REDITUS

Dewatering Management Plan

4 Delmar Parade & 812 Pittwater Road

Dee Why NSW

DA2022/0145

Prepared for Landmark Group Australia Pty Ltd

7 June 2022

Version 1

reditusconsulting.com

Dewatering Management Plan

4 Delmar Parade & 812 Pittwater Road, Dee Why NSW

Prepared for Landmark Group Australia Pty Ltd

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Financial Year 2021/2022 No. 973

Financial Year 2021/2022 No. SC40974

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This report has been prepared for Landmark Group Australia Pty Ltd (ACN 144 079 792) in accordance with the terms and conditions of appointment for proposal P21181 dated 6 September 2021.

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Report No:	21181RP01
Report Date:	7 June 2022
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Roles and Responsibilities

During development construction, the Principal Contractor will be responsible for implementing the appropriate management of the groundwater discharge as detailed in this Dewatering Management Plan.

All environmental monitoring, assessment of results and compliance reporting must be completed by a suitably qualified environmental consultant and certified Environmental Practitioner - Site Contamination Specialist.

Monitoring, analysis and assessment of offsite groundwater levels (offsite drawdown) must be completed by a suitability qualified hydrogeologist.

Geotechnical and structural engineering advice may be required if offsite groundwater drawdown threshold levels are triggered.

Details of the nominated Principal Contractor, Hydrogeologist and Environmental Consultant are provided in the Table below.

It must be noted that the Dewatering Management Plan is not inclusive of all conditions of consent in relation to groundwater management, and that the Principal Contractor is responsible for making itself aware of, and complying with, all relevant conditions of any permits, licenses and approvals.

This Dewatering Management Plan must be reviewed by a suitability qualified professional on a regular basis to ensure compliance with relevant environmental legislation and guidelines. The Dewatering Management Plan should be updated where required to comply with any changes to relevant environmental legislation and guidelines.

Nominated Principal Contractor, Hydrogeologist and Environmental Consultant Details

Role	Company	Contact Information
Principal Contractor	To be advised	**Name:** **Title:** **Phone:**
Hydrogeologist & Environmental Consultant	Reditus Consulting Pty Ltd	**Name:** Lee Douglass **Title:** Principal Hydrogeologist EIANZ Certified Environmental Practitioner - Site Contamination Specialist **Phone:** 0412 625 989

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Executive Summary

Reditus Consulting Pty Ltd (Reditus) were commissioned by Landmark Group Australia Pty Ltd to prepare a Dewatering Management Plan (DMP) for the proposed mixed-use development located at 4 Delmar Parade and 812 Pittwater Road, Dee Why NSW (the site).

The proposed development includes the demolition of existing structures and construction of a mixed-use development comprising three commercial tenancies and 230 apartments over 2 basements levels, lot consolidation and subdivision.

The basement will require excavation below the groundwater table and will require dewatering to enable construction.

The proposed CSM / Diaphragm wall construction design prevents groundwater inflows (to minimise as much as possible the take of groundwater) from upper-unconsolidated Alluvial aquifer following completion of the construction works. This will effectively create a water-tight seal from the alluvial aquifer to the basement. The remainder of the basement will be designed as partially 'Drained Basement', as the ongoing groundwater inflows from the underlying low permeability Hawkesbury Sandstone can be effectively managed and meets the monitoring and reporting requirements of a regulated exemption for requiring a Water Access Licence (applicable to groundwater take volumes of <3ML/year do not require a water access licence to be held).

The inherent impermeable nature of the CSM / Diaphragm Walls will prevent groundwater inflow from the unconsolidated (alluvial sand formation), therefore the only groundwater inflows will be limited to that from the underlying low permeability sandstone (vertical inflow from the base). The excavation and dewatering will only commence after the CSM / Diaphragm Walls have been completed.

The DMP provides details on the hydrogeological setting, construction design, predictions of groundwater extraction volumes, and assessment of potential dewatering impacts. The DMP also provides management strategies to minimise adverse environmental impacts including proposed water treatment system, environmental control procedures, monitoring program, performance criteria and compliance reporting requirements.

Groundwater take estimates were predicted, incorporating both groundwater inflows and matrix removal through excavation. The groundwater inflow was predicted using a steady-state analytical method developed by Marinelli and Niccoli (2000). The following 'Most Likely' groundwater take estimates were predicted during construction and ongoing drained basement take:

Dewatering Area	**Predicted Groundwater Inflow Take (ML/yr)**	**Predicted Matrix Take (ML)**	**Total Groundwater Take During Construction (ML)**
Basement Excavation	**2.39**	6.87	9.26

Given that groundwater will be intercepted and require dewatering during construction of the basement, the proposed development is considered to be an aquifer inference activity requiring assessment and authorisation under the Water Management Act 2000 (within a Water Sharing Plan zone, regulated by WaterNSW).

Reditus notes the following:

- **Water Sharing Plan**: The site is mapped within the Sydney Basin Central Groundwater Source, under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. The Sydney Basin Central Groundwater Source is a Porous Rock Groundwater Source.
- **Alluvial Aquifer**: This water bearing zone is not mapped within the Metropolitan Coastal Sands Groundwater Source, therefore is not considered to be managed under a Water Sharing Plan area, therefore is considered to be regulated under the Water Act 1912. The majority of groundwater take results from the once-off matrix excavation works during construction (**5.47ML**). Given that the low permeability CSM wall minimises groundwater inflow from the surrounding alluvial aquifer (Model Scenario 1: **<0.1ML/yr**), there will be negligible take from this alluvial aquifer once construction is complete.
- **Porous Rock Aquifer:** This water bearing zone is mapped under the Sydney Basin Central Groundwater Source, under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011, therefore considered to be regulated by WaterNSW under the WMA 2000. The predicted ongoing groundwater take from this aquifer was **2.39ML/yr** through the drained basement design. An estimated **1.40ML** take will result from matrix removal during construction works.

To address the mandatory requirements of WaterNSW and NSW DPIE-Water assessment, a DMP was required for the relevant applications. This mandatory information has been summarised within the WaterNSW “Dewatering Checklist for a Water Management Works Approval” form, with the DMP prepared in general accordance with the NSW DPIE (2021) *Minimum Requirements for Building Site Groundwater Investigations and Reporting*. The purpose of this DMP is to facilitate an application for:

- “Approval for Water Supply Works and/or Water Use” to be submitted to WaterNSW under the Water Management Act 2000 and Part 5 of the Water Act 1912.

Reditus note that if approval is granted under the WMA 2000, an application for a “new water access licence with a zero share component” will typically be needed to be completed and a suitable groundwater entitlement will also need to be obtained from the market to account for the groundwater take during the construction phase (as total groundwater take during construction is predicted to be **9.26ML**). This entitlement must be obtained from within the same groundwater source. This will typically need to be obtained within three months of granting of the Zero Access Licence.

Once construction is complete, the long-term groundwater take through the Drained Basement design was predicted to be **2.39ML/yr**. Works or activities that intersect or interfere with groundwater systems and where take is incidental to the primary purpose of the activity, or where there is no take, are managed as aquifer interference activities. Aquifer interference activities taking 3ML or less of groundwater per year are exempt from requiring a Water Access Licence (WAL). As such, a WAL will not be required following completion of construction.

Based on the groundwater inflow and impact assessment, the basement dewatering activities are considered to be of **Minimal Impact** under the NSW DPI (2012) Aquifer Interference Policy, WMA 2000 and the NSW DPI (2018) *Assessing Groundwater Applications Water Resource Plans Fact Sheet*.

To assist the WaterNSW assessment, the following required information required to support the "Approval for Water Supply Works and/or Water Use" application is listed in the table below.

Checklist Item & Required Information Description	**DMP Findings**	**Relevant Page No:**
1: Current groundwater levels, preferably based on at least three repeat measurements from at least three monitoring bores and should be used to develop a water table map for the site and its near environs, be accompanied by an interpretation of the groundwater flow direction from these data, and an assessment of the likely level to which groundwater might naturally rise during the life of the building.	Daily onsite groundwater elevations were obtained from 3 onsite monitoring wells over a 204 period (7 months) between 21 October 2021 and 12 May 2022. This covered significant rainfall events including the16 day period between 23 February and 9 March, where 740mm of rainfall occurred (67% of average annual rainfall of 1,101mm). Groundwater flow direction was inferred to be towards the northwest, towards Pittwater Road. Groundwater contour plan for October 2021 and May 2022 are provided in Figures 4 & 5, Appendix A. Standing groundwater levels measured from monitoring wells ranged between RL 23.0m and RL 32.8m. The average of the maximum levels reported in the three (3) monitoring wells was 29.2mAHD. As demonstrated in the monitoring data set, groundwater confined/semi-confined Sandstone aquifers in the Sydney region can vary naturally by ±4m or more during prolonged periods of dry or wet weather.	Pg. 12-14 Section 4.2.
2: Predictions of total volume of groundwater to be extracted during the life of the approval (or during the construction period) – the method of calculation and the basis for parameter estimates and any assumptions used to derive the volume are to be clearly documented.	An analytical steady state model was used to predict groundwater extraction volumes, including both that contained in the excavation matrix and inflow during construction. The total groundwater take volume over the excavation and construction period was predicted to be **9.26 ML**. This includes: • a matrix volume of **6.87ML** from the Alluvial and Sandstone aquifer. • a groundwater inflow volume of **2.39ML/yr** from the Sandstone aquifer during construction, which is located within the Sydney Basin Central Groundwater Source, under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. Following completion of construction, the predicted ongoing groundwater inflows from the partially drained basement was **2.39ML/yr.**	Pg. 18-29 Section 5.
3: Predicted duration of dewatering at the property, noting that temporary water supply works approvals are generally issued for no more than 24 months.	The duration of dewatering during construction is expected to be less than 12 months. Permanent dewatering will be required due to the partially drained basement design, of **2.39ML/yr.**	Pg. 8-9 Section 3.3

4: Details of how dewatering volumes are to be measured, e.g. by calibrated flow meter or other suitable method, and of the maximum depth of the proposed dewatering system.	Groundwater extraction volumes are to be measured using a calibrated flow meter (inline Magflow meter). The maximum depth of the proposed dewatering system has been determined by the Bulk Excavation Level (BEL) of RL 21.5 mAHD (0.5m below the Finished Floor Level FFL of RL 22.0 mAHD).	Pg. 7 & 66
5: Details of any predicted impacts or particular issues, e.g. proximity of groundwater dependent ecosystems springs; or water supply losses by neighbouring groundwater users; or potential subsidence impacts on nearby structures or infrastructure.	Groundwater Impact Assessment has been completed in Section 7, based on the predicted offsite drawdown model results, in general accordance with the NSW DPI (2018) Assessing Groundwater Applications Water Resource Plans Fact Sheet and Minimal Impact criteria as per the NSW DPI (2012) Aquifer Interference Policy. Identification of Potential Dewatering Impacts are presented in Section 9. The nearest high priority GDE is mapped 'Wetland' located approximately 20km to the south. The closest registered groundwater supply bore (GW108144 – irrigation bore for Brookvale Oval) was located 900m to the southwest of the site. Given the most likely predicted drawdown within 25m from the excavation boundary is negligible (<0.1m), the dewatering works are unlikely to cause a detrimental impact GDEs or water supply works. The proposed CSM / Diaphragm Wall (keyed into low permeability sandstone) will significantly minimise drawdown within the surrounding alluvial aquifer. The predicted drawdown in the surrounding alluvial aquifer was <0.1m within 2m of the basement wall (as demonstrate by the Scenario 1 Best-Case model conditions). A drawdown in the water table of 1m or less is considered unlikely to result in off-site geotechnical settlement impacts. A drawdown monitoring program and contingency recommendation are provided.	Pg 36-40.
6: Details of monitoring proposed during the dewatering program. These should be designed to inform and facilitate the protection of any identified potential impacts.	The requirements for monitoring, management and compliance reporting of potential impacts (including discharge water quality, drawdown/settlement, noise, vibration and odour) are detailed in Sections 10 to 13 of this DMP.	Pg. 52-70

7: Details of ambient groundwater quality conditions beneath the property and of any proposed treatment to be applied to pumped water prior to disposal – at a minimum, treatment must be undertaken to remove contaminants, manage pH levels, reduce suspended solids and turbidity to acceptable levels and ensure that dissolved oxygen levels are compatible with ambient quality requirements in receiving waters. Groundwater cannot be re-injected into an aquifer without the specific approval of, and licensing by, WaterNSW.	Groundwater sampling has been completed on the adjoining site at 2 Delmar Parade Dee Why (Section 4.2.3). The groundwater sampling and laboratory data reported concentrations potential contaminants of concern below the adopted ANZG (2018) 95% marine water quality guidelines, with the exception of the following: ▪ Copper of 2ug/L (1.3ug/L); ▪ Nickel of 11ug/L to 16ug/L (7ug/L); and ▪ Zinc of 24ug/L to 33ug/L (15ug/L) Based on the above concentrations, water treatment will be required. The proposed water treatment system is specified in Section 11. Water Quality Objectives (Section 8) and Adopted Discharge Criteria (Section 8.3) are provided in the DMP. Groundwater re-injection is not currently proposed.	Pg. 15-16, 55-58, 41-47
8: Details of how reporting will occur during and following the dewatering program, to confirm that predicted quantities and quality objectives were met.	Weekly dewatering reports summarising the monitoring results are recommended for the Stage 1 & 2 monitoring periods. Following completion of the Stage 1 & Stage 2 monitoring period, ongoing monitoring reports will be completed on a Fortnightly basis during Stage 3 monitoring period. A "Completion Report" detailing the volume of water taken and groundwater condition post construction dewatering activities, will be provided to the WaterNSW/NRAR within 6 months of dewatering completion.	Pg. 70 Section 13
9: Description of the method of dewatering and related construction including any proposal to use temporary piling or support walls and the relative depths thereof.	The basement will be constructed as partially Water-Tight and partially Drained basement design: A CSM / Diaphragm wall is proposed to be constructed around the excavation perimeter, which will be keyed at least 1.5m into moderate-high strength sandstone of naturally low permeability strata. The proposed CSM / Diaphragm wall construction design prevents groundwater inflows (to minimise as much as possible the take of groundwater) from upper-unconsolidated Alluvial aquifer following completion of the construction works. This will effectively create a water-tight seal from the alluvial aquifer to the basement. Therefore the only groundwater inflow will be limited to that from the underlying sandstone walls and base (horizontal inflow from the southern and western excavation walls, and vertical inflow from the base). Given the naturally low permeability of the sandstone (based on site specific measurements), groundwater inflows are expected to be negligible (<3ML/yr) and considered able to be effectively managed	Pg. 7-10 Section 3 Pg. 55-58 Section 11

	under a Drained Basement design with implementation of an appropriate management plan. The excavation and dewatering will only commence after the CSM / Diaphragm Walls have been completed. Groundwater is proposed to be extracted using either a series of spearpoints installed internally around the perimeter of the excavation, or 3-5 large diameter extraction wells within the excavation. The spearpoints and extraction wells will be installed to the Bulk Excavation Level or base of the alluvial sediments. Once the unconsolidated alluvial sediments are removed from within the excavation, and the excavation extends into sandstone, groundwater extraction using sump pumps is likely to be sufficient.

1. Introduction

Reditus Consulting Pty Ltd (Reditus) were commissioned by Landmark Group Australia Pty Ltd to prepare a Dewatering Management Plan (DMP) for the proposed mixed-use development located at 4 Delmar Parade and 812 Pittwater Road, Dee Why NSW (the site).

The proposed development includes the demolition of existing structures and construction of a mixed-use development comprising three commercial tenancies and 230 apartments over 2 basements levels, lot consolidation and subdivision.

The site location and proposed development basement layout is provided in **Figure 1, Appendix A.** The site details are summarised in Table 1-1 below.

Table 1-1: Site Identification Details

Site Characteristics	Details
Street Address	4 Delmar Parade and 812 Pittwater Road, Dee Why NSW
Lot & Deposited Plan	▪ SP32071 (4 Delmar Parade, Dee Why NSW) ▪ SP32072 (812 Pittwater Road, Dee Why NSW)
LGA	Northern Beaches Council
Zoning	'B4 – Mixed Use' according to the Warringah Local Environmental Plan (LEP) 2011
Site Coordinates to the approximate centre of the site (GDA2020-MGA56)	Easting: 341016 Northing: 6263479
Site Area	Total: 7,791 m^2 (by survey)
Basement Excavation Area	Total: 6,216 m^2 (as per DA plans)
Water Sharing Plan & Groundwater Source	Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. Sydney Basin Central Groundwater Source.
Current Land Owners	Dee Why 3 Pty Limited (ACN: 634 195 350) Dee Why 4 Pty Limited (ACN: 639 570 568) Greenwich Road Pty Limited (ACN: 636 032 258) Anglo Road Pty Limited (ACN: 636 032 187) of Level 25, 88 Phillip Street, Sydney, NSW 2000
Site Locality Map	Figure 1, Appendix A
Site Layout	Figure 2, Appendix A

Given that groundwater will be intercepted and require dewatering during construction of the basement, the proposed development is considered to be an aquifer inference activity requiring assessment and authorisation under the Water Management Act (WMA) 2000 (within a Water Sharing Plan zone, regulated by WaterNSW).

To address the mandatory requirements of WaterNSW and NSW DPIE-Water assessment, a DMP was required for the relevant applications. This mandatory information has been summarised within the WaterNSW "Dewatering Checklist for a Water Management Works Approval" form, with the DMP prepared in general accordance with the NSW DPIE (2021) *Minimum Requirements for Building Site Groundwater Investigations and Reporting*. The purpose of this DMP is to facilitate an application for:

- "Approval for Water Supply Works and/or Water Use" to be submitted to WaterNSW under the Water Management Act 2000 and Part 5 of the Water Act 1912.

Reditus note that if approval is granted under the WMA 2000, an application for a "new water access licence with a zero share component" will typically be needed to be completed and a suitable groundwater entitlement will also need to be obtained from the market to account for the groundwater take during the construction phase (as total groundwater take during construction is predicted to be 9.26ML). This entitlement must be obtained from within the same groundwater source. This will typically need to be obtained within three months of granting of the Zero Access Licence.

1.1. Objectives

Dewatering activities have the potential to impact the surrounding environment, primarily associated with:

- Potential settlement issues as a result of groundwater drawdown outside the site.
- Potential groundwater drawdown impacts on surrounding water supply works (e.g. domestic bores) or environmental groundwater uses.
- Potential issues with groundwater drawdown in acid sulfate soil environments.
- Potential mobilisation and migration of contamination from offsite sources.

The primary objectives of the DMP are to:

- Provide details on the hydrogeological setting of the site and a summary of key environmental factors relevant to dewatering with specific focus on water quality and aquifer properties at the site;
- Provide details of the proposed development layout, construction design and dewatering methods;
- Predict dewatering extraction volumes required for the development works during construction;
- Determine the potential impacts of the dewatering activity to groundwater dependent ecosystems (GDEs), springs, water supply works and potential for subsidence impacts on nearby structures or infrastructure (through assessment against the Minimal Impact thresholds detailed under the NSW DPI (2012) Aquifer Interference Policy, WMA 2000 and the NSW DPI (2018) *Assessing Groundwater Applications Water Resource Plans Fact Sheet*);
- Provide details of the proposed dewatering pumping method and proposed water treatment system to ensure compliance with relevant guidelines and regulations;
- Provide management strategies to minimise adverse environmental impacts; and

- Establish environmental control procedures, monitoring program, performance criteria and compliance reporting to assess the potential impacts of extracted groundwater on the receiving environment and the effectiveness of implemented controls.

1.2. Scope of Works

To meet the above objectives, the following scope of work was undertaken:

- A desktop site assessment, including review of previous reports where available;
- A review of relevant groundwater policy, legislation, regulations and guidelines, including:
  - NSW DPI (2012) Aquifer Interference Policy;
  - Water Management Act 2000 and Part 5 of the Water Act 1912;
  - NSW DPIE (2021) Minimum Requirements for Building Site Groundwater Investigations and Reporting;
  - NSW DPI (2018) Assessing Groundwater Applications Water Resource Plans Fact Sheet;
  - WaterNSW "Dewatering Checklist for a Water Management Works Approval" and "Geotechnical Investigation Reports Minimum Requirements" fact sheet;
- Review of construction proposal details relevant to dewatering and proposed dewatering methodology;
- Development of groundwater elevation contour plan, interpretation of groundwater flow direction and assessment of the likely level fluctuations during the life of the building;
- Data analysis and interpretation of slug test data and water quality data previously collected from the site;
- Develop conceptual flow model to replicate the proposed excavation activity and ongoing groundwater take through the partially-drained basement design. This was completed using a steady-state analytical groundwater flow model for best-case, most likely and upper-case scenarios, allowing prediction of groundwater inflow volumes and groundwater drawdown extent resulting from the proposed basement excavation and construction design:
  - Completion of analytical equations to derive groundwater extraction volumes using a range of representative aquifer parameters from published literature values and site specific data; and
  - Estimate volume of groundwater required to be removed during the dewatering process and assess the likely impacts of the dewatering activities on other groundwater users/receptors against the Minimal Impact thresholds detailed in the NSW DPI (2018) Assessing Groundwater Applications Water Resource Plans Fact Sheet.
- Specify the discharge water quality criteria, anticipated treatment requirements and proposed water treatment system, sampling frequency and compliance reporting requirements; and
- Preparation of this Dewatering Management Plan.

1.3. Roles and Responsibilities

The Principal Contractor will be responsible for implementing the appropriate management of dewatered groundwater as detailed in this document. It must be noted that the DMP is not inclusive of all conditions of consent in relation to dewatering and groundwater management, and that the Principal Contractor is responsible for making itself aware of, and complying with, all relevant conditions of the permits, licenses and approvals referred to in Section 6.

All environmental monitoring, assessment of results and compliance reporting must be completed by a suitably qualified environmental consultant and certified Environmental Practitioner - Site Contamination Specialist.

Monitoring, analysis and assessment of offsite groundwater levels (offsite drawdown) must be completed by a suitability qualified hydrogeologist.

Geotechnical and structural engineering advice may be required if offsite groundwater drawdown threshold levels are triggered.

This Dewatering Management Plan must be reviewed by a suitability qualified professional on a regular basis to ensure compliance with relevant environmental legislation and guidelines. The Dewatering Management Plan should be updated where required to comply with any changes to relevant environmental legislation and guidelines.

Details of the nominated Principal Contractor, Hydrogeologist and Environmental Consultant are provided in Table 1-2 below.

Table 1-2: Nominated Principal Contractor, Hydrogeologist and Environmental Consultant Details

Role	Company	Contact Information
Principal Contractor	**To be advised**	**Name:** **Title:** **Phone:**
Hydrogeologist & Environmental Consultant	Reditus Consulting Pty Ltd	**Name:** Lee Douglass **Title:** Principal Hydrogeologist EIANZ Certified Environmental Practitioner - Site Contamination Specialist **Phone:** 0412 625 989

1.4. Limitations

A detailed statement of limitations for this report is provided in Section 15.

This report is based on the Scope of Work outlined in Section 1.2. Reditus prepared this report in a manner consistent with the normal level of care and expertise exercised by members of the environmental and hydrogeological assessment profession.

This report relates only to the objectives stated and does not relate to any other work undertaken for the Client (Landmark Group Australia Pty Ltd). It is a report based on the information reported in previous environmental assessments by others, and data made available to Reditus. These conditions stated in this report may change with time and space.

All conclusions regarding the property area are the professional opinions of Reditus, subject to the qualifications in the report. Whilst normal assessments of data reliability have been made, Reditus assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside of Reditus, or developments resulting from situations outside the scope of this project. The client acknowledges that this report is for the exclusive use of the client.

All groundwater models include some degree of uncertainty in their predictions as they are, by necessity, simplifications of complex real world systems. Whilst every effort is made to ensure that the primary model reflects the best-case, most-likely case and upper-case understanding of site conditions, this cannot be guaranteed and any model result presented as a single number should be viewed with a degree of caution.

Factors which significantly affect the groundwater model and impact assessment results include dewatering rate, dewatering design, dewatering period, aquifer characteristics and degree of aquifer variability (including hydraulic conductivity, specific yield/ storativity, porosity, recharge, heterogeneity).

2. Document and Data Review

The following documents specific to the site were provided to Reditus for preparation of this DMP:

- Asset Geotechnical Engineering Pty Ltd (25 November 2021) Geotechnical Investigation, Proposed Mixed-use Development, 4 Delmar Parade & 812 Pittwater Road, Dee Why NSW (ref: 6561-G1);
- Rothelowman (14 December 2021) DA Submission Master Plan Architectural Drawings (ref: 221054); and
- Norton Survey Partners (23 November 2021) Registered Survey Plan, Plan Showing Partial Detail and Levels Over No.4 Delmar Parade & No.812 Pittwater Road, Dee Why (ref: 53046).

In addition to the above documents, the following supplementary local hydrogeological and geotechnical information pertaining to the neighbouring property at 2 Delmar Parade, Dee Why was provided to Reditus:

- Douglas Partners Pty Ltd (January 2016) Report on Geotechnical Investigation Proposed Multi-Storey Development 818 Pittwater Road, Dee Why (2 Delmar Parade, Dee Why) (ref: 85260.00.R.001.Rev0);
- Alliance Geotechnical Pty Ltd (20 July 2020) Geotechnical Investigation Report for Proposed Multi -Storey Development at 2 Delmar Parade, Dee Why NSW 2099 (ref: 10753-GR-1-1 Rev A); and
- Douglas Partners Pty Ltd (September 2020) Dewatering Management Plan, 2 Delmar Parade, Dee Why (ref: 85260.04.R.001.Rev4)

3. Proposed Development

3.1. Development Details

Based on the Master Plan Architectural Drawing Set (Rothelowman, 14 December 2021) submitted with the development application (DA2022/0145), The proposed development includes the demolition of existing structures and construction of a mixed use development comprising three commercial tenancies and 230 apartments over 2 basements levels, lot consolidation and subdivision. Copies of the architectural drawings are provided in **Appendix B**.

The proposed excavation footprint is provided in **Figure 2, Appendix A** and cross-sections of basement in context of the hydrogeological setting are provided in **Figure 3a, 3b and 3c, Appendix A.**

The basement will be constructed using a Cutter Soil Mix (CSM) / Diaphragm Wall construction method, which will be keyed at least 1.5m into moderate-high strength sandstone, of naturally low permeability strata.

The proposed CSM wall construction design prevents groundwater inflows (to minimise as much as possible the take of groundwater) from upper-unconsolidated Alluvial aquifer following completion of the construction works. This will effectively create a water-tight seal from the alluvial aquifer to the basement. The remainder of the basement will be designed as partially 'Drained Basement', as the ongoing groundwater inflows from the underlying low permeability Hawkesbury Sandstone can be effectively managed and meets the monitoring and reporting requirements of a regulated exemption for requiring a Water Access Licence (applicable to groundwater take volumes of <3ML/year do not require a water access licence to be held).

The inherent impermeable nature of the CSM / Diaphragm Walls will prevent groundwater inflow from the unconsolidated (alluvial sand formation), therefore the only groundwater inflows will be limited to that from the underlying low permeability sandstone (vertical inflow from the base). The excavation and dewatering will only commence after the CSM / Diaphragm Walls have been completed.

The ground surface elevation, finished floor levels (FFL), bulk excavation level (BEL) are provided in Table 3-1 below.

Table 3-1: Summary of Proposed Excavation Parameters

Descriptions	Elevation (RLm AHD)
Basement Excavation Footprint Area (m^2)	6,216
Site Surface Elevation	Approximately 27.5 (nothwest) to 33.0 (southeast)
Basement Finished Floor Level (FFL)	22.0
Bulk Excavation Level (BEL)	21.5

3.2. Basement Construction Methodology

The proposed construction is of a partially Water-Tight and partially Drained basement design:

- **Upper Water-Tight Basement Zone:** A CSM / Diaphragm wall is proposed to be constructed around the excavation perimeter, which will be keyed at least 1.5m into moderate-high strength sandstone of naturally low permeability strata. The proposed CSM / Diaphragm wall construction design prevents groundwater inflows (to minimise as much as possible the take of groundwater) from upper-unconsolidated Alluvial aquifer following completion of the construction works. This will effectively create a water-tight seal from the alluvial aquifer to the basement.
- **Lower Drained-Basement Zone:** The inherent impermeable nature of the CSM / Diaphragm wall will prevent/minimise groundwater inflow from the unconsolidated aquifer (alluvial sand and clay formation), therefore the only groundwater inflow will be limited to that from the underlying sandstone walls and base (horizontal inflow from the southern and western excavation walls, and vertical inflow from the base). Reditus anticipate that the proposed lower ground floor construction is to be of a drained basement design, consisting of a sub-slab drainage system. The basement floor is understood to consist of slab-on-grade, strip or pad footings where sandstone bedrock is exposed at BEL. Given the naturally low permeability of the sandstone (based on site specific measurements), groundwater inflows are expected to be negligible (<3ML/yr) and considered able to be effectively managed under a Drained Basement design with implementation of an appropriate management plan. The predicted inflows of <3ML/yr meet the monitoring and reporting requirements of a regulated exemption for requiring a Water Access Licence (WAL), for ongoing groundwater take component (once construction is complete).

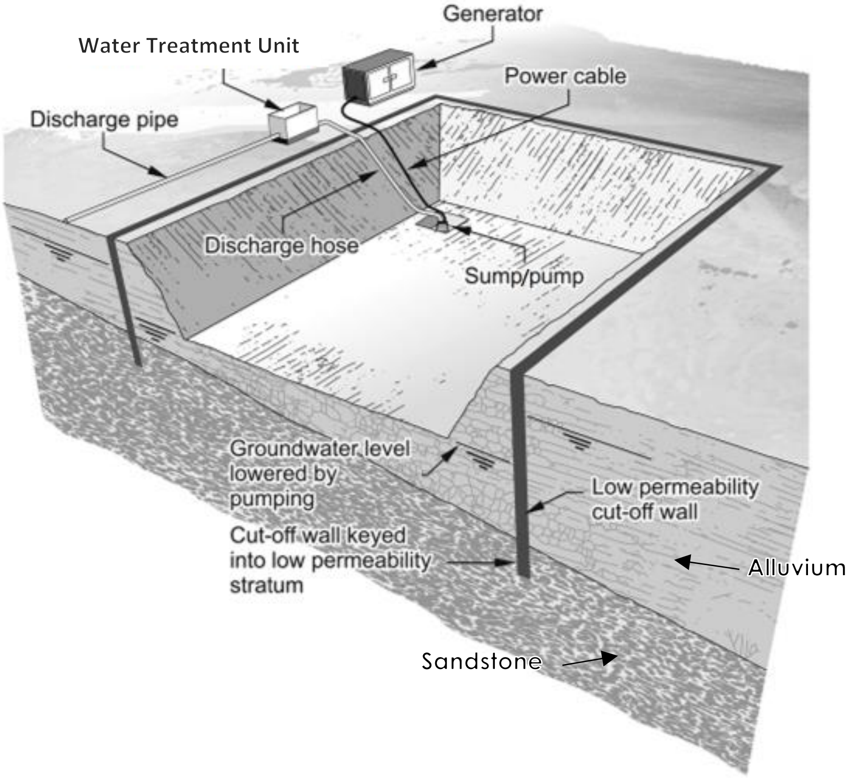


Figure 1: Example of Low Permeability CSM / Diaphragm wall Construction Dewatering

The excavation and dewatering will only commence after the CSM / Diaphragm Walls have been completed. Groundwater from within the CSM / Diaphragm Walls is proposed to be extracted using a combination of either a series of spearpoints internally around the permitter of the excavation and/or internal large diameter extraction wells and/or sumps.

Once the unconsolidated alluvial sediments are removed from within the excavation, and the excavation extends into sandstone, groundwater extraction using sump pumps is likely to be sufficient.

From an environmental perspective, the proposed basement construction method is recommended as it is effective in:

- Mitigating the risk of environmental impacts associated with drawdown of the water table, and the potential settlement of unconsolidated soils (through installation of the CSM / Diaphragm wall, keyed into low permeability sandstone);
- Reducing the volume of extracted groundwater to be discharged off-site.

Irrespective of the method, the dewatering depth shall be minimised to the extent practicable to reduce the volume of water to be extracted and to limit groundwater drawdown.

Dewatering is likely to be required to operate 24 hours a day / seven days a week to maintain groundwater level at the base of the excavation and ensure that basement is kept dry.

3.3. Dewatering Extraction Rate and Duration

The uncertainty around the final dewatering methods prevent absolute quantitative assessment of the pumping rates and project volumes. The many variables involved in dewatering make predicting flow rates problematic. These variables include variations in recharge rates, effects of varying geology on hydraulic conductivity and soil porosity, and natural and built hydraulic barriers and recharge zones.

The approximate duration to complete the necessary excavation works and construction is 12 weeks for the construction component.

To minimise interruptions to the project and unnecessary expenditure, it is recommended that extraction pumps that can cater for low to high flow rates rather than mobilising multiple pumps that may not be required if lower flows are encountered.

The predicted extraction volume required to be dewatered is provided in Section 5 below, with the 'most likely' groundwater take predicted to be 9.26ML. The majority of this groundwater take (6.87ML) is apportioned to matrix storage (watered stored within pore space), as opposed to groundwater inflow (2.39ML/yr) into the excavation void.

As such, the rate of groundwater extraction will be highly dependent on the required time frame for excavation works and can be varied to match excavation depth speed and/or discharge restrictions (if any).

Assuming an excavation period of 3 months, an average groundwater extraction and discharge rate of <1.5L/s is expected to be maintained to keep the excavation free of water. Once the excavation is completed to the BEL, an average discharge rate of <0.08L/s (<4.5L/min) is expected to maintain the groundwater level below the BEL.

3.4. Discharge Methods

Approval shall be obtained from Northern Beaches Council (Council) to direct dewatered and treated groundwater to the stormwater network. Dewatered groundwater is expected to be directed to the stormwater drain entry point along Delmar Parade, located on the northern site boundary.

A permit from Council is required for any dewatering of groundwater. Council require groundwater/tailwater to be discharged must be compliant with the General Terms of Approval/Controlled Activity permit issued by WaterNSW (if applicable), Landcom's 'Managing Urban Stormwater: Soils and Construction' (2004) (Blue Book), Council's Compliance and Enforcement Policy and legislation including Protection of the Environment Operations Act 1997 and Contaminated Lands Act 1997. All approvals, water discharges and monitoring results are to be documented and kept on site. Copies of all records shall be provided to the appropriate regulatory authority, including Council, upon request.

A direct connection to stormwater is a preferred and it is expected that a direction connection to the stormwater pit from the dewatering and treatment system will be completed on Delmar Parade.

Treatment of extracted groundwater will be required during the proposed dewatering program to improve the water quality and minimise potential impacts to the receiving waters relevant details are provided in Section 10.

The water quality of the extracted groundwater shall be assessed prior to discharge to the stormwater network, and then weekly thereafter during its release to monitor the waters suitability for continuous discharge. This monitoring will guide the initial type and level of treatment required to minimise environmental risks associated with the waters release, and reassessment of the treatment measures during the dewatering program.

3.4.1. Optional Onsite Reuse

Groundwater may potentially be used for onsite construction purposes (i.e. dust suppression, washing) following treatment. The total volume of groundwater required to be dewatered precludes onsite reuse as the primary discharge and disposal method.

Treatment of extracted groundwater may be required to improve the water quality and minimise potential impacts to the potential receptors. The water quality of the extracted groundwater shall be assessed prior to reuse. This monitoring will guide the initial type and level of treatment required to minimise environmental risks associated with the waters release, and reassessment of the treatment measures during the dewatering program.

3.4.2. Optional Reinjection

Whilst unlikely based on the proposed CSM / Diaphragm Wall construction method, reinjection of groundwater may be required to control drawdown effects, to mitigate potential Acid Sulfate Soil generation effects and/or settlement effects.

Treatment of extracted groundwater will be required to improve the water quality and minimise potential impacts to the potential receptors prior to re-injection.

Regulatory approval from WaterNSW/NRAR would be required for any reinjection.

4. Site Characterisation

Previous geotechnical and environmental investigations have been completed at the site (and neighbouring sites) which provide an understanding of the site geology and hydrogeology. A summary of the geological and hydrogeological setting is provided in Sections 4.1 and 4.2 below.

4.1. Summary of Geological Setting

Based on a review of the Sydney 1:100,000 Geological Series Sheet S 9130 (1983), the site is underlain by middle Triassic Hawkesbury Sandstone, described as medium to coarse grained quartz sandstone, very minor shale and laminite lenses.

These rocks typically weather to form residual clay soils of medium to high plasticity and residual sandy soils. It is believed that the geological sequence at the Site is close to the base of the Hawkesbury Sandstone which is underlain by the Newport Formation of the Narrabeen Group. The Newport formation tends to be more variable in lithology with interbedded lithic-quartz sandstone, siltstone, shale, claystone, sandstone and laminite.

4.1.1. Site Specific Geology

The site-specific geology has been determined through intrusive site investigations as reported by Asset Geotechnical (November 2021).

The generalised site stratigraphy was described as follows:

- **Unconsolidated Sediments** (thickness ranging between 0m and 11.5m):
    - **FILL:** SAND and Silty SAND, loose to medium dense;
    - **ALLUVIUM**: SAND and Silty SAND, medium dense, with some thin CLAY and Silty CLAY beds, stiff to very stiff;
    - **RESIDUAL** (thickness ranging between 0.4 and 0.8m): CLAY, Silty CLAY, Sandy CLAY, stiff to very stiff.
- **Hawkesbury Sandstone Bedrock:**
    - Extremely Weathered, extremely low strength, assessed as Class 5 Sandstone (thickness ranging between 0.4 and 3.5m).
    - Highly Weathered to Slightly Weathered, Medium to High Strength (top of rock ranging between 31.91mAHD and 15.55mAHD.

The stratigraphy of the site comprises 0m to 11.5 m of unconsolidated fill/alluvial soils, which increase in thickness towards the northwest. Alluvium is absent in the southeast section of the site, where the site surface consists of sandstone exposed at the surface or directly beneath the concrete. The alluvial soils consisted of SAND and Silty SAND, medium dense, with some thin CLAY and Silty CLAY beds, stiff to very stiff.

The top of the sandstone bedrock was encountered at a depth of 0.2m in BH5, and dipped to a depth of 11.5m in BH8. The upper 0.4m to 3.5m of the encountered sandstone was extremely weathered of extremely low strength sandstone.

Bedrock defects and seams are recorded in the sandstone cores. There was one Sandy Clay seams with a thickness of 50mm in the medium to high strength sandstone of BH1. The majority of the joints have a dipping angle of 5 to 10 degrees with a maximum dipping angle of 70 to 80 degrees.

4.1.2. Acid Sulfate Soils

Acid sulfate soils (ASS) occur predominantly on coastal land with elevations generally below 5m Australian Height Datum (AHD). These soils also occur further inland in saline seepage areas, rivers, lake beds and irrigation channels. Where present, draw-down of the local water table can expose ASS to oxidising conditions creating acidity and mobilising metals at potentially harmful concentrations.

Review of the NSW Acid Sulphate Soils Risk Map - Sydney, 1:25,000 notes that the site is not listed in an area of ASS probability.

The Warringah LEP 2011 Acid Sulfate Soils Map indicates the Site is not listed within a classified ASS zone.

Based on the above, the proposed development and associated groundwater dewatering will unlikely pose an unacceptable risk in regards to the generation and associated impacts due to acid sulfate soils.

4.2. Summary of Hydrogeological Setting

There are two main systems operating within the development extent on the site

- **Unconfined Alluvial Aquifer:** Shallow unconfined to semi-confined groundwater system within the shallow unconsolidated Quaternary Alluvial Sediments;
- **Confined Fractured Sandstone Aquifer:** Deeper, Confined / Semi-confined groundwater system of the Triassic bedrock formation (Hawkesbury Sandstone Formation) of weathered and fractured sandstone below the alluvial sediments.

4.2.1. Site Groundwater Elevations and Inferred Flow Direction

A total of three (3) groundwater monitoring wells (BH1, BH5 and BH8) have been installed and monitored across the site.

The groundwater monitoring wells have been installed to depths ranging between RL 13.2 mAHD and RL 17.7mAHD, which is below the proposed basement FFL of RL 22 mAHD and BEL of 21.5mAHD. All groundwater monitoring wells have been constructed within the sandstone, as this is the formation which will be limiting groundwater inflows during dewatering (alluvial aquifer will be excluded by the CSM / Diaphragm wall construction keyed into sandstone).

Groundwater monitoring well locations are provided on **Figure 2, Appendix A**. Copies of borehole drilling logs and well construction logs are provided in **Appendix D.**

Groundwater level monitoring was conducted using both programable data loggers and manual measurements over an extended period of time, incorporating periods of both dry and extreme rainfall conditions:

- **Manual:** Groundwater elevation measurements recorded on 20 October 2021 and 12 May 2022; and
- **Data Loggers**: Groundwater elevations were recorded over a period of **204 days**, approximately 7 months, between 21 October 2021 and 12 May 2022. This covered significant rainfall events including the16 day period between 23 February and 9 March, where 740mm of rainfall occurred (67% of average annual rainfall of 1,101mm)

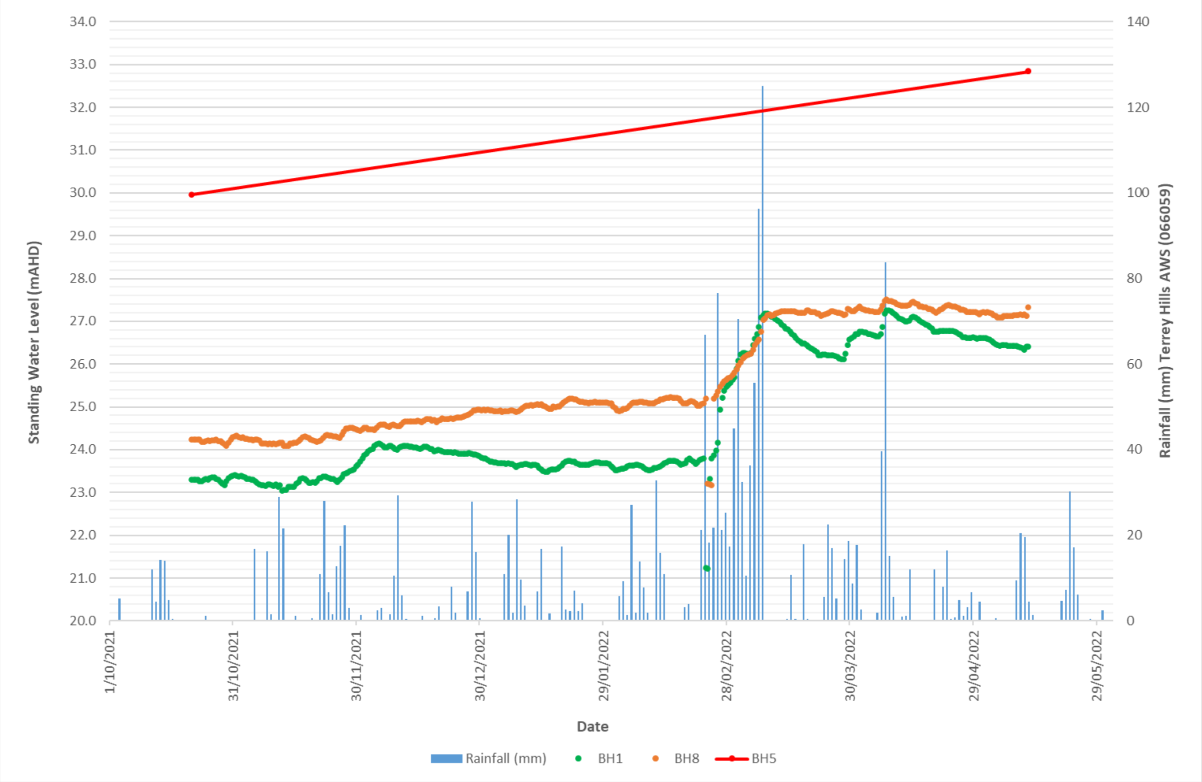
A summary of groundwater monitoring wells, standing groundwater levels and measurement dates are provided in Table 4-1 below.

Table 4-1: Manual Groundwater Elevation Measurements

Well ID	Date	Top of Casing (RL mAHD)	Depth of Well (RL mAHD)	Depth to Water (mbgs)	Standing Water Level (RL mAHD)
BH1	20/10/2021	28.927	13.2	5.628	23.299
	12/05/2022			2.512	26.415
BH5	20/10/2021	32.831	17.7	2.864	29.967
	12/05/2022			**0** *(surface)*	32.831
BH8	20/10/2021	30.554	14.8	6.313	24.241
	12/05/2022			3.226	27.328

Based on the reported standing groundwater levels listed in Table 4-1 above, the groundwater elevation contours were interpolated using kriging methods, with the inferred groundwater flow direction toward the northwest, consistent with the bedrock dip.

Groundwater elevation measurements were record twice a day, over a 204 day period, between 21 October 2021 and 12 May 2022. Standing water level (SWL, RL mAHD), overlain with the recorded rainfall (Terrey Hills AWS 066059) have been plotted in Graph 1 below.



Graph 1: Groundwater Elevation and Rainfall Measurements over 204 day period (7 months)

Reditus notes the groundwater data logger for BH5 was missing during the retrieval process. As such, daily groundwater measurements from BH5 could not be obtained for assessment. However, given that the groundwater level was reported at the ground surface on 12 May 2022, the piezometric head is expected to be above ground level at this location of the site during wet periods.

The following key findings were reported from the long-term groundwater elevation monitoring:

- Groundwater elevations responded rapidly to intense rainfall (23 February to 9 March) with a rise of approximately 3.6m at BH8 (24mAHD to 27.6mAHD) and 4.2m at BH1 (23mAHD to 27.2mAHD).
- Groundwater elevation increased by at least 2.8m at BH5, where the standing water level was measured at the surface on 12 May 2022. This indicates potential artesian conditions in the southeast section of the site after intense and significant rainfall events.
- The maximum groundwater elevation reported over the period was as follows:
  - BH1: 27.2mAHD (~1.73m below ground level)
  - BH5: 32.8mAHD (surface)
  - BH8: 27.6mAHD (~2.95m below ground level)
  - Average of Maximum: 29.2mAHD
  - Median of Maximum: 27.6mAHD

4.2.2. Site Specific Hydraulic Conductivity

Rising head aquifer tests (slug tests) were completed on all three (3) groundwater monitoring wells BH1, BH5 and BH8 on 21 October 2021.

Groundwater elevation measurements were collected at nominal intervals using programable pressure transducers (diver data loggers) following the instantaneous removal of water from the well column (assumed to be instantaneous). Groundwater displacement measurements were analysed using a computer software package AQTESOLV Pro (version 4.0). The groundwater displacement data was analysed using the Bouwer-Rice (1976)[1] and Hvorslev (1951)[2] solution for slug test in an unconfined aquifer. Estimates of hydraulic conductivity were calculated and are summarised in Table 4-2 below. Slug test analysis output is provided in **Appendix E**.

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[1] Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.

[2] Hvorslev, M.J., 1951. Time Lag and Soil Permeability in Ground-Water Observations, Bull. No. 36, Waterways Exper. Sta. Corps of Engrs, U.S. Army, Vicksburg, Mississippi, pp. 1-50.

Table 4-2: Estimates of Hydraulic Conductivity – Hawkesbury Sandstone

Well ID	Hydraulic Conductivity (m/day)		
	Bower-Rice	**Hvorslev**	**Average**
BH1	7.99 x 10^{-3}	8.74 x 10^{-3}	8.3 x 10^{-3}
BH5	2.74 x 10^{-3}	2.91 x 10^{-3}	2.82 x 10^{-3}
BH8	2.09 x 10^{-2}	2.25 x 10^{-2}	2.17 x 10^{-2}
Median	**8.37 x 10^{-3} m/day (Hawkesbury Sandstone)**		

The above estimates of hydraulic conductivity are generally consistent with literature values[3,4] for fractured sandstone.

Rising head slug tests were completed on three (3) groundwater well within the alluvial sediments on the adjacent site to the north (2 Delmar Parade, Dee Why) on 6 July 2020 (Douglas Partners, September 2020). The estimated hydraulic conductivity of the alluvial aquifer ranged between:

- **Alluvial Aquifer:** 0.147 and 1.9 m/day.

4.2.3. Groundwater Quality Sampling Results

Site specific groundwater samples had not been collected at the time of reporting.

Groundwater samples were collected from the adjoining site to the north at 2 Delmar Parade, which hydraulic downgradient of the site. Therefore groundwater quality results from 2 Delmar Parade are likely to be representative of the ambient groundwater conditions at the site.

Collection and analysis of groundwater samples from three (3) monitoring wells (BH1, BH2, & BH3) was completed by Douglas Partners on 13 January 2016. Copies of the laboratory results are provided in **Appendix C**. The groundwater samples were submitted to the NATA accredited laboratory Envirolab for the analysis of:

- Volatile Organic Compounds (VOCs)
- Total Recoverable Hydrocarbons (TRH);
- Benzene, Toluene, Ethylbenzene, Xylenes (BTEX);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Organochlorine Pesticides (OCPs) and Organophosphorus Pesticides (OPPs);
- Polychlorinated Biphenyl (PCBs) and Phenols;
- Hardness, including calcium and magnesium; and

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[3] Heath, R.C. (1983) Basic ground-water hydrology, U.S. Geological Survey Water-Supply Paper 2220, 86p.

[4] Domenico and Schwartz (1990) Physical and Chemical Hydrogeology 2nd Edition

- Eight Priority Heavy Metals (including arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc).

All samples collected from monitoring wells (BH1, BH2 & BH3) reported concentrations of TRH, PAHs, PCBs, Phenolics and OPPs below the laboratory limit of reporting.

Concentrations of heavy metals were reported below the ANZG (2018) 95% Marine Water Quality Guidelines (nearest ecological water receptor Dee Why Lagoon), with the exception of the following:

- Copper of 2ug/L (1.3ug/L);
- Nickel of 11ug/L to 16ug/L (7ug/L); and
- Zinc of 24ug/L to 33ug/L (15ug/L)

BH3 reported low concentrations for toluene (38 µg/L), short-chain TRH (C_6-C_9) (76 µg/L), chloroform (14 µg/L), DDT (0.002 µg/L) and dieldrin (0.002 µg/L). These chemicals were not recorded above laboratory reporting limits in BH1 or BH2. Results for these contaminants were within the site acceptance criteria (SAC).

