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4 November 2022
E25358.G12_Rev1

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Groundwater Take Assessment
Proposed Mixed-use Development
160 Lord Sheffield Circuit, Penrith NSW

1. INTRODUCTION

1.1. BACKGROUND

At the request of Urban Apartments Pty Ltd (the Client), EI Australia (EI) has prepared this Groundwater Take Assessment (GTA) for 160 Lord Sheffield Circuit, Penrith NSW (the site).

EI has prepared a Geotechnical Investigation (GI) report for the site, referenced E25358.G03_Rev2, dated 4 November 2022.

1.2. PROPOSED DEVELOPMENT

The following documents were used to assist in the preparation of this analysis:

- Architectural Drawings prepared by SJB Architects – Job No.6626, Drawing Nos. A-1000, Revision 8 and A-1501, Revision 7, Drawing No. A-1001, Revision 12, Drawing No. A-1002, Revision 11, Drawing No. A-1502, Revision 5, dated 1 November 2022;
- Preliminary Structural Drawings prepared by van der Meer (NSW) Pty Ltd – Job No. SY220-070, Drawing Nos. S02-01 and S02-02 (RevC), and S02-11 (RevB), dated 3 November 2022;
- Transport for New South Wales Piling Report prepared by van der Meer (NSW) Pty Ltd – Job No. SY220-070, RevB, dated 2 November 2022; and
- Detail Survey Plan prepared by SDG Pty Ltd – Reference No.8635, Issue A, dated 11 January 2022.

Based on the provided documents, EI understands that the proposed development involves the construction of a ten storey mixed use development overlying a three-level basement. The lowest basement level is proposed to have a finished floor level (FFL) of RL 18.15m. The Bulk Excavation Level (BEL) is assumed as RL 17.80m to allow for the construction of the basement slab. To achieve the BEL, an excavation depth up to 9.20m to 10.20m Below Existing Ground Level (BEGL) is expected. Locally deeper excavations may be required for footings, service trenches, crane pads, and lift overrun pits.

1.3. ASSESSMENT OBJECTIVES

The objective of this GTA is to provide an estimation of the groundwater take volumes that require pumping out during the construction and operational stage of the development, estimation of the groundwater drawdown as a result of the dewatering (if any).

2. SITE MODEL

2.1. MODELED SECTIONS

Two SEEP/W sections have been modelled to account for the proposed excavation perimeter. Two sections are detailed below, detailed plan showing location of two sections are presented in **Figure 1** at the end of this report.

- **Section A-A:** In north-south direction through the site.
- **Section B-B:** In east-west direction through the site.

2.2. SUBSURFACE CONDITIONS PERMEABILITY

For the purpose of the GTA, the subsurface conditions outlined in our GI have been simplified into four stratigraphy units for the finite element model. A summary of the modelled soil/rock materials and permeability values which were adopted are presented in **Table 1** below.

Table 1 Summary of Subsurface Conditions and Adopted Design Parameters

Material [1]	Adopted RL of Top of Unit (m AHD) [2]			Adopted Permeability (m/s)	Anisotropy Ky'/Kx'
	Section A-A	Section B-B [4]			
		W	E		
Topsoil/Fill [3]	27.5	27.5	27.8	1.0×10^{-5}	1.0
Clayey Soil [3]	27.0	27.0	26.6	1.0×10^{-7}	1.0
Sandy Soil/Gravel [3]	23.0	23.1	20.0	1.0×10^{-4}	1.0
Sandstone/Shale Bedrock [3]	15.5	16.0	13.3	1.0×10^{-8}	0.1

Notes:

1 For more detailed descriptions of subsurface conditions reference should be made to the Geotechnical Investigation Report.
2 Depths and levels presented in **Table 1** above are generalised using the most conservative levels from the Geotechnical Investigation across the excavation area for the purpose of groundwater seepage modelling.
3 Permeability values have been correlated for material encountered during the GTA using Look (2014).
4 Adopted RL of Top of Unit was based on the average subsurface conditions encountered in all boreholes for Section A-A, and was based on BH1 and BH6 only for Section B-B.

EI carried out a pump-out test within BH4M. The monitoring well was screened between 4.9m BEGL to 10.9m BEGL within the Sandy Soil/Gravel. High groundwater flows was observed during the pump-out test and hence a permeability of 1.0×10^{-4} m/s was adopted for the sandy soil/gravel based on known correlations.

2.3. GROUNDWATER OBSERVATIONS

As part of the GI scope, EI had installed one monitoring well (BH4M) for groundwater monitoring. Groundwater measurements are presented in **Table 2** below.

