Appendix F

Water Management Plan (Emerge, 2023)



Water Management Plan

Lot 101 (no. 752) Wallcliffe Road, Margaret

River

Project No: EP18-128(10)





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Executive Summary

Wallcliffe House Pty Ltd (the proponent) are proposing to redevelop Lot 101 Wallcliffe Road, Margaret River (herein referred to as 'the site') for tourism purposes. The site is located within the Shire of Augusta Margaret River and is approximately 5.2 ha in size and is found approximately 8 km south-west of the Margaret River townsite. The site is generally bounded by the Margaret River and associated riparian vegetation to the north-west, a nature reserve to the south and existing tourism land uses and residences to the east.

The site contains one of the original farms and homesteads built by the Bussell family (known as 'Wallcliffe House') with the construction of the buildings commenced in 1858. It included a number of sandstone and ancillary buildings, as well as significant cultivated gardens and grounds. The buildings were significantly damaged by a bushfire in 2011, and while these are no longer in use, the cultivated gardens and grounds surrounding the buildings have continued to be maintained to a high standard.

MJA Studio and See Design Studio have prepared a draft concept plan to support the development of the site, which is intended to be a world-class boutique hotel that respects and enhances the cultural heritage and history of the site, its location as well as integration and reconnection to the existing endemic landscape.

This development application water management strategy (WMS) has been prepared to identify the water management approach to support the proposed development.

Water will be managed using an integrated water cycle management approach, which has been developed using the philosophies and design approaches described in the *Stormwater Management Manual for Western Australia*.

The first step in applying integrated water cycle management in urban catchments is to establish agreed environmental values for receiving waters and their ecosystems. Characteristics of the existing environment within the site have been investigated. In summary, the environmental investigations conducted to date indicate that:

- Long term climatic averages indicate that the site receives 951.7 mm on average annually with the majority of rainfall received in May to August.
- The site slopes towards Margaret River with an average grade between 10-15%. Existing ground levels range from 2 m Australian height datum (AHD) to 64 mAHD.
- The site soils include limestone outcrops/pinnacles at various locations, surficial layers of fill
 overlying sand or limestone, natural dune sand and shallow layers of sand overlying clayey sand
 associated with weathering of granite (in the eastern portion of the site adjacent to Margaret
 River).
- Soil permeability of shallow soils ranges between 0.4 m/day to >25 m/day. Permeability of limestone has been measured at between 8m/day and 12 m/day.
- The site is not identified as having any risk of acid sulfate soils (ASS) based on the available regional mapping and is unlikely to be a consideration based on the site characteristics.



- Given the proximity to the coast (located 600 m to the west of the site), assets either below the 5 mAHD contour or at a horizontal distance of 200 m from the coast may potentially be exposed to coastal processes such as storm surge, inundation and erosion based on the outcomes of the Shire of Augusta Margaret River Coastal Hazard Risk Management and Adaption Plan (CHRMAP).
- There are no waterways or surface flow channels present on site, and frequent and minor event runoff is likely to infiltrate within the site at or close to source. Major event runoff would likely result in some sheet flow over both impermeable and permeable surfaces given the steep slope of the site.
- The site is immediately adjacent to the Margaret River and associated riparian vegetation.
- There are no wetlands located within the site.
- Groundwater levels beneath the site range between 0.43 mAHD at the western/ north west boundary adjacent to Margaret River to 3.78 mAHD at the site centre.
- The site is underlain by the Wallcliffe surficial aquifer, which provides a sustainable groundwater resource of approximately 22,000 kL per annum.
- Historical land use of the site has included low density agriculture, a residence, and tourismrelated purposes.

The overall objective for integrated water cycle management for the development is to maintain the pre-development hydrological regime. This WMS has adopted an integrated water cycle management approach to manage:

- Potable water supply there is an existing connection to potable water provided by the Water Corporation which will be upgraded and utilised for the proposed development.
- Wastewater servicing an onsite wastewater treatment plant (WWTP) with infiltration onsite of treated water. This WMP also includes a site and soil evaluation to support the proposed wastewater servicing approach, and to demonstrate that the site can comply with the intent of AS1547:2012
- Non-potable water supply will be supplied by groundwater, which has historically been used
 for irrigation purposes within the site and is extracted from the surficial Wallcliffe aquifer
 beneath the site.
- Surface water management which will adopt an at source infiltration approach, consistent with the historical approach to water management at the site.
- Groundwater management will be passive and will avoid interaction with underlying groundwater levels. Groundwater quality will be improved removing historical agricultural uses, and by addressing surface water quality using a water sensitive urban design approach, which mimics natural processes at the surface and at source.
- Flood protection to be addressed by ensuring that the development is located above the elevation identified to be higher risk (i.e. above 5 mAHD).

The proposed criteria and the manner in which they are proposed to be achieved are presented in **Table E 1**. The elements summarised in **Table E 1** demonstrate that the site can be developed for the intended use.

Water Management Plan

Lot 101 (no. 752) Wallcliffe Road, Margaret River



Table E 1: Water management criteria and compliance summary

Management Aspect	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of Implementation	
Water supply, conservation, and	WC1	Use appropriate non-potable water sources for irrigation	Utilise locally sourced groundwater to meet irrigation demand	Proponent	Currently and following construction	
wastewater	WC2	Minimise potable water use	Use of water efficient appliances.	Proponent	Construction	
			Use of water efficient fittings.	Proponent	Ongoing	
			Only non-potable water to be used for irrigation	Proponent	Ongoing	
Wastewater	WW1	Ensure appropriate management of wastewater	Design and implement on onsite wastewater treatment system which appropriately addresses nutrients	Proponent	Construction and ongoing	
Stormwater management	SW1	Floor levels of habitable buildings at or above the elevation identified to mitigate future coastal processes risk	Floor levels of habitable buildings will be located above the predicted future coastal hazard risk elevation.	Proponent	Detailed drainage design	
	SW2	Manage the small rainfall event runoff at source	Low profile swales used to treat and infiltrate frequent event runoff	Proponent	Detailed design	
			High permeability of soils adjacent to paved areas used for infiltration	Proponent	Detailed drainage design	
			Soakwells used to infiltrate roof and some paved area runoff	Proponent	Detailed drainage design	
	SW3	Manage runoff from minor and major rainfall events to control erosion	Pavement and impermeable areas to be directed to permeable portions of the site where they will infiltrate	Proponent	Detailed drainage design	

Water Management Plan

Lot 101 (no. 752) Wallcliffe Road, Margaret River



Table E 1: Water management criteria and compliance summary (continued)

Management Aspect	Criteria number	Criteria description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of Implementation
Stormwater management (continued)	SW4	Adopt a passive at-source approach to stormwater management infrastructure	Soakwells, minor verge swales and infiltration within permeable portions of the site. No formal infiltration basins are proposed be constructed	Proponent	Detailed drainage design
	SW5	Utilise appropriate non-structural measures to reduce nutrient loads	Ongoing management of nutrient inputs from fertilisers to include use of slow-release fertilisers and monitoring to guide fertiliser application (e.g., visual monitoring, leaf and tissue analysis)	Proponent	Currently and ongoing
			Maintenance and responsive management of any effluent disposal system to maintain nutrient discharge targets	Proponent	Following construction and ongoing
Groundwater management	GW1	Stormwater infiltration infrastructure to be located at least 500 mm above highest known groundwater level	Infiltration structures will be >3.1 mAHD to provide at least 500 mm clearance from highest known groundwater levels beneath the site.	Proponent	Construction
	GW2	Buildings to be protected from groundwater inundation	Buildings to be located at or above 2.6 m AHD, which will ensure that these are above potential groundwater inundation.	Proponent	Construction



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Appendices

Appendix A

Wallcliffe House concept plan

Appendix B

Douglas Partners Geotechnical Investigation

Appendix C

Pump Test – Western Irrigation 2022



Abbreviations

Table A1: Abbreviations – General terms

General terms				
AEP	Annual exceedance probability			
ANZECC	Australian and New Zealand Environment and Conservation Council			
ARI	Average recurrence interval			
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand			
ASS	Acid sulfate soils			
BGL	Below ground level			
BGS	Below ground surface			
BUWM	Better Urban Water Management			
CHRMAP	Coastal Hazard Risk Management and Adaption Plan			
СРТ	Cone penetration tests			
DLR	Design loading rate			
EC	Electrical conductivity			
LTV	Long-term trigger value			
MGL	Maximum groundwater level			
NWQMS	National Water Quality Management Strategy			
RWT	Rainwater tanks			
TN	Total nitrogen			
TP	Total phosphorous			
TWL	Top water level			
WELS	Water efficiency labelling and standards			
WMS	Water management strategy			
WSUD	Water sensitive urban design			
WWG	Water wise gardens			
WWTP	Wastewater treatment plant			



Table A2: Abbreviations – Organisations

Organisations				
ВоМ	Bureau of Meteorology			
DBCA	Department of Biodiversity Conservation and Attractions			
DoH	Department of Health			
DWER	Department of Water and Environmental Regulation			
SAMR	Shire of Augusta Margaret River			
WAPC	Western Australian Planning Commission			
WC	Water Corporation of Western Australia			

Table A3: Abbreviations – units of measurement

Units of measurement	Units of measurement				
cm	Centimetre				
ha	Hectare				
m	Metre				
m²	Square metre				
m AHD	Metres in relation to the Australian height datum				
mm	Millimetre				
°C	Degrees Celsius				
mg/L	Milligrams per litre				
mS/cm	Millisiemens per centimetre				
μS/cm	Microsiemens per centimetre				



1 Introduction

1.1 Background

Wallcliffe House Pty Ltd (the proponent) are proposing to redevelop Lot 101 Wallcliffe Road, Margaret River (herein referred to as 'the site') for tourism purposes and is located within the Shire of Augusta Margaret River.

The site is approximately 5.2 ha in size and is located approximately 8 km south-west of the Margaret River townsite. The site is generally bounded by the Margaret River and associated riparian vegetation to the north-west, a nature reserve to the south and existing residential and tourism (chalet and camping land uses) to the east (which includes the Margaret River rowing club). The location and boundaries of the site are shown in **Figure 1**.

1.2 Town planning context

The site is currently zoned as 'tourism' (and 'tourist area') under the Shire of Augusta Margaret River LPS No.1.

1.3 Purpose of this report

It is important that the manner in which stormwater runoff from developed areas is managed to avoid flooding and protect the environment is clearly documented early in the planning process. This approach provides the framework for actions and measures to achieve the desired outcomes at the development stage of a project. The development approval (DA) application details the water management approach to support the proposed redevelopment, and this Water Management Plan supports the DA.

1.4 Policy framework

There are a number of State and Local Government policies of relevance to the site. These policies include:

- Government Sewerage Policy (DPLH 2019)
- State Planning Policy 2.9 Water Resources (DPLH 2021)
- Draft State Planning Policy 2.9 Planning for Water (Government of WA 2022)
- Planning Bulletin No. 64: Acid Sulfate Soils (WAPC 2009)
- Planning Bulletin No. 83: Planning for Tourism (WAPC 2013)

In addition to the above policies, there are a number of published guidelines and standards available that provide direction regarding the water discharge characteristics that urban developments should aim to achieve. These are key inputs that relate either directly or indirectly to the site and include:

Integrated Science & Design

• National Water Quality Management Strategy (NWQMS) (ANZECC and ARMCANZ 2000)



- Australian Runoff Quality (Engineers Australia 2006)
- Stormwater Management Manual for Western Australia (DWER 2022)
- Better Urban Water Management (BUWM) (WAPC 2008)
- Australian Rainfall and Runoff (Ball J et al. 2019)
- Decision Process for Stormwater Management in Western Australia (DWER 2017)
- Draft Margaret River Protection Strategy (SAMR 2018)
- Australian Standard 1547:2012 Onsite Domestic Wastewater Management (SAI Global 2012)

1.5 WMS objectives

This WMS has been developed in consideration of the objectives and principles detailed in BUWM (WAPC 2008). It supports the redevelopment of the site, and is based on the following major objectives:

- Protect the high amenity values provided by Margaret River and surrounds.
- Provide a broad level water management framework to support future redevelopment.
- Ensure appropriate treatment of wastewater from the site is provided.
- Incorporate appropriate best management practices into the drainage system that address the environmental and stormwater management issues identified.
- Minimise ongoing operation and maintenance costs for the proponent.
- Develop a water supply and conservation strategy for the site that will consider the supply available.
- Gain support from DWER and Shire of Augusta Margaret River for the proposed method to manage water within the site and which avoids potential impacts on downstream areas.

Detailed objectives for water management within the site are further discussed in **Section 4**.



2 Proposed development

MJA Studio have prepared a concept plan to detail the proposed redevelopment of the site, which is provided in **Appendix A**.

The site is intended to be developed as a boutique hotel that will accommodate up to 25 keys (62 guests) and is intended to respect and acknowledge the cultural heritage and history of the site, its location as well as the existing landscape values. The principles being adopted will see new buildings be located within the footprint of the existing fire damaged buildings (which could not be restored), as well being constructed throughout the site including new guest cottages and suites, an operations building and wastewater treatment plant, guest and staff parking, an estate management office, a guest spa and supporting utility infrastructure.

The proposed new buildings aim to retain the 'essence' of the former buildings as much as possible by utilising the natural local limestone blocks as well as masonry, timber framing and rammed earth. The existing mature cultivated gardens and areas of remnant vegetation within the site are proposed to be retained, although some modification to this vegetation may be required as part of development.

The development of the site necessitates upgrades to the capacity of existing services. The upgrades include wastewater treatment and disposal, potable water supply, firefighting water supply, electricity, and communication services. In particular, the management of wastewater will be upgraded from the former domestic-scale system to one that is suitable for the proposed development and that will minimise the potential for nutrients to enter the surrounding environment.

The stormwater management infrastructure will be passive and will be integrated into the design of the site. There will be no requirement for a large formalised drainage system as sheet flow and localised infiltration will be adopted, consistent with the historic function and design of the site.



3 Pre-development Environment

3.1 Climate

The closest weather station to the site which records rainfall and temperature data is located in Witchcliffe (Bureau of Meteorology (BoM) station number 9746), situated approximately 11.7 km south-east of the site. Based on weather data collected from 1999 to 2021 at the Witchcliffe station, the local area experiences an average of 951.7 mm of annual rainfall, as detailed in **Table 1**. Temperature data is also recorded at the Witchcliffe station, indicating the highest a mean maximum temperature of 27.1°C is in February, while the mean minimum temperature of 8.2°C is in July and August (BoM 2023).

Table 1: Median (decile 5) annual rainfall from 1919 to 2023 at Witchcliffe (station number 9746) (BoM 2023)

Witchcliffe	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Median rainfall (mm)	12.3	12.2	27.8	62.6	132.3	179.7	194.1	157.7	108.7	63.8	34.7	17.9	951.7

3.2 Topography

The topography of the site slopes down from Wallcliffe Road in the east towards Margaret River in the west-north-west. Existing ground levels range from 2 m Australian height datum (AHD) along the western boundary adjacent to Margaret River, to 12 mAHD at its northern extent, 22 mAHD in the south west near the Wallcliffe Cliffs and 64 mAHD at the south eastern extent (i.e., closest to Wallcliffe Road). The land generally slopes from southeast to northwest, with an average grade between 10-15%. The site includes small localised flat portions where the landscape has presumably been modified to accommodate historical habitation of the site.

Topographic contours of the site are shown in Figure 2.

3.3 Geotechnical conditions

3.3.1 Geology

Geological mapping for the Cowaramup – Mentelle area (DME 2000) area indicates that the land is underlain by the Leeuwin Complex comprising fresh to weathered granite. It also indicates that the hills immediately to the west of the site are comprised of the Spearwood Dunal system, being sand over calcarenite (coarse grained limestone).

Geotechnical site investigations (CMW Geosciences 2018; Douglas Partners 2021, 2022, 2023) indicated that the ground conditions encountered were generally aligned with the regional mapping, with the exception that the sand of the Spearwood Dunal system extends into the site.



Soil landscape mapping (compiled by the Department of Primary Industries and Regional Development (DPIRD)) indicates the site is within the 'Gracetown low slopes phase' soil landscape which is described as 'deep yellow brown siliceous sands over limestone' (i.e. Spearwood Sands), which is shown in **Figure 3**.

3.3.2 Site investigations

3.3.2.1 CMW Geosciences Geotechnical Investigation

The site geology and soils were investigated by CMW Geosciences (2018). The investigation included a site walkover, nine hand auger boreholes to facilitate onsite infiltration testing (using a falling head method), twelve test pits to 0.5 m - 3.0 m below ground surface (BGS) and dynamic cone penetrometer tests in accordance with AS1289.6.3.2. The locations of test pits and augered bores are shown in **Appendix B**.

In summary, the soils observed beneath the site included:

- The presence of limestone outcrops/pinnacles at various locations.
- Surficial layers of fill overlying sand and limestone.
- Fill within some test pits comprised sand and limestone cobbles and boulders.
- Loose to medium dense sand fill overlying natural dune sand to the maximum depth investigated of 2.8 m. The sand (fill and natural) was logged as dark brown to black with fines and organics (<5% by weight).
- Sand over shallow limestone was encountered on the natural slopes with outcropping limestone visible on adjacent portions of the slope. Further north, the limestone ceases to outcrop, and a deeper (>1.2 m) layer of sand was observed.
- Natural dune sand in the north-eastern portion of the site, east of the existing pond and east of the existing boat house.
- A shallow layer of sand overlying a clayey sand residual soil, associated with the weathering of the granite in the eastern portion of the site, towards the shore of the river.

3.3.2.2 2020-2023 Douglas Partners Geophysical and Geotechnical Investigations

Douglas Partners conducted multiple investigations between 2020 and 2023 and these are summarised in **Table 2**. The location of testing undertaken are shown in **Figure 3** and in the geotechnical reports contained in **Appendix B**.

Table 2: Douglas Partners Geotechnical and Geophysical Investigations (2020-2023)

Time	Scope of Work
8 th – 10 th September 2020 (Douglas Partners 2020)	 Seismic refraction (SR) for the depth to various rock types Ground Penetrating Radar (GPR) to target karstic features and map the depth to rock. Multi-channel Analysis of Surface Waves (MASW) to aid in the interpretation of the SR and GPR Eight geophysical survey transects



Table 2: Douglas Partners Geotechnical and Geophysical Investigations (2020-2023) (continued)

Time	Scope of Work
30 th and 31 st August 2021 (Douglas Partners 2021)	Six hand augered boreholes Perth sand penetrometer (PSP) testing adjacent to these boreholes Six in-situ infiltration tests
24 th and 26 th January 2022 (Douglas Partners 2022)	 Four diamond core bore holes 21 cone penetration tests (CPT) (10 CPTs within the upper portions of the site and 11 CPTU's (cone piezocone penetration test) within the lower portion of the site) 13 test pits Six hand auger boreholes PSP tests Four geophysical survey transects Six in situ infiltration tests Soil and rock laboratory analysis
15 th and 16 th February 2023 (Douglas Partners 2023)	 15 CPTs Excavation of six test pits Drilling of four hand auger boreholes PSP tests Eleven in-situ infiltration tests Falls head tests within an existing monitoring well Laboratory testing

In summary, the ground conditions encountered at the site are summarised as:

- **Sandy topsoil (Unit 0)** Fine to coarse grained sand, 100 mm to 200 mm thick, with silt and various amounts of gravel, roots, and rootlets, encountered at some test locations.
- Sandy fill (Unit 1) Encountered to depths up to 1.6 m, variably compacted and fine to medium grained sand, grey-brown, with various amounts of silt at several locations. Some of this fill is likely disturbed soils from previous land usage. The fill also included some gravelly sand and gravelly clayey sand layers from the surface to a depth of 0.6 m BGL in 2022 investigation.
- Residual sand of the Spearwood System (Unit 2) Comprised of fine to medium grained sand, grey-yellow-orange-brown, with trace silt, limestone cobbles and gravel, encountered at depths up to 9.5 m BGL at all deeper test locations during the 2022 and 2023 investigations. Natural sand was generally medium dense to dense, however very loose to loose zones of 0.3 m to 6 m thick were recorded at some test locations, at depths of between 1.5 9.5 m BGL. A zone of very low density (possibly void within very weakly cemented sand) was found between 4.5 m and 4.7 m depth at test location 14 during the 2023 investigation but is considered to be localised without impacts on the proposed development.
- Limestone of the Spearwood System (upper portions of the site only) (Unit 3) Very weakly to strongly cemented, very low to very high strength underlying the unit 2, encountered to a depth up to 14.5 m BGL (limit of 2022 investigation). Sand zones observed to varying depths between 0.6 m and 2.3 m in thickness within the limestone rock. A localised void or rock discontinuity, likely infilled with very loose sand was found at depth of 6.6 m BGL at test location 5, over a 0.6 m depth interval during the 2023 investigation.
- Residual soils of the Leeuwin Complex (Unit 4) Observed at the lower portions of the site beneath the Unit 2 sand soil and as a thin layer underlying the Unit 3 limestone further southeast mid-slope. It consisted of clayey sand, clayey sandy gravel, sandy silt, silty sand, clay,



and sandy clay. This soil type encountered to a depth of 13.4 m BGL within the lower portions of the site and reduced in thickness between 0.1 - 0.7 m in the upper portions of the site.

• **Granulite and granite of the Leeuwin Complex (Unit 5)** – Encountered underlying Unit 4 residual soils, extending to the maximum termination test depth of 20 m.

A conceptual cross section of the measured and anticipated ground conditions beneath the potential infiltration and lower portions of the site, based on the geotechnical and geophysical investigations performed across the site, is shown in **Plate 1**.

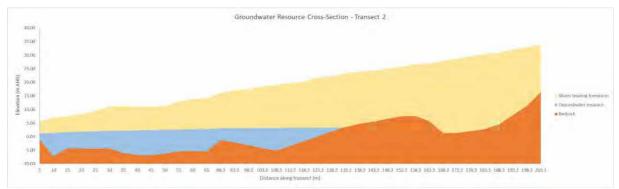


Plate 1: Conceptual model of the ground conditions beneath the site (Emerge Associates 2022)

3.3.2.3 Emerge Associates

Emerge Associates drilled nine boreholes MW01 to MW08 and MW04D and installed eight groundwater monitoring wells.

The ground conditions were generally consistent with CMW Geosciences and Douglas Partners geotechnical investigations, being logged as natural sand to depths of between 3 m and 9 m, overlying limestone (calcarenite of Spearwood System). Two monitoring wells (MW04 and MW06) encountered different soil profiles, MW04 observed silty clay to a depth of 5 m BGL overlying sandy clay to the test termination depth of 7.5 m BGL, whereas MW06 recorded silty clay to a depth of 2 m BGL overlying the natural sand.

3.3.3 Soil permeability

A number of in-situ infiltration tests using falling head method were carried out within shallow sand (Unit 1) and sand fill (Unit 2), at depths of between 0.5 m and 2.0 m during the Douglas Partners 2020-2023 investigations. The results are summarised in **Table 3** and the locations of the testing undertaken are shown in **Figure 3**. The permeability of the soils underlying the site indicate that the majority of the site will be suitable to use onsite infiltration measures, with permeability of shallow soils recorded >25 m/day. The deeper soil profile/limestone has also been permeability tested, with onsite measurement of the limestone at depth recording permeability between 8 and 12 m/day.



Table 3: Summary of In-situ permeability testing

Investigation	Test Location	Depth (m)	Measured Permeability (m/day)*	In-situ Condition of the Tested Material
Douglas Partners	1	2.0	>25	Unit 2: Sand, trace silt, medium
(2021)	2	2.0	2.6**	dense
	3	2.0	0.4**	
	4	2.0	4.9	
	5	2.0	8.5	
	6	2.0	4.1	
Douglas Partners (2022)	5	1.0	>25	Unit 2: Sand, trace silt, medium dense
	6	1.0	0.7**	Unit 1: Fill/sand
	9	1.3	13	Unit 2: Sand, trace silt, medium
	15	1.0	12	dense
	20	1.0	15	Unit 1: Fill/sand
	24	1.0	>25	Unit 2: Sand, trace silt, medium dense
Douglas Partners	16	1.6	18	Unit 2: Sand, trace silt, medium
(2023)	17	0.5	14	dense
	18	1.6	>25	
	19	1.8	>25	
	20	0.6	11	Unit 1: Fill/sand, dark grey- brown, with silt, medium dense
		1.5	>25	Unit 2: Sand, trace silt, medium
	21	1.6	22	dense
	22	2.0	>25	
	23	2.0	>25	
	24	2.0	10	
	25	2.0	9	
	52	14	8-12	Limestone of deeper soil profile

^{*}Hvorslev's method.

The infiltration testing undertaken demonstrates that infiltration at source approaches are appropriate for the site.

^{**}Lower infiltration rates at test locations 2, 3 and 6 were likely attributed to the presence of limestone at testing depth.



3.3.4 Acid sulfate soils

The site is not identified as having any risk of acid sulfate soil (ASS) based on the available regional mapping prepared by the Department of Water and Environment Regulation (DWER). Margaret River, adjacent to the northern boundary of the site, is identified as having a low to moderate risk of ASS within 3 m of the natural soil surface. Given no disturbance of Margaret River is proposed, and construction works within the site are unlikely to occur below the permanent groundwater table, ASS is unlikely to be a risk requiring management.

Available ASS mapping for the site is shown in Figure 4.

3.4 Coastal processes

The site is situated approximately 600 m east of the coastline, with the development located adjacent to Margaret River (which meanders to the river mouth for approximately 1.2 km from the site) and is seasonally open to the ocean.