4.2.4. Registered Groundwater Bore Search

A search of the WaterNSW Registered Groundwater Bore Database (https://realtimedata.waternsw.com.au/water.stm) indicated two (2) registered groundwater bores with a 500m radius of the site:

- GW105849: Located approximately 100m north/northeast of the site.
  - Monitoring Bore
  - Report to have been drilled to a depth of 15m (approximately RL 12.8 mAHD) with a standing water level of 1.47m
- GW105850: Located approximately 125m north/northwest of the site
  - Monitoring Bore
  - Report to have been drilled to a depth of 15m (approximately RL 15.9 mAHD) with a standing water level of 1.47m

There are no registered groundwater bores within 500m of the site that registered for water supply works.

4.2.5. Groundwater Dependant Ecosystems (GDE) Search

Groundwater dependent ecosystems (GDEs) are a diverse and important component of biological diversity. The term GDE takes into account ecosystems that use groundwater as part of their survival strategies. GDEs can potentially include wetlands, vegetation, mound springs, river base flows, cave ecosystems, playa lakes and saline discharges, springs, mangroves, river pools, billabongs and hanging swamps and near-shore marine ecosystems.

The groundwater dependence of ecosystems can range from complete to partial reliance on groundwater, such as might occur during droughts. The degree and nature of groundwater dependence will influence the extent to which they are affected by changes to the groundwater system, both in quality and quantity.

Many land and water use activities within a catchment can affect groundwater dependent ecosystem function and viability. It is important to manage these land and water use activities within a regulatory and licensing framework. Risk assessment guidelines for groundwater dependent ecosystems have been developed to operate within the regulatory and licensing framework provided by the Water Management Act 2000 and Water Sharing Plans (WSPs). The guidelines are based on an assessment of various ecological and risk factors that are important to decisions on allowing a proposed activity or development.

WSPs have been developed for groundwater systems in NSW to preserve water resources by establishing rules for sharing water between different types of water uses.

The site's Alluvial Sediment Aquifer is not known to be regulated under WMA 2000 through a WSP. The Alluvial aquifer is not mapped within the Metropolitan Coastal Sands Groundwater Source under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011.

The site's deeper porous/fractured rock Sandstone Aquifer is located within the following WSP:

- Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 - Sydney Basin Central Groundwater Source.

Based on a review of the Water Sharing Plan, the nearest high priority GDE is mapped as 'Wetland', located approximately 20km to the south.

Both Dee Why Lagoon and Curl Curl Lagoon are mapped as high potential GDEs (Bureau of Meteorology Groundwater Dependent Ecosystem Atlas), which are located approximately 1km to the northeast and southeast respectively.

5. Groundwater Take and Drawdown Estimates

5.1. Summary of Geology and Hydrogeology

The generalised subsurface profile was comprised of unconsolidated fill, alluvial deposits and residual soils, overlying sandstone bedrock. There are two main groundwater systems operating within the development extent on the site:

- **Unconfined Alluvial Aquifer:** Shallow unconfined to semi-confined groundwater system within the shallow unconsolidated Quaternary Alluvial Sediments;
- **Confined Fractured Sandstone Aquifer:** Deeper, Confined / Semi-confined groundwater system of the Triassic bedrock formation (Hawkesbury Sandstone Formation) of weathered and fractured sandstone below the alluvial sediments.

For the purposes of this assessment, the two aquifers are considered to be hydraulically connected, where groundwater flow can occur between the two systems. As such, for conservatism the Fractured Sandstone is considered semi-confined for the purpose of the model.

The maximum standing groundwater levels measured onsite ranged from RL 32.8m AHD in the southeast topographic high point (BH5 May 2022), to RL 27.2 mAHD in the north-eastern section of the site (BH1 April 2022). For conservatism, a weighted average of the maximum onsite groundwater elevations was used in the prediction of the 'Most Likely' and 'Upper-Case' groundwater to account for natural groundwater gradient across the site. These values were adopted in the analytical model to predict groundwater take and extent of groundwater drawdown.

Based on a proposed Bulk Excavation Level (BEL) of RL 21.5mAHD and a maximum average standing water level of RL 29.2 mAHD, there was up to 7.7m of groundwater requiring to be dewatered to ensure that the excavation surfaces are workable.

5.2. Conceptual Flow Model

A conceptual model is a description of the site, site works and groundwater systems presented both as text and graphically. This description is then approximated using an analytical solution to allow prediction of groundwater behaviour.

The groundwater extraction estimate comprises two key components to be considered:

1. The component of groundwater present within the aquifer matrix, which will be removed as part of the excavation process (pore water); and
2. The component of inflow into the excavation from the surrounding aquifer (walls and base) during the dewatering activity.

The conceptual flow model developed for this assessment was a "steady state" model – a snapshot in time representing average conditions. This snapshot was completed based on conservative assumptions of the excavation depth and proposed shoring wall designs, which estimate the greatest groundwater inflow. Note that more detailed analysis can be provided through a three dimensional flow model (beyond the scope of the current assessment).

A generalised conceptual cross-section of the proposed dewatering activity is presented in **Figure 3a, 3b & 3c, Appendix A**.

The inherent impermeable nature of the CSM / Diaphragm wall will prevent/minimise groundwater inflow from the unconsolidated aquifer (alluvial sand and clay formation), therefore the only groundwater inflow will be limited to that from the underlying sandstone walls and base (horizontal inflow from the southern and western excavation walls, and vertical inflow from the base). Reditus anticipate that the proposed lower ground floor construction is to be of a drained basement design, consisting of a sub-slab drainage system. The basement floor is understood to consist of slab-on-grade, strip or pad footings where sandstone bedrock is exposed at BEL. Given the naturally low permeability of the sandstone (based on site specific measurements), groundwater inflows are expected to be negligible (<3ML/yr) and considered able to be effectively managed under a Drained Basement design with implementation of an appropriate management plan. The predicted inflows of <3ML/yr meet the monitoring and reporting requirements of a regulated exemption for requiring a Water Access Licence (WAL), for ongoing groundwater take component (once construction is complete).

The excavation and dewatering will only commence after the CSM / Diaphragm Walls have been completed. Groundwater from within the CSM / Diaphragm Walls is proposed to be extracted using a combination of either a series of spearpoints internally around the permitter of the excavation and/or internal large diameter extraction wells and/or sumps.

Once the unconsolidated alluvial sediments are removed from within the excavation, and the excavation extends into sandstone, groundwater extraction using sump pumps is likely to be sufficient.

Conceptually, the CSM / Diaphragm Walls has been assigned a relatively low hydraulic conductivity (K) value of $8.64\text{x}10^{-5}$ m/day ($1\text{x}10^{-9}$m/sec), which is consistent with concrete. Given that the CSM / Diaphragm Walls will extend into the medium to high strength sandstone, the groundwater inflow into the excavation void will be limited by the hydraulic conductivity of the CSM / Diaphragm Walls and underlying Fractured Sandstone Confined Aquifer.

To estimate the groundwater extracted present within the aquifer matrix, which will be removed as part of the excavation process, the porosity of the matrix is multiplied by the saturated excavation volume.

The saturated excavation volume was calculated by determining the difference between the conservative standing groundwater level and the BEL, multiplied by the approximate excavation area.

To estimate the groundwater inflow volumes, Reditus used the Marinelli and Niccoli (2000)[5] steady-state analytical solution. This solution provides a convenient means for estimating groundwater inflows into excavations, and is considered applicable to use as a conservative assessment for the ongoing groundwater seepage into the proposed drained basement design.

The analytical method of Marinelli and Niccoli (2000) requires a simplification of the hydrogeological environment and was used to provide a broad range of potential drawdown and groundwater inflow. The equations calculate groundwater inflow from the aquifer based on the conceptual model.

The conceptual flow model was approximated by analytical models, which are divided into two zones separated by a conceptual no-flow boundary where horizontal flow will occur level with the excavation base:

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[5] Marinelli, F, and Niccoli, W.L. (2000) *Simple analytical equations for estimating ground water inflow to a mine pit*: Groundwater, v. 38, no.2, p. 311-314

- **Zone 1** – exists above the base of the excavation and represents lateral flow to the excavation via the surrounding walls. Given that the CSM / Diaphragm Walls extends into the sandstone bedrock, the Zone 1 inflow is limited by the hydraulic conductivity of the CSM / Diaphragm Walls and the Sandstone, as opposed to unrestricted flow from the Alluvial aquifer.
- **Zone 2** – extends from the bottom of the excavation downward and considers vertical upward groundwater inflow to the excavation bottom into the void. Given that the CSM / Diaphragm Walls extend into the sandstone bedrock, the vertical inflow component is limited by the hydraulic conductivity of the Sandstone Aquifer.

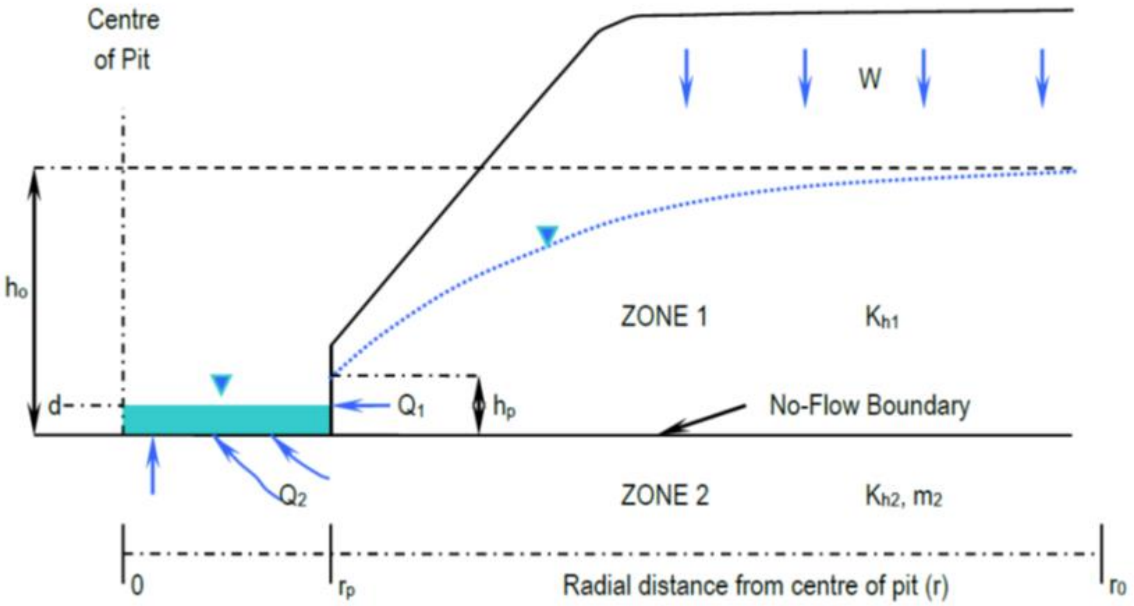


Figure 5-1: Conceptual Model of Analytical Solution

The analytical solution for Zone 1 considered steady state, unconfined, horizontal radial flow, with uniformly distributed recharge at the water table. This represents the volume of water laterally flowing into the excavation through the CSM / Diaphragm Walls (considered to be relativity impermeable). Whilst the CSM / Diaphragm Walls may completely inhibit lateral groundwater inflow, as conservative hydraulic conductivity of 8.64x10^{-5} m/day (1x10^{-9}m/sec) was adopted.

The analytical solution for Zone 2 is based on steady-state flow to one side of a circular disk sink of constant and uniform drawdown. The circular disk sink represents the volume of water needing to be removed to dewater the site to the target dewatering level at the BEL of RL 21.5m.

For the development of the conceptual flow model for the proposed excavation, the circular disk sink was assumed to encompass the approximate area of the excavation footprint. The total excavation is approximated as a single large well and as such the circular disk sink was assigned a radius of based on the footprint of the proposed excavation.

Monthly rainfall data was obtained from the Australian Government Bureau of Meteorology (Terrey Hills AWS 066059), from a weather station approximately 10km northwest the site. The data set from weather station extends back to 2004, which provided 18 years of rainfall data encompassing longer term climatic trends. The mean annual rainfall (based on monthly observations) from a period between 2002 and 2022 was 1,101mm. This converted to an assumed average daily rainfall of 0.00302m/day.

5.3. Summary of Aquifer Parameters

The hydraulic conductivity of the Alluvial Sediments will vary depending on the grain size, degree of sorting and connectivity between sediment layers. Slug Tests have been completed at three monitoring wells on the adjacent site to the north (2 Delmar Parade, Dee Why) on 6 July 2020 (Douglas Partners, September 2020). The estimated hydraulic conductivity of the alluvial aquifer ranged between 0.147 and 1.9 m/day. However, given the CSM / Diaphragm Wall will extend into the sandstone, the Zone 1 horizontal inflow will be governed by the hydraulic conductivity of the CSM and the Sandstone walls, and not the Alluvial deposits.

The Zone 2 inflow will be governed by the hydraulic conductivity of the Fractured Sandstone Aquifer. The hydraulic conductivity of the fractured sandstone rock will be restricted by the connectivity and extent of the bedding layers and joints or faults, as well as the degree of connection to the overlying Alluvial Aquifer. Site specific rising head slug tests were completed to allow estimation of the Sandstone hydraulic conductivity (refer to Table 4-2 in Section 4.2 above). A summary of the hydraulic conductivity values are provided in Table 5-1 below.

Table 5-1: Hydraulic Conductivity Values

		Hydraulic Conductivity (m/day)
Alluvial Aquifer	Min	0.17
	Max	1.9
	Average	1.0
	Median	0.95
Sandstone Aquifer	Min	$2.74\text{x}10^{-3}$
	Max	$2.25\text{x}10^{-2}$
	Average	$1.10\text{x}10^{-2}$
	Median	$8.37\text{x}10^{-3}$
CSM / Diaphragm Wall	Assumed	$8.64\text{x}10^{-5}$

5.4. Model Scenario Descriptions

All groundwater models include some degree of uncertainty in their predictions as they are, by necessity, simplifications of complex real world systems. Whilst every effort is made to ensure that the primary model reflects the best-case, most-likely case and upper-case understanding of site conditions, this cannot be guaranteed and any model result presented as a single number should be viewed with a degree of caution.

Factors which affect the dewatering rate, groundwater take and extent of drawdown within the steady state model include dewatering rate, dewatering design, dewatering period, aquifer characteristics and degree of aquifer variability (including hydraulic conductivity, specific yield/ storativity, porosity, recharge, heterogeneity).

It is considered impractical to determine these factors by pumping tests and further analytical assessment, based on the relatively small scale of the development and the likely relatively low risk of impact to groundwater in the shallow water bearing zone given the CSM / Diagraph Wall construction method.

Typical representative values were used in the model. Assessment of the range of typical values and their effects on the model predictions were made to allow sound management decisions using **Best Case, Upper Case and Most Likely** scenarios ().

Table 5-2: Analytical Model Scenarios

Scenario	Description
Best Case	▪ Zone 1 inflows were limited to the permeability of the CSM walls of $8.64\text{x}10^{-5}$ m/day. ▪ Zone 2 inflows from the base (vertical) were limited to the median permeability of the sandstone with an assumed anisotropy of 10% of median horizontal permeability at $8.37\text{x}10^{-4}$ m/day. ▪ Initial groundwater head of 27.6mAHD was adopted based on the median of the long-term highest-level reported in the monitoring wells over the 204 day monitoring period.
Most Likely	▪ Zone 1 inflows were limited to the average permeability of the CSM walls and Sandstone at $4.2\text{x}10^{-3}$ m/day. This was considered to represent the most likely scenario as approximately 50% of the site permitter walls will consist of CSM walls (north-western half of the site) and the other 50% will consist of exposed sandstone excavation walls (south-eastern half of the site). The average permeability of the two wall types was considered to be representative to their proportions. ▪ Zone 2 inflows from the base (vertical) are limited to the median permeability of the sandstone with an assumed anisotropy of 10% of median horizontal permeability at $8.37\text{x}10^{-4}$ m/day. ▪ Initial groundwater head (29.2mAHD) was adopted as the average of the long-term highest-level reported in the monitoring wells over the 204 day monitoring period.

Scenario	Description
Upper Case	▪ Zone 1 inflows were limited to the median permeability of Sandstone at 8.37x10^{-3} m/day. This was considered to represent the upper case scenario, as approximately 50% of the site permitter walls will be of significantly lower permeability CSM walls (north-western half of the site). This scenario is considered to be conservative and likely to over-predict the groundwater inflows from Zone 1. ▪ Zone 2 inflows from the base (vertical) are limited to the median permeability of the sandstone with an assumed anisotropy of 10% of horizontal permeability at 8.37x10^{-4} m/day. ▪ Initial groundwater head (29.2mAHD) was adopted as the average of the long-term highest-level reported in the monitoring wells over the 204 day monitoring period.

5.5. Analytical Model Equations

5.5.1. Groundwater Take Volume within the Excavation Matrix

The following equation was utilised to estimate the groundwater volume present in the aquifer matrix directly removed through excavation:

$$V = \emptyset \times m \tag{1}$$

$$m = (H_0 - BEL) \times A \tag{2}$$

where:

V = groundwater volume present in the aquifer matrix directly removed through excavation (m^3).

ϕ = matrix porosity

m = volume of saturated aquifer matrix to be excavated

H_0 = initial water table elevation (RLm)

BEL = basement excavation level (RLm)

A = area of excavation

Based on the proposed development, approximately 34,188m^3 of Alluvial deposits and 27,972m^3 of Sandstone will require excavation from the site. Based on the reported depth to groundwaters, approximately 80% of the Alluvial deposits are assumed to be saturated, and 100% of the Sandstone.

5.5.2. Groundwater Inflow Take Volume Estimate

The steady state inflow rate into the disk sink is given by the following equations[2]:

Zone 1:

$$Q_1 = W\pi\left(r_o^2 - r_p^2\right) \tag{3}$$

$$h_o = \sqrt{h_p^2 + \frac{W}{K_{h1}}\left[r_0^2 ln\left(\frac{r_o}{r_p}\right) - \frac{\left(r_0^2 - r_p^2\right)}{2}\right]} \tag{4}$$

Zone 2:

$$Q_2 = 4r_p\left(\frac{K_{h2}}{m_2}\right)(h_0 - d) \tag{5}$$

$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}} \tag{6}$$

where:

Q = groundwater flux (m^3/day)

K_{h1} = horizontal hydraulic conductivity (m/day) at Zone 1

K_{h2} = horizontal hydraulic conductivity (m/day) at Zone 2

K_{v2} = vertical hydraulic conductivity (m/day) at Zone 2

m_2 = vertical hydraulic conductivity anisotropy parameter

d = depth of water (above target dewatering level) within final excavation (m) *(assumed to be 0 at final excavation depth)*

r_p = radius from centre of excavation (circular disk sink) (m)

r_o = drawdown radius from centre of excavation (iterative calculation)

h_0 = initial saturated thickness above base of excavation (m)

h_p = saturated thickness above the base of excavation at the excavation wall (r_p), which is assumed 0m

W = rainfall recharge rate (assumed % of the mean daily rainfall)

5.5.3. Groundwater Drawdown Extent

The following equations were used to calculated the groundwater drawdown resulting from the groundwater take into the excavation[2]:

$$H_{1(r)} = H_0 - h_0 + \sqrt{h_p^2 + \frac{W}{K_{h1}}\left[r_o^2 \ln\left(\frac{r}{r_p}\right) - \frac{\left(r^2 - r_p^2\right)}{2}\right]} \qquad (7)$$

where:

$H_{1(r)}$ = hydraulic head elevation (m) at a radial distance (r) from excavation centre

H_0 = initial groundwater elevation (mRL)

h_0 = initial saturated thickness above base of excavation (m)

r = radial distance from excavation centre (m)

z = vertical depth below the excavation bottom (assumed to be 0m)

W = rainfall recharge rate (assumed % of the mean daily rainfall)

K_{h1} = horizontal hydraulic conductivity (m/day) at Zone 1

5.6. Analytical Assumptions and Input Parameters

5.6.1. Assumptions

The analytical solution was based on the following assumptions, after Marinelli and Niccoli (2000):

- Steady state, unconfined, horizontal radial flow, with uniformly distributed recharge at the water table.
- The excavation walls are approximated as a circular cylinder.
- Groundwater flow is horizontal. The Dupuit-Forchheimer approximation (McWhorter and Sunada 1977) is used to account for changes in saturated thickness due to depression of the water table.
- The static (pre-excavation) water table is approximately horizontal.
- Uniform distributed recharge occurs across the site as a result of surface infiltration. All recharge within the radius of influence (cone of depression) of the pit assumed to be captured by the excavation.
- Groundwater flow toward the pit is axially symmetric.
- Hydraulic head is initially uniform (hydrostatic) throughout Zone 2. Initial head is equal to the elevation of the initial water table in Zone 1.
- The disk sink has a constant hydraulic head equal to the elevation of the "pit lake water surface". If the pit is completely dewatered, the disk sink head is equal to the elevation of the pit bottom – in this case the target dewatering level.
- Flow to the disk sink is three dimensional and axially symmetric.
- Materials within Zone 2 are anisotropic, and the principal coordinate directions for hydraulic conductivity are horizontal and vertical.

5.6.2. Parameters

The parameters used to estimate the groundwater take from the excavation of saturated matrix are presented in Table 5-3 below. The parameters used to estimate the steady-state groundwater inflow within the analytical solution are provided in Table 5-4 below.

Table 5-3: Parameters of Groundwater Removal through Excavation

Parameter	Unit	Most Likely
Bulk Excavation Level (BEL)	RL m	21.5
Excavation Area	m^2	6,216
Volume of Saturated Alluvial Deposits	m^3	27,350
Effective Porosity (ϕ) of Alluvial Deposits	-	0.2
Volume of Saturated Sandstone	m^3	27,972
Effective Porosity (ϕ) of Alluvial Deposits	-	0.05

Table 5-4: Groundwater Inflow Analytical Model Input Parameters

Parameter	Unit	Best Case	Most Likely	Upper Case
Zone 1				
r_p	m	44.49	44.49	44.49
r_o	m	47.72	71.07	81.10
W	m/day	$3.02\text{x}10^{-4}$ (10% of average annual rainfall)	$3.02\text{x}10^{-4}$ (10% of average annual rainfall)	$3.02\text{x}10^{-4}$ (10% of average annual rainfall)
h_0^{*}	m	6.1	7.7	7.7
h_p^{**}	m	0	0	0
K_{h1}	m/day	$8.64\text{x}10^{-5}$	$4.23\text{x}10^{-3}$	$8.73\text{x}10^{-3}$

Zone 2				
K_{h2}	m/day	$8.37x10^{-3}$	$8.37x10^{-3}$	$8.37x10^{-3}$
K_{v2}	m/day	$8.37x10^{-4}$	$8.37x10^{-4}$	$8.37x10^{-4}$
d	RL m	0	0	0

5.7. Summary of Model Results

5.7.1. Estimate of Groundwater Volume Removed within Excavations

The groundwater matrix removal was estimated using equation 1 and equation 2, with predictions provided in Table 5-5 below.

Table 5-5: Prediction of Groundwater Volume Removed within the Excavation Matrix

Groundwater Volume Removed from Matrix (ML)	Saturated Volume (m^3)	Porosity	Groundwater Matrix Take (ML)
Alluvial Deposits	27,350	0.2	5.47
Sandstone	27,972	0.05	1.40
		Total	**6.87**

5.7.2. Prediction of Groundwater Inflow

The groundwater inflow was estimated using equation 3, 4, 5 & 6, with predictions provided in Table 5-6 below assuming a 12 month dewatering program.

Table 5-6: Prediction of Groundwater Inflows over the Construction Dewatering Period

Groundwater Inflow	Best Case	Most Likely	Upper Case
Zone 1 & Zone 2	1.15	**2.39**	2.91

5.7.3. Summary of 'Most Likely' Total Predicted Groundwater Take

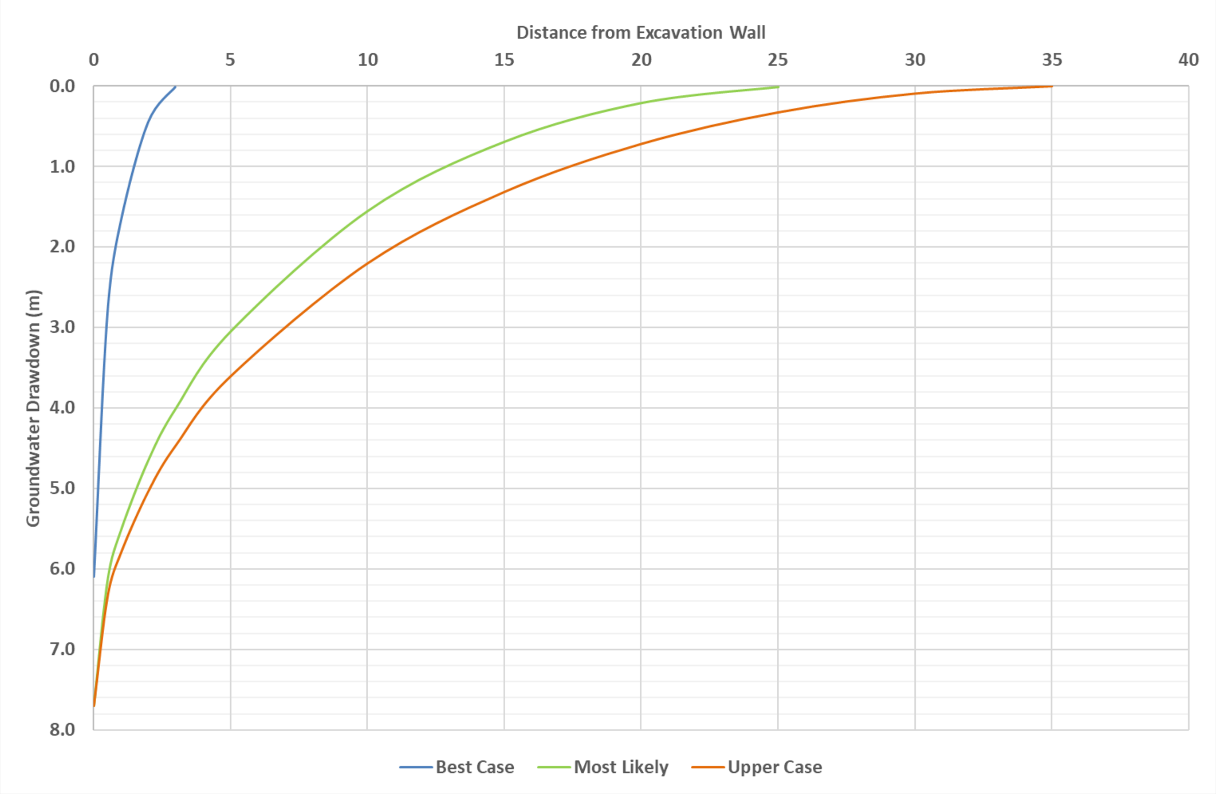
Based on the anticipated 12 month dewatering program (including both the initial matrix storage removed via excavation over the initial 3 months, and the groundwater inflow over the 12 month period until the basement tank is constructed) the following total groundwater extraction volumes were predicted as presented in Table 5-7 below:

Table 5-7: Most Likely Predicted Groundwater Take

Dewatering Area	Predicted Groundwater Inflow Take (ML/yr)	Predicted Matrix Take (ML)	Total Groundwater Take During Construction (ML)
Basement Excavation	**2.39**	6.87	9.26

5.7.4. Prediction of Drawdown Distance

As part of the dewatering assessment, the extent of groundwater drawdown was estimated at regular distance intervals from the edge of the circular disk sink (approximate excavation edge) and at the nearest neighbouring building (immediately adjacent to the proposed excavation perimeter at 2 Delmar Parade, Dee Why). The estimated drawdown at distance from the excavation/basement wall has been provided in Graph 2.



Graph 2: Extent of Drawdown from Basement/Excavation Wall

It is the professional experience of Reditus that the groundwater levels in fractured Hawkesbury Sandstone in the Sydney region can vary naturally by ±4m or more during prolonged periods of dry or wet weather (as demonstrated in the long-term groundwater monitoring of site wells during 2021-2022). Accordingly, a drop in the groundwater level of 4m or less is considered unlikely to result in off-site geotechnical settlement impacts within the sandstone rock aquifer.

Drawdown outside the site has the potential to be sufficient to induce settlement in overlying buildings unless an appropriate DMP is implemented. A suitability qualified geotechnical consultant will be required to determine the potential settlement impacts caused by the potential drawdown as a result of the proposed dewatering activities. Detailed geotechnical considerations are beyond the scope of this assessment.

If drawdown approaching 1.0m is identified in the monitoring points outside the excavation shoring walls, geotechnical and structural engineering advise should be sought, and consideration should be given to control of the off-site water table depression (if deemed required). This is likely to have in implication on the costs of the project but is recommended in order to reduce the risk of damage to adjacent buildings and roadways (refer to Section 9 and 10).

The closest high priority GDE is located approximately 20km to the south. Given the most likely predicted drawdown within 25m from the excavation boundary is negligible (<0.1m), the dewatering works are unlikely to cause a detrimental impact to these receptors as it's within levels of natural fluctuations.

The closest registered groundwater supply bore (GW108144 – irrigation bore for Brookvale Oval) was located 900m to the southwest of the site. Given the most likely predicted drawdown within 25m from the excavation boundary is negligible (<0.1m), the dewatering works are unlikely to cause a detrimental impact to registered water supplies.

Whilst every effort has been made to make accurate predictions in the dewatering volumes and off-site effects, it is strongly recommended that water levels be monitored regularly in the dewatered area and in surrounding properties (refer to Section 10 and 12) to ensure that local variations in hydraulic properties in the aquifer do not result in unacceptable groundwater table depression.

6. Legislation, Regulation and Relevant Endorsed Guidelines

To facilitate the construction and basement dewatering, in relation to impacts of groundwater resources and the surrounding environment, the following statutory requirements need to be achieved to address the WaterNSW regulations.

The majority of NSW groundwater is covered by statutory Water Sharing Plans and the NSW Aquifer Interference Policy (AIP). In the absence of a relevant Water Sharing Plan, groundwater is regulated under the Water Act 1912.

Given that groundwater will be incepted and dewatered during construction, the proposed development is considered to be an aquifer inference activity requiring authorisation from WaterNSW under either the Water Management Act 2000 and/or the Water Act 1912.

6.1. Environmental Planning and Assessment Act 1979

Conditions of consent in relation to dewatering are likely to be prescribed by the Council in the Development Consent and NSW DPIE General Terms of Approval for the works issued under the Environmental Planning and Assessment Act (1979). A copy of the approval must be kept on location at all times.

6.2. Protection of the Environment Operations (POEO) Act 1997

The POEO Act 1997 and its associated schedules and regulations are directly relevant to dewatering operations. In particular, the Act includes requirements prohibiting the pollution of waters, preventing or minimising air and noise pollution, regarding maintenance and operation plant in a proper and efficient condition/manner, and for minimising and managing wastes.

The Act also requires notification to the NSW Environmental Protection Authority (EPA) and Council, when a pollution incident occurs that causes or threatens material harm to the environment (including discharges above the set limits in Table 8-1 to the stormwater and where any unacceptable impact to the receiving waters is identified).

6.3. NSW Water Quality Objectives (2006)

The NSW Water Quality Objectives are the agreed environmental values and long-term goals for NSW's surface waters. They set out:

- the community's values and uses for our rivers, creeks, estuaries and lakes (i.e. healthy aquatic life, water suitable for recreational activities like swimming and boating, and drinking water); and
- a range of water quality indicators to help us assess whether the current condition of our waterways supports those values and uses.

The site is located within the ‘Gosford and Northern Beaches Lagoons’ catchment area. The water quality objectives of the Dee Why Lagoon and catchment include aquatic ecosystems, visual amenity, secondary contact recreation, primary contact recreation and aquatic food (cooked).

6.4. Northern Beaches Council – Dewatering Discharge Approval / Permit

A permit from Council is required for any dewatering of groundwater.

Council require groundwater/tailwater to be discharged must be compliant with the General Terms of Approval/Controlled Activity permit issued by WaterNSW (if applicable), Landcom's 'Managing Urban Stormwater: Soils and Construction' (2004) (Blue Book), Council's Compliance and Enforcement Policy and legislation including Protection of the Environment Operations Act 1997 and Contaminated Lands Act 1997. All approvals, water discharges and monitoring results are to be documented and kept on site. Copies of all records shall be provided to the appropriate regulatory authority, including Council, upon request.

Council typically requires that the Principal Contractor provide a copy of the DMP to Council prior to commencing discharge of groundwater from site.

Council are required to provide 'written approval' (usually in the form of a permit) as part of "Application for approval for water supply works, and/or water use" with the WaterNSW prior to discharge of the treated groundwater to the stormwater network.

6.5. Water Act 1912 and Water Management Act 2000

Dewatering for construction purposes and ongoing basement dewatering is classified as an aquifer interference activity under the NSW Aquifer Interference Policy 2012.

WaterNSW are responsible for waters work approvals under the provisions of the Water Management Act 2000 (WMA) which includes regulation of all aquifer interference activities within Water Sharing Plan management areas. WaterNSW also are responsible for water works approvals for all groundwater extraction in areas outside Water Sharing Plan management areas, as well as State Significant Development.

Reditus notes the following:

- **Water Sharing Plan**: The site is mapped within the Sydney Basin Central Groundwater Source, under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. The Sydney Basin Central Groundwater Source is a Porous Rock Groundwater Source.
- **Alluvial Aquifer**: This water bearing zone is not mapped within the Metropolitan Coastal Sands Groundwater Source, therefore is not considered to be managed under a Water Sharing Plan area, therefore is considered to be regulated under the Water Act 1912. The majority of groundwater take results from the once-off matrix excavation works during construction (**5.47ML**). Given that the low permeability CSM wall minimises groundwater inflow from the surrounding alluvial aquifer (Model Scenario 1: **<0.1ML/yr**), there will be negligible take from this alluvial aquifer once construction is complete.
- **Porous Rock Aquifer:** This water bearing zone is mapped under the Sydney Basin Central Groundwater Source, under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011, therefore considered to be regulated by WaterNSW under the WMA 2000. The predicted ongoing groundwater take from this aquifer was **2.39ML/yr** through the drained basement design. An estimated **1.40ML** take will result from matrix removal during construction works.

While minor aquifer interference activities works are generally exempt from the full extent of the WMA 2000, an application for "Approval for Water Supply Works and/or Water Use" (previously known as a Dewatering Licence) is required, regardless if the total volume of groundwater extracted is expected to exceed <3 ML per year. A Water Access License (WAL), or written approval from WaterNSW/NRAR if no licence is required, must be obtained prior to commencement.

The following information must be provided in support of the “Approval for Water Supply Works and/or Water Use” application:

- A copy of a valid planning consent for the project;
- A copy of the written authorisation for the disposal of the extracted groundwater;
- A Dewatering Management Plan, which clearly and concisely set out:
  - Current groundwater levels, preferably based on at least three repeat measurements from at least three monitoring bores and should be used to develop a water table map for the site and its near environs, be accompanied by an interpretation of the groundwater flow direction from these data, and an assessment of the likely level to which groundwater might naturally rise during the life of the building.
  - Predictions of total volume of groundwater to be extracted during the life of the approval (or during the construction period) – the method of calculation and the basis for parameter estimates and any assumptions used to derive the volume are to be clearly documented. Details of how dewatering volumes are to be measured, and of the maximum depth of the proposed dewatering system.
  - Predicted duration of dewatering at the property, noting that temporary water supply works approvals are generally issued for no more than 24 months.
  - Details of how dewatering volumes are to be measured, e.g. by calibrated flow meter or other suitable method, and of the maximum depth of the proposed dewatering system.
  - Details of any predicted impacts or particular issues, e.g. proximity of groundwater dependent ecosystems springs; or water supply losses by neighbouring groundwater users; or potential subsidence impacts on nearby structures or infrastructure.
  - Details of monitoring proposed during the dewatering program. These should be designed to inform and facilitate the protection of any identified potential impacts.
  - Details of ambient groundwater quality conditions beneath the property and of any proposed treatment to be applied to pumped water prior to disposal – at a minimum, treatment must be undertaken to remove contaminants, manage pH levels, reduce suspended solids and turbidity to acceptable levels and ensure that dissolved oxygen levels are compatible with ambient quality requirements in receiving waters. Groundwater cannot be re- injected into an aquifer without the specific approval of, and licensing by, WaterNSW.
  - Details of how reporting will occur during and following the dewatering program, to confirm that predicted quantities and quality objectives were met.
  - Description of the method of dewatering and related construction including any proposal to use temporary piling or support walls and the relative depths thereof.

Further information on the aquifer interference policy and licencing requirements are available from the WaterNSW website.

Reditus note that if/once approval has been provided, an application for a “new water access licence with a zero share component” may be required to be completed and a suitable groundwater entitlement may also need to be obtained from the market to account for the groundwater take within the same groundwater source (in this case, Sydney Basin Central Groundwater Source, under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources (2011). This will need to be obtained within three months of granting of the Zero Access Licence.

Works or activities that intersect or interfere with groundwater systems and where take is incidental to the primary purpose of the activity, or where there is no take, are managed as aquifer interference activities. Aquifer interference activities taking 3ML or less of groundwater per year are exempt from requiring a Water Access Licence (WAL). As such, a WAL will not be required following completion of construction.

6.5.1. Water Sharing Plans (WSPs)

WSPs are being progressively developed for rivers and groundwater systems across NSW following the introduction of the Water Management Act 2000. WSPs made under the WMA are being prepared as Minister's plans under Section 50 of the Act. These plans protect the health of our rivers and groundwater while also providing water users with perpetual access licences, equitable conditions, and increased opportunities to trade water through separation of land and water.

WSPs provide a legislative basis for sharing water between the environment and consumptive purposes. Under the WMA, a plan for the sharing of water must protect each water source and its dependent ecosystems and must protect basic landholder rights.

The site's Alluvial Sediment Aquifer is not known to be regulated under WMA 2000 through Water Sharing Plan. It is not located within the Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources (2016).

The site deeper Fractured Sandstone Aquifer is located within the following WSP:

- Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources (2011) – Sydney Basin Central Groundwater Source.

6.5.2. Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources (2011) - Sydney Basin Central.

The Sydney Central Basin Groundwater Source is bounded by the main arm of the Hawkesbury River to the north and by the Nepean River to the west and south. Much of Sydney's population is within this groundwater source (with a total area of 3, 757.59 square kilometres), and bores are evenly distributed across the area. The geology consists of sedimentary sandstone and siltstone formations with intervening coal seams.

The Sydney Basin is an elongate structural sedimentary basin consisting of Carboniferous to Triassic age rocks. The Basin is geologically bounded by fractured rocks of the Lachlan Fold Belt to the west and New England Fold Belt to the east.

Private bore yields are typically low at around 0.1–1 L/s but higher bore yields up to 20 L/s are associated with fracture zones which allow for improved groundwater flow. Extraction is often self-regulating with yields being limited by the connection between fractures in the rock. In many cases a bore will be pumped dry before any significant impact can be seen on dependent ecosystems or other water users.

The Sydney Basin Central Groundwater Source is recharged primarily from rainfall. The valley floors with overlying Quaternary alluvium are areas for groundwater discharge with water levels within monitoring bores observed to be sub-artesian to artesian.

The long-term average annual extraction limit (LTAAEL) is 45,915 ML/yr. There was 93% (42,700ML/yr) unassigned volume of water from the Sydney Basin Central management area based on the 2018-2019 entitlements.

6.6. NSW Aquifer Interference Policy 2012

The purpose of the NSW Aquifer Interference Policy 2012 is to explain the role and requirements of the Minister administering the WMA in the water licensing and assessment processes for aquifer interference activities under the WMA and other relevant legislative frameworks. The NSW Aquifer Interference Policy 2012:

1. clarifies the requirements for obtaining water licences for aquifer interference activities under NSW water legislation; and
2. establishes and objectively defines considerations in assessing and providing advice on whether more than minimal impacts might occur to a key water-dependent asset.

The proposed development will result in aquifer interference under the NSW Aquifer Interference Policy (2012) as groundwater will be removed from at least one aquifer. Accordingly, groundwater licensing may be required.

6.6.1. Licensing of Water Taken Through Aquifer Interference

A water licence is required under the WMA (unless an exemption applies or water is being taken under a basic landholder right) where any act by a person carrying out an aquifer interference activity causes:

- the removal of water from a water source; or
- the movement of water from one part of an aquifer to another part of an aquifer; or
- the movement of water from one water source to another water source, such as:
  - from an aquifer to an adjacent aquifer; or
  - from an aquifer to a river/lake; or
  - from a river/lake to an aquifer.

A licence for the removal of water from a water source may be required for the development.

6.7. Relevant National and NSW EPA Endorsed Guidelines

Approval for the disposal of groundwater to stormwater will be regulated by Council.

The adopted water quality guidelines for discharge waters are the:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018);
- ANZECC/ARMCANZ (2000) Default Trigger Values (TVs) for Physical and Chemical Stressors (used in the absence of ANZG 2018); and
- Guidelines for Managing Risks in recreational Water (NHMRC 2008) / Drinking Water Criteria (NHMRC 2017).

Use of the 95% protection level (for the ANZG 2018 Guidelines) is based on an assumption that the surrounding watercourses are moderately disturbed ecosystems (as receiving road and stormwater runoff from adjacent highly urbanised environment). In the absence of ANZG (2018) DGVs, the ANZECC (2000) trigger values (TVs) were adopted.

This DMP will need to be revised if changes to the DGVs occur. If this change occurs during the current proposed dewatering period, this is to be reflected in a revised DMP.

There are currently no endorsed water quality guideline values in NSW for secondary contact which may occur during recreational activities. Reditus notes that the health-based drinking water guidelines criteria (NHMRC 2017) were derived based on the long-term consumption of 2L/day of the water. Incidental ingestion of water from Broad Water (which are saline) during recreational activities unlikely to exceed more than 50mL/day, which is equivalent to approximately two mouthfuls of water. For conservatism, the greater of the health-based drinking water criteria or the aesthetic criteria (NHMRC 2017) multiplied by ten (10) has been chosen to address the secondary contact recreational uses of water. This factor of ten (10) is considered conservative as it is equivalent to long-term ingestion of 200mL/day of water.

7. Groundwater Impact Assessment

7.1. Minimal Impact Considerations

The WMA 2000 includes the concept of ensuring "no more than minimal harm" for both the granting of water access licences and the granting of aquifer interference approvals.

The Aquifer Interference Policy includes a set of minimal impact considerations for assessing the impacts of all aquifer interference activities, including those regulated under the WMA 2000, the Water Act 1912 and those decided under other legislation. The NSW DPI (2018) *Assessing Groundwater Applications Water Resource Plans Fact Sheet* provides a framework for the Minimal Impact threshold criteria.

Aquifer interference approvals are not to be granted unless the Minister is satisfied that adequate arrangements are in force to ensure that no more than minimal harm will be done to any water source, or its dependent ecosystems, as a consequence of its being interfered with in the course of the activities to which the approval relates.

Whilst aquifer interference approvals are not required to be granted, the minimal harm test under the WMA is not activated for the assessment of impacts. Therefore, this Policy establishes and objectively defines minimal impact considerations as they relate to water-dependent assets and these considerations will be used as the basis for providing advice to the Minister.

All NSW groundwater sources have been categorised as being either highly productive or less productive, based on the general character of the water source meeting or not meeting the criteria of 1500 mg/L total dissolved solids and a bore yield rate of greater than 5 L/s. This categorisation applies to a whole groundwater source as it is defined in a water sharing plan, not to the specific groundwater conditions at a particular location. The minimal impact considerations for the highly productive groundwater sources are different to those for the less productive groundwater sources.

Thresholds for minimal impact considerations have been developed for each groundwater source in NSW. Within the WMA, Table 1 – Minimal Impact Considerations for Aquifer Interference Activities are categorised into type of groundwater sources and are presented in Table 7-1 below. The thresholds relate to impacts on groundwater table and pressure, and to groundwater and surface water quality.

Table 7-1: Highly and Less Productive Groundwater Source Types

Highly Productive	Less Productive
▪ Alluvial; ▪ Coastal Sands; ▪ Porous Rock; – Great Artesian Basin - Eastern Recharge and Southern Recharge; – Great Artesian Basin – Surat, Warrego and Central; – other porous rock; and ▪ Fractured Rock.	▪ Alluvial; ▪ **Porous Rock; and** ▪ **Fractured Rock**

The proposed development is considered to be located in a Less Productive groundwater source based on both the Sandstone Porous/Fractured Rock Aquifer, as yields are less than <5L/s. An assessment of the 'Minimal Impact Considerations' is provided in Table 7-2 below.

Table 7-2: Minimal Impact Considerations under the Aquifer Interference Policy & NSW DPI (2018) ***Assessing Groundwater Applications Water Resource Plans Fact Sheet***

Aquifer Groundwater Source	**Alluvial Deposits – Alluvial Groundwater Source** **Hawkesbury Sandstone - Porous and Fractured Rock Groundwater Sources**
Aquifer Type	**Alluvial Deposits: Unconfined** **Hawkesbury Sandstone: Confined / Semi-confined**
Category	**Less Productive**
Level 1 Minimal Impact Consideration	**Assessment**
Impact on Water Table **(unconfined aquifer)**	
1. Less than 0.1 metre cumulative drawdown in the water table 40 metres from any: a. high-priority, groundwater-dependent ecosystem, or b. high-priority, culturally significant site.	The proposed CSM / Diaphragm Wall (keyed into sandstone) will significantly minimise drawdown within the surrounding alluvial aquifer. The predicted drawdown in the surrounding alluvial aquifer was <0.1m within 2m of the basement wall (as demonstrate by the Scenario 1 Best-Case conditions). Based on the prediction of <0.1m drawdown in the alluvial aquifer within 2m of the basement wall, there will be **Minimal Impact** to the water table.
2. An additional drawdown of not more than 10% of the pre-development TAD to a maximum of 2 metres at any: a. 3rd or higher order surface water source measured at 40 metres from the high bank. b. water supply works (excluding those on the same property), subject to negotiation with impacted parties.	
3. A cumulative drawdown of no more than 10% of the pre-development TAD of the unconfined aquifer at a distance of 200 metres from any water supply works including the pumping bores.	

Impact on Water Pressure **(Confined/semi-confined aquifer)** 1. A cumulative drawdown of not more than 40% of the pre-development TAD at a distance of 200 metres from any water supply works including the pumping bores. 2. An additional drawdown of not more than 3 metres at any water supply works (excluding those on the same property) subject to negotiation with impacted parties.	The closest registered groundwater supply bore (GW108144 – irrigation bore for Brookvale Oval) was located 900m to the southwest of the site. **Given the most likely predicted drawdown within 25m from the excavation boundary is negligible (<0.1m), the dewatering works are unlikely to cause a detrimental impact to registered water supplies.**
Impact on Water Quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	**Given the most likely predicted drawdown within 25m from the excavation boundary is negligible (<0.1m), the dewatering works are unlikely to lower the beneficial use beyond 40 metres from the activity.**

Based on the above assessment, the basement dewatering activities are considered to be of **Minimal Impact** under the NSW DPI (2018) Assessing Groundwater Applications Water Resource Plans Fact Sheet, NSW DPI (2012) AIP and WMA 2000.

7.2. WSP Rules for Water Access Approval

A summary of the water sharing rules for granting of access licences (as detailed within the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 - Sydney Basin Central Groundwater Source), compared against the results of the above assessment, are presented Table 7-3 below. Reditus note that the following rules are used as a guide only and actual approval conditions are granted at the discretion of the NSW DPIE.

Table 7-3: Summary of Water Access Rules and Findings of Assessment

Relevant WSP Rule	Assessment
Granting of access licences may be considered for the following: ▪ Specific purpose access licences including local water utility, major water utility, domestic and stock and town water supply. ▪ Commercial access licences under a controlled allocation order made in relation to any unassigned water	The dewatering works for the development are not specified but may be considered as under a Commercial access licence conditions.

To minimise interference between neighbouring water supply works, no water supply works to be granted or amended within the following distances of existing bores: ▪ 400m from an aquifer access licence bore on another landholding, or ▪ 100m from a basic landholder rights bore on another landholding, or ▪ 50m from a property boundary (unless written consent from neighbour), or ▪ 1000m from a local or major water utility bore, or ▪ 200m from a Department monitoring bore (unless written consent from NSW Office of Water). *The plan lists circumstances in which these distance rules may be varied and exemptions from these rules.*	The closest registered bore is located over 400m from the site.
To protect bores located near contamination, no water supply works are to be granted or amended within: ▪ 250m of contamination as identified within the plan, or ▪ 250m to 500m of contamination as identified within the plan unless no drawdown of water will occur within 250m of the contamination source, ▪ a distance greater than 500m of contamination as identified within the plan if necessary to protect the water source, the environment or public health and safety. *The plan lists circumstances in which these distance rules may be varied and exemptions from these rules.*	The United branded Service Station at 625 Pittwater Road (~60m from the site) has been notified on the NSW EPA Contaminated Sites Register. The service station is currently under assessment by the NSW EPA if regulation is warranted under the CLM Act. Given all model Scenarios predict that there will be no drawdown within 35m of the basement, and that the service station is hydraulically down gradient of the development site, there is unlikely to be a risk.
To protect bores located near sensitive environmental areas, no water supply works to be granted or amended within the following distances of high priority Groundwater Dependent Ecosystems (GDEs) (non Karst) as identified within the plan: ▪ 100m for bores used solely for extracting basic landholder rights. ▪ 200m for bores used for all other access licences. ▪ 500m of high priority karst environment GDEs.	Based on a review of the WSP, there are no high priority Groundwater Dependent Ecosystems (GDEs) within 20km of the site (including springs, geothermal springs, wetlands and karst).

▪ 40m from the top of the high bank of a river or stream. or ▪ 100m from the top of an escarpment. *The plan lists circumstances in which these distance rules may be varied and exemptions from these rules.*	
To protect groundwater dependent culturally significant sites, no water supply works to be granted or amended within the following distances of groundwater dependent cultural significant sites as identified within the plan: ▪ 100m for bores used for extracting for basic landholder rights, or ▪ 200m for bores used for all other aquifer access licences *The plan lists circumstances in which these distance rules may be varied and exemptions from these rules.*	Based on a review of the WSP, there are no groundwater dependent cultural significant sites within 200m of the site associated dewatering works.
Available Water Determinations (AWDs): ▪ 100% stock and domestic, local and major utilities and specific purpose access licences ▪ 1ML/unit of share aquifer access licences *AWD for aquifer access licences may be reduced in response to a growth in use.*	In accordance with WaterNSW exemptions, A Water Access Licence would not be required for 2.39ML/yr of groundwater take from the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 – Sydney Basin Central.
Trading Rules ▪ INTO groundwater source: Not permitted ▪ WITHIN groundwater source: Permitted subject to local impact assessment ▪ Conversion to another category of access licence: Not permitted.	

