrastructure projects.

He has a proven track record in leading multidiscipline design teams to develop sound, practical and economic solutions that are responsive to the environmentally sustainable imperatives expected of modern structures.

Rennie is well known for his ability to contribute to the design process in a holistic manner that transcends his structural background, and encompasses all engineering disciplines.

Rennie has lectured at Swinburne University on Fire Technology, and has been a guest speaker at RMIT and University of Melbourne on specialist structural topics

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5. Scope of Meinhardt's Report

This statement is based on the information provided by the Melbourne Metro Rail Project in their Environmental Effects Statement – Summary Report and technical appendices, obtained via download on the 24/5/2016 from the Melbourne Metro Rail Project's website, which was publically accessible.

In particular elements were reviewed against the impact they may have to the Melbourne Grammar School Campus adjacent the proposed new Domain Station.

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6. Meinhardt's Peer Review – Expert Evidence

I base my statements on the report produced by my office, in which I was the reviewer. The report is titled *Building Structures – Peer Review of Environmental Effects Statement for Melbourne Metro Rail Project on behalf of Melbourne Grammar School*, dated, *19th of June 2016*.

This statement is pursuant of the following points addressed by the Minister of Planning in the Inquiry and Advisory Committee Terms of Reference;

b. iii. – I assert that there are likely adverse effects due to the project that should be considered. That have not yet been addressed.

b. iv. – I assert that the assessment contained in the ESS and technical appendices does not address the full risks, nor provided mitigating measures

b. v. – I assert that the EPR's do not adequately cover the risks appropriately.

b. Vii. – The following submission should be assessed by the Inquiry in consideration of the ESS.

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7. Recommendations Arising from EES Peer Review

I recommended that the following EPR's be modified and where not provided, created.

7.1. ESS Section 18 – Groundwater

The EES states *that "Since the minimal drawdown predicted means the risk of impacts to groundwater dependent values is low, no specific Environmental Performance Requirements have been recommended for this station precinct. However the project-wide Environmental Performance Requirements of developing a detailed design phase model and a Groundwater Management Plan to assess and manage impacts associated with the detailed design still apply"* Environmental Effects Statement Technical Appendix O – Groundwater Part 2, section 13.5 pg 194.

This statement appears to be inconsistent with the modelling which estimates potentially significant groundwater drawdowns during construction.

Consequently Meinhardt recommends that Melbourne Grammar School requests additional Environmental Performance Requirements for Melbourne Metro Rail Project in relation to protecting MGS from the consequences of this potential impact.

7.2. ESS Section 19 – Ground Movement and Land Stability

Impact – Land Stability

Environmental Performance Requirements

Design and construct the permanent structures and temporary works so as to limit ground movements to within appropriate acceptability criteria (to be determined in consultation with the relevant stakeholders) for vertical, horizontal, and angular deformation, as appropriate, for project activities during the construction and operational phase.

&

Adopt construction techniques for Melbourne Metro to limit ground movement to within appropriate acceptability criteria (to be determined in consultation with the relevant stakeholders).

Meinhardt's Recommendation

Meinhardt recommends this Environmental Protection Requirement should be modified so that the acceptability criteria for the Domain Precinct are developed in consultation and with the approval of Melbourne Grammar School as the significant stakeholder in the precinct.

Please refer back to Meinhardt's Report in Appendix B for full details. (*Building Structures – Peer Review of Environmental Effects Statement for Melbourne Metro Rail Project on behalf of Melbourne Grammar School)*

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8. Declaration

I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

Signature

Date: 11/8/16

Attachments:

Attachment A – Curriculum Vitae

Attachment B – Building Structures – Peer Review of Environmental Effects Statement for Melbourne Metro Rail Project on behalf of Melbourne Grammar School

James HARGREAVES

Senior Consultant – Structures

James worked in the field of structural engineering for over ten years for various organisations throughout Australia.

During this time he has been involved in a variety of projects across various construction sectors. These include, Health, Defense, Education, Mining and Metals, Highrise, Commerical, Corrective Services, Water and Wastewater, Industrial, Sports Stadia, Aviation and Telecommunications.

His experience in these fields has delved into most construction methods, materials and design techniques, from fence posts for elephant enclosures to post-disaster functional hospital design.

Qualifications

- Bachelor of Engineering (Civil) – BEng (Hons)

Professional Affiliations& Activities

- Member, Institute of Engineers Australia

Professional Experience

2014 - Present	Senior Consultant – Structures	Meinhardt (Vic) Pty Ltd
2011 - 2014	Design Engineer - Structures	Meinhardt (Vic) Pty Ltd
2007 – March 2011	Graduate Structural Engineer	Sinclair Knight Merz
2006 – Feb 2007	Assistant Engineer	Connell Hatch

Career Experience

Expert Reports

Engineering expert reports involving evaluation of technical specifications, designs, documentation, as constructed works, preparation of reports and briefing of legal counsel for the following:

Project	Client	Details
Metropolitan Fire Brigade - Fire Station No. 24: Glen Iris	MFB	Investigation and reporting on cracking and deficient structural design. Briefed legal consul.
Ceiling Collapse at Rathdowne Place	Australian Unity	Investigation and reporting into the causes of a ceiling collapse in an aged care home and review of the remaining ceiling systems throughout.
Building Settlement -3-5 Carmyle Ave, Toorak.	Private	Investigation in the causes of cracking in to a 1890s Stone Horse Stable Conversion Dwelling.
Flood Damage to Goodstart Roseanna	Goodstart Early Learning	Investigation, reporting and rectification of the flood damage caused by a burst water mains to a federation timber stumped house conversion.

Technical Reports and Studies

Project	Client	Details
Review of Concrete Slab design and construction for residential dwellings in the western suburbs of Melbourne	Building Commission Victoria	A study of the process of design, documentation, construction and certification of residential slabs with respect to their performance on reactive soils in western Melbourne.

Review of post-disaster cladding fo Townsville Hospital	Queensland Department of Health	Detailed study and testing of appropriate cladding system to maintain post-disaster functionality of Townsville Hospital against Cat 5 Cyclones.
Goodstart Learning Building Reviews	Goodstart Early Learning	Structural Condition Assessments to various Daycare centres throughout Melbourne.

Project Experience
The below project list covers my professional working history as a structural engineer.

Civic Projects

- MFB Altona – Project Leader
- MFB Engineering Works – Project Leader
- Hawthorn Townhouses and Child Care – Project Leader
- Victoria County Court Refurbishment – Project Leader
- Booran Road Reservoir – Park Development – Project Leader

Residential Projects

- Rise Apartments, Perth – Construction Documentation and Site Engineer
- Axiom on Hay/ Thirteen24 - 1324 Hay Street, West Perth - Construction Documentation and Site Engineer
- Qubis, 403 Newcastle Street, Perth: 4 Storey Apartments - Construction Documentation and Site Engineer
- 5 Ozone Pde, Cottesloe: 3 storey residential single occupancy - Construction Documentation and Site Engineer
- Sails Apartments, Mixed Use Development, Applecross - Construction Documentation and Site Engineer
- Abode 318, Melbourne: 56 Storey Apartments – Project Leader
- 568 Collins Street: 68 Storey Apartments –Project Leader
- Hemingway Apartments: 4 Storeys – Construction Documentation and Site Engineer
- E567 Apartments: 11 Storeys – Design Engineer
- Prima Pearl: 73 Storeys Apartments – Design Engineer
- Hawthorn Townhouses and Child Care – Project Leader
- Rialto – Building Engineer
- 4-12 Leicester Place, Carlton: 26 storeys – Project Leader

Health Care Projects

- Gold Coast University Hospital – Design Engineer
  - Central Energy Plant
  - IPU Wards
  - Pathology and Education Building
- Townsville Hospital Redevelopment – Design Engineer
  - North Block
  - Theatre Expansion
  - Central Energy Facility
  - Oncology
  - Existing Acute Block Refit
- Hedland Regional Resource Centre – Design Engineer
- Box Hill Hospital – Design Engineer

Defence

- Amberley RAAF Base, Gatehouses – Design Engineer

Corrective Services Projects

- Broome Prison – Design Engineer

Mining and Metals Projects

- BHP Bilton Iron Ore Expansion Projects –Design Engineer
  - RGP5 (Rapid Growth Project 5) – Finucane Island and Nelson Point – Building
  - RPG6 (Rapid Growth Project 6) – Design Engineer (FEA, Wharf Steel Pile Caps)
- Rio Tinto – Iron Ore Major Projects – Design Engineer
  - Car Dumper – Outgo Works – Concrete Work
  - Dampier Fuel Wharf (Parker Point) - Access platforms, Walkways and Dolphins