The Shire of Augusta Margaret River commissioned the preparation of a *Coastal Hazard Risk Management and Adaption Plan* (CHRMAP) (Shore Coastal 2015) to provide strategic guidance on management and adaptation in key coastal settlements that may be exposed to coastal processes such as storm surge, inundation and erosion.

The CHRMAP (Shore Coastal 2015) considered Prevelly and the areas near the mouth of the Margaret River, and while estuarine flooding for Margaret River was not specifically identified as an issue, it was indicated that assets located up to the 5 m AHD contour or at a horizontal distance of 200 m from the coast may be exposed to coastal processes (i.e. storm surge, inundation and erosion) during the 100-year planning period. While portions of the site are located below the 5 m AHD contour, the habitable floor levels of buildings are located above 5 m AHD. Based on current predictions, the proposed development is unlikely to be significantly impacted by coastal storm surge or inundation.

3.5 Hydrology

3.5.1 Surface water

There are no waterways or surface flow channels present on site.

Runoff from most rainfall events is expected to infiltrate at source within the sandy layer of soils present. Major rainfall events (e.g. 1% AEP event) may result in localised sheet flow due to the steep slope of the site. The historical development has included some minor runoff capture features which have been integrated into small portions of paved areas, and infiltrate locally. The majority of paved areas within the site discharge to permeable areas immediately adjacent to the pavement via sheet flow where it infiltrates to the existing soils.



3.5.1.1 Margaret River

The Margaret River, a major perennial watercourse, is located directly adjacent to the western boundary of the site. While the topography of the site would direct extreme rainfall event runoff towards Margaret River (as indicated above), runoff from the majority of rainfall events is expected to infiltrate at source within the sandy layer of soils. The location of Margaret River is shown on **Figure 1**.

The portion of the Margaret River adjacent to the site forms part of the lower reaches of the River, with the river mouth (where it connects with the Indian Ocean) located approximately 1.2 km west of the site (based on the meandering river channel). Margaret River retains a diversity of habitats including pools, riffles, cascades, low flow channels, floodplains, and backwaters.

Riparian vegetation values associated with the Margaret River is largely located outside the site boundary and is located between the site and the waterbody of the River. The width of the riparian vegetation adjacent to the site varies between 0 m and 25 m, with a small portion of the site having direct access to Margaret River.

The hydrology of Margaret River and its catchment has been summarised by the former Department of Water (now DWER) in the Margaret River Hydrology Summary (DoW 2008). The nearest flow gauging station is significantly upstream at Willmots Farm (approximately 6.2 km north east of the site), and the report is more focussed on annual flows, rather than event based (peak) flows and levels in Margaret River.

The Willmots Farm gauging station (station number 610001) recorded an average annual discharge volume of 77,387 ML between 21 May 1970 and 27 September 2023. According to the representative hydrograph (**Plate 2**) of Margaret River (DWER 2011), it regularly ceases to flow during summer and early autumn (between December and April). This is evidenced by the flow discharge data at the Willmots Farm gauging station, which recorded an average 113.7 day no-flow period between 2000 and 2023.

The peak flood levels are more likely to be influenced by coastal processes (tide, storm surge, seasonal formation of sand bar blocking the River) than flow rates within Margaret River, and preliminary guidance regarding potential peak water elevation at the coast is provided in the Shire of Margaret River CHRMAP (Shore Coastal 2015).



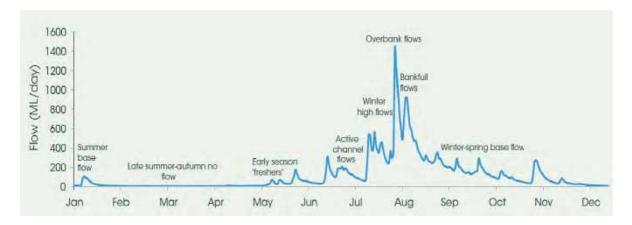


Plate 2: Representative Hydrograph of Margaret River (DWER 2011)

3.5.1.2 Margaret River Water quality

There is no long-term surface water quality data available for the Margaret River in proximity to the site, however Emerge Associates conducted surface water monitoring at immediately adjacent upstream and downstream locations of Margaret River on a quarterly basis between August 2022 and May 2023. The surface water sampling locations are shown in **Figure 2** and results summaries in **Table 4**. The NWQMS (ANZECC and ARMCANZ 2000) guideline for slightly disturbed lowland rivers in Southwest Australian is provided for reference, though it is noted that given Margaret River is the downstream end of a historically rural catchment these trigger values may not be appropriate.

Table 4: Surface water quality summary

Sampling Location	Sampling Time	рН	EC (mS/cm)	TN (mg/L)	TP (mg/L)
NWQMS		6.5-8.0	0.12-0.3	1.2	0.065
Upstream	August 2022	7.61	506	0.4	0.02
	November 2022	8.04	24,467	0.2	0.2
	February 2023	7.74	28,377	0.7	0.09
	May 2023	7.46	26,133	0.6	0.04
	Average	7.71	19,871	0.5	0.09
Downstream	August 2022	7.67	586	0.5	0.02
	November 2022	8	35,114	0.1	0.1
	February 2023	7.5	28,352	0.4	0.07
	May 2023	7.31	26,250	0.5	0.01
	Average	7.62	22,576	0.4	0.05

The results indicate that nearby Margaret River is considered neutral to slightly alkaline with pH ranging from 7.31 to 8.04. Electrical conductivity (EC) levels vary from 506 to 35,114 mS/cm and are elevated as compared to NWQMS guidelines at both upstream and downstream surface water



sampling locations between November 2022 and May 2023. The high EC values in summer and autumn are likely attributed to the high evaporation and non-flow period at the Margaret River. The low EC values are likely associated with the heavy rainfall in winter months.

Total nitrogen (TN) concentrations range from 0.1 to 0.7 mg/L and are low in comparison to NWQMS guidelines at both upstream and downstream locations. Total phosphorus (TP) concentrations range from 0.01 to 0.2 mg/L and are elevated in comparison to NWQMS guidelines at upstream (in November 2022 and February 2023) and downstream (in November 2022) sampling locations. The highest nutrient concentrations occur at the upstream sampling location in summer (November 2022 and February 2023).

3.5.1.3 Wetlands

No wetlands of national or international significance were identified within the site or nearby.

The Geomorphic Wetlands Leeuwin Naturaliste Ridge and Donnybrook to Nannup (DBCA-043) and Geomorphic Wetlands South West (DBCA-040) indicates that there are no geomorphic wetlands identified within the site.

3.5.2 Groundwater

3.5.2.1 Groundwater levels

The site is within the Busselton-Capel Groundwater Area and the Cape to Cape North subarea.

Groundwater levels have been measured at the site since 2021, with the installation of eight monitoring bores by Emerge Associates. The locations of the bores (bores MW01 to MW08) are shown on **Figure 2**.

Data loggers were installed in MW01, MW02, MW03 and MW04 in 2021. The objective was to characterise existing groundwater levels and to determine if local groundwater levels reflected river levels.

Figure 2 shows the 'maximum groundwater level contours' which is the highest elevation recorded at each location during the monitoring period between June 2021 and May 2023. The groundwater contours were further refined by levels measured at the existing bores and additional measurements from Douglas Partners (2022, 2023) in February 2022 and in February 2023. Contours were then extrapolated further north and south to allow an estimation of the size of the groundwater resource beneath the site.

The peak groundwater levels recorded ranged between 2.43 mAHD to 3.78 mAHD. A summary of the peak groundwater levels is provided in **Table 5**.



Table 5: Groundwater measurement summary

Monitoring well ID	Date of peak GWL	Minimum GWL (mAHD)	Peak GWL (mAHD)	Range in GWL (m)
MW01	11/06/2022	0.43	2.43	2
MW02	07/06/2022	0.90	2.48	1.58
MW03	02/02/2022	1.48	2.73	1.25
MW04	20/09/2021	2.62	3.78	1.16

The data from the dataloggers has been plotted with groundwater elevation (in mAHD) over time (see **Chart 1**, **Chart 2**, **Chart 3** and **Chart 4**).

The groundwater data is likely influenced by atmospheric pressure and other small scale diurnal fluctuations, which could vary the measured depth by approximately 400 mm from a low pressure system to a high pressure system. The groundwater level fluctuations appear to reflect River levels following large rainfall events, suggesting that there is some measure of connectivity with Margaret River. MW01, located immediately adjacent to the River, showed the largest groundwater level fluctuation ranging between 0.43 mAHD to 2.43 mAHD. This indicates a strong connectivity to the River and MW01 appears to be more influenced by tidal variations and river levels following rainfall events than the other three bores.

Groundwater levels become higher moving further up the hill and away from the River, following the localised the topography. Separation between the natural soil surface and groundwater increases at the same time. This is illustrated by the soil profile developed based on site geophysical investigations shown in **Appendix B**.

Note that there are some differences in the time steps chosen to record data to enable an assessment of the data which best represents groundwater fluctuation and if the bores were influenced by tides or River levels. Regardless of the time step all data is still within the time range required to obtain a clear picture of groundwater levels, fluctuations, and River level influences.



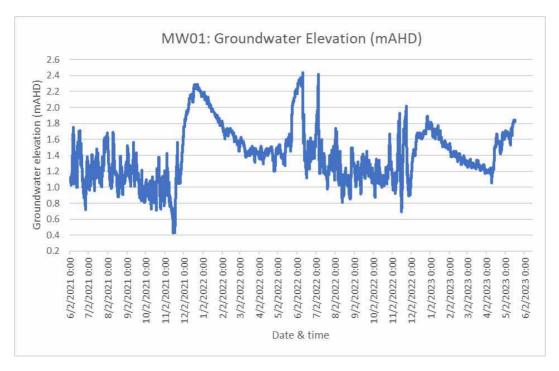


Chart 1: Groundwater levels recorded between June 2021 to May 2023 at MW01.

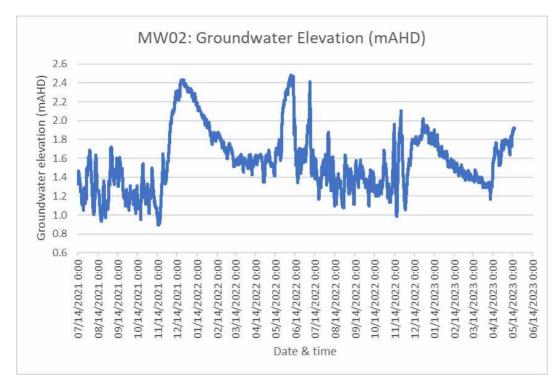


Chart 2: Groundwater levels recorded between July 2021 to May 2023 at MW02.



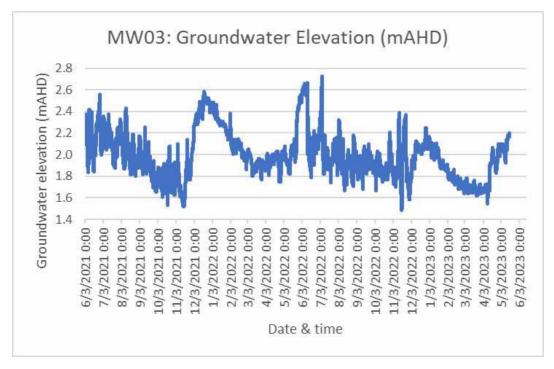


Chart 3: Groundwater levels recorded between June 2021 to May 2023 at MW03.

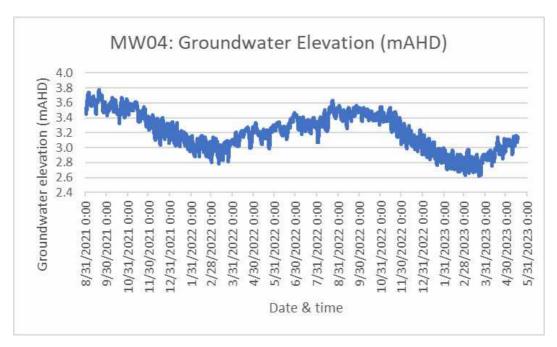


Chart 4: Groundwater levels recorded between August 2021 to May 2023 at MW04.



Based on the measured groundwater levels it can be inferred that the groundwater resource has a strong connection to the River, however given the reduced extent of variation at MW04 (furthest from the River) it can be inferred that that the influence of the River diminishes with increasing distance. This suggests that the groundwater resource may be susceptible to River water intrusion if over-extraction were to occur close to the River, but that extract further from the River will be less susceptible.

Production bores (PB01 and PB02, shown in **Figure 2**) within the site have been installed to depth of approximately 8 m BGL to 13 m BGL (approximately -3 m AHD to -11 mAHD). These depths were determined via down hole camera inspection by Western Irrigation in January 2022 (Western Irrigation 2022). This indicates that the depth of groundwater resource likely varies across the site, but that the base of the water bearing formation is at least approximately -3 m AHD to -11 mAHD.

3.5.2.2 Groundwater quality

There is no long-term groundwater quality monitoring data available for the site, however shallow groundwater has historically been utilised to irrigate landscaped portions of the site, and the condition of irrigated vegetation is excellent (from a plant health perspective). Based on this, it is inferred that the quality of groundwater is appropriate for long term irrigation of vegetation and landscaped areas.

Western Irrigation (2022) undertook a bore assessment of the two existing production bores servicing Wallcliffe House in January 2022, water samples were collected intermittently throughout pump testing. The water samples collected during the step test have been adopted as the most representative groundwater quality, as water quality would have been less disturbed due to reduced drawdown. The laboratory analysis from the production bores is summarised in **Table 6**, and the full laboratory results are contained in **Appendix C**. Whilst the assessment of production bore integrity focused on irrigation parameters, subsequent testing undertaken by Emerge Associates has adopted a broader range of water quality analytes.

Table 6: Laboratory results of groundwater samples collected prior to step test being undertaken

Bore	рН	EC (mS/cm)	Total Alkalinity – Bicarbonate (mg/L)	Hardness (mg)	Total dissolved salts (TDS) (mg/L)	Fe (mg/L)
PB01	7.4	1.47	260	320	810	0.07
PB02	7.2	1.96	290	390	1080	0.23

As shown in **Table 6** both production bores returned similar water quality results and indicate a suitable source of water for long term irrigation.

Groundwater quality monitoring was also conducted by Emerge Associates at eight bores (MW01-MW04, PB02, MW04D, MW07 and MW08) between August 2022 and May 2023. **Table 7** summarises the measured nutrient concentrations at the site with the bore locations shown in **Figure 2**. Whilst not intended for groundwater, to provide some context the measured groundwater characteristics



are compared with NWQMS guidelines (ANZECC and ARMCANZ 2000) for slightly disturbed lowland rivers in Southwest Australia and long-term trigger values (LTVs) in irrigation water.

Table 7: Measured groundwater quality

Bore ID		рН	EC (mS/cm)	TN (mg/L)	TP (mg/L)
NWQMS – Lowland River		6.5-8.0	0.12-0.3	1.2	0.065
NWQMS – LTV in irrigation water		-	-	5	0.05
MW01	Average	7.18	1,872	8.1	2.33
MW02	Average	7.37	1,622	3.9	2.99
MW03	Average	7.18	1,777	0.6	0.45
MW04	Average	7.43	1,317	3.9	2.04
PB02	Average	7.57	1,458	3.2	0.01
MW04D	May 2023	7.81	1,293	3	0.01
MW07	May 2023	7.71	2,527	1.2	0.44
MW08	May 2023	7.54	1,848	3.8	0.14

The results show that the groundwater beneath the site presents a neutral pH condition and EC values range from 1,301 to 2,527 mS/cm. TN concentrations range from 0.4 to 9.6 mg/L and are elevated in comparison to NWQMS guidelines for lowland rivers and LTV irrigation water in six of the eight bores (MW01, MW02, MW04, PB02, MW04D and MW08). TP concentrations range from 0.01 to 4.97 mg/L and also exceed NWQMS guidelines in six of the eight bores (MW01, MW02, MW03, MW04, MW07 and MW08). The highest nutrient concentrations occur in the northern and central region of the site at MW01, MW02 and MW04, however it is noted that TP is not reflected in the deeper parts of the groundwater resource (at PB02, MW04D).

Whilst recorded nutrient concentrations in the shallow portion of the underlying groundwater resource, the nutrient concentrations in groundwater do not appear to have negatively affected nutrient concentrations in Margaret River, which remain generally low.

3.5.2.3 Wallcliffe Surficial aquifer

The site is located within the Leeuwin Complex which is classified as surficial and fractured rock aquifers. During the *Hydrogeological Assessment* (Emerge Associates 2022), a thin weathered zone and overlying surficial deposits were identified beneath the site that holds a groundwater resource. This resource, referred to as the Wallcliffe Surficial Aquifer relies on the infiltration of rainfall from the contributing recharge catchment area.

The Wallcliffe Surficial aquifer beneath the site was assessed in the *Hydrogeological Assessment* (Emerge Associates 2022) to determine the volume of the groundwater resource available to support irrigation. The Wallcliffe aquifer is recharged by a 58 ha catchment uphill to approximately



Wilderness Road by rainfall and is recharged between 5,500 kL/year to 44,100 kL/year, depending on the assumptions used (% recharge of rainfall, size of catchment, etc.). The median calculated recharge has been adopted as the sustainable recharge of the Wallcliffe Aquifer at approximately 22,100 kL/year; this considers potential impacts of climate change and rainfall variation.

Based on this assessment and adopting a conservative approach to maintain a sustainable yield, the sustainable yield available beneath the site is estimated to be 22,079 kL per annum.

3.6 Existing and historical land use

A review of available historical aerial imagery indicates that a majority of the site was cleared of native vegetation prior to 2004 (Landgate 2018). The site historically supported one of the original farms and homesteads built by the Bussell family (known as 'Wallcliffe House') with construction of the buildings commenced in 1858. The site included a number of large sandstone buildings, dairy, and ancillary buildings, as well as a significant mature cultivated garden. It has supported agricultural, residential and tourism land uses since 1858.

The previously existing buildings within the site were destroyed by a bushfire in 2011. They include the original Wallcliffe House (built between 1855 and 1865) in the centre of the site and the dairy located to the north-east of the original Wallcliffe House. West of Wallcliffe House was a large dwelling (the former Chaney Residence) which was built in the early 2000s. South of the large dwelling was a rectangle building which was possibly used as a service building.

The landscaped portion of the site (around the existing buildings) has been earthworked and retained (terraced) to create flat building platforms, lawns, and garden beds. Immediately north of the dairy is an extensive area of grassed lawn and a small (dry) dam. South and east of the dairy the elevation of the site rises relatively steeply.

The site has not been used for residential or tourism purposes since the 2011 Margaret River bushfire significantly damaged the buildings discussed above, however, the gardens and grounds have continued to be maintained to a high standard since this time.

3.7 Summary of existing environment

In summary, the environmental investigations conducted to date indicate that:

- Long term climatic averages indicate that the site receives 951.7 mm on average annually with the majority of rainfall received in May to August.
- The site slopes towards Margaret River with an average grade between 10-15%. Existing ground levels range from 2 m AHD to 64 mAHD.
- The site soils include limestone outcrops/pinnacles at various locations, surficial layers of sandy topsoil/fill overlying sand or limestone. In the lower portion of the site adjacent to Margaret River, the surficial layer is underlain by a layer of clayey sand, sandy silt, silty sand, and clay, overlying granitic bedrock.



- Soil permeability of shallow soils ranges between 0.4 m/day to >25 m/day. Deeper limestone has
 a measured permeability of 8-12 m/day.
- The site is not identified as having any risk of ASS based on the available regional mapping and is unlikely to be a consideration based on the site characteristics.
- Given the proximity to the coast (located 600 m west of the site), assets either below the 5 m
 AHD contour or at a horizontal distance of 200 m from the coast may potentially be exposed to coastal processes such as storm surge and inundation based on the outcomes of the CHRMAP.
- There are no waterways or surface flow channels present on site, and frequent and minor event runoff is likely to infiltrate within the site at or close to source. Major event runoff would likely result in some sheet flow over both impermeable and permeable surfaces given the steep slope of the site.
- The site is immediately adjacent to the Margaret River and associated riparian vegetation.
- There are no wetlands located within the site.
- Groundwater levels beneath the site vary from 0.43 mAHD to 3.78 mAHD based on observations
 of four bores between June 2021 and May 2023.
- The site is underlain by the Wallcliffe Surficial aquifer, which provides a sustainable groundwater resource of approximately 22,000 kL per annum.
- Historical land use of the site has included low density agriculture, a residence, and tourismrelated purposes.



4 Design Criteria and Objectives

4.1 Integrated water cycle management

The *State Water Strategy* (Government of WA 2003) endorses the promotion of integrated water cycle management and application of water sensitive urban design (WSUD) principles to provide improvements in the management of stormwater, and to increase the efficient use of other existing water supplies.

The key relevant principles of integrated water cycle management include:

- Considering all water sources, including wastewater, stormwater, and groundwater
- Integrating water and land use planning
- Allocating and using water sustainably and equitably
- Integrating water use with natural water processes.

Integrated water cycle management addresses not only physical and environmental aspects of water resource use and planning, but also integrates other social and economic concerns. Design objectives for Wallcliffe House will deliver best practice outcomes in terms of:

- Potable water supply
- Wastewater servicing and management
- Non-potable water supply sustainability
- Surface water management and water sensitive urban design
- Groundwater management
- Flood protection.

The first step in applying integrated water cycle management in catchments is to establish agreed environmental values for receiving environments. The existing environmental context of the site has been discussed in **Section 3** of this document. Guidance regarding environmental values and criteria is provided by a number of National and State policies and guidelines and site specific studies undertaken in and around the site, as detailed in **Section 1.4**.

The design criteria discussed in the following sections are based on the assessment of the existing environment within the site, with the aim of achieving the outcomes discussed above.



4.2 Water supply and conservation

This WMS proposes the following water supply and wastewater management design criteria:

<u>Criteria WC1</u> Use appropriate non-potable water sources for irrigation

Criteria WC2 Minimise potable water use

The manner in which these objectives will be achieved is further detailed in Section 5

4.3 Wastewater management

The principle behind the wastewater management system is to provide appropriate servicing of the site, whilst also mitigating risk to the downstream environment.

<u>Criteria WW1</u> Ensure appropriate management of wastewater

The manner in which these objectives will be achieved is further detailed in Section 6.

4.4 Surface water management

The principles behind surface water management at the site are to ensure surface water is appropriately treated and that Margaret River (as described in **Section 3.5**) is not detrimentally affected by the development. This WMS proposes the following stormwater design criteria:

<u>Criteria SW1</u> Floor of habitable buildings to at or above the elevation identified to mitigate future coastal processes risk

Criteria SW2 Manage the small rainfall event runoff at source

Criteria SW3 Manage runoff from minor and major rainfall events to control erosion

Criteria SW4 Adopt a passive at-source approach to stormwater management infrastructure

Criteria SW5 Utilise appropriate non-structural measures to reduce nutrient loads

The manner in which these objectives will be achieved is further detailed in Section 7.

4.5 Groundwater management

This WMS proposes the following groundwater management criteria:

<u>Criteria GW1</u> Stormwater infiltration infrastructure to be located at least 500 mm above highest known groundwater level

Criteria GW2 Buildings to be protected from groundwater inundation

The manner in which these objectives will be achieved is further detailed in **Section 8**.



5 Water Supply and Conservation

5.1 Fit for purpose water use

Conservation of water through fit-for-purpose use and best management practices is encouraged so that water is not wasted. Fit-for-purpose principles have been utilised in the water conservation strategy for the site.

5.1.1 Potable supply

The site is serviced by potable water from the Water Corporation's supply network, and is currently delivered via a 150 mm distribution pipeline located along the eastern side of the Wallcliffe Road reserve. The site currently has a 20 mm diameter domestic connection, which will need to be increased to suit the proposed development. The development will require a suitably sized header tank designed to maintain supply for a stipulated period of time during a power-outage.

5.1.2 Groundwater

The Water Register (DWER 2023) indicates that the site is located in the Busselton-Capel groundwater area, within the Cape to Cape North subarea. The formation beneath the site is recorded as the Combined Leeuwin Surficial/fractured rock aquifer, and there is 'limited information' available regarding the allocation status of this resource.

As indicated in Section 3, the Wallcliffe Surficial aquifer exists beneath the site. It has a measured capacity of approximately 70,000 kL and a sustainable yield of approximately 22,100 kL/year; this considers potential impacts of climate change and rainfall variation.

DWER has granted an allocation to take 16,500 kL/year of groundwater (GWL207725) and the use is guided by a Groundwater Operating Strategy (GOS) that has been approved by DWER in 2022.

The irrigation system on the site is currently supplied from two low-yielding and shallow bores positioned into the Wallcliffe Surficial aquifer. One bore is near the dam in the northern portion of the site and the other is near the south western corner. Extracted groundwater is pumped to two tanks located west of Wallcliffe Road near the access driveway into the site. These two tanks then irrigate the site by gravity. The irrigation system has historically been operated three days per week in summer and anecdotally the tanks rarely if ever run dry.

The future development of the site will be supported by a replacement extraction location, positioned further from the River than the current extraction points but within the same groundwater resource. The location has yet to be finalised however installation of the bore and subsequent extraction will comply with the requirements of the *Rights in Water and Irrigation Act* 1914.



5.1.3 Stormwater harvesting

The roof areas of the proposed development provide an opportunity to harvest rainfall for later non-potable uses within the site. To do so would likely require localised collection from each roof area and harvested water would need to be pumped to a central storage location. Stormwater harvesting is not required to deliver the project and therefore is not currently detailed within the site designs. However, future development within the site may incorporate rainwater harvested from roof surfaces. This is identified now as a potential water source that could assist in achieving resilience in meeting non-potable needs within the site.