Based on the above, the proposed dewatering works generally complies with the general rules for granting of a water access licence under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 – Sydney Basin Central management area.

8. Water Quality Objectives

8.1. Receiving Environment

The site is situated within a highly urbanised residential and commercial/industrial area. The extracted groundwater will be treated and discharged to the stormwater network via connection to an approved location by Council.

Dewatered groundwater is expected to be directed to the stormwater drain entry point along Delmar Parade, located on the northern site boundary.

Based on the local topography, the receiving waters of the stormwater network are understood to be Dee Why Lagoon, located to the northeast of the site.

The Dee Why Lagoon catchment is considered a moderately disturbed ecosystem, which receives water from a highly urbanised environment, including multiple waste streams. Use of the ANZG (2018) 95% protection level for ecological receptors has been adopted on this basis.

8.2. Adopted Discharge Water Quality Guidelines

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) provide detailed approaches and advice on identifying appropriate guideline values for the protection of environmental receptors. These guideline values help to ensure that agreed community values and their management goals are protected.

The ANZG (2018) have been recently endorsed by the NSW EPA, which supersede the previous ANZECC & ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Applying the ANZECC (2000) guidelines to the range of community values relied largely on a single line of evidence (chemical assessment) to determine whether or not a guideline value was exceeded. The ANZG (2018) Water Quality Guidelines improve confidence in our assessments by:

- introducing a systematic approach to assessing a number of lines of evidence along the pressure–stressor–ecosystem receptors pathway
- promoting decisions on the basis of the integrated weight of evidence.

For the protection of aquatic ecosystems, locally derived guideline values are most appropriate. In the absence of locally derived guideline values or other jurisdictionally-legislated requirements (as in this case), the ANZG (2018) provide default guideline values (DGVs) for assessing the impacts of physio-chemical parameters and potential toxicants on aquatic ecosystems, as well as advice on tailoring DGVs to suit the local region. Where DGVs are not available within the ANZG (2018), the ANZECC (2000) guidelines trigger values (TVs) are adopted.

It is specifically noted in the ANZG (2018) guidelines that "the Water Quality Guidelines are not intended to directly apply to contaminant concentrations in industrial discharges or stormwater quality (unless stormwater systems are regarded as having relevant community value)".

The ANZG (2018) provides guidance on assessing a waste discharge. The ANZG (2018) Water Quality Management Framework and associated monitoring data can be used to assess compliance or potential impacts of a waste discharge on water quality. Assessing a waste discharge in this way aims to ensure that it complies with the conditions of approval and is not causing environmental harm. The Water Quality Management Framework provides a step-by-step approach to protect the community values of waterways.

8.2.1. Water Quality Management Framework

The Water Quality Management Frameworks has the following steps which are adopted as part of this DMP:

- **Step 1: Examine current understanding**
  - Use current understanding to develop or refine a conceptual model of key waterway processes and how the waste discharge could affect local waterways.
  - Site-specific information on the operation and receiving environment (e.g. current water quality and temporal and spatial release characteristics of the discharge, mixing zones and regulatory compliance points, water quality and ecology of the receiving environment).
  - As further monitoring data become available, update and refine the current understanding.
- **Step 2: Define community values and management goals**
  - Establish or refine community values and more specific management goals (including level of protection) for the relevant waterways at stakeholder involvement workshops.
  - The relevant values adopted are the 95% protection level of marine ecosystems and recreational use.
- **Step 3: Define relevant indicators**
  - Select indicators for relevant pressures identified for the system, the associated stressors and the anticipated ecosystem receptors.
  - Based on previous groundwater quality information, the analytical suite detailed in Section 4.2.3 has been adopted as primary indicators. Other indicators include visual inspection at the discharge point of the stormwater into Dee Why Lagoon for any signs of potential adverse effects (e.g. turbidity, increased algae presence, discolouration).
- **Step 4: Determine water quality guideline values**
  - Determine the water quality guideline values for each of the relevant the biological, chemical and physical indicators required to provide the desired level of protection for the management goals of relevant waterways.
  - The DMP adopts the ANZG (2018) DGVs and the ANZECC (2000) TVs in the absence of DGVs. Results of monitoring data from the stormwater drain and Dee Why Lagoon will also be used for the assessment to determine if adverse environmental impact are occurring from groundwater discharge.
- **Step 5: Define draft water quality objectives**
  - Use the guideline values or narrative statements chosen for each selected indicator as draft water quality objectives to ensure the protection of all identified community values and their management goals.

- **Step 6: Assess if draft water quality objectives are met**
  - Use measurements from monitoring of each relevant indicator to assess whether current water quality meets the draft water quality objectives.
  - This includes comparison of the water quality monitoring data for each relevant indicator with the water quality objectives, together with the evidence from any additional lines of evidence (such as results from at the edge of the mixing zone).
  - The weight-of-evidence process evaluates results from multiple lines of evidence across the pressures, stressors and ecosystem receptors relevant to the waste discharge. It is the key process by which the protection of community values is assessed. Multiple potential outcomes are possible from a weight-of-evidence evaluation. The resulting evaluation of water quality results will be used to determine if adverse trends are evident as a result of the discharge of groundwater to stormwater.
  - If the Water Quality Objectives are met, then management should focus on maintaining discharge quality. If Water Quality Objectives are not met and potential adverse trends are evident, the following options will be considered:
    - formulate, assess and prioritise management strategies to improve existing water quality associated with the waste discharge (Steps 8 to 10), and/or
    - reassess the appropriateness of the water quality guideline values (Step 7), and/or
    - consider selection of additional or alternative indicators or lines of evidence (Step 7).
- **Step 7: Consider additional indicators or refine water quality objectives**
  - Assess the need to revise or add to the lines of evidence or indicators and the water quality guideline values.
- **Step 8: Consider alternative management strategies**
  - Evaluate the effectiveness of current management strategies to address the identified water quality issues and recommend possible improvements. Improved or alternative management strategies are formulated, assessed and prioritised.
- **Step 9: Assess if water quality objectives are achievable**
  - Use information gained from Steps 6 to 8 to assess whether the water quality objectives are achievable.
- **Step 10: Implement agreed management strategy**
  - Document and implement agreed management strategies, including, in some cases, a suitable and agreed adaptive management framework.

This DMP details the current management strategy to be implemented.

8.2.2. ANZG (2018) Physical and Chemical Stressor Details

As noted above, there are two types of physical and chemical stressors that directly affect aquatic ecosystems that can be distinguished: those that are directly toxic to biota, and those that, while not directly toxic, can result in adverse changes to the ecosystem (e.g. algae blooms). In the absence of site specific guideline values, the following DGVs were adopted as water quality assessment criteria in order to assess this situation:

- **ANZECC (2000)**[1] Default trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems in Estuaries. These trigger values do not represent direct toxicity to biota, but can potentially result in non-toxic impacts to the ecosystem. ANZG (2018) do not currently provide DGV for physical and chemical stressors, therefore the ANZECC (2000) trigger values have been adopted; and
- **ANZG (2018) DGVs & ANZECC (2000)**[2] Australian and New Zealand Guidelines for Water Quality. Trigger values for Marine Water under the 95% protection levels. These trigger values represent toxicity to biota.

The adopted DGV criteria are protective of receptors at the point of exposure (i.e. stormwater drain and Dee Why Lagoon), and are overly conservative for the assessment of direct discharge water quality in areas where ecological receptors are not present (i.e. Site discharge into Stormwater drains). On this basis, the Dee Why Lagoon waters are considered the only receiving environment requiring protection. Reditus notes that the use of the DGVs is conservative and may not represent the Dee Why Lagoon local system.

Since the publication of ANZECC (2000), an Errata document has been issued which details that Nitrate values in Table 3.4.1 (page 3.4-5) are deleted and replaced with "Under Review" (http://www.agriculture.gov.au/SiteCollectionDocuments/water/nwqms-guidelines-4-vol1-errata.pdf). Furthermore, Nitrate guidelines values in ANZECC 2000 have been reviewed and recalculated (https://www.mfe.govt.nz/publications/fresh-water/updating-nitrate-toxicity-effects-freshwater-aquatic-species). The recalculated trigger values for 95% level of protection was 2.4mg/L for Nitrate-N.

It is important to note that the Draft Water Quality Objectives (WQO) listed below are specific to aquatic ecosystems only and are not intended as discharge water quality criteria. The adopted guidelines contain information on the comparison of test data with guideline DGVs & TVs. It emphasises that exceedances of the DGVs and TVs are an early warning mechanism to alert managers of a potential problem and are not intended to be an instrument to assess compliance and should not be used in this capacity.

The guidelines recognise that the environmental values and unique conditions of a site and specific behaviour of contaminants in different environments are important considerations when applying the guidelines. Factors relevant to assessing point source discharges include the flow rote of the discharge, receiving water flows and/or intensity of tidal exchange, and the levels of risk that vary from acute to chronic exposure.

Mixing zones are a tool for responsible management of the environment. As detailed within the ANZG (2018), mixing zone are described as an explicitly defined area around an effluent discharge where some, or all, water quality objectives may not be met. It is a generally accepted practice to apply the concept of a mixing zone for waste water discharges (such as stormwater). As a consequence, some community values of the water body may not be protected. The responsibility lies with the discharger to minimise this impact by keeping the mixing zone as small as practicable. They are designed to limit the impact to the environment that would otherwise occur if discharges were allowed to flow unchecked into waterways.

Critical to assessing the impact of an effluent discharge on beneficial uses and values is understanding the dilution and dispersion of the effluent. For discharges to marine environments, characteristics such as tidal and current movements, density and temperature differences, depth of water and rate of flow need to be considered to assess the dilution capabilities of the waterbody under various scenarios.

8.2.3. Recreational Water Quality (NHMRC 2012 & 2017)

The greater of the health based drinking water criteria (NHMRC 2012) multiplied by ten or the aesthetic criteria have been chosen to address the primary and secondary contact recreational uses of water.

8.3. Draft Water Quality Objectives - DGVs

A summary of the discharge water quality criteria is provided in Table 8-1 below for the water quality parameters and chemical of concern, which have been selected on the basis of site operational history, regional setting and site groundwater quality.

It is important to note that the Water Quality Objectives (WQO) listed in Table 8-1 below are specific to aquatic ecosystems only and are not intended as discharge water quality criteria. The ANZG (2018) framework emphasises that comparison of test data with guideline DGVs that 'exceedances of the DGVs are an "early warning" mechanism to alert managers of a potential problem and are not intended to be an instrument to assess "compliance", and should not be used in this capacity.

ANZG (2018) recognises that the environmental values and unique conditions of a site and specific behaviour of contaminants in different environments are important considerations when applying the guidelines. Factors relevant to assessing point source discharges include the flow rote of the discharge, receiving water flows and/or intensity of tidal exchange, and the levels of risk that vary from acute to chronic exposure.

Table 8-1: Water Quality Objectives - DGVs

Analyte Group	Analyte	ANZG (2018) Marine Water Quality Guidelines (µg/L)	Recreational Water Quality Criteria.
BTEX	Benzene	500	1,000
	Ethylbenzene	5	3,000
	Toluene	180	8,000
	Xylene (m)	75	6,000
	Xylene (p)	200	
	Xylene (o)	350	
Heavy Metals	Arsenic	24	50
	Cadmium	0.7	5
	Chromium	27.4	50
	Copper	1.3	1,000
	Nickel	7	200
	Lead	4.4	50
	Zinc	15	5,000
	Mercury	0.1	10
PAHs	Phenanthrene	0.6	-
	Anthracene	0.1	-
	Flouranthane	1	-
	Benzo(a)Pyrene	0.1	0.1
	Naphthalene	70	-
Pesticides	Atrazine	13	200
	Carbofuran	0.06	100
	Chlorodane	0.03	20

	Chlorpyrifos	0.009	100
	2,4-D	280	300
	DDT	0.006	90
	Diazinon	0.01	40
	Dimethoate	0.15	70
	Diquat	1.4	70
	Endosulfan	0.005	200
	Endrin	0.04	-
	Fenitrothion	0.2	70
	Glyphosate	370	1,000
	Heptachlor	0.01	-
	Lindane	0.2	100
	Malathion	0.05	700
	Methomyl	3.5	200
	Molinate	3.4	40
	Parathion	0.004	200
	Simazine	3.2	200
	2,4,5-T	36	1,000
	Tebuthiuron	2.2	-
	Temephos	0.05	4,000
	Thibencarb	2.8	400
	Thiram	0.01	70
	Toxafene	0.1	-
	Trifluralin	2.6	900
PCBs	Aroclor 1242	0.3	-
	Aroclor 1254	0.01	-
VOCs	1,1-DCA	90	-
	1,2-DCA	1,900	30
	1,1,1-TCA	270	-
	1,1,2-TCA	1,900	-
	1,1,2,2-TCA	400	-
	PCA	80	-
	DCM	4,000	40
	Chloroform	370	30
	Carbon Tetrachloride	240	30
	Vinyl Chloride	100	3
	DCE	700	600
	TCE	330	-
	PCE	70	500
	CB	55	100
	1,2-DCB	160	10
	1,3-DCB	260	200
	1,4-DCB	60	3
	1,2,3-TCB	3	50
	1,2,4-TCB	20	

	1,3,4-TCB	8	
	1,2,3,4-PCB	2	-
	1,2,3,5-PCB	3	-
	1,2,4,5-PCB	5	-
	PCB	1.5	-
Total Petroleum Hydrocarbons	TPH/TRH	2 (mg/L) [a]	-
Total Nitrogen	Total Nitrogen	300 [b]	-
Nitrate	Nitrate	2400 [c]	500,000
Total Phosphorus	Total Phosphorus	30 [b]	-
Ammonia	Ammonia	910 (pH dependant)	5,000
pH	pH	7.0-8.5 [b]	6.5-8.5
Total Suspended Solids	TSS	50,000	-
Turbidity	Turbidity	10 NTU	5 NTU
Temperature	Temperature	15-30˚C	-
Sheens/Odours	Sheens/Odours	No Observable Sheen or Odour	-

a - Recommended water quality criteria (NSW EPA).

b - ANZECC (2000) Default trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems for Estuaries (Table 3.3.2 Chapter 3 Aquatic Ecosystems).

c - Errata document has been issued which details that Nitrate values in Table 3.4.1 (page 3.4-5) are deleted and replaced with "Under Review" (http://www.agriculture.gov.au/SiteCollectionDocuments/water/nwqms-guidelines-4-vol1-errata.pdf). The Nitrate guidelines values in ANZG (2018) have been reviewed and recalculated (https://www.mfe.govt.nz/publications/fresh-water/updating-nitrate-toxicity-effects-freshwater-aquatic-species). With values for 95% level of protection reported at 2.4mg/L for Nitrate-N.

Analytes such as Total Suspended Solids (TSS) and other easily observable aspects from the dewatering process will need to monitored closely as adverse public interest in this site is a foreseeable possibility

- Total suspended solids (TSS) < 50 mg/L
- No observable sheen or odour
- Turbidity < 10 NTU
- Temperature < 30˚C

9. Potential Dewatering Impacts

Dewatering operations have the potential to impact receptors and the surrounding environment if not managed appropriately. This section outlines key areas of concern with respect to dewatering and potential environmental impacts.

Procedures for the management of potential environmental impacts are detailed in Section 10.

9.1. Receiving Water Quality

Typically, large volume and/or well flushed water bodies have a capacity to buffer the discharge of potential contaminants depending on the flow rate and duration of discharge. While the receiving waters are subject to the influences of an urbanised catchment, dewatering activities must not contribute to or cause significant decreases in receiving waters quality. Potential impacts associated with releasing dewatered groundwater to receiving waters (via the stormwater network) are summarised below.

9.1.1. Physicochemical Parameters

Changes to natural pH levels in a receiving waterway can be directly or indirectly detrimental to aquatic biota as particular species can be intolerant to specific conditions caused by dewatering processes.

Acidifying the receiving waters can cause metals bound to sediment and organic matter to be liberated, increasing toxicity and enhancing the bioavailability of background metals. Oxidation of dissolved metals can also strip oxygen from the receiving waters resulting in fish kills, however this is less likely in medium to high flow systems such as Dee Why Lagoon.

Turbidity and suspended solids impact on a receiving environment include siltation, reduction of the euphotic zone affecting photosynthetic organisms by limiting light transmission through the water column this has a flow on effect as the food chain is disrupted affecting benthic organisms and higher level organisms.

9.1.2. Nutrients

Streams/rivers, canals and coastal lakes environments have the ability to assimilate and export nutrients (such as nitrogen and phosphorus) through a variety of pathways including flushing, bacterial conversion and permanent accumulation in sediments. Under favourable conditions these cycles can help buffer the receiving environment from potentially deleterious effects of nutrient loading. These effects can include eutrophication, potentially toxic algal blooms, increased oxygen demand and ammonia toxicity.

While the buffering ability of the receiving environment should not be relied upon as a management strategy, the efficiency of a particular water body to process nutrients is an important consideration in assessing the potential impacts of eutrophication of a water body.

9.1.3. Heavy Metals

High concentrations of potentially harmful metals may be encountered in the groundwater depending on geology and historical uses of the site (and surrounding properties).

Whilst metals and associated compounds occur naturally in the environment and are essential for many organisms, the potential toxicity of metals to aquatic biota generally increases with concentration, particularly when in dissolved form. Furthermore, concentrations of dissolved metals may fluctuate throughout dewatering as water is drawn in from surrounding environments.

Metal toxicity also varies between different species of a particular metal, the physical and chemical characteristics of the receiving environment, and biological receptors. Thus, the size, tidal/mixing/flushing regime, and background concentrations of metals in the receiving waterway must be taken into account when assessing compliance.

Importantly, the total load and duration of metals discharged also needs to be considered when assessing potential chronic effects of metals on biota, though this is less crucial in deeper water with strong tidal interaction where the risk of accumulation is minimised.

9.1.4. Petroleum Hydrocarbons and Chlorinated Solvents

The site has been used for both residential and commercial purposes. The site was also neighbouring commercial properties.

An offsite groundwater sample on 2 Delmar Parade Dee Why (BH3) reported low concentrations of toluene (38 µg/L), short-chain TRH (C6-C9) (76 µg/L), and chloroform (14 µg/L).

Research indicates that petroleum hydrocarbons toxicity is highly variable, as they contain many hydrocarbon chain compounds. Generally, petroleum hydrocarbon based compounds can naturally biodegrade given the right conditions and generally degrade to lesser toxic substances.

The chemical degradation products of the potential VOC contaminants in groundwater, specifically chlorinated hydrocarbons including tetrachloroethene (PCE) and degradation daughter products trichloroethene (TCE), dichloroethene (DCE) and vinyl chloride (VC) can be of greater ecological and human health risk than the parent compounds and are therefore are considered to be significant.

Whilst not currently required based on recent results, TRH and VOC compounds may require treatment prior to discharge, which can be achieved via several methods. The treatment system may consist of a single remediation method, such as air stripping or filtered through activated carbon (sorption) to remediate the water to a suitable standard for disposal or re-injection.

9.1.5. Other Contaminants

Other hydrocarbon contamination (PAHs and Phenols) and other common anthropogenic contaminants (PFAS, OCPs, OPPs and PCBs) have not been identified exceeding the adopted ecological criteria within the localised groundwater. An offsite groundwater sample on 2 Delmar Parade Dee Why (BH3) reported concentrations of DDT (0.002 µg/L) and dieldrin (0.002 µg/L) above the laboratory limited of detection.

Whilst these contaminants are not expected to be present at elevated concentrations during the dewatering process (based on the most recent groundwater quality data), historical use of pesticides and other chemicals are known in the surrounding area. As such, monitoring of these compounds (as identified in previous environmental investigations) is strongly recommended.

9.2. Settlement of Unconsolidated Soils

Dewatering has the potential to induce settlement in loose sands and soft sediments, possibly compromising the structural integrity of surrounding structures. This is likely to be lessor of an issue with water bearing rock aquifers.

There is potential that drawdown outside the site may be sufficient to induce settlement in overlying buildings unless an appropriate DMP is implemented. A suitability qualified geotechnical consultant will be required to determine the potential settlement impacts caused by the potential drawdown because of the proposed dewatering activities. Detailed geotechnical considerations are beyond the scope of this assessment.

A suitably qualified engineer is required to determine the risk of settlement, potential impacts on the integrity of adjacent structures (i.e. buildings, roads, pipelines, etc.), and appropriate management measures.

9.3. Acid Sulfate Soils

Acid sulfate soils (ASS) occur predominantly on coastal land with elevations generally below 5m Australian Height Datum (AHD). These soils also occur further inland in saline seepage areas, rivers, lake beds and irrigation channels. Where present, draw-down of the local water table can expose ASS to oxidising conditions creating acidity and mobilising metals at potentially harmful concentrations.

Review of the NSW Acid Sulphate Soils Risk Map - Sydney, 1:25,000 notes that the site is not listed in an area of ASS probability.

The Warringah LEP 2011 Acid Sulfate Soils Map indicates the Site is not listed within a classified ASS zone.

Based on the above, the proposed development and associated groundwater dewatering will unlikely pose an unacceptable risk in regards to the generation and associated impacts due to acid sulfate soils.

9.4. Impact to Water Supply Works and GDEs

As detailed in Section 7 above, the basement dewatering works will not adversely impact on any water supply works, high priority GDEs, and is not expected to result in a change to water quality.

Based on the above assessment, the basement dewatering activities are considered to be of **Minimal Impact** under the NSW DPI (2018) Assessing Groundwater Applications Water Resource Plans Fact Sheet, NSW DPI (2012) AIP and WMA 2000.

9.5. Noise, Vibration and Odour

Noise and vibrations are generated by pumps, generators and treatment systems which typically operate 24 hours a day during dewatering operations. Offensive odours, such as hydrogen sulphide can also be liberated through excavation of sand and or soils with high organic content. Other odours from volatile organic compounds can occur from sites contaminated with petroleum hydrocarbons or solvents. It is also common for diesel fumes to emanate from dewatering pumps and generators where electric systems cannot be used.

Noise, vibrations and odour have the potential to cause a public nuisance, particularly in dense residential areas such as the is site, and may also impact on the natural movements or behaviour of wildlife.

10. Management of Potential Impacts

10.1. Drawdown

The depth of groundwater extraction infrastructure and the rate of extraction shall be limited to the minimum requirements set in the hydrogeological model to achieve the lowering of groundwater within the site to undertake construction works.

Dewatering shall be managed in consultation with a suitably qualified environmental and geotechnical engineer to ensure the structural integrity as built structures is not compromised.

Whilst effort has been made to make accurate predictions in the dewatering volumes and off-site effects, it is strongly recommended that water levels be monitored regularly in the dewatered area and in surrounding properties to ensure that local variations in hydraulic properties in the alluvial sands/clays and sandstone do not result in unacceptable groundwater table depression or mounding.

Monitoring of groundwater levels outside the basement wall at a minimum of three locations is recommended on a daily basis (refer to Section 0). This must include:

- Dedicated monitoring wells screened within the Alluvial aquifer to monitor drawdown and mounding; and
- Dedicated monitoring wells screened within the Sandstone aquifer to monitor drawdown and mounding.

If drawdown approaching 1.0m is identified in the monitoring points outside the shoring wall or near existing buildings, geotechnical and structural engineering advise should be sought, and consideration should be given to control of the off-site water table depression (if deemed required).

This is likely to have in implication on the costs of the project but may be recommended in order to reduce the risk of damage to adjacent buildings and roadways. Control methods may include:

- Grouting / sealing of sandstone fracture flow pathways through drilling and injection of cement/bentonite slurry or foam compounds to reduce groundwater inflows.
- Reinjection of extracted water along the site boundary. This may require some injection points to be outside the site boundary, and may require a variation to the dewatering licence obtained from WaterNSW. Injection water quality would be required to be meet NSW EPA endorsed guideline criteria.

10.2. Discharge of Groundwater

Groundwater discharge shall be controlled in a manner which does not create a flooding hazard. The rate of groundwater extraction will be highly dependent on the required time frame for excavation works and can be varied to match excavation depth speed and/or discharge restrictions (if any).

Assuming an excavation period of 3 months, an average groundwater extraction and discharge rate of <1.5L/s is expected to be maintained to keep the excavation free of water. Once the excavation is completed to the BEL, an average discharge rate of <0.08L/s (<4.5L/min) is expected to maintain the groundwater level below the BEL.

During extreme rainfall/storm/tide events the local stormwater drainage system can become full or flooded. If combined stormwater and dewatering flows exceed the capacity of the stormwater drainage system, discharge shall be reduced or, if necessary, stopped until stormwater flows, and / or tidal inundation subsides. Routine inspections at the stormwater inlet will need to be conducted by the Site Manager or on appropriate delegate during storm events and greater than overage tides.

The flowing sections may be required during the dewatering process if deemed necessary by the licencing provider and Council.

10.2.1. Water Quality Testing Prior to Discharge

Prior to discharge of extracted groundwater, the groundwater will be recirculated back into the open excavation/ or temporary onsite water storage to allow clearing of sediment from the dewatering system and allow water quality to stabilised. Once conditions have stabilised, initial batch testing of extracted water will be completed and compared against the WQO listed in Table 8-1 above.

The treated groundwater will be tested for analytes specified in Section 12, following receipt of the test results, the Environmental Manager/Consultant, in consultation with Council (where required), shall determine the suitability for discharge to the stormwater network. Compliance with the WQO set out in Table 8-1 is required prior to discharge. Additional components to the water treatment process may be required if initial batch testing results do not meet the WQO.

Reditus note that the period between collecting the pre-start samples and discharging from site can exceed one week (more if test results are not favourable and retesting is required) and that this should be accounted for in the construction program.

10.3. Noise and Vibration

The following methods shall be employed to reduce noise emissions resulting from dewatering operations:

- Preference shall be given to electric powered dewatering pumps over diesel / fuel powered equipment (due to the sound generated being lower with electric pumps). The proposed pumps are noted to be electrical vacuum header pump.
- Installation and maintenance of high efficiency mufflers for all noise generating plant. All reasonable steps shall be taken to acoustically baffle and muffle all plant and equipment.
- Pump equipment and generators shall be located away from site boundaries where possible, with consideration to adjoining residences, Installation of acoustically baffled enclosures around and generators and pump is recommended to minimise noise issues or complaints.
- All sub contractors to be managed to ensure they work only within defined hours.
- Where there are several noise generating equipment, schedule operations to minimise cumulative impacts.
- Keep equipment well maintained.
- Ensure engine shrouds (acoustic linings) are installed (where feasible).

It is the responsibility of the Site Manager to ensure appropriate management of vibration, noise and odour during dewatering operations, and that the management approaches adopted are in accordance with the Council Conditions of Consent and any relevant management plan (e.g. Construction Environmental Management Plan, Demolition Management Plan, Excavation Management Plan, or Construction Noise and Vibration Management Plan).

10.4. Odour

Routine odour monitoring should be undertaken to identify offensive odours and avoid potential impacts on adjacent site users. Control measures, such as deodorants or passing the discharge through a carbon filter tank, shall be adopted in the event odours are considered unacceptable levels at the site boundary. Where odour controls prove ineffective, activities that cause an offensive odour shall cease until odour emissions are resolved.

11. Dewatering and Water Treatment System

The proposed dewatering system and treatment system (if required) to be operated at the site is specified below.

11.1. Dewatering System

Dewatering is proposed to commence following the competition of CSM / Diaphragm walls. This will minimise/prevent groundwater inflows from the alluvial aquifer, resulting in significantly lower dewatering volume requirements.

Groundwater is proposed to be extracted using a combination of a series of spearpoints internally around the permitter of the excavation and/or internal large diameter extraction wells.

It is anticipated that 3-5, extraction wells of approximately 300mm diameter will be installed within the site to depths below the BEL. Spear-points may also be installed around the internal side of the CSM / Diaphragm wall at regular spacings, to either the depth of the BEL or base of the alluvial sediments. The exact specification will be determined by the Dewatering Contractor and will be dependent on pump sizing and water treatment flow capacity.

Each of the spearpoints and/or internal extraction wells will be connected to a header main around the site perimeter. The header line is then connected to a settlement tank and treatment system (if required) prior to proposed dewatering. Reinjection is currently not proposed.

Groundwater will be pumped from one or more locations within the excavation and directed through a main header line. The header line will then be connected to a water treatment system (detailed in Section 11.2 below) prior to proposed discharge to the stormwater pit.

The typical components of the Dewatering System for the internal large diameter extraction wells are shown and detailed in Figure 11-1 below.

Figure 11-1: Key Components of the Dewatering System

The spearpoint pumping system typically comprises 50mm diameter slotted PVC casing, with 40mm pressure hose from each spearpoint connected to a main header line which is pumped using a liquid ring pump.

11.2. Water Treatment System (if required during construction)

Depending on the water quality results established during initial dewatering monitoring works, a water treatment system may be required during construction, given the excavation and dewatering method. The process diagram for a potential water treatment system is provided in Figure 11-2 below.

The water treatment system may comprise the following elements:

- Sediment Tank;
- Chemically Enhanced Primary Treatment (CEPT) System:
  - Including internal Chemical Dosing Unit for pH Adjustment and Flocculent Dosing

Figure 11-2: Water Treatment Plant Process Diagram

Details of each component of the WTP is provided in the sections below.

11.2.1. Settlement Tank

A suitability sized Sediment Tank will be installed to initially to allow for the heavy suspended particles in waters to settle and also to serve as a balance tank to regulate any inconsistent or irregular flows. The settlement tank allows for a maximum settling time for a continuous flow of water.

11.2.2. Chemically Enhanced Primary Treatment (CEPT) System

Following the initial sedimentation primary treatment, the water is then preferentially piped to a "Chemically Enhanced Primary Treatment (CEPT) System" unit which has an inbuilt dosing and control system provide automatic water treatment.

Physio-chemical processes allow the operator to adjust pH, remove total suspended solids and control heavy metal precipitation. The following sequence of water treatment process is proposed:

- Adjustment of pH; if pH recorded outside a range of 6.5-8.5.
- Chemical dosing with a flocculate (aluminium chloride) to remove fine sediments.

- Following the flocculation process the water flows upwards through a clarifier (similar to lamella box) to further filter suspended matter before discharging through a fabric filter.
- The CEPT is fitted with a flow meter capable of monitoring the total volume of water treated/discharged.

Groundwater monitoring and discharge will be completed in stages to ensure the protection of the receiving water environments.

Prior to any groundwater discharge commencing from the site to stormwater, an initial round of sampling must be conducted during the installation of the dewatering system. All groundwater will be retained onsite until water quality objectives have been achieved.

Once groundwater discharge water quality objectives are demonstrated to be achieved (which may require modifications to the dewatering systems or implementation of water treatment technologies if required), continuous discharge may occur in accordance with the DMP.

11.2.3. Contingency Water Treatment Equipment

Where the above procedures prove ineffective at decreasing concentrations of dissolved and/or total metals or other contaminants to appropriate levels, the inclusion of the following procedures in the treatment train may be recommended:

- Media Filtration Units to remove additional sediment loads to target any suspended heavy metal particulate, as well as removal of dissolved heavy metals via ionic exchange;
- pH/Eh Modification to maximum metal precipitation/flocculation;
- Air-stripping unit or Granulated Activated Carbon (GAC) unit to target any dissolved phase TPH/VOC contamination.

The role of the Media Filtration units (if required) will be to provide secondary water treatment for the removal of any residual heavy metals from the water. The Media Filtration Units may encompass a combination of sand and ionic resin units. The sand media will be appropriately sized to remove fine suspended particular matter and any bound heavy metals. The ionic resin media will be selected based on the particular heavy metal chemical properties, which will remove targeted dissolved heavy metals from the water stream through adsorption and ionic exchange. The rate of heavy metal removal will be dependant on the residence time of the water within the vessel.

The role of pH modification is to utilise the heavy metal geochemistry to change dissolved metals to insoluble precipitates by modifying pH and Eh. Certain metals will form mineral complexes under specific pH/Eh conditions, which are then able to be removed from the water stream as particulate through flocculation and coagulation process. Following removal of the heavy metals, the treated water pH/Eh is then adjusted back to within the adopted discharge criteria. This process can be enhanced through Media Filtration.

The role of the air strippers is to volatilise dissolved volatile contaminants, removing them from the groundwater influent stream. The vapour phase contaminants are captured and diverted through external GAC hoppers where they are sorbed. Treated groundwater influent then undergoes tertiary polishing treatment to remove any remaining dissolved phase hydrocarbons and reduce background heavy metals through particulate filtration. This is achieved via filtration of the groundwater influent through GAC and ion exchanging media filtration vessels via the process of adsorption and ion exchange.

Initial monitoring of discharge water quality shall provide the information required to optimise the water treatment regime.

Any addition of chemical agents must be managed by a suitably qualified environmental scientist and the chemicals approved for use by the NSW EPA. Intensive monitoring of treatment agent dose rates and discharge water quality must be untaken to optimise the water treatment regime specific to the site.

11.2.4. Maintenance of Water Treatment System

Routine maintenance of the treatment equipment will be required to ensure optimum performance. The discharge pipeline and any protective structures, such as driveway ramps/culverts, must be checked for leaks and damage on a regular basis. Retention structures must also be inspected regularly to ensure adequate performance and structural integrity.

Chemical treatment and settlement is likely to result in the retention of organic and/or inorganic material. Removal of the accumulated material will be required periodically to avoid re-suspension of accumulated sediment and reduction of treatment system capacity. Strategies to limit the volume of waste to be removed should be developed in consultation with the project environmental consultant.

12. Water Quality Monitoring Program

Monitoring of the discharge water will be completed for the estimated 12 month duration of the dewatering activities in accordance with the monitoring schedules below.

All monitoring of water quality will be completed by a suitably qualified person, using calibrated equipment to collect samples that are representative of the discharge and analysis completed by a NATA accredited laboratory.

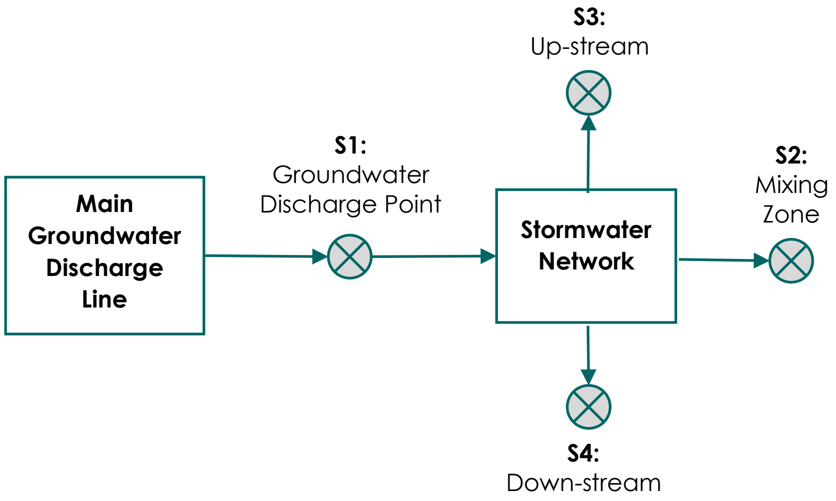
Council must be notified of any results received that indicate an adverse environmental impact within 24 hours of results being obtained.

Monitoring of the discharge water will be completed for the estimated 12 month duration of the construction dewatering activities in accordance with the monitoring schedules below. All monitoring of water quality will be completed by a suitably qualified person, using calibrated equipment to collect samples that are representative of the discharge.

Specifications set out in the dewatering and discharge licence (if any) will outline the specific frequency of assessment, an interim sampling and monitoring program is outlined below.

12.1. Water Quality Monitoring Locations

Water quality samples will be collected from the following locations as presented in the flow chart below.



The following descriptions of the sampling locations are provided below:

- S1: Groundwater Discharge Point:
  - A sample of the groundwater discharge prior to discharge into the stormwater drain. The sample will be collected directly from the main groundwater discharge line, representing the water quality following final treatment.
- S2: Stormwater Channel – Mixing Zone:
  - A sample of the receiving waters at the mixing zone boundary.
- S3: Stormwater Channel – Up-stream:
  - A sample of the receiving waters at a location approximately 100m up-stream from the stormwater discharge point.

- S4: Stormwater Channel / Broad Water Outlet– Down-stream:
  - A sample of the receiving waters at either an accessible location within the stormwater channel or at the discharge point at Dee Why Lagoon.

In the event that groundwater discharge waters (S1) can be demonstrated to consistently meet the adopted DGVs, sampling of the receiving waters at monitoring points S2, S3 and S4 can cease.

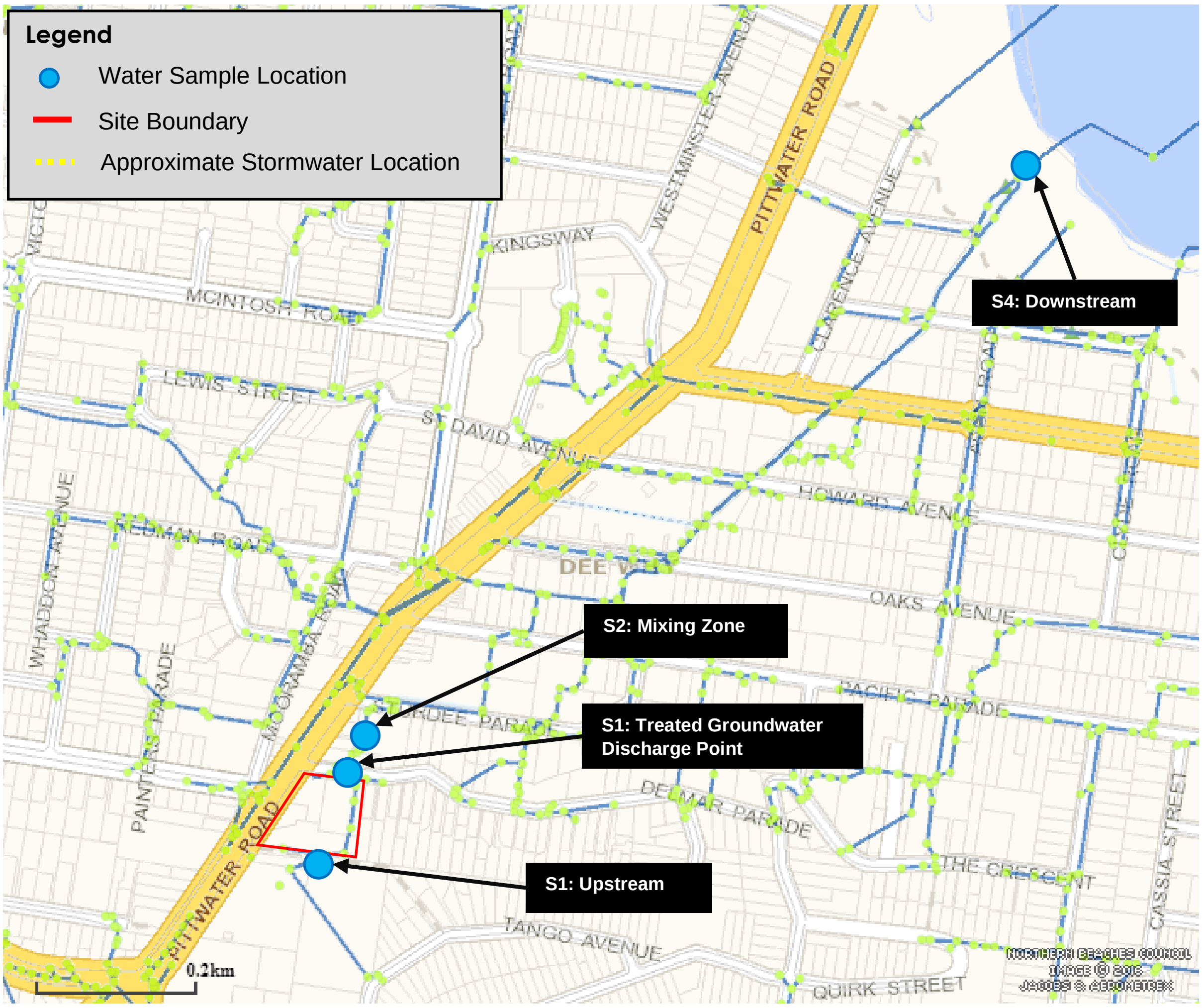


Figure 12-1: Proposed Water Quality Sample Locations

12.2. Water Quality Monitoring Frequency and Analysis

Water quality treatment may be required prior to discharge of the extracted groundwater to the Council stormwater system.

Water quality monitoring would need to be performed prior to commencement of treated water discharge. This monitoring period is defined as the 'Stage 1: Initial Assessment / Trial Run Period' and will allow for assessment of water quality treatment performance, compliance against the adopted discharge criteria, establish if additional water treatment methods are required to achieve discharge criteria and establish background water quality in the event that deviations from the adopted discharge criteria are technically justifiable.

Subsequent ongoing monitoring will also be required to confirm the on-site treatment system is functioning as intended. This monitoring has been segmented into two stages, 'Stage 2: Initial Operational Discharge Monitoring Period' to establish treated water quality trends during continuous discharge, and 'Stage 3: Ongoing Operational Discharge Monitoring Period' with a lower testing frequency to confirm ongoing treatment performance once Stage 2 water quality trends have been established.

The Stage 4 period encompasses the ongoing permanent dewatering requirements as per the NSW DPIE (2021) Minimum Requirements for Building Site Groundwater Investigations and Reporting guidelines.

Council must be notified immediately of any pollution incidents as the regulator (including discharges above the set limits in Table 8-1 to the stormwater and where any unacceptable impact to the receiving waters is identified).

12.2.1. **Stage 1:** Initial Commissioning Assessment / Trial Run Period

An initial sampling program must be conducted during the installation and commissioning of the dewatering pumping and treatment system, prior to any discharge of groundwater form the site. This will enable baseline discharge water quality to be established and determine if the employed level of groundwater treatment is suitable to ensure compliance with the adopted discharge criteria, prior to offsite discharge.

The initial commissioning sampling program should be completed on at least three (3) consecutive sampling events, and at minimum comprise two (2) representative samples, one collected prior to treatment and one collected from the discharge line of the dewatering treatment system.

Representative samples of the receiving waters (S2, S3 and S4) should also be collected to establish baseline/background conditions. This should include at least two (2) baseline sampling events, preferable one during drier periods and one during wetter periods.

The samples must be analysed for all water quality parameters as per below and as listed in Table 12-1.

Daily field monitoring of the following parameters from the inlet and outlet sides of the treatment system.

- pH
- Electrical Conductivity(EC)
- Dissolved oxygen (DO);
- Redox Potential (mV)
- Turbidity (NTU)

As per Appendix A of the NSW DPIE (2021) *Minimum Requirements for Building Site Groundwater Investigations and Reporting* guidelines, discharge water quality samples collected will be submitted for analysis to a NATA accredited laboratory for the following analytes listed in Table 12-1 below.

Table 12-1: List of required laboratory water quality tests and schedule (NSW DPIE 2021 - Appendix A)

Type	Corresponding Laboratory Analysis	Testing Requirement
Physical Parameters	Alkalinity (bicarbonate, carbonate, hydroxide and total), electrical conductivity (EC), pH, redox potential (Eh), total dissolved solids (TDS), total hardness, temperature, dissolved oxygen (DO).	Mandatory
Other Physical Parameters	Turbidity* (NTU), total suspended solids* (TSS), total organic carbon* (TOC), sodium absorption ratio* (SAR)	Mandatory for discharge to any receiving waters
Major Anions	Sulfate (SO4), chloride (Cl), carbonates (CO3), bromide (Br), fluoride (F)	Mandatory
Major Cations	Calcium (Ca), magnesium (Mg), sodium (Na), potassium (K)	Mandatory
Ionic Balance	Cation/Anion balance (as a percentage)	Mandatory
Dissolved Inorganics and Dissolved Heavy Metals	Aluminium (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), boron (B), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), lithium (Li), manganese (Mn), mercury (Hg), molybdenum (Mo), nickel (Ni), selenium (Se), silica (dissolved SiO2), silver (Ag), strontium (Sr), uranium (U), vanadium (V), zinc (Zn)	Mandatory for baseline thereafter negotiable, depending on site setting unless otherwise required by another regulatory body
Nutrients	Ammonia (NH3), nitrate (NO3), total nitrogen (N), oxidised nitrogen (N), total phosphorus (P), reactive phosphorus (P)	Mandatory for baseline thereafter negotiable, depending on site setting unless otherwise required by another regulatory body
Microbiological organisms	Faecal coliforms, faecal streptococci, Escherichia coli	Mandatory for baseline thereafter negotiable, depending on site setting unless otherwise required by another regulatory body
Organics	Benzene toluene ethylbenzene xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs), total recoverable hydrocarbons (TRHs)	Mandatory for baseline thereafter negotiable, depending on site contamination status unless otherwise required by another regulatory body.

Other	Range of analytes relevant to site-specific contaminants of environmental concern: ▪ pesticides (OCPS, OPPs) ▪ polychlorinated biphenyls (PCBs) ▪ semivolatile chlorinated hydrocarbons (SVOCs) and volatile chlorinated hydrocarbons (VOCs) ▪ phenols	As required by the NSW EPA, on the advice of a specialist environmental consultant or as required by another regulatory body.

The sampling frequency should be maintained until the target parameters and chemical concentrations in treated water stabilised (i.e. consecutive tests are within ±10% of the observed results) and within the adopted discharge criteria for three consecutive periods.

Following completion of the initial baseline /trail run monitoring program, an assessment will be completed by a suitability qualified environmental consultant to determine that groundwater discharge will not pose an environmental risk and will not result in adverse environmental effects. If potential unacceptable impact to the receiving waters is identified, contingency groundwater treatment options should be considered and adopted where appropriate.

The Stage 1 Initial Assessment / Trial Run Period may be extended if stabilisation is not observed, or the treated water exiting the treatment system does not satisfy the adopted discharge criteria.

During the Stage 1 Initial Assessment / Trial Run Period, all collected groundwater seepage (including treated waters) must be retained/recirculated on-site and is not permitted to be discharged to Council Stormwater network until it is proven to meet the adopted discharge criteria or considered to not pose an unacceptable risk to the receiving waters.

12.2.2. **Stage 2:** Initial Operational Discharge Monitoring Period

After successful completion of the Stage 1 Trial Run period, treated groundwater may be continuously discharge directly to the Council Stormwater system.

A daily sampling frequency of the S1 discharge waters for a 2 week period is recommended during the Stage 2 Initial Operational Discharge of the onsite water treatment system.

The daily sampling program should at minimum comprise two (2) representative samples, one collected prior to treatment and one collected from the discharge line of the dewatering treatment system.

Representative samples of the receiving waters (S2, S3 and S4) should also be collected to establish background conditions and allow assessment of any impact from the discharge.

The samples must be analysed for all water quality parameters as per below and as listed in Table 12-1 above.

The daily sampling frequency should be maintained for a minimum of 2 weeks, until the target parameters and chemical concentrations in treated water stabilised (i.e. consecutive tests are within ±10% of the observed results) and within the adopted discharge criteria for five consecutive days.

Following completion of the initial operational period, an assessment will be completed by a suitability qualified environmental consultant to determine that groundwater discharge is not posing an environmental risk and is not resulting in adverse environmental effects. If an unacceptable impact to the receiving waters is identified, discharge of groundwater must stop and contingency groundwater treatment options should be considered and adopted where appropriate.

Council must be notified immediately of any pollution incidents as the regulator (including discharges above the set limits in Table 8-1 to the stormwater and where any unacceptable impact to the receiving waters is identified).

12.2.3. **Stage 3:** Ongoing Operational Discharge Monitoring Period

After successful completion of the Stage 2 Initial Operation Discharge period, treated groundwater may be continuously discharged directly to the Council Stormwater system.

Daily monitoring of pH and Turbidity of the Treated Discharge Waters (S1) must be maintained throughout the dewatering process. Daily field monitoring of the following parameters from the inlet and outlet sides of the treatment system.

- pH
- Turbidity (NTU)

The sampling program should at minimum comprise two (2) representative samples, one collected prior to treatment and one collected from the discharge line of the dewatering treatment system.

Representative samples of the receiving waters (S2, S3 and S4) should also be collected to establish background conditions and allow assessment of any impact from the discharge.

Weekly water samples will be collected from the dewatering discharge point during the active construction dewatering and discharge activities, as listed in Table 12-1 above.

The weekly sampling frequency should be maintained for the remainder of the dewatering and discharge program.

Monthly groundwater sampling is also required from the three (3) groundwater monitoring wells, with laboratory testing as per Table 12 1 above.

Results of the monitoring must be reviewed by the appointed environmental consultant on a weekly basis to determine that groundwater discharge is not posing an environmental risk and is not resulting in adverse environmental effects. If an unacceptable impact to the receiving waters is identified, discharge of groundwater must stop and contingency groundwater treatment options should be considered and adopted where appropriate.

Council must be notified immediately of any pollution incidents as the regulator (including discharges above the set limits in Table 8-1 to the stormwater and where any unacceptable impact to the receiving waters is identified).

12.2.4. **Stage 4:** Partially Drained Basement Permanent Dewatering

As the proposed partially drained basement development is not watertight enough to prevent all groundwater inflow, the following monitoring schedules apply for the period that the proposed development will be taking groundwater:

- monthly in situ field water quality measurements and determinations using a calibrated handheld water quality meter of both groundwater and discharge water; this must include a minimum of electrical conductivity (specific conductance at 25°C), temperature, pH and redox potential.

- monthly meter readings with dates and times of measurement (to monitor annual discharge volumes and average flow rates and confirm ongoing correct functioning of the installed meter).

NSW DPIE requires developers and consultants to incorporate these schedules and specific annual reporting arrangements to the relevant agency (WaterNSW or NRAR) into a documented building management system for the property. This way, the actual take can be determined at any time during the life of the building (typically 100 years).

12.3. Water Sample Collection

Discharge and receiving waters will be analysed in the field using a calibrated water quality meter to assess the EC, DO, pH, Turbidity, ORP and Temperature.

Water samples will be taken directly from the discharge line sample ports or using a surface water grab sampler for the remaining analytes mentioned in Section 12.2 above.

Samples are to be placed directly into appropriately preserved, laboratory supplied sampling containers, labelled with the project identification, sample name/location, sample date and who collected the sample. Samples for dissolved heavy metal analysis shall be field filtered using 0.45um disposable filters.

Once samples are obtained, they are to be stored and transported in an ice cooled Esky to the laboratory under a chain-of-custody (CoC).