Water and Wastewater Projects

- W2W Alliance – Design Reviewer and Design Engineer
- Sydney Desalination Plant – Project Co-ordination and Design Engineer
- Gold Coast Desalination Plant – Design Engineer
- Cleaner Seas Alliance - Wastewater Treatment Plants – Design Engineer
  - Northern WWTP
  - Southern WWTP
  - Marlin Coast WWTP
  - Edmonton WWTP

Education Projects

- University of Western Australia – Construction Documentation and Site Engineer
- MOHTEC – University of Melbourne School od Dentistry – Project Engineer
- Gold Coast University Hospital – see Health

Industrial Projects

- Boral Plasterboard and Plaster Distribution Facility. - Design Engineer
- Curtin Avenue (Monkey Steel Premises Rectification) – Project Manager

Sports Projects

- Queensland State Tennis Centre 7000 Seat stadium – Tennyson – Design Engineer
- Gold Coast Stadium 28000 Seat Stadium – Design Engineer
- Monbulk Soccer Pavilion - Design Engineer
- Pakenham Racecourse at Tynong – Project Leader

Commercial/Retail

- Henley Saab - Construction Documentation and Site Engineer
- Perth Zoo Elephant Enclosure – Construction Documentation and Site Engineer
- BWS (Liquor Store), West Leederville – Inspection and Rectification Design Engineer
- 470 Collins Street – Building Extension, new 2x storeys over forecourt
- 737 Bourke St – Refurbishment – Project Engineer
- 700 Collins St – Refurbishment – Project Leader
- Chadstone Shopping Centre – Stage 38 - New Office and Hotel – Project Leader
- Lithgow Workers Club Motel, NSW – Design Engineer
- 167 Cremorne St – MYOB Fitout – Project Leader

Telecommunications

- Telstra Telecommunications rollout
  - Westwood Sth - Bldg Ext - Design Engineer

- Airlie Beach Bld Ext - Design Engineer
- Charlotte TE - BES study – Inspecting and reporting
- Charlotte - Bldg Ext - Design Engineer
- Victoria Pt - Bldg Ext - Design Engineer
- Pier - Bldg Ext - Design Engineer

Aviation

- Cairns Domestic Terminal Redevelopment – Design Engineer
- Melbourne Airport – Various – Project & Design Engineer

Aged Care

- Rathdowne Place – Carlton/Carlton Wellbeing – Building 5 - Project Leader
- Central Park – Project Engineer
- BlueCross – Scotchmans Creek – Project Leader

Transportation

- Glen Waverley Station Upgrade – Project Leader

Building Structures

Peer Review of Environmental Effects Statement for Melbourne Metro Rail Project on behalf of Melbourne Grammar School

Project Reference: 115975

June 2016

Prepared For:

Melbourne Grammar School
355 St Kilda Road
Melbourne VIC 3004

Meinhardt

Level 12, 501 Swanston Street
Melbourne, Vic 3000

P. 03 8676 1200 | F. 03 8676 1201
www.meinhardtgroup.com

REV	DATE	WRITTEN BY	REVIEWED BY	APPROVED BY
A	19/06/16	Andrew Vangelista	James Hargreaves	Rennie Darmanin

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1 Executive Summary

Meinhardt was engaged by Melbourne Grammar School (MGS) to undertake a peer review of the Environmental Effects Statement (EES) for the Melbourne Metro Rail Project. The purpose of this peer review is to inform MGS's formal response to the EES.

This report relates to the impact on MGS's building structures with respect to the following aspects of the EES:
EES Section 13 – Noise and Vibration
EES Section 18 – Groundwater
EES Section 19 – Ground Movement and Land Stability

The EES divides the MMRP into nine precincts, based on the location of the project components and construction works, the potential impacts on the local areas and the characteristics of the surrounding areas. For the MGS peer review, only the EES sections relating to precincts likely to affect MGS have been reviewed; these are Precinct 1 - Tunnels
Precinct 7 – Domain Station

Noise and Vibration – in relation to impact on MGS's building structures

1. The EES adequately identifies the key issues associated with Noise and Vibration impacts that could potentially arise from the MMRP.

2. Of the 7 risk categories identified for the **Construction Phase** of MMRP, after the proposed Environmental Performance requirements are implemented:
   a. 3 risks have a residual classification of **Low**
   b. 1 risk has a residual classification of **Medium**
   c. 2 risks have a residual classification of **High** (construction vibration impacting on amenity and ground Bourne noise)
   d. 1 risk is unclassified (vibration impacting buried pipework)

3. Of 3 risk categories identified for the Operational Phase of MMRP, all risks have a residual risk classification of Low, after the proposed Environmental Performance Requirements are implemented.

4. Mitigation measures outlined in the EES fail to reduce the residual risks of some items to low or very low. Consequently Meinhardt recommends that MGS requests alterations to the various Environmental Performance Requirements applicable to Noise and Vibration, as described in section 5.5 of this report.

5. The EPR ***do not*** protect MGS from ***airbourne construction noise*** as there are no applicable Guideline Noise Levels.

6. The EPR ***do not*** protect MGS from ***ground bourne construction noise*** as there are no applicable Guideline Noise Levels for education facilities.

Groundwater– in relation to impact on MGS's building structures

1. The EES adequately identifies the key issues associated with Groundwater.

2. However, the ESS does not adequately address the potential impact of a construction phase groundwater inflow rate into the Domain station excavation of up to 150 m3/day, and the subsequent 2.5m to 5m groundwater drawdown, in relation to the potential impacts on the MGS buildings.

3. Consequently Meinhardt recommends that MGS requests additional Environmental Performance Requirements for MMRP in relation to protecting MGS from the consequences of this potential impact.

Ground Movement and Land Stability– in relation to impact on MGS's building structures

1. The EES adequately identifies the key issues associated with Ground Movement and Land Stability impacts that could potentially arise from the MMRP.

2. Mitigation measures outlined in the EES reduce the residual risks of ground movement to low or very low.

3. One of the EPRs specifically requires the GMP to undertake any required repair work for properties and assets affected by ground movement.

4. Meinhardt recommends that MGS accept the Environmental Performance Requirements for MMRP in relation to Ground Movement and Land Stability, with modifications as described in section 7.5 of this report.

Enabling Works

1. Enabling works have been determined to not have significant effects on the environment and are therefore **not subject to the requirements of this EES,** even though these works will impact on MGS.

2 Introduction

Meinhardt was engaged by Melbourne Grammar School (MGS) to undertake a peer review of the Environmental Effects Statement (EES) for the Melbourne Metro Rail Project. The purpose of this peer review is to inform MGS's formal response to the EES.

The findings of this report are for the MGS's use in preparing its submission to Planning Panels Victoria.

This report relates to the impact on MGS's building structures with respect to the following aspects of the EES:

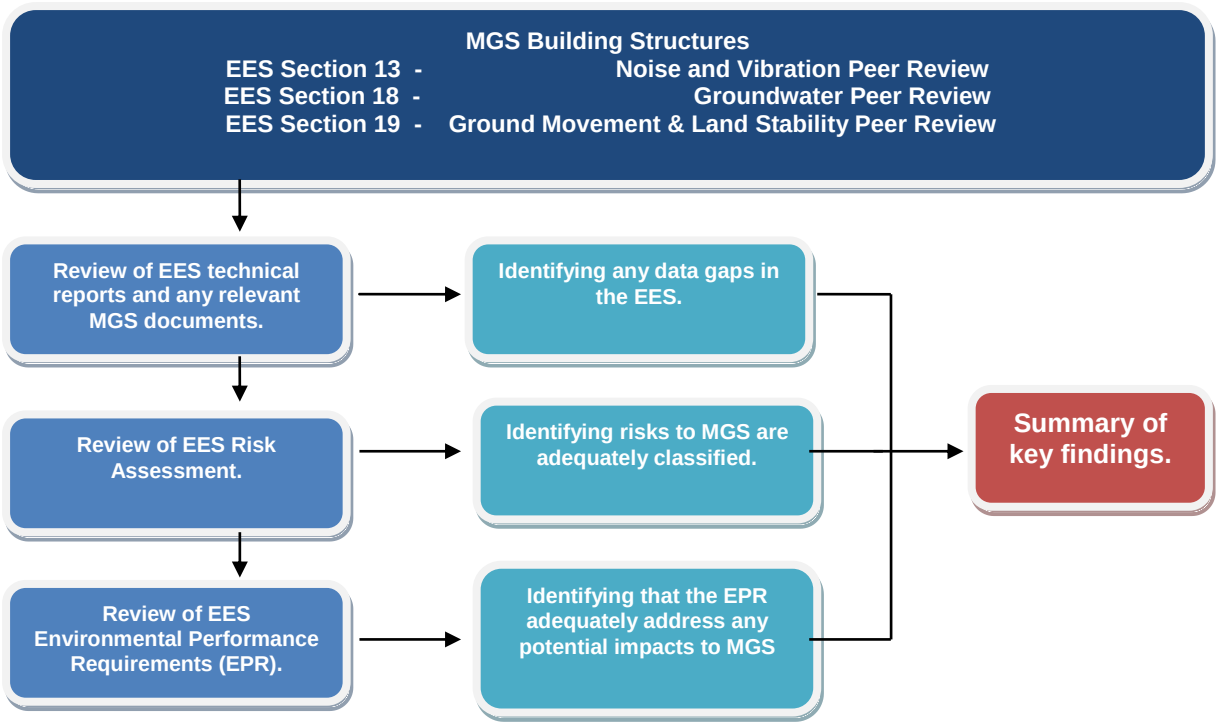
- EES Section 13 – Noise and Vibration
- EES Section 18 – Groundwater
- EES Section 19 – Ground Movement and Land Stability

3 Methodology and Assumptions

3.1 Methodology of this peer review

The ESS *"evaluates the potential effects of the project on a local and project-wide basis and recommends Environmental Performance Requirements that define the project-wide outcomes that must be achieved during the design, construction and operation of Melbourne Metro to avoid, manage or mitigate these impacts."*

To review the EES evaluation process and its subsequent recommendations and findings, Meinhardt has adopted the methodology detailed below.