5.2 Water conservation measures

Waterwise gardening (WWG) principles, and water efficient fixtures and appliances (WEFA) will be used to ensure that the development minimises the use of water overall, as well as implementing alternative fit-for-purpose supply options (discussed in **Section 5**).

5.2.1 Water efficient fixtures and appliances

Significant reductions in internal water uses can be achieved with the use of WEFA which will be utilised in all buildings within the site.

5.2.2 Waterwise gardens

The development will undertake a variety of WWG measures to limit water use. The following methods and approaches will be considered:

- Maintain the existing established landscaped areas, which will minimise disturbance to the site, water use, and nutrient requirements typically required to establish such areas.
- Retain existing native vegetation wherever possible.
- The adoption of water wise species, with a focus on using local native water wise species or if necessary species from regions with similar climates.
- Additional turf areas to be minimised where possible.
- The irrigation system will be designed to be staged to only irrigate those areas that require it, including landscaped gardens and turfed lawns.
- Irrigation will not be undertaken if there has been recent rainfall and soil moisture conditions indicate that it is not warranted.
- Soil amendments/improvements will be utilised where required to minimise water repellence and the efficient uptake of water by plants.
- Established native vegetation that does not require additional water will not require permanent irrigation and if it were necessary (e.g. due to extreme weather conditions), this would be done so by contingency irrigation (e.g. temporary or hand-held irrigation).
- A trickle feed irrigation system will be implemented where possible to ensure conservative water use.
- Irrigation will only occur between 6 pm to 9 am, except for the establishment of newly planted areas and only for a period of up to 28 consecutive days, commencing from the day of planting.



- Operation of the irrigation system will be electronically controlled, with regular reviews of the irrigation programme in response to weather conditions.
- Regular inspections and maintenance will be undertaken to ensure minimal losses via damaged infrastructure.
- Each abstraction point will have an approved water meter attached to monitor water usage.

Irrigation requirements across the site will be minimised by utilising WWG practices in all planted areas. Where possible, planting will occur during winter in all development landscaped areas to remove the need for establishment irrigation and maximise plant survivability. It is noted that much of the site already contains mature landscaped areas, and the establishment phase is anticipated to be limited to areas that may be disturbed as part of construction and/or are associated with the new buildings.

Irrigation will utilise the fit-for-purpose sources detailed in **Section 5**, thus achieving **Criteria WC1** and **WC2**.



6 Wastewater Management Strategy

The site was historically served by on-site domestic-scale treatment units. These systems will be located then suitably and properly decommissioned. Development of the site will increase the demand for wastewater collection and disposal. Wastewater will be collected from each new building by means of gravity property sewers to one or several small pump stations that each in turn will pump the wastewater to a single facility.

6.1 Expected wastewater demand

The anticipated wastewater volumes have been based on an annual water demand assessment that has accounted for the following uses/services:

- Hotel guests (at full capacity) 62 guests
- Staff (during peak times) 67 per day (which accounts for permanent and potential ad hoc staff)
- Main kitchen/restaurant 180 sittings per day
- Tea Room and Bar
- Guest spa facility 25 uses per day
- Incidental laundry
- Ancillary uses (bin washdown, car wash, etc.)

The anticipated patronage and wastewater generation is summarised in Table 8.

Table 8: Anticipated wastewater generation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Season	Peak	Peak	Shoulder	Shoulder	Shoulder	Off peak	Off peak	Off peak	Shoulder	Shoulder	Shoulder	Peak
Occupancy	79%	79%	67%	67%	67%	57%	57%	57%	67%	67%	67%	79%
Daily wastewater	18.8kL	18.8kL	14.5kL	14.5kL	14.5kL	13.5kL	13.5kL	13.5kL	14.5kL	14.5kL	14.5kL	18.8kL

Based on the occupancy detailed in **Table 8** (varying between 57 % and 79%), the annual wastewater generated is anticipated to be approximately 5,700 kL/year. However, and as discussed in **Section 6.3.9**, the system and disposal of wastewater has been designed based on 100% occupancy year round.



6.2 Options assessment

The approach to wastewater management has considered three options:

- 1. Connection to Water Corporation infrastructure at Gnarabup has been investigated. The nearest potential outfall to accept wastewater pumped from the site to the Water Corporation operated Prevelly wastewater treatment plant is an existing wastewater pump station located opposite and to the west of the intersection of Chuditch Place and Bandicoot Close, approximately 2.5 km south of the site (referred to as the 'Chuditch Place PS'). A private pressure main would be required to be installed and located along the road reserves of Wallcliffe Road then Chuditch Place. This would discharge into the wastewater system near the Chuditch Place PS. The Water Corporation have indicated that whilst in principle the proposal may be feasible the current system does not have the capacity to accept additional flows (without system upgrade). The Gnarabup option is not technically feasible as it would have a downhill pressure main gradient, which would not be accepted by the Water Corporation to their system.
- 2. Connection to Water Corporation infrastructure near the western edge of Margaret River townsite. It is uncertain whether the Water Corporation infrastructure has the capacity to accept wastewater from the site. This would require the site to pump wastewater via a pressure main along Wallcliffe Road, to either near Farrelly Street or possibly along a slightly shorter pressure main to near the intersections with Wallcliffe Road and either Tyrone Loop or Mansfield Avenue. The length of the pressure main will be about 6.5 km to 7 km depending on the route.

A fundamental Water Corporation design prerequisite with a private wastewater pressure main is that the main conveys wastewater to minimise the chance of the sewage going septic, and as such should turn over at least once per day. With the relatively low flows from the development, this requirement would not be achieved within such a long pipe section. Detention times in the pressure main are likely to be longer which may create a risk of odour issues at the discharge point, and therefore Option 2 is not considered to be technically viable.

3. Onsite wastewater treatment and disposal via a Fujiclean system. A proprietary package wastewater treatment plant (WWTP) will provide the core treatment of the raw wastewater. As well as a biological treatment process for the treatment of organic matter, the WWTP also includes nitrification and denitrification processes for nitrogen removal.

An onsite wastewater system will need to be able to dispose of/manage the treated/recycled water within the site and at an appropriate distance from Margaret River. It will also need to mitigate the risk that nutrients could potentially migrate towards Margaret River. The system will also need to operate in a spatially constrained site and be managed in the context of the ongoing operations of a resort style development.

Option 3 is considered to be the most feasible and is the only practically implementable option.



6.3 Onsite wastewater treatment plant

The wastewater treatment system will achieve tertiary treatment of effluent as described in detail in the *Engineering Aspects* report (Civil Group 2023) and also summarised in the following sections.

6.3.1 System summary

Package WWTPs are extremely common for premises outside of the Water Corporation's licence area as well as remote locations/mine camps and can treat domestic strength wastewater to a treated effluent suitable for basic liquid effluent disposal methods (such as low exposure risk recycled water reuse applications). Solids accumulated in package WWTPs are routinely removed via vacuum truck for off-site treatment and disposal. The proposed treatment system at Wallcliffe House is a Fujiclean system that will treat the wastewater to a much higher quality than a conventional septic tank (which are still very common throughout the Margaret River and broader Southwest region). In addition to the package WWTP, the Fujiclean system proposed for Wallcliffe House will be accompanied by an effluent polishing plant to provide further filtration and treatment of the effluent produced from the package WWTP. The polishing plant includes membrane filtration and chemical dosing to remove phosphorous. Membrane filtration also removes a high fraction of viruses, pathogens, and other microorganisms from the treated effluent. The high-quality effluent (both from a chemical and biological perspective) means that a wider range of disposal methods are appropriate to be considered.

Based on the typical specification for this type of system, the proposed package WWTP will achieve TN concentrations of <10 mg/L, and following the additional polishing proposed TP concentrations will be reduced to <1 mg/L. An important final step will be applied during the infiltration of treated water, whereby an engineered soil media designed for its ability to further remove phosphorous will be installed beneath effluent infiltration areas. Based on manufacturers advice the use of the soil media beneath the infiltration areas will result in near total (99%) removal of phosphorous until such time as the media is exhausted. For the purposes of the nutrient balance (Section 6.5) a more modest 90% reduction has been assumed. The lifespan of the media is influenced by depth of soil media and concentration of phosphorous in effluent. Initial calculations indicate that the media will need to be replaced approximately every four to five years to continue to provide full removal of phosphorous (pending occupancy).

The effluent quality produced from the proposed package WWTP, polishing plant and proposed approach to infiltration will therefore be of a higher quality than that generated from utility-operated wastewater treatment plants in Western Australia.

6.3.2 Chemical dosing

Chemical dosing of treated effluent for chemical phosphorous removal is not common due to the cost and resultant sludge generated. Most utility operated WWTPs in WA rely only on biological phosphorous removal in the core treatment process, resulting in a typical total effluent phosphorous of 5 mg/L in metropolitan areas, and >10 mg/L in regional areas.



6.3.3 Membrane filtration

Membrane filtration of all treated effluent will be adopted however is rare even for utility operated WWTPs. Membrane filtration involves very small filtration apertures, removing essentially all particulate solids from the effluent (a total suspended solids of <1 mg/L is expected). For most utility operated WWTPs, filtration of final effluent is undertaken via screen filter or disc filter, which have a filtration aperture >100 times larger than membranes. With such filtration, a total suspended solids of 20 mg/L is acceptable and in accordance with recycled water guidelines. Membrane filtration is typically reserved only for high demand applications (e.g., industrial process water supply, or indirect potable reuse) or where sensitive environmental receptors are nearby (i.e. Margaret River).

6.3.4 Effluent polishing

The effluent polishing plant proposed for the Wallcliffe House WWTP will generate low volumes of sludge due to the chemical removal of phosphorous. The dosed chemical causes soluble species (of which phosphorous is one) to precipitate out of solution as a solid, which can then be filtered. The waste stream from the polishing plant will be fed to the sludge dewatering plant, which thickens and dewaters the sludge to the degree whereby it is suitable for offsite disposal to landfill as a solid. The dewatered liquid is recovered back to the effluent polishing plant for further treatment.

6.3.5 Maintenance

Whilst the Fujiclean system is very low maintenance (a 'set and forget' system), the overall system will incorporate operation and maintenance agreements with equipment vendors to ensure that the system operates reliably to a high standard suited to the development and as required by current legislation.

6.3.6 Buffer storage

Buffering storage will also be incorporated into the system to provide contingency storage in the event of maintenance, power outage, or fault with individual system components.

The buffer storage will be incorporated before and after the package WWTP and will ensure there is time for an operator to attend the site and for brief power outages. This will safeguard the surrounding environment from potential wastewater spillage or overflow.

6.3.7 Monitoring

The system will be monitored by both hotel staff and the maintenance contractor to respond in a timely manner. Maintenance contracts will be set up to ensure response times are stipulated and guaranteed and the system is then designed to suit this.

6.3.8 Backup electricity

Backup electricity and suitable buffer-storage tanks will be incorporated into the wastewater system to avoid any risk of overflow spillage entering the environment (in particular Margaret River) in case



of a breakdown of part of the system. A back-up generator will ensure constant electricity supply to the wastewater system in the event of prolonged power outages.

6.3.9 Effluent disposal requirements

Land application systems typically discharge wastewater via soil absorption systems (e.g., flatbed leach drains) or irrigation systems (e.g., subsurface irrigation or surface irrigation). The method by which wastewater is dispersed to the land influences the amount of land required for application.

Based on the expected daily generation of wastewater, a maximum system demand has been estimated to be 24 kL/day (based on 100% occupancy), though this could be as low as 13.5 kL/day during off peak times. As described in **Section 6.1**, occupancy is expected to vary from approximately 57 % during off peak to 79 % during peak times, and therefore the assessment using 100 % occupancy is conservative.

The suitability of the land to accept the anticipated wastewater stream is assessed in **Section 3.3**.

6.3.10 Treatment system separation

The GSP stipulates that on-site sewage systems are not to be located within 100 m of a drainage system that discharges directly into a waterway or significant wetland without treatment. The key consideration is the setback from Margaret River. The site has recently been thoroughly investigated via intrusive site investigations (see **Section 3.3.2** and **3.3.3**) involving test pitting and infiltration testing at the proposed locations of subsurface infiltration systems. The investigations confirmed that there are three locations within the 'Arrivals Paddock' that provide sufficient infiltration capacity, and which are in excess of 100 m from Margaret River foreshore. The proposed locations of the infiltration cells in relation to the River are shown on **Figure 5** with site plans contained in **Appendix A**.

6.4 Site and soil evaluation

6.4.1 Summary of relevant site conditions

The characteristics of the site that are relevant to the disposal of treated effluent within the site are discussed in **Section 3**, and summarised in **Table 9**, which is based on AS1547:2012 Table K1 potential site limitations.



Table 9: Site and soil evaluation summary

Site characteristic	Summary	Disposal implications
Topography/slope	Site ranges from 2 mAHD to 64 mAHD with a slope of 15% generally steep slope towards the River	The site is too steep for recycled water disposal methods that rely on shallow/flat infiltration areas or surface irrigation.
Soil depth	Soil depth beneath potential infiltration areas is >20 m	20 m soil provides more than enough profile to provide additional treatment and to store effluent during long periods of wet weather
Soil category and permeability	Shallow soils are sand and limestone, limestone increasing with depth, overlying strongly to weakly weathered granite with decreasing permeability. Permeability in shallow sand soils >25 m/day	Site soils are considered as Category 1, permeability suitable for onsite infiltration of recycled water
Depth to groundwater	Portions of the site next to the River have >2 m separation, however portions of the site >100 m from the river have >20 m clearance above groundwater	Depth to groundwater at locations >100 m from the river is >2 m, providing a deep soil profile and long pathway for effluent
Duration of continuous soil saturation	Soils are moderate to highly permeable and not seasonally saturated	No impediment imposed by duration of soil saturation
Dispersive soil	Soils have high measured permeability and are not sodic	No impediment imposed by soil sodicity
Site area	5.2 ha, mostly vegetated/landscaped	The site has a large enough spatial extent to facilitate infiltration of recycled water
Proximity to environmental assets	Margaret River immediately adjacent to the site	Approximately 30% of the site >100 m from the River, and the proposed infiltration areas (within the 'Arrival Paddock') are >100 m from the River
Other nearby resource users	No other users of the Wallcliffe Aquifer	No impediment imposed by other land users

In summary of the site conditions, onsite infiltration of recycled water is suitable given the permeable nature of soils located >100 m from Margaret River and deep profile of permeable soils. However, infiltration measures should be subsurface and have a consolidated depth profile (i.e. along a topographical contour) given the slope of the site.

AS1547:2012 indicates that where slope is a design constraint consideration should be provided to risk of erosion, buildability, and seepage. These factors can be appropriately managed in the design of subsurface infiltration cells.

6.4.2 Design loading rate and land application area

Substantive guidance is provided to onsite effluent disposal system design and effluent disposal by the Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974 and AS 1547:2012. It is however noteworthy that the tertiary system proposed for use (as described in **Section 6.3**) is significantly more sophisticated than a typical residential septic or secondary treatment system, and therefore warrants additional consideration.



When considering the sizing of the land application area for the site AS1547:2012 recommends selecting an appropriate design loading rate (DLR) from the values presented in Table L1. When selecting an appropriate DLR (based on the site soils and permeability) it is recommended to use a conservative value if there is uncertainty regarding the capacity of the site to accommodate on-site wastewater disposal. Based on the site soil investigations (see **Section 3.3**) and the recommended treatment system a DLR of 50 mm/day would be appropriate. However, given the steep slope of the site (> 15 %) towards Margaret River a more conservative approach to DLR selection has been made resulting in a DLR of 30 mm/day based on Table L1.

Using the selected DLR, the maximum trench width of 2.53 m and a peak daily design flow rate (see **Table 8**) the required length of leach drains can be determined using the formula given in Section L4.2 of AS1547:2012. Best on this information the required length of leach drains to effectively treat the peak daily flow rate would be 330 lineal metres and have a spatial footprint of 575 m² for the infiltration of treated effluent.

Due to the steep topography of the site, a traditional (e.g., infiltration trench, flatbed leach drains or other similar) approach is not possible, and therefore the treated/recycled water is proposed to be infiltrated within subsurface cells/leach drains. These will utilise infiltration cells such as EcoAID, Tunnelwell or Stormtech cells generally consistent with those shown in Figure L2 from AS 1547:2012 and will be sized to provide sufficient void space to accommodate 24 kL of infiltration storage (maximum daily wastewater generation). Measured infiltration rates at the proposed cell locations (see **Section 3.3.3**) indicate that this volume would readily infiltrate into the underlying soils within 24 hours. This is based on a design permeability of 5 m/day, which is significantly less than the measured permeability of ~25m/day in the shallow soil profile and 8-12 m/day in lower permeability limestone areas (noting that the preferred locations Are those with a sandy profile and high permeability).

The land area required for these cells would be approximately 60 m², significantly less than that calculated by AS1547:2012 methodology, however, the portion of the site that the proposed infiltration cells will be located (referred to the arrivals paddock and immediate surrounds) and which is >100 m from the River is approximately 16,000 m², which is approximately 28 times the surface area indicated a required by AS1547:2012, and therefore the site has sufficient land area to achieve the intent and objectives of AS1547:2012. This area is shown in **Figure 5.**

With the proposed treatment area being located on a steep slope consideration of stormwater surface runoff is required so that the leach drains do not become hydraulically overloaded, thereby reducing the overall effectiveness of the system. As specified in Section 5.5.3.6 of AS1547:2012, when subsurface solutions are proposed on steep slopes, bund or cutoff drains are recommended upslope of each drain to ensure that surface runoff is directed around subsurface infiltration systems. Therefore, either vegetation cover, built form or localised landforms are utilised upslope of the proposed infiltration locations.

Given the soil profile underlying the infiltration cells (permeable sandy/limestone soils >20 m) and the large area of the site, the approach proposed is consistent with the stated intent of AS1547:2012, which is to meet the performance objectives for the on-site system of providing sufficient capacity to



receive, treat and absorb all treated wastewater flows within the site boundary in an effective and sustainable manner which protects public health and the environment.

6.4.3 Contingency in design

To provide additional standby capacity, and also redundant service capacity, three 24 kL storage cells are proposed (i.e., triple the maximum daily capacity will be provided). These will be approximately 24 m in length, approximately 2 m wide and will be installed along the topographic contour at locations that have been tested to confirm infiltration capacity. The use of these will be rotated as required to suit operational and maintenance needs. This is greater than the additional 100% reserve area recommended by AS1547:2012 (see Section 5.5.3.4) and suits the sensitive nature of the surrounding environment in the vicinity of the land application areas.

Based on the assessment of wastewater demand and the expected occupancy, the proposed disposal system will provide almost four times the anticipated capacity required during peak times and over five times the anticipated capacity required during off-peak times.

6.4.4 Risk reduction measures

A summary of relevant risk reduction measures applicable to the site and the selected wastewater treatment solution are provided in **Table 10**, which is based on AS1547:2012 Tables A1 and A2, and presents the measures taken to reduce the risks associated with the development.

Table 10: Design risk reduction measures for the site

Potential Risk	Potential cause	Risk mitigation measure
Wastewater system hydraulic failure	Inadequately sized wastewater treatment system and undersized land application area	 Designing for maximum daily wastewater generation rather than likely peak wastewater volumes Use of a conservative approach for land application area sizing Provide additional contingency storage
Biological failure from power outage causing cessation of pumps and aerators	Loss of power which stops the operation of the treatment system. This can cause a backup of wastewater and reduce the effectiveness of the system	Backup generators are required for the treatment system Additional storage provided within buffer tanks Contingency/management plans are in place in case of loss of power Staff are made aware of contingency planning in case of loss of power
High rainfall or torrential downpours	Excessive surface runoff can hydraulically overload the land application areas	Use of built form or localised landforms to direct surface runoff around land application areas



Table 10: Design risk reduction measures for the site (continued)

Potential Risk	Potential cause	Risk mitigation measure
Wastewater biological failure from washout of bacteria	Inadequate hydraulic design of the wastewater system (i.e. undersized, inappropriate treatment system, etc.)	 Designing for a larger hydraulic loading than anticipated Additional storage provided within buffer tanks Use of a conservative approach to the sizing of land application area Provide multiple disposal area to provide contingency within the system
Site constraints	Steep slopes located within proposed land application area	 Conservative approach taken for selection of DLR Appropriate selection of disposal system for the steep slopes (i.e. subsurface disposal) Install disposal systems perpendicular to the fall of the slope
Clogged outlet filters	Inadequate servicing of wastewater system	Implementation of a regular monitoring and maintenance program Conservative estimate of maximum wastewater flows within system Flow balancing across disposal locations to ensure even distribution of hydraulic loads
Sludge and scum solids fill tank and overflow to soakage field	Irregular pump/maintenance schedule, undersized wastewater treatment system	Implementation of a regular monitoring and maintenance program Follow maintenance schedule as per manufacturers specifications
Build-up of excessive solids to land application area	High organic loading and insufficient settling of solids within wastewater treatment system	Provision of a contingency land application area for additional disposal area Implementation of a regular monitoring and maintenance program
Uneven distribution system/broken/damaged distribution lines	Traffic over land application area	Minimise compaction during installation Ensure land application area is protected by fences/barriers Ensure 'no-go' areas area are specified in the monitoring and maintenance program

6.5 Nutrient balance

In order to assess the potential nutrient load that may be directed to the downstream environment, and to determine if this will provide an acceptable outcome, and nutrient mass balance analysis has been undertaken. The mass balance assesses a worst-case outcome, combining the following circumstances and assumptions:

- 100% occupancy for a three-month period
- No flow within Margaret River for a three-month period
- Flow from wastewater treatment system directly enters the Wallcliffe Aquifer and River as a combined system



- No additional attenuation provided by natural processes that could be expected within the soil profile
- Nutrient concentrations in the River are consistent with those measured and constant throughout the assessment period (TN 0.425 mg/L TP 0.069 mg/L)
- Adjacent portion of the River that water could interact with is 9 ha at an average 3 m depth providing 270,000 kL of potential storage
- The Wallcliffe Aquifer is 69,300 kL of potential storage
- Varied nutrients measured in the Wallcliffe Aquifer are temporary as the source of these (historical agricultural land use) has been removed.
- Wastewater treatment system outputs (to the infiltration cells) are TN 10 mg/L and TP 1 mg/L
- Additional polishing achieved by soil media beneath infiltration cells removing 90% of phosphorous, therefore resulting TP concentration being infiltrated is 0.1 mg/L.

Based on the nutrient mass balance undertaken, the following results are noted:

- Existing (static) nutrient mass in the River: TN 115 kg, TP 19kg.
- Nutrient mass in recycled water (prior to filtration through treatment media): TN 21.6 kg, TP 2.16 kg.
- Resulting nutrient concentration in Wallcliffe Aquifer/Margaret River over 3 month no flow period: TN 0.51 mg/L TP 0.070 mg/L.
- When anticipated occupancy rates are adopted the nutrient concentrations in Wallcliffe Aquifer/Margaret River over 3 month no flow period reduces to TN 0.49 mg/L TP 0.0694 mg/L.

In order to provide a holistic project assessment, the nutrient application that may be expected to maintain the high standard of landscaping evident at the site has also been considered. Whilst native vegetation and unfertilised garden beds will be the typical approach adopted, based on the maintenance of the approximate extents of traditional style landscaping the following nutrient inputs can be determined:

- Landscaped area requiring fertiliser input: 1.2 ha.
- Fertiliser rate 60.6 kg/ha/year TP 10.2 kg/ha/year (based on UNDO Tool combined 'non-native gardens', 'sport', 'native vegetation').
- Assume 75% plant uptake of applied nutrients and 25% of nutrients applied are leached.
- Nutrient output from the site is consistent throughout the year.
- No further attenuation is provided by movement through soil and the aquifer.
- Nutrient mass leached from fertiliser use over three-month period: TN 4.54kg, TP 0.765kg
- Resulting nutrient concentration in Wallcliffe Aquifer/Margaret River over 3 month no flow period when combined with wastewater outputs: TN 0.52 mg/L TP 0.072 mg/L.

The nutrient mass balance for both treated/recycled water and other anticipated uses (fertiliser) shows that the potential nutrient concentrations that might be experienced in the Wallcliffe Aquifer and Margaret River are marginally above the existing nutrient concentrations. It is noted that the potential nutrient concentrations that might occur as a result of developing the site are well below (by an order of magnitude) the maximum levels that have already been recorded in Margaret River adjacent to the site (see **Section 3.5**).



In summary:

- 1. The nutrient (mass) outputs from the site are orders of magnitude less than the existing nutrients recorded in the Wallcliffe Aquifer and in Margaret River.
- 2. The combined Wallcliffe Aquifer and Margaret River provide a very large receiving environment, of which the daily treated/recycled wastewater output is 0.0071 % of the total receiving environment volume.
- 3. Combined nutrients from treated/recycled water and potentially leached fertiliser will cause a very slight increase in nutrient concentrations however this will be within the recorded natural variability of nutrients within the Wallcliffe Aquifer and in Margaret River.



7 Stormwater Management Strategy

Stormwater runoff from the site is already being managed at source, and in accordance with best practice. The access road to the site for example is unkerbed and runoff sheet flow moves away from the pavement into the adjoining landscaped or natural bush areas. This has ensured that direct discharge of runoff to Margaret River does not occur.