Table 2 Summary of Groundwater Levels

Monitoring Well ID	Date of Observation	Approximate Depth to Groundwater Level (m BEGL)	Approximate RL of Groundwater Level (m AHD)
BH4M	15-Dec-21	7.1	20.5
	15-Jul-22	6.1	21.5

A design groundwater level of RL 22.5m has been adopted for assessment of groundwater seepage inflow rates and groundwater take volumes within the excavation. This groundwater level is 1m higher than the highest measured groundwater level in BH4M to account for possible seasonal variations.

2.4. SHORING SYSTEM

Based on the provided structural drawings, EI understands that the shoring system can be summarised as following:

- Secant Pile Wall: Piles will be socketed to toe levels ranging from RL 11.65m to RL 13.70m towards the eastern portion of the site and ranging from RL 14.4m to RL 15.05m towards the western portion of the site.

This assessment does not assess the overall stability and embedment depth of the shoring system. Once final designs are made available, this assessment should be revised accordingly.

3. GROUNDWATER TAKE ASSESSMENT

3.1. GROUNDWATER SEEPAGE VOLUMES DURING CONSTRUCTION PHASE

3.1.1. Volume of Dewatering Beneath Shoring Wall

Groundwater seepage analysis for flow beneath the shoring wall during construction has been undertaken using SEEP/W, a finite element groundwater seepage analysis software. SEEP/W estimates the seepage rate of water entering the excavation from beneath the shoring wall. This model estimates the volume of water which will be required to be dewatered during the construction of the basement and until the dewatering is turned off.

For the purpose of this modelling, it has been assumed that:

- The subsurface conditions were horizontal along the site. The permeability values presented in **Table 1** above were adopted for each unit.
- The secant pile shoring walls are assumed to be impermeable, and have been modelled to a socket of 1.0m below top of sandstone/shale bedrock for the simplicity of the model.
- For the simplicity of this model, temporary dewatering will be undertaken within the basement retaining wall perimeter to 0.5m below BEL, or about RL 17.3m.
- An external design groundwater level of RL 22.5m was assumed to be constant at 50 m away from the shoring wall.
- Section A-A is 25m in width and runs 186m in length.
- Section B-B is 184m in width and runs 80m in length.
- The basement will be constructed in 180 days.

The SEEP/W model is presented in **Appendix A and B. Table 3** below provides the estimated groundwater inflow rate into the basement.

Table 3 Summary of Analysis Results

Section	Inflow per m length of section (m^3/sec)	Inflow per m length of section (m^3/day)	Inflow into excavation per section (m^3/day)	Total Inflow during construction per section (ML/180 days)	Total Inflow during construction (ML/180 days)
Section A-A	2.35×10^{-8}	2.03×10^{-3}	0.38	0.07	0.10
Section B-B	2.43×10^{-8}	2.10×10^{-3}	0.17	0.03	

3.2. ASSESSMENT OF GROUNDWATER TAKE DURING OPERATIONAL PHASE

A fully tanked/watertight basement solution is adopted for the long term management of groundwater pressure. The volume of water removed each year from a tanked basement is governed by its design. With the use of an appropriate design, it is possible to limit groundwater ingress in a tanked basement to volumes which are negligible.

4. CONCLUSIONS AND COMMENTS

Considering that the basement walls and slab will be designed as tanked for the development's lifetime, and based on findings of this report and within the limitations of available data, EI concludes that:

- Construction phase groundwater take will be approximately **0.10ML / 180 days** during construction.
- Operational phase groundwater take will be negligible during lifetime of the building.
- The above estimate is based on the following assumptions:
  - The secant pile wall system is fully impermeable;
  - Continuous dewatering in order to maintain the groundwater at a depth of 0.5m below BEL during construction, and construction of the basement will take 180 days;
  - This assessment does not take into consideration any excavation that may be required for footings, service trenches, lift pits, or crane pads. This additional excavation, if required, is not expected to affect the retention or the dewatering system.
- In our opinion, the dewatering will have negligible, if any, adverse impact on the neighbouring properties. The groundwater drawdown adjacent to the site caused by dewatering is considered negligible.

Should any design or construction conditions differ from that adopted in this report; this GTA should be reviewed and updated as required.

5. LIMITATIONS

This report has been prepared for the exclusive use of Urban Apartments Pty Ltd who is the only intended beneficiary of EI's work. The scope of the inspections carried out for the purpose of this report is limited to those agreed with Urban Apartments Pty Ltd.

No other party should rely on the document without the prior written consent of EI, and EI undertakes no duty, or accepts any responsibility or liability, to any third party who purports to rely upon this document without EI's approval.