3.2 Assumptions

- The EES divides the MMRP into nine precincts, based on the location of the project components and construction works, the potential impacts on the local areas and the characteristics of the surrounding areas.

- For the MGS peer review, only the EES sections relating to precincts likely to affect MGS have been reviewed; these are
  Precinct 1 - Tunnels
  Precinct 7 – Domain Station

- Only the EES sections identified in section 2 of this report are addressed in this peer review.

4 MMRP – general implications for MGS Building Structures

4.1 Summary of key EES statements

ITEM	EES Statement	EES/other page reference
1.	Overall, the EES has concluded that achieving the outcomes set by the recommended Environmental Performance Requirements would ensure MMRP achieves acceptable environmental, social and economic outcomes	EES summary report pg. 2
2.	The layout of the Domain station has been revised to reduce the impact on the Shrine of Remembrance	EES summary report pg. 8
3.	The Concept Design within the EES is not the final design for MMRP	EES summary report pg. 12
4.	The EPR are designed to ensure that the project's contractors adopt measures to avoid, manage or reduce the project's environmental impacts by defining the outcomes to be achieved rather than specifying the approach to be taken	EES summary report pg. 13
5.	The EES has identified proposed project boundaries that encompass all the key locations that would be used for permanent structures and temporary construction work sites, above and below ground.	EES summary report pg. 13
6.	MMRP includes twin tunnels each with a diameter of 7 to 7.5 metres	EES summary report pg. 17
7.	The tunnels will run under the St Kilda Road road reserve north of the Domain station. South of Domain station, the tunnels would generally remain beneath the St Kilda Road road reserve.	EES summary report pg. 17
8.	The cut and cover construction methodology is proposed for the new underground station, called Domain, to be located underneath St Kilda Road between Albert Road and Bowen Crescent.	EES summary report pg. 29
9.	The station would have three entrances: within the Shrine of Remembrance Reserve, within the relocated Domain tram interchange in the centre of St Kilda Road and within open space between Albert Road and St Kilda Road where the South African Soldiers Memorial is currently located.	EES summary report pg. 29
10.	The main construction activities at the site would be: ▪ Early works, including the removal of trees, the relocation and protection of utilities and the relocation and protection of the South African Soldiers Memorial located within the Albert Road Reserve ▪ Relocation, removal or upgrade of traffic islands, trams stops and shelters along St Kilda Road, including the Domain tram interchange ▪ Station structural works ▪ Station architectural, mechanical and electrical fit-out ▪ Track works and installation of rail systems ▪ Site remediation, including landscaping and tree re-planting, and the restoration of St Kilda Road (including tram stops) ▪ Restoration of Edmund Herring Oval and Albert Road Reserve.	EES summary report pg. 30
11.	During construction, one tram track, one bike lane and one traffic lane in each direction would be provided along St Kilda Road during construction.	EES summary report pg. 24

12.	Enabling works are specific small scale works that would be initiated earlier than the major Melbourne Metro works (and potentially before the conclusion of the EES process) to minimise disruption to businesses and residents during construction of the project. These works include the protection and relocation of utilities in specified locations, such as telecommunications conduits, gas and water mains, sewers and stormwater drains. The Minister for Planning has determined that these specific works would not have significant effects on the environment and would not need an EES to proceed. MMRA would still need to obtain and comply with all required statutory approvals in undertaking these works	EES summary report pg. 26
14.	Construction work sites would be required on each side of St Kilda Road, at Edmund Herring Oval and Albert Road Reserve, as well as within the St Kilda Road construction footprint.	EES summary report pg. 30
15.	MMRP would provide opportunities to encourage walking and cycling. Improvements that would occur directly as a result of the project include a new pedestrian underpass on St Kilda Road, aligned with the new Domain station	EES summary report pg. 35
16.	The closure of Domain Road and the reduction in St Kilda Road to one lane in each direction (in the Domain station precinct) during construction would have a potentially significant impact on traffic operations.	EES summary report pg. 40
17.	Compared to other locations, there would be a higher number of truck movements in the three precincts where the major construction work sites would be based, including the Domain station precinct.	EES summary report pg. 41
18	The operation of Melbourne Metro would require permanent reconfiguration of St Kilda Road, between Domain Road and Toorak Road to optimize the thoroughfare for all modes of transport.	EES summary report pg. 42

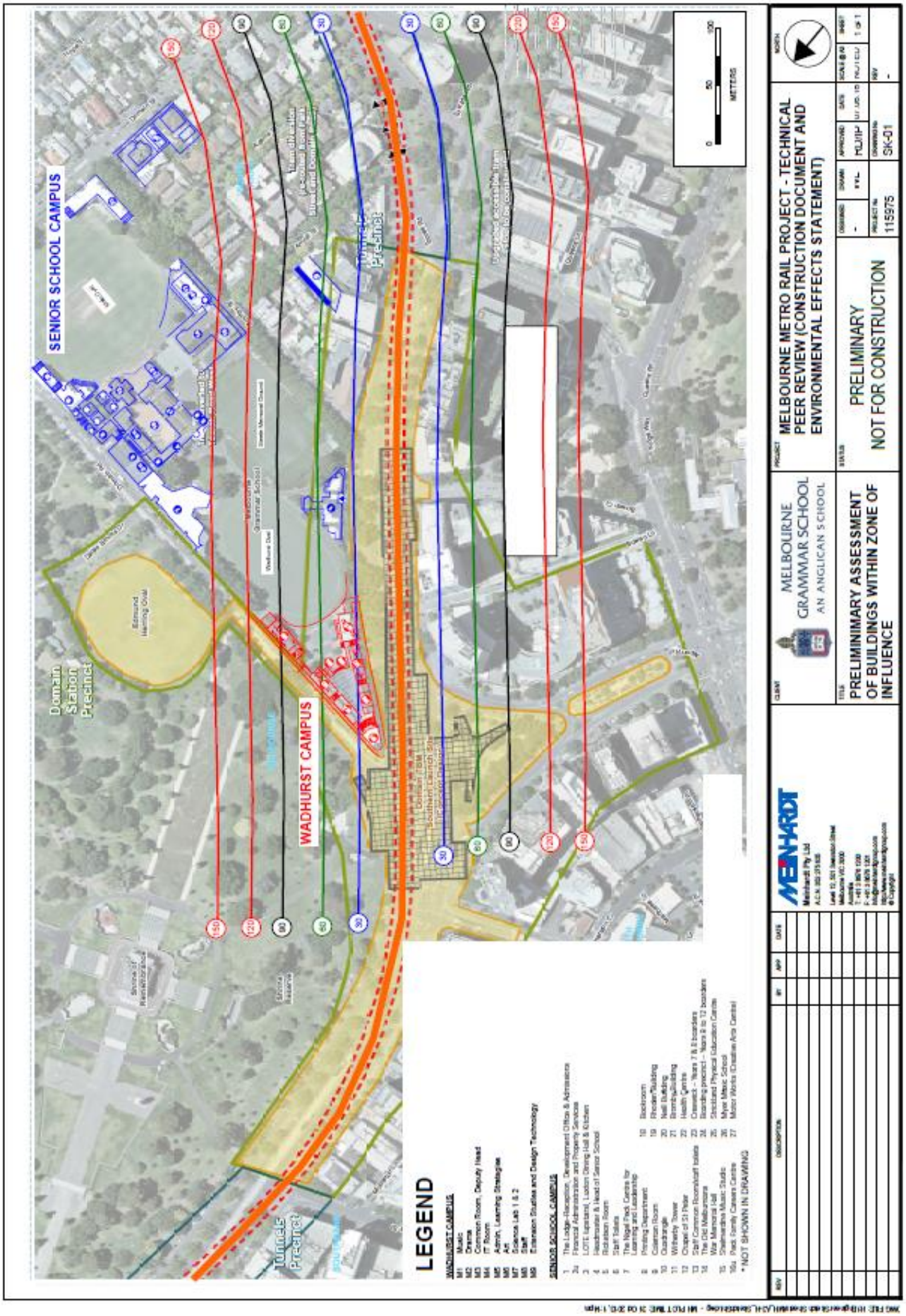
4.1.1 MGS Building Assets within MMRP Zone of Influence

- Meinhardt has established a Zone of Influence being measured as 150 metres horizontally from the proposed tunnel alignment centreline.