7.1 Site stormwater management measures

The stormwater management strategy proposed for the site is to retain and treat the small event runoff at source, with larger events infiltrating locally in surrounding permeable areas. The stormwater management approach has been determined in consultation with Shire of Augusta Margaret River and DWER and is consistent with the historical approach taken within the site.

The proposed development will lead to some additional impermeable surfaces, mainly associated with the rooves on new buildings (e.g. the workshop and carparking areas). However, this is unlikely to change the peak runoff rates significantly, even in a major storm event. WSUD practices will be adopted in the design of the stormwater management system, including:

- **Soakwells.** Roof runoff will be captured and infiltrated in soakwells or may be harvested for onsite non-potable use. Runoff exceeding the capacity of these measures will be conveyed on the surface to the nearest surrounding permeable portion of the site where it will infiltrate.
- **Surface based flow**. All pavement areas will be graded, shaped, and managed to dispose of runoff by surface/sheet flow without the need for a formal piped network.
- **Localised infiltration**. Low profile sheet flow over natural or landscaped surfaces will avoid the need for large bio-retention or detention basins.
- **Vegetated swales adjacent to road pavement**. These have been designed to capture and treat the minor amounts of hydrocarbons and sediments that may occur on these areas.
- **Erosion control**. Localised areas adjacent to pavement require some minor erosion control, particularly where the pavement is steep. This will take the form of rock spawls or local material shaped to slow down runoff and to avoid erosion.
- Localised direction to infiltration areas. Some localised pavement areas may be collected via gully grate and directed to soakwell/subsurface infiltration as currently occurs on site.

7.2 Control of impacts to Margaret River

All drainage and erosion control structures are located within the site boundary and do not extend into the Margaret River and associated riparian vegetation (which is largely outside the site boundary). New planting and landscape treatments within the site will be provided consistent with the treatment requirements of the structures and in consideration of the vegetation within the site, surrounding area, and the Margaret River to ensure protection of these values.



8 Groundwater Management Strategy

The principle behind the groundwater management strategy for the site is to maintain or improve groundwater quality.

8.1 Groundwater level management

As discussed in **Section 3**, the underlying groundwater is at least 2.4 m BGL for most of the site. The site will not require active groundwater controls. Rather, buildings and the base of any infiltration structures will all easily achieve an appropriate clearance above groundwater, on the basis that the habitable floor of buildings will be above the elevation identified for future coastal hazard risk, which is much higher than known groundwater.

8.2 Groundwater quality management

The main objective of the management of groundwater quality is to maintain or improve the existing groundwater quality. This can be achieved by reducing the total nutrient load to groundwater from sources within the development and via treatment of surface runoff prior to infiltrating to groundwater. The absence of historical agricultural activities within the site can be expected to provide a large benefit in reduction of nutrient inputs to the site.

The further reduction of nutrient loads to groundwater will be achieved by the following measures:

- Ensuring that the wastewater approach considers and appropriately treats nutrients.
- Retain existing landscaped areas and native vegetation wherever possible.
- Apply WWG principles to design of additional landscaped areas.
- Minimise fertiliser use to establish and maintain vegetation within existing and new landscaped areas, such that nutrient loss to groundwater is minimised.
- Direct stormwater to vegetated swales/permeable portions of the site.



9 Management and Maintenance Plan

9.1 Management objectives

The design and construction of WSUD features will be undertaken in a manner that promotes the long-term health of the structural measures. These often require active ongoing management, particularly in the first years after construction, to ensure that they continue to provide their intended functions. This also incorporates a monitoring regime to provide guidance to the management actions which will ensure that the overall objectives are met. The overall management objectives are to:

- Maintain the wastewater treatment system to minimise nutrients being discharged to the environment.
- Maintain WSUD features including vegetated swales and erosion control measures.
- Minimise ongoing non-potable (irrigation) water use.
- Ensure that the system remains in an appropriate and sustainable condition.

The overall objective will be achieved through the implementation of a number of management actions that will be carried out at regular intervals. As the works are part of a private development with no areas to be handed over to the Shire of Augusta Margaret River, no timeframe for continuation of management and maintenance is specified, however the proponent commits to maintaining the development to the level detailed in this WMP. The key areas that will be addressed through the implementation of this management plan are discussed in the following sections.

9.2 Nutrient and water quality

Nutrient inputs will be managed to ensure that the water quality leaving the site is appropriate. Ongoing measures that will be utilised to control nutrient inputs and therefore groundwater quality will include:

- Use of slow-release fertilisers where appropriate
- Use of appropriate monitoring/testing to inform fertiliser application (e.g. visual monitoring, leaf and tissue analysis, etc.)
- If applicable, monitoring and management of any treated wastewater that may be used/infiltrated within the site to ensure that it meets expected water quality parameters
- Ongoing maintenance of wastewater management systems to ensure that the outputs meet the required specifications
- Erosion and sediments.



The ongoing management and maintenance of the stormwater management system will include:

- Periodic visual inspection of the vegetated swales, infiltration systems (soakwells) and the entire site for erosion and sedimentation
- Removal of built-up sediments in response to observations
- Repair of any significant erosion in response to observations.

9.3 Monitoring and maintenance

The overall condition of the development and wastewater treatment system will be monitored during regular maintenance which will be implemented after the completion of the civil and landscaping works and will be ongoing.

Visual assessments will be regularly undertaken to monitor the overall condition of the development, with the aim to ascertain that the maintenance activities (as detailed in **Section 9**) are achieving the management and maintenance objectives. The monitoring undertaken will guide/refine the maintenance of the site.

The site maintenance and management will remain the responsibility of the proponent. Once the concept design and approach to servicing the site has been refined and detailed design progressed, a monitoring and maintenance schedule will be developed and implemented. The monitoring and maintenance schedule will address issues such as:

- Fertiliser control regime
- Weed management and removal
- Turf management
- Sediment management
- Erosion management.



10 Implementation Plan

10.1 Reporting

It is anticipated that there will be the requirement to undertake ongoing monitoring and to prepare and implement a maintenance schedule for the onsite wastewater management system. If required, monitoring and reporting of the wastewater treatment system will occur to ensure the specifications are in line with any required approval and operating licence. No other reporting is proposed.

10.2 Roles and responsibilities

This WMP provides a framework that the proponent can utilise to assist in implementing an integrated water cycle management strategy that has been based upon site-specific investigations and is consistent with relevant State and Shire of Augusta Margaret River policies. The responsibility for working within the framework established within this WMP rests with the proponent.

10.3 Funding

As the site constitutes a single landholding, the development will be funded by the proponent.

10.4 Review

This WMP is not proposed to be reviewed unless the proposed development undergoes significant change (i.e., increase in impervious areas throughout the site) post-lodgment of the WMP. If the development is substantially modified, drainage requirements may need to be reviewed and the criteria proposed revised to ensure that all are still appropriate.



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Figures



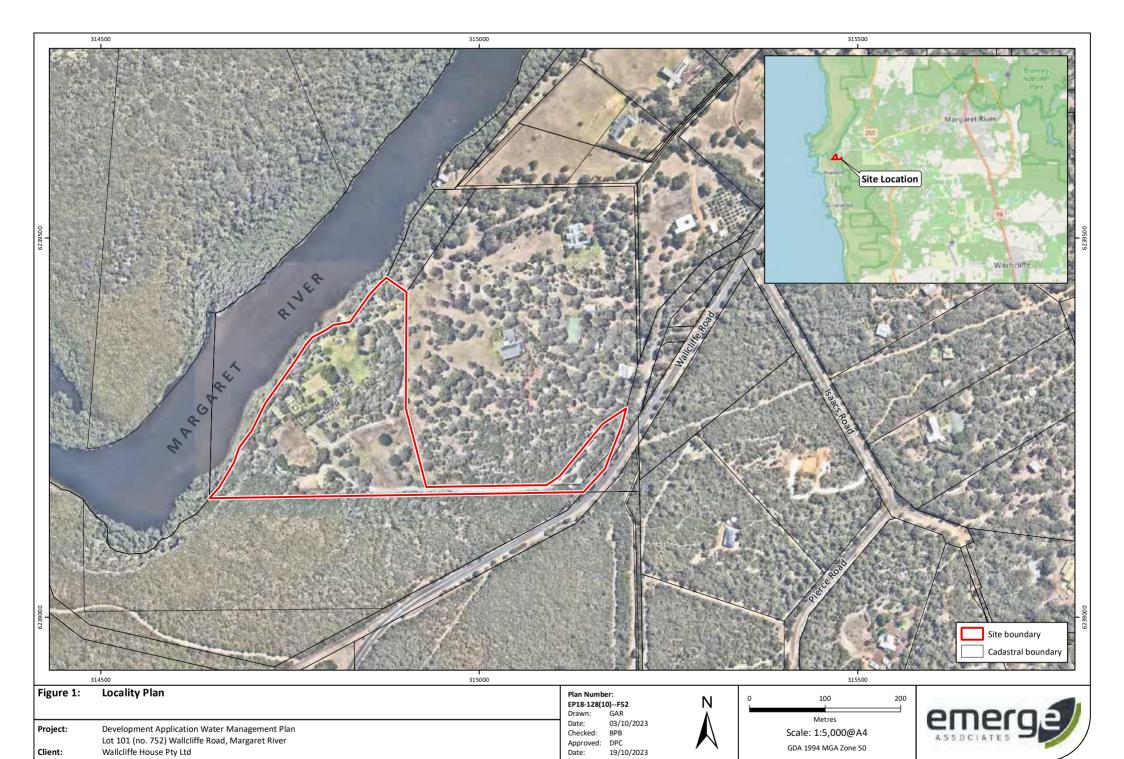
Figure 1: Locality Plan

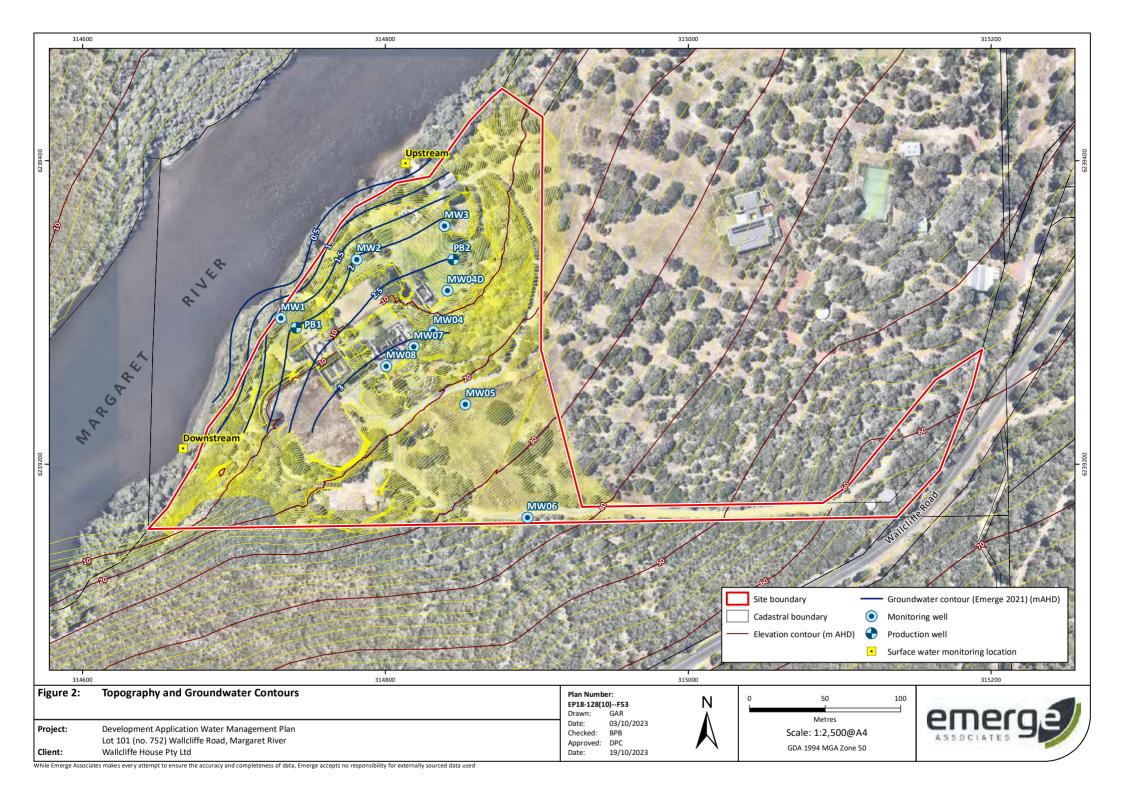
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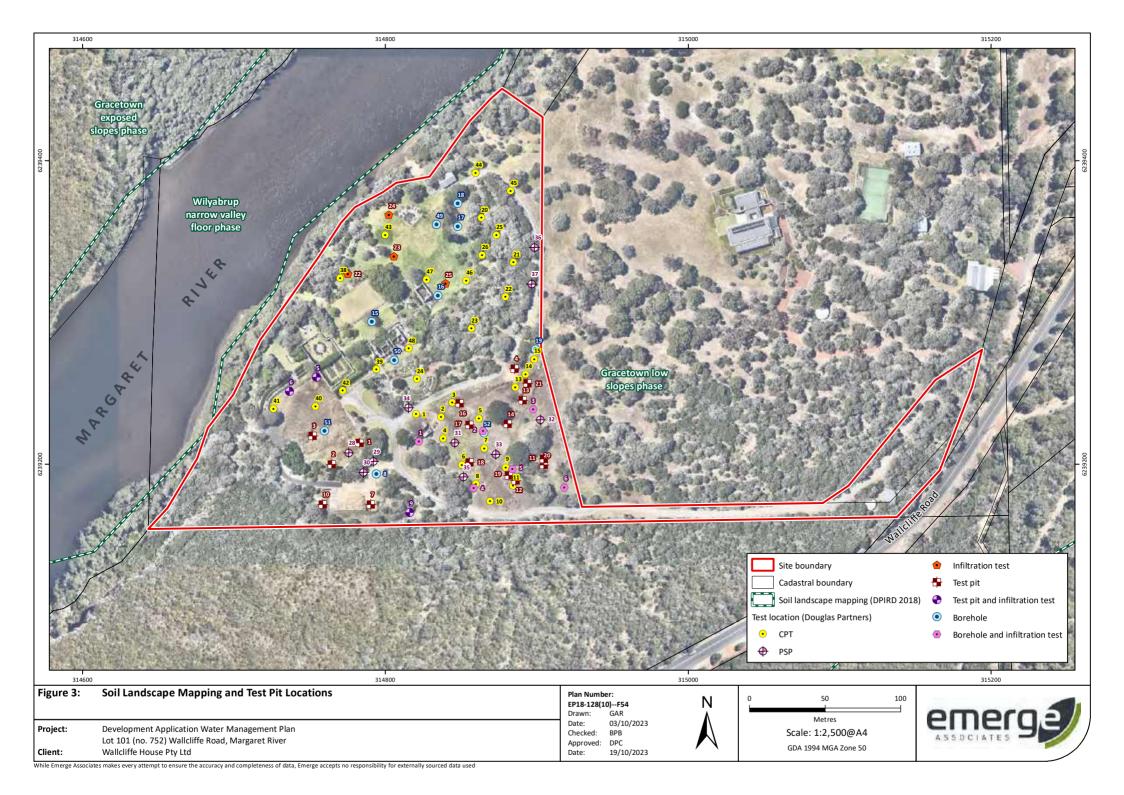
Figure 3: Soil Landscape Mapping and Test Pit Locations

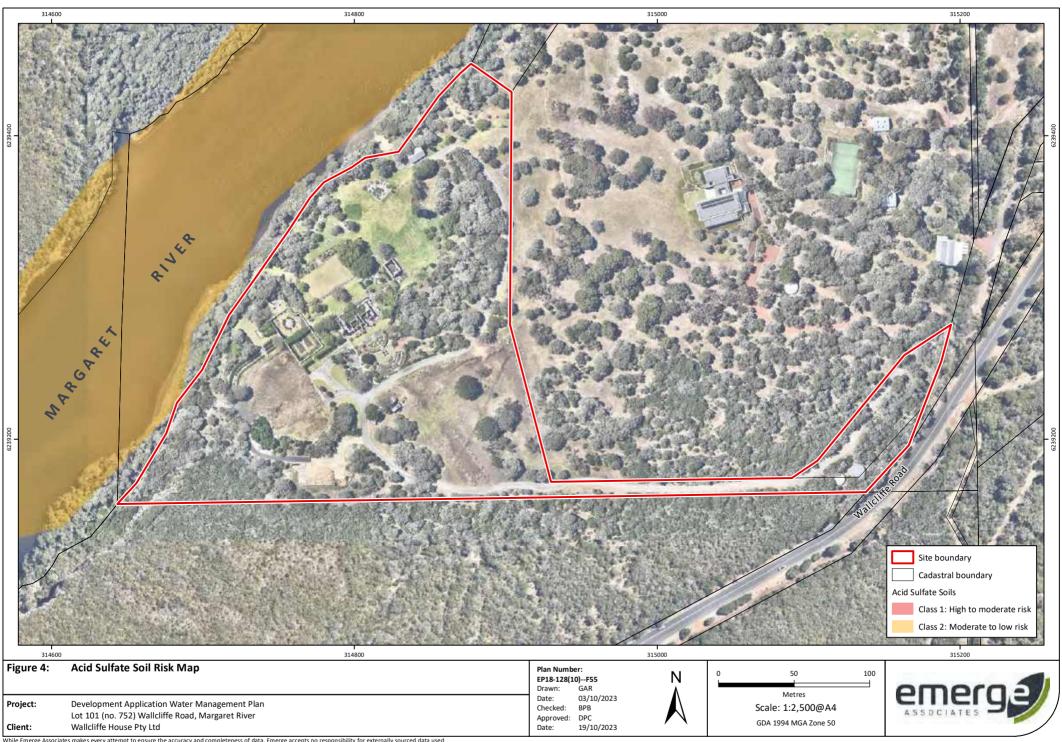
Figure 4: Acid Sulfate Soil Risk Map

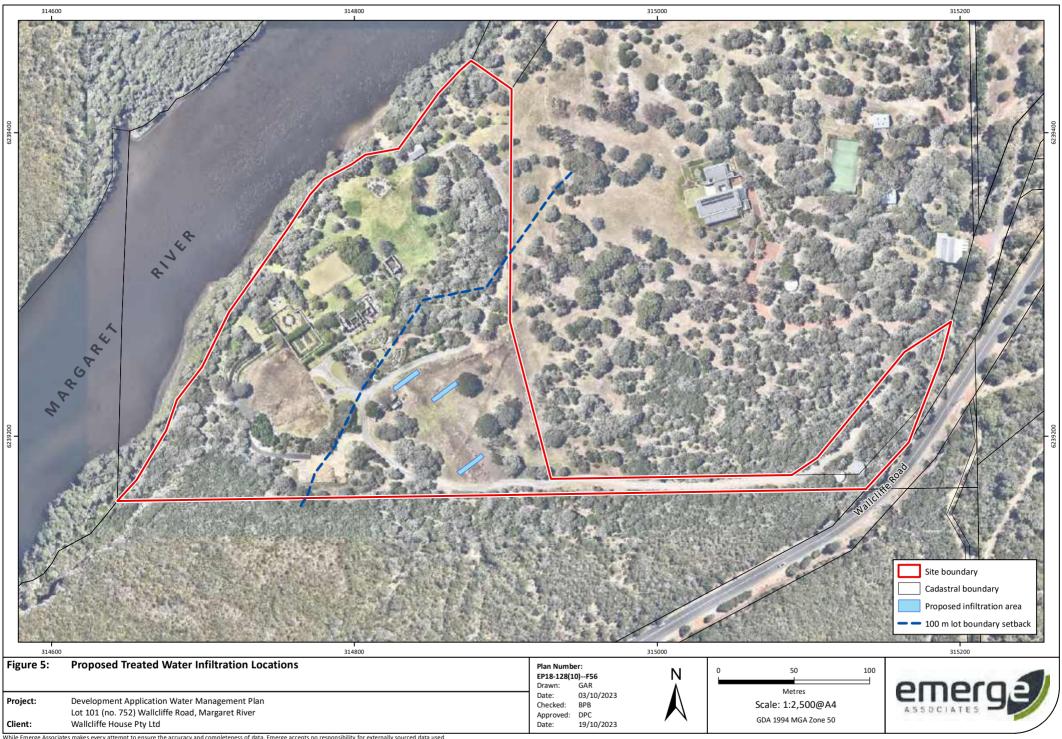
Figure 5: Proposed Treated Water Infiltration Locations











Appendix A Wallcliffe House concept plan







18.08.23 INTERIM CONSULTANT ISSUE 15.09.23 INTERIM CONSULTANT ISSUE

AMENDMENT

LANDSCAPE: HERITAGE:

PROJECT MANAGER: THE LANDSMITH COLLECTION TOWN PLANNING: TAYLOR BURRELL BARNETT PAUL BANGAY / SEEDESIGN HOCKING HERITAGE THE CIVIL GROUP ENCYCLE CUNDALL BRAD GOODE & ASSOCIATES

THE LANDSMITH COLLECTION PROJECT

WALLCLIFFE HOUSE DEVELOPMENT APPLICATION

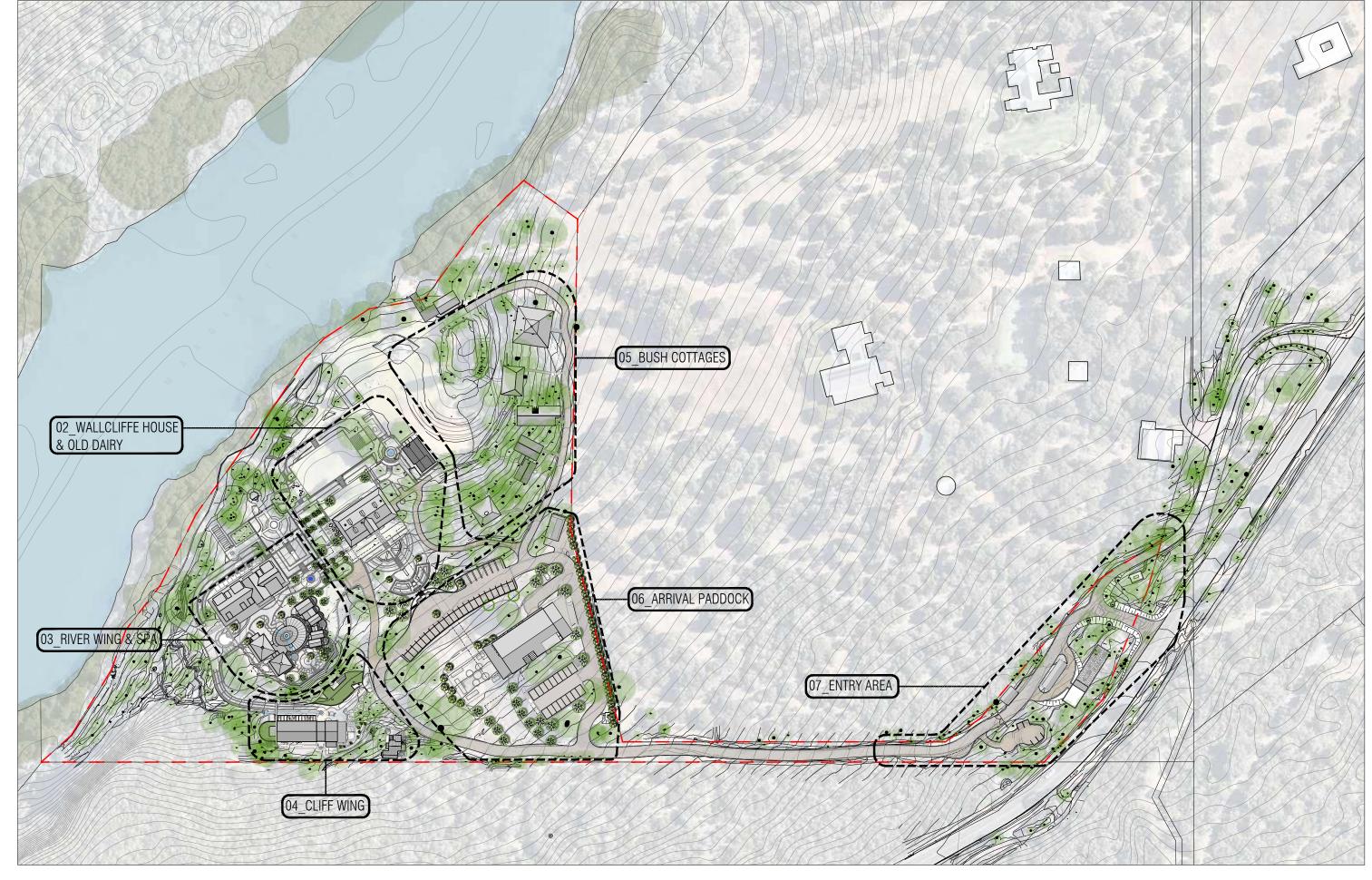
PROJECT ADDRESS

PROJECT STATUS

MARGARET RIVER, WA

PROJECT NUMBER 752 WALLCLIFFE ROAD (LOT 101) 18126 1:1500 @ A3 PROPOSED MASTER PLAN

DA1.04





REV.	DATE	AMENDMENT
A	18.08.23	INTERIM CONSULTANT ISSUE
В	15.09.23	INTERIM CONSULTANT ISSUE
С	24.10.23	ISSUE FOR INFORMATION
D D	02.11.23	ISSUE FOR DA

PROJECT MANAGER: THE LANDSMITH COLLECTION TOWN PLANNING: TAYLOR BURRELL BARNETT LANDSCAPE: PAUL BANGAY / SEEDESIGN HERITAGE: HOCKING HERITAGE ENVIRONMENTAL: EMERGE ASSOCIATES CIVIL: THE CIVIL GROUP TRAFFIC: TRANSCORE WASTE: ENCYCLE SUSTAINABILITY: CUNDALL CULTURAL: BRAD GOODE & ASSOCIATES

THE LANDSMITH COLLECTION

WALLCLIFFE HOUSE

PROJECT ADDRESS 752 WALLCLIFFE ROAD (LOT 101) MARGARET RIVER, WA

DEVELOPMENT APPLICATION

18126 PROJECT STATUS

PROJECT NUMBER 1:1500 @ A3

DRAWING MASTER PLAN SITE ZONES DRAWING NO. DRAFTER CHECKED REV. DA1.05

Appendix B



Douglas Partners Geotechnical Investigation



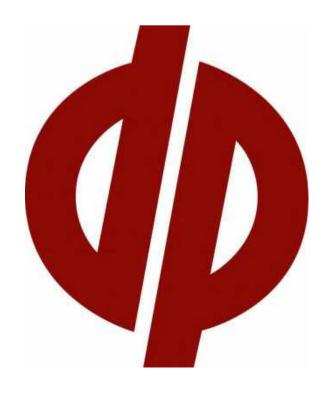


Report on Geotechnical Investigation

Proposed Wallcliffe House Re-development 752 Wallcliffe Road, Margaret River, WA

Prepared for Wallcliffe House Pty Ltd

Project 96717.02 March 2022





Document History

Document details

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

		Date
Author	:	2 March 2022
Reviewer		2 March 2022





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Report on Geotechnical Investigation Proposed Wallcliffe House Re-development 752 Wallcliffe Road, Margaret River, WA

1. Introduction

This report presents the results of a geotechnical investigation undertaken for the proposed re-development of Wallcliffe House at 752 Wallcliffe Road, Margaret River, WA. The investigation was commissioned in an email dated 15 December 2021 by Duncan Haslam of Wallcliffe House Pty Ltd and was undertaken in accordance with Douglas Partners' proposal P96717.02 dated 7 December 2021.