12.4. Monitoring of Discharge Flow Rate, Groundwater Drawdown and In-situ Groundwater Quality

Discharge flow rates, as well as groundwater levels and groundwater quality outside the excavation shall be monitored in general accordance with the NSW DPIE (2021) Minimum Requirements for Building Site Groundwater Investigations, as per Table 12-2 below.

Table 12-2: Monitoring Programme for Discharge Flow Rates and Groundwater Levels

Parameter	Location	Frequency
Discharge Rates and Volumes	Calibrated flow meter (eg. inline Magflow meter) on discharge pipeline	**Daily**
Groundwater Level	From three (3) groundwater monitoring wells located outside the excavation.	**Daily:** For 2 weeks prior to dewatering commencement. During the entire dewatering period For a minimum of two months following the cessation of pumping.
Groundwater In-situ Quality Measurements: ▪ electrical conductivity (specific conductance at 25°C), ▪ temperature, ▪ pH; and ▪ eduction-oxidation (redox) potential	From three (3) groundwater monitoring wells located outside the excavation.	**Weekly:** For 2 weeks prior to dewatering commencement. During the entire dewatering period For a minimum of two months following the cessation of pumping.
Groundwater Quality Testing: As per Table 12-1		**Monthly:** At least 2 sampling rounds prior to dewatering to establish baseline conditions.

12.5. Contingencies

Based on the above proposed management and mitigation measures to be employed during the dewatering activities, the DMP should be effective to manage the potential impacts, however contingent actions may be required should the scenarios listed below arise.

Table 12-3: Mitigation Measures for Potential Dewatering Issues

Potential Scenario	Mitigation Measures
Treated water does not achieve the adopted discharge criteria following completion of the Stage 1 monitoring period.	Implementation/adjustment of physical and/or treatment processes and/or installation of larger retention structures should be completed. As per Section 11.2.3, additional water treatment measures may include Media Filtration Units (Sand, GAC or Ionic Resins), Air-stripping Units or pH/Eh modification. Once additional treatment technologies are installed, the Stage 1 monitoring period should be repeated to confirm that the adopted discharge criteria will be achieved. Council must be notified immediately of any pollution incidents as the regulator (including discharges above the set limits in Table 8-1 to the stormwater and where any unacceptable impact to the receiving waters is identified).
During the Stage 2 and Stage 3 monitoring periods, if quality of treated water does not meet the adopted discharge criteria.	Discharge to the stormwater system must be suspended, tail water should be retained onsite and stored in appropriate bulk containers for further on-site treatment and sampling until it is proven to mee the adopted discharge criteria. If unexpected monitoring results indicate that the quality of the receiving water has changed (as a direct result of the dewatering activities), modification of management practices must be implemented, including up-scaling of the treatment measures. Implementation/adjustment of physical and/or treatment processes and/or installation of larger retention structures should be completed as an initial procedure to mitigate unacceptable levels of chemical contaminants (e.g. dissolved heavy metals, petroleum hydrocarbons, VOCs or pesticides). Where increased dissolved oxygen of the discharge waters is required, an aerator should be installed within the treatment line. Where implemented contingencies prove ineffective at mitigating risks to the receiving water way, ceasing dewatering may be the only options until such time that other management techniques can be applied. To avoid potential damage to the constructed basement in such a situation, consideration should be given to obtaining an Emergency Permit to discharge to sewer with Sydney Water.

	Otherwise, it may be necessary to have collected waters removed by a licenced liquid waste contractor should quantities accumulate beyond the onsite storage capacity. Council must be notified immediately of any pollution incidents as the regulator (including discharges above the set limits in Table 8-1 to the stormwater and where any unacceptable impact to the receiving waters is identified).
The treated groundwater quality cannot satisfy the nominated discharge criteria.	Should all feasible onsite water treatment options become exhausted, application to Council for a Trade Waste Licence could potentially be obtained for discharge to sewer. Alternatively, an Environmental Protection Licence (EPL) may be applied for with the NSW EPA for direct discharge into Broad Water.
Excessive groundwater drawdown (>1m), as determined by geotechnical/ structural engineer, resulting in unacceptable offsite settlement.	If offsite drawdown is <1.0m but approaching 1.0m is identified in the monitoring points outside the CSM / D-Wall, or if groundwater quality is observed to change beyond 'pre-dewatering' baseline conditions, consideration should be given to control of the off-site water table depression through re-injection. This is likely to have in implication on the costs of the project but is recommended in order to reduce the risk of damage to adjacent buildings and roadways. The primary control method of reinjection would require some injection well/ spearpoints to be installed outside the site boundary CSM / D-Wall, and may require a variation to the dewatering licence obtained from the WaterNSW / NRAR. **If groundwater drawdown exceeds levels >1.0m, immediately cease dewatering and contact hydrogeologist, geotechnical engineer and structural engineer.**

12.6. Principal Contractor Inspection Requirements

The Principal Contractor will be responsible for the following inspection activities and reporting requirements:

- Perform daily visual inspection of groundwater discharge stream at the stormwater connection point for any signs of unexpected conditions (e.g. discolouration, odours, sheens, oils, sediment);
- Routine maintenance of the groundwater dewatering system will be required to ensure optimum performance. The discharge pipeline and any protective structures, such as driveway ramps/culverts, must be checked for leaks and damage on a regular basis. Retention structures must also be inspected regularly to ensure adequate performance and structural integrity;
- Record and report any incidents of poor drainage, uncontrolled discharge or spills within the basement drainage system capture zone. Groundwater discharge must be

immediately suspended in the event of any spills or environmental incidents and immediately reported to a suitability qualified environmental consultant. Groundwater discharge must not re-commence until discharge quality can be demonstrated to not result in unacceptable adverse environmental impact;

- Maintain erosion and sediment control measures in a functioning condition until all earthwork activities are completed;
- Devise ana implement appropriate remedial measures where any controls or devices are not functioning effectivity or are inappropriate;
- The site manager will maintain records and comments on the condition of existing erosion and run-off controls (drains, silt fences, catch drains etc) dewatering procedures and test results, discharge rates and volumes, groundwater level and pH measurements, and any site instruction issued to contractors to undertake works on the dewatering and treatment equipment;
- Maintain rainfall data, to be filled onsite.
- All daily inspection reports, environmental incidents and controlled discharge records will be maintained and the information provided within monitoring assessment reports.
- Council must be notified immediately of any pollution incidents as the regulator (including discharges above the set limits in Table 8-1 to the stormwater and where any unacceptable impact to the receiving waters is identified).

13. Records and Reporting

The Principal Contractor shall maintain a record of all water quality and groundwater level monitoring, along with details of corrective and preventative actions implemented in relation to the dewatering activity. The following reports shall be prepared:

- Stage 1 & 2: A weekly (interim) report issued upon receipt of laboratory analysis results that identifies potential compliance issues or water quality impacts that require immediate action, and other recommended preventive/corrective actions
- Stage 3: Fortnightly dewatering report summarising the water quality data and management strategies implemented during the entire works. The report shall include a summary of discharge and receiving waters quality results, a statistical appraisal of the data, control charts showing quality results, a compliance assessment, indications of potential environmental harm, and comments and/or corrective actions implemented during the works.

The following information must be maintained and may be required to be submitted to WaterNSW / NRAR on completion of dewatering as part of "Completion Report" within six months of completion of dewatering:

- Volume of groundwater pumped, the volume discharged offsite (and/or reinjected if applicable), the discharge / reinjection rate and the duration of pumping;
- Groundwater level monitoring data and water table map depicting the aquifer's settled groundwater conditions and a comparison to the baseline conditions;
- All water quality monitoring data including results of any water quality testing;
- Location and construction of groundwater extraction works that are abandoned after dewatering has ceased; and
- A detailed interpreted hydrogeological report identifying all actual resource and third party impacts, including an assessment of altered groundwater flows and an assessment of any subsidence or excessive settlement induced in nearby buildings and property and infrastructure.

Reditus note that if approval is granted under the WMA 2000, an application for a "new water access licence with a zero share component" will typically be needed to be completed and a suitable groundwater entitlement will also need to be obtained from the market to account for the groundwater take during the construction phase (as total groundwater take during construction is predicted to be **8.22ML**). This entitlement must be obtained from within the same groundwater source. This will typically need to be obtained within three months of granting of the Zero Access Licence.

Once construction is complete, the long-term groundwater take through the Drained Basement design was predicted to be **2.39ML/yr**. Works or activities that intersect or interfere with groundwater systems and where take is incidental to the primary purpose of the activity, or where there is no take, are managed as aquifer interference activities. Aquifer interference activities taking 3ML or less of groundwater per year are exempt from requiring a Water Access Licence (WAL). As such, a WAL will not be required following completion of construction.

14. References

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NSW DPI (2018) Assessing Groundwater Applications Water Resource Plans Fact Sheet

NSW DPIE (2021) Minimum Requirements for Building Site Groundwater Investigations and Reporting

15. Limitations

The report or document does not purport to provide legal advice and any conclusions or recommendations made should not be relied upon as a substitute for such advice.

This report is based on the Scope of Work outlined in Section 1.2. Reditus prepared this report in a manner consistent with the normal level of care and expertise exercised by members of the environmental and hydrogeological assessment profession.

The report does not constitute a recommendation by Reditus for the client (Landmark Group Australia Pty Ltd) or any other party to engage in any commercial or financial transaction and any decision by the client or other party to engage in such activities is strictly a matter for the client.

The report relies upon data, surveys, measurements and results taken at or under the site at particular times and conditions specified herein. Any findings, conclusions or recommendations only apply to the aforementioned circumstances and no greater reliance should be assumed or drawn by the client. Furthermore, the report has been prepared solely for use by the client and Reditus accepts no responsibility for its use by other parties. The client agrees that Reditus' report or associated correspondence will not be used or reproduced in full or in part for promotional purposes and cannot be used or relied upon by any other individual, party, group or company in any prospectus or offering. Any individual, party, group or company seeking to rely this report cannot do so and should seek their own independent advice.

No warranties, express or implied, are made. Subject to the scope of work undertaken, Reditus assessment is limited strictly to identifying typical environmental conditions associated with the subject property based on the scope of work and testing undertaken and does not include and evaluation of the structural conditions of any buildings on the subject property or any other issues that relate to the operation of the site and operational compliance of the site with state or federal laws, guidelines, standards or other industry recommendations or best practice. Scope of work undertaken for assessments are agreed in advance with the client and may not necessarily comply with state or federal laws or industry guidelines for the type of assessment conducted.

Additionally, unless otherwise stated Reditus did not conduct soil, air or wastewater analyses including asbestos or perform contaminated sampling of any kind. Nor did Reditus investigate any waste material from the property that may have been disposed off the site, or undertake and assessment or review of related site waste management practices.

The results of this assessment are based upon (if undertaken as part of the scope work) a site inspection conducted by Reditus personnel and/or information from interviews with people who have knowledge of site conditions and/or information provided by regulatory agencies. All conclusions and recommendations regarding the property are the professional opinions of the Reditus personnel involved with the project, subject to the qualifications made above.

While normal assessments of data reliability have been made, Reditus assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside of Reditus, or developments resulting from situations outside the scope of this project/assessment.

Reditus is not engaged in environmental auditing and/or reporting of any kind for the purpose of advertising sales promoting, or endorsement of any client's interests, including raising investment capital, recommending investment decisions, or other publicity purposes. Reditus assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside of Reditus, or developments resulting from situations outside the scope of this project.

Information relating to soil, groundwater, waste, air or other matrix conditions in this document is considered to be accurate at the date of issue. Surface, subsurface and atmospheric conditions can vary across a particular site or region, which cannot be wholly defined by investigation. As a result, it is unlikely that the results and estimations presented in this report will represent the extremes of conditions within the site that may exist. Subsurface conditions including contaminant concentrations can change in a limited period of time and typically have a high level of spatial heterogeneity.

From a technical perspective, there is a high degree of uncertainty associated with the assessment of subsurface, aquatic and atmospheric environments. They are prone to be heterogeneous, complex environments, in which small subsurface features or changes in geologic conditions or other environmental anomalies can have substantial impact on water, air and chemical movement.

Major uncertainties can also occur with source characterisation, assessment of chemical fate and transport in the environment, assessment of exposure risks and health effects, and remedial action performance. These factors make uncertainty an inherent feature of potentially impacted sites. Technical uncertainties are characteristically several orders of magnitude greater at impacted sites than for other kinds of projects.

All groundwater models include some degree of uncertainty in their predictions as they are, by necessity, simplifications of complex real world systems. Whilst every effort is made to ensure that the primary model reflects the best-case, most-likely case and upper-case understanding of site conditions, this cannot be guaranteed and any model result presented as a single number should be viewed with a degree of caution.

Factors which significantly affect the groundwater model and impact assessment results include dewatering rate, dewatering design, dewatering period, aquifer characteristics and degree of aquifer variability (including hydraulic conductivity, specific yield/ storativity, porosity, recharge, heterogeneity).

Reditus' professional opinions are based upon its professional judgment, experience, and training. These opinions are also based upon data derived from the limited testing and analysis described in this report or reports reviewed. It is possible that additional testing and analysis might produce different results and/or different opinions or other opinions. Reditus has limited its investigation(s) to the scope agreed upon with its client. Reditus believes that its opinions are reasonably supported by the testing and analysis that has been undertaken (if any), and that those opinions have been developed according to the professional standard of care for the environmental consulting profession in this area at this time. Other opinions and interpretations may be possible. That standard of care may change and new methods and practices of exploration, testing and analysis may develop in the future, which might produce different results.

Appendix A - Figures

Map

21181_rp02_f01_siteloc_v01

Date of Export

24/05/2022

Author	**Approver**
KS	LD

Data Source

Metromap, Google Maps, Open Street Map, NSW Government

Legend

▭ Approximate Site Boundary

▨ Surface Water

— Major Roads

— Railways

— Rivers

— Streams

— Minor Channels

Figure 1 - Site Location

4 Delmar Parade & 812 Pittwater Rd, Dee Why, NSW

21181 - Dewatering Management Plan

Willow Frank

Map	
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Date of Export	Map Scale (approx. at A3)
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Author	Approver
KS	LD
Data Source	
Metromap, Google Maps, Open Street Map, Geoscience Australia	

Legend

☐ Approximate Site Boundary

🟥 Basement Footprint

Borehole and Well Locations

⊕ Borehole

⊕ Groundwater Monitoring Well

Figure 2 - Borehole and Groundwater Monitoring Well Locations

4 Delmar Parade & 812 Pittwater Rd, Dee Why, NSW

21181 - Dewatering Management Plan

Willow Frank

Figure 3a
Inferred Groundwater Level Cross Section

4 Delmar Parade and 812 Pittwater Road, Dee Why
Dewatering Management Plan
21181

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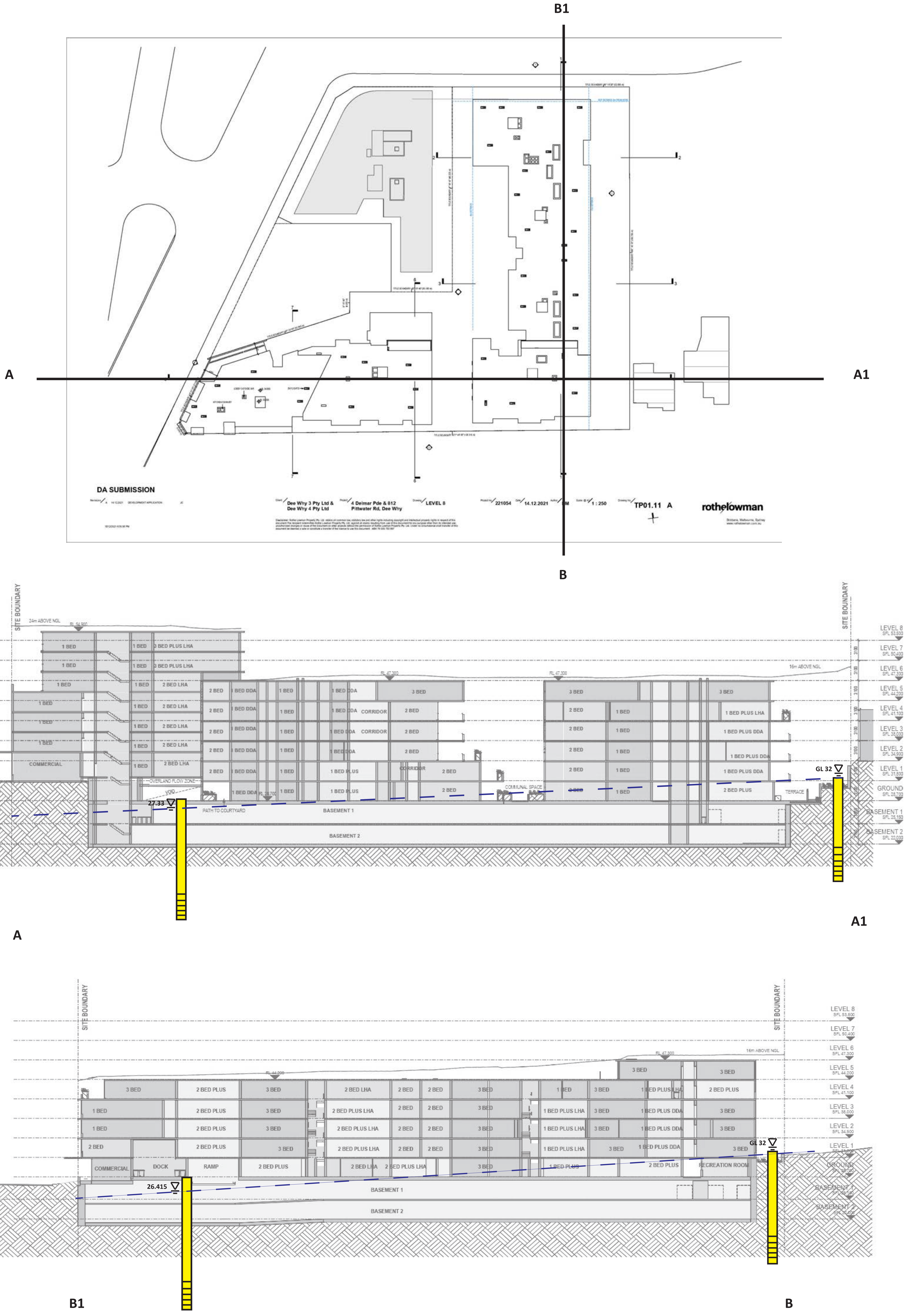


Figure 3b
Conceptual Cross-Section of Dewatering (Transect A-A1)

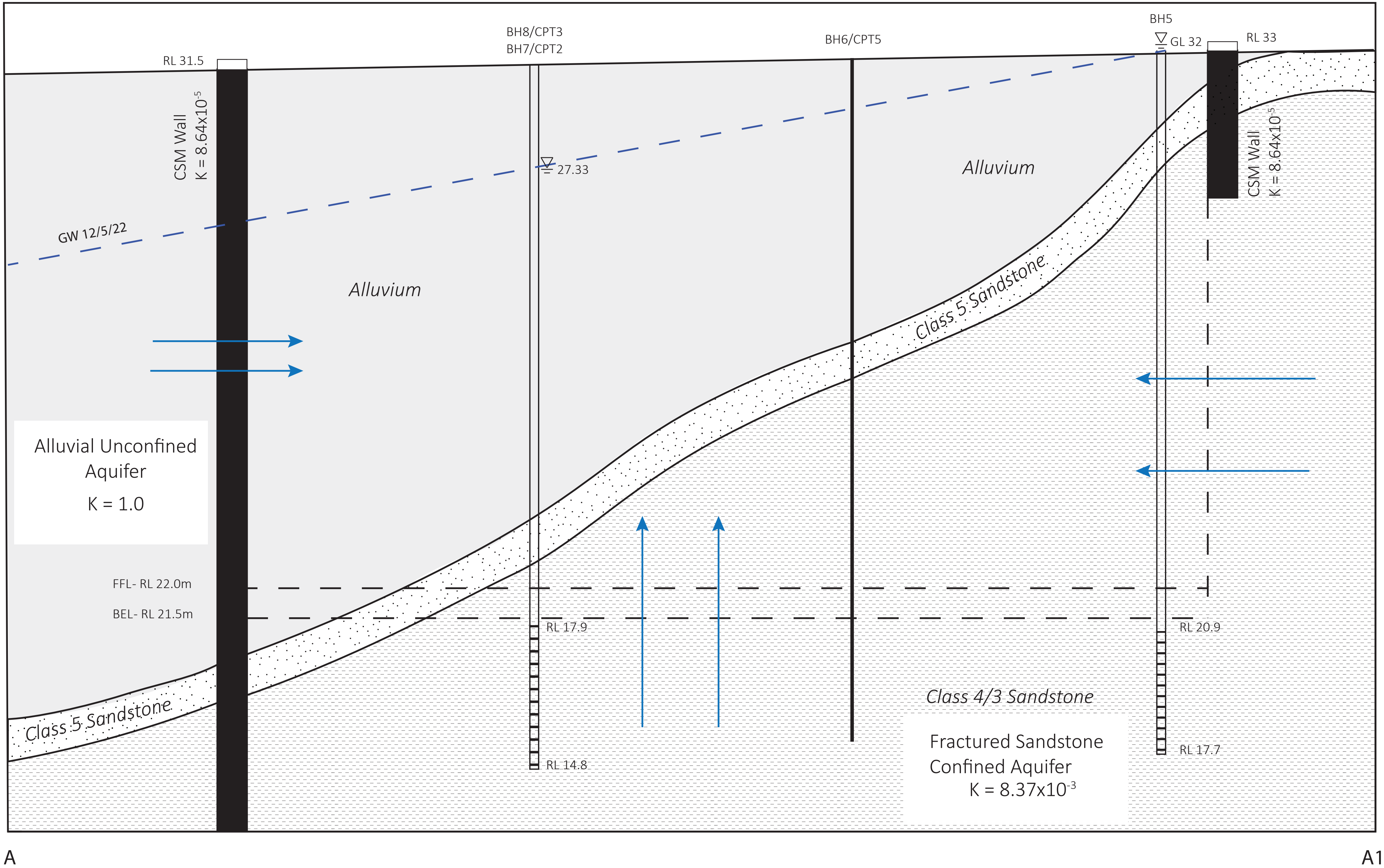
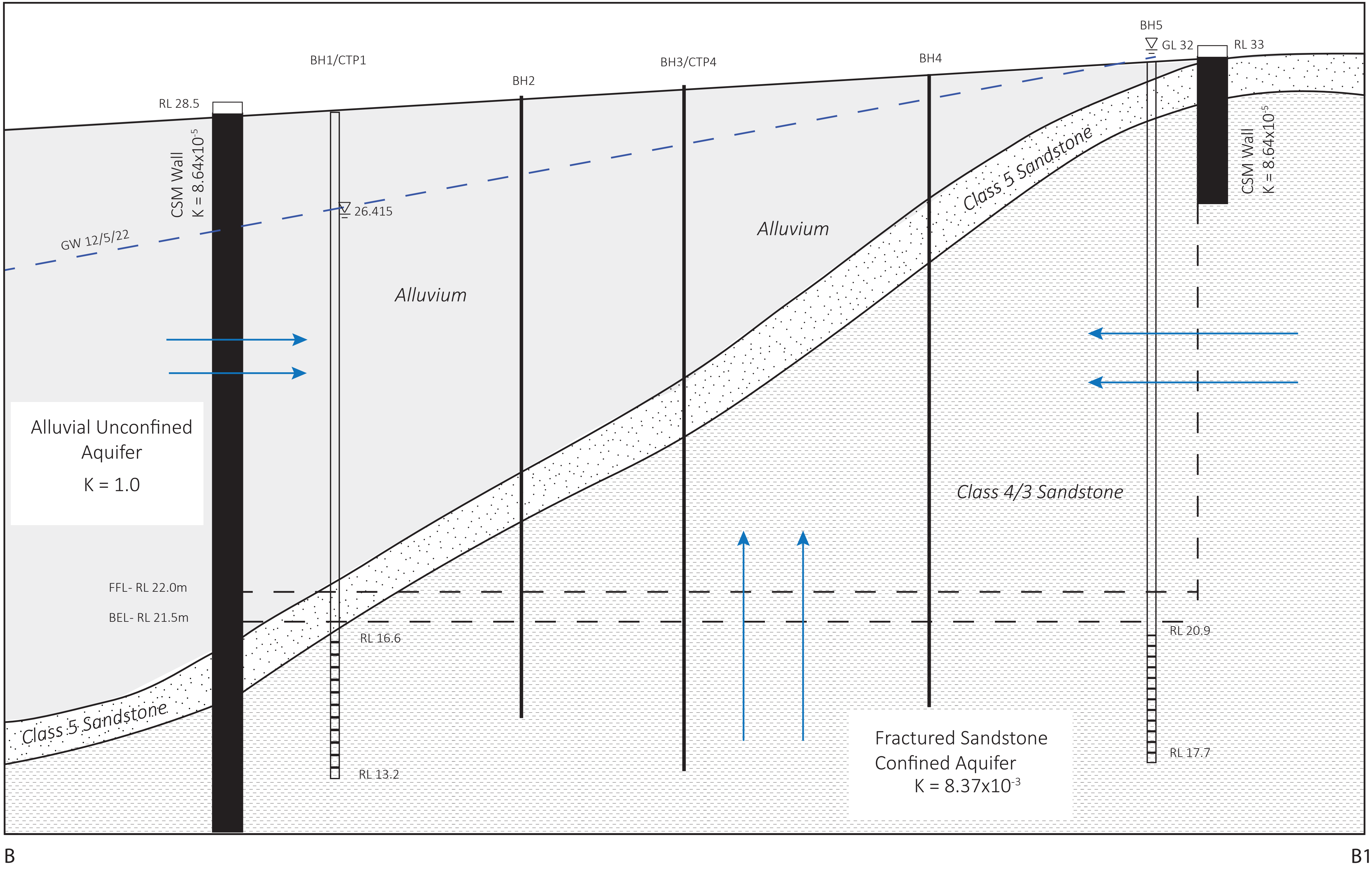


Figure 3c
Conceptual Cross-Section of Dewatering (Transect B-B1)

4 Delmar Parade and 812 Pittwater Road, Dee Why
Dewatering Management Plan
21181



Map

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Author	**Approver**
KS	LD

Data Source

Metromap, Google Maps, Open Street Map, Geoscience Australia

Legend

- ▭ Approximate Site Boundary
- 🟥 Basement Footprint
- ⇒ Groundwater Flow Direction
- — Groundwater Contour Intervals (1m interval) - mAHD

Well Locations

- ⊕ Groundwater Monitoring Well

Figure 4 - Groundwater Flow Direction (20/10/21)

4 Delmar Parade & 812 Pittwater Rd, Dee Why, NSW

21181 - Dewatering Management Plan

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Map	
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Date of Export	**Map Scale (approx. at A3)**
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Author	**Approver**
KS	LD
Data Source	
Metromap, Google Maps, Open Street Map, Geoscience Australia	

Legend

🟥 Basement Footprint

⬛ Approximate Site Boundary

⇒ Groundwater Flow Direction

— Groundwater Contour Intervals (1m interval) - mAHD

Well Locations

⊕ Groundwater Monitoring Well

Figure 5 - Groundwater Flow Direction (12/05/22)

4 Delmar Parade & 812 Pittwater Rd, Dee Why, NSW

21181 - Dewatering Management Plan

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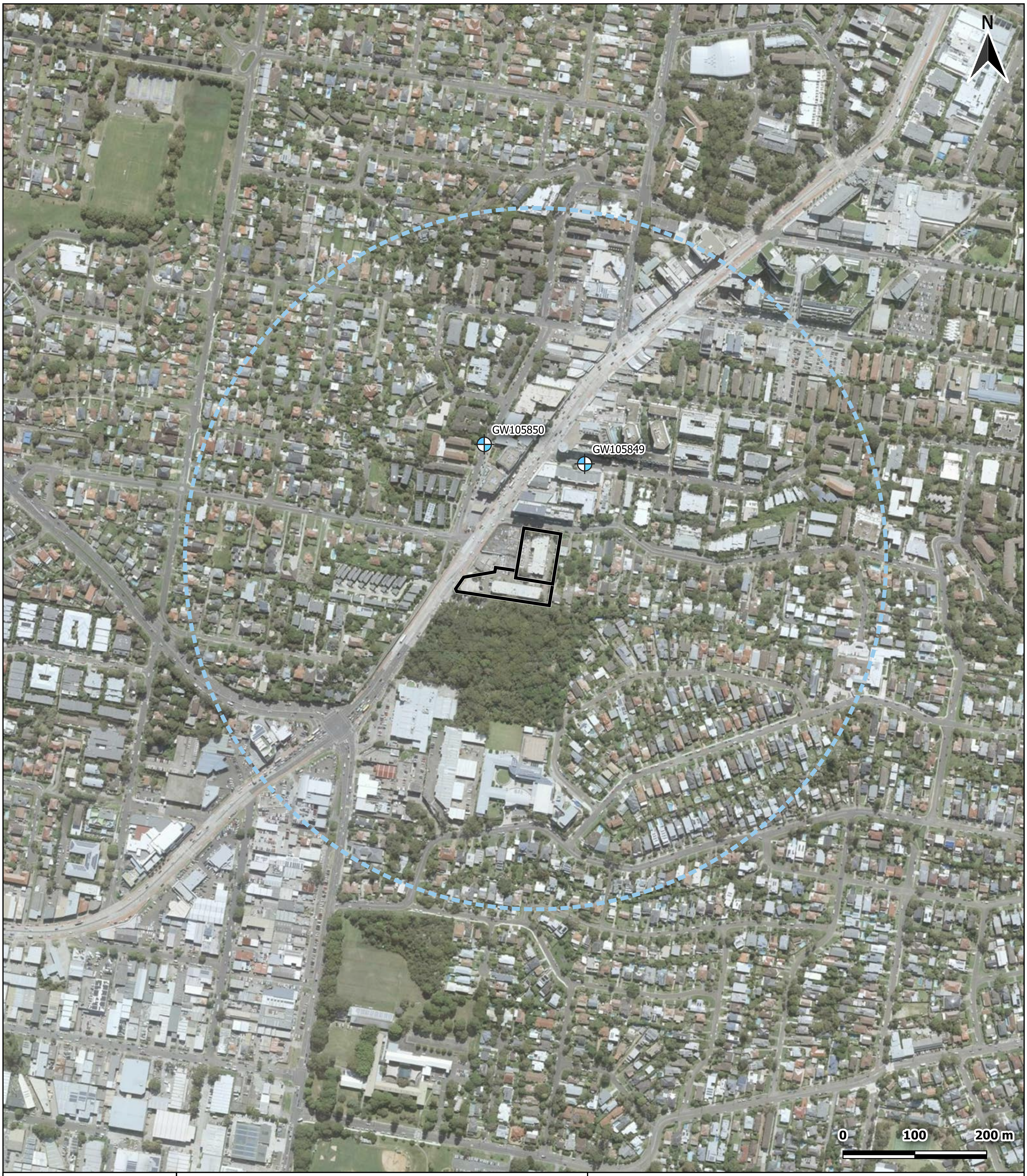

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Author	**Approver**
KS	LD
Data Source	
Metromap, Google Maps, Open Street Map, Geoscience Australia	

Legend

▭	Approximate Site Boundary
⊕	NSW BOM GW Bores - April 2022

Figure 6 - NSW Registered Groundwater Bores (500m radius)

4 Delmar Parade & 812 Pittwater Rd, Dee Why, NSW

21181 - Dewatering Management Plan

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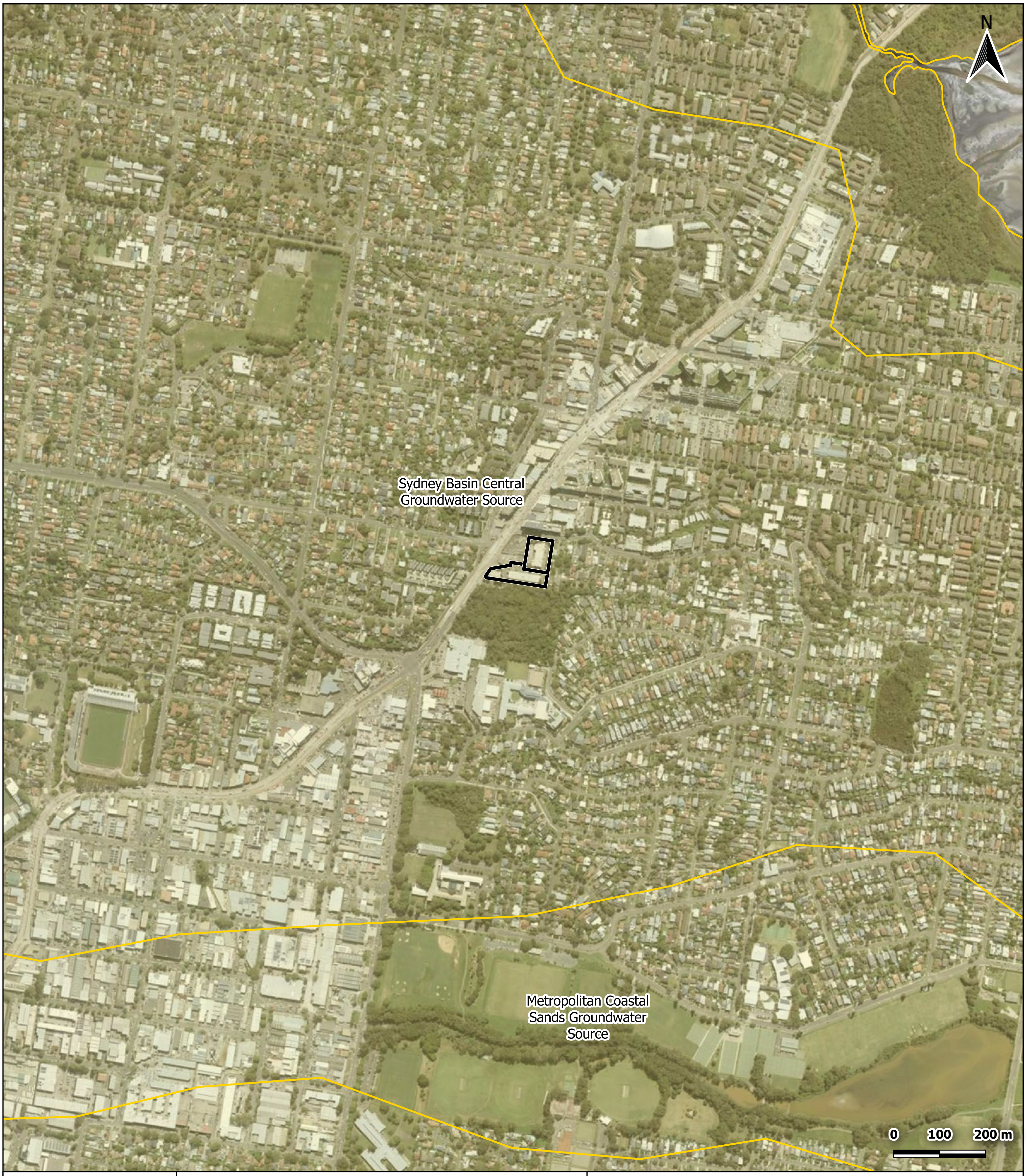

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KS	LD
Data Source	
Metromap, Google Maps, Open Street Map, Geoscience Australia	

Legend

▢ Approximate Site Boundary

🟨 AU BOM GW Sharing Plans

Figure 7 - BOM GW Sharing Plans

4 Delmar Parade & 812 Pittwater Rd, Dee Why, NSW

21181 - Dewatering Management Plan

Willow Frank

Appendix B – Development Application Drawings

TP00.00	COVER SHEET	A
TP00.02	DEMOLITION PLAN	A
TP00.03	SITE SURVEY PLAN	A
TP00.04	SITE PLAN	A
TP00.05	SITE ANALYSIS PLAN	A
TP00.06	SUBDIVISION PLAN	A
TP00.07	BULK EXCAVATION DIAGRAM	A
TP01.01	BASEMENT 2	A
TP01.02	BASEMENT 1	A
TP01.03	GROUND	A
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TP01.05	LEVEL 2	A
TP01.06	LEVEL 3	A
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TP01.08	LEVEL 5	A
TP01.09	LEVEL 6	A
TP01.10	LEVEL 7	A
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TP02.06	SITE ELEVATIONS	A
TP03.01	SECTIONS	A
TP03.02	SECTIONS 2	A
TP05.01	SHADOW ANALYSIS - POV	A
TP05.02	SHADOW ANALYSIS - POV	A
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TP10.01	DEVELOPMENT SUMMARY	A
TP12.01	NOTIFICATION - SITE PLAN	A
TP12.02	NOTIFICATION - NORTH ELEVATION	A
TP12.03	NOTIFICATION - SOUTH ELEVATION	A

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Client / **Dee Why 3 Pty Ltd & Dee Why 4 Pty Ltd**

Project / **4 Delmar Pde & 812 Pittwater Rd, Dee Why**

Drawing / **COVER SHEET**

Project No / **221054**

Date / **14.12.2021**

Author / **SJ**

Scale @ A3 /

Drawing No / **TP00.00 A**

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Demolition Notes

Contractor to confirm existing conditions on site.

Contractor to demolish existing structure/remove all materials. Cut and seal services as required in accordance with local authority requirements and a.s. codes for that trade u.n.o

Protection of works as required by local authorities

Cleaning of site to epa requirements by contractor

Asbestos
Contractor to allow for complete demolition & removal of all asbestos products. All asbestos products to be removed & handled as per relevant Australian standards

Extent of demolition works as indicated on this drawing & heritage consultants drawings & specifications, including but not limited to the following:

Removal/demolition of all existing floor/slabs & footings, external and internal walls, windows, doors, cladding, gutters, downpipes, rainwater heads, cappings, flashing gutter board supports etc. u.n.o

Removal/demolition of all existing works including but not limited to external steps, paths, carparks, planters & landscaping, gates, fences, garden walls, retaining walls, bollards, light blades signs, columns etc. u.n.o

Removal/demolition of all existing fixtures and fittings including but not limited to lights, taps, basins, wcs etc. Disconnection & removal of existing services to be undertaken by appropriate contractors

Contractor to make good damage to adjoining buildings, pavement, laneways, roads, fences, kerbs, channels, services, street furniture, carspace markings etc. (ie. Any adjoining objects/materials not within site boundary) resulting from demolition works.

All repairs to authority requirements or to condition prior to demolition. Contractors are responsible for relocation and co-ordination of road carparking markings, ticket machines etc.

Preliminary
Precautionary measures to be undertaken as described in AS.2601-2001. A "hazardous substances management plan" is to be implemented before and during demolition. If the preliminary investigation of the building identifies any hazardous materials contained therein. These materials will be removed as per the guidelines of the responsible authority and clearance certificate obtained before demolition commences.

Safety fencing
Security fences shall be provided to the street boundary of the demolition site and any additional precautionary measures, taken as may be necessary to prevent unauthorised entry to the site, where the demolition site adjoins a public thoroughfare the common boundary between them shall be fenced for its full length with a hoarding unless the least horizontal distance between the common boundary and the nearest part of the structure is greater than twice the height of the structure. The fencing shall be the equivalent of the chain wire as specified in AS.1725

Notices lettered in accordance with AS.1319 and displaying the words "warning demolition in progress", or similar, shall be fixed to the fencing at appropriate places to warn the public. Provision shall be made for ready access to the site by emergency services personnel in the event of fire or accident.

Demolition work
Structures shall be demolished in the reverse order to that of their construction. The order of demolition for buildings shall be progressive, storey by storey, having proper regard to the type of construction. No part of any structure shall be left unsupported or unattended in such a condition that it may collapse or become dangerous. Precautions shall be taken to ensure that the stability of all parts of the structure, and the safety of persons on and outside the site, will be maintained in the event of sudden and severe weather changes.

Walls on the boundaries are to be demolished in a safe and workmanship like manner. Walls shall not be laterally loaded by accumulated debris or rubble, to the extent that they are in danger of collapse, allowable loading of the suspended floors shall be determined by an independent structural engineer.

Dust control
The techniques adopted for stripping out and for demolition shall minimise the release of dust into the atmosphere. Before the commencement of stripping or demolition in an area of a structure, any existing accumulations of dust in that area shall be collected, placed in suitable containers and removed. Selection of an appropriate collection technique, such as vacuuming or hosing down, shall take due account of the nature of the dust and the type of hazard it presents. Dust generated during stripping, or during the breaking down of the building fabric to removable sized pieces, shall be kept damp until it is removed from the site or can be otherwise contained. The use of excess water for this purpose shall be avoided.

Noise control
Noise shall be minimised as far as practicable, by the selection of appropriate methods and equipment, and by the use of silencing devices wherever practicable to epa/code requirements.

Note:
1. Attention is drawn to recommendations in AS.2436
2. Hours of operating equipment may be restricted by regulatory authority

Fire services
Where a fire hydrant service or a fire hose reel service is provided in a building, it shall be available at all times during the demolition of the building, so that all remaining storeys except the two uppermost storeys, are serviced. Access to the fire protection services, including any booster fitting, shall be maintained at all times. If a sprinkler system is installed in a building to be demolished, it shall be maintained in an operable condition at each storey below the two uppermost unstripped storeys.

Suitable portable fire extinguishers shall be kept at all times in working areas and are not protected by other fire services, and maintained in an operable condition.

Adjoining properties
Safe access to and egress from adjoining buildings shall be maintained at all times for the duration of the demolition work. No demolition activity shall cause damage to or adversely affect the structural integrity of adjoining buildings. The effects of vibration and conversion on adjoining buildings and their occupants shall be minimised by selecting demolition methods and equipment appropriate to the circumstances. Where any surface of an adjoining building is exposed by demolition, the need for weatherproofing the exposed surface shall be investigated and temporary or permanent protection provided as appropriate. Precautions shall be taken to minimise the spreading of mud and debris by vehicles leaving the site.

General
Openings in existing walls and floors, through which there is a risk of persons falling to lower level, shall be either properly guarded or boarded over and the boarding secured against unauthorised or accidental removal. Precautions shall be taken to prevent glass from falling on any person in or outside the building. Demolished material shall not be allowed to fall freely outside the structure unless it is confined within a chute or similar enclosure, which is clear of obstructions to objects falling freely.

Demolished material shall be removed progressively from the site and at any time, shall not be allowed to accumulate to the extent that it presents a hazard to the public or to site personnel.

All drawings to be read in conjunction with heritage consultants drawings and specifications

Site protection/shoring legend
Permanent site shoring
Temporary site shoring
Note:
Refer structural engineers drawings for all site protection and shoring details

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Client / Dee Why 3 Pty Ltd &
Dee Why 4 Pty Ltd

Project / 4 Delmar Pde & 812
Pittwater Rd, Dee Why

Drawing / DEMOLITION PLAN

Project No / 221054

Date / 14.12.2021

Author / SJ

Scale @ A1 / 1 : 250

Drawing No. / TP00.02 A

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▨ SUBJECT SITE

▨ 2 DELMAR UNDER CONSTRUCTION

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Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **SITE SURVEY PLAN**

Project No / **221054**

Date / **14.12.2021**

Author / **DM**

Scale @ A3 / **1 : 250**

Drawing No / **TP00.03 A**

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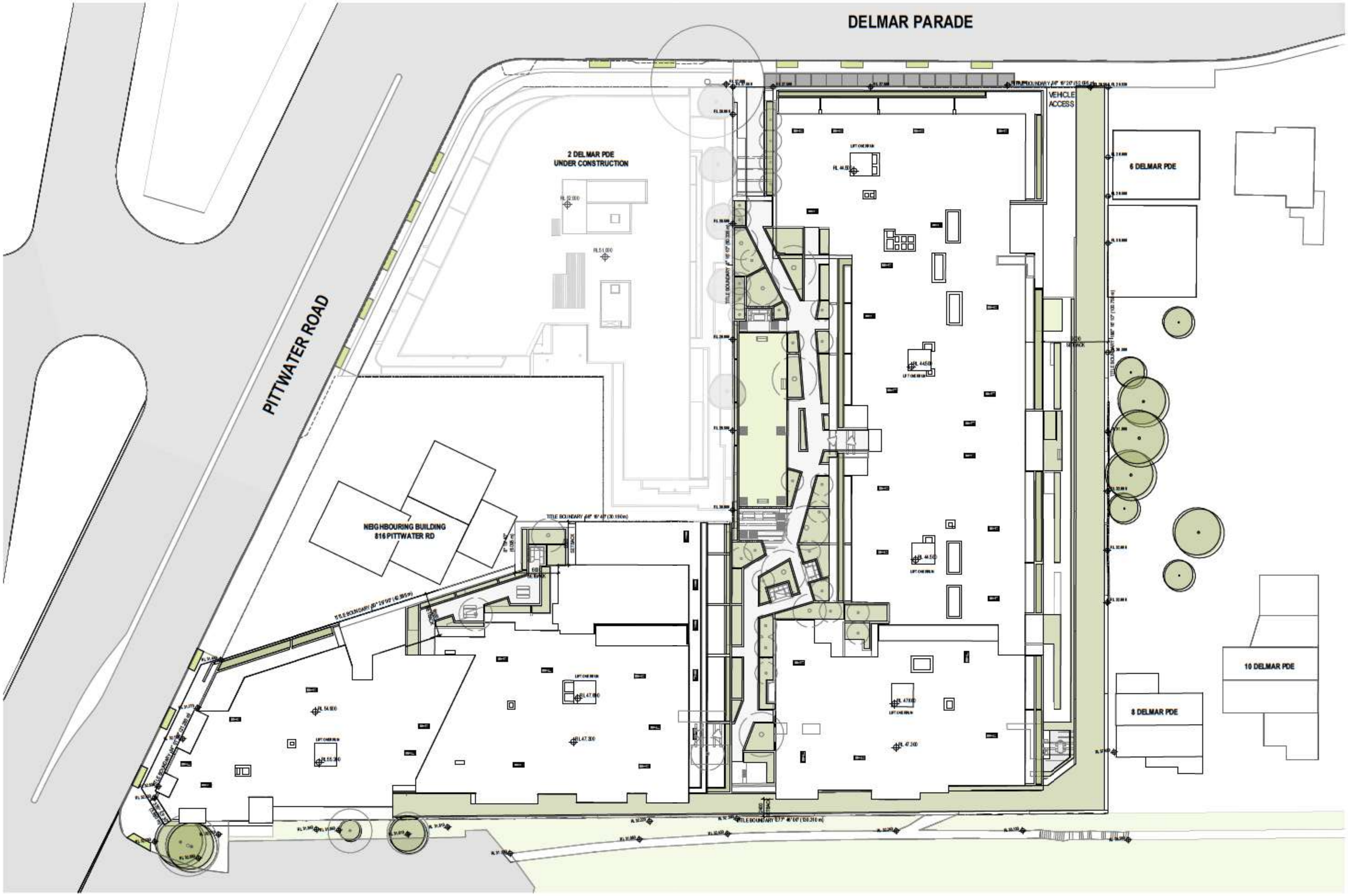

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Client / Dee Why 3 Pty Ltd &
Dee Why 4 Pty Ltd

Project / 4 Delmar Pde & 812
Pittwater Rd, Dee Why

Drawing / SITE PLAN

Project No / 221054

Date / 14.12.2021

Author / SJ

Scale @ A1 / 1 : 250

Drawing No. / TP00.04 A

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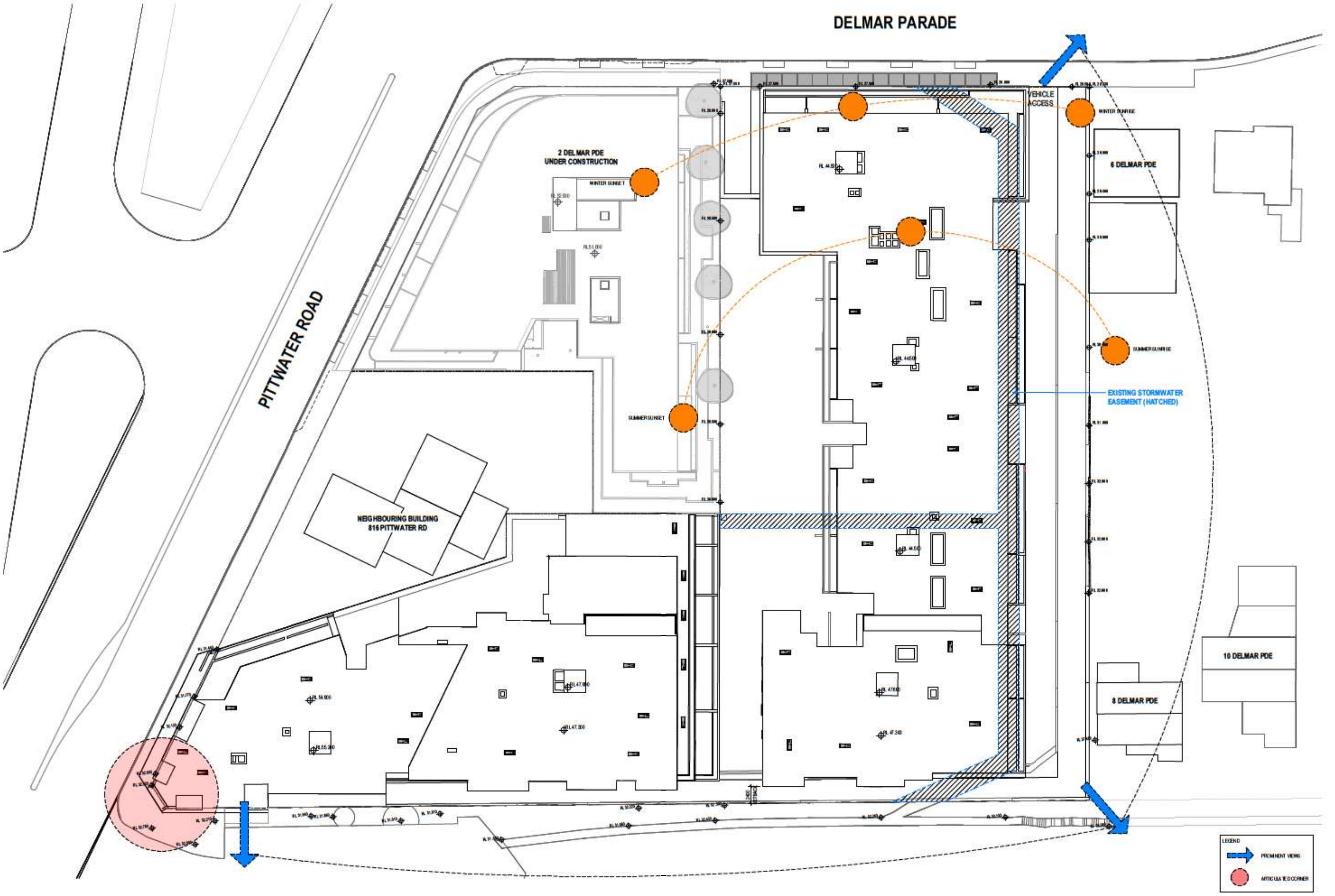