- This was established using the following assumptions
  - the base of the works associated with the MMRP extends to approximately 40 metres below surface
  - a width of the Domain Station cavern of 25 metres
  - a slope of influence of 1V:2H
  - a 50% buffer

  - so (0.5 X 25m) + (2 X 40m) = 92.5m , 92.5 X 1.5 = 138m, rounded up to 150m

- We have identified 12 Building assets within this zone, summarised as follows;
  - 4 buildings within 30m of the tunnel alignment centreline
  - 6 buildings between 30m and 60m from the tunnel alignment centreline
  - 0 buildings between 60m and 90m from the tunnel alignment centreline
  - 0 buildings between 90m and 120m from the tunnel alignment centreline
  - 1 building between 120m and 150m from the tunnel alignment centreline


SENIOR SCHOOL CAMPUS
WADHURST CAMPUS
Domain Station Precinct
Tunnels Precinct
Arts Precinct
LEGEND
PRELIMINARY
NOT FOR CONSTRUCTION
MELBOURNE METRO RAIL PROJECT - TECHNICAL PEER REVIEW (CONSTRUCTION DOCUMENT AND ENVIRONMENTAL EFFECTS STATEMENT)
PRELIMINARY ASSESSMENT OF BUILDINGS WITHIN ZONE OF INFLUENCE
MELBOURNE GRAMMAR SCHOOL
AN ANGLICAN SCHOOL
SK-01
115975
METERS

5 EES Section 13 – Noise and Vibration

5.1 EES evaluation objective against which the project is to be assessed

The Scoping Requirements issued by the Minister for Planning include evaluation objectives against which the project must be assessed.

In relation to ***Amenity,*** the evaluation objective is '***to minimise adverse air quality, noise and vibration effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase"***

5.2 Review of EES technical reports

5.2.1 Documents reviewed

- EES Summary Report
- EES Chapter 13 – Noise & Vibration
- EES Technical Appendix I – Noise and Vibration
- EES Technical Appendix I – Noise and Vibration – Appendix A
- EES Technical Appendix I – Noise and Vibration – Appendix B - Part 1
- EES Technical Appendix I – Noise and Vibration – Appendix B - Part 2
- EES Technical Appendix I – Noise and Vibration – Appendix C
- EES Technical Appendix I – Noise and Vibration – Appendix D
- EES Technical Appendix I – Noise and Vibration – Appendix E
- EES Technical Appendix I – Noise and Vibration – Appendix F
- EES Technical Appendix I – Noise and Vibration – Appendix G
- State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1 (SEPP N-1)
- Environment Protection Authority Noise Control Guidelines Publication 1254 (EPA 1254)
- Victorian Passenger Rail Infrastructure Noise Policy (Victorian Government, 2013)
- EPA Publication 480, Environmental Guidelines for Major Construction Sites, 1996
- NSW Interim Construction Noise Guideline, Department of Environment and Climate Change, 2009
- Australian Standard AS2436-2010, Guide to noise and vibration control on construction, demolition and maintenance sites. (AS 2436)
- German Standard DIN 4150-3 Structural Vibration Part 3: Effects of vibration on structures (DIN 4150)
- American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE), Chapter 48, Sound and Vibration Control
- NSW Rail Infrastructure Noise Guideline, May 2013
- Australian Standard AS2187.2-2006 Explosives – Storage and Use Part 2: Use of explosives
- British Standard BS6472-1:2008. Guide to Evaluation of Human Exposure to Vibration in Buildings. Part 1: Vibration sources other than blasting
- NSW Assessing Vibration: a technical guideline, Department of Environment and Conservation, 2006

5.3 Risk Assessment

A risk assessment process was adopted in the EES that adopted the following methodology:

- Undertaking baseline measurements (noise and vibration)
- Determining appropriate criteria / Guideline Targets
- Undertaking predictions and determining if criteria / Guideline Targets would be met
- Identifying appropriate mitigation options where the assessment predicted an exceedance to a criterion or
  Guideline Target
- Evaluating residual risks

Meinhardt has reviewed the risk assessment in Chapter 6 of the MMRP Noise and Vibration Impact Assessment (Appendix I of the EES) and in Chapter 13, Precinct 7: Domain Station Report (Appendix I of the EES). The risks identified, that impact on MGS, are summarised as follows:

ITEM	CATEGORY	EVENT
construction		
C1	Airborne Noise Construction of Melbourne Metro – general construction activities	Noise levels exceeding relevant criteria
C2	Vibration Construction of Melbourne Metro - tunnelling	Vibration levels from tunnelling exceeding Guideline Targets for structural damage and resulting in structural damage
C3	Vibration Construction of Melbourne Metro – general construction activities (not including tunnelling)	Vibration levels from tunnelling exceeding Guideline Targets for structural damage
C4	Vibration Construction of Melbourne Metro - tunnelling	Vibration levels from tunnelling exceeding Guideline Targets for human comfort
C5	Vibration Construction of Melbourne Metro – general construction activities (not including tunnelling)	Vibration levels from tunnelling exceeding Guideline Targets for human comfort
C6	Vibration Construction of Melbourne Metro - tunnelling	Vibration levels from tunnelling exceeding Guideline Targets for vibration-sensitive equipment
C7	Vibration Construction of Melbourne Metro – general construction activities (not including tunnelling)	Vibration levels from tunnelling exceeding Guideline Targets for vibration-sensitive equipment
C8	Ground-borne noise and vibration Construction of Melbourne Metro - tunnelling	Ground-borne noise and vibration levels from tunnelling impacting on Highly Sensitive Areas (hospital wards, operating theatres)
C9	Ground-borne noise and vibration Construction of Melbourne Metro - Additional Construction Works	Ground-borne noise and vibration levels from general construction impacting on Highly Sensitive Areas (hospital wards, operating theatres)
C10	Ground-borne noise and vibration Construction of Melbourne Metro - tunnelling	Ground-borne noise and vibration levels from tunnelling impacting on Bio-resources
C11	Ground-borne noise and vibration Construction of Melbourne Metro - Additional Construction Works	Ground-borne noise and vibration levels from tunnelling impacting on Bio-resources
C12	Ground-borne noise and vibration Construction of Melbourne Metro - tunnelling	Ground-borne noise exceeds Guideline Targets
C13	Ground-borne noise and vibration Construction of Melbourne Metro – additional construction works (not including tunnelling)	Ground-borne noise exceeds Guideline Targets
	Ground-borne noise and vibration Construction of Melbourne Metro - tunnelling	Ground-borne noise and vibration levels from tunnelling impacting on Highly Sensitive Areas (hospital wards, operating theatres)

ITEM	CATEGORY	EVENT
operation		
O1	Airborne noise - trains Operation of passenger trains causes increase in airborne noise	Exceeds criteria
O2	Airborne noise – fixed Infrastructure Operation of fixed infrastructure causes increase in airborne noise	Exceeds criteria
O3	Vibration Operation of passenger trains generates vibration	Exceeds human comfort Guideline Targets (and building damage Guideline Targets)
O4	Vibration Operation of passenger trains generates vibration	Exceeds Guideline Targets for vibration-sensitive equipment
O5	Ground-bourne Noise Operation of passenger trains generates groundborne noise	Exceeds Guideline Targets

5.4 Impact Assessment

- The EES adequately identifies the key issues associated with Noise and Vibration.
- Of the 7 risk categories identified for the **Construction Phase** of MMRP, after the proposed Environmental Performance requirements are implemented:
  - 3 risks have a residual classification of **Low**
  - 1 risk has a residual classification of **Medium**
  - 2 risks have a residual classification of **High** (construction vibration impacting on amenity and ground Bourne noise)
  - 1 risk is unclassified (vibration impacting buried pipework)
- Of the 3 risk categories identified for the **Operational Phase** of MMRP, all risks have a residual risk classification of **Low**, after the proposed Environmental Performance Requirements are implemented.
- Mitigation measures outlined in the EES fail to reduce the residual risks of some items to low or very low.
- Consequently Meinhardt recommends that MGS seek to amend the Environmental Performance Requirements for MMRP.