It is understood that the proposed development of the site includes the construction of several buildings and associated basement and tunnels, a natural pool and car parking areas.

The aim of the investigation was to assess the subsurface soil and groundwater conditions across the site in order to provide:

- the soil profile and depth to rock (limestone and granitic bedrock) across the site;
- possible foundation risks at the locations of the proposed building envelopes, including areas of uncontrolled fill, compressible layers, depth to rock and other possible problematic ground conditions. If encountered, make suggestions in terms of recommended strategies to address any identified risks;
- site classification in accordance with AS 2870-2011;
- earthquake site factor in accordance with AS 1170.4;
- excavation conditions, in particular at the proposed basement and tunnel structures and pool, and suitable safe batter slopes for the proposed excavations;
- recommendations on suitable foundation systems for the various proposed buildings and provision
 of geotechnical parameters for foundation design including allowable bearing pressures for pad
 and strip footings;
- estimated short and long-term settlements associated with the recommended founding systems, including potential differential settlements across the proposed structures;
- recommendations on geotechnical parameters to enable pile design in accordance with AS 2159;
- assess the requirement and suitable underpinning method for an existing limestone block wall near the propose Mulberry Wing building;
- advice on suitable retention systems and geotechnical design parameters for retaining walls
 design. It is noted that the proposed Leaf Cottage will possibly be piled to minimise impact on the
 existing limestone block wall downslope and the proposed bush cottages will be built on poles to
 accommodate a relatively steep topography;
- recommendations in relation to the founding of slabs on ground and external pavements, including indicative external pavement CBR;



- a suitable design permeability rate at shallow depth for the purposes of stormwater disposal and comments on the suitability of soakwells (including suitable minimum distances from foundations);
- assess the depth to groundwater, in particular in the low parts of the site and possibly identify fresh
 groundwater from salty groundwater (the accuracy of this assessment will depend on suitable
 contrast between fresh and salty/brackish water); and
- assess the risk of acid sulfate soils based on a review of desktop information.

The investigation included:

- the drilling of four boreholes using diamond coring drilling techniques;
- the performance of twenty one cone penetration tests (10 CPT's within the upper portions of the site and 11 CPTU's within the lower portions of the site);
- the excavation of thirteen test pits;
- the drilling of six hand auger boreholes;
- Perth sand penetrometer testing adjacent to the abovementioned test pits and boreholes and at seven additional locations;
- a geophysical survey along four transects;
- six in situ infiltration tests; and
- laboratory testing of selected soil and rock samples.

The details of the field work are presented in this report, together with comments and recommendations on the issues listed above.

2. Site Description

The site comprises no. 752 Wallcliffe Road and is bounded by the Margaret River to the northwest and bushland elsewhere.

At the time of the investigation, the site was occupied by the ruins of two buildings (slabs and walls) at its centre (Wallcliffe House and Dairy, shown on Photos 1 and 2 next page), an earthworked area approximately 40 m to the southwest of the abovementioned buildings (see Photo 3 next pages) and associated soft landscape, hardstand and vacant areas elsewhere.

Several retaining walls, including a 5.3 m high limestone block retaining wall (see Photo 3) were observed surrounding the existing Wallcliffe House building and at the south-western corner of the site. Access roads were observed crossing the site along the southern, western and eastern site boundaries and at its centre. A pond feature, pump and boat sheds (see Photo 4) were observed at the north-eastern corner of the site. A concrete hardstand (slab of the former Cliff Wing building and associated driveway, see Photo 5) was also observed at the south-western corner of the site.



Photo 1: View of the existing Wallcliffe House derelict building from test location 24 looking northwest.



Photo 2: View of the existing Dairy derelict building from test location 47 looking south.





Photo 3: View of the existing earthworked area from test location 40 looking southeast, with existing limestone block wall in the background.



Photo 4: View of the existing pond feature, pump and boat sheds from test location 47 looking northeast.





Photo 5: View of the former Cliff Wing building slab looking east from test location 10.

Based on a survey plan provided by the client, the site generally slopes from a highest point of RL 38 m at the south-eastern corner, to RL 1 m along the south-eastern bank of the Margaret River.

The Cowaramup-Mentelle 1:50,000 Regolith Landform sheet 1930-III and part of 1830-II indicates that the site is underlain by bedrock of the Leeuwin Complex of the Cowaramup System comprising fresh to weathered granulite and granite. The Quindalup System (calcareous sand) and the Spearwood System (quartz sand overlying calcarenite, ie limestone) are shown immediately to the south of the site.

However, other available information (see Section 5), indicates that the site is underlain by the Spearwood System (ie quartz sand and limestone), inferred to in turn overlay soils and rock of the Leeuwen Complex bedrock.

Given the proximity of the site to the Margaret River (ie along the north-western site boundary), it is anticipated that groundwater level is either near river level (ie ≤ RL 1 m) or at a higher level if perched on shallower soils and rock of the Leeuwin Complex.

Published acid sulphate risk mapping indicates that the majority of the site area is mapped as "no known risk of acid sulphate soils occurring within 3 m of natural soil surface". However, an area of "moderate to low risk of acid sulphate soils occurring within 3 m of natural soil surface" is shown along the northwestern site boundary, associated with the Margaret River.



3. Previous Studies (October 2018, September 2020 and June/August 2021)

Previous geotechnical investigations were carried out (CMW Geosciences, 2018 and Douglas Partners, 2020) and groundwater monitoring bores were installed by Emerge Associates (2021) within the site, and included:

- CMW Geosciences, 2018:
 - o the excavation of twelve test pits (TP01 to TP12);
 - o the drilling of nine hand auger boreholes (HA01 to HA09); and
 - dynamic cone penetration tests adjacent to the abovementioned test pits and boreholes.
- Douglas Partners, 2020:
 - o a geophysical investigation was undertaken by Douglas Partners within the site in September 2020, and comprised the acquisition and interpretation of the following data:
 - Seismic Refraction: for the generation of seismic compressional (p-) wave velocity models to interpret the depth to the various rock types and areas of reduced velocity;
 - Ground Penetrating Radar (GPR): to target shallow and deep geological anomalies relating to karstic features and interpret the depth to rock, to a depth of 10 m below existing site levels; and
 - Multi-channel Analysis of Surface Waves (MASW): for the generation of seismic shear (s-) wave velocity models as a supplementary method to aid in the interpretation of the Seismic Refraction and GPR.
- Douglas Partners, 2021:
 - the drilling of six hand auger boreholes;
 - o Perth sand penetrometer tests adjacent to the abovementioned boreholes; and
 - six in-situ infiltration tests.
- Emerge Associates, June and August 2021:
 - drilling of six boreholes (MW01 to MW06), and installation of five groundwater monitoring wells with boreholes MW01 to MW05.

Test pit and borehole logs from the 2018 and 2021 investigations are included in Appendices C and D and the test locations, including the location of the 2020 geophysical investigation survey lines and the 2021 boreholes by Emerge, are shown on Drawing 2 in Appendix B. The results of the geophysical survey are included in the GBG Maps Report 70585 in Appendix E. The results from these former investigations were considered for this study and in particular were incorporated in the description of the ground conditions and soil model outlined in Section 5.1 and the groundwater observations in Section 5.2.

4. Field Work

The field work was carried out on 24 and 26 January 2022 (test pits, hand auger boreholes, Perth sand penetrometers and geophysical survey) and between 31 January and 3 February 2022 (diamond core



boreholes, CPTs and CPTUs) and supervised by geotechnical engineers from Douglas Partners. The field work comprised:

- the drilling of four boreholes using diamond coring drilling techniques;
- the performance of twenty one cone penetration tests (10 CPT's within the upper portions of the site and 11 CPTU's within the lower portions of the site);
- the excavation of thirteen test pits:
- the drilling of six hand auger boreholes;
- Perth sand penetrometer testing adjacent to the abovementioned test pits and boreholes and at seven additional locations;
- a geophysical survey along four transects;
- · six in situ infiltration tests; and
- laboratory testing of selected soil and rock samples.

The diamond core boreholes were drilled using a Hydrapower Scout Mark V drilling rig, to depths of between 14.5 m and 20.1 m below existing surface levels. The boreholes were drilled using water flush drilling techniques in soil and HQ drilling techniques in rock. Standard penetration tests (SPTs) were conducted at 1.5 m intervals in soil.

Following completion of the drilling, standpipes were installed at the four borehole locations, to depths of between 14.4 m and 20 m (RL 11.7 m and RL-6.0 m) below existing ground levels, for groundwater levels monitoring.

The cone penetration tests (CPTs and CPTUs) were carried out by using a 36 mm diameter instrumented cone with a following 130 mm long friction sleeve attached to rods of the same diameter, pushed continuously at a rate of 2 cm/sec into the soil by hydraulic thrust from a truck rig. Strain gauges in the cone and sleeve measure resistance to penetration and this data allows the assessment of the type and condition of the materials penetrated. A piezocone was used in the lower portions of the site, to provide additional information (over that provided by a simple CPT cone), relating to groundwater conditions. The cone penetration tests were pushed to refusal depths of between 0.4 m and 13.5 m below existing ground levels on inferred limestone or granitic rock, except at test locations 30 to 32, 36, 42, 44 and 45, where target depths of between 4 m and 12 m were achieved. Upon withdrawing the CPT probe, each location was "dipped" to measure any groundwater level.

The test pits were excavated using a 14 tonne excavator equipped with a 1 m wide toothed bucket, to refusal depths of between 0.6 m and 2.5 m below existing ground levels on limestone rock, except at test locations 5, 6, 11, 13 and 14 where a target depth of 3 m was achieved.

The hand auger boreholes were drilled using a 110 mm hand auger to refusal depths of between 0.6 m and 1.8 m below existing ground levels on limestone rock, except at test locations 15 and 16 where a target depth of 3 m was achieved.

The boreholes (diamond core and hand augers) and test pits were logged in general accordance with AS1729-2017 by engineers from Douglas Partners.



PSP tests were carried out adjacent to the abovementioned test pits and boreholes and at seven additional locations in accordance with AS 1289.6.3.3. Results of PSP testing were used to assess the in situ density of the shallow soils.

The geophysical survey was carried out between 24 and 26 January 2022, and comprised the acquisition and interpretation of the following data:

- Seismic Refraction: for the generation of seismic compressional (p-) wave velocity models to interpret the depth to the various rock types and areas of reduced velocity;
- Ground Penetrating Radar (GPR): to target shallow and deep geological anomalies relating to karstic features and interpret the depth to rock, to a depth of 8 m below existing site levels;
- Multi-channel Analysis of Surface Waves (MASW): for the generation of seismic shear (s-) wave velocity models as a supplementary method to aid in the interpretation of the Seismic Refraction and GPR; and
- Electrical Resistivity Tomography (ERT): to map the groundwater level.

In-situ infiltration tests were performed using the falling head method at depths of 1 m and 1.3 m below existing ground levels, adjacent to test locations 5, 6, 9, 15, 20 and 24. The location, depths of testing, and results are discussed in detail in Section 5.3.

The boreholes (diamond core and hand augers), cone penetration tests (CPTs and CPTUs), test pits and PSPs were set out by a geotechnical engineer relative to site features and were determined using a handheld GPS. The approximate location is shown on Drawing 1 in Appendix B. Surface elevations at the test locations were obtained from a survey plan provided by the client and are quoted in metres above AHD on the CPT traces, borehole and test pit logs in Appendix F.

5. Field Work Results

5.1 Ground Conditions

Detailed CPT (CPTs and CPTUs) traces, borehole logs (diamond core and hand augers), test pit logs and PSP results encountered during the 2022 investigation are included in Appendix F, together with notes defining descriptive terms and classification methods used in Appendix A.

The ground conditions encountered at the test locations during the various investigations (2018-2022) can be summarised with the following ground model:

- Unit 0: SANDY TOPSOIL (SAND SP-SM) 100 mm to 300 mm thick, fine to coarse grained, grey-brown, with silt and various amounts of gravel, roots and rootlets, encountered at some test locations.
- Unit 1: SANDY FILL (SAND SP-SM, Silty SAND SM, Gravelly SAND SP-SM, Gravelly Clayey SAND SC and Sandy GRAVEL GP-GC) – fine to coarse grained, various colours between grey and red, fine to coarse sized sand, locally including some medium plasticity fines, encountered to depths up to 2.4 m. The fill was variably compacted and therefore should generally be considered uncontrolled. Location of the encountered fill and loose zones are indicated in Table 1 (next pages).



A 30 mm thick geogrid was recorded overlying and within the fill at tests locations TP10, HA01 and HA07, during the CMW Geosciences 2018 investigation. PVC pipe fragments, rubber and brick pieces, glass, concrete tiles, plastic cap, metal plate, wooden planks, PACM and building materials were observed within the fill at several locations (HA05 during the CMW Geosciences 2018 investigation and 3, 5 to 7, 10, 14, 16 and 19 during the Douglas Partners 2022 investigation).

Unit 2: Residual Sand of Spearwood System (SAND SP/SP-SM and Silty Sandy GRAVEL GM)
 – fine to medium grained, grey-yellow-orange-brown, with various amounts of limestone boulders,
 cobbles, gravel and silt encountered to depths of between 0.2 m (refusal on limestone rock) and
 7 m below existing ground levels at most test locations (except at test locations TP04, TP12 and
 HA05 during the CMW Geosciences 2018 investigation and test location 4 during the Douglas
 Partners 2022 investigation).

The natural sand was generally very loose to loose to depths of between 0.3 m and 7 m becoming medium dense and denser with depth (refer to Table 1 on page 11 for thicknesses and levels of loose zones).

Limestone pinnacles were observed within the sand of Unit 2 at test locations TP01, TP05 during the CMW Geosciences 2018 investigation, and from 2.4 m depth at test location 11 during the Douglas Partners 2022 investigation.

- Unit 3: Limestone of the Spearwood System (upper portions of the site only) weakly to strongly cemented, very low to very high strength underlying the sand of Unit 2 at the majority of the test locations within the upper portions of the site, encountered to the limit of investigation up to 14.4 m depth. Exceptions were all test locations within the lower portions of the site and some test locations within the upper portions of the site. Depth and levels of encountered limestone are provided in Table 1 (next pages). Sand and sandy gravely zones approximately varying between 0.1 m and 2.2 m in thickness, were recorded at various depths within the limestone rock.
- Unit 4: Residual Soils of the Leeuwin Complex (Clayey SAND SC, Clayey Sandy GRAVEL GC, Sandy SILT ML, Silty SAND SM, CLAY and Sandy CLAY CL) firm to hard and medium dense to dense, fine to coarse grained sand, fine to medium sized gravel, low plasticity fines, pink-greengrey-orange-brown-white. The Unit 4 soils were encountered underlying the Unit 2 sand within the lower portions of the site (test location TP10 during the CMW Geosciences 2018 investigation and test locations 38, 43, 44 and 49 during the Douglas Partners 2022 investigation) and as a thin layer underlying the Unit 3 limestone further southeast mid-slope (test locations 50 and 51 during the Douglas Partners 2022 investigation). The Unit 4 soils reduced in thickness within the upper portions of the site (ie between 0.1 m and 0.7 m) and increased in thickness (between 4.3 m and 9.8 m) within the lower portions of the site.
- Unit 5: Granulite and Granite of the Leeuwin Complex extremely weathered to highly weathered, extremely low to low strength, with some layers of moderately weathered to slightly weathered, low to high strength. The Unit 5 rock was encountered either underlying the Unit 4 residual soils (test location TP10 during the CMW Geosciences 2018 investigation and test locations 38, 43 and 49 to 51 during the Douglas Partners 2022 investigation), or the Unit 3 limestone (test location 46 during the Douglas Partners 2022 investigation), to the maximum test termination depth (20 m at test location 51). Although not encountered within testing depth in the upper half of the site, Unit 5 bedrock is strongly inferred to underly Unit 3 limestone rock. The depths and relative levels of inferred granulite and granitic bedrock surface are summarised in Table 1.



Sand, sandy silt and sandy gravely zones approximately 0.3 m and 2.5 m in thickness, were recorded at various depths within the granitic rock of Unit 5.

An exception to the above was the occurrence of alluvial soils comprising Silty SAND SM and Silty Gravelly SAND SM overlying the Unit 2 soils, to a depth of 1.5 m below existing ground level at test location 49.

A schematic ground model of the ground conditions anticipated beneath the site is shown in Figure 1 below.

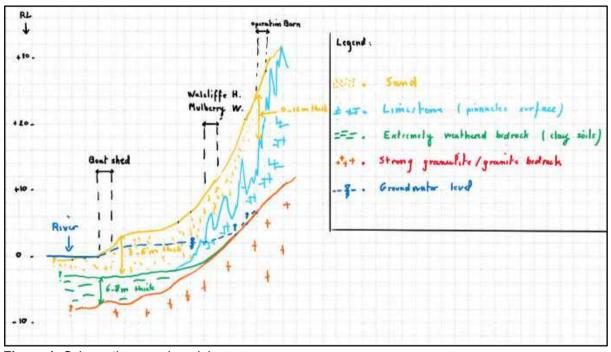


Figure 1: Schematic ground model.

Another cross section showing the ground conditions beneath the proposed building footprints and access tunnels is shown on Drawing 3 in Appendix B. In particular, this cross section highlights where limestone (in blue in the drawing) was encountered above proposed basement and tunnel levels.



Table 1: Depth and Levels of Selected Ground Features

	Test	Surface	F	ill		Loose	Soils		Lim	estone	Resid	lual Soils		te / Granitic edrock
Investigation	Location	Level [1]	Depth	Level of	Dept	h (m)	Level (m AHD)	Depth	Level	Depth	Level	Depth	Level
		(m AHD)	to Base (m)	Base (m AHD)	From	То	From	То	(m)	(m AHD)	(m)	(m AHD)	(m)	(m AHD)
	TP01	24.4	NE	NE	-	-	-	-	1.0 [2]	23.4 [2]	NE	NE	NE	NE
	TP02	25.4	NE	NE	-	-	-	-	0.2	25.2	NE	NE	NE	NE
m	TP03	21.0	0.7	20.3	-	-	-	-	1.6	19.4	NE	NE	NE	NE
. 2018	TP04	15.0	0.8[3]	14.2[3]	-	-	-	-	0.8	14.2	NE	NE	NE	NE
CMW Geosciences September 2018	TP05	15.0	0.3	14.7	-	-	-	-	0.8 [2]	14.2 ^[2]	NE	NE	NE	NE
	TP06	14.2	0.8	13.4	-	-	-	-	NE	NE	NE	NE	NE	NE
S seo	TP07	19.0	NE	NE	GL	>1.0	19.0	<18.0	NE	NE	NE	NE	NE	NE
scien	TP08	7.5	1.0 [4]	6.5 ^[4]	0.8	>2.2	6.7	<5.3	NE	NE	NE	NE	NE	NE
Geos	TP09	5.5	NE	NE	-	-	-	-	NE	NE	NE	NE	NE	NE
M M	TP10	4.5	0.2 [5]	4.3 [5]	-	-	-	-	NE	NE	1.0	3.5	NE	NE
	TP11	17.5	NE	NE	-	-	-	-	0.8	16.7	NE	NE	NE	NE
	TP12	21.5	1.2	20.3	-	-	-	-	1.2	20.3	NE	NE	NE	NE
	HA01	15.0	0.3 [5]	14.7 ^[5]	1	-	-	1	0.4 ^[6]	14.6 ^[6]	NE	NE	NE	NE

- [2]: Sand and limestone pinnacles.
- [3]: Fill extends into the underlying limestone rock.
- [4]: Includes foreign materials.
- [5]: Includes a 30 mm thick geogrid layer.
- [6]: Refusal on limestone cobble (inferred limestone rock).
- [7]: Limestone pinnacle.
- [8]: Perth Sand Penetrometer, no sample recovered.
- [9]: Inferred from Perth Sand Penetrometer blow counts.
- GL Ground Level.
- Not tested.



Table 1 (continued): Depth and Levels of Selected Ground Features

	Test	Surface	F	711		Loose	Soils		Lim	estone	Resid	lual Soils		e / Granitic drock
Investigation	Location	Level ^[1] (m AHD)	Depth to Base	Level of Base		h (m)	,	m AHD)	Depth (m)	Level (m AHD)	Depth (m)	Level (m AHD)	Depth (m)	Level (m AHD)
			(m)	(m AHD)	From	То	From	То	(111)	(III AIID)	(111)	(III AIID)	(111)	AIID)
_	HA02	14.2	0.2	14.0	-	-	-	-	0.4 ^[6]	13.8 ^[6]	NE	NE	NE	NE
s September	HA03	15.5	1.2	14.3	1.2	>2.0	14.3	<13.5	NE	NE	NE	NE	NE	NE
Septe	HA04	9.5	1.8	7.7	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CMW Geosciences Sep 2018	HA05	7.5	1.0 ^[4]	6.5 ^[4]	0.9	>2.0	6.6	<5.5	NE	NE	NE	NE	NE	NE
	HA06	7.0	0.8	6.2	0.7	>1.1	6.3	<5.9	NE	NE	NE	NE	NE	NE
	HA07	15.5	1.0 ^[5]	14.5 ^[5]	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
WW	HA08	11.0	1.5	9.5	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	HA09	14.0	NE	NE	GL	>1.0	14.0	<13.0	NE	NE	NE	NE	NE	NE
ø	1	22.2	NE	NIT	GL	0.3	22.2	21.9	3.2	40.0	NE	NE	NE	NE
rtner 021	1	22.2	NE	NE	2.25	2.55	19.95	19.65	3.2	19.0	INE	NE	INE	NE
Douglas Partners August 2021	2	25.9	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
ougle	3	27.9	NE	NE	NE	NE	NE	NE	3.3	24.6	NE	NE	NE	NE
٥	4	30.1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

- [2]: Sand and limestone pinnacles.
- [3]: Fill extends into the underlying limestone rock.
- [4]: Includes foreign materials.
- [5]: Includes a 30 mm thick geogrid layer.
- [6]: Refusal on limestone cobble (inferred limestone rock).
- [7]: Limestone pinnacle.
- [8]: Perth Sand Penetrometer, no sample recovered.
- [9]: Inferred from Perth Sand Penetrometer blow counts.
- GL Ground Level.
- Not tested.



Table 1 (continued): Depth and Levels of Selected Ground Features

	Test	Surface	F	ill		Loose	Soils		Lim	estone	Resid	lual Soils		te / Granitic drock
Investigation	Location	Level ^[1] (m AHD)	Depth to Base	Level of Base		h (m)	,	n AHD)	Depth	Level	Depth	Level	Depth	Level (m
		()	(m)	(m AHD)	From	То	From	То	(m)	(m AHD)	(m)	(m AHD)	(m)	AHD)
Douglas Partners	5	31.1	NE	NE	3.15	>4.2	27.95	<26.9	NE	NE	NE	NE	NE	NE
August 2021	6	35.9	NE	NE	NE	NE	NE	NE	3.3	32.6	NE	NE	NE	NE
	1	15.0	0.35	14.65	NE	NE	NE	NE	0.8	14.2	NE	NE	NE	NE
)22	2	15.0	0.6	14.4	NE	NE	NE	NE	0.8	14.2	NE	NE	NE	NE
ary 20	3	13.0	0.85 ^[4]	12.15 ^[4]	NE	NE	NE	NE	2.0	11.0	NE	NE	NE	NE
ebrua	4	23.0	0.6	22.4	NE	NE	NE	NE	0.6	22.4	NE	NE	NE	NE
ary/F	5	10.0	0.4 ^[4]	9.6 ^[4]	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Janu	6	10.0	1.5 ^[4]	8.5 ^[4]	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Douglas Partners January/February 2022	7	21.5	0.3 ^[4]	21.2 ^[4]	NE	NE	NE	NE	0.5	21.0	NE	NE	NE	NE
Partr	8	21.8	0.2	21.6	NE	NE	NE	NE	0.6	21.2	NE	NE	NE	NE
ıglas	9	28.1	NE	NE	NE	NE	NE	NE	2.5	25.6	NE	NE	NE	NE
Dou	10	21.0	0.25	20.75	NE	NE	NE	NE	0.75	20.25	NE	NE	NE	NE
	11	32.2	NE	NE	NE	NE	NE	NE	2.4 ^[7]	29.6 ^[7]	NE	NE	NE	NE

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- [4]: Includes foreign materials.
- [5]: Includes a 30 mm thick geogrid layer.
- [6]: Refusal on limestone cobble (inferred limestone rock).
- [7]: Limestone pinnacle.
- [8]: Perth Sand Penetrometer, no sample recovered.
- [9]: Inferred from Perth Sand Penetrometer blow counts.
- GL Ground Level.
- Not tested.