REFER TO URBAN DESIGN REPORT

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Client / Dee Why 3 Pty Ltd &
Dee Why 4 Pty Ltd

Project / 4 Delmar Pde & 812
Pittwater Rd, Dee Why

Drawing / SITE ANALYSIS PLAN

Project No / 221054

Date / 14.12.2021

Author / JC

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Drawing No / TP00.05 A

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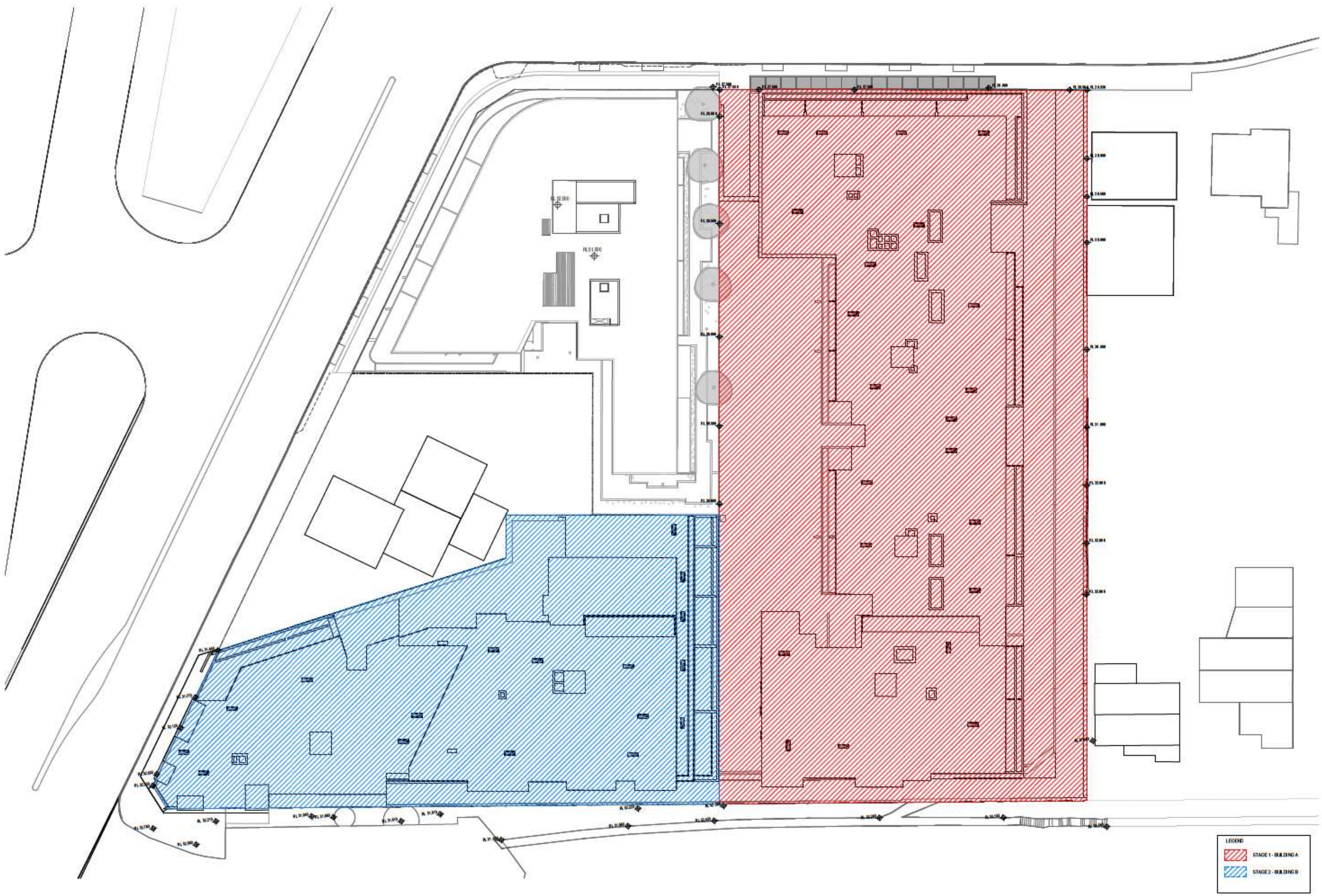

LEGEND

- 🟥 STAGE 1 - BUILDING A
- 🟦 STAGE 2 - BUILDING B

REFER TO SUBDIVISION PLAN

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Dee Why 4 Pty Ltd**

Project / **4 Delmar Pde & 812
Pittwater Rd, Dee Why**

Drawing / **SUBDIVISION PLAN**

Project No / **221054**

Date / **14.12.2021**

Author / **JC**

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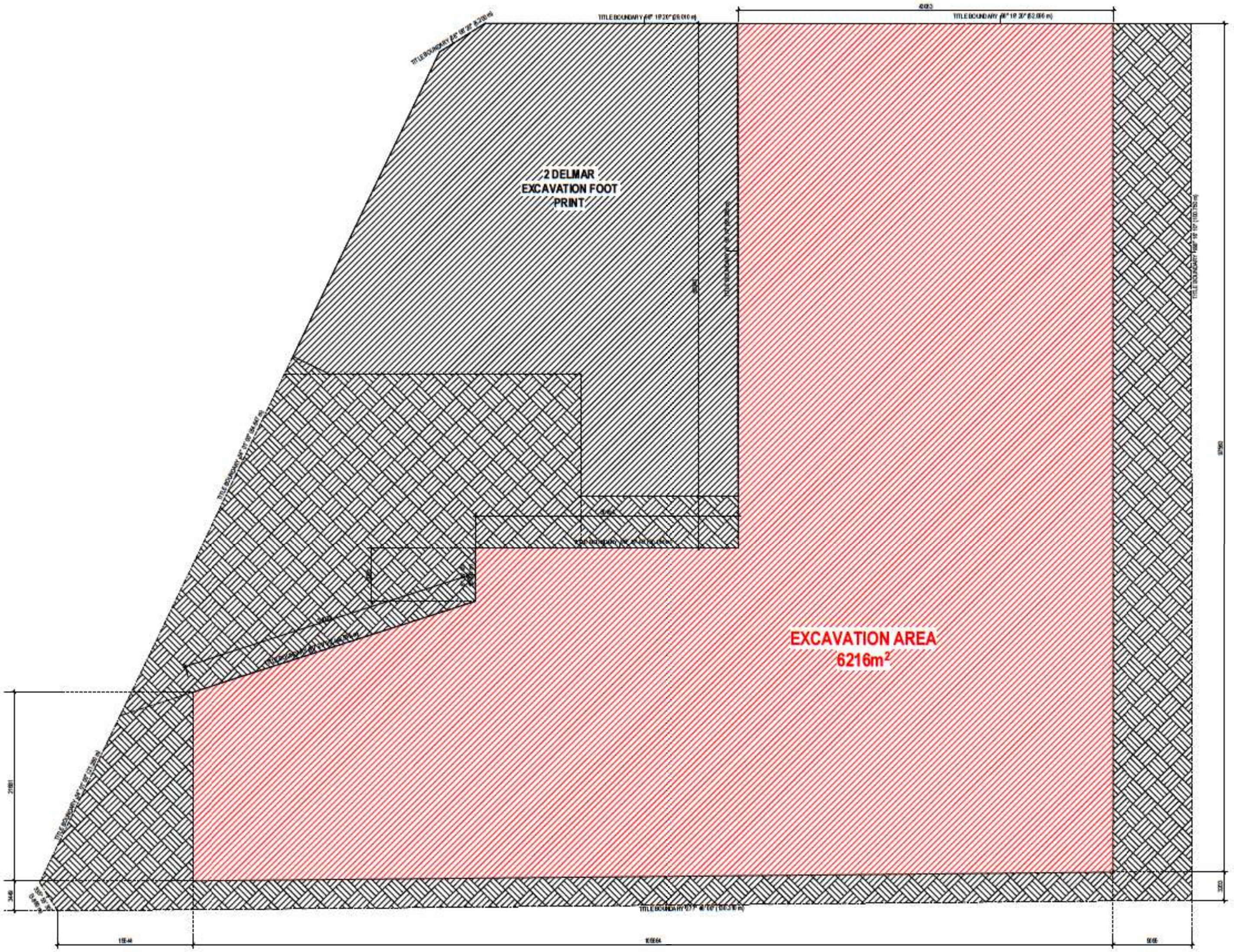

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Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **BULK EXCAVATION**
DIAGRAM

Project No / **221054**

Date / **14.12.2021**

Author / **SJ**

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Drawing No / **TP00.07 A**

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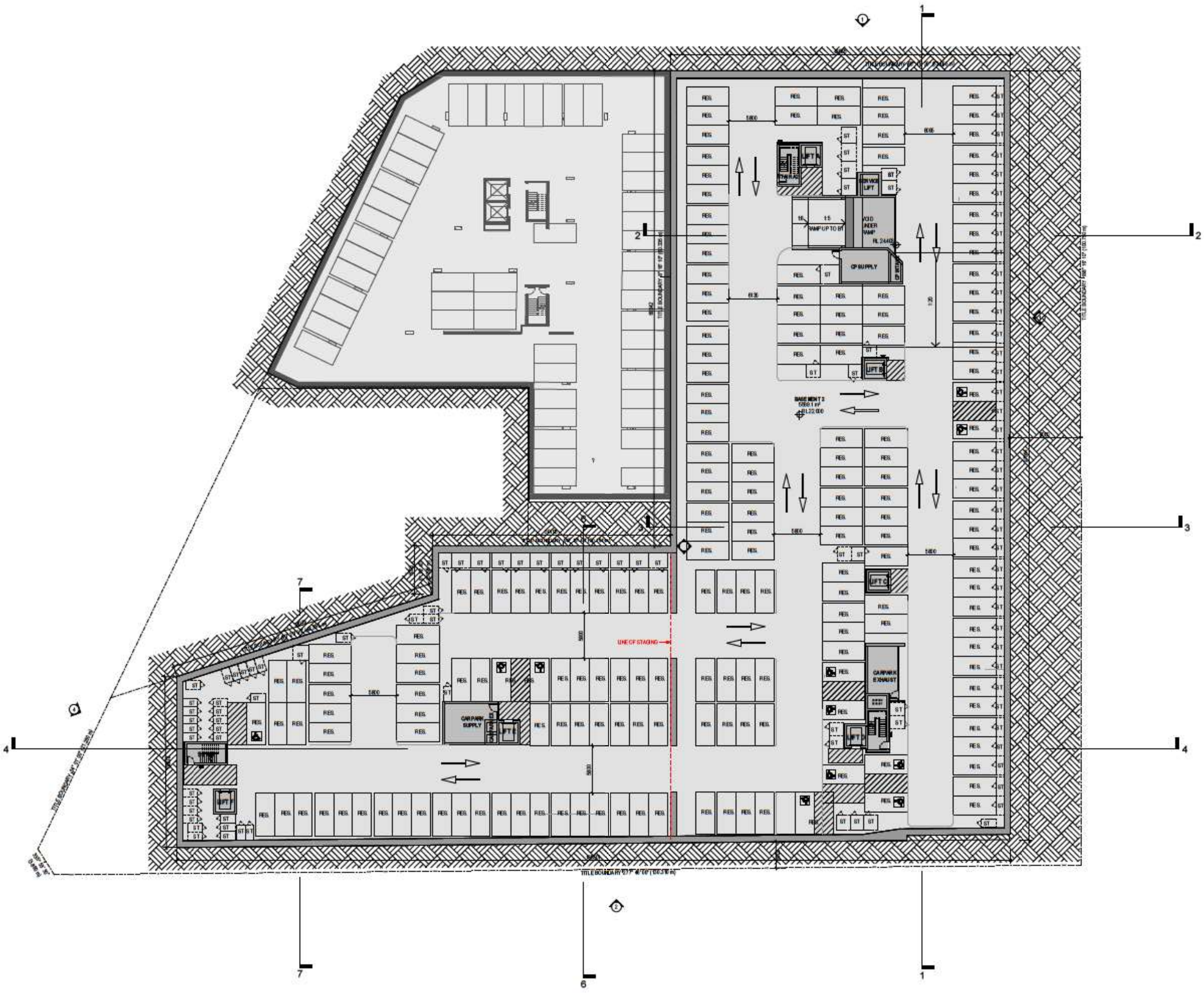

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Dee Why 4 Pty Ltd

Project / 4 Delmar Pde & 812
Pittwater Rd, Dee Why

Drawing / BASEMENT 2

Project No / 221054

Date / 14.12.2021

Author / BR

Scale @ A1 / 1 : 250

Drawing No / TP01.01 A

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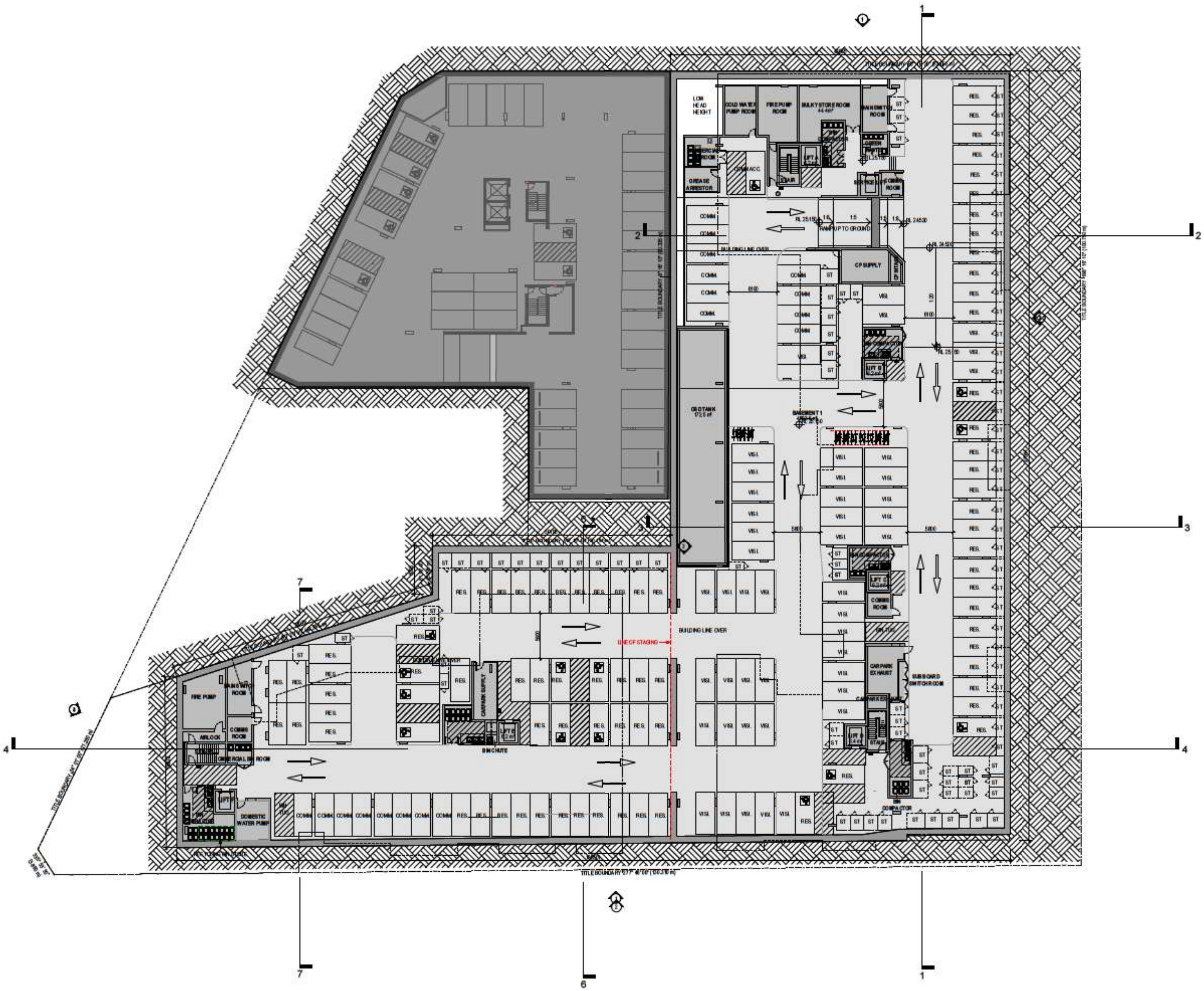

DA SUBMISSION

Revisions / A 14.12.2021 DEVELOPMENT APPLICATION JC

14/12/2021 1:43:31 PM

Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **BASEMENT 1**

Project No / **221054**

Date / **14.12.2021**

Author / **BR**

Scale @ A1 / **1 : 250**

Drawing No / **TP01.02 A**

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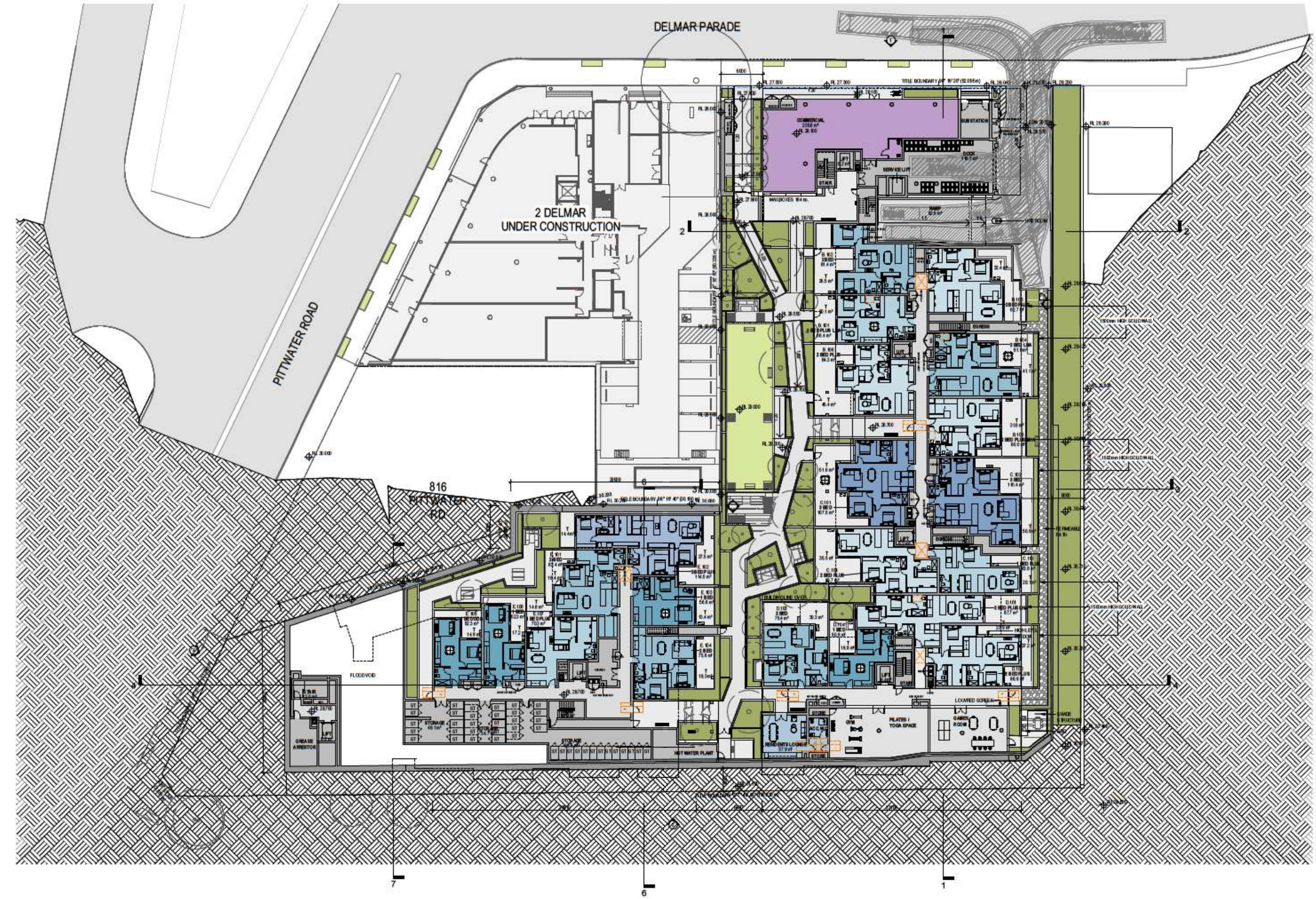

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15/12/2021 6:28:43 PM

Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **GROUND**

Project No / **221054** Date / **14.12.2021** Author / **DM** Scale @ A1 / **1 : 250**

Drawing No / **TP01.03 A**

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15/12/2021 6:29:04 PM

Client / Dee Why 3 Pty Ltd &
Dee Why 4 Pty Ltd

Project / 4 Delmar Pde & 812
Pittwater Rd, Dee Why

Drawing / LEVEL 1

Project No / 221054

Date / 14.12.2021

Author / DM

Scale @ A1 / 1 : 250

Drawing No. / TP01.04 A

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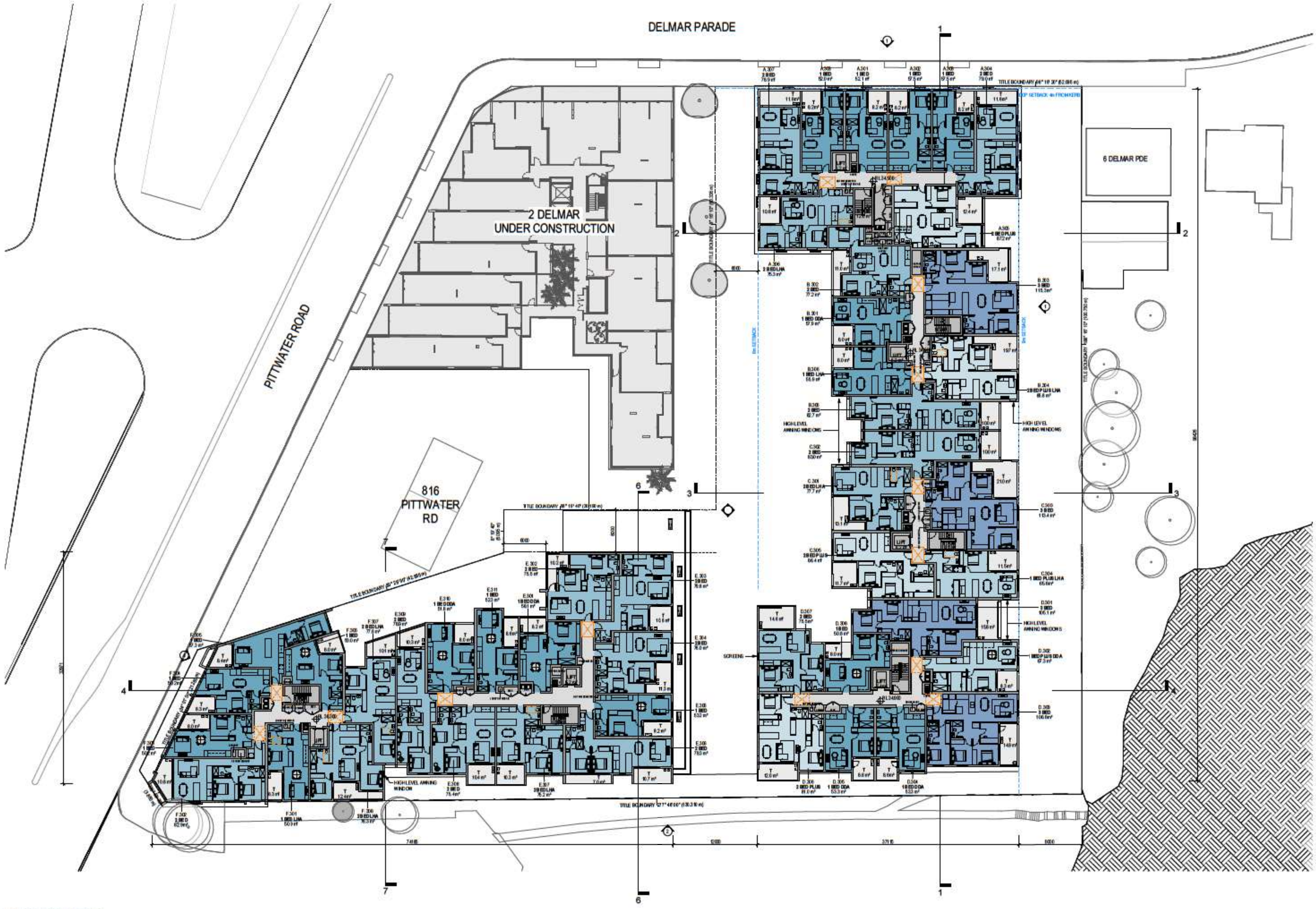

DA SUBMISSION

Revisions / A 14.12.2021 DEVELOPMENT APPLICATION JC

15/12/2021 6:29:29 PM

Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **LEVEL 2**

Project No / **221054**

Date / **14.12.2021**

Author / **DM**

Scale @ A3 / **1 : 250**

Drawing No / **TP01.05 A**

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DA SUBMISSION

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15/12/2021 6:29:54 PM

Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **LEVEL 3**

Project No / **221054**

Date / **14.12.2021**

Author / **DM**

Scale @ A3 / **1 : 250**

Drawing No / **TP01.06 A**

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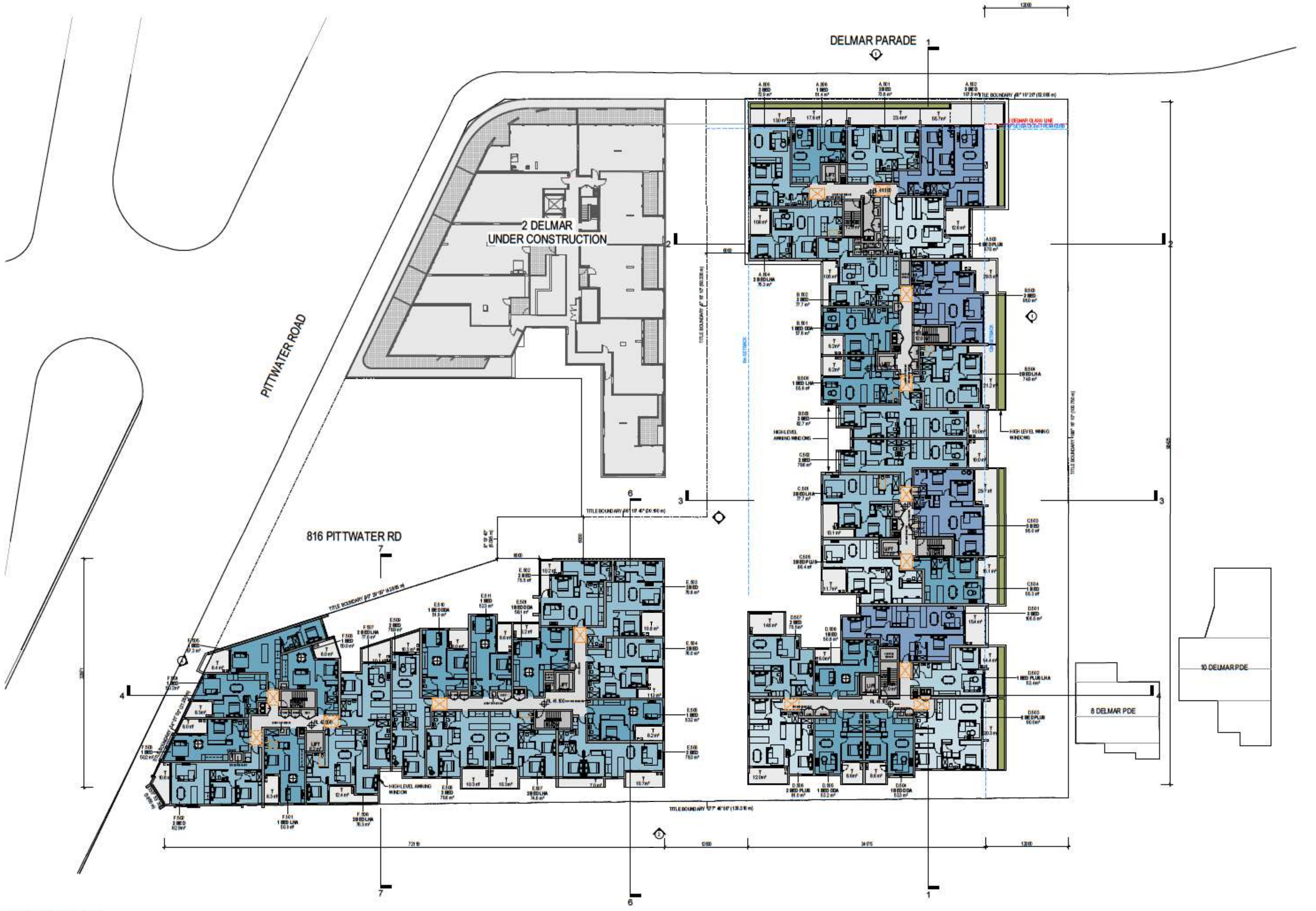

DA SUBMISSION

Revisions / A 14.12.2021 DEVELOPMENT APPLICATION JC

15/12/2021 6:30:17 PM

Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **LEVEL 4**

Project No / **221054** Date / **14.12.2021** Author / **DM** Scale @ A3 / **1 : 250**

Drawing No / **TP01.07 A**

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15/12/2021 6:30:31 PM

Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **LEVEL 5**

Project No / **221054**

Date / **14.12.2021**

Author / **DM**

Scale @ A3 / **1 : 250**

Drawing No / **TP01.08 A**

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DA SUBMISSION

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15/12/2021 6:30:42 PM

Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **LEVEL 6**

Project No / **221054**

Date / **14.12.2021**

Author / **DM**

Scale @ A3 / **1 : 250**

Drawing No / **TP01.09 A**

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DA SUBMISSION

Revisions / A 14.12.2021 DEVELOPMENT APPLICATION JC

15/12/2021 6:30:52 PM

Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **LEVEL 7**

Project No / **221054**

Date / **14.12.2021**

Author / **DM**

Scale @ A3 / **1 : 250**

Drawing No / **TP01.10 A**

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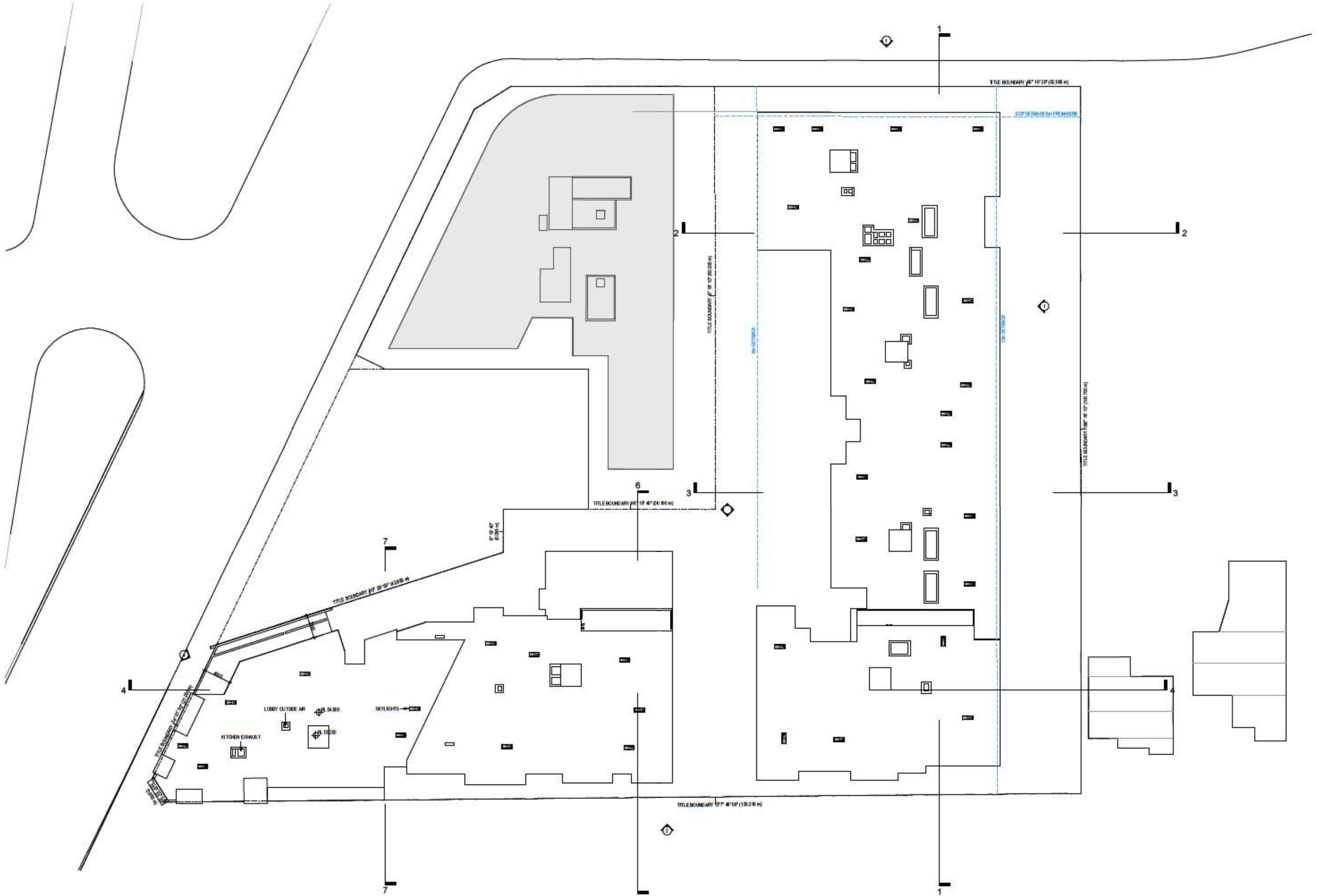

DA SUBMISSION

Revisions / A 14.12.2021 DEVELOPMENT APPLICATION JC

15/12/2021 6:30:58 PM

Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **LEVEL 8**

Project No / **221054**

Date / **14.12.2021**

Author / **DM**

Scale @ A1 / **1 : 250**

Drawing No / **TP01.11 A**

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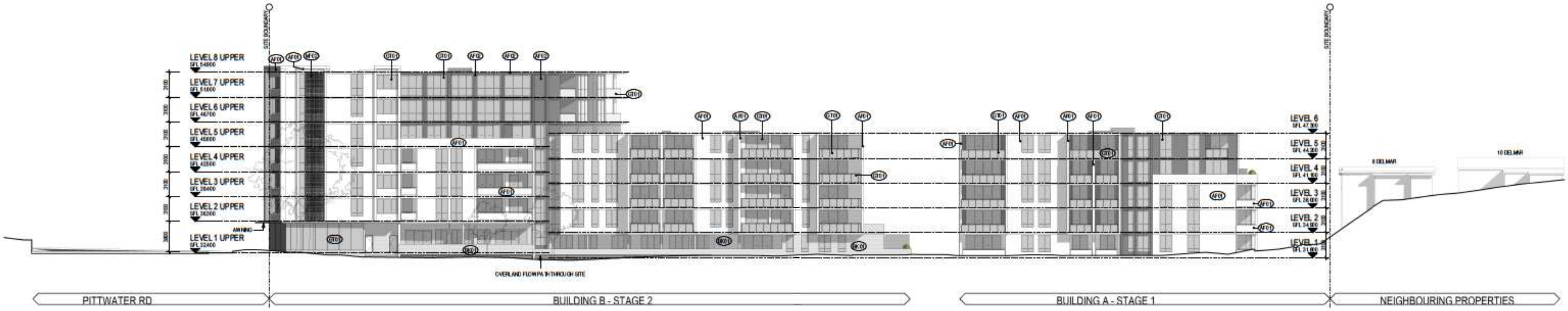

SOUTH ELEVATION

NORTH ELEVATION

MATERIAL LEGEND

AF01 - Applied Finish White
AF02 - Applied Finish Dark Grey
BK01 - Brick Austral Leisure or similar
BK02 - Honed Blockwork Natural or similar
BK03 - Breezeblock White or similar
GT01 - Glazing Clear
GT02 - Glazing Opaque
MF01 - Metal Finish Charcoal
MF02 - Metal Finish White

Refer to Design Report Material Palette

DA SUBMISSION

Revisions / A 14.12.2021 DEVELOPMENT APPLICATION JC

14/12/2021 1:46:23 PM

Client / **Dee Why 3 Pty Ltd & Dee Why 4 Pty Ltd**

Project / **4 Delmar Pde & 812 Pittwater Rd, Dee Why**

Drawing / **SITE ELEVATIONS**

Project No / **221054**

Date / **14.12.2021**

Author / **DM**

Scale @ A1 / **1 : 250**

Drawing No / **TP02.05 A**

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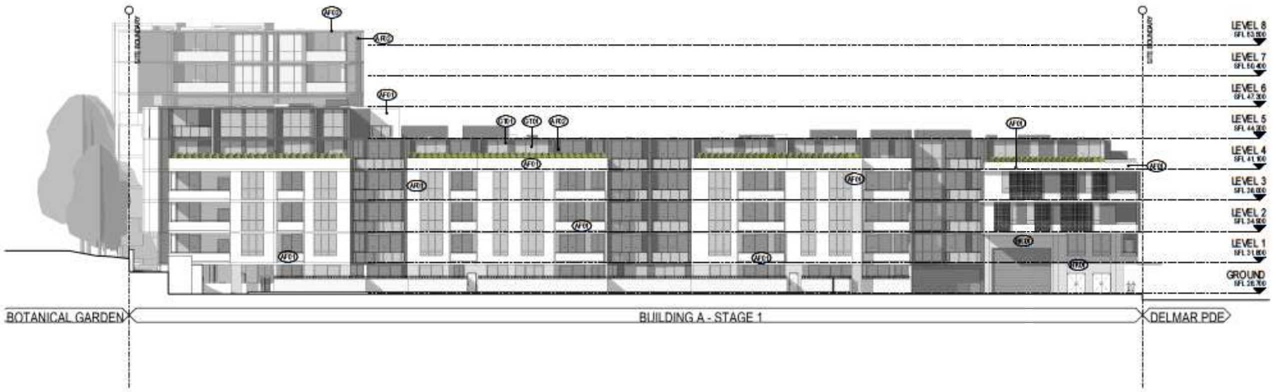
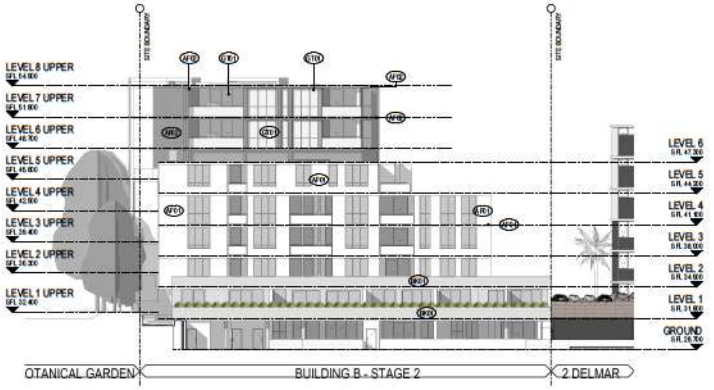
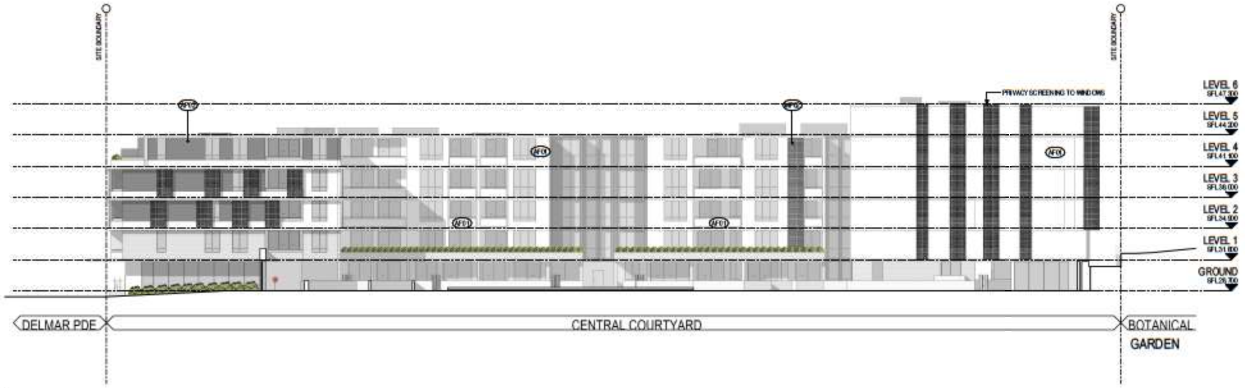


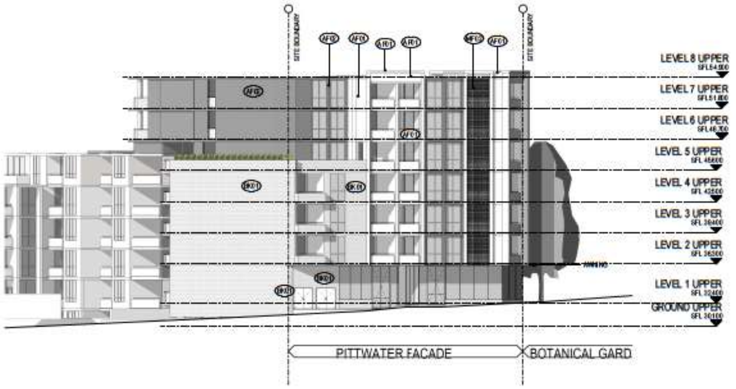
BUILDING A EAST ELEVATION



BUILDING B EAST ELEVATION



BUILDING A WEST ELEVATION



BUILDING B SOUTH WEST ELEVATION

MATERIAL LEGEND

AF01 - Applied Finish White
AF02 - Applied Finish Dark Grey
BK01 - Brick Austral Leisure or similar
BK02 - Honed Blockwork Natural or similar
BK03 - Besserblock White or similar
GT01 - Glazing Clear
GT02 - Glazing Opaque
MF01 - Metal Finish Charcoal
MF02 - Metal Finish White

Refer to Design Report Material Palette

DA SUBMISSION

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14/12/2021 1:47:30 PM

Client / **Dee Why 3 Pty Ltd & Dee Why 4 Pty Ltd**

Project / **4 Delmar Pde & 812 Pittwater Rd, Dee Why**

Drawing / **SITE ELEVATIONS**

Project No / **221054**

Date / **14.12.2021**

Author / **DM**

Scale @ A1 / **1 : 250**

Drawing No. / **TP02.06 A**

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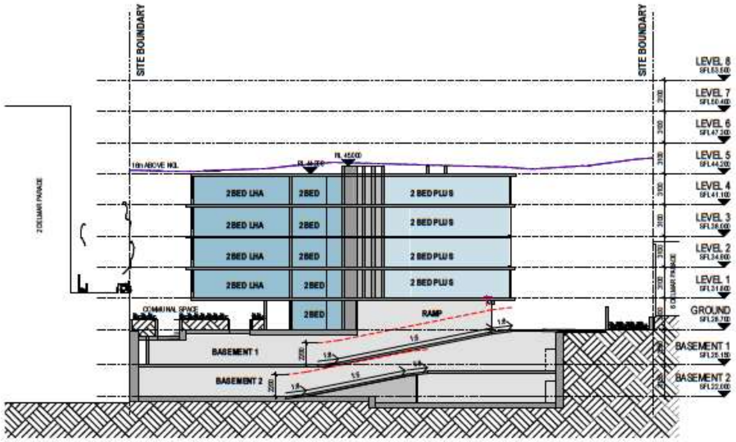
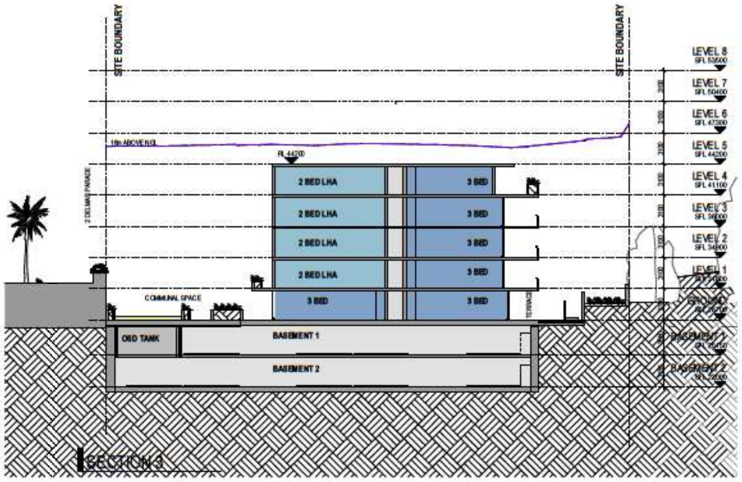
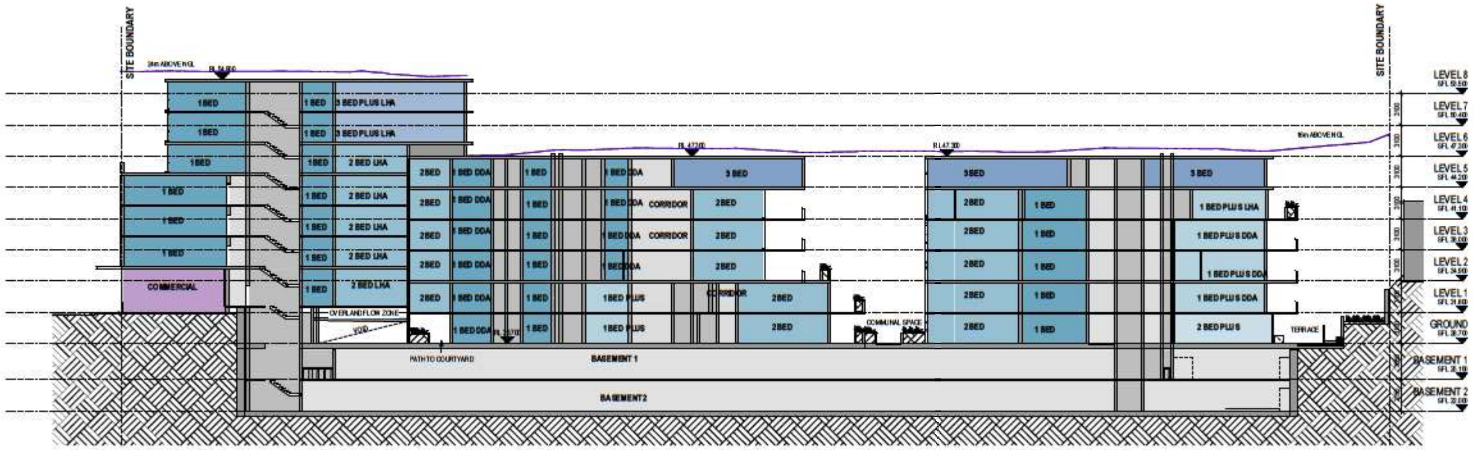


SECTION 2



SECTION 3



SECTION 4

DA SUBMISSION

Revisions / A 14.12.2021 DEVELOPMENT APPLICATION JC

16/12/2021 9:24:09 AM

Client / Dee Why 3 Pty Ltd &
Dee Why 4 Pty Ltd

Project / 4 Delmar Pde & 812
Pittwater Rd, Dee Why

Drawing / SECTIONS

Project No / 221054 Date / 14.12.2021 Author / BR Scale @ A1 / 1 : 250

Drawing No. / TP03.01 A

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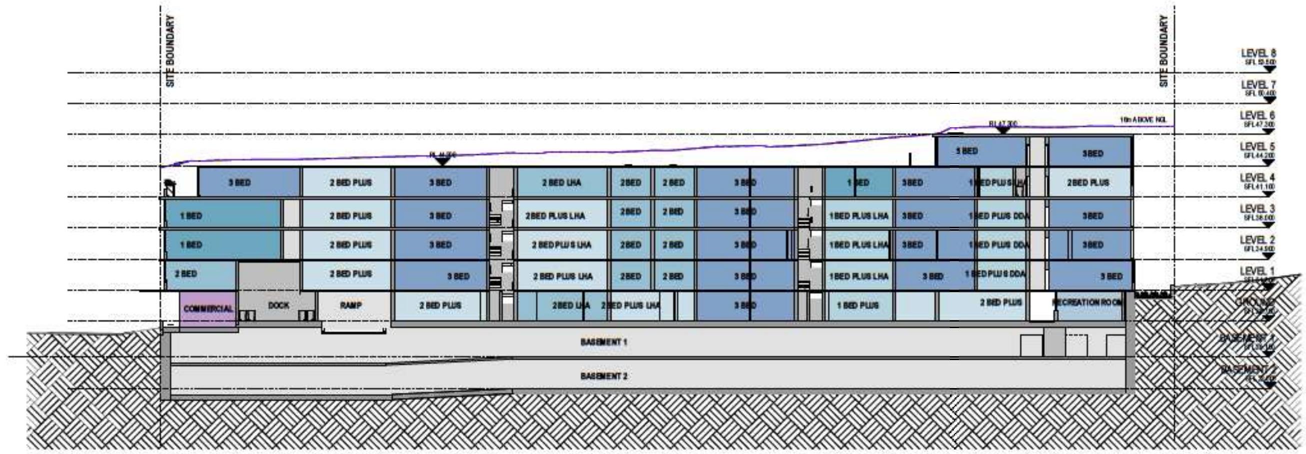
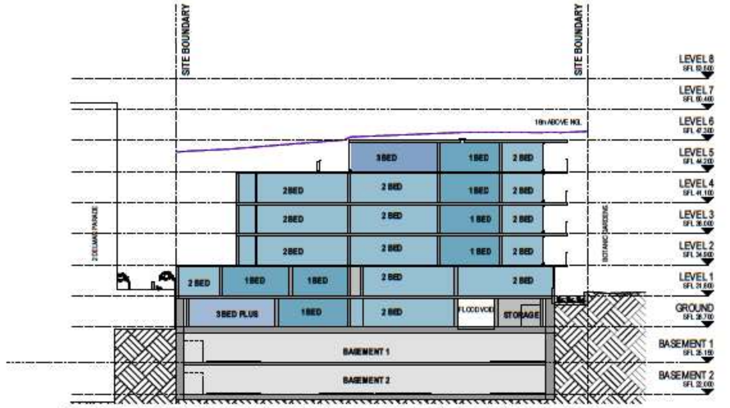
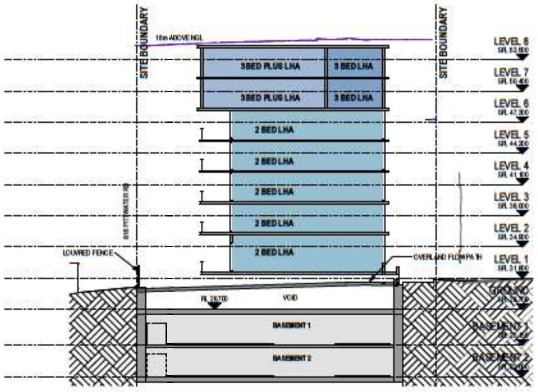