5.5 Environmental Performance Requirements

Draft EES evaluation objective:

Amenity: To minimise adverse noise or vibration effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.

The following table summarises the EES recommended EPR for the Precinct 4: Parkville Station, together with our recommendations associated with each EPR.

<table>
<tr><th>Impact</th><th>Environmental Performance Requirements</th><th>Meinhardt comments</th></tr>
<tr><td>Noise and Vibration</td><td>Appoint an acoustic and vibration consultant to predict construction noise and vibration (through modelling) and update the modelling to reflect current construction methodology, site conditions and specific equipment noise and vibration levels (this would require noise and vibration measurements). The model would be used to determine appropriate mitigation to achieve the Environmental Performance Requirements.
The acoustic and vibration consultant would also be required to undertake noise and vibration monitoring to assess levels
with respect to Guideline Targets specified in the Environmental Performance Requirements. Where monitoring indicates exceedances of Guideline Targets, apply appropriate management measures as a soon as possible.</td><td>Meinhardt believes this EPR is acceptable</td></tr>
<tr><td>Noise and Vibration</td><td>Develop and implement a communications plan to liaise with potentially affected community stakeholders and land owners regarding potential noise and vibration impacts. The plan shall include procedures for complaint management.</td><td>Meinhardt recommends this EPR should be modified so that the Communications Plan for the Domain Precinct is developed in consultation and with the approval of MGS as the significant stakeholder in the precinct.</td></tr>
<tr><td>Construction generated airborne noise</td><td>Develop and implement a plan to manage construction noise in accordance with EPA Publication 1254 Noise Control Guidelines.</td><td>This EPA publication provides no Guideline Noise levels in relation to construction during the day.

Consequently there is a significant risk that MGS Buildings will be impacted adversely by airbourne construction noise for a significant period.

Meinhardt recommends MGS seek additional limits on airbourne construction noise emissions to limit noise levels emitted to MGS buildings.</td></tr>
<tr><td>Building damage</td><td>Implement management actions if due to construction activity, the following DIN 4150 Guideline Targets for structural damage to buildings (for short-term vibration or long-term vibration) are not achieved.
Short-term vibration on structures
<table>
<tr><th rowspan="2">Type of structure</th><th colspan="3">Vibration at the foundation, mm/s (Peak Component Particle Velocity)</th><th>Vibration at horizontal plane of highest floor at all frequencies</th></tr>
<tr><th>1 to 10 Hz</th><th>10 to 50 Hz</th><th>50 to 100 Hz[1]</th><th>mm/s (Peak Component Particle Velocity)</th></tr>
<tr><td>Type 1: Buildings used for commercial purposes, industrial buildings and buildings of similar design</td><td>20</td><td>20 to 40</td><td>40 to 50</td><td>40</td></tr>
<tr><td>Type 2: Dwellings and buildings of similar design and/or occupancy</td><td>5</td><td>5 to15</td><td>15 to 20</td><td>15</td></tr>
<tr><td>Type 3: Structures that have a particular sensitivity to vibration e.g. heritage buildings</td><td>3</td><td>3 to 8</td><td>8 to 10</td><td>8</td></tr>
</table>
Notes:
1. At frequencies above 100 Hz, the values given in this column may be used as minimum values.
2. Vibration levels marginally exceeding those vibration levels in the table would not necessarily mean that damage would occur and further investigation would be required to determine if higher vibration levels can be accommodated without risk of damage.
3. For civil engineering structures (e.g. with reinforced concrete constructions used as abutments or foundation pads) the values for Type 1 buildings may be increased by a factor of 2.
4. Short-term vibration is defined as vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated.</td><td>Meinhardt believes this EPR is acceptable. We further recommend that MGS provide and have incorporated into the EPR a register of MGS buildings within the zone of influence together with the building assets classification against this DIN standard. (Meinhardt can assist in preparing this register as part of a Baseline Structural Review)

The use of this German standard is considered acceptable as there are no Victorian requirements for managing construction vibration.

We further recommend that all measurement and evaluation of effects of vibration on structures shall be carried out in accordance with DIN 4150.</td></tr>
</table>

Long term vibration on structures

Type of structure	Vibration Velocity, mm/s (Peak Component Particle Velocity) in horizontal plane at all frequencies
Buildings used for commercial purposes, industrial buildings and similar design	10
Dwellings and buildings of similar design and/or occupancy	5
Structures that have a particular sensitivity to vibration e.g. heritage buildings	2.5

Notes:

1. Vibration levels marginally exceeding those in the table would not necessarily mean that damage would occur and further investigation would be required to determine if higher vibration levels can be accommodated without risk of damage.
2. Long-term vibration during construction to demonstrate compliance with agreed vibration guideline targets. Take remedial action if limits are not met.

Damage to underground infrastructure

Implement management actions if the following DIN 4150 Guideline Targets for buried pipework/underground infrastructure from construction are not achieved.

Pipe Material	Vibration Velocity, mm/s (PPV)
Steel	100
Clay, concrete, reinforced concrete, prestressed concrete, metal	80
Masonry, plastic	50

Notes:

1. These values may be reduced by 50% when evaluating the effects of long-term vibration on buried pipework.
2. It is assumed pipes have been manufactured and laid using current technology (however it is noted that this is not the case for the majority of buried pipework potentially affected by Melbourne Metro).
3. Compliance is to be achieved with asset owner's Utility Standards.

Meinhardt believes this EPR is acceptable. We further recommend that MGS request that is EPR clearly states that it is applicable to both Authority Infrastructure as well as privately owned underground pipes and infrastructure.

The use of this German standard is considered acceptable as there are no Victorian requirements for managing construction vibration.

We further recommend that all measurement and evaluation of effects of vibration on underground infrastructure shall be carried out in accordance with DIN 4150.

Construction vibration impacting upon amenity

Implement Management Actions if the Guideline Targets (VDVs) (based on Table 1 in BS6472-1:2008) for continuous (as for TBMs and roadheaders), intermittent, or impulsive vibration are not achieved.

Location	Vibration Dose Value, VDV ($m/s^{1.75}$)			
	Day 7am to 10pm		Night 10pm to 7am	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residences	0.20	0.40	0.10	0.20
Offices, schools, educational institutions, places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes:

1. The Guideline Targets are non-mandatory; they are goals that should be sought to be achieved through the application of feasible and reasonable mitigation measures. If exceeded then management actions would be required.
2. The VDVs may be converted to PPVs within a future Noise and Vibration Construction Management Plan.

Meinhardt believes this EPR should be modified to remove Note 1.

Meinhardt recommends that MGS request these Guideline Targets to be mandatory, otherwise this EPR may be ineffectual.

The use of this British standard is considered acceptable as there are no Victorian requirements for managing construction vibration.

We further recommend that all measurement and evaluation of effects of vibration impacting on amenity shall be carried out in accordance with BS6472-1:2008)

Structural damage, impact on amenity

Comply with Australian Standard AS2187.2-2006, Explosives – Storage and use Part 2 – Use of explosives for all blasting.
For Highly Sensitive Areas, hospital wards, operating theatres and Bio-resources and areas with vibration-sensitive equipment which are not covered in AS2187.2-2006, develop a plan in consultation with facilities owners that:

- Avoids damage to vibration-sensitive equipment
- Minimises adverse impact on Highly Sensitive Areas and Bio-resources.

Rock blasting is indicated as a possibility in other sections of the EES.
Meinhardt recommends MGS request this EPR be included as being applicable to Precinct 7.
Meinhardt further recommends RMIT consider whether any of its Building Structures house Highly Sensitive Areas, and whether it wishes to have this EPR amended to list all such MGS areas.
Meinhardt also recommends MGS considers whether MGS prefers to attempt to prohibit blasting within the Domain Precinct.

Construction ground-borne noise impacting upon amenity

Implement management actions as determined in consultation with potentially affected land owners to protect amenity at residences, sleeping areas in hospital wards, student accommodation and hotel rooms where the following ground-borne noise Guideline Targets (from the NSW Interim Construction Noise Guideline) are exceeded during construction.

Time Period	Internal Target, $L_{Aeq,15min}$ (dB)
Evening, 6pm to 10pm	40
Night, 10 pm to 7am	35

Note:

1. Levels are only applicable when ground-borne noise levels are higher than airborne noise levels.
2. The noise levels are assessed at the centre of the most affected habitable room.
3. Management Actions include extensive community consultation to determine acceptable level of disruption and provision of respite accommodation in some circumstances.

This EPR makes reference only to residences, and does not refer to other sensitive land uses such as educational institutions.

Consequently there is a significant risk that MGS Buildings will be impacted adversely by ground-bourne construction noise for a significant period.

Meinhardt recommends MGS seek additional limits on ground bourne construction noise emissions to limit noise levels emitted to MGS buildings.