Table 1 (continued): Depth and Levels of Selected Ground Features

	Test	Surface	F	ill		Loose	Soils		Lim	estone	Resid	lual Soils		te / Granitic drock
Investigation	Location	Level [1] (m AHD)	Depth to Base	Level of Base		h (m)	,	m AHD)	Depth	Level	Depth	Level (m	Depth	Level (m
		,	(m)	(m AHD)	From	То	From	То	(m)	(m AHD)	(m)	AHD)	(m)	AHD)
	12	32.1	NE	NE	NE	NE	NE	NE	1.4	30.7	NE	NE	NE	NE
	13	26.3	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
)22	14	27.2	0.2 ^[4]	27.0 ^[4]	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
ary 20	15	11.0	0.25	10.75	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Douglas Partners January/February 2022	16	8.0	0.3 ^[4]	7.7 ^[4]	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	17	2.8	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	18	2.8	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
ners .	19	23.5	0.5 ^[4]	23.0 ^[4]	NE	NE	NE	NE	1.8	21.7	NE	NE	NE	NE
Partı	20	5.0	[8]	[8]	NE	NE	NE	NE	1.65 ^[9]	3.35 ^[9]	NE	NE	NE	NE
ıglas	21	12.9	[8]	[8]	NE	NE	NE	NE	1.65 ^[9]	11.25 ^[9]	NE	NE	NE	NE
Dougl	22	15.3	[8]	[8]	NE	NE	NE	NE	2.1 ^[9]	13.2 ^[9]	NE	NE	NE	NE
	23	14.5	[8]	[8]	NE	NE	NE	NE	1.95 ^[9]	12.55 ^[9]	NE	NE	NE	NE
	24	17.2	[8]	[8]	GL ^[9]	0.9[9]	17.2 ^[9]	16.3 ^[9]	NE	NE	NE	NE	24	17.2

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- [5]: Includes a 30 mm thick geogrid layer.
- [6]: Refusal on limestone cobble (inferred limestone rock).
- [7]: Limestone pinnacle.
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- [9]: Inferred from Perth Sand Penetrometer blow counts.
- GL Ground Level.
- Not tested.



Table 1 (continued): Depth and Levels of Selected Ground Features

Investigation	Test	Surface	F	ill		Loose	Soils		Lim	estone	Resid	lual Soils		te / Granitic drock
Investigation	Location	Level ^[1] (m AHD)	Depth to Base	Level of Base	_	th (m)	,	m AHD)	Depth	Level	Depth	Level (m	Depth	Level (m
		,	(m)	(m AHD)	From	То	From	То	(m)	(m AHD)	(m)	AHD)	(m)	AHD)
	25	8.8	[8]	[8]	GL ^[9]	0.45 ^[9]	8.8 ^[9]	8.35 ^[9]	2.4 ^[9]	6.4 ^[9]	NE	NE	NE	NE
	26	6.2	[8]	[8]	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Douglas Partners January/February 2022	28	16.0	0.4	15.6	NE	NE	NE	NE	0.4	15.6	NE	NE	NE	NE
ary 2(29	21.3	1.0	20.3	1.0	3.6	20.3	17.7	3.7	17.6	NE	NE	NE	NE
ary/Februar	30	21.3	1.1	20.2	0.7	>4.2	20.6	<17.1	NE	NE	NE	NE	NE	NE
	31	25.0	0.4	04.0	GL	1.5	25.0	23.5	5.2	19.8	NE	NE	NE	NE
Janus	31	25.0	0.4	24.6	4.0	>6.0	21.0	<19.0	5.2	19.0	INC	INC	INE	INE
ners ,	32	29.3	NE	NE	GL	0.8	29.3	28.5	7.6	21.7	NE	NE	NE	NE
Parti	32	29.3	NE	NE	4.9	10.5	24.4	18.8	7.0	21.7	IN⊏	INE	INE.	INE
ıglas	33	28.8	0.5	28.3	GL	0.5	28.8	28.3	4.8	24.0	NE	NE	NE	NE
Dougl	34	19.5	0.6	18.9	2.5	4.1	17.0	15.4	4.1	15.4	NE	NE	NE	NE
	35	28.5	NE	NE	GL	0.9	28.5	27.6	4.3	24.2	NE	NE	NE	NE
	36	15.5	0.6	14.9	0.6	1.1	14.9	14.4	NE	NE	NE	NE	36	15.5

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- [5]: Includes a 30 mm thick geogrid layer.
- [6]: Refusal on limestone cobble (inferred limestone rock).
- [7]: Limestone pinnacle.
- [8]: Perth Sand Penetrometer, no sample recovered.
- [9]: Inferred from Perth Sand Penetrometer blow counts.
- GL Ground Level.
- Not tested.



Table 1 (continued): Depth and Levels of Selected Ground Features

	Test	Surface	F	Fill		Loos	e Soils		Lim	estone	Resid	lual Soils		te / Granitic edrock
Investigation	Location	Level ^[1] (m AHD)	Depth to Base	Level of Base		h (m)	,	m AHD)	Depth	Level	Depth	Level (m	Depth	Level (m
		,	(m)	(m AHD)	From	То	From	То	(m)	(m AHD)	(m)	AHD)	(m)	AHD)
	37	18.0	1.3	16.7	0.6	2.1	17.4	15.9	5.2	12.8	NE	NE	NE	NE
	38	6.9	NE	NE	GL	2.5	6.9	4.4	NE	NE	8.1	-1.2	12.4	-5.5
Douglas Partners January/February 2022	39	15.5	1.5	14.0	GL	2.0	15.5	13.5	6.0	9.5	NE	NE	NE	NE
ary 2(40	14.0	1.6	12.4	GL	2.5	14.0	11.5	5.4	8.6	NE	NE	NE	NE
January/Februa	41	10.0	2.3	7.7	GL	2.3	10.0	7.7	6.1	3.9	NE	NE	NE	NE
	42	14.2	1.3	12.9	GL	2.2	14.2	12.0	5.3	8.9	NE	NE	NE	NE
	43	7.0	1.1	5.9	GL	3.3	7.0	3.7	NE	NE	5.1	1.9	13.5	-6.5
ners	44	6.0	2.1	3.9	1.0	2.0	5.0	4.0	NE	NE	4.0	2.0	NE	NE
Parti	45	10.8	0.6	10.2	0.6	1.2	10.2	9.6	NE	NE	NE	NE	NE	NE
ıglas	46	7.2	NE	NE	GL	4.7	7.2	2.5	4.7	7.2	NE	NE	5.8	1.4
Dougl	47	7.5	0.6	6.9	GL	1.7	7.5	5.8	NE	NE	NE	NE	NE	NE
	48	15.5	NE	NE	GL	2.2	15.5	13.3	5.5	10.0	NE	NE	NE	NE
_	49	5.5	1.0	4.5	NE	NE	NE	NE	NE	NE	2.8	2.7	12.7	-7.2

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- [4]: Includes foreign materials.
- [5]: Includes a 30 mm thick geogrid layer.
- [6]: Refusal on limestone cobble (inferred limestone rock).
- [7]: Limestone pinnacle.
- [8]: Perth Sand Penetrometer, no sample recovered.
- [9]: Inferred from Perth Sand Penetrometer blow counts.
- GL Ground Level.
- Not tested.



Table 1 (continued): Depth and Levels of Selected Ground Features

	Test	Surface	F	Fill		Loose	Soils		Lim	estone	Resid	lual Soils		te / Granitic drock
Investigation	Location	Level [1] (m AHD)	Depth	Level of	Dept	h (m)	Level (m AHD)	Depth	Level	Depth	Level (m	Depth	Level (m
		(III AND)	to Base (m)	Base (m AHD)	From	То	From	То	(m)	(m AHD)	(m)	AHD)	(m)	AHD)
<i>φ</i> >	50	14.0	NE	NE	GL	4.5	14.0	9.5	7.0	7.0	14.4	-0.4	15.15	-1.15
ırtner bruar	51	14.0	1.5	12.5	GL	2.6	14.0	11.4	2.6	11.4	13.05	0.95	13.15	0.85
as Pa y/Fel 2022					GL	7.0	26.1	19.1						
Douglas Partners January/February 2022	52	26.1	NE	NE	7.5	8.45	18.6	17.65	7.0	19.1	NE	NE	NE	NE
۵ گ					9.0	10.95	17.1	15.15						

- [2]: Sand and limestone pinnacles.
- [3]: Fill extends into the underlying limestone rock.
- [4]: Includes foreign materials.
- [5]: Includes a 30 mm thick geogrid layer.
- [6]: Refusal on limestone cobble (inferred limestone rock).
- [7]: Limestone pinnacle.
- [8]: Perth Sand Penetrometer, no sample recovered.
- [9]: Inferred from Perth Sand Penetrometer blow counts.
- GL Ground Level.
- Not tested.



Geophysical sections and associated interpreted geological sections from the 2022 geophysical survey along each Transect 1 to 4 are included in the GBG Maps Report 70670 (Drawings 70670-02 and 70670-03, Appendix A) in Appendix I. The following approximate seismic velocity ranges were adopted to differentiate between each of the main seismic layers (ie interpreted geological units):

- Layer 1 (seismic p-wave velocities between 200 m/s and 1,000 m/s): interpreted as sand;
- Layer 2 (seismic p-wave velocities of between 1,000 m/s and 2,200 m/s): strong soils and weak rock, interpreted beneath this site as clayey soils or extremely weathered granitic rock within the lower portions of the site, or weakly cemented limestone rock, possibly of low or lower rock strength with interbedded sand layers within the upper portions of the site:
- Layer 3 (seismic p-wave velocities of between 2,200 m/s and 4,000 m/s): moderately strong
 rock, interpreted beneath this site as both highly weathered to moderately weathered granulite or
 granitic bedrock (within the lower portions of the site and below limestone within the upper portions
 of the site), or well-cemented limestone rock (possibly of medium to high strength) within the upper
 portions of the site; and
- Layer 4 (seismic p-wave velocities of >4,000 m/s): strong rock, interpreted beneath this site to include granulite or granitic bedrock of high or higher strength.

The following comments regarding likely ground conditions across the site can be made from the 2022 geophysical interpreted results:

- The depth to the top of limestone rock within the upper portions of the site (ie thickness of soil overlying limestone rock) varies between less than 2.0 m and 12.0 m below existing site levels.
- The depth to the top of granulite and granitic bedrock is interpreted at depths of:
 - between 12 m and 16 m below existing site levels (ie thickness of soil overlying granulite and granitic bedrock) along the south-eastern bank of the Margaret River, increasing to 28.0 m below existing ground levels at the northern corner of the site (ie north-western end of Transect 3); and
 - o between 12 m and 34 m below existing site levels (ie below limestone rock) within the upper portions of the site.

The interpreted results of the Douglas Partners 2020 geophysical survey, undertaken within the vacant area at the south-eastern corner of the site, are generally consistent with the Douglas Partners 2022 geophysical survey results. The 2020 geophysical report is included in Appendix E.

The Ground Penetrating Radar data did not indicate the occurrence of any caves or large voids beneath the site along the Douglas Partners 2020 and 2022 survey lines.

The Douglas Partners 2020 GPR survey identified the occurrence of two anomalies in the ground conditions along the surveyed lines within the vacant area at the south-eastern corner of the site (see Drawing 1 in Appendix B). One diamond core borehole was drilled at the location of one of the abovementioned anomalies located within the footprint of the proposed Operation Barn footprint. The results indicate that such anomalies comprise loose uncemented zones within the limestone or soil filled karst features, rather than a void, and therefore should not have any impact on the proposed development.



5.2 Groundwater

The groundwater levels measured in the standpipes installed at test locations 49, 51 and 52 on 3 February 2022, are summarised in Table 3 below. Groundwater levels interpreted from pore pressure measurements at some of the CPTU test locations and observed in some of the hand auger boreholes drilled on 25 January 2022, are also summarised in Table 3 below. The CPTs, test pits and hand auger boreholes were immediately backfilled following sampling, which precluded any longer-term monitoring of groundwater levels.

The groundwater levels measured in the monitoring wells installed at test locations MW01 to MW05 during the June and August 2021 investigations by Emerge Associates, are also summarised in Table 3 below.

Table 3: Summary of Groundwater Observations

Investigation	Test Location	Surface Level (m AHD) ^[1]	Date of Observation	Groundwater Depth (m)	Approximate Groundwater Level (m AHD)
	MW01	2.99 ^[1]		1.58	1.4
	MW02	7.38 ^[1]		6.03	1.35
Emerge Associates	ates MW03 5.16 ^[1] MW04 9.29 ^[1] MW05 21.89 ^[1] 2 September 2021 7.15 2 >6.00 <1	2.6			
2021	MW04	9.29 ^[1]	2 September 2021	7.15	2.1
	MW05	21.89 ^[1]		>6.00	<15.9
	MW06	35.20 ^[2]		>8.20	<27
	17	2.80 ^[2]	05.1	0.50	2.3
	18	2.80 ^[2]	25 January 2022	0.35	2.45
	38	6.90 ^[2]		5.50	1.4
	43	7.00 ^[2]	4.5-1	5.25	1.75 (perched [3])
Douglas Partners 2022	44	6.00 ^[2]	1 February 2022	3.70	2.3 (perched [3])
2022	46	7.20 ^[2]		4.10	3.1
	49	5.50 ^[2]		3.30	2.2
	51	14.00 ^[2]	3 February 2022	10.70	3.3
	52	26.10 ^[2]		>14.4	<11.7

Note

- [1] Surface level provided by Emerge Associates.
 - [2] Surface level interpolated based on a survey plan provided by the client.
 - [3] Results suggest that groundwater is perched on clay layer within the soil profile.

It should be noted that groundwater levels are affected by various factors such as climatic conditions, land usage and the Margaret River and ocean levels (which is impacted by tides, storm surges and long-term sea level rise) and will therefore vary with time. In accordance with the State Coastal Planning Policy Number 2.6, an allowance for sea level rise of 0.9 m over a 100 year planning timeframe to 2110 is suggested, and 10 mm/year beyond 2110.

An attempt was made to interpret results of the 2022 geophysical survey to inform on groundwater levels. The geophysical data suggests groundwater levels between RL 0 m and RL 3 m along the



Margaret River south-eastern bank, increasing to a maximum point at RL 7 m at the centre of Transects 1 and 3. However, this interpreted data conflict with groundwater observations (observations at RL 3 m rather than RL 7 m) and therefore is recommended to be disregarded.

It should be noted that the differentiation between saline and fresh water could not be made from the Electrical Resistivity Tomography (ERT) models, owing to insufficient contrast in the assessed ground.

5.3 Results of Infiltration Testing

A total of 12 in-situ infiltration tests using a falling head method were carried out within shallow sand and sand fill, at depths of between 1 m and 2 m during the Douglas Partners 2021 and 2022 investigations. Field permeability values were estimated using a method based on Hvorslev (1951). Permeability can also be estimated from particle size distribution test results from samples taken from the same depths at infiltration test locations, using the Hazen's formula. The Hazen's formula provides an indication of the permeability for clean sand with rounded particle shape in loose conditions, and thus it should be considered with caution. Table 4 below summarises the permeability results.

Table 4: Summary of In Situ Permeability Testing

	Test	Depth	Measured Per	rmeability ^[1]	Derived Perm	neability ^[2]	In Situ Condition of the
Investigation	Location	(m)	(m/s)	(m/day)	(m/s)	(m/day)	Tested Material
	1		6.1 x 10 ⁻⁴	>25			
	2		3.0 x 10 ⁻⁵ [3]	2.6[3]			
Douglas Partners 2021	3		4.6 x 10 ⁻⁶ [3]	0.4[3]	2.9 x 10 ⁻⁴	25	Unit 2: SAND SP, trace silt,
	4	2	5.7 x 10 ⁻⁵	4.9			medium dense
	5		9.8 x 10 ⁻⁵	8.5			
	6		4.7 x 10 ⁻⁵	4.1	2.6 x 10 ⁻⁴	22	
	5	4	5.2 x 10 ⁻⁴	>25	-	-	Unit 2: SAND SP-SM, with
	6	1	8.6 x 10 ⁻⁶	0.7 ^[3]	-	-	Unit 1: FILL/SAND SP-SM,
Douglas	9	1.3	1.5 x 10 ⁻⁴	13	-	-	
Partners 2022	15	1	1.4 x 10 ⁻⁴	12	-	-	Unit 2: SAND SP-SM, with
	20	1	1.8 x 10 ⁻⁴	15	3.2 x 10 ⁻⁴	>25	silt, medium dense
	24	1	4.5 x 10 ⁻⁴	>25	-	-	

Notes: [1]: Hvorslev's method.

6. Laboratory Testing

A geotechnical laboratory testing programme was carried out by a NATA registered laboratory during the 2022 investigation and comprised:

• the particle size distribution of six soil samples;

^{[2]:} Hazen's formula applied to laboratory result regarding soil grading.

^{[3]:} Lower infiltration rates during testing possibly from localised ground anomalies at testing depth.



- Atterberg limits and linear shrinkage of one soil sample;
- modified maximum dry density, optimum moisture content and California bearing ration of three soil samples;
- pH, chloride and sulphate of three soil samples; and
- unconfined compressive strength (UCS) of four rock samples.

The point load index of twenty seven rock samples were also tested by Douglas Partners.

The detailed test report sheets are given in Appendices G and H, with the results summarised in Tables 5 to 7 next pages, together with results from the Douglas Partners 2021 investigation.



Table 5: Summary of Laboratory Testing for Soil Characterisation

Investigation	Test Location	Depth (m)	Soil Description	Fines (%)	Sand (%)	Gravel (%)	D ₁₀	D ₆₀	LL (%)	PL (%)	PI (%)	LS (%)
Douglas Partners 2021 Douglas 2 0.5 Unit 1: FILL/SAND SP, trace silt Douglas 1 0.1 - 0.3 Unit 1: FILL/SAND SP, with gravel and silt 5 63 22 0.16 0.5 0.17 0.40 0.1	0.38	-	-	-	-							
	2			4	96	0	0.17	0.40	-	-	-	-
Douglas	3			2	98	0	0.17	0.40	-	-	-	-
Partners 2021	4	1.7 – 2.3	Unit 2: SAND SP, trace silt	3	97	0	0.17	0.43	-	-	-	-
	5			3	97	0	0.17	0.40	-	-	-	-
	6			4	96	0	0.16	0.38	-	-	-	-
	2	0.5	Unit 1: FILL/SAND SP, trace silt	2	98	0	0.16	0.35	-	-	ı	-
	10	0.1 – 0.3	Unit 1: FILL/SAND SP, with gravel and silt	5	63	22	0.16	0.50	-	,	-	-
Douglas	13	0.5	Unit 2: SAND SP, trace silt	3	97	0	0.17	0.40	-	-	-	-
Partners 2022	20	1.0	Unit 2: SAND SP, trace silt	4	96	0	0.18	0.49	-	-	1	-
	49	3.0 – 3.6	Unit 4: Clayey SAND SC, trace gravel	28	68	4	-	0.44	32	22	10	4.0
	51	0.5 – 1.5	Unit 1: FILL/SAND SP, trace silt	9	91	0	0.10	0.40	-	-	-	-

Notes: Fines are particles smaller than 75 µm.

Sand is particles larger than 75 µm and smaller than 2.36 mm.

Gravel is particles larger than 2.36 mm and smaller than 63 mm.

A D_{10} of 0.17 mm means that 10% of the sample particles are less than 0.17 mm.

A D_{60} of 0.40 mm means that 60% of the sample particles are less than 0.40 mm.

LL: liquid limit

PL: plastic limit

PI: plasticity index

LS: linear shrinkage

"-" means not tested.



Table 6: Results of Laboratory Testing for Pavement Design Parameters

Test Location	Depth (m)	MMDD (t/m³)	Soaked CBR (%)	OMC (%)	Swell (%)	Material
2	0.5	1.76	12	11.5	0	Unit 1: FILL/SAND SP, trace silt
10	0.1 – 0.3	1.79	20	10.5	0	Unit 1: FILL/SAND SP, with gravel and silt
13	0.5	1.81	15	13.0	0	Unit 2: SAND SP, trace silt

Notes: MMDD: modified maximum dry density.

CBR: 4-day soaked California bearing ratio under a 4.5kg confining surcharge.

OMC: optimum moisture content.

Table 7: Results of Laboratory Testing for Soil Aggressivity

					Exposure	Classifica	ition
Test	Depth (m)	Soil Description	Soil	Co	ncrete		Steel
Location	(,		Condition ^[1]	рН	SO4 (mg/kg)	рН	CI (mg/kg)
50	1.5 – 1.95	Unit 2: Sand SP, trace silt		8.4	<10	8.4	22
51	0.5 – 1.5	Unit 1: FILL/SAND SP, trace silt	В	7.5	47	7.5	37
52	1.5 – 1.95	Unit 2: Sand SP, trace silt		7.6	<10	7.6	34

Notes:

[1]: Soil Type based on guideline presented in AS 2159-2009 and summarise below:

Soil Type A – High permeability soils (eg sands and gravels) which are in groundwater.

Soil Type B – Low permeability soils (eg silts and clays) or all soils above groundwater.

Scale of aggressivity based on threshold values given in AS 2159-2019

Non-aggressive	Mild	Moderate	Severe	Very Severe
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Table 8: Results of Rock Strength Tests

Test Location	Depth (m)	Point Load Index Is(50) (MPa)	Unconfined Compressive Strength (UCS, MPa)	Derived Rock Strength
	13.80 - 13.90	0.01	-	EL
	15.60 - 15.70	0.00	-	EL
49	16.50 - 16.55	0.01	-	EL
49	17.65 - 17.80	0.30	-	М
	17.95 - 18.00	0.72	-	М
	18.90 - 19.00	0.06	-	VL
	9.55 - 9.85	-	29.29	Н
50	11.50 - 11.60	0.08	-	VL
	12.70 - 12.80	1.16	-	Н

Note: '-' means not tested.



Table 8 (continued): Results of Rock Strength Tests

Test Location	Depth (m)	Point Load Index Is(50) (MPa)	Unconfined Compressive Strength (UCS, MPa)	Derived Rock Strength
50	16.40 - 16.45	0.29	-	L
50	16.55 - 16.65	0.41	-	М
	2.60 - 2.80	-	26.07	Н
	5.80 - 5.95	4.31	-	VH
	8.65 - 8.70	0.24	•	L
	9.15 - 9.25	0.70	-	М
	9.35 - 9.50	-	1.90	VL
	10.25 - 10.45	0.45	-	М
	11.90 - 12.00	0.75	-	М
51	12.65 - 12.70	0.12	-	L
	13.40 - 13.50	0.04	-	VL
	14.20 - 14.35	0.03	•	EL
	17.25 - 17.35	0.02	-	EL
	18.35 - 18.45	0.02	-	EL
	19.25 - 19.35	0.03	-	VL
	19.55 - 19.60	0.07	-	VL
	19.70 - 19.80	0.04	-	VL
	8.73 - 8.83	4.78	-	VH
	8.85 - 9.00	-	53.14	Н
52	11.25 - 11.35	2.05	-	Н
	12.90 - 13.00	4.08	-	VH
	14.00 - 14.20	3.83	-	VH

Note: '-' means not tested.

7. Proposed Development

It is understood that the proposed development includes the construction of:

- several buildings as described below:
 - \circ Wallcliffe House with ground floor at RL 11.0 m and associated basement with its base at RL 8.5 m;
 - River Wing with ground floor at RL 13.8 m and associated partial basement with its base at RL 10.5 m;
 - o An access tunnel between the proposed Wallcliffe House and River Wing buildings basements;



- Mulberry Wing with ground floor at RL 13.9 m and associated basement with its base at RL 10.5 m;
- o An access tunnel between the proposed River Wing and Mulberry Wing buildings basements;
- o Cliff Wing and associated partial basement with its base at RL 21.6 m;
- Operation Barn and associated partial upper basement with its base at RL 25.0 m and lower basement with its base at RL 22.4 m. A piled retaining wall is proposed to form the southeastern boundary of the proposed building basement;
- An access tunnel between the proposed Wallcliffe House and Operation Barn buildings basements, with its base varying between RL 11.0 m at its north-western end, RL 16.8 m at its centre and RL 22.4 m at its south-eastern end;
- Dairy/Provedore with ground floor at RL 7.7 m;
- o Leaf Cottages likely supported on piles and Bush Cottages likely supported on poles;
- o Estate Management, Surf Shack and Boat Shed structures;
- a natural pool with its base varying between RL 2.0 m and RL 3.4 m; and
- car parking areas.