SECTION 5



SECTION 6



SECTION 7

DA SUBMISSION

Revisions / A 14.12.2021 DEVELOPMENT APPLICATION JC

16/12/2021 9:24:13 AM

Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **SECTIONS 2**

Project No / **221054**

Date / **14.12.2021**

Author / **JC**

Scale @ A1 / **1 : 250**

Drawing No / **TP03.02 A**

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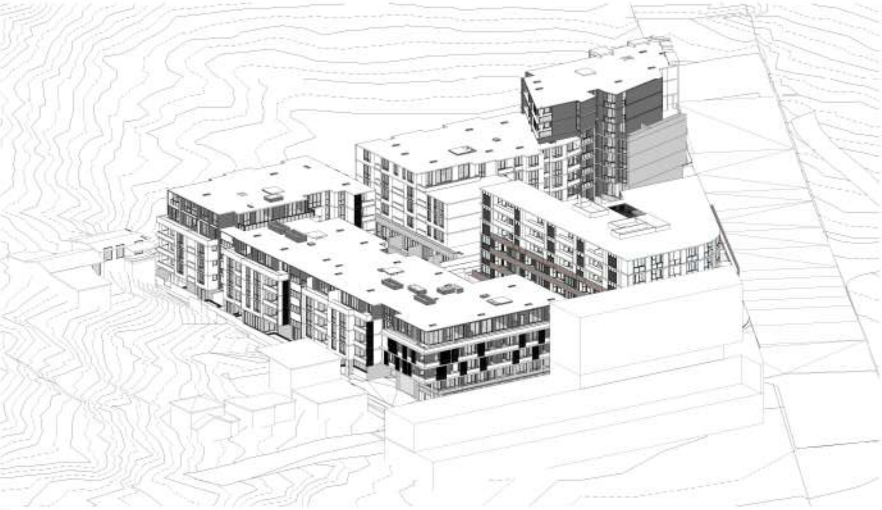
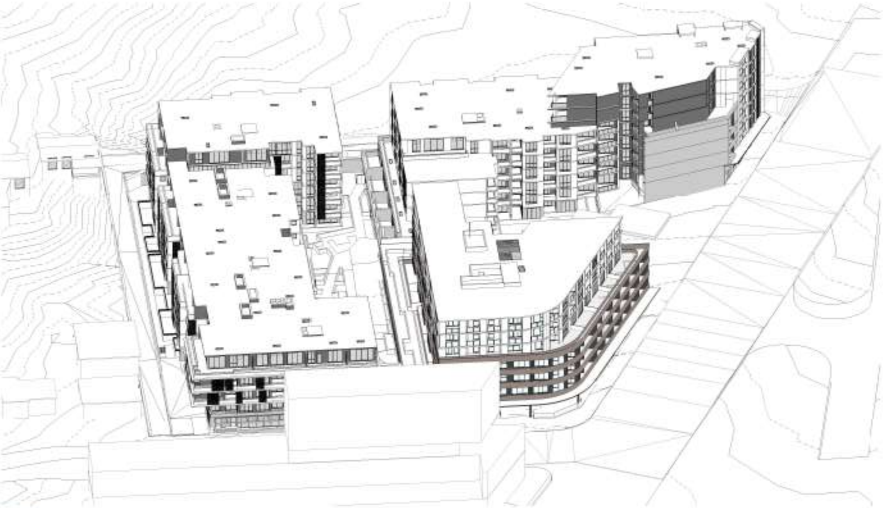
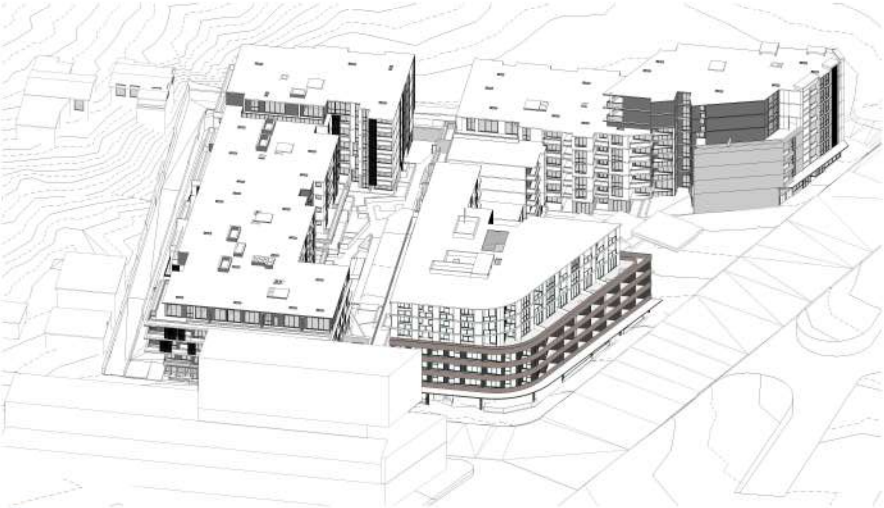


0900

1000



1100



1200

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14/12/2021 2:12:57 PM

Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **SHADOW ANALYSIS -**
POV

Project No / **221054**

Date / **14.12.2021**

Author / **JC**

Scale @ A1 /

Drawing No / **TP05.01 A**

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1300

1400

1500

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14/12/2021 2:15:15 PM

Client / **Dee Why 3 Pty Ltd &
Dee Why 4 Pty Ltd**

Project / **4 Delmar Pde & 812
Pittwater Rd, Dee Why**

Drawing / **SHADOW ANALYSIS -
POV**

Project No / **221054**

Date / **14.12.2021**

Author / **JC**

Scale @ A1 /

Drawing No / **TP05.02 A**

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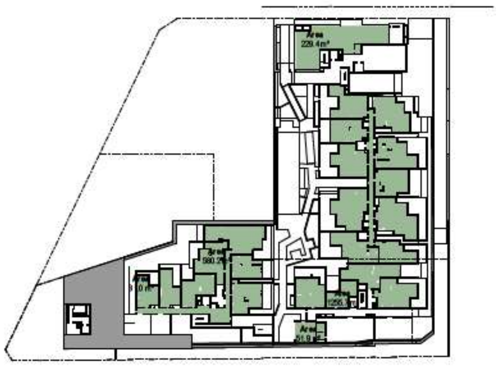
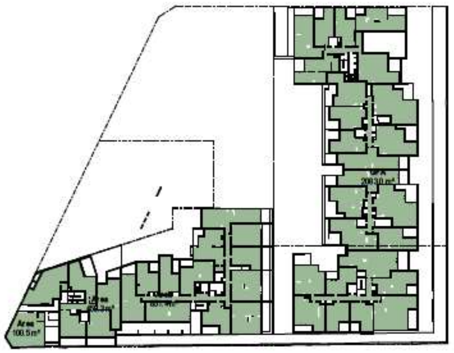


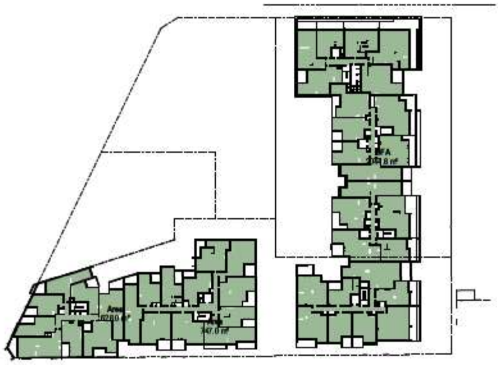
GROUND



LEVEL 1

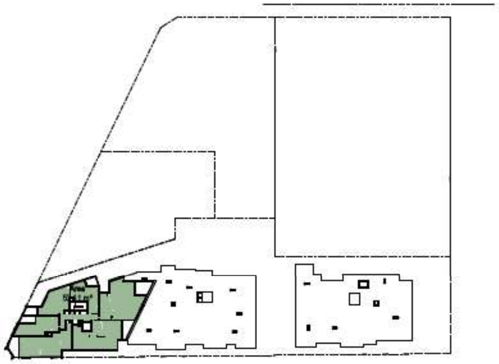
LEVEL 2

LEVEL 3

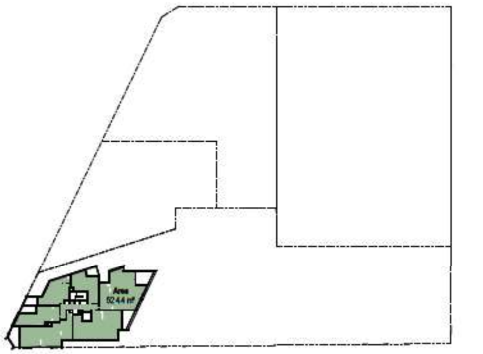


LEVEL 4

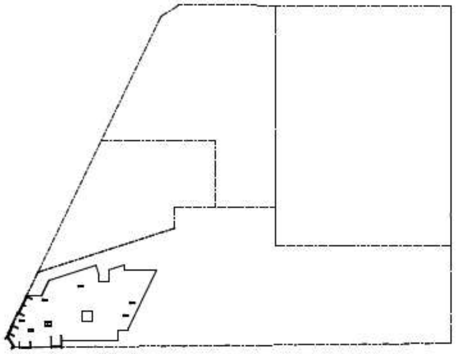
LEVEL 5



LEVEL 6



LEVEL 7



LEVEL 8

GFA
AREA
19005.8 m²

19005.8 m²

GFA - 2.4-1	
LEVEL	AREA
GROUND	2117.2 m²
LEVEL 1	2934.4 m²
LEVEL 2	2965.6 m²
LEVEL 3	2965.6 m²
LEVEL 4	2791.9 m²
LEVEL 5	1155.9 m²

14930.5 m²

SITE AREA: 6800m²

PERMISSIBLE FSR: 16320m²

GFA - 3.2-1	
LEVEL	AREA
GROUND	31.0 m²
LEVEL 1	559.8 m²
LEVEL 2	627.4 m²
LEVEL 3	626.4 m²
LEVEL 4	628.0 m²
LEVEL 5	554.1 m²
LEVEL 6	524.1 m²
LEVEL 7	524.4 m²

4075.2 m²

SITE AREA: 990m²

PERMISSIBLE FSR: 3168m²

SITE AREA	FSR	PERMISSIBLE GFA
7790m²	2.4 & 3.2	19488m²

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15/12/2021 6:31:16 PM

Client / **Dee Why 3 Pty Ltd &
Dee Why 4 Pty Ltd**

Project / **4 Delmar Pde & 812
Pittwater Rd, Dee Why**

Drawing / **GFA PLANS**

Project No / **221054**

Date / **14.12.2021**

Author / **RIC**

Scale @ A1 / **1 : 750**

Drawing No / **TP06.01 A**

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🟩 3M - 6M DIMENSION
🟩 GREATER THAN 6M DIMENSION

DEEP SOIL	% Achieved
417.6 m²	5%
545.3 m²	7%

TOTAL DEEP SOIL	% Achieved
962.8 m²	12%

SITE AREA = 7790 m²

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14/12/2021 2:23:41 PM

Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **DEEP SOIL**

Project No / **221054**

Date / **14.12.2021**

Author / **BR**

Scale @ A1 / **1 : 250**

Drawing No / **TP06.03 A**

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🟥 PRINCIPAL COMMUNAL SPACE

🟨 COMMUNAL OPEN SPACE THAT ACHIEVES 2HR SOLAR ACCESS BETWEEN 9AM AND 3PM JUNE 21 = 974m²

PRINCIPAL COMMUNAL SPACE AREA	AREA WITH SOLAR ACCESS	% WITH SOLAR ACCESS
677 m²	358.5 m²	53%

50% ACHIEVES 2HR SOLAR ACCESS BETWEEN 9AM AND 3PM JUNE 21

TOTAL COMMUNAL OPEN SPACE	% Achieved
1948.0 m²	25%

SITE AREA = 7790 m²

DA SUBMISSION

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14/12/2021 2:18:15 PM

Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **COMMUNAL /**
LANDSCAPE PLAN

Project No / **221054** Date / **14.12.2021** Author / **BR** Scale @ A1 / **1 : 250**

Drawing No / **TP06.04 A**

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RESIDENTIAL STORAGE WITHIN APARTMENT			
LEVEL	UNIT	UNIT TYPE	VOLUME
GROUND	B.101	1 BED PLUS LHA	11 m^3
GROUND	B.102	2 BED	9 m^3
GROUND	B.103	2 BED PLUS	13 m^3
GROUND	B.104	2 BED LHA	12 m^3
GROUND	B.105	2 BED PLUS LHA	10 m^3
GROUND	B.106	2 BED PLUS	10 m^3
GROUND	C.101	3 BED	12 m^3
GROUND	C.102	3 BED	6 m^3
GROUND	C.103	1 BED PLUS	7 m^3
GROUND	C.104	2 BED PLUS	12 m^3
GROUND	D.101	2 BED PLUS LHA	9 m^3
GROUND	D.102	2 BED PLUS	11 m^3
GROUND	D.103	2 BED	4 m^3
GROUND	D.104	1 BED	5 m^3
GROUND	E.101	2 BED	11 m^3
GROUND	E.102	3 BED PLUS	22 m^3
GROUND	E.103	1 BED	3 m^3
GROUND	E.104	2 BED	5 m^3
GROUND	E.105	1 BED DDA	4 m^3
GROUND	E.106	1 BED	4 m^3
GROUND	E.107	1 BED PLUS	10 m^3
LEVEL 1	A.201	1 BED	3 m^3
LEVEL 1	A.202	2 BED	4 m^3
LEVEL 1	A.203	2 BED PLUS	6 m^3
LEVEL 1	A.204	2 BED LHA	4 m^3
LEVEL 1	A.205	2 BED	4 m^3
LEVEL 1	A.206	1 BED	3 m^3
LEVEL 1	B.201	1 BED DDA	6 m^3
LEVEL 1	B.202	2 BED	4 m^3
LEVEL 1	B.203	3 BED	10 m^3
LEVEL 1	B.204	2 BED PLUS LHA	6 m^3
LEVEL 1	B.205	2 BED	5 m^3
LEVEL 1	B.206	1 BED LHA	4 m^3
LEVEL 1	C.201	2 BED LHA	6 m^3
LEVEL 1	C.202	2 BED	4 m^3
LEVEL 1	C.203	3 BED	11 m^3
LEVEL 1	C.204	1 BED PLUS LHA	6 m^3
LEVEL 1	C.205	2 BED PLUS	12 m^3
LEVEL 1	D.201	3 BED	6 m^3
LEVEL 1	D.202	1BED PLUS DDA	11 m^3
LEVEL 1	D.203	3 BED	15 m^3
LEVEL 1	D.204	1 BED LHA	3 m^3
LEVEL 1	D.205	1 BED LHA	3 m^3
LEVEL 1	D.206	2 BED	5 m^3
LEVEL 1	D.207	2 BED	4 m^3
LEVEL 1	D.208	1 BED	5 m^3
LEVEL 1	E.201	2 BED	6 m^3
LEVEL 1	E.202	2 BED	6 m^3
LEVEL 1	E.203	1 BED	9 m^3
LEVEL 1	E.204	1 BED	3 m^3
LEVEL 1	E.205	2 BED	5 m^3
LEVEL 1	E.206	2 BED	5 m^3
LEVEL 1	E.207	1 BED PLUS LHA	9 m^3
LEVEL 1	E.208	2 BED	6 m^3
LEVEL 1	E.209	2 BED	4 m^3
LEVEL 1	E.210	1 BED DDA	4 m^3
LEVEL 1	E.211	1 BED	4 m^3
LEVEL 1	E.212	1 BED PLUS	10 m^3
LEVEL 1 UPPER	F.201	1 BED	4 m^3
LEVEL 1 UPPER	F.202	1 BED	3 m^3
LEVEL 1 UPPER	F.203	2 BED LHA	4 m^3
LEVEL 1 UPPER	F.204	1 BED	4 m^3
LEVEL 2	A.301	1 BED	3 m^3
LEVEL 2	A.302	1 BED	5 m^3
LEVEL 2	A.303	1 BED	5 m^3
LEVEL 2	A.304	2 BED	4 m^3
LEVEL 2	A.305	2 BED PLUS	11 m^3
LEVEL 2	A.306	2 BED LHA	4 m^3
LEVEL 2	A.307	2 BED	4 m^3
LEVEL 2	A.308	1 BED	3 m^3
LEVEL 2	B.301	1 BED DDA	6 m^3
LEVEL 2	B.302	2 BED	4 m^3
LEVEL 2	B.303	3 BED	10 m^3
LEVEL 2	B.304	2 BED PLUS LHA	6 m^3
LEVEL 2	B.305	2 BED	5 m^3
LEVEL 2	B.306	1 BED LHA	4 m^3
LEVEL 2	C.301	2 BED LHA	6 m^3
LEVEL 2	C.302	2 BED	4 m^3
LEVEL 2	C.303	3 BED	11 m^3
LEVEL 2	C.304	1 BED PLUS LHA	6 m^3
LEVEL 2	C.305	2 BED PLUS	12 m^3
LEVEL 2	D.301	3 BED	6 m^3

RESIDENTIAL STORAGE WITHIN APARTMENT			
LEVEL	UNIT	UNIT TYPE	VOLUME
LEVEL 2	D.302	1 BED PLUS DDA	11 m^3
LEVEL 2	D.303	3 BED	15 m^3
LEVEL 2	D.304	1BED DDA	3 m^3
LEVEL 2	D.305	1BED DDA	3 m^3
LEVEL 2	D.306	2BED PLUS	9 m^3
LEVEL 2	D.307	2 BED	4 m^3
LEVEL 2	D.308	1 BED	5 m^3
LEVEL 2	E.301	1BED DDA	5 m^3
LEVEL 2	E.302	2 BED	5 m^3
LEVEL 2	E.303	2 BED	4 m^3
LEVEL 2	E.304	2 BED	5 m^3
LEVEL 2	E.305	1 BED	3 m^3
LEVEL 2	E.306	2 BED	4 m^3
LEVEL 2	E.307	2 BED LHA	4 m^3
LEVEL 2	E.308	2 BED	4 m^3
LEVEL 2	E.309	2 BED	5 m^3
LEVEL 2	E.310	1BED DDA	4 m^3
LEVEL 2	E.311	1 BED	4 m^3
LEVEL 2 UPPER	F.301	1 BED LHA	3 m^3
LEVEL 2 UPPER	F.302	2 BED	5 m^3
LEVEL 2 UPPER	F.303	1 BED	3 m^3
LEVEL 2 UPPER	F.304	1 BED	3 m^3
LEVEL 2 UPPER	F.305	1 BED	5 m^3
LEVEL 2 UPPER	F.306	1 BED	3 m^3
LEVEL 2 UPPER	F.307	2 BED LHA	4 m^3
LEVEL 2 UPPER	F.308	2 BED LHA	5 m^3
LEVEL 3	A.401	1 BED	3 m^3
LEVEL 3	A.402	1 BED	5 m^3
LEVEL 3	A.403	1 BED	5 m^3
LEVEL 3	A.404	2 BED	4 m^3
LEVEL 3	A.405	2BED PLUS	11 m^3
LEVEL 3	A.406	2 BED LHA	4 m^3
LEVEL 3	A.407	2 BED	4 m^3
LEVEL 3	A.408	1 BED	3 m^3
LEVEL 3	B.401	1BED DDA	6 m^3
LEVEL 3	B.402	2 BED	4 m^3
LEVEL 3	B.403	3 BED	10 m^3
LEVEL 3	B.404	2BED PLUS LHA	6 m^3
LEVEL 3	B.405	2 BED	5 m^3
LEVEL 3	B.406	1 BED LHA	4 m^3
LEVEL 3	C.401	2 BED LHA	6 m^3
LEVEL 3	C.402	2 BED	4 m^3
LEVEL 3	C.403	3 BED	11 m^3
LEVEL 3	C.404	1BED PLUS LHA	6 m^3
LEVEL 3	C.405	2BED PLUS	12 m^3
LEVEL 3	D.401	3 BED	6 m^3
LEVEL 3	D.402	1 BED PLUS DDA	11 m^3
LEVEL 3	D.403	3 BED	15 m^3
LEVEL 3	D.404	1BED DDA	3 m^3
LEVEL 3	D.405	1BED DDA	3 m^3
LEVEL 3	D.406	2 BED	9 m^3
LEVEL 3	D.407	2 BED	4 m^3
LEVEL 3	D.408	1 BED	5 m^3
LEVEL 3	E.401	1BED DDA	5 m^3
LEVEL 3	E.402	2 BED	5 m^3
LEVEL 3	E.403	2 BED	4 m^3
LEVEL 3	E.404	2 BED	5 m^3
LEVEL 3	E.405	1 BED	3 m^3
LEVEL 3	E.406	2 BED	4 m^3
LEVEL 3	E.407	2 BED LHA	4 m^3
LEVEL 3	E.408	2 BED	4 m^3
LEVEL 3	E.409	2 BED	5 m^3
LEVEL 3	E.410	1BED DDA	4 m^3
LEVEL 3	E.411	1 BED	4 m^3
LEVEL 3 UPPER	F.401	1 BED LHA	3 m^3
LEVEL 3 UPPER	F.402	2 BED	5 m^3
LEVEL 3 UPPER	F.403	1 BED	3 m^3
LEVEL 3 UPPER	F.404	1 BED	3 m^3
LEVEL 3 UPPER	F.405	1 BED	5 m^3
LEVEL 3 UPPER	F.406	1 BED	3 m^3
LEVEL 3 UPPER	F.407	2 BED LHA	4 m^3
LEVEL 3 UPPER	F.408	2 BED LHA	5 m^3
LEVEL 4	A.501	2 BED	4 m^3
LEVEL 4	A.502	3 BED	6 m^3
LEVEL 4	A.503	2BED PLUS	17 m^3
LEVEL 4	A.504	2 BED LHA	4 m^3
LEVEL 4	A.505	2 BED	4 m^3
LEVEL 4	A.506	1 BED	3 m^3
LEVEL 4	B.501	1BED DDA	6 m^3
LEVEL 4	B.502	2 BED	4 m^3
LEVEL 4	B.503	3 BED	7 m^3
LEVEL 4	B.504	2 BED LHA	4 m^3

RESIDENTIAL STORAGE WITHIN APARTMENT			
LEVEL	UNIT	UNIT TYPE	VOLUME
LEVEL 4	B.505	2 BED	5 m^3
LEVEL 4	B.506	1 BED LHA	4 m^3
LEVEL 4	C.501	2 BED LHA	6 m^3
LEVEL 4	C.502	2 BED	4 m^3
LEVEL 4	C.503	3 BED	5 m^3
LEVEL 4	C.504	1 BED	4 m^3
LEVEL 4	C.505	2 BED PLUS	12 m^3
LEVEL 4	D.501	3 BED	6 m^3
LEVEL 4	D.502	1 BED PLUS LHA	3 m^3
LEVEL 4	D.503	2 BED PLUS	10 m^3
LEVEL 4	D.504	1 BED DDA	3 m^3
LEVEL 4	D.505	1 BED DDA	3 m^3
LEVEL 4	D.506	2 BED PLUS	9 m^3
LEVEL 4	D.507	2 BED	4 m^3
LEVEL 4	D.508	1 BED	5 m^3
LEVEL 4	E.501	1 BED DDA	5 m^3
LEVEL 4	E.502	2 BED	5 m^3
LEVEL 4	E.503	2 BED	4 m^3
LEVEL 4	E.504	2 BED	5 m^3
LEVEL 4	E.505	1 BED	3 m^3
LEVEL 4	E.506	2 BED	4 m^3
LEVEL 4	E.507	2 BED LHA	4 m^3
LEVEL 4	E.508	2 BED	4 m^3
LEVEL 4	E.509	2 BED	5 m^3
LEVEL 4	E.510	1 BED DDA	4 m^3
LEVEL 4	E.511	1 BED	4 m^3
LEVEL 4 UPPER	F.501	1 BED LHA	3 m^3
LEVEL 4 UPPER	F.502	2 BED	5 m^3
LEVEL 4 UPPER	F.503	1 BED	3 m^3
LEVEL 4 UPPER	F.504	1 BED	3 m^3
LEVEL 4 UPPER	F.505	1 BED	5 m^3
LEVEL 4 UPPER	F.506	1 BED	3 m^3
LEVEL 4 UPPER	F.507	2 BED LHA	4 m^3
LEVEL 4 UPPER	F.508	2 BED LHA	5 m^3
LEVEL 5	D.601	3 BED	9 m^3
LEVEL 5	D.602	3 BED	16 m^3
LEVEL 5	D.603	2 BED	4 m^3
LEVEL 5	D.604	2 BED PLUS	11 m^3
LEVEL 5	D.605	3 BED	11 m^3
LEVEL 5	E.601	3 BED	5 m^3
LEVEL 5	E.602	1 BED	3 m^3
LEVEL 5	E.603	2 BED	4 m^3
LEVEL 5	E.604	2 BED LHA	4 m^3
LEVEL 5	E.605	2 BED	4 m^3
LEVEL 5	E.606	2 BED	5 m^3
LEVEL 5	E.607	1 BED DDA	4 m^3
LEVEL 5	E.608	1 BED	4 m^3
LEVEL 5	E.609	1 BED DDA	5 m^3
LEVEL 5 UPPER	F.601	3 BED	6 m^3
LEVEL 5 UPPER	F.602	1 BED	5 m^3
LEVEL 5 UPPER	F.603	1 BED	3 m^3
LEVEL 5 UPPER	F.604	1 BED	3 m^3
LEVEL 5 UPPER	F.605	2 BED LHA	4 m^3
LEVEL 5 UPPER	F.606	2 BED PLUS	5 m^3
LEVEL 6 UPPER	F.701	3 BED	6 m^3
LEVEL 6 UPPER	F.702	1 BED	5 m^3
LEVEL 6 UPPER	F.703	1 BED	3 m^3
LEVEL 6 UPPER	F.704	1 BED	3 m^3
LEVEL 6 UPPER	F.705	3 BED PLUS LHA	16 m^3
LEVEL 6 UPPER	F.706	3 BED LHA	6 m^3
LEVEL 7 UPPER	F.801	3 BED	6 m^3
LEVEL 7 UPPER	F.802	1 BED	5 m^3
LEVEL 7 UPPER	F.803	1 BED	3 m^3
LEVEL 7 UPPER	F.804	1 BED	3 m^3
LEVEL 7 UPPER	F.805	3 BED PLUS LHA	16 m^3
LEVEL 7 UPPER	F.806	3 BED LHA	6 m^3

RESIDENTIAL STORAGE IN BASEMENTS + GROUND CAR PARKS & STORAGE AREA	
VOLUME	NO. OF STORAGE CAGES
BLD A	132
BLD B	107

132

107

TOTAL STORAGE: 239

ALL BASEMENT STORAGE CAGES MINIMUM 4.5m^3 TO MEET MINIMUM ADG REQUIREMENTS

ADG REQUIREMENTS

UNIT TYPE	STORAGE SIZE VOLUME
1 BEDROOM UNIT	6m^3
2 BEDROOM UNIT	8m^3
3 BEDROOM UNIT	10m^3

At least 50% of the required storage is to be located in the apartment

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Revisions			
A	14.12.2021	DEVELOPMENT APPLICATION	JC

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Client / **Dee Why 3 Pty Ltd & Dee Why 4 Pty Ltd**

Project / **4 Delmar Pde & 812 Pittwater Rd, Dee Why**

Drawing / **STORAGE SCHEDULE**

Project No / **221054**

Date / **14.12.2021**

Author / **JC**

Scale @ A1 /

Drawing No / **TP06.21 A**

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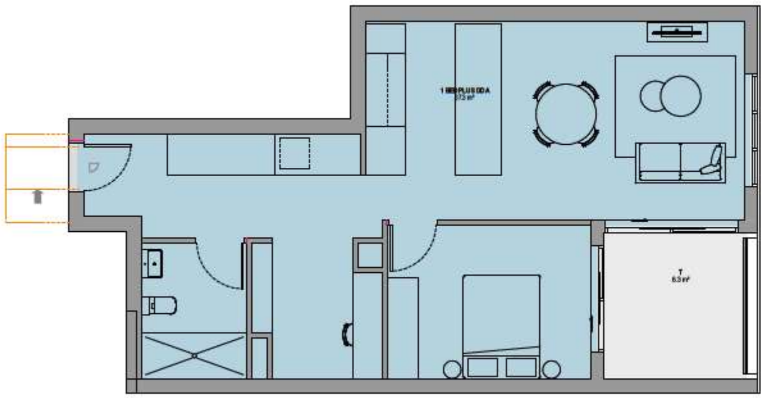
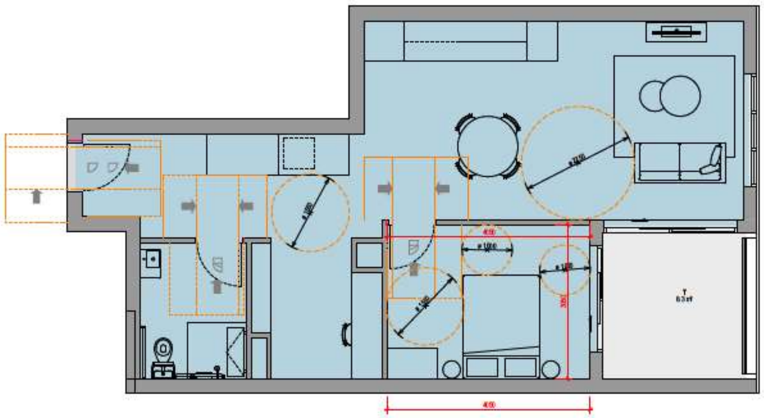


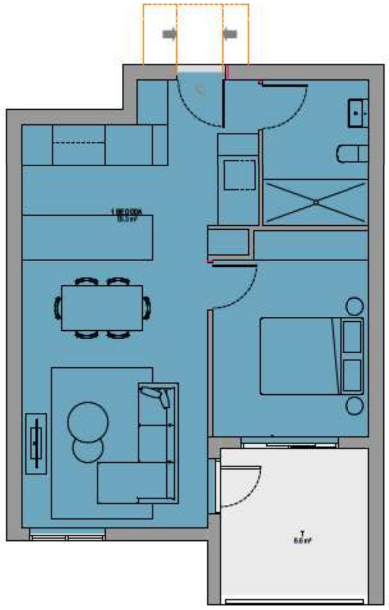
UNIT 1A - PRE



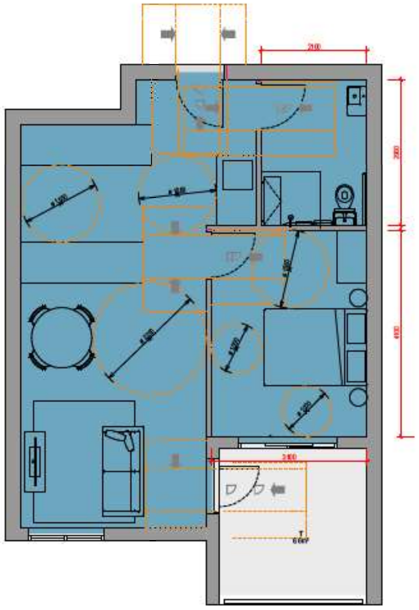
UNIT 1A - POST

UNIT NUMBERS

D202
D302
D402



UNIT 1E DDA - PRE



UNIT 1E DDA - POST

UNIT NUMBERS

D304
D305
D404
D405
D504
D505

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Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **ADAPTABLE PLANS**

Project No / **221054**

Date / **14.12.2021**

Author / **JC**

Scale @ A1 / **1 : 50**

Drawing No / **TP06.31 A**

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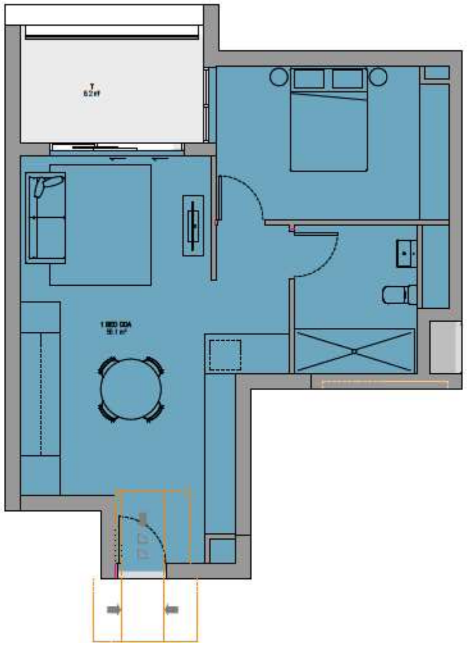

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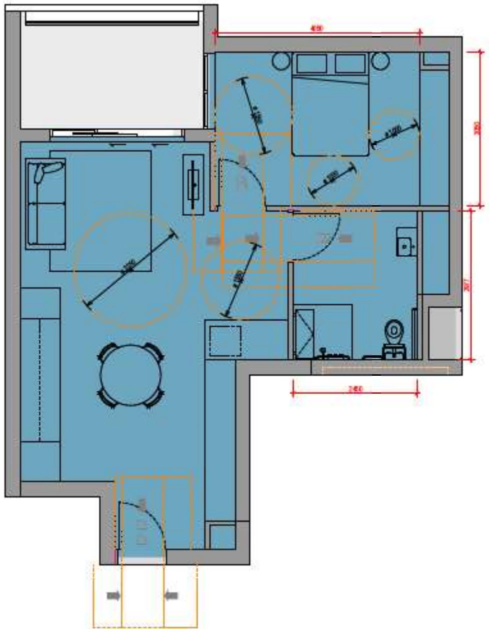
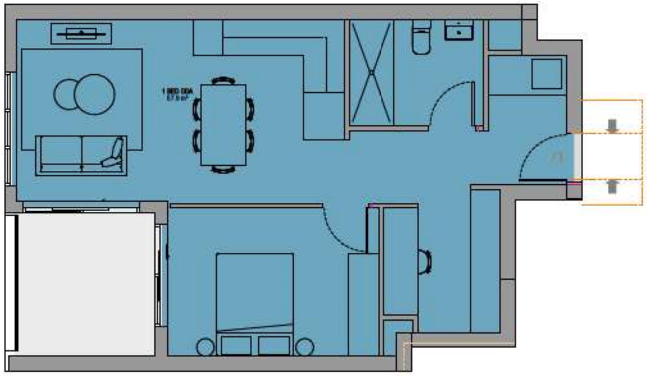
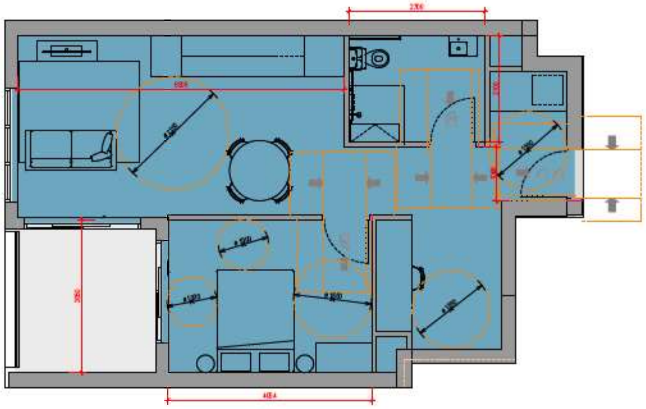


UNIT 1G DDA POST

UNIT NUMBERS
E301
E401
E501
E609



UNIT 1B DDA PRE



UNIT 1B DDA POST

UNIT NUMBERS
B201
B301
B401
B501

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Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **ADAPTABLE PLANS**

Project No / **221054**

Date / **14.12.2021**

Author / **JC**

Scale @ A3 / **1 : 50**

Drawing No / **TP06.32 A**

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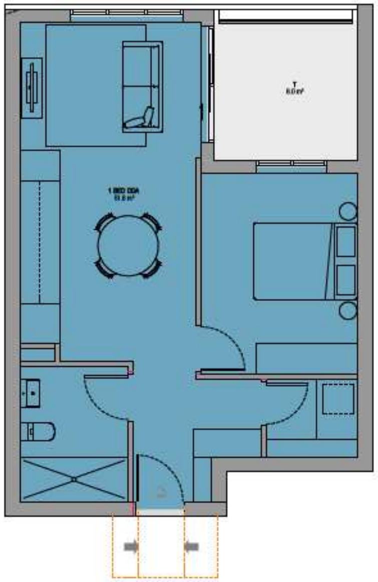
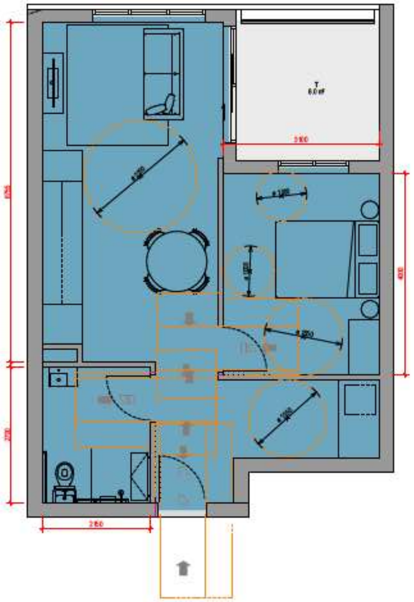


UNIT 1I DDA PRE



UNIT 1I DDA POST

UNIT NUMBERS
E105
E210
E310
E410
E510
E607

ADAPTABLE UNITS

NUMBER	TYPE	TOTAL UNITS	BUILDING
B.201	1 BED DDA	1	BLD A
B.301	1 BED DDA	1	BLD A
B.401	1 BED DDA	1	BLD A
B.501	1 BED DDA	1	BLD A
D.202	1 BED PLUS DDA	1	BLD A
D.302	1 BED PLUS DDA	1	BLD A
D.304	1 BED DDA	1	BLD A
D.305	1 BED DDA	1	BLD A
D.402	1 BED PLUS DDA	1	BLD A
D.404	1 BED DDA	1	BLD A
D.405	1 BED DDA	1	BLD A
D.504	1 BED DDA	1	BLD A
D.505	1 BED DDA	1	BLD A
E.105	1 BED DDA	1	BLD B
E.210	1 BED DDA	1	BLD B
E.301	1 BED DDA	1	BLD B
E.310	1 BED DDA	1	BLD B
E.401	1 BED DDA	1	BLD B
E.410	1 BED DDA	1	BLD B
E.501	1 BED DDA	1	BLD B
E.510	1 BED DDA	1	BLD B
E.607	1 BED DDA	1	BLD B
E.609	1 BED DDA	1	BLD B
		23	

LHA SILVER LEVEL COMPLIANT UNITS

NUMBER	TYPE	TOTAL UNITS	BUILDING
B.101	1 BED PLUS LHA	1	BLD A
B.104	2 BED LHA	1	BLD A
B.105	2 BED PLUS LHA	1	BLD A
D.101	2 BED PLUS LHA	1	BLD A
A.204	2 BED LHA	1	BLD A
B.204	2 BED PLUS LHA	1	BLD A
B.206	1 BED LHA	1	BLD A
C.201	2 BED LHA	1	BLD A
C.204	1 BED PLUS LHA	1	BLD A
D.204	1 BED LHA	1	BLD A
D.205	1 BED LHA	1	BLD A
E.207	1 BED PLUS LHA	1	BLD B
F.203	2 BED LHA	1	BLD B
A.306	2 BED LHA	1	BLD A
B.304	2 BED PLUS LHA	1	BLD A
B.306	1 BED LHA	1	BLD A
C.301	2 BED LHA	1	BLD A
C.304	1 BED PLUS LHA	1	BLD A
E.307	2 BED LHA	1	BLD B
F.301	1 BED LHA	1	BLD B
F.307	2 BED LHA	1	BLD B
F.308	2 BED LHA	1	BLD B
A.406	2 BED LHA	1	BLD A
B.404	2 BED PLUS LHA	1	BLD A
B.406	1 BED LHA	1	BLD A
C.401	2 BED LHA	1	BLD A
C.404	1 BED PLUS LHA	1	BLD A
E.407	2 BED LHA	1	BLD B
F.401	1 BED LHA	1	BLD B
F.407	2 BED LHA	1	BLD B
F.408	2 BED LHA	1	BLD B
A.504	2 BED LHA	1	BLD A
B.504	2 BED LHA	1	BLD A
B.506	1 BED LHA	1	BLD A
C.501	2 BED LHA	1	BLD A
D.502	1 BED PLUS LHA	1	BLD A
E.507	2 BED LHA	1	BLD B
F.501	1 BED LHA	1	BLD B
F.507	2 BED LHA	1	BLD B
F.508	2 BED LHA	1	BLD B
E.604	2 BED LHA	1	BLD B
F.605	2 BED LHA	1	BLD B
F.705	3 BED PLUS LHA	1	BLD B
F.706	3 BED LHA	1	BLD B
F.805	3 BED PLUS LHA	1	BLD B
F.806	3 BED LHA	1	BLD B
		46	

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Client / **Dee Why 3 Pty Ltd &**
Dee Why 4 Pty Ltd

Project / **4 Delmar Pde & 812**
Pittwater Rd, Dee Why

Drawing / **ADAPTABLE PLANS &**
LHA SCHEDULE

Project No / **221054**

Date / **14.12.2021**

Author / **JC**

Scale @ A1 / **1 : 50**

Drawing No / **TP06.33 A**

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BUILDING A - DELMAR PDE

LEVEL	RESIDENTIAL	RESIDENTIAL AMENITIES	PARKING	COMMERCIAL	CIRCULATION/ SERVICES	TERRACE	APARTMENTS						TOTAL UNITS
							No. 1 BEDS	No. 1 BEDS PLUS	No. 2 BEDS	No. 2 BEDS PLUS	No. 3 BEDS	No. 3 BEDS PLUS	
BASEMENT 2	0.0 m²	0.0 m²	5589.1 m²	0.0 m²	94.2 m²	0.0 m²	0	0	0	0	0	0	0
BASEMENT 1	0.0 m²	0.0 m²	4883.5 m²	0.0 m²	92.2 m²	0.0 m²	0	0	0	0	0	0	0
GROUND	1165.6 m²	219.4 m²	92.6 m²	235.8 m²	271.4 m²	474.8 m²	1	2	3	6	2	0	14
LEVEL 1	1922.1 m²	0.0 m²	0.0 m²	0.0 m²	221.5 m²	336.9 m²	7	2	9	3	4	0	25
LEVEL 2	2035.8 m²	0.0 m²	0.0 m²	0.0 m²	233.1 m²	311.2 m²	9	2	8	4	4	0	27
LEVEL 3	2035.8 m²	0.0 m²	0.0 m²	0.0 m²	234.1 m²	311.8 m²	9	2	9	3	4	0	27
LEVEL 4	1868.0 m²	0.0 m²	0.0 m²	0.0 m²	224.9 m²	402.4 m²	7	1	9	4	4	0	25
LEVEL 5	510.9 m²	0.0 m²	0.0 m²	0.0 m²	56.7 m²	99.2 m²	0	0	1	1	3	0	5
LEVEL 5 UPPER	0.0 m²	0.0 m²	0.0 m²	0.0 m²	0.0 m²	0.0 m²	0	0	0	0	0	0	0
	9538.2 m²	219.4 m²	10565.3 m²	235.8 m²	1428.1 m²	1936.4 m²	33	9	39	21	21	0	123
							26.8%	7.3%	31.7%	17.1%	17.1%	0.0%	100%

GFA - BLD A	
LEVEL	AREA
GROUND	1536.9 m²
LEVEL 1	2083.0 m²
LEVEL 2	2218.0 m²
LEVEL 3	2218.0 m²
LEVEL 4	2044.8 m²
LEVEL 5	553.7 m²
	10654.5 m²

(INCLUDING COMMERCIAL)

BUILDING B - PITTWATER RD

LEVEL	RESIDENTIAL	RESIDENTIAL AMENITIES	PARKING	COMMERCIAL	CIRCULATION/ SERVICES	TERRACE	APARTMENTS						TOTAL UNITS
							No. 1 BEDS	No. 1 BEDS PLUS	No. 2 BEDS	No. 2 BEDS PLUS	No. 3 BEDS	No. 3 BEDS PLUS	
BASEMENT 2	0.0 m²	0.0 m²	0.0 m²	0.0 m²	76.7 m²	0.0 m²	0	0	0	0	0	0	0
BASEMENT 1	0.0 m²	0.0 m²	0.0 m²	0.0 m²	544.9 m²	0.0 m²	0	0	0	0	0	0	0
GROUND	504.1 m²	0.0 m²	0.0 m²	0.0 m²	514.4 m²	139.0 m²	3	1	2	0	0	1	7
GROUND UPPER	0.0 m²	0.0 m²	0.0 m²	0.0 m²	14.0 m²	0.0 m²	0	0	0	0	0	0	0
LEVEL 1	830.6 m²	0.0 m²	0.0 m²	0.0 m²	135.5 m²	160.8 m²	4	2	6	0	0	0	12
LEVEL 1 UPPER	247.5 m²	0.0 m²	0.0 m²	203.0 m²	86.3 m²	67.2 m²	3	0	1	0	0	0	4
LEVEL 2	755.6 m²	0.0 m²	0.0 m²	0.0 m²	89.8 m²	114.0 m²	4	0	7	0	0	0	11
LEVEL 2 UPPER	495.5 m²	0.0 m²	0.0 m²	0.0 m²	57.0 m²	74.3 m²	5	0	3	0	0	0	8
LEVEL 3	755.4 m²	0.0 m²	0.0 m²	0.0 m²	90.0 m²	117.8 m²	4	0	7	0	0	0	11
LEVEL 3 UPPER	495.5 m²	0.0 m²	0.0 m²	0.0 m²	56.6 m²	74.3 m²	5	0	3	0	0	0	8
LEVEL 4	755.4 m²	0.0 m²	0.0 m²	0.0 m²	88.8 m²	113.9 m²	4	0	7	0	0	0	11
LEVEL 4 UPPER	495.5 m²	0.0 m²	0.0 m²	0.0 m²	57.0 m²	74.3 m²	5	0	3	0	0	0	8
LEVEL 5	632.6 m²	0.0 m²	0.0 m²	0.0 m²	69.5 m²	118.7 m²	4	0	4	0	1	0	9
LEVEL 5 UPPER	431.0 m²	0.0 m²	0.0 m²	0.0 m²	50.1 m²	131.4 m²	3	0	1	1	1	0	6
LEVEL 6 UPPER	490.5 m²	0.0 m²	0.0 m²	0.0 m²	50.6 m²	70.4 m²	3	0	0	0	2	1	6
LEVEL 7 UPPER	492.2 m²	0.0 m²	0.0 m²	0.0 m²	50.1 m²	70.4 m²	3	0	0	0	2	1	6
	7381.2 m²	0.0 m²	0.0 m²	203.0 m²	2031.4 m²	1326.4 m²	50	3	44	1	6	3	107
							46.7%	2.8%	41.1%	0.9%	5.6%	2.8%	100%

GFA - BLD B	
LEVEL	AREA
GROUND	611.3 m²
LEVEL 1	1411.2 m²
LEVEL 2	1374.9 m²
LEVEL 3	1374.9 m²
LEVEL 4	1375.0 m²
LEVEL 5	1156.4 m²
LEVEL 6	524.1 m²
LEVEL 7	524.4 m²
	8352.2 m²

(INCLUDING COMMERCIAL)

BUILDING A & B SUMMARY

RESIDENTIAL	RESIDENTIAL AMENITIES	PARKING	COMMERCIAL	CIRCULATION/ SERVICES	TERRACE	APARTMENTS						TOTAL UNITS
						No. 1 BEDS	No. 1 BEDS PLUS	No. 2 BEDS	No. 2 BEDS PLUS	No. 3 BEDS	No. 3 BEDS PLUS	
16919.4 m²	219.4 m²	10565.3 m²	438.8 m²	3472.0 m²	3262.8 m²	83	12	83	22	27	3	230
						36.1%	5.2%	36.1%	9.6%	11.7%	1.3%	100%

GFA
AREA
19006.8 m²
19006.8 m²

(INCLUDING COMMERCIAL)

MAX ALLOWABLE GFA = 19486m²

BASEMENT CARPARKS

Level	CARPARKS			
	Residential	Visitor	Commercial	Total
BASEMENT 2	195	0	0	195
BASEMENT 1	80	46	19	145
GROUND	0	0	0	0
	275	46	19	340

Level	Visitor Bicycle Parks
BASEMENT 1	20
GROUND	2

TOTAL BASEMENT AREA: 11 500m²

TOTAL TANDEMS: 16

AMENDED WARRINGAH DCP 2011

Parking rates within the Dee Why Town Centre

Multi dwelling housing, Residential flat buildings, Serviced apartments, Shop-top housing:

- 0.6 spaces per 1 bedroom dwelling
- 0.9 spaces per 2 bedroom dwelling
- 1.4 spaces per 3 bedroom dwelling
- 1 visitor space per 5 units or part of dwellings
- 1 car share space per 25 dwellings (for properties with more than 25 dwellings) each with car share space replacing (1) regular car parking space.

Business Premises:

- 1 space per 40m² GFA excluding customer service/access areas
- for customer service/access areas 1 space per 16.4m² GFA

Office Premises:

- 1 space per 40m² GFA

Shop (includes retail/business component of shop top housing, retail premises and neighbourhood shop):

- 1 space per 23.8m² GLFA (4.2 spaces per 100m² GLFA)

*For preliminary feasibility purposes. Areas are not to be used for purpose of lease or sale agreements. Layouts may not comply with building regulations or other regulatory requirements. The information contained in this schedule is believed to be correct at the time of printing. Areas are generally measured in accordance with the Property Council of Australia Method of Measurement.