Operational Noise and Vibration

Appoint an acoustic and vibration consultant to predict noise and vibration and determine appropriate mitigation to achieve the Environmental Performance Requirements. The acoustic and vibration consultant would also be required to undertake commissioning noise and vibration measurements to assess levels with respect to the Environmental Performance Requirements.

Meinhardt believes this EPR is acceptable

Operational airborne noise impacting on amenity

Avoid, minimise or mitigate rail noise where the following PRINP (Victorian Passenger Rail Infrastructure Noise Policy, April 2013) Investigation Thresholds are exceeded during operation.

Time	Type of Receiver	Investigation Thresholds
Day (6am – 10pm)	Residential dwellings and other buildings where people sleep including aged persons homes, hospitals, motels and caravan parks Noise sensitive community buildings, including schools, kindergartens, libraries	65 dBL_{Aeq} and a change in 3 dB(A) or more or 85 dBL_{Amax} and a change in 3 dB(A) or more
Night (10pm – 6am)	Residential dwellings and other buildings where people sleep including aged persons homes, hospitals, motels and caravan parks	60 dBL_{Aeq} and a change in 3 dB(A) or more or 85 dBL_{Amax} and a change in 3 dB(A) or more

Notes:

1. If an investigation shows that the thresholds are not exceeded, then no further action is considered under the PRINP
2. L_{Amax}, for this assessment, is defined as maximum A-weighted sound pressure level and is the 95 percentile of the highest value of the A-weighed sound pressure level reached within the day or night
3. For the Melbourne Metro the location of assessment is at 1 m from the centre of the window of the most exposed external façade

Meinhardt believes this EPR is acceptable

Operational airborne noise causing adverse impact on amenity

Comply with State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1 (SEPP N-1). This does not apply to trains and trams.

Meinhardt believes this EPR is acceptable for MGS as there are no elements of fixed infrastructure such as ventilation shafts in the Domain Precinct.

Operational ground-borne noise impacting upon amenity

Where operational ground-borne noise trigger levels are exceeded for sensitive occupancies as shown in the table below (trigger levels are based on the Rail Infrastructure Noise Guideline,17 May 2013 (RING(1)), assess feasible and reasonable mitigation to reduce noise towards the relevant ground-borne noise trigger level.

Sensitive land use	Time of day	Internal noise trigger levels
Residential	Day (7am-10pm)	40 dBL_{ASmax} and an increase in existing rail noise level by 3 dB(A) or more
	Night (10pm -7am)	35 dBL_{ASmax} and an increase in existing rail noise level by 3 dB(A) or more
Schools, educational institutions, places of worship	When in use	40-45 dBL_{ASmax} and an increase in existing rail noise level by 3 dB(A) or more
Hospitals (bed wards and operating theatres)	24 hours	35 dB(A) L_{ASMax}
Offices	When in use	45 dB(A) L_{ASMax}
Cinemas and Public Halls	When in use	30 dB(A) L_{ASMax}
Drama Theatres	When in use	25 dB(A) L_{ASMax}
Concert halls, Television and Sound Recording Studios	When in use	25 dB(A) L_{ASMax}

1. RING provides trigger levels for residential and schools, educational institutions and places of worship, but does not provide guidance on acceptable ground-borne noise levels for other types of sensitive receivers. Ground-borne noise trigger levels for other types of sensitive occupancies have been developed based on RING and industry knowledge.
2. Specified noise levels refer to noise from heavy or light rail transportation only (not ambient noise from other sources)
3. Assessment location is internal near to the centre of the most affected habitable room.
4. L_{ASmax} refers to the maximum noise level not exceeded for 95% of the rail pass-by events.
5. For schools, educational institutions, places of worship the lower value of the range is most applicable where low internal noise levels is expected.

Meinhardt believes this EPR is acceptable

Operational vibration impacting on amenity	During operation, achieve the Guideline Targets (based on Table 1 in BS6472-1:2008) or background levels (whichever is higher) for vibration as follows: VDV ($m/s^{1.75}$) Day 7am to 10pm / Night 10pm to 7am Location | Day Preferred Value | Day Maximum Value | Night Preferred Value | Night Maximum Value Residences | 0.20 | 0.40 | 0.10 | 0.20 Offices, schools, educational institutions, places of worship | 0.40 | 0.80 | 0.40 | 0.80 Workshops | 0.80 | 1.60 | 0.80 | 1.60 Notes: 1. The Guideline Targets are non-mandatory; they are goals that should be sought to be achieved through the application of feasible and reasonable mitigation measures. 2. Compliance with these values implies no structural damage due to operation	Meinhardt believes this EPR is acceptable

6 EES Section 18 – Groundwater

6.1 EES evaluation objective against which the project is to be assessed

The Scoping Requirements issued by the Minister for Planning include evaluation objectives against which the project must be assessed.

In relation to ***Hydrology, water quality and waste management***, the evaluation objective is '***To protect waterways and waterway function and surface water and groundwater quality in accordance with statutory objectives, to identify and prevent potential adverse environmental effects resulting from the disturbance of contaminated or acid-forming material and to manage excavation spoil and other waste in accordance with relevant best practice principles"***

6.2 Review of EES technical reports

6.2.1 Documents reviewed

- EES Summary Report
- EES Chapter 18 – Groundwater
- EES Technical Appendix O – Groundwater Part 1
- EES Technical Appendix O – Groundwater Part 2
- EES Technical Appendix O – Groundwater Part 3
- EES Technical Appendix O – Groundwater Part 4
- EES Technical Appendix O – Groundwater Part 5
- EES Technical Appendix O – Groundwater Part 6

6.2.2 Summary of key EES statements

ITEM	EES Statement	EES/other page reference
1.	Groundwater would be encountered across almost the entire Melbourne Metro alignment.	EES chapter 18 pg. 1
2.	The principal potential impacts of Melbourne Metro on groundwater arise because most of the tunnels, stations and other sub-surface infrastructure are located below the watertable.	EES chapter 18 pg. 1
3	Groundwater can seep into excavations that are below the watertable, which can result in groundwater drawdown around the structures during construction and operation.	EES chapter 18 pg. 1
4	Groundwater drawdown is the primary pathway for potential impacts on groundwater dependent assets to occur.	EES chapter 18 pg. 1
5	Tanking methods (sealing structures to minimise groundwater inflow) would reduce groundwater inflow to negligible rates during both construction and operation, and prevent impacts to these assets.	EES chapter 18 pg. 1
6	For the mined sections of tunnels and other excavations, (e.g. the construction of Domain Station) the drawdown associated with construction would be short-term and groundwater levels would recover after tanking of the structures at the end of construction	EES chapter 18 pg. 1
7	As all structures associated with Melbourne Metro would be tanked for operation, drawdown would be insignificant post construction.	EES chapter 18 pg. 1
8	Temporary impacts to local groundwater dependent assets may occur during the construction of Melbourne Metro as a result of groundwater drawdown, but the use of standard design techniques and mitigation measures can minimise drawdown so that impacts are acceptable.	EES chapter 18 pg. 1

9	The highest groundwater elevations along the alignment occur in the Parkville area at 25 m AHD (Australian Height Datum)	EES chapter 18 pg. 8
10	The lowest groundwater elevations coincide with groundwater sinks such as the North and South Yarra Main Sewers, the City Loop tunnels and the CityLink tunnels as well as deep basements in Parkville, the CBD and Southbank.	EES chapter 18 pg. 8
11	There is a possibility of activating potential acid sulfate soil (PASS) through lowering of the watertable in Coode Island Silt or in fresh to slightly weathered Melbourne Formation.	EES chapter 18 pg. 13
12	When the watertable fluctuates, acidic groundwater can be produced and heavy metals can be mobilised, causing corrosion of underground concrete and steel structures, foundations or services	EES chapter 18 pg. 13
13	The expected geology across this precinct is Melbourne Formation in the tunnels and lower half of the station box and Brighton Group in the upper half of the station box. The Brighton Group within this precinct is unsaturated and the watertable occurs in the Melbourne Formation. Testing shows that the Brighton Group has a low potential to generate acidity. Deep fresh to slightly weathered Melbourne Formation rock, typically present at depths greater than 24 m, has moderate to high potential to generate acidity. Shallow highly weathered to extremely weathered Melbourne Formation is typically non-acid forming and hence low risk.	EES Technical Appendix O – Groundwater Part 2, pg 187
14	There are eight groundwater monitoring bores in this precinct and groundwater levels have been monitored at least once at each.	EES Technical Appendix O – Groundwater Part 2, pg 188
15	The bores in this precinct record groundwater levels below 0 m AHD. Under natural conditions, groundwater levels in this area would be expected to be above sea level, given the distance from Port Phillip Bay (more than 3.5 km). Groundwater flow would be to the south-west, towards the low lying Albert Park Lake (a former swamp). The South Yarra Main Sewer runs along the northern edge of Albert Park Lake and it is possible that there is some water loss from the lake to the sewer.	EES Technical Appendix O – Groundwater Part 2, pg 189
16	These low levels are likely to be due to the presence of the South Yarra Main Sewer which crosses the tunnel alignment and runs along Domain Road and Albert Road. The base of the sewer is approximately -10 m AHD where it crosses the alignment and the diameter of the sewer is almost 3 m. The sewer is over 100 years old and likely to be of brick and concrete construction. Therefore, the capacity of the sewer to prevent groundwater ingress is almost certainly compromised and in this area it appears to be acting as a drain.	EES Technical Appendix O – Groundwater Part 2, pg 189
17	As the sewer appears to be acting as a major groundwater drain in the area, its replacement may cause groundwater levels in the east of this precinct to rise by up to 5 m.	EES Technical Appendix O – Groundwater Part 2, pg 189
18	The depth to groundwater in this precinct ranges between approximately 7 m to 12.5 m below ground level. The shallowest groundwater levels are in the north-west of the precinct.	EES Technical Appendix O – Groundwater Part 2, pg 189
19	Modelling indicates that a construction phase groundwater inflow rate into the Domain station excavation of up to 150 m3/day was predicted	EES Technical Appendix O – Groundwater Part 6, pg 45
20	A maximum groundwater drawdown of between 2.5m and 5.0m is estimated in the groundwater modelling carried out at the Domain Station	EES Technical Appendix O – Groundwater Part 6, pg 46