EI has used a degree of care and skill ordinarily exercised in similar tasks by reputable members of the geotechnical industry in Australia as at the date of this document. No other warranty, expressed or implied, is made or intended. Each section of this report must be read in conjunction with the whole of this report, including its appendices and attachments.

The conclusions presented in this report are based on a limited assessment of conditions, with specific locations chosen to be as representative as possible under the given circumstances.

EI's professional opinions are reasonable and based on its professional judgment, experience, training and results from analytical data. EI may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified by EI.

EI's professional opinions contained in this document are subject to modification if additional information is obtained through further investigation, observations, or validation testing and analysis during remedial activities. In some cases, further testing and analysis may be required, which may result in a further report with different conclusions.

6. CLOSURE

Please do not hesitate to contact the undersigned should you have any questions.

For and on behalf of
EI Australia

Author	Technical Reviewer
[redacted]	[redacted]
Max (Yuhui) Chen Geotechnical Engineer	Stephen Kim Senior Geotechnical Engineer

Attachments: Figure 1 - Modelled Section
Appendix A – SEEP/W Model - Section A-A
Appendix B – SEEP/W Model - Section B-B
Important Information

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SERVICES SHOULD BE LOCATED BY MORE ACCURATE METHODS.

UNDERGROUND ELEC			KS	
No	Surface RL	Approx Dep	ce RL	Qu
1	27.18			
2	27.23	0.70	26.53	
3	27.29			
4	27.29	0.80	26.49	
5	27.24	1.00	26.24	
6	27.34			
7	27.27			
8	27.40			
9	27.36	1.10	26.26	
10	27.32			
11	27.51			
12	27.40	1.80	25.60	
13	27.35			
14	27.45			
15	27.45			
16	27.55	0.80	26.75	
17	27.64			
18	27.69			
19	27.71	0.80	26.91	
20	27.72			
21	27.62			
22	27.66	0.80	26.86	
23	27.75	0.80	26.95	
24	27.67			
25	27.54			
26	27.54	1.00	26.54	
27	27.79	2.10	25.69	
28	27.78			
29	27.48			

Map Source:
SDG Pty Ltd, Ref: 8635, Issue: A, dated 11 January 2022;
van der meer, Job No. SY220-070, Drawing Nos. S02-01 and S02-02, Rev. C, dated 3 November 2022;

LEGEND (All Locations are Approximate)

- Site boundary
- Basement boundary
- Modeled sections
- Borehole locations
- Borehole/monitoring well location

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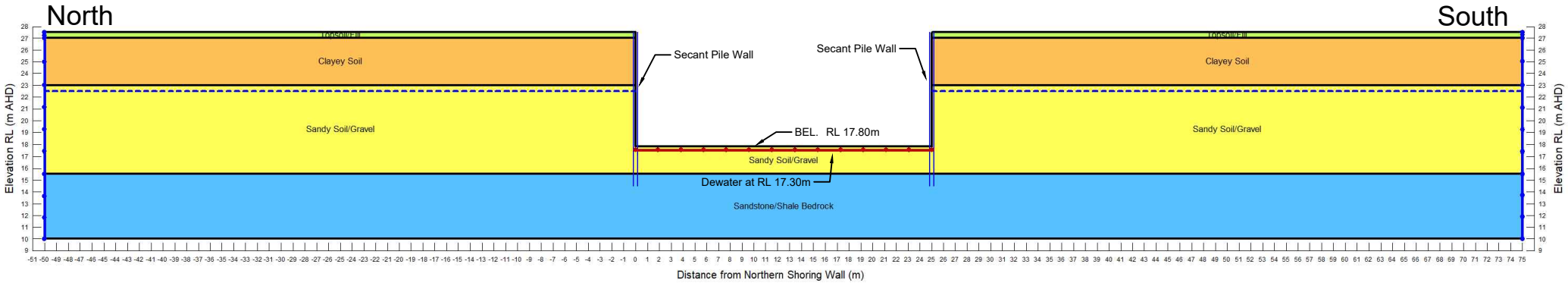
Approved:	S.K.
Date:	04-11-22

Urban Apartments Pty Ltd
Groundwater Take Assessment
160 Lord Sheffield Circuit, Penrith NSW
Modelled Sections