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DA SUBMISSION

Revisions / A 14.12.2021 DEVELOPMENT APPLICATION JC

Client / **Dee Why 3 Pty Ltd & Dee Why 4 Pty Ltd**

Project / **4 Delmar Pde & 812 Pittwater Rd, Dee Why**

Drawing / **DEVELOPMENT SUMMARY**

Project No / **221054**

Date / **14.12.2021**

Author / **JC**

Scale @ A1 /

Drawing No / **TP10.01 A**

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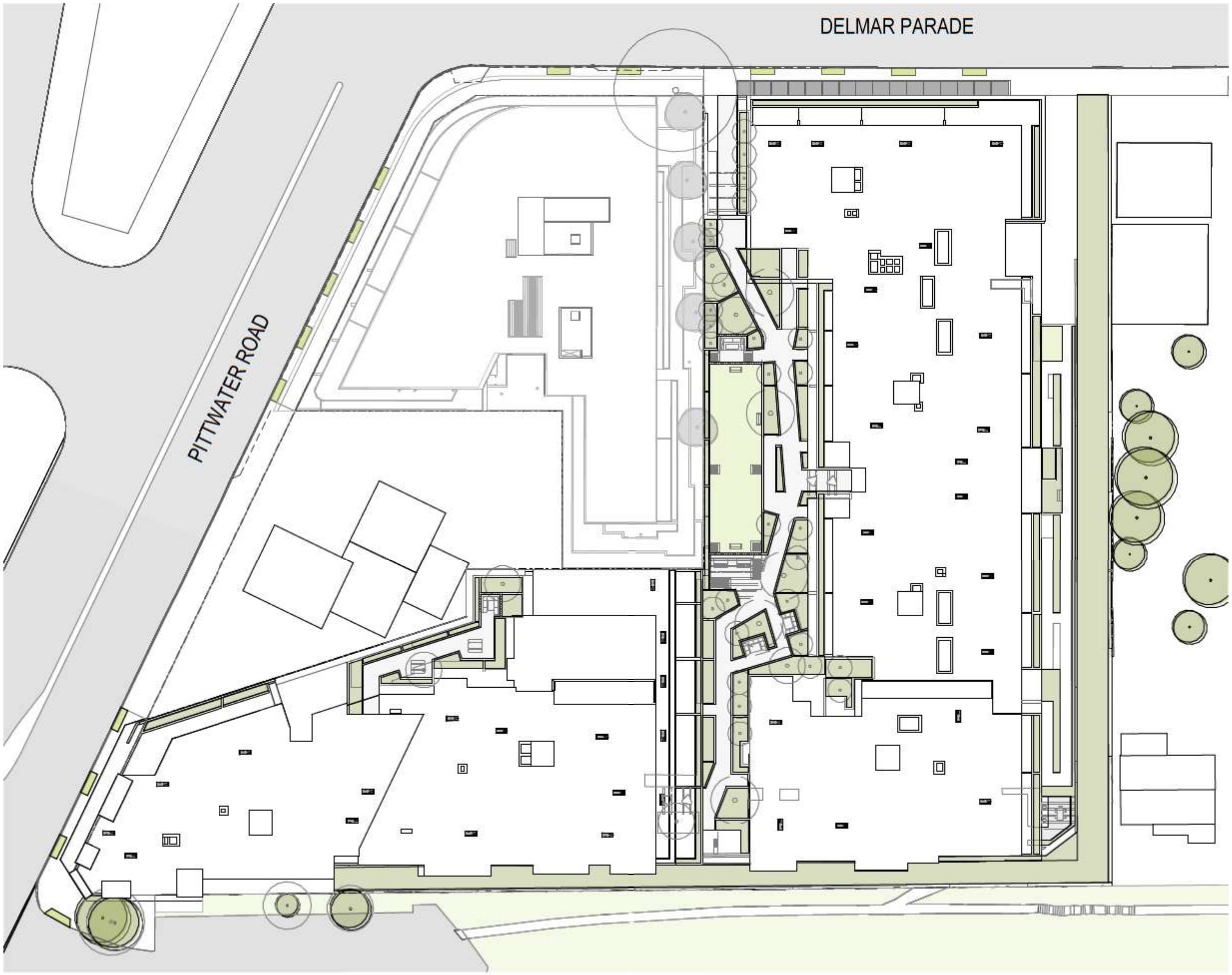

Revisions / A 14.12.2021 DEVELOPMENT APPLICATION JC

Project / **4 Delmar Pde & 812 Pittwater Rd, Dee Why**

Drawing / **NOTIFICATION - SITE PLAN**

Project No / **221054**

Date / **14.12.2021**

Author / **JC**

Scale: @ A3 / **1 : 500**

Drawing No. / **TP12.01 A**

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NORTH ELEVATION

WEST ELEVATION

EAST ELEVATION

Revisions / A 14.12.2021 DEVELOPMENT APPLICATION JC

Project / 4 Delmar Pde & 812
Pittwater Rd, Dee Why

Drawing / NOTIFICATION -
ELEVATIONS

Project No / 221054

Date / 14.12.2021

Author / JC

Scale: @ A3 / 1 : 400

Drawing No. / TP12.02 A

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SOUTH WEST ELEVATION

SOUTH ELEVATION

Revisions / A 14.12.2021 DEVELOPMENT APPLICATION JC

Project / **4 Delmar Pde & 812 Pittwater Rd, Dee Why**

Drawing / **NOTIFICATION - ELEVATIONS**

Project No / **221054**

Date / **14.12.2021**

Author / **JC**

Scale: @ A3 / **1 : 400**

Drawing No. / **TP12.03 A**

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Appendix C – Groundwater Sample Laboratory Results

12 Ashley Street, Chatswood, NSW 2067
tel: +61 2 9910 6200

email: sydney@envirolab.com.au
envirolab.com.au

Envirolab Services Pty Ltd - Sydney | ABN 37 112 535 645

CERTIFICATE OF ANALYSIS 140027

Client:

Douglas Partners Pty Ltd
96 Hermitage Rd
West Ryde
NSW 2114

Attention: Richard Lamont

Sample log in details:

Your Reference:	**85260.01, Due Diligence**		
No. of samples:	6 Waters		
Date samples received / completed instructions received	13/01/16	/	13/01/16

Analysis Details:

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	20/01/16	/	27/01/16
Date of Preliminary Report:	Not Issued		

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Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Jacinta Hurst
Laboratory Manager

VOCs in water Our Reference: Your Reference Date Sampled Type of sample	UNITS ------------- ------------	140027-1 BH2 13/01/2016 Water	140027-2 BH3 13/01/2016 Water	140027-3 BH1 13/01/2016 Water
Date extracted	-	13/01/2016	13/01/2016	13/01/2016
Date analysed	-	14/01/2016	14/01/2016	14/01/2016
Dichlorodifluoromethane	µg/L	<10	<10	<10
Chloromethane	µg/L	<10	<10	<10
Vinyl Chloride	µg/L	<10	<10	<10
Bromomethane	µg/L	<10	<10	<10
Chloroethane	µg/L	<10	<10	<10
Trichlorofluoromethane	µg/L	<10	<10	<10
1,1-Dichloroethene	µg/L	<1	<1	<1
Trans-1,2-dichloroethene	µg/L	<1	<1	<1
1,1-dichloroethane	µg/L	<1	<1	<1
Cis-1,2-dichloroethene	µg/L	<1	<1	<1
Bromochloromethane	µg/L	<1	<1	<1
Chloroform	µg/L	<1	14	<1
2,2-dichloropropane	µg/L	<1	<1	<1
1,2-dichloroethane	µg/L	<1	<1	<1
1,1,1-trichloroethane	µg/L	<1	<1	<1
1,1-dichloropropene	µg/L	<1	<1	<1
Cyclohexane	µg/L	<1	<1	<1
Carbon tetrachloride	µg/L	<1	<1	<1
Benzene	µg/L	<1	<1	<1
Dibromomethane	µg/L	<1	<1	<1
1,2-dichloropropane	µg/L	<1	<1	<1
Trichloroethene	µg/L	<1	<1	<1
Bromodichloromethane	µg/L	<1	<1	<1
trans-1,3-dichloropropene	µg/L	<1	<1	<1
cis-1,3-dichloropropene	µg/L	<1	<1	<1
1,1,2-trichloroethane	µg/L	<1	<1	<1
Toluene	µg/L	<1	39	<1
1,3-dichloropropane	µg/L	<1	<1	<1
Dibromochloromethane	µg/L	<1	<1	<1
1,2-dibromoethane	µg/L	<1	<1	<1
Tetrachloroethene	µg/L	<1	<1	<1
1,1,1,2-tetrachloroethane	µg/L	<1	<1	<1
Chlorobenzene	µg/L	<1	<1	<1
Ethylbenzene	µg/L	<1	<1	<1
Bromoform	µg/L	<1	<1	<1
m+p-xylene	µg/L	<2	<2	<2
Styrene	µg/L	<1	<1	<1
1,1,2,2-tetrachloroethane	µg/L	<1	<1	<1
o-xylene	µg/L	<1	<1	<1

VOCs in water Our Reference:	UNITS	140027-1	140027-2	140027-3
Your Reference	------------- -	BH2	BH3	BH1
Date Sampled	------------	13/01/2016	13/01/2016	13/01/2016
Type of sample		Water	Water	Water
1,2,3-trichloropropane	µg/L	<1	<1	<1
Isopropylbenzene	µg/L	<1	<1	<1
Bromobenzene	µg/L	<1	<1	<1
n-propyl benzene	µg/L	<1	<1	<1
2-chlorotoluene	µg/L	<1	<1	<1
4-chlorotoluene	µg/L	<1	<1	<1
1,3,5-trimethyl benzene	µg/L	<1	<1	<1
Tert-butyl benzene	µg/L	<1	<1	<1
1,2,4-trimethyl benzene	µg/L	<1	<1	<1
1,3-dichlorobenzene	µg/L	<1	<1	<1
Sec-butyl benzene	µg/L	<1	<1	<1
1,4-dichlorobenzene	µg/L	<1	<1	<1
4-isopropyl toluene	µg/L	<1	<1	<1
1,2-dichlorobenzene	µg/L	<1	<1	<1
n-butyl benzene	µg/L	<1	<1	<1
1,2-dibromo-3-chloropropane	µg/L	<1	<1	<1
1,2,4-trichlorobenzene	µg/L	<1	<1	<1
Hexachlorobutadiene	µg/L	<1	<1	<1
1,2,3-trichlorobenzene	µg/L	<1	<1	<1
Surrogate Dibromofluoromethane	%	96	98	97
Surrogate toluene-d8	%	98	101	97
Surrogate 4-BFB	%	94	100	94

vTRH(C6-C10)/BTEXN in Water						
Our Reference:	UNITS	140027-1	140027-2	140027-3	140027-4	140027-5
Your Reference	------------ -	BH2	BH3	BH1	BD1/130116	Trip Blank
Date Sampled	------------	13/01/2016	13/01/2016	13/01/2016	13/01/2016	13/01/2016
Type of sample		Water	Water	Water	Water	Water
Date extracted	-	13/01/2016	13/01/2016	13/01/2016	13/01/2016	13/01/2016
Date analysed	-	14/01/2016	14/01/2016	14/01/2016	14/01/2016	14/01/2016
TRHC_6 - C_9	µg/L	<10	76	<10	<10	[NA]
TRHC_6 - C_{10}	µg/L	<10	77	<10	<10	[NA]
TRHC_6 - C_{10} less BTEX (F1)	µg/L	<10	38	<10	<10	[NA]
Benzene	µg/L	<1	<1	<1	<1	<1
Toluene	µg/L	<1	39	<1	<1	<1
Ethylbenzene	µg/L	<1	<1	<1	<1	<1
m+p-xylene	µg/L	<2	<2	<2	<2	<2
o-xylene	µg/L	<1	<1	<1	<1	<1
Naphthalene	µg/L	<1	<1	<1	<1	[NA]
Surrogate Dibromofluoromethane	%	96	98	97	103	99
Surrogate toluene-d8	%	98	101	97	99	100
Surrogate 4-BFB	%	94	100	94	101	99

vTRH(C6-C10)/BTEXN in Water		
Our Reference:	UNITS	140027-6
Your Reference	------------ -	Trip Spike
Date Sampled	------------	13/01/2016
Type of sample		Water
Date extracted	-	13/01/2016
Date analysed	-	14/01/2016
Benzene	µg/L	108%
Toluene	µg/L	110%
Ethylbenzene	µg/L	101%
m+p-xylene	µg/L	107%
o-xylene	µg/L	110%
Surrogate Dibromofluoromethane	%	97
Surrogate toluene-d8	%	99
Surrogate 4-BFB	%	103

svTRH (C10-C40) in Water					
Our Reference:	UNITS	140027-1	140027-2	140027-3	140027-4
Your Reference	------------- -	BH2	BH3	BH1	BD1/130116
Date Sampled	------------	13/01/2016	13/01/2016	13/01/2016	13/01/2016
Type of sample		Water	Water	Water	Water
Date extracted	-	14/01/2016	14/01/2016	14/01/2016	14/01/2016
Date analysed	-	14/01/2016	14/01/2016	14/01/2016	14/01/2016
TRHC $_{10}$ - C $_{14}$	µg/L	<50	<50	<50	<50
TRHC $_{15}$ - C $_{28}$	µg/L	<100	<100	<100	<100
TRHC $_{29}$ - C $_{36}$	µg/L	<100	<100	<100	<100
TRH>C $_{10}$ - C $_{16}$	µg/L	<50	<50	<50	<50
TRH>C $_{10}$ - C $_{16}$ less Naphthalene (F2)	µg/L	<50	<50	<50	<50
TRH>C $_{16}$ - C $_{34}$	µg/L	<100	<100	<100	<100
TRH>C $_{34}$ - C $_{40}$	µg/L	<100	<100	<100	<100
Surrogate o-Terphenyl	%	93	88	90	88

PAHs in Water - Low Level Our Reference:	UNITS	140027-1	140027-2	140027-3
Your Reference	-------------	BH2	BH3	BH1
Date Sampled	------------	13/01/2016	13/01/2016	13/01/2016
Type of sample		Water	Water	Water
Date extracted	-	14/01/2016	14/01/2016	14/01/2016
Date analysed	-	14/01/2016	14/01/2016	14/01/2016
Naphthalene	µg/L	<0.2	<0.2	<0.2
Acenaphthylene	µg/L	<0.1	<0.1	<0.1
Acenaphthene	µg/L	<0.1	<0.1	<0.1
Fluorene	µg/L	<0.1	<0.1	<0.1
Phenanthrene	µg/L	<0.1	<0.1	<0.1
Anthracene	µg/L	<0.1	<0.1	<0.1
Fluoranthene	µg/L	<0.1	<0.1	<0.1
Pyrene	µg/L	<0.1	<0.1	<0.1
Benzo(a)anthracene	µg/L	<0.1	<0.1	<0.1
Chrysene	µg/L	<0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	µg/L	<0.2	<0.2	<0.2
Benzo(a)pyrene	µg/L	<0.1	<0.1	<0.1
Indeno(1,2,3-c,d)pyrene	µg/L	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	µg/L	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	µg/L	<0.1	<0.1	<0.1
Benzo(a)pyrene TEQ	µg/L	<0.5	<0.5	<0.5
Total +ve PAH's	µg/L	NIL (+)VE	NIL (+)VE	NIL (+)VE
Surrogate p-Terphenyl-d14	%	103	89	93

OCP in water - trace level Our Reference: Your Reference Date Sampled Type of sample	UNITS ------------- ------------	140027-1 BH2 13/01/2016 Water	140027-2 BH3 13/01/2016 Water	140027-3 BH1 13/01/2016 Water
Date extracted	-	20/01/2016	20/01/2016	20/01/2016
Date analysed	-	20/01/2016	20/01/2016	20/01/2016
HCB	µg/L	<0.001	<0.001	<0.001
Heptachlor	µg/L	<0.001	<0.001	<0.001
Heptachlor Epoxide	µg/L	<0.001	<0.001	<0.001
Aldrin	µg/L	<0.001	<0.001	<0.001
gamma-BHC (Lindane)	µg/L	<0.001	<0.001	<0.001
alpha-BHC	µg/L	<0.001	<0.001	<0.001
beta-BHC	µg/L	<0.001	<0.001	<0.001
delta-BHC	µg/L	<0.001	<0.001	<0.001
trans-Chlordane	µg/L	<0.001	<0.001	<0.001
cis-Chlordane	µg/L	<0.001	<0.001	<0.001
Oxychlordane	µg/L	<0.001	<0.001	<0.001
Dieldrin	µg/L	<0.001	0.002	<0.001
p,p-DDE	µg/L	<0.001	<0.001	<0.001
p,p-DDD	µg/L	<0.001	<0.001	<0.001
p,p-DDT	µg/L	<0.001	0.002	<0.001
Endrin	µg/L	<0.001	<0.001	<0.001
Endrin Aldehyde	µg/L	<0.001	<0.001	<0.001
Endrin Ketone	µg/L	<0.001	<0.001	<0.001
alpha-Endosulfan	µg/L	<0.001	<0.001	<0.001
beta-Endosulfan	µg/L	<0.001	<0.001	<0.001
Endosulfan Sulfate	µg/L	<0.001	<0.001	<0.001
Methoxychlor	µg/L	<0.001	<0.001	<0.001
Surrogate OC Recovery	%	69	80	115

OP Pesticides -Trace Level Our Reference: Your Reference Date Sampled Type of sample	UNITS ------------- ------------	140027-1 BH2 13/01/2016 Water	140027-2 BH3 13/01/2016 Water	140027-3 BH1 13/01/2016 Water
Date prepared	-	20/01/2016	20/01/2016	20/01/2016
Date analysed	-	20/01/2016	20/01/2016	20/01/2016
Demeton-S-methyl	µg/L	<0.01	<0.01	<0.01
Dichlorvos	µg/L	<0.01	<0.01	<0.01
Diazinon	µg/L	<0.01	<0.01	<0.01
Dimethoate	µg/L	<0.01	<0.01	<0.01
Chlorpyrifos	µg/L	<0.01	<0.01	<0.01
Chlorpyrifos methyl	µg/L	<0.01	<0.01	<0.01
Malathion	µg/L	<0.01	<0.01	<0.01
Fenthion	µg/L	<0.01	<0.01	<0.01
Azinphos Ethyl	µg/L	<0.01	<0.01	<0.01
Azinphos Methyl	µg/L	<0.01	<0.01	<0.01
Chlorfenvinphos (E)	µg/L	<0.01	<0.01	<0.01
Chlorfenvinphos (Z)	µg/L	<0.01	<0.01	<0.01
Ethion	µg/L	<0.01	<0.01	<0.01
Fenitrothion	µg/L	<0.01	<0.01	<0.01
Parathion (Ethyl)	µg/L	<0.01	<0.01	<0.01
Parathion (Methyl)	µg/L	<0.01	<0.01	<0.01
Primiphos Ethyl	µg/L	<0.01	<0.01	<0.01
Primiphos Methyl	µg/L	<0.01	<0.01	<0.01
Surrogate OP Recovery - TPP	%	90	95	138

PCB in water - trace level				
Our Reference:	UNITS	140027-1	140027-2	140027-3
Your Reference	-------------	BH2	BH3	BH1
Date Sampled	------------	13/01/2016	13/01/2016	13/01/2016
Type of sample		Water	Water	Water
Date prepared	-	20/01/2016	20/01/2016	20/01/2016
Date analysed	-	20/01/2016	20/01/2016	20/01/2016
Aroclor 1016	µg/L	<0.01	<0.01	<0.01
Aroclor 1221	µg/L	<0.01	<0.01	<0.01
Aroclor 1232	µg/L	<0.01	<0.01	<0.01
Aroclor 1242	µg/L	<0.01	<0.01	<0.01
Aroclor 1248	µg/L	<0.01	<0.01	<0.01
Aroclor 1254	µg/L	<0.01	<0.01	<0.01
Aroclor 1260	µg/L	<0.01	<0.01	<0.01
Total PCB's (as above)	µg/L	<0.01	<0.01	<0.01

HM in water - dissolved Our Reference:	UNITS	140027-1	140027-2	140027-3	140027-4
Your Reference	-------------	BH2	BH3	BH1	BD1/130116
Date Sampled	------------	13/01/2016	13/01/2016	13/01/2016	13/01/2016
Type of sample		Water	Water	Water	Water
Date prepared	-	14/01/2016	14/01/2016	14/01/2016	14/01/2016
Date analysed	-	14/01/2016	14/01/2016	14/01/2016	14/01/2016
Arsenic-Dissolved	µg/L	<1	<1	<1	<1
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	1	<1	<1	<1
Copper-Dissolved	µg/L	<1	2	<1	<1
Lead-Dissolved	µg/L	<1	<1	<1	<1
Nickel-Dissolved	µg/L	16	11	4	4
Zinc-Dissolved	µg/L	24	33	24	26
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05

Total Phenolics in Water				
Our Reference:	UNITS	140027-1	140027-2	140027-3
Your Reference	------------- -	BH2	BH3	BH1
Date Sampled	------------	13/01/2016	13/01/2016	13/01/2016
Type of sample		Water	Water	Water
Date extracted	-	14/01/2016	14/01/2016	14/01/2016
Date analysed	-	14/01/2016	14/01/2016	14/01/2016
Total Phenolics (as Phenol)	mg/L	<0.05	<0.05	<0.05

Miscellaneous Inorganics				
Our Reference:	UNITS	140027-1	140027-2	140027-3
Your Reference	-------------	BH2	BH3	BH1
Date Sampled	------------	13/01/2016	13/01/2016	13/01/2016
Type of sample		Water	Water	Water
Date prepared	-	14/01/2016	14/01/2016	14/01/2016
Date analysed	-	14/01/2016	14/01/2016	14/01/2016
Hardness	mgCaCO3/L	36	41	28
Calcium - Dissolved	mg/L	3.3	11	0.9
Magnesium - Dissolved	mg/L	6.6	3.5	6.2

Method ID	Methodology Summary
Org-013	Water samples are analysed directly by purge and trap GC-MS.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013.
Ext-020	Analysis subcontracted to Australian Government - National Measurement Institute. NATA Accreditation No: 198
Metals-022 ICP-MS	Determination of various metals by ICP-MS.
Metals-021 CV-AAS	Determination of Mercury by Cold Vapour AAS.
Inorg-031	Total Phenolics by segmented flow analyser (in line distillation with colourimetric finish). Solids are extracted in a caustic media prior to analysis.
Metals-020 ICP-AES	Determination of various metals by ICP-AES.

QUALITY CONTROL VOCs in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			13/01/2016	140027-1	13/01/2016 || 13/01/2016	LCS-W1	13/01/2016
Date analysed	-			14/01/2016	140027-1	14/01/2016 || 14/01/2016	LCS-W1	14/01/2016
Dichlorodifluoromethane	µg/L	10	Org-013	<10	140027-1	<10 || <10	[NR]	[NR]
Chloromethane	µg/L	10	Org-013	<10	140027-1	<10 || <10	[NR]	[NR]
Vinyl Chloride	µg/L	10	Org-013	<10	140027-1	<10 || <10	[NR]	[NR]
Bromomethane	µg/L	10	Org-013	<10	140027-1	<10 || <10	[NR]	[NR]
Chloroethane	µg/L	10	Org-013	<10	140027-1	<10 || <10	[NR]	[NR]
Trichlorofluoromethane	µg/L	10	Org-013	<10	140027-1	<10 || <10	[NR]	[NR]
1,1-Dichloroethene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Trans-1,2-dichloroethene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,1-dichloroethane	µg/L	1	Org-013	<1	140027-1	<1 || <1	LCS-W1	116%
Cis-1,2-dichloroethene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Bromochloromethane	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Chloroform	µg/L	1	Org-013	<1	140027-1	<1 || <1	LCS-W1	103%
2,2-dichloropropane	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,2-dichloroethane	µg/L	1	Org-013	<1	140027-1	<1 || <1	LCS-W1	103%
1,1,1-trichloroethane	µg/L	1	Org-013	<1	140027-1	<1 || <1	LCS-W1	112%
1,1-dichloropropene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Cyclohexane	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Carbon tetrachloride	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Benzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Dibromomethane	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,2-dichloropropane	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Trichloroethene	µg/L	1	Org-013	<1	140027-1	<1 || <1	LCS-W1	102%
Bromodichloromethane	µg/L	1	Org-013	<1	140027-1	<1 || <1	LCS-W1	99%
trans-1,3-dichloropropene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
cis-1,3-dichloropropene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,1,2-trichloroethane	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Toluene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,3-dichloropropane	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Dibromochloromethane	µg/L	1	Org-013	<1	140027-1	<1 || <1	LCS-W1	98%
1,2-dibromoethane	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Tetrachloroethene	µg/L	1	Org-013	<1	140027-1	<1 || <1	LCS-W1	98%
1,1,1,2-tetrachloroethane	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Chlorobenzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Ethylbenzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Bromoform	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
m+p-xylene	µg/L	2	Org-013	<2	140027-1	<2 || <2	[NR]	[NR]
Styrene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,1,2,2-tetrachloroethane	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
o-xylene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]

QUALITY CONTROL VOCs in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
1,2,3-trichloropropane	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Isopropylbenzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Bromobenzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
n-propyl benzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
2-chlorotoluene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
4-chlorotoluene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,3,5-trimethyl benzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Tert-butyl benzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,2,4-trimethyl benzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,3-dichlorobenzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Sec-butyl benzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,4-dichlorobenzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
4-isopropyl toluene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,2-dichlorobenzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
n-butyl benzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,2-dibromo-3-chloropropane	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,2,4-trichlorobenzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Hexachlorobutadiene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
1,2,3-trichlorobenzene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Surrogate Dibromofluoromethane	%		Org-013	96	140027-1	96 || 98 || RPD: 2	LCS-W1	95%
Surrogate toluene-d8	%		Org-013	96	140027-1	98 || 98 || RPD: 0	LCS-W1	100%
Surrogate 4-BFB	%		Org-013	96	140027-1	94 || 92 || RPD: 2	LCS-W1	102%

QUALITY CONTROL vTRH(C6-C10)/BTEXN in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			13/01/2016	140027-1	13/01/2016 || 13/01/2016	LCS-W1	13/01/2016
Date analysed	-			14/01/2016	140027-1	14/01/2016 || 14/01/2016	LCS-W1	14/01/2016
TRHC_6 - C_9	µg/L	10	Org-016	<10	140027-1	<10 || <10	LCS-W1	103%
TRHC_6 - C_{10}	µg/L	10	Org-016	<10	140027-1	<10 || <10	LCS-W1	103%
Benzene	µg/L	1	Org-016	<1	140027-1	<1 || <1	LCS-W1	110%
Toluene	µg/L	1	Org-016	<1	140027-1	<1 || <1	LCS-W1	101%
Ethylbenzene	µg/L	1	Org-016	<1	140027-1	<1 || <1	LCS-W1	101%
m+p-xylene	µg/L	2	Org-016	<2	140027-1	<2 || <2	LCS-W1	101%
o-xylene	µg/L	1	Org-016	<1	140027-1	<1 || <1	LCS-W1	101%
Naphthalene	µg/L	1	Org-013	<1	140027-1	<1 || <1	[NR]	[NR]
Surrogate Dibromofluoromethane	%		Org-016	96	140027-1	96 || 98 || RPD: 2	LCS-W1	95%
Surrogate toluene-d8	%		Org-016	96	140027-1	98 || 98 || RPD: 0	LCS-W1	100%
Surrogate 4-BFB	%		Org-016	96	140027-1	94 || 92 || RPD: 2	LCS-W1	102%

QUALITY CONTROL svTRH (C10-C40) in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			14/01/2016	[NT]	[NT]	LCS-W1	14/01/2016
Date analysed	-			14/01/2016	[NT]	[NT]	LCS-W1	14/01/2016
TRHC_{10} - C_{14}	µg/L	50	Org-003	<50	[NT]	[NT]	LCS-W1	102%
TRHC_{15} - C_{28}	µg/L	100	Org-003	<100	[NT]	[NT]	LCS-W1	120%
TRHC_{29} - C_{36}	µg/L	100	Org-003	<100	[NT]	[NT]	LCS-W1	106%
TRH>C_{10} - C_{16}	µg/L	50	Org-003	<50	[NT]	[NT]	LCS-W1	102%
TRH>C_{16} - C_{34}	µg/L	100	Org-003	<100	[NT]	[NT]	LCS-W1	120%
TRH>C_{34} - C_{40}	µg/L	100	Org-003	<100	[NT]	[NT]	LCS-W1	106%
Surrogate o-Terphenyl	%		Org-003	73	[NT]	[NT]	LCS-W1	76%

QUALITY CONTROL PAHs in Water - Low Level	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			14/01/2016	[NT]	[NT]	LCS-W1	14/01/2016
Date analysed	-			14/01/2016	[NT]	[NT]	LCS-W1	14/01/2016
Naphthalene	µg/L	0.2	Org-012	<0.2	[NT]	[NT]	LCS-W1	96%
Acenaphthylene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NR]	[NR]
Acenaphthene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NR]	[NR]
Fluorene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	LCS-W1	103%
Phenanthrene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	LCS-W1	89%
Anthracene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NR]	[NR]
Fluoranthene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	LCS-W1	90%
Pyrene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	LCS-W1	94%

QUALITY CONTROL PAHs in Water - Low Level	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Benzo(a)anthracene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NR]	[NR]
Chrysene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	LCS-W1	110%
Benzo(b,j+k) fluoranthene	µg/L	0.2	Org-012	<0.2	[NT]	[NT]	[NR]	[NR]
Benzo(a)pyrene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	LCS-W1	87%
Indeno(1,2,3-c,d)pyrene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NR]	[NR]
Dibenzo(a,h)anthracene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NR]	[NR]
Benzo(g,h,i)perylene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NR]	[NR]
Surrogate p-Terphenyl-d14	%		Org-012	77	[NT]	[NT]	LCS-W1	92%

QUALITY CONTROL OCP in water - trace level	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			20/01/2016	[NT]	[NT]	LCS-W1	20/01/2016
Date analysed	-			20/01/2016	[NT]	[NT]	LCS-W1	20/01/2016
HCB	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
Heptachlor	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	LCS-W1	60%
Heptachlor Epoxide	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
Aldrin	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	LCS-W1	61%
gamma-BHC (Lindane)	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	LCS-W1	65%
alpha-BHC	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
beta-BHC	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
delta-BHC	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
trans-Chlordane	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
cis-Chlordane	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
Oxychlordane	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
Dieldrin	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	LCS-W1	74%
p,p-DDE	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
p,p-DDD	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
p,p-DDT	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	LCS-W1	99%
Endrin	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	LCS-W1	80%
Endrin Aldehyde	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
Endrin Ketone	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
alpha-Endosulfan	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
beta-Endosulfan	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
Endosulfan Sulfate	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
Methoxychlor	µg/L	0.001	Ext-020	<0.001	[NT]	[NT]	[NR]	[NR]
Surrogate OC Recovery	%		Ext-020	[NT]	[NT]	[NT]	LCS-W1	68%

QUALITY CONTROL OP Pesticides -Trace Level	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			20/01/2016	[NT]	[NT]	LCS-W1	20/01/2016
Date analysed	-			20/01/2016	[NT]	[NT]	LCS-W1	20/01/2016
Demeton-S-methyl	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Dichlorvos	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Diazinon	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	LCS-W1	58%
Dimethoate	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Chlorpyrifos	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	LCS-W1	72%
Chlorpyrifos methyl	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Malathion	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Fenthion	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Azinphos Ethyl	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Azinphos Methyl	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Chlorfenvinphos (E)	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Chlorfenvinphos (Z)	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Ethion	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	LCS-W1	89%
Fenitrothion	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Parathion (Ethyl)	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	LCS-W1	90%
Parathion (Methyl)	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Primiphos Ethyl	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Primiphos Methyl	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Surrogate OP Recovery -TPP	%		Ext-020	[NT]	[NT]	[NT]	LCS-W1	67%

QUALITY CONTROL PCB in water - trace level	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			20/01/2016	[NT]	[NT]	LCS-W1	20/01/2016
Date analysed	-			20/01/2016	[NT]	[NT]	LCS-W1	20/01/2016
Aroclor 1016	µg/L	0.01	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Aroclor 1221	µg/L	0.01	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Aroclor 1232	µg/L	0.01	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Aroclor 1242	µg/L	0.01	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Aroclor 1248	µg/L	0.01	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Aroclor 1254	µg/L	0.01	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Aroclor 1260	µg/L	0.01	Ext-020	<0.01	[NT]	[NT]	[NR]	[NR]
Total PCB's (as above)	µg/L	0.010	Ext-020	<0.01	[NT]	[NT]	LCS-W1	88%

QUALITY CONTROL HM in water - dissolved	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			14/01/2016	140027-1	14/01/2016 || 14/01/2016	LCS-W3	14/01/2016
Date analysed	-			14/01/2016	140027-1	14/01/2016 || 14/01/2016	LCS-W3	14/01/2016
Arsenic-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	140027-1	<1 || <1	LCS-W3	99%
Cadmium-Dissolved	µg/L	0.1	Metals-022 ICP-MS	<0.1	140027-1	<0.1 || <0.1	LCS-W3	104%
Chromium-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	140027-1	1 || 1 || RPD: 0	LCS-W3	97%
Copper-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	140027-1	<1 || <1	LCS-W3	105%
Lead-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	140027-1	<1 || <1	LCS-W3	102%
Nickel-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	140027-1	16 || 16 || RPD: 0	LCS-W3	99%
Zinc-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	140027-1	24 || 24 || RPD: 0	LCS-W3	98%
Mercury-Dissolved	µg/L	0.05	Metals-021 CV-AAS	<0.05	140027-1	<0.05 || [N/T]	LCS-W3	71%

QUALITY CONTROL Total Phenolics in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			14/01/2016	[NT]	[NT]	LCS-W1	14/01/2016
Date analysed	-			14/01/2016	[NT]	[NT]	LCS-W1	14/01/2016
Total Phenolics (as Phenol)	mg/L	0.05	Inorg-031	<0.05	[NT]	[NT]	LCS-W1	100%

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			14/01/2016	[NT]	[NT]	LCS-W1	14/01/2016
Date analysed	-			14/01/2016	[NT]	[NT]	LCS-W1	14/01/2016
Hardness	mgCaCO3/L	3		[NT]	[NT]	[NT]	[NR]	[NR]
Calcium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	108%
Magnesium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	110%

QUALITY CONTROL VOCs in water	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date extracted	-	140027-2	13/01/2016 || 15/01/2016
Date analysed	-	140027-2	14/01/2016 || 15/01/2016
Dichlorodifluoromethane	µg/L	140027-2	<10 || <10
Chloromethane	µg/L	140027-2	<10 || <10
Vinyl Chloride	µg/L	140027-2	<10 || <10
Bromomethane	µg/L	140027-2	<10 || <10
Chloroethane	µg/L	140027-2	<10 || <10
Trichlorofluoromethane	µg/L	140027-2	<10 || <10
1,1-Dichloroethene	µg/L	140027-2	<1 || <1
Trans-1,2-dichloroethene	µg/L	140027-2	<1 || <1
1,1-dichloroethane	µg/L	140027-2	<1 || <1
Cis-1,2-dichloroethene	µg/L	140027-2	<1 || <1
Bromochloromethane	µg/L	140027-2	<1 || <1
Chloroform	µg/L	140027-2	14 || 14 || RPD: 0
2,2-dichloropropane	µg/L	140027-2	<1 || <1
1,2-dichloroethane	µg/L	140027-2	<1 || <1
1,1,1-trichloroethane	µg/L	140027-2	<1 || <1
1,1-dichloropropene	µg/L	140027-2	<1 || <1
Cyclohexane	µg/L	140027-2	<1 || <1
Carbon tetrachloride	µg/L	140027-2	<1 || <1
Benzene	µg/L	140027-2	<1 || <1
Dibromomethane	µg/L	140027-2	<1 || <1
1,2-dichloropropane	µg/L	140027-2	<1 || <1
Trichloroethene	µg/L	140027-2	<1 || <1

QUALITY CONTROL VOCs in water	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Bromodichloromethane	µg/L	140027-2	<1 || <1
trans-1,3-dichloropropene	µg/L	140027-2	<1 || <1
cis-1,3-dichloropropene	µg/L	140027-2	<1 || <1
1,1,2-trichloroethane	µg/L	140027-2	<1 || <1
Toluene	µg/L	140027-2	39 || 37 || RPD: 5
1,3-dichloropropane	µg/L	140027-2	<1 || <1
Dibromochloromethane	µg/L	140027-2	<1 || <1
1,2-dibromoethane	µg/L	140027-2	<1 || <1
Tetrachloroethene	µg/L	140027-2	<1 || <1
1,1,1,2-tetrachloroethane	µg/L	140027-2	<1 || <1
Chlorobenzene	µg/L	140027-2	<1 || <1
Ethylbenzene	µg/L	140027-2	<1 || <1
Bromoform	µg/L	140027-2	<1 || <1
m+p-xylene	µg/L	140027-2	<2 || <2
Styrene	µg/L	140027-2	<1 || <1
1,1,2,2-tetrachloroethane	µg/L	140027-2	<1 || <1
o-xylene	µg/L	140027-2	<1 || <1
1,2,3-trichloropropane	µg/L	140027-2	<1 || <1
Isopropylbenzene	µg/L	140027-2	<1 || <1
Bromobenzene	µg/L	140027-2	<1 || <1
n-propyl benzene	µg/L	140027-2	<1 || <1
2-chlorotoluene	µg/L	140027-2	<1 || <1
4-chlorotoluene	µg/L	140027-2	<1 || <1
1,3,5-trimethyl benzene	µg/L	140027-2	<1 || <1
Tert-butyl benzene	µg/L	140027-2	<1 || <1
1,2,4-trimethyl benzene	µg/L	140027-2	<1 || <1
1,3-dichlorobenzene	µg/L	140027-2	<1 || <1
Sec-butyl benzene	µg/L	140027-2	<1 || <1
1,4-dichlorobenzene	µg/L	140027-2	<1 || <1
4-isopropyl toluene	µg/L	140027-2	<1 || <1
1,2-dichlorobenzene	µg/L	140027-2	<1 || <1
n-butyl benzene	µg/L	140027-2	<1 || <1
1,2-dibromo-3-chloropropane	µg/L	140027-2	<1 || <1
1,2,4-trichlorobenzene	µg/L	140027-2	<1 || <1
Hexachlorobutadiene	µg/L	140027-2	<1 || <1
1,2,3-trichlorobenzene	µg/L	140027-2	<1 || <1
Surrogate Dibromofluoromethane	%	140027-2	98 || 107 || RPD: 9
Surrogate toluene-d8	%	140027-2	101 || 99 || RPD: 2
Surrogate 4-BFB	%	140027-2	100 || 94 || RPD: 6

QUALITY CONTROL vTRH(C6-C10)/BTEXN in Water	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date extracted	-	140027-2	13/01/2016 || 15/01/2016
Date analysed	-	140027-2	14/01/2016 || 15/01/2016
TRHC_6 - C_9	µg/L	140027-2	76 || 75 || RPD: 1
TRHC_6 - C_{10}	µg/L	140027-2	77 || 78 || RPD: 1
Benzene	µg/L	140027-2	<1 || <1
Toluene	µg/L	140027-2	39 || 37 || RPD: 5
Ethylbenzene	µg/L	140027-2	<1 || <1
m+p-xylene	µg/L	140027-2	<2 || <2
o-xylene	µg/L	140027-2	<1 || <1
Naphthalene	µg/L	140027-2	<1 || <1
Surrogate Dibromofluoromethane	%	140027-2	98 || 107 || RPD: 9
Surrogate toluene-d8	%	140027-2	101 || 99 || RPD: 2
Surrogate 4-BFB	%	140027-2	100 || 94 || RPD: 6

QUALITY CONTROL HM in water - dissolved	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	140027-3	14/01/2016 || 14/01/2016
Date analysed	-	140027-3	14/01/2016 || 14/01/2016
Arsenic-Dissolved	µg/L	140027-3	<1 || [N/T]
Cadmium-Dissolved	µg/L	140027-3	<0.1 || [N/T]
Chromium-Dissolved	µg/L	140027-3	<1 || [N/T]
Copper-Dissolved	µg/L	140027-3	<1 || [N/T]
Lead-Dissolved	µg/L	140027-3	<1 || [N/T]
Nickel-Dissolved	µg/L	140027-3	4 || [N/T]
Zinc-Dissolved	µg/L	140027-3	24 || [N/T]
Mercury-Dissolved	µg/L	140027-3	<0.05 || <0.05

Report Comments:

OC/OP/PCB's in water analysed by NMI. Report No.RN1099230.

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test
NR: Test not required
<: Less than
PQL: Practical Quantitation Limit
RPD: Relative Percent Difference
>: Greater than
NT: Not tested
NA: Test not required
LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Appendix D – Groundwater Monitoring Well Construction Logs

assetgeoenviro

Borehole Log

BH no:	**BH1**
sheet:	1 of 4
job no.:	6561

client:	Landmark Group	**started:**	14.9.2021
principal:		**finished:**	14.9.2021
project:	Proposed Mixed-use Development	**logged:**	JL
location:	4 Delmar Parade & 812 Pittwater Road, Dee Why NSW	**checked:**	MAB
equipment:	Truck-Mounted Drilling Rig	**RL surface:**	28.90 m approx.
diameter:	110mm **inclination:** -90° **bearing:** --- **E:** **N:**	**datum:**	AHD

drilling information | **material information**

method	support	water	notes samples, tests, etc	RL	depth metres	graphic log	USCS symbol	**material description** soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	hand penetro-meter kPa 100 200 300 400	**structure and additional observations**
ATD	N	None Observed					PAVERS	CONCRETE Pavement				PAVEMENT
				28.5	0.2 0.5		FILL	Silty SAND, fine to medium grained, dark brown, trace of gravel and brick fragments	D-M	L		FILL
				28.0	0.5 1.0		FILL	Silty SAND, fine grained, grey to dark grey, trace of gravels		MD		
				27.5 27.0 26.5	1 1.5 2.0 2.5		CL	Sandy CLAY, medium plasticity, brown	M	F-St		ALLUVIUM
				26.0 25.5	2.5 3.0 3.5		SC	Clayey SAND, fine to medium grained, brown to red	M-<Wp	D-VD		
				25.0 24.5	4.0 4.5							RESIDUAL
				24.0	4.8 5.0		SM	Silty SAND, fine grained, pale brown, trace of extremely weathered sandstone fragments		VD		

REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

Hard Practical Refusal

Borehole Log

BH no:	**BH1**
sheet:	2 of 4
job no.:	6561

client: Landmark Group
principal:
project: Proposed Mixed-use Development
location: 4 Delmar Parade & 812 Pittwater Road, Dee Why NSW
equipment: Truck-Mounted Drilling Rig
diameter: 110mm **inclination:** -90° **bearing:** --- **E:** **N:**

started: 14.9.2021
finished: 14.9.2021
logged: JL
checked: MAB
RL surface: 28.90 m approx.
datum: AHD

drilling information | **material information**

method	support	water	notes samples, tests, etc	RL	depth metres	graphic log	USCS symbol	**material description** soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	**structure and additional observations**
ATD	N	None Observed	D	23.5 23.0	5.5 6.0		SM	Silty SAND, fine grained, pale brown, trace of extremely weathered sandstone fragments *(continued)*	M- <Wp	VD		
				22.5	6 6.5			SANDSTONE, fine to medium grained, pale grey and pale brown				
				22.0 21.5 21.0 20.5 20.0 19.5 19.0	7.0 7.5 8.0 8.5 9.0 9.5 10.0			Borehole No: BH1 continued as cored hole from 6.5m				

6561 BH LOGS.GPJ 7/10/21

REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

Cored Borehole Log

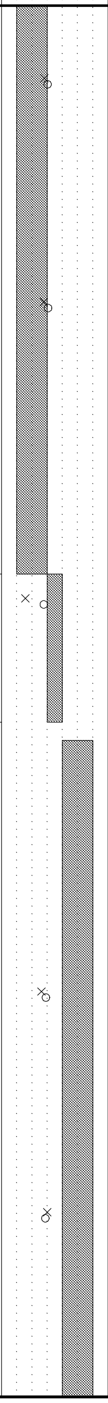
BH no:	**BH1**
sheet:	3 of 4
job no.:	6561

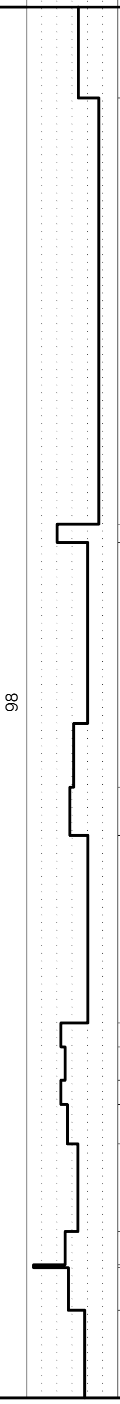
client: Landmark Group
principal:
project: Proposed Mixed-use Development
location: 4 Delmar Parade & 812 Pittwater Road, Dee Why NSW
equipment: Truck-Mounted Drilling Rig
diameter: 110mm **inclination:** -90° **bearing:** --- **E:** **N:**

started: 14.9.2021
finished: 14.9.2021
logged: JL
checked: MAB
RL surface: 28.90 m
datum: AHD

drilling information | **material information** | **rock mass defects**

method	support & core-lift	water	RL	depth metres	graphic log / core recovery	rock substance description (rock type; grain characteristics, colour, structure, minor components)	weathering	Is(50) MPa (D=diametral ×, A=axial ○)	RQD %	defect description (type, inclination, thickness, shape, roughness, coating)
		None Observed	22.5	6.5		Continued from non-cored borehole from 6.5m				
NMLC			22.0	6.5		SANDSTONE, fine to medium grained, pale grey to grey, massive to poorly developed layering at 0°, thckly to medium bedded	HW - MW	D=0.25 A=0.32		PT, pl, 10-15°, cl
			21.5	7.0 / 7.5				D=0.24 A=0.33		FZ, 5°, ro, fill
			21.0 / 20.5	8.0 / 8.5			MW	D=0.06 A=0.24	98	
			20.0	8.87		Sandy CLAY, medium plasticity, pale grey				
				8.93		SANDSTONE, fine to medium grained, grey, poorly to well developed layering at 0°, medium to thinly bedded	SW - FR			PT, pl, 3°, sm, cl PT, un, 0-3°, ro , cl
			19.5 / 19.0	9.0 / 9.5				D=0.2 A=0.28		PT, pl, 20°, ro, fill PT, un, 0-5°, ro, fill JT, un, 60-70°, ro, cl PT, pl, 0-3°, ro, cl PT, pl, 0°, sm , cl
		None Observed	18.5 / 18.0	10.0 / 10.5 / 11.0				D=0.31 A=0.27		PT, pl, 0-3°, sm, cl PT, fill,10mm PT, un, 10-15°, ro, cl





REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

assetgeoenviro

Cored Borehole Log

BH no:	**BH1**
sheet:	4 of 4
job no.:	6561

client:	Landmark Group	**started:**	14.9.2021
principal:		**finished:**	14.9.2021
project:	Proposed Mixed-use Development	**logged:**	JL
location:	4 Delmar Parade & 812 Pittwater Road, Dee Why NSW	**checked:**	MAB
equipment:	Truck-Mounted Drilling Rig	**RL surface:**	28.90 m
diameter:	110mm **inclination:** -90° **bearing:** --- **E:** **N:**	**datum:**	AHD

drilling information					**material information**					**rock mass defects**		
method	support & core-lift	water	RL	depth metres	graphic log core recovery	**rock substance description** rock type; grain characteristics, colour, structure, minor components	weathering	estimated strength MPa EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	$Is_{(50)}$ MPa D=diametral × A=axial ○	RQD %	defect spacing mm 20 60 200 600 2000	**defect description** type, inclination, thickness, shape, roughness, coating specific general
NMLC			17.5 17.0 16.5 16.0 15.5 15.0	11.5 12.0 12.5 13.0 13.5		SANDSTONE, fine to medium grained, grey, poorly to well developed layering at 0°, medium to thinly bedded *(continued)*	SW - FR		D=0.32 A=0.37 D=0.27 A=1 D=0.73 A=0.85	98		PT, un, 5-45°, sm, cl PT, pl, 2°, ro, cl PT, pl, 2°, ro, cl PT, un, 0-5°, sm, fill PT, un, 0-5°, ro, fill PT, pl, 3°, ro, cl PT, un, 0-10°, ro, cl PT, pl, 10°, sm, cl
			14.5 14.0 13.5 13.0	13.9 14.0 14.5 15.0 15.5 16.0		NMLC terminated @ 13.9m. BH1 terminated at 13.9m.						