21	At the end of construction, the drawdown cone extending from the station is predicted to be roughly elliptical with the long axis along the length of the station (north-west to south-east) and extending several hundred metres from the station. The shape of the drawdown cone is affected by the South Yarra Main Sewer.	EES Technical Appendix O – Groundwater Part 2, pg 193
22	Domain station would be tanked for operation and therefore long term inflows are expected to be minor.	EES Technical Appendix O – Groundwater Part 2, pg 193
23	The inflow rate is determined by the construction of the tanking and the aim for Domain station in the Concept Design is Haack Tightness Class 2, which limits daily inflow to 0.05 L/m2 per 100 m length	EES Technical Appendix O – Groundwater Part 2, pg 193
24	The estimated groundwater drawdown as a result of the minor inflows to the station is predicted to be less than 0.2 m immediately above the station at steady state. This minimal drawdown means that no impacts on groundwater dependent values are anticipated at Domain station during operation.	EES Technical Appendix O – Groundwater Part 2, pg 193

6.3 Risk Assessment

A risk assessment process was adopted in the EES that adopted the following methodology:

- Setting of the context for the environmental risk assessment
- Development of consequence and likelihood frameworks and the risk assessment matrix
- Review of project description and identification of impact assessment pathways by specialists in each relevant discipline area
- Allocation of consequence and likelihood ratings and determination of preliminary initial risks
- Further investigation of impact pathways and presence of receptors to confirm or revise initial risk rankings
- Development of Environmental Performance Requirements and mitigation measures to reduce initial risks ranked moderate (or higher), to achieve residual risk rankings.

Meinhardt has reviewed the risk assessment in Chapter 6 of the MMRP Groundwater Impact Assessment (Appendix O of the EES) and in Chapter 13, Precinct 7: Domain Station Report (Appendix O of the EES). The risks identified, that impact on UoM, are summarised as follows:

ITEM	CATEGORY	EVENT
G1	Groundwater drawdown causing migration of contaminant plumes	Groundwater drawdown causing existing contaminant plumes to migrate to areas previously unaffected by Contamination. Pumping groundwater from excavations leads to drawdown that could cause contaminated groundwater to migrate to third party properties, and reduce current and future beneficial uses of groundwater at those properties. If the contaminant plume consists of volatile substances, there is the potential for vapour to enter structures on neighbouring properties as a result of the migration of contamination
G2	Groundwater drawdown oxidising Potential Acid Sulfate Soils (PASS) resulting in increased groundwater acidity	Groundwater drawdown may expose PASS to air causing oxidiation of sulfide minerals and impacts on groundwater quality, including increased acidity and heavy metal content, causing corrosion of underground concrete and steel structures, foundations or services.

6.4 Impact Assessment

- The EES adequately identifies the key issues associated with Groundwater.
- However, the ESS does not adequately address the potential impact of a construction phase groundwater inflow rate into the Domain station excavation of up to 150 m3/day, and the subsequent 2.5m to 5m groundwater drawdown, in relation to the potential impacts on the MGS buildings.
- Consequently Meinhardt recommends that MGS requests additional Environmental Performance Requirements for MMRP in relation to protecting MGS from the consequences of this potential impact.

6.5 Environmental Performance Requirements

Draft EES evaluation objective:

Hydrology, water quality and waste management:
To protect waterways and waterway function and surface water and groundwater quality in accordance with statutory objectives, to identify and prevent potential adverse environmental effects resulting from the disturbance of contaminated or acid-forming material and to manage excavation spoil and other waste in accordance with relevant best practice principles

The following table summarises the EES recommended EPR for the Precinct 1: Tunnels, together with our recommendations associated with each EPR.

Impact	Environmental Performance Requirements	Meinhardt comments
Groundwater	Design the tunnel and underground structures so that they minimise groundwater drawdown during construction and operation to minimise impacts on groundwater dependent values, ground movement and contamination plume migration.	Meinhardt believes this EPR is acceptable
Groundwater	Develop a groundwater model for the detailed design phase to predict impacts associated with any changes to construction techniques or operational design features proposed during detailed design, and reconfirm that the Environmental Performance Requirements and mitigation measures are sufficient to mitigate impacts from changes in groundwater levels, flow and quality. Undertake monitoring during construction to ensure that predictions are accurate and mitigation measures are appropriate.	Meinhardt believes this EPR is acceptable.
Groundwater	Develop and implement a Groundwater Management Plan (GMP) detailing groundwater management approaches to address the predicted impacts to groundwater dependent values during construction. The GMP must be based on the detailed design phase groundwater model, and should include the following details: ▪ Approach to collection, treatment and disposal of groundwater collected during construction in accordance with the MMRA Groundwater Disposal Strategy ▪ Identifying and if necessary, specifying mitigation measures to protect groundwater dependent vegetation during periods of drawdown ▪ An approach identified in consultation with the EPA so that contaminant migration causes no significant impacts on beneficial uses and vapour intrusion into underground structures, and establish appropriate monitoring networks to confirm effectiveness of approach ▪ Methods for minimising drawdown in areas of known PASS and establishing appropriate monitoring networks to confirm effectiveness of approach ▪ Methods for minimising drawdown at any existing recharge bores and establishing appropriate monitoring networks to confirm effectiveness of mitigation drawdown ▪ Groundwater drawdown trigger levels for groundwater dependant values at which additional mitigation measures must be adopted ▪ Design, operation and management of groundwater injection borefields ▪ Contingency measures if impacts occur at existing active groundwater bores and surface water bodies. The GMP must satisfy the EPA and relevant water authorities that groundwater dependent values will be protected. The groundwater management plan should also address MMRA's sustainability requirements where appropriate.	Meinhardt believes this EPR is acceptable
Groundwater	Use the Groundwater Disposal Strategy and GMP to obtain a Trade Develop a groundwater disposal All Construction / GW055 Waste Agreement with the relevant Water Retailers for groundwater strategy that confirms disposal Operation GW056 disposal.	Meinhardt believes this EPR is acceptable
Groundwater	Develop and implement a groundwater monitoring plan as part of the GMP that details sufficient monitoring of drawdown to verify that no significant impacts occur from potential: ▪ Contaminant migration on the beneficial uses of groundwater at third party properties caused by drawdown and vapour intrusion to underground structures • Activation of PASS and groundwater acidification ▪ Reduction in access to water for bore owners in the area around the project ▪ Reduction in access to groundwater for trees– particularly in the Tunnels precinct between CBD South and Domain stations, and the CBD South station and eastern portal precincts • Change in groundwater levels in any existing recharge bores that may be present in the area around the project.	Meinhardt believes this EPR is acceptable

The EES states that "*Since the minimal drawdown predicted means the risk of impacts to groundwater dependent values is low, no specific Environmental Performance Requirements have been recommended for this station precinct. However the project-wide Environmental Performance Requirements of developing a detailed design phase model and a Groundwater Management Plan to assess and manage impacts associated with the detailed design still apply"* EES Technical Appendix O – Groundwater Part 2, section 13.5 pg 194.

This statement appears to be inconsistent with the modelling which estimates potentially significant groundwater drawdowns during construction.

Consequently Meinhardt recommends that MGS requests additional Environmental Performance Requirements for MMRP in relation to protecting MGS from the consequences of this potential impact.