8. Comments

8.1 Site Classification

As described in Section 5.1, the site is underlain by a profile consisting of sand, locally very loose to loose to significant depths, overlying limestone rock within the upper portions of the site and residual soils of the Leeuwin Complex within the lower portions of the site. Fill, generally considered uncontrolled, was also encountered overlying the natural sand at some locations. Therefore, in accordance with AS 2870-2017, it is considered that the site should be classified as 'Class P'.

The current site classification could be amended to 'Class A' in accordance with AS 2870-2011, following excavations to proposed basement levels and site preparation as described in Section 7.3 and subsections next pages.

Alternatively, the current site classification ('Class P') may be considered acceptable for the proposed buildings if a piling system option, as discussed in Section 8.6.2 is adopted and anticipated for the proposed Operations Barn and Leaf Cottages as discussed in Section 8.3.

It is noted that AS 2870 applies to single houses, townhouses and the like classified as Class 1 and 10a under the Building Code of Australia. It also applies to light industrial and commercial buildings if they are similar in size, loading and superstructure flexibility to those designs included in AS 2870.



8.2 Site Seismic Classification

Ground conditions encountered at the site generally comprise sandy soils, including significant zones of very loose and loose sand, overlying competent limestone rock (and competent clays in the lower part of the site), in turn overlying granulite and granite bedrock.

An earthquake design soil sub-class of De is generally considered appropriate across the site in accordance with AS 1170.4-2007 due to the occurrence of loose soils, including the building envelopes for the proposed Operation Barn, Leaf Cottage, Dairy farm, Mulberry and River Wings, and Wallcliffe House.

A sub-class Ce is considered suitable where no significant loose sand was encountered, for instance at the locations of the proposed Bush Cottages on the hillside in the northern eastern part of the site, and at the location of the proposed Estate Management building. Owing to the variability in strength of the limestone of Unit 3, a sub-class Ce is also recommended where shallow rock occurs, for instance beneath the envelope of the proposed Cliff Wing building in the upper southern part of the site.

The Hazard Factor (Z) for the site is 0.08, according to AS1170.4-2007.

8.3 Site Preparation

The recommendations in this section are based on Douglas Partners current understanding of the proposed development and available information, and thus should be reviewed and revised, if required, once the proposed development progresses to a detailed stage of the project.

It is recommended that all site works be undertaken under the supervision of an experienced geotechnical engineer.

Prior to the proposed buildings (includes associated proposed tunnel alignments), pavements and pool construction, all topsoil, vegetation and any deleterious materials resulting from the removal of the existing buildings and hardstand areas, should be stripped from the proposed buildings, tunnels, pavement and pool envelopes.

Any tree roots remaining from clearing operations should be completely removed, and the excavations backfilled with material of similar geotechnical properties to the surrounding ground, and compacted to achieve a dry density ratio of not less than 95% relative to modified compaction.

It is recommended that following site stripping, the natural subgrade be assessed by a geotechnical engineer to determine whether previous vegetation, roots or deleterious materials remain. Any such materials will require removal.

The ground conditions at the base of the proposed buildings, tunnels and pool footprints are likely to comprise:

- Wallcliffe House, Mulberry Wing and Dairy/Provedore (test locations 3, 15, 16, 39, 40, 42, 47, 48, 50 and 51):
 - o ground level: loose sand (fill and natural) possibly between 1.5 m and 2 m thick becoming medium dense with depth or overlying limestone rock;



- basement level: limestone rock of variable strength, including high strength rock and sand zones.
- River Wing and access tunnels between the proposed Wallcliffe House and River Wing and River Wing and Mulberry Wing buildings basements (test locations 5, 6, 39 to 42 and 51):
 - o ground level: very loose to loose fill (includes foreign items) to depths of between 0.4 m and 2.3 m overlying medium dense sand;
 - basement level and along the proposed tunnel alignments: medium dense sand or high strength limestone with sand bands.
- Cliff Wing (test locations 7 and 10): dense to very dense fill (includes foreign items to a depth of around 0.3 m) overlying very dense sand which in turn overlies medium to high limestone rock within 1 m of the ground surface.
- Operation Barn (test locations 13, 31 to 33, 35 and 52): loose to medium dense sand at ground level and very loose to loose sand varying between 4 m and 7 m in thickness, with bands of medium to very high strength limestone rock.
- Access tunnel between the proposed Wallcliffe House and Operation Barn buildings basements (test locations 24, 31, 34 and 50): loose sand possibly 1.5 m thick becoming medium dense with depth or overlying limestone rock at the north-western end and central portion of the tunnel alignment and medium dense sand overlying loose sand (2 m thick) at the south-eastern end of the proposed tunnel alignment,
- Leaf Cottage (test locations 29 and 30): medium dense to dense sand over limestone rock away
 from the existing limestone block wall and very loose to loose sand possibly to 5 m depth closer to
 the existing limestone block wall.
- Bush Cottages (20 to 23, 25, 26, 36, 37, 44 and 45): generally medium dense becoming denser with depth sand, with some shallow loose layers up to 0.9 m depth.
- Dairy/Provedore: uncontrolled fill was encountered, and very loose to loose natural sand occurs to possibly 5 m below proposed finished floor level (overlying limestone and granitic bedrock).
- Estate Management (test location 19): dense fill with foreign materials to 0.5 m depth over dense sand.
- Natural pool (test locations 17, 18 and 49): loose to medium dense sandy soils to a depth of 2.8 m over loose becoming medium dense with depth clayey sand.

<u>Proposed Wallcliffe House, River Wing, Mulberry Wing, Cliff Wing, Bush Cottages, Estate</u> Management and Access Tunnels

As described in Section 5.1, uncontrolled fill materials (that includes PVC pipe fragments, rubber and brick pieces, glass, concrete tiles, plastic cap, metal plate, wooden planks, PACM and building materials), were recorded within the fill at test locations 3, 5 to 7, 10 and 19 during the Douglas Partners 2022 investigation, to depths of between 0.2 m and 1.3 m below existing ground levels. Such fill is considered to form an unsuitable foundation material in its current condition.



It is therefore recommended that the subgrade beneath the proposed River Wing, Mulberry Wing, Cliff Wing, and Estate Management building footprints be raked to a depth of 1 m in the first instance, to identify any zones that includes unsuitable fill for use as foundation materials. If zones of excessive unsuitable foundation materials are identified, a suitable remediation measure could include:

- excavation and chasing of the unsuitable materials or alternatively in-situ screening, for instance
 using a screening bucket fitted on an excavator; followed by
- inspection of the subgrade at the base of the excavations by an experienced geotechnical engineer, in order to determine whether previous unsuitable materials remain at subgrade level, or if further excavations are required; followed by
- compaction of the base of the excavation to achieve a dry density ratio of not less than 95% relative to modified compaction; followed by
- replacement of the excavated material using the excavated fill following treatment as described above.

The known area of deeper uncontrolled fill to a depth of 1.3 m beneath the River Wing envelope (at test location 6, and possibly 2.3 m at nearby test location 41) should be excavated to its base. The soil fraction of the uncontrolled fill could be re-used following screening, and confirmation of the screened material's suitability by a geotechnical engineer.

Based on the findings of the investigations, the soils at anticipated ground and basement levels of the proposed buildings are likely to generally include very loose to loose soils up to 2.3 m depth overlying medium dense and denser sand or high strength limestone with sand bands.

If both limestone and sand materials are encountered at foundation level, either:

- the weaker material (sand) should be removed to expose rock distributed uniformly and the irregular surface, should be levelled using mass concrete. The objective of these provisions is to minimise the presence of localised hard spots beneath the footings; or
- alternatively, if the majority of the base of footing excavations comprises sand with only localised limestone rock, over-excavating the limestone rock to a depth of at least 0.5 m below pad and strip founding level, and placing compacted granular soils (eg excavated sand or imported sand fill) back to proposed founding level, is recommended.

Furthermore, the density and strength of any very loose to loose materials present beneath foundation level will require some improvement, prior to any construction of the proposed buildings. Given the relatively shallow depth of the very loose to loose soils beneath at ground and basement levels, it is considered that a compaction strategy using a heavy roller together complemented with hand compaction of all footing excavations, as detailed below, should be suitable to densify any very loose to loose soils for the proposed buildings.

Prior to excavation for foundations, it is recommended that the exposed subgrade beneath the building envelopes covered under this section be proof compacted using a heavy (say 16 tonne) vibrating smooth drum roller. Any areas that show signs of excessive deformation during compaction should be continually compacted until deformation ceases or, alternatively, the poor quality material could be excavated and replaced with suitable structural fill compacted to achieve a dry density ratio of not less than 95% relative to modified compaction. The base of the proposed access tunnels could be compacted using a vertical rammer if limited space restricts access to larger compaction plant.



Following excavation for footings, it is recommended that an inspection by an experienced geotechnical engineer be undertaken in the first instance, in order to:

- assess the presence or otherwise of any loose soils below the base of the excavations; and
- assess a suitable remediation measure to improve these materials density, if encountered during the inspection.

As mentioned above, a suitable remediation measure to improve any loose soils, should be assessed during the recommended site inspection. However, assuming the depth to the base of the loose soils does not significantly exceed 2.3 m, as encountered at the test location 42, then a suitable remediation measure to treat loose soils could include:

- excavation to a depth of 1 m below the base of the footing excavations;
- compaction of the base of the excavation to achieve a dry density ratio of not less than 95% relative to modified compaction, using large roller, if possible, or a vertical rammer if space is limited; and
- replacement of the excavated material using the excavated soils.

However, if some loose sand remains at depth following the abovementioned approach, consideration could be given to adopt ground improvement techniques such as microfine cement injection or compaction grouting, to treat any loose sand remaining following the above approach.

Compaction control in sand could be carried out using a Perth sand penetrometer (PSP) test in accordance with test method AS 1289.6.3.3. The sand subgrade should be compacted to achieve a minimum blow count of 8 blows per 300 mm rod penetration to a depth of not less than 1 m below founding level. It should be noted that this compaction level has not been directly correlated to a dry density of 95% relative to modified compaction. Lower blow counts than the above level may be acceptable provided that a correlation between Perth sand penetrometer (PSP) test and dry density ratio has been established by a NATA accredited laboratory and following review by a geotechnical engineer.

It is understood that the propose bush cottages will possibly be fully supported on poles. The above site preparation would apply if the poles are founded on shallow pads. If piled, the above site preparation would not be required provided the poles are bearing in either medium dense and denser natural sand or limestone, as encountered at these locations.

Proposed Dairy/Provedore

Uncontrolled fill was recorded to depth of 1.8 m near the existing building envelope during the CMW Geosciences 2018 investigation (test locations HA4, HA5 and TP08) and possibly during Douglas Partners 2022 investigation (test location 47). Very loose to loose ground conditions (sand) was identified to a depth of 5 m at the nearest deep test location (46) about 20 m to the north.

The uncontrolled fill will require treatment as detailed in the previous section. The loose ground does not form a suitable foundation material and will require site preparation as per the above section assuming loads are light, or a pile foundation system bearing into the limestone and granite, below a depth of possibly at least 6 m to 8 m (about RL-1 m to RL 1 m).



Furthermore, the results of the nearby deep test location (46) indicated the occurrence of loose soils below groundwater, which may lose strength and stiffness in response to an applied cyclic stress, for instance earthquake shaking, causing it to behave like a liquid. Based on the anticipated depth to groundwater and the density of the natural sand at depth (loose), it is considered that some of the soils underlying the proposed Dairy/Provedore building present a high risk of liquefaction potential, and therefore a piled foundation system is preferred for this building.

Proposed Leaf Cottage and Operation Barn

As described early in this section, very loose to loose soils were recorded beneath the proposed Leaf Cottage and Operation Barn footprints to depths of between 0.5 m and 7.6 m below existing ground levels. The very loose to loose soils within the proposed Operation Barn footprint may be representative of loose uncemented zones within the limestone. Therefore, given the increased thickness of very loose to loose soils, and considering that a piled foundation system is likely required for the proposed Leaf Cottage building (to minimise impact on the existing limestone block wall downslope), a piled foundation system is recommended for the proposed Leaf Cottage and Operation Barn, bearing into high to very high strength limestone rock encountered around RL 15 m at test locations 1, 2, 30, 32 and 52 during the Douglas Partners 2022 investigation.

Proposed Natural Pool and Car Parking Areas

Beneath proposed natural pool and pavement areas (car parking), surface proof-compaction using a heavy roller as discussed earlier in this section, is anticipated to be suitable, without any further ground reinforcement requirements.

8.4 Excavation Conditions, Batter Slopes, Slope Stability and Groundwater

Excavations to the proposed basements, tunnels and natural pool base levels are likely to be undertaken through very loose to dense sand (natural and fill) very weakly to strongly cemented limestone rock.

Excavations in sand and weakly cemented (ie low strength limestone) should be readily achieved using standard earthmoving equipment (ie 5 tonne excavator in sand and 20 tonne excavator or heavier in limestone rock). The abovementioned earthmoving equipment might need to be fitted with tynes, hydraulic hammer, or rock header and associated slow excavation rates, for excavations in strong limestone rock and limestone pinnacles, such as encountered at some locations during the investigations.

It is recommended that batter slopes not steeper than 1.5H:1V (horizontal: vertical) be adopted, for temporary excavations not deeper than 3 m in sand materials. For excavations no deeper than 4 m in low strength or stronger limestone, a batter slope no steeper than 0.75H:1V is recommended at this stage.

The batter angles abovementioned are valid provided no surcharge loads (including live loads such as vehicles and machinery and excavated materials) apply at the top of the slope. If loads are applied at the top of the batter, then a site specific assessment of stability should be undertaken, or consideration could be given to the use of earth retaining structures, as described in Section 8.5.



The results of the Douglas Partners 2022 investigation (test locations 1, 2, 29 and 30) indicate that the existing limestone block retaining wall is likely founded on medium to high strength limestone rock. Thus, the requirement for underpinning of the abovementioned limestone block retaining wall is not considered required by Douglas Partners, providing the Leaf Cottage building proposed to be constructed in the relative vicinity of the existing wall is founded on piles to transfer loads below the toe level of the existing retaining wall, or into natural strong limestone rock if encountered above the wall toe.

As described in Section 5.2, groundwater was observed between RL 1 m and RL 3.5 m in the lower half of the site. Given the base levels of the proposed basements and tunnels (ie to a minimum RL 8.5 m), groundwater is not anticipated to impact the proposed basement and tunnel excavations.

However, given the proposed lowest excavation level within the proposed natural pool footprint (ie RL 2 m) groundwater will impact excavations for the proposed pool, and dewatering (say using well points) to a depth of approximately 1 m below the base of the excavation will be required. The well points will be used to minimise the risk of sand running into excavations. The pool design will require some consideration about hydrostatic uplift pressures and buoyancy forces.

Groundwater level is anticipated to decrease during the dry months of the year, and when the river level is low. Therefore, planning the proposed natural pool excavations near the end of summer and/or at low river level is recommended to minimise the requirement for groundwater control. It is also recommended that groundwater level be assessed prior to the earthworks to assess the likelihood of encountering groundwater within proposed natural pool excavation depths, and the requirement for the abovementioned dewatering.

8.5 Design Parameters for Earth Retaining Systems

As described in Section 7, it is understood that a piled retaining wall is proposed to form the south-eastern boundary of the proposed Operations Barn building basement.

A contiguous piled wall is recommended for construction of the abovementioned retaining wall or any other retaining walls within the site. Continuous Flight Auger piles (CFA) are typically used in Western Australia to form contiguous pile walls. Continuous Flight Auger piles (CFA) offer many advantages over conventional bored piles to construct the walls given the former do not require the use of temporary casing or drilling fluid as part of the piling operations. Contiguous piles are installed at close spacings typically with nominal gaps between the piles or just touching, hence there is no continuous barrier to prevent ingress of infiltrating water or migration of soil into the basement excavation. The use of a powerful pilling rig is recommended, in order to achieve suitable penetration into the high to very high strength limestone rock encountered around RL 15 m at test locations 32 and 52 within the proposed Operations Barn building footprint. The prospective contractors should be provided with this geotechnical report for the selection of suitable piling equipment.

For a permanent ground retention system solution, such as anticipated for the proposed Operations Barn building basement, the contiguous pile wall should be associated to shotcreting and possibly soil nailing and/or propping.

Consideration was given to the use of sheet piles, however sheet piles installation is considered unsuitable at this site owing to the occurrence of strong limestone above excavation depths.



Design parameters for the design of temporary and permanent retaining structures are suggested in Table 9 below.

Table 9: Suggested Soil Parameters for Retaining Wall Design

	Drained Angle of	Undrained Shear	Soil Unit Weight above Water γ (kN/m³)	Coefficient of Active Earth Pressure		
Soil Type		Strength C _u (kPa)		Active K _a	At rest K ₀	Passive K _p
Units 1 and 2 Fill and Natural Sand (Loose)	30	0	18	0.33	0.5	3
Unit 2 – Natural Sand (Medium dense)	32	0	20	0.31	0.47	3.2
Unit 3 – Very Weakly to Weakly Cemented Limestone	25 - 30	N/A	20	-	-	400 kPa

Note [1]: Ultimate values that need to incorporate a factor of safety of at least two to derive a design value. See text below.

The values about earth pressures in Table 9 above assume some horizontal ground behind the wall and would need to be reassessed if the ground is sloped, which could increase active and at-rest pressure, and decrease passive pressure. For instance, assuming a 10 degrees unfavourable slope behind and in front of the wall, the active and at-rest pressure behind the wall would increase by about 10% and the passive pressure at the toe of the wall would decrease by about 30%. Douglas Partners should be contacted if slopes apply.

It should also be noted that the parameters regarding passive earth pressure coefficients and passive pressure values (last column of Table 9) are ultimate values and do not incorporate a factor of safety. Because the stress-strain relationship curve for lateral loading is not linear, relatively large strains are required to mobilise full passive pressure but only relatively small strains are required to mobilise half the passive pressure, therefore it would be prudent to incorporate a factor of safety of at least two, to derive design values from the ultimate values.

8.6 Foundation Systems

8.6.1 Shallow Footings

Shallow foundation systems comprising slab, pad and strip footings should be suitable to support the proposed Wallcliffe House, River Wing, Mulberry Wing, Cliff Wing, Bush Cottages, Estate Management, and possibly the Dairy/Provedore (as discussed in Section 8.3) provided compaction of all loose sand is successfully achieved during site preparation as described in Section 8.3, and for any other lightly loaded structures. Footings of buildings covered by AS 2870-2011 should be designed to satisfy the requirements of this Standard for 'Class A' conditions, provided compaction of all loose sand is successfully achieved during site preparation as described in Section 8.3.

If the proposed structures are not covered by AS 2870-2011, then the foundation should be designed using engineering principles. The allowable bearing pressures in Table 10 next page are suggested, provided compaction of all loose sand is successfully achieved during site preparation as described in Section 8.3.



The estimated settlements beneath various square pad and strip footing widths are also provided in Table 10 below, assuming the maximum allowable bearing pressures summarised in the same table.

Table 10: Estimated Settlements of Square Pad and Strip Footings

Footing S	Size (m)	Founding Depth Below Existing Site Levels (m)	Allowable Bearing Pressure (kPa)	Estimated Total Settlement (mm)
Ded	1.0	0.5	000	5 - 10
Pad	2.0		200	10 - 15
Otalia	0.5		160	5 - 10
Strip	Strip 1.0		190	10 - 15
D. d	1.0		250	5 - 10
Pad	2.0		220[2]	15
Strip	0.5	250	40. 45	
	Sulp	1.0		230

Notes: [1] Owing to possible variability of the limestone and to minimise differential settlements across the building envelope, the allowable bearing pressures suggested in Table 10 above for granular soils are also recommended where limestone rock occurs near founding level.

[2] Maximum allowable bearing pressure to limit total settlements to 15 mm.

If compaction of all loose sand during site preparation as described in Section 8.3 is not achieved, for instance as considered likely at the Dairy/Provedore site, and for possibly lightly loaded structures, the allowable bearing pressures in Table 11 below are suggested.

Table 11: Estimated Settlements of Square Pad and Strip Footings (if compaction of all loose

sand is not achieved and for possibly lightly loaded structures)

Footing S	Size (m)	Founding Depth Below Existing Site Levels (m)	Allowable Bearing Pressure (kPa)	Estimated Total Settlement (mm)
	1.0		100	10 - 15
Pad	2.0	0.5 and 1.0	80 ^[2]	15
0	0.5		100	10 - 15
Strip	1.0		90 ^[2]	15

Notes: [1] Owing to possible variability of the limestone and to minimise differential settlements across the building envelope, the allowable bearing pressures suggested in Table 6 above for granular soils are also recommended where limestone rock occurs near founding level.

[2] Maximum allowable bearing pressure to limit total settlements to 15 mm.

Lower settlements than summarised in Tables 10 and 11 are anticipated where limestone rock is at or near foundation levels.



The majority of the settlement is anticipated to occur as loads are applied during construction. Long-term settlements are likely to be 10% to 30% of the total settlement and as such, are likely to be around 5 mm. Owing to the possible occurrence of both limestone and sand near foundation levels, differential settlements of the order of the total settlement are recommended to be assumed in the design between footing locations.

8.6.2 Piled Foundations

As discussed in Section 8.3, piled foundations are recommended to support the proposed Operations Barn and Leaf Cottage buildings, and possibly the Dairy/Provedore (at this latter location owing to both loose soils and soil liquefaction risk). It should be noted that a foundation system design strategy that assumes a piled system is considered a safer solution for proposed buildings and relatively heavy structures, rather than relying on suitable compaction of the encountered loose sand.

CFA piles could be adopted for the proposed Operations Barn, Leaf Cottage and Dairy/Provedore buildings.

The abovementioned piles are constructed by drilling a borehole, placing reinforcement and grouting the hole. The pile hole is typically drilled using continuous flight auger (CFA) technique or conventional drilling with casing. These piles can be used individually or can work in groups for supporting of compressive loads, resisting negative skin friction, tensile loads, or bending moments.

It should be noted that it is not possible to obtain high quality logs of the excavated shafts or to identify the material at pile toe level during the construction of CFA piles, until the auger is withdrawn and the pile shafts are formed. Accordingly, these piles are typically installed to pre-determined levels. Instrumentation of drilling parameters such as torque and rate of penetration and volume of injected concrete will provide a degree of assurance of the materials in which the pile is formed.

The above pile types involve soil excavation to target founding level and hence would produce spoil that needs to be handled and disposed of in a suitable manner.

If pile groups are required for the support loads, it is recommended that there is a clearance of at least 2.5 pile diameters between each pile to minimise the effect of pile interaction.

The following pile design parameters are suggested for CFA piles bearing into limestone rock of Unit 3 below around RL 15 m within the proposed Operations Barn and Leaf Cottage building footprints, and into either limestone of granitic bedrock below likely RL 0 m at the Dairy/Provedor site:

• Ultimate end bearing: $f_b = 2,500 \text{ kPa}$ in limestone of Unit 3 below RL 15 m

 $f_b = 2,500 \text{ kPa}$ in either limestone or underlying bedrock below

RL 0 m at the Dairy/Provedor site.

• Average shaft friction: $f_{m,s} = 20 \text{ kPa in sand of Unit 2 and 50 kPa in limestone of Unit 3.}$

The above values consider the variable strength of this geological unit (in particular Unit 3).

It is emphasised that the values listed above are the design ultimate geotechnical strength $R_{d,ug}$ in accordance with AS 2159:2011, and should be multiplied by the geotechnical reduction factor Φ_g discussed below in order to obtain the design geotechnical strength $R_{d,g}$.



Australian Standard AS 2159-2009 provides the minimum requirements for the design of piled footings based on a limit state approach. Accordingly, the calculated ultimate pile capacity depends on the selected geotechnical strength reduction factor.

Selection of the geotechnical strength reduction factor (Φ g) in accordance with AS 2159 Table 4.3.2 (A) is based upon a series of individual risk ratings and the final value of Φ g depends on the following factors:

- a) Site: the type, quantity and quality of testing.
- b) Design: design methods and parameter selection.
- c) Installation: construction control and monitoring.
- d) Pile testing regime testing benefit factor based on percentage of piles tested and the type of testing. If some testing is carried out, an increase in the value of Φg may be possible depending on the type and extent of the testing. It is noted that Table 8.2.4(B) of AS 2159-2009 requires that 5% to 15% of piles should be subject to integrity testing if the value of Φg adopted by the structural designer exceeds 0.4.
- e) Redundancy: whether other piles can take up load if a given pile settles or fails.

Of the above factors, Douglas Partners can only comment directly upon the site factors under a). The pile designer must determine the individual risk factors b) - e) with knowledge of the pile construction specification that will be applied to the works.

The assessed AS 2159 risk factors assigned by Douglas Partners to the site conditions for the investigation is '4', '3' and '3' respectively for each of the three individual risk factors in item a) above.

As the adopted reduction factor is a function of the above combined effect, it is therefore best determined at detailed design. For preliminary design, a Φ_g value of 0.48 is suggested assuming that no pile testing (ie dynamic or static pile tests) will be undertaken at the site. The Piling Standard (AS 2159) encourages pile load testing by allowing the adoption of higher pile capacities if piles are proposed to be tested.

The settlement of an individual pile founded in limestone rock of Unit 3 (considering the variability of the limestone rock) is expected to be in the order of 1% of pile diameter at normal working loads. Larger settlement should be anticipated under pile groups but would require a separate analysis once details on pile loads and pile arrangement are known.