6561 BH LOGS.GPJ 7/10/21

A	25.9.21	Initial issue
issue	date	description

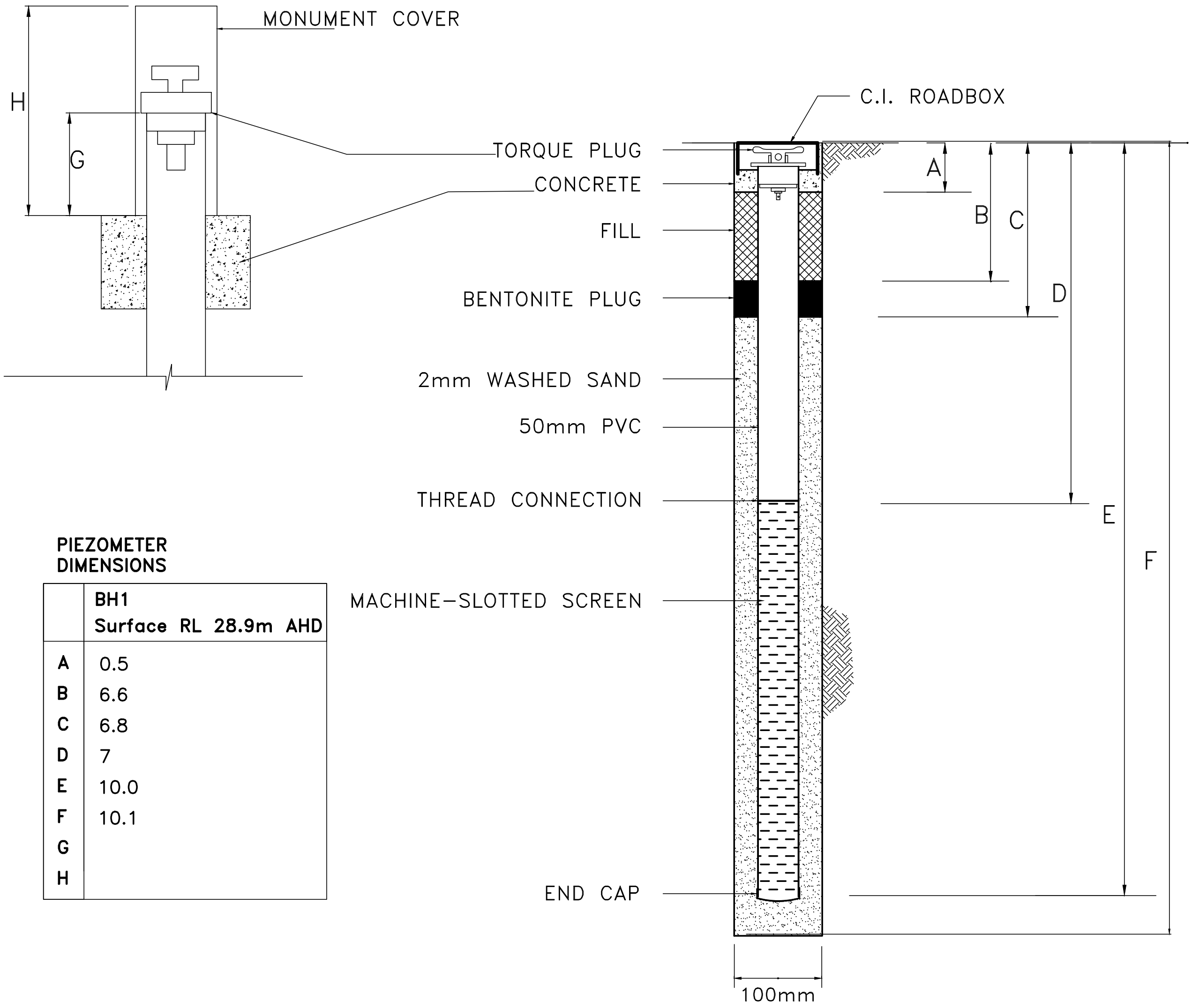
assetgeoenviro
2.06/56 Delhi Rd
North Ryde NSW 2113
t: 02 9878 6005
e: info@assetgeoenviro.com.au

Proposed Mixed-use Development
4 Delmar Parade, Dee Why NSW
for
Landmark Group Australia Pty Ltd

Core Photos – BH1

drawn: MAB
date: 25.6.2021
checked: MAB
scale: 1:4 A4

job no.: 6561
fig: —
issue: A



PIEZOMETER DIMENSIONS

	BH1 Surface RL 28.9m AHD
A	0.5
B	6.6
C	6.8
D	7
E	10.0
F	10.1
G	
H	

GROUNDWATER READINGS

DATE:	BOREHOLE	DEPTH (m)	REDUCED LEVEL	COMMENTS
17.9.2021	BH1	–	–	Bailed out drilling water on completion.

A	22.9.21	INITIAL ISSUE
issue	date	description

assetgeoenviro

Asset Geotechnical Engineering Pty Ltd
2.06/56 Delhi Rd, North Ryde NSW 2113
t: 02 9878 6005
e: info@assetgeoenviro.com.au

PROPOSED MIXED-USE DEVELOPMENT
4 DELMAR PARADE & 812 PITTWATER
ROAD, DEE WHY NSW
for
LANDMARK GROUP

PIEZOMETER DETAILS – BH1

drawn: JL
date: 22.9.21
checked: MAB
scale: NTS

job no.: 6561
fig: —
issue: A

assetgeoenviro

Borehole Log

BH no:	**BH5**
sheet:	1 of 4
job no.:	6561

client:	Landmark Group	**started:**	16.9.2021
principal:		**finished:**	16.9.2021
project:	Proposed Mixed-use Development	**logged:**	JL
location:	4 Delmar Parade & 812 Pittwater Road, Dee Why NSW	**checked:**	MAB
equipment:	Truck-Mounted Drilling Rig	**RL surface:**	32.66 m approx.
diameter:	110mm **inclination:** -90° **bearing:** --- **E:** **N:**	**datum:**	AHD

drilling information						**material information**						
method	support	water	notes samples, tests, etc	RL	depth metres	graphic log	USCS symbol	**material description** soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	hand penetro-meter kPa 100 200 300 400	**structure and additional observations**
ATD	N	None Observed		32.5		■		CONCRETE PAVEMENT				PAVEMENT
				32.0	0.2 0.5	▨		SANDSTONE, fine grained, extremely weathered, very low strength, white				RESIDUAL
				31.5 31.0 30.5 30.0 29.5 29.0 28.5 28.0	1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0			Borehole No: BH5 continued as cored hole from 0.75m				Hard Practical Refusal

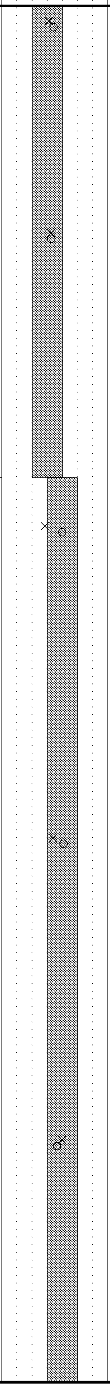
Cored Borehole Log

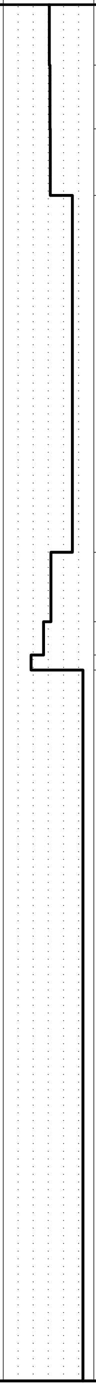
BH no: BH5
sheet: 2 of 4
job no.: 6561

client: Landmark Group
principal:
project: Proposed Mixed-use Development
location: 4 Delmar Parade & 812 Pittwater Road, Dee Why NSW
equipment: Truck-Mounted Drilling Rig
diameter: 110mm **inclination:** -90° **bearing:** --- **E:** **N:**

started: 16.9.2021
finished: 16.9.2021
logged: JL
checked: MAB
RL surface: 32.66 m
datum: AHD

drilling information					material information					rock mass defects		
method	support & core-lift	water	RL	depth metres	graphic log core recovery	rock substance description rock type; grain characteristics, colour, structure, minor components	weathering	estimated strength MPa EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	$Is_{(50)}$ MPa D=diametral × A=axial ○	RQD %	defect spacing mm 20 60 200 600 2000	defect description type, inclination, thickness, shape, roughness, coating specific general
		None Observed		0.5								
			32.0			Continued from non-cored borehole from 0.75m						
NMLC				0.75		SANDSTONE, fine grained, massive to poorly developed layering at 10°, medium to thickly bedded, pale brown	HW - MW		D=0.35 A=0.5			
				1.0								PT, pl, 5°, ro, cl
			31.5									PT, un, 5-15°, ro, fill
												PT, un, 10-20°, ro, fill
				1.5					D=0.41 A=0.42			
			31.0									
				2.0								
			30.5									
				2.31		SANDSTONE, fine to medium grained, pale grey to grey, poorly to well developed layering at 10°, thinly to vey thinly bedded.	MW - SW		D=0.26 A=0.96			
				2.5								PT, XW, pl, 10°, ro, cl
			30.0									PT, XW, un, 10°, ro, cl
												FZ, XW, SM, 50mm
				3.0						99		
			29.5									
				3.5					D=0.48 A=1.07			
			29.0									
				4.0								
			28.5									
				4.5					D=0.95 A=0.65			
			28.0									
				5.0								
		None Observed	27.5									





6561 BH LOGS.GPJ 7/10/21

REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

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Cored Borehole Log

BH no: BH5
sheet: 3 of 4
job no.: 6561

client: Landmark Group
principal:
project: Proposed Mixed-use Development
location: 4 Delmar Parade & 812 Pittwater Road, Dee Why NSW
equipment: Truck-Mounted Drilling Rig
diameter: 110mm **inclination:** -90° **bearing:** --- **E:** **N:**

started: 16.9.2021
finished: 16.9.2021
logged: JL
checked: MAB
RL surface: 32.66 m
datum: AHD

drilling information | **material information** | **rock mass defects**

method: NMLC
water: None Observed
RQD %: 99

depth metres	RL	rock substance description (rock type; grain characteristics, colour, structure, minor components)	weathering	Is(50) MPa (D=diametral × A=axial ○)
		SANDSTONE, fine to medium grained, pale grey to grey, poorly to well developed layering at 10°, thinly to vey thinly bedded. *(continued)*	MW - SW	D=0.57 A=20.2
6.51		SANDSTONE, fine to medium grained, pale brown with white mottles, red ironstone interbedded, poorly developed layering at 10°, medium bedded	SW	D=0.64 A=1.5 D=0.26 A=1.09 D=0.15 A=0.73
8.61		SHALE, fine grained, dark grey, well developed layering	MW - SW	
9.81		SANDSTONE, fine grained, grey, poorly to well developed at 5°, thinly to very thinly bedded	SW - FR	D=0.04 A=0.91

Depth marks: 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0
RL marks: 27.0, 26.5, 26.0, 25.5, 25.0, 24.5, 24.0, 23.5, 23.0, 22.5

estimated strength MPa: EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH

defect spacing mm: 20, 60, 200, 600, 2000

defect description (type, inclination, thickness, shape, roughness, coating; specific / general)

- FZ, XW, CL, 30mm
- PT, un, 3°, ro, cl
- PT, XW-HW, pl, 5°, ro, fill
- PT, XW, st, 10°, ro, cl
- PT, XW< un, 0°, ro, cl
- PT, XW, un, 5°, ro, cl

6561 BH LOGS.GPJ 7/10/21

REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

Cored Borehole Log

BH no: BH5
sheet: 4 of 4
job no.: 6561

client: Landmark Group
principal:
project: Proposed Mixed-use Development
location: 4 Delmar Parade & 812 Pittwater Road, Dee Why NSW
equipment: Truck-Mounted Drilling Rig
diameter: 110mm **inclination:** -90° **bearing:** --- **E:** **N:**

started: 16.9.2021
finished: 16.9.2021
logged: JL
checked: MAB
RL surface: 32.66 m
datum: AHD

drilling information					material information					rock mass defects			
method	support & core-lift	water	RL	depth metres	graphic log core recovery	**rock substance description** rock type; grain characteristics, colour, structure, minor components	weathering	estimated strength MPa EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Is(50) MPa D=diametral × A=axial ○	RQD %	defect spacing mm 20 60 200 600 2000	**defect description** type, inclination, thickness, shape, roughness, coating specific	general
NMLC				10.5		SANDSTONE, fine grained, grey, poorly to well developed at 5°, thinly to very thinly bedded *(continued)*	SW - FR	H	D=0.51 A=1.57				
			22.0										
				11.0									
			21.5										
				11.5					D=0.51 A=1.21				
			21.0										
				12.0									
			20.5										
				12.5					D=0.57 A=0.71				
			20.0							99			
				13.0									
			19.5										
				13.5					D=0.4 A=0.93			PT, XW-HW, un, 0-10°, ro, cl	
			19.0										
				14.0									
			18.5									PT, XW, un, 10°, ro, cl	
				14.5					D=1.54 A=0.9				
			18.0										
				15.0									
				15		NMLC terminated @ 15m BH5 terminated at 15m							
			17.5										

6561 BH LOGS.GPJ 7/10/21

issue	date	description
A	25.9.21	Initial issue

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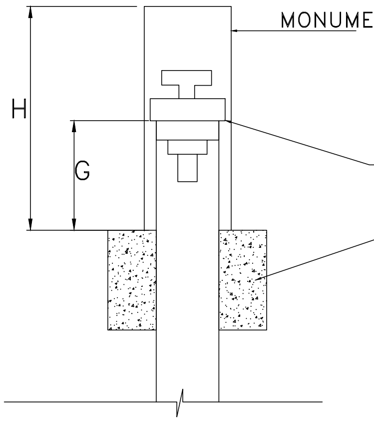
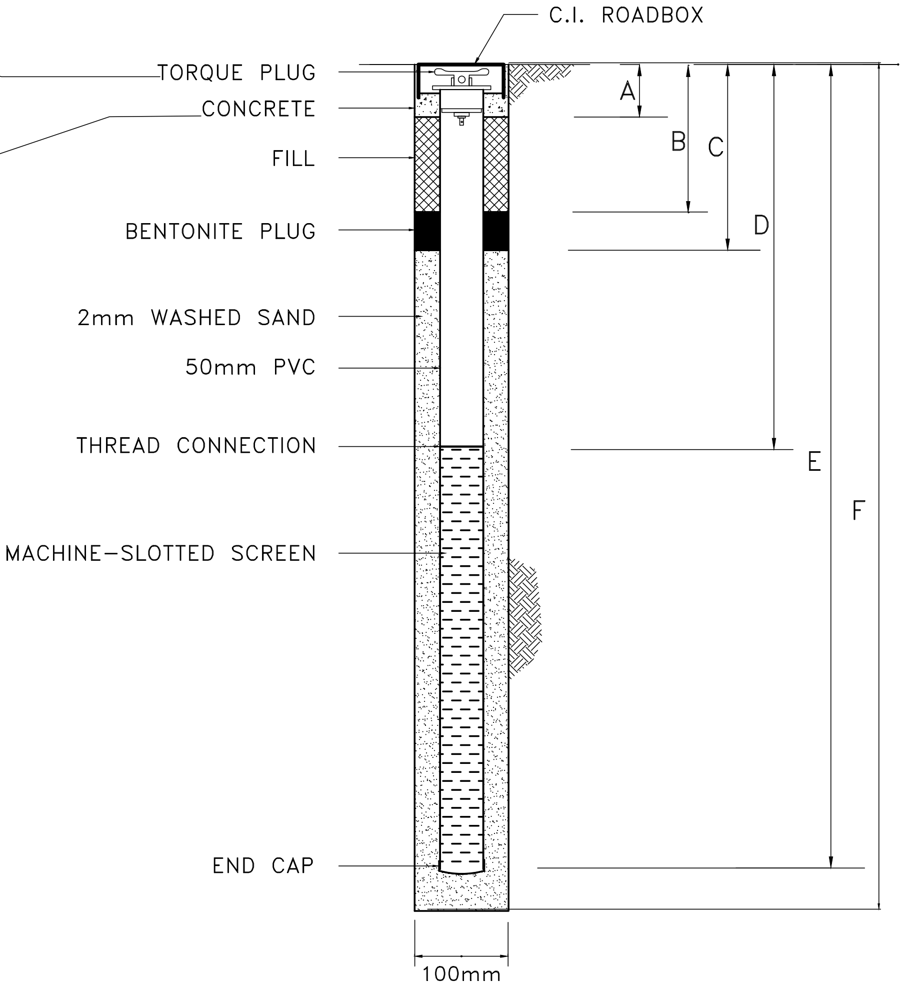
Proposed Mixed-use Development
4 Delmar Parade, Dee Why NSW
for
Landmark Group Australia Pty Ltd

Core Photos – BH5

drawn: MAB
date: 25.6.2021
checked: MAB
scale: 1:4 A4
job no.: 6561
fig: —
issue: A





PIEZOMETER DIMENSIONS

	BH5 **Surface RL 32.7m AHD**
A	0.5
B	11.6
C	11.8
D	11.85
E	14.85
F	15.0
G	
H	

GROUNDWATER READINGS

DATE:	**BOREHOLE**	**DEPTH (m)**	**REDUCED LEVEL**	**COMMENTS**
17.9.2021	BH5	–	–	Bailed out drilling water on completion.

A	22.9.21	INITIAL ISSUE
issue	date	description

assetgeoenviro

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PROPOSED MIXED-USE DEVELOPMENT
4 DELMAR PARADE & 812 PITTWATER
ROAD, DEE WHY NSW
for
LANDMARK GROUP

PIEZOMETER DETAILS – BH5

drawn: JL
date: 22.9.21
checked: MAB
scale: NTS

job no.: 6561
fig: –
issue: A

assetgeoenviro

Borehole Log

BH no:	**BH8**
sheet:	1 of 4
job no.:	6561

client:	Landmark Group	**started:**	17.9.2021
principal:		**finished:**	17.9.2021
project:	Proposed Mixed-use Development	**logged:**	JL
location:	4 Delmar Parade & 812 Pittwater Road, Dee Why NSW	**checked:**	MAB
equipment:	Truck-Mounted Drilling Rig	**RL surface:**	30.51 m approx.
diameter:	110mm **inclination:** -90° **bearing:** --- **E:** **N:**	**datum:**	AHD

drilling information						**material information**						
method	support	water	notes samples, tests, etc	RL	depth metres	graphic log	USCS symbol	**material description** soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	hand penetro-meter kPa 100 200 300 400	**structure and additional observations**
ADT	N					■		CONCRETE PAVEMENT				PAVEMENT
					0.2	▨	SM	Silty SAND, fine to medium grained, dark grey to grey	M-<Wp	L-MD		FILL
				30.0	0.5	▨						
						▨				MD-D		
				29.5	1.0	▨						
				29.0	1.5	▨						
				28.5	2.0	▨						
					2.3	░	SM	Silty SAND, fine to medium grained, brown to dark brown				ALLUVIUM
				28.0	2.5	░						
			D			░						
				27.5	3.0	░						
				27.0	3.5	░						
				26.5	4.0	░						
				26.0	4.5	░						
					5.0							

REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

Borehole Log

BH no:	**BH8**
sheet:	2 of 4
job no.:	6561

client:	Landmark Group	**started:**	17.9.2021
principal:		**finished:**	17.9.2021
project:	Proposed Mixed-use Development	**logged:**	JL
location:	4 Delmar Parade & 812 Pittwater Road, Dee Why NSW	**checked:**	MAB
equipment:	Truck-Mounted Drilling Rig	**RL surface:**	30.51 m approx.
diameter:	110mm **inclination:** -90° **bearing:** --- **E:** **N:**	**datum:**	AHD

drilling information						**material information**						
method	support	water	notes samples, tests, etc	RL	depth metres	graphic log	USCS symbol	**material description** soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	hand penetro-meter kPa 100 200 300 400	**structure and additional observations**
ADT	N	►					SM	Silty SAND, fine to medium grained, brown to dark brown *(continued)*	M-<Wp	MD-D		
					5.2		SM	Silty SAND, fine grained, grey and brown	Wp-Wl	D		RESIDUAL
				25.0	5.5							
				24.5	6.0							
				24.0	6.5							
				23.5	7.0							
				23.0	7.5							
				22.5	8.0							
				22.0	8.5							
				21.5	9.0							
					9.3		SM	Silty SAND, fine grained, brown and purple				
				21.0	9.5							
					10.0							

REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

Hard Practical Refusal

Borehole Log

BH no:	**BH8**
sheet:	3 of 4
job no.:	6561

client:	Landmark Group	**started:**	17.9.2021
principal:		**finished:**	17.9.2021
project:	Proposed Mixed-use Development	**logged:**	JL
location:	4 Delmar Parade & 812 Pittwater Road, Dee Why NSW	**checked:**	MAB
equipment:	Truck-Mounted Drilling Rig	**RL surface:**	30.51 m approx.
diameter:	110mm **inclination:** -90° **bearing:** --- **E:** **N:**	**datum:**	AHD

drilling information						material information						
method	support	water	notes samples, tests, etc	RL	depth metres	graphic log	USCS symbol	**material description** soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	hand penetro-meter kPa 100 200 300 400	**structure and additional observations**
ADT	N						SM	Silty SAND, fine grained, brown and purple *(continued)*	Wp-Wl	D		
				20.0	10.5							
				19.5	11.0							
				19.0	11.5							
				18.5	12.0							
				18.0	12.5							
				17.5	13.0							
				17.0	13.5							
				16.5	14.0							
				16.0	14.5							
					15.0							

Borehole No: BH8 continued as cored hole from 15m

REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED

Cored Borehole Log

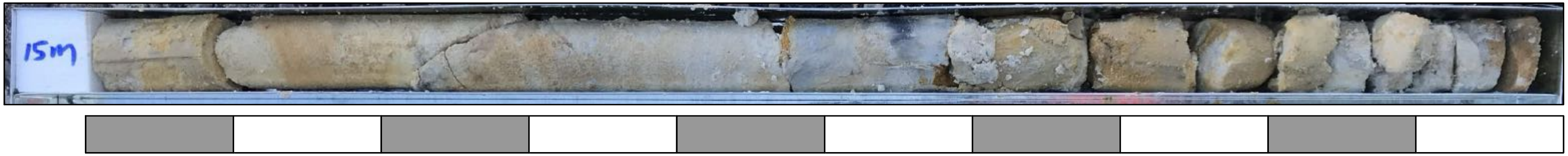
BH no:	**BH8**
sheet:	4 of 4
job no.:	6561

client:	Landmark Group	**started:**	17.9.2021
principal:		**finished:**	17.9.2021
project:	Proposed Mixed-use Development	**logged:**	JL
location:	4 Delmar Parade & 812 Pittwater Road, Dee Why NSW	**checked:**	MAB
equipment:	Truck-Mounted Drilling Rig	**RL surface:**	30.51 m
diameter:	110mm **inclination:** -90° **bearing:** --- **E:** **N:**	**datum:**	AHD

drilling information					**material information**					**rock mass defects**		
method	support & core-lift	water	RL	depth metres	graphic log core recovery	**rock substance description** rock type; grain characteristics, colour, structure, minor components	weathering	estimated strength MPa EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	$Is_{(50)}$ MPa D=diametral × A=axial ○	RQD %	defect spacing mm 20 60 200 600 2000	**defect description** type, inclination, thickness, shape, roughness, coating specific general
			15.5	15.0		Continued from non-cored borehole from 15m						
NMLC					15	SANSTONE, fine grained, massive	HW - MW		D=0.09 A=0.25	93		PT, XW, un, 45°, ro, cl, 70mm PT, XW, SM, 5mm
			15.0	15.5								
			14.5	16.0								
					16	NMLC terminated @ 16.m BH8 terminated at 16m						
			14.0	16.5								
			13.5	17.0								
			13.0	17.5								
			12.5	18.0								
			12.0	18.5								
			11.5	19.0								
			11.0	19.5								

6561 BH LOGS.GPJ 7/10/21

REFER TO EXPLANATION SHEETS FOR DESCRIPTION OF TERMS AND SYMBOLS USED



issue	date	description
A	25.9.21	Initial issue

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Proposed Mixed-use Development
4 Delmar Parade, Dee Why NSW
for
Landmark Group Australia Pty Ltd

Core Photos – BH8

drawn: MAB

date: 25.6.2021

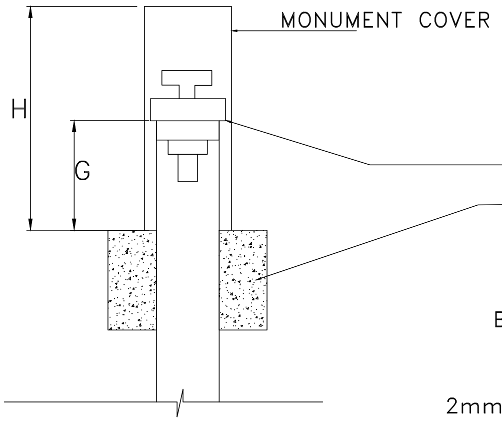
checked: MAB

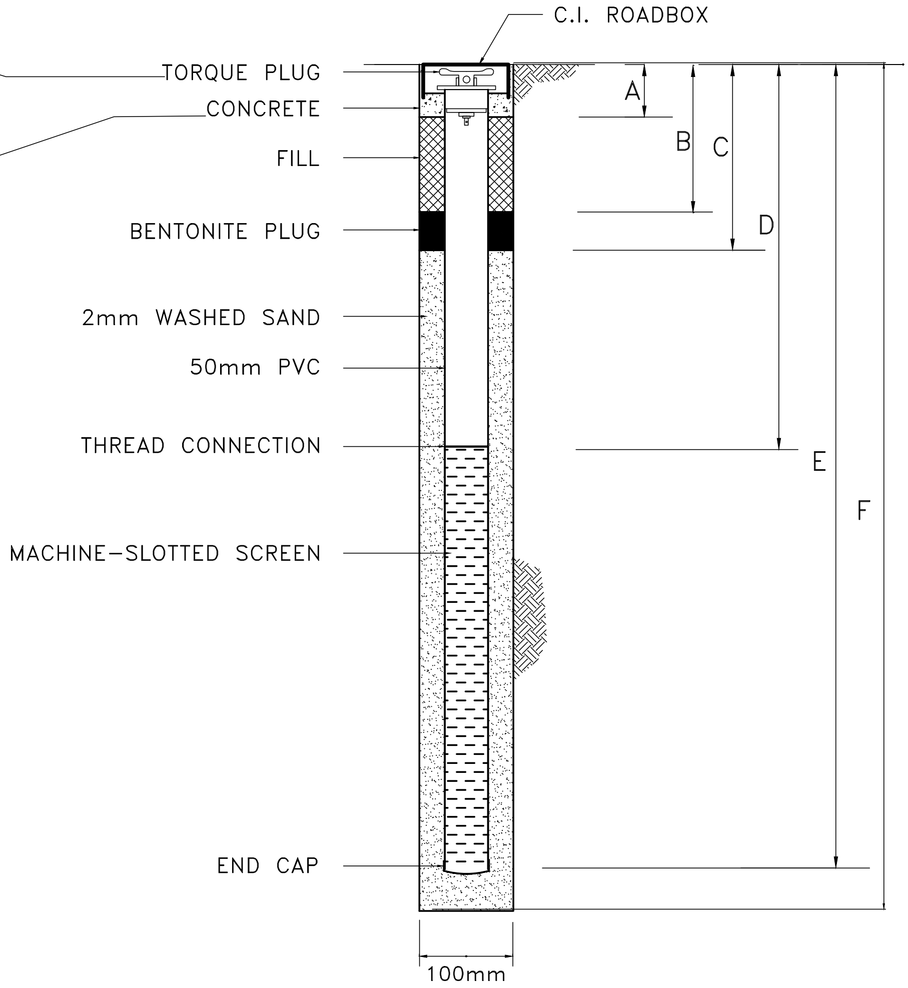
scale: 1:4 A4

job no.: 6561

fig: —

issue: A





PIEZOMETER DIMENSIONS

	BH8 **Surface RL 30.5m AHD**
A	0.5
B	4.8
C	5
D	12.6
E	15.6
F	15.7
G	
H	

GROUNDWATER READINGS

DATE:	**BOREHOLE**	**DEPTH (m)**	**REDUCED LEVEL**	**COMMENTS**
17.9.2021	BH8	–	–	Bailed out drilling water on completion.

A	22.9.21	INITIAL ISSUE
issue	date	description

assetgeoenviro

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PROPOSED MIXED–USE DEVELOPMENT
4 DELMAR PARADE & 812 PITTWATER
ROAD, DEE WHY NSW
for
LANDMARK GROUP

PIEZOMETER DETAILS – BH8

drawn: JL

date: 22.9.21

checked: MAB

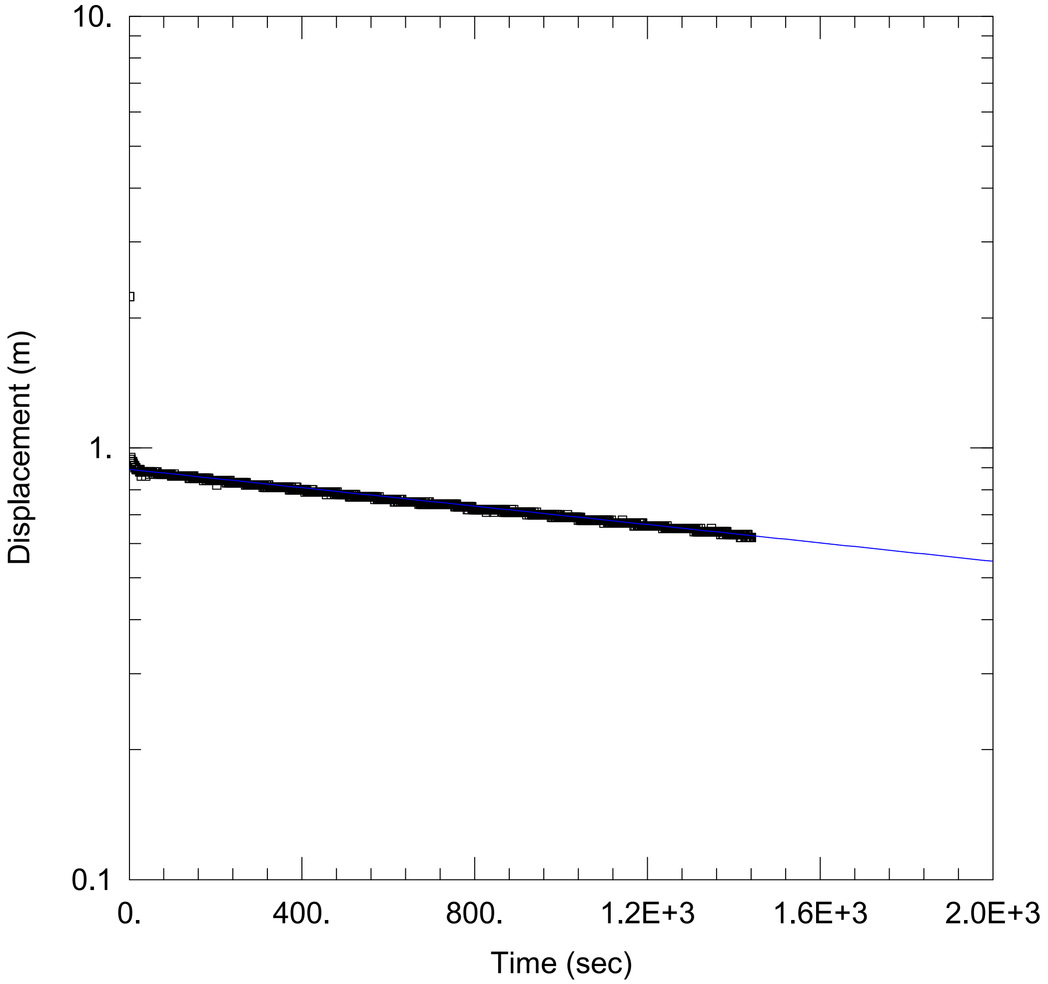
scale: NTS

job no.: 6561

fig: –

issue: A

Appendix E – Rising Head Test (Slug Test) Analysis Output



WELL TEST ANALYSIS

Data Set: C:\...\BH1.aqt
Date: 06/01/22 Time: 17:39:44

PROJECT INFORMATION

Company: Reditus
Client: Landmark
Project: 21181
Location: BH1
Test Date: 21 Oct 2021

AQUIFER DATA

Saturated Thickness: 10.07 m
Anisotropy Ratio (Kz/Kr): 1.

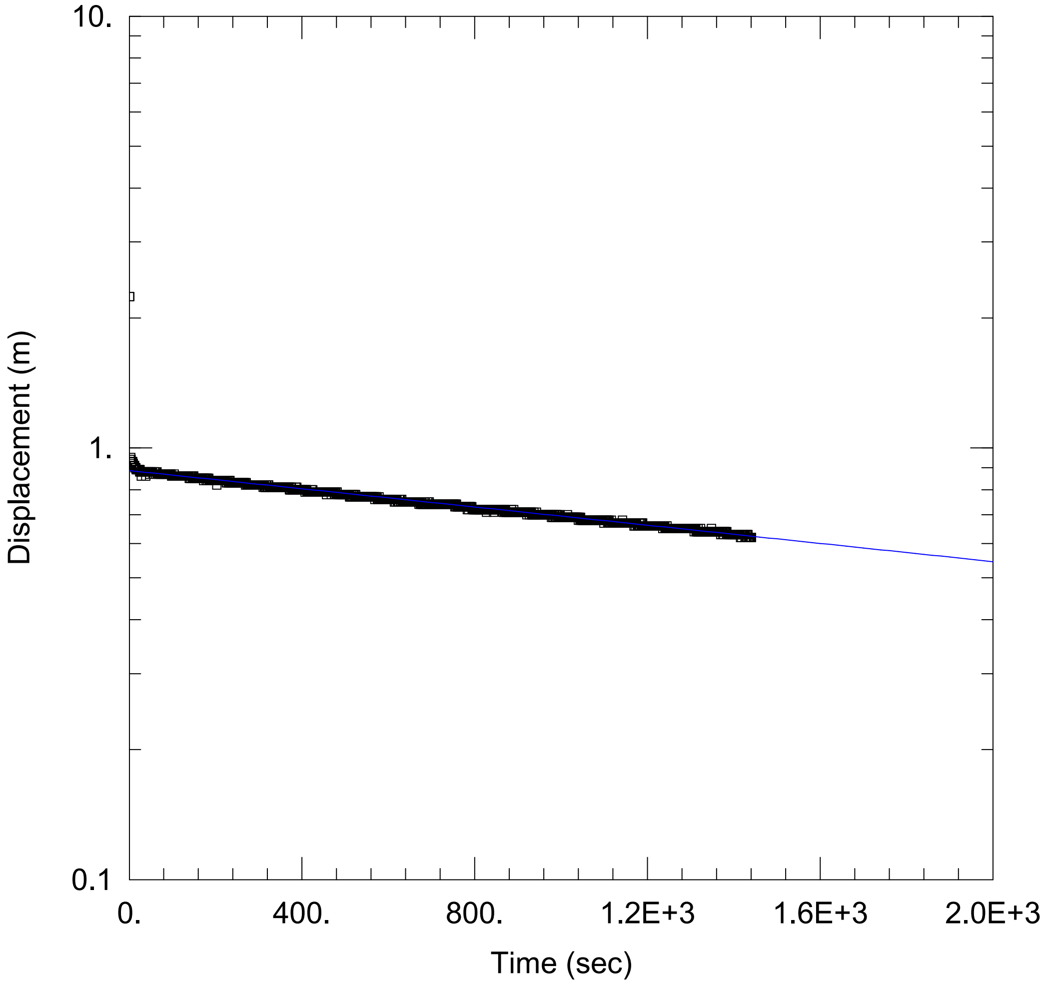
WELL DATA (BH1)

Initial Displacement: 2.24 m
Static Water Column Height: 10.07 m
Total Well Penetration Depth: 9.972 m
Screen Length: 3. m
Casing Radius: 0.025 m
Well Radius: 0.055 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.007993 m/day
y0 = 0.892 m



WELL TEST ANALYSIS

Data Set: C:\...\BH1.aqt
Date: 06/01/22 Time: 17:10:03

PROJECT INFORMATION

Company: Reditus
Client: Landmark
Project: 21181
Location: BH1
Test Date: 21 Oct 2021

AQUIFER DATA

Saturated Thickness: 10.07 m
Anisotropy Ratio (Kz/Kr): 1.

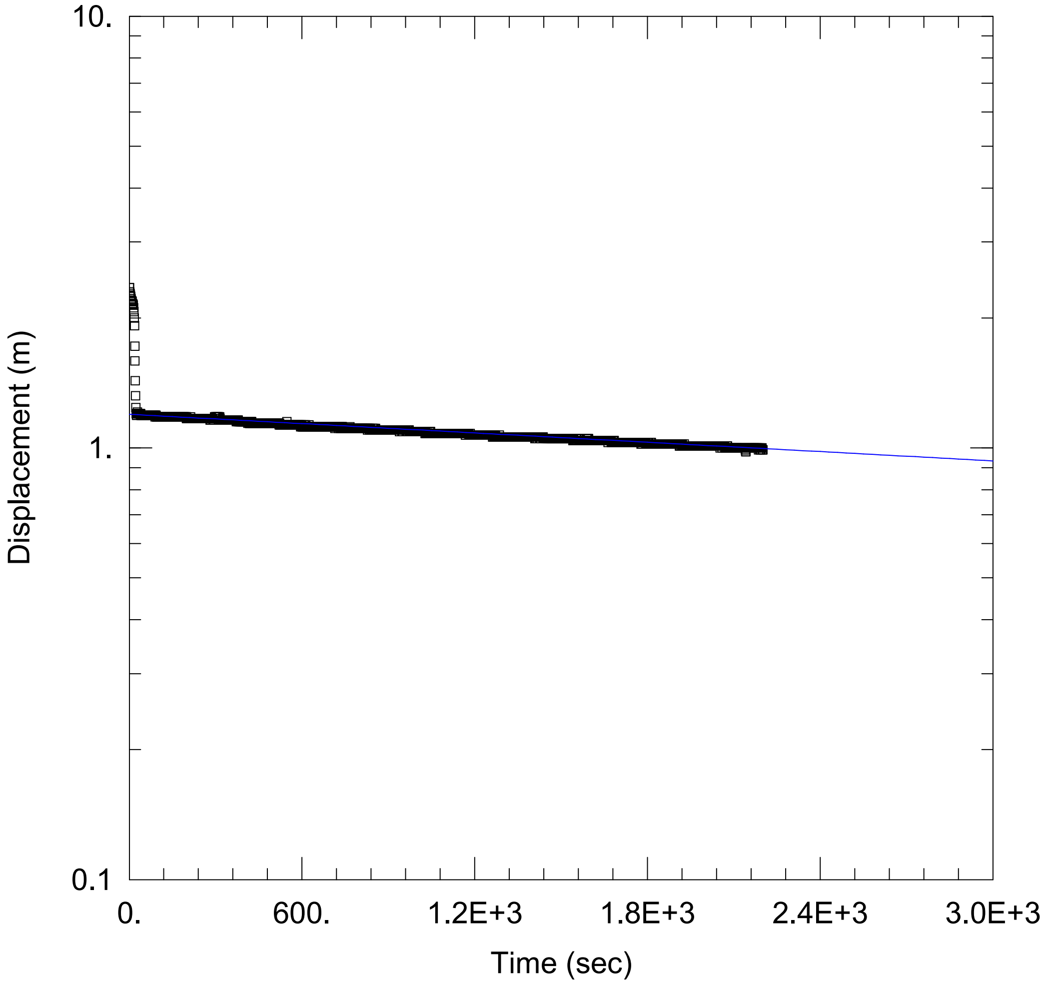
WELL DATA (BH1)

Initial Displacement: 2.24 m
Static Water Column Height: 10.07 m
Total Well Penetration Depth: 9.972 m
Screen Length: 3. m
Casing Radius: 0.025 m
Well Radius: 0.055 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.008743 m/day
y0 = 0.8861 m



WELL TEST ANALYSIS

Data Set: C:\...\BH5.aqt
Date: 06/01/22 Time: 17:38:13

PROJECT INFORMATION

Company: Reditus
Client: Landmark
Project: 21181
Location: BH1
Test Date: 21 Oct 2021

AQUIFER DATA

Saturated Thickness: 12.14 m
Anisotropy Ratio (Kz/Kr): 1.

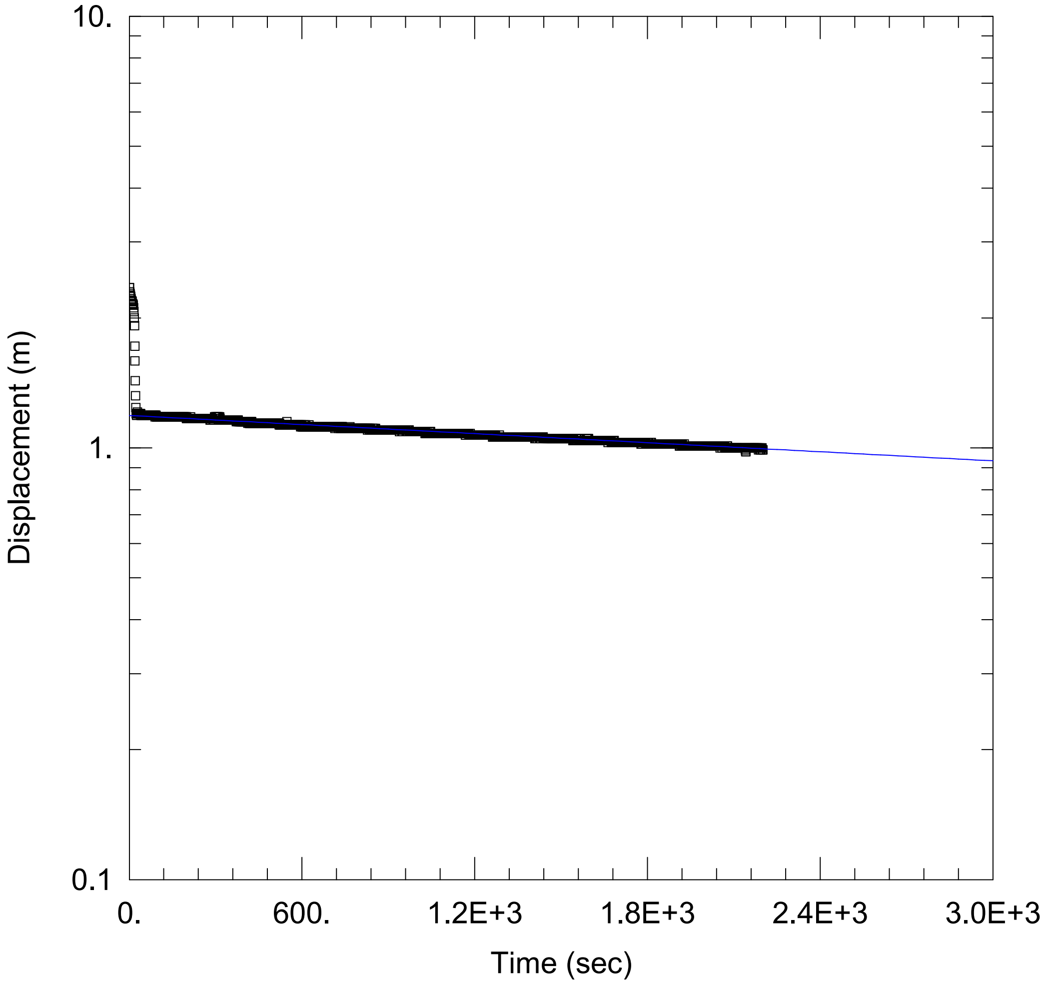
WELL DATA (BH5)

Initial Displacement: 2.35 m
Static Water Column Height: 12.14 m
Total Well Penetration Depth: 11.99 m
Screen Length: 3. m
Casing Radius: 0.025 m
Well Radius: 0.055 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.002735 m/day
y0 = 1.196 m



WELL TEST ANALYSIS

Data Set: C:\...\BH5.aqt
Date: 06/01/22
Time: 17:38:52

PROJECT INFORMATION

Company: Reditus
Client: Landmark
Project: 21181
Location: BH1
Test Date: 21 Oct 2021

AQUIFER DATA

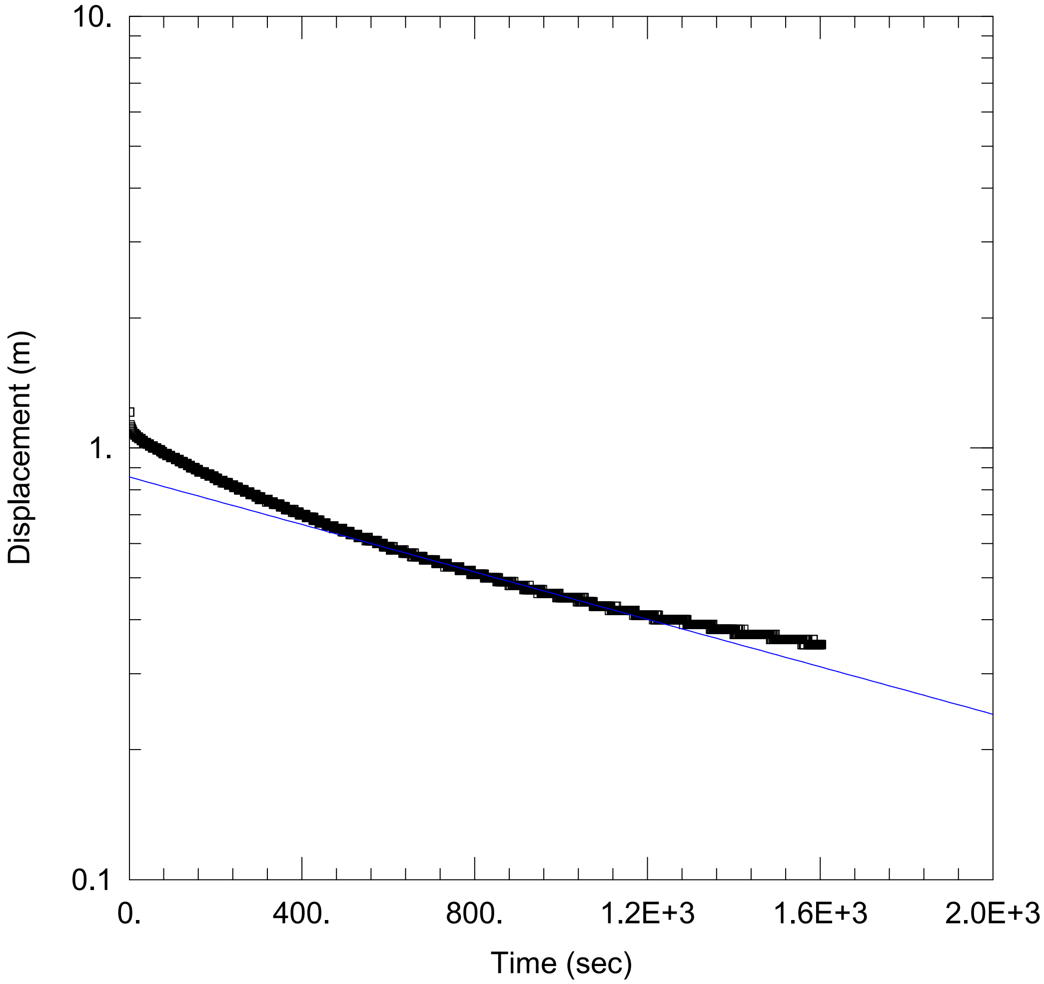
Saturated Thickness: 12.14 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH5)

Initial Displacement: 2.35 m
Static Water Column Height: 12.14 m
Total Well Penetration Depth: 11.99 m
Screen Length: 3. m
Casing Radius: 0.025 m
Well Radius: 0.055 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 0.002905 m/day
y0 = 1.189 m



WELL TEST ANALYSIS

Data Set: C:\...\BH8.aqt
Date: 06/01/22
Time: 18:26:46

PROJECT INFORMATION

Company: Reditus
Client: Landmark
Project: 21181
Location: BH1
Test Date: 21 Oct 2021

AQUIFER DATA

Saturated Thickness: 12.14 m
Anisotropy Ratio (Kz/Kr): 1.

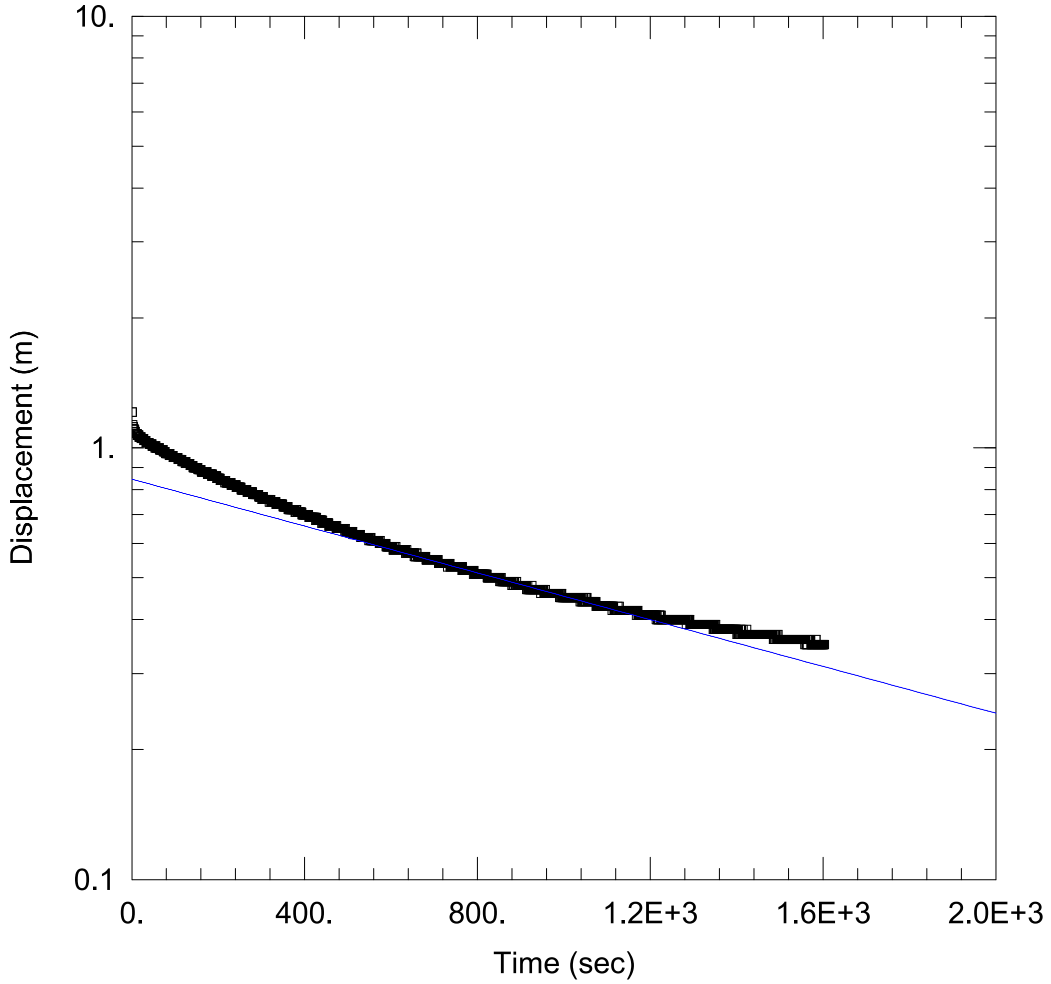
WELL DATA (BH8)

Initial Displacement: 1.21 m
Static Water Column Height: 9.387 m
Total Well Penetration Depth: 11.99 m
Screen Length: 3. m
Casing Radius: 0.025 m
Well Radius: 0.055 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.02088 m/day
y0 = 0.8561 m



WELL TEST ANALYSIS

Data Set: C:\...\BH8.aqt
Date: 06/01/22 Time: 18:27:11

PROJECT INFORMATION

Company: Reditus
Client: Landmark
Project: 21181
Location: BH1
Test Date: 21 Oct 2021

AQUIFER DATA

Saturated Thickness: 12.14 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH8)

Initial Displacement: 1.21 m
Static Water Column Height: 9.387 m
Total Well Penetration Depth: 11.99 m
Screen Length: 3. m
Casing Radius: 0.025 m
Well Radius: 0.055 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.02247 m/day
y0 = 0.8462 m