7 EES Section 19 – Ground Movement and Land Stability

7.1 EES evaluation objective against which the project is to be assessed

The Scoping Requirements issued by the Minister for Planning include evaluation objectives against which the project must be assessed.

In relation to ***Land Stability***, the evaluation objective is ***'To avoid or minimise adverse effects on land stability that might arise directly or indirectly from project works"***

7.2 Review of EES technical reports

7.2.1 Documents reviewed

- EES Summary Report
- EES Chapter 19 – Ground Movement and Land Stability
- EES Technical Appendix P – Ground Movement and Land Stability Part 1
- EES Technical Appendix P – Ground Movement and Land Stability Part 2
- EES Technical Appendix P – Ground Movement and Land Stability Part 3
- EES Technical Appendix P – Ground Movement and Land Stability Part 4
- EES Technical Appendix P – Ground Movement and Land Stability Part 5
- EES Technical Appendix P – Ground Movement and Land Stability Part 6
- EES Technical Appendix P – Ground Movement and Land Stability Part 7

7.2.2 Summary of key EES statements

ITEM	EES Statement	EES/other page reference
1.	Ground movement is an expected outcome on any tunnelling project	EES chapter 19 pg. 1
2.	Predominantly, the tunnels alignment is located within favourable geological units for ground stability, while meeting the key requirement to achieve safe design gradients for rail operations.	EES chapter 19 pg. 1
3	Ground movements may occur above and adjacent to Melbourne Metro works due to the following mechanisms: ▪ Underground excavation-induced ground movement ▪ Open cut excavation-induced ground movement ▪ Primary consolidation settlement of soft soils, primarily Coode Island Silt ▪ Slope instability	EES chapter 19 pg. 1
4	Buildings, utilities and civil infrastructure – such as roads, tram lines, rail lines, bridges and pipes – would potentially be subjected to the effects of ground movement caused by excavation activities.	EES chapter 19 pg. 2
5	Excavation-induced ground movements would only occur during the construction phase.	EES chapter 19 pg. 2
6	The Potential Zone of Influence relating to ground movement has been defined by the estimated 5 mm excavation-induced ground surface settlement contours, together with areas potentially subject to primary consolidation settlement greater than 10 mm. Prior experience demonstrates that tunnelling projects have negligible impacts on structures outside these parameters. Structures and underground services within these parameters have been considered in the ground movement impact assessment conducted for the EES.	EES chapter 19 pg. 3

7	Predominantly, the project alignment would traverse bedded and folded sedimentary rock, the Melbourne Formation, which forms the rock beneath much of Melbourne. A layer of generally very stiff sedimentary soil is found overlying the Melbourne Formation generally from Kings Domain to the eastern portal.	EES chapter 19 pg. 5
8	The vertical extent of the study area is based on the vertical alignment of the tunnels: up to 40 m below ground level.	EES chapter 19 pg. 8

7.3 Risk Assessment

A risk assessment process was adopted in the EES that adopted the following methodology:

- Development of preliminary assessment inputs
- Determination of the Potential Zone of Influence for ground movement
- Identification of impact assessment pathways
- Site specific assessment
- Investigation of impact pathways and presence of receptors to confirm or revise initial risk rankings
- Development of Environmental Performance Requirements and mitigation measures to reduce initial risks ranked moderate (or higher), to achieve residual risk rankings.

Meinhardt has reviewed the risk assessment in Chapter 7 of the MMRP Ground Movement and Land Stability Impact Assessment (Appendix P of the EES). The risks identified, that impact on UoM, are summarised as follows:

ITEM	CATEGORY	EVENT
LS1	Construction stage excavations cause ground movement	Potential impacts on existing buildings and/or infrastructure
LS2	Construction stage groundwater inflows to excavations result in ground movement (consolidation settlement)	Potential impacts on existing buildings and/or infrastructure
LS3	Combined effects of excavation induced ground movement and consolidation settlement	Potential impacts on existing buildings and/or infrastructure
LS4	Unexpected ground conditions or unexpected ground movement	Moderate or worse impacts to existing structures and/or infrastructure.
LS5	Tunnel construction encountering rock with greater rock mass strength than expected	May necessitate a change in construction methods in a zone of mixed geological conditions leading to increased ground movement or cause TBM to go off-line. Requirement to change construction method or repair/retool TBM could result in project delay
LS6	Underground Excavations	Very high strength rock mass requires drilling and blasting as a method of excavation. This could result in delays in tanking of tunnels or underground excavations.
LS7	Tunnel construction	Modelled levels of ground movement are underestimated as a consequence of unforeseen geology, groundwater conditions, surface conditions and unexpected building conditions or use of different equipment types.
LS8	Ground heave as a result of excessive face pressure by the TBMs in shallow cover areas	Unacceptable ground movement.
LS9	Groundwater inflow to excavations much greater than that estimated due to interception of high permeability zones that are difficult to control.	Consolidation settlement magnitude and extents greater than that estimated resulting in moderate or worse impacts to existing structures and/or infrastructure.
LS10	Ongoing leakage into tunnels and underground structures during operation	Depressurisation of compressible sediments resulting in consolidation settlement with subsequent unacceptable impacts on structures, utilities and/or infrastructure.

7.4 Impact Assessment

- The EES adequately identifies the key issues associated with Ground Movement and Land Stability.
- The EES Impact Assessment has not considered individual impacts of settlement on all structures, utilities and infrastructure with the Domain precinct.
- Mitigation measures outlined in the EES reduce the residual risks associated with Ground Movement and Land Stability to low or very low.
- Consequently Meinhardt recommends that MGS accept the Environmental Performance Requirements for MMRP in relation to Groundwater.

7.5 Environmental Performance Requirements

Draft EES evaluation objective:

Land Stability: ***'To avoid or minimise adverse effects on land stability that might arise directly or indirectly from project works"***

The following table summarises the EES recommended EPR for the Precinct 7: Domain Station, together with our recommendations associated with each EPR.

Impact	Environmental Performance Requirements	Meinhardt comments
Land Stability	Develop and maintain geological and groundwater models which: ▪ Use monitored ground movement and ground water levels prior to construction to identify pre-existing movement; ▪ Inform tunnel design and the construction techniques to be applied for thevarious geological and groundwater conditions; ▪ Assess potential drawdown and identify trigger levels for implementing additional mitigation measures to minimise potential primary consolidation settlement; and ▪ Assess potential ground movement effects from excavation and identify trigger levels for implementing additional mitigation measures to minimise potential ground movement effects	Meinhardt believes this EPR is acceptable
Land Stability	Design and construct the permanent structures and temporary works so as to limit ground movements to within appropriate acceptability criteria (to be determined in consultation with the relevant stakeholders) for vertical, horizontal, and angular deformation, as appropriate, for project activities during the construction and operational phase	Meinhardt recommends this EPR should be modified so that the acceptability criteria for the Domain Precinct is developed in consultation and **with the approval** of MGS as the significant stakeholder in the precinct.
Land Stability	Develop and implement a ground movement plan for construction and operational phases of the project that: ▪ Addresses the location of structures/assets which may be susceptible to damage by ground movement resulting from Melbourne Metro works; ▪ Identifies appropriate ground movement impact acceptability criteria for buildings, utilities, trains, trams and pavement in consultation with the various stakeholders; ▪ Identifies mitigation measures to ensure acceptability criteria can be met; ▪ Identifies techniques for limiting settlement of buildings and protecting buildings from damage; ▪ Addresses additional measures to be adopted if acceptability criteria are not met such as reinstatement of any property damage; ▪ Addresses monitoring ground movement surrounding proposed Melbourne Metro works and at the location of various structures/assets to measure consistency with the predicted model; ▪ Consult with land and asset owners that could potentially be affected and where mitigation measures would be required	Meinhardt believes this EPR is acceptable
Land Stability	Conduct pre-construction condition surveys for the assets predicted to be affected by ground movement. Develop and maintain a data base of as built and pre construction condition information for each potentially affected structure, specifically including: ▪ Identification of structures/assets which may be susceptible to damage resulting from ground movement resulting from Melbourne Metro works; ▪ Results of condition surveys of structures, pavements, significant utilities and parklands to establish baseline conditions and potential vulnerabilities; ▪ Records of consultation with landowners in relation to the condition surveys; ▪ Post construction stage condition surveys conducted, where required	Meinhardt believes this EPR is acceptable

Land Stability	Adopt construction techniques for Melbourne Metro to limit ground movement to within appropriate acceptability criteria (to be determined in consultation with the relevant stakeholders).	Meinhardt recommends this EPR should be modified so that the acceptability criteria for the Domain Precinct is developed in consultation and **with the approval** of MGS as the significant stakeholder in the precinct.
Land Stability	For properties and assets affected by ground movement, undertake any required repair works	Meinhardt believes this EPR is acceptable