Figure: 1

Project: E25358.G12



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Approx Scale:	As Shown

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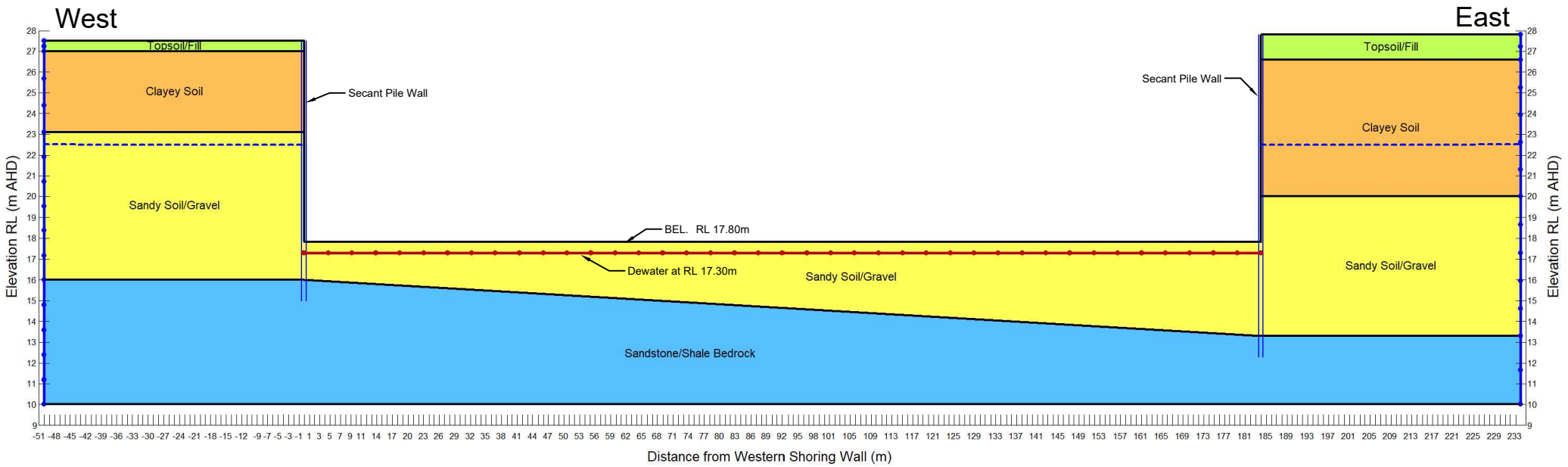
SEEP/W Model - Section A-A

Appendix:
A

Project: E25358.G12



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Urban Apartments Pty Ltd
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SEEP/W Model - Section B-B

Appendix:
B

Project: E25358.G12

Important Information

SCOPE OF SERVICES

The geotechnical report ("the report") has been prepared in accordance with the scope of services as set out in the contract, or as otherwise agreed, between the Client And EI Australia ("EI"). The scope of work may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

RELIANCE ON DATA

EI has relied on data provided by the Client and other individuals and organizations, to prepare the report. Such data may include surveys, analyses, designs, maps and plans. EI has not verified the accuracy or completeness of the data except as stated in the report. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations ("conclusions") are based in whole or part on the data, EI will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to EI.

GEOTECHNICAL ENGINEERING

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared for a specific client, for a specific project and to meet specific needs, and may not be adequate for other clients or other purposes (e.g. a report prepared for a consulting civil engineer may not be adequate for a construction contractor). The report should not be used for other than its intended purpose without seeking additional geotechnical advice. Also, unless further geotechnical advice is obtained, the report cannot be used where the nature and/or details of the proposed development are changed.

LIMITATIONS OF SITE INVESTIGATION

The investigation programme undertaken is a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions. The data derived from the site investigation programme and subsequent laboratory testing are extrapolated across the site to form an inferred geological model, and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation, the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies. The engineering logs are the subjective interpretation of subsurface conditions at a particular location and time, made by trained personnel. The actual interface between materials may be more gradual or abrupt than a report indicates.

SUBSURFACE CONDITIONS ARE TIME DEPENDENT

Subsurface conditions can be modified by changing natural forces or man-made influences. The report is based on conditions that existed at the time of subsurface exploration. Construction operations adjacent to the site, and natural events such as floods, or ground water fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. EI should be kept appraised of any such events, and should be consulted to determine if any additional tests are necessary.

VERIFICATION OF SITE CONDITIONS

Where ground conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of the report that EI be notified of any variations and be provided with an opportunity to review the recommendations of this report. Recognition of change of soil and rock conditions requires experience and it is recommended that a suitably experienced geotechnical engineer be engaged to visit the site with sufficient frequency to detect if conditions have changed significantly.

REPRODUCTION OF REPORTS

 Where information from the accompanying report is to be included in contract documents or engineering specification for the project, the entire report should be included in order to minimize the likelihood of misinterpretation from logs.

REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the Client and no other party. EI assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of EI or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

OTHER LIMITATIONS

EI will not be liable to update or revise the report to take into account any events or emergent circumstances or fact occurring or becoming apparent after the date of the report.