Depending on the piling rig proposed for the works, consideration will need to be given to the requirement of a granular working platform to ensure stability and trafficability of the rig across the site.

8.7 Soil Aggressivity

Results of the testing performed on two soil samples for pH, chloride and sulphate ion concentrations were compared with the exposure classifications in AS 2159–2009. The results indicate a non-aggressive classification for soils above groundwater.



For structures below groundwater, such as the proposed natural pool and the foundation system of the proposed dairy if piled, a 'severe' exposure classification to concrete in accordance with AS 2159-2009 is recommended to consider possible saline groundwater ingress from the nearby tidal river.

8.8 Pavement Design Parameters

The shallow soils at the site generally comprise sandy soils (fill and natural).

Based on observations made in the field and Douglas Partners' experience with similar materials and the result of laboratory testing summarised in Table 6 in Section 6, a subgrade CBR design value of 12% is suggested for the design of pavement on the sand subgrade materials. The abovementioned CBR value is suggested, provided that the subgrade is compacted achieve a dry density ratio of not less than 95% relative to modified compaction and suitably drained.

A modulus of subgrade reaction of 55 kPa/mm under wheel loading is recommended for the sand subgrade for rigid pavement design, based on the CBR value of 12% mentioned above. It should be noted that this value only applies to wheel loads, as modulus of subgrade reaction is a function of the size of the loaded area rather than an intrinsic characteristic of the ground.

8.9 Soil Permeability and Stormwater Disposal

Results of the permeability testing summarised in Section 5.3 indicates that measured and derived permeabilities generally exceeded 3 m/day, except test locations 2 and 3 (Douglas Partners 2021 investigation) and test location 6 (Douglas Partners 2022 investigation) where the permeabilities were possibly affected by localised ground anomalies at testing depth. It is suggested that a preliminary design permeability of 4.6 x 10⁻⁵ m/s (approximately 4 m/day) is adopted for the sand underlying the site

On-site stormwater infiltration using soakwells or other infiltration systems within sand is considered suitable. A clearance of not less than 0.5 m is typically suggested between the base of drainage systems and top of limestone rock. It should be noted that limestone rock is anticipated to occur at or near foundation levels of some of the proposed buildings envelopes and therefore might impact drainage design if stormwater infiltration is proposed at these locations.

A horizontal clearance of 2 m between any proposed soakwells and building footings, is recommended.

8.10 Acid Sulphate Soil Risk

Published acid sulfate soil risk mapping for the area indicates that the site is located in an area of "no known risk of acid sulfate soils occurring within 3 m of natural soils surface". This level of risk generally corresponds to the areas of sand of the Spearwood System as depicted by the published geological mapping.

The natural ground conditions encountered during the geotechnical investigation appear to be in broad agreement with the published geological mapping (ie sand of the Spearwood System). Thus, the level



of acid sulfate soil risk assigned to sands of the Spearwood System is considered to be supported by the encountered ground conditions.

Consequently, further detailed investigations for acid sulfate soils at this site are not considered to be warranted on the proviso that dewatering for construction is not required.

9. References

- 1. AS 2870 (2011). Residential Slabs and Footings. Standards Australia.
- 2. AS 1289 (2000). Methods of Testing Soils for Engineering Purposes. Standards Australia.
- 3. AS 1289.6.3.3 (1999). Soil Strength and Consolidation Tests-Determination of the Penetration Resistance of a Soil Perth Sand Penetrometer Test. Standards Australia.
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- 5. AS 3798 (2007). Guidelines on Earthworks for Commercial and Residential Developments. Standards Australia.
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- 7. Hvorslev, M.J. (1951). *Time Lag and Soil Permeability in Ground-Water Observations*. Bulletin. No. 36, Waterways Experiment Station Corps of Engineers, U.S. Army, Vicksburg, Mississippi.

10. Limitations

Douglas Partners has prepared this report for the proposed Wallcliffe House Re-development at 752 Wallcliffe Road, Margaret River, WA in accordance with Douglas Partners' proposal P96717.02 dated 7 December 2021 and acceptance received from Duncan Haslam of Wallcliffe House Pty Ltd in an email dated 15 December 2021. The work was carried out under Douglas Partners' Conditions of Engagement. This report is provided for the exclusive use of Wallcliffe House Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of Douglas Partners, does so entirely at its own risk and without recourse to Douglas Partners for any loss or damage. In preparing this report Douglas Partners has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after Douglas Partners' field testing has been completed.

Douglas Partners' advice is based upon the conditions encountered during the previous and current investigations. The accuracy of the advice provided by Douglas Partners in this report may be affected



by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical component set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. Douglas Partners cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by Douglas Partners. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

 In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes.
 They may not be the same at the time of construction as are indicated in the report;
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions.
 The potential for this will depend partly on borehole or pit spacing and sampling frequency:
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Soil Descriptions

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Туре	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Туре	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded a good representation of all particle sizes
- Poorly graded an excess or deficiency of particular sizes within the specified range
- Uniformly graded an excess of a particular particle size
- Gap graded a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

in line grained soils (2007) lines)		
Term	Proportion	Example
	of sand or	
	gravel	
And	Specify	Clay (60%) and
		Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace
		sand

In coarse grained soils (>65% coarse)

- with clavs or silts

- with clays of site	,	
Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)

- with coarser fraction

With oddioor had		
Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with 'Mix of Soil and Cobbles/Boulders' with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	Н	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil derived from in-situ weathering of the underlying rock;
- Extremely weathered material formed from in-situ weathering of geological formations.
 Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil deposited by streams and rivers;

- Estuarine soil deposited in coastal estuaries;
- Marine soil deposited in a marine environment;
- Lacustrine soil deposited in freshwater lakes;
- Aeolian soil carried and deposited by wind;
- Colluvial soil soil and rock debris transported down slopes by gravity;
- Topsoil mantle of surface soil, often with high levels of organic material.
- Fill any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.

Soil tends to stick together.

Sand forms weak ball but breaks easily.

Wet (W) Soil feels cool, darkened in colour.

Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w <PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w >PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈LL' (i.e. near the liquid limit).
- 'Wet' or 'w >LL' (i.e. wet of the liquid limit).

Rock Descriptions Barting

Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $Is_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

Strength Term	Abbreviation	Unconfined Compressive Strength MPa	Point Load Index * Is ₍₅₀₎ MPa
Very low	VL	0.6 - 2	0.03 - 0.1
Low	L	2 - 6	0.1 - 0.3
Medium	М	6 - 20	0.3 - 1.0
High	Н	20 - 60	1 - 3
Very high	VH	60 - 200	3 - 10
Extremely high	EH	>200	>10

^{*} Assumes a ratio of 20:1 for UCS to $ls_{(50)}$. It should be noted that the UCS to $ls_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

RQD % = <u>cumulative length of 'sound' core sections ≥ 100 mm long</u> total drilled length of section being assessed

where 'sound' rock is assessed to be rock of low strength or stronger. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes	
Thinly laminated	< 6 mm	
Laminated	6 mm to 20 mm	
Very thinly bedded	20 mm to 60 mm	
Thinly bedded	60 mm to 0.2 m	
Medium bedded	0.2 m to 0.6 m	
Thickly bedded	0.6 m to 2 m	
Very thickly bedded	> 2 m	

Symbols & Abbreviations

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

С	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia

Water

PQ

\triangleright	Water seep
∇	Water level

Sampling and Testing

	•	0
Α		Auger sample
В		Bulk sample
D		Disturbed sample
Ε		Environmental sample
U ₅₀		Undisturbed tube sample (50mm)
W		Water sample
pp		Pocket penetrometer (kPa)
PID		Photo ionisation detector
PL		Point load strength Is(50) MPa
S		Standard Penetration Test

Diamond core - 81 mm dia

Description of Defects in Rock

Shear vane (kPa)

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

Sz

В	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting

Sheared Zone

Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
V	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
СО	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	siltv

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

ро	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

Talus

Graphic Symbols for Son and Rock				
General	General Sedimentary Rocks			
	Asphalt	294	Boulder conglomerate	
	Road base		Conglomerate	
4.4.4.4	Concrete	.0.	Conglomeratic sandstone	
	Filling		Sandstone	
Soils			Siltstone	
	Topsoil		Laminite	
	Peat		Mudstone, claystone, shale	
	Clay		Coal	
	Silty clay		Limestone	
////	Sandy clay	Metamorphic	Rocks	
	Gravelly clay		Slate, phyllite, schist	
<u> </u>	Shaly clay	- + + + + +	Gneiss	
	Silt	· :	Quartzite	
	Clayey silt	Igneous Roc	ks	
	Sandy silt	+ + + + + + + + + + + + + + + + + + + +	Granite	
	Sand	<	Dolerite, basalt, andesite	
	Clayey sand	× × × : × × × :	Dacite, epidote	
	Silty sand	\vee \vee \vee	Tuff, breccia	
0000	Gravel	P	Porphyry	
0.000	Sandy gravel			
	Cobbles, boulders			

Sampling Methods

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thinwalled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the insitu soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low

reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

 In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

> 4,6,7 N=13

 In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

15, 30/40 mm

Sampling Methods

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Cone Penetration Tests



Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

•	Cone tip resistance	q
•	Sleeve friction	f_s
•	Inclination (from vertical)	i
•	Depth below ground	Z

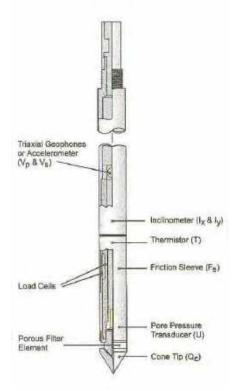


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.



Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Туре	Measures
Standard	Basic parameters (qc, fs, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V _s), compression wave velocity (V _p), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration Tests

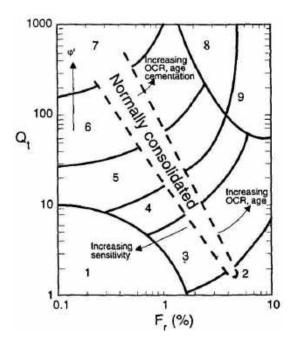


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation. The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G₀. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

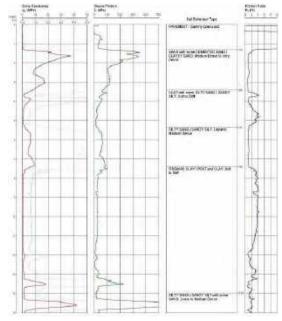
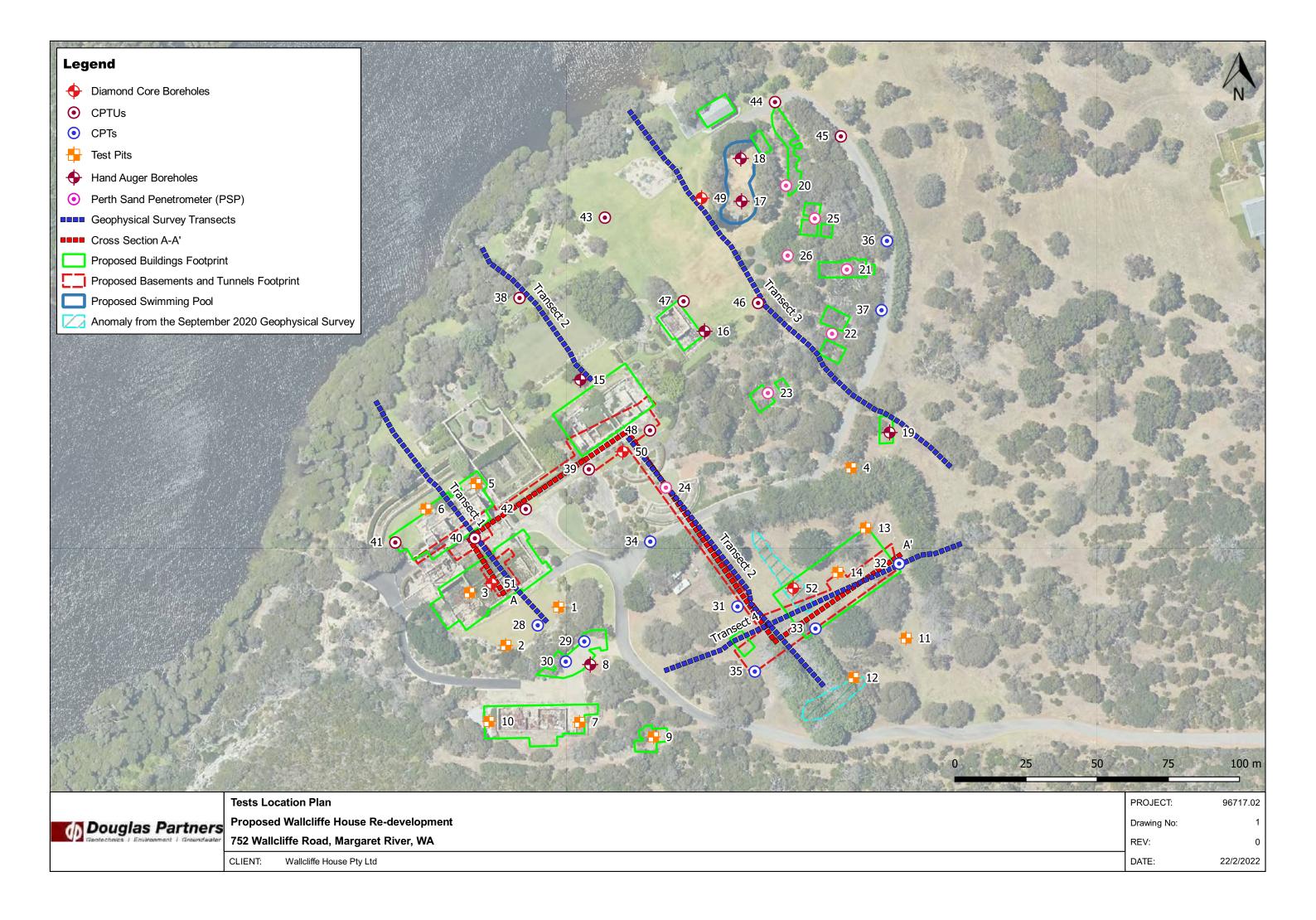
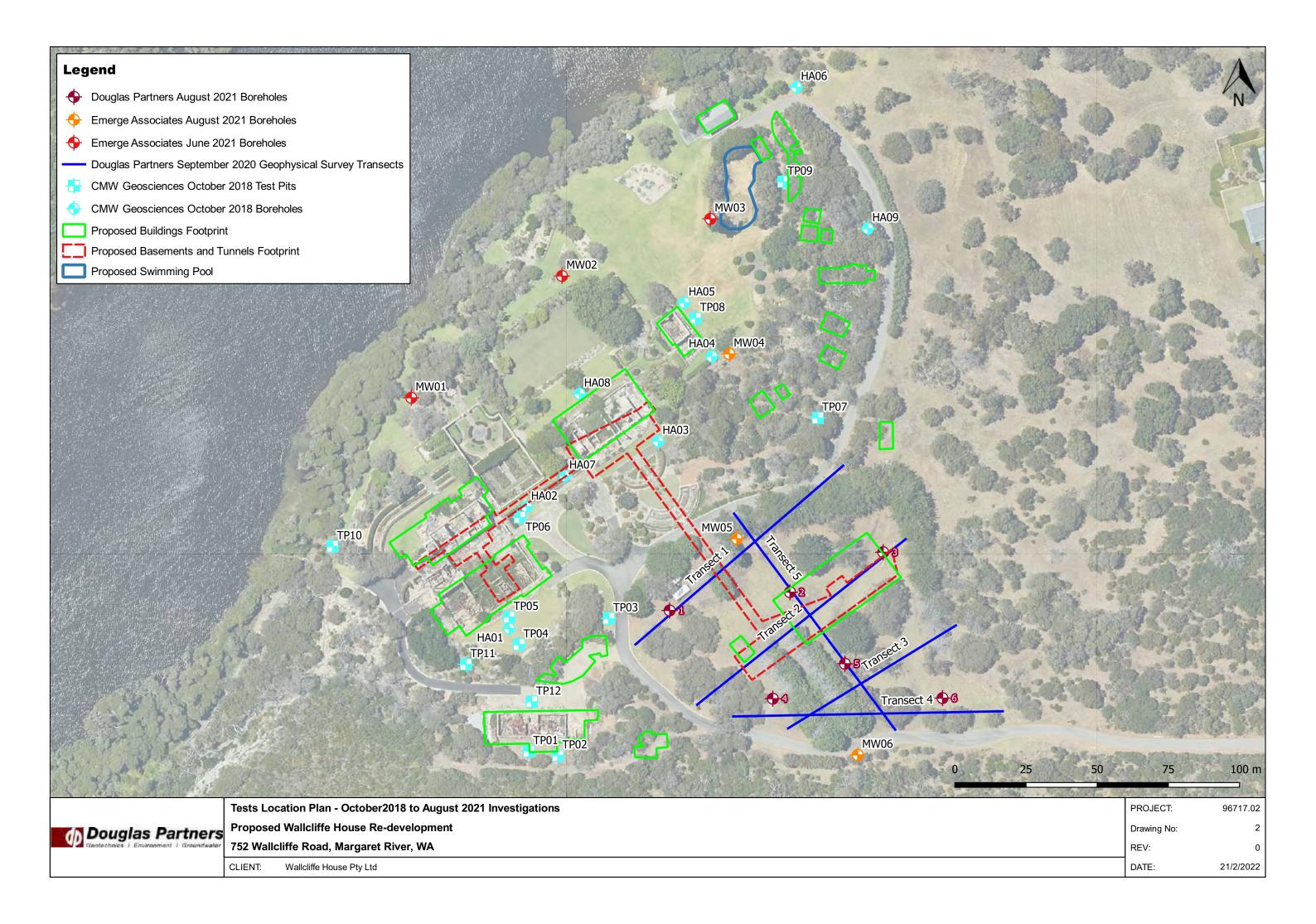


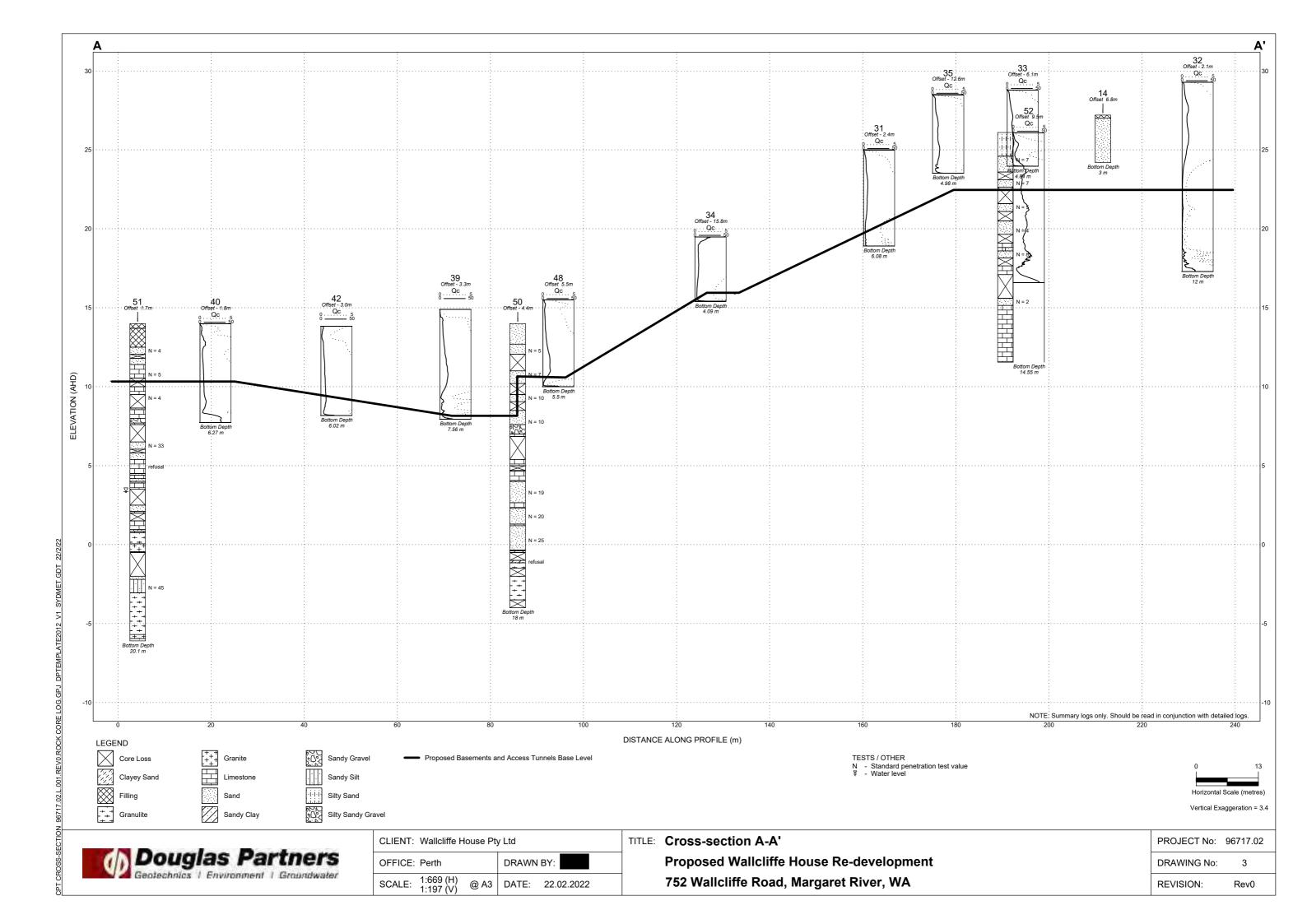
Figure 4: Sample Cone Plot

Appendix B

Drawings







Appendix C

Results of the CMW Geosciences 2018 Field Work

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

Logged by: MW	10	Position:	. E3	14774m N.6239164m (MGA 51) Plant: JCB 3CX	1.20		Sileet 1 01 1
Checked By: PB		Elevatio		Contractor: ANH Contracting		Dimei	nsions : 0.50m x 1.70m
Samples & Insi				Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	_ <u>₹</u>	
				TOPSOIL: Silty SAND: fine to coarse grained, dark brown; trace organics; trace roots and rootlets. SP: SAND: fine to coarse grained, dark brown; trace silt; with organics; trace roots.			
		1 -		at 0.80m, becoming brown. SAND and LIMESTONE PINNACLES: fine to coarse grained, brown; limestone, fine to medium grained, low to high strength, not leached.	М		
		2 -	-	Test pit terminated at 1.70 m			
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		3 -	-				
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			-				
		4 -	1				

Termination Reason: Refusal on limestone. Remarks: Groundwater not encountered.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

1.0	gged by: N	/\\/	Doc	sition:	E 3	14784m N.6239163m (MGA 51) Plant: JCB 3CX			
	necked By:			vation.		Contractor: ANH Contracting		Dimo	acions : 0 50m v 0 50m
	iconeu by	. ו		√au01		Contractor. AND Contracting	T		nsions : 0.50m x 0.50m
Groundwater		es & Insitu Tests	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
	Depth	Type & Results						28	
					-888	TOPSOIL: Silty SAND: fine to coarse grained, dark brown; with organics (<5%			
						by weight); trace roots and rootlets.			
				:		LIMESTONE (CALCADENITE), fine to medium avained have and white me	-		
						LIMESTONE (CALCARENITE): fine to medium grained, brown and white; no leaching, high strength.	М		
				:	\vdash	15001			
				-	\Box				
				_	Н	T			
					- 1	Test pit terminated at 0.50 m			
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Termination Reason: Refusal on cap rock. Remarks: Groundwater not encountered.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

1.0	ogged by: N	0/2010 .4\A/	Pos	sition:	E 3	14802m N.6239211m (MGA 51) Plant: JCB 3CX	1.20		Sileet 1 01 1
	hecked By:			vation.		Contractor: ANH Contracting		Dime	nsions : 0.50m x 1.60m
		s & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	_ <u>≩</u>	
						FILL: SAND: fine to coarse grained, brown; trace fines; trace organics		_	
						FILL: SAND: fine to medium grained, dark brown; trace fines; lenses of clayey gravel.	-		
				1 -		SP: SAND: fine to medium grained, dark brown; with fines; twith organics (<5% by weight).	М		
				-		Test pit terminated at 1.60 m			
						rest pit commuted at 1.00 m			
					-				
				2 -					
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				3 -					
					-				
				-					
				4 -					

Termination Reason: Refusal on cap rock. Remarks: Groundwater not encountered.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

Logged		//2018 //W	Pos	sition:	E.3	14770m N.6239202m (MGA 51) Plant: JCB 3CX	1:20		Sheet 1 of 1
Checke	ed By:	РВ	Ele	vation	1:	Contractor: ANH Contracting			nsions : 0.50m x 2.40m
	Sample	s & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observation
<u> </u>				Η.		FILL: SAND: fine to coarse grained, brown; trace fines; trace organics.		L.	
				-		FILL: SAND: fine to medium grained, dark brown; trace fines. Lens of clayey gravel.			
				-		FILL: SAND: fine to medium grained, dark brown; trace fines; trace organics.			
				1 -		FILL: SAND and LIMESTONE): fine to coarse grained, yellowish brown; Limestone, fine to medium grained, yellowish brown to white; recovered as gravel, cobbles and boulders, very low to high strength.			
				-			M		
				-					
				2 -					
						Test pit terminated at 2.40 m			
				-	1	lest pit terminated at 2.40 m			
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		ason: Refusal on			L_ ∣		\perp	L	

Termination Reason: Refusal on limestone. Remarks: Groundwater not encountered.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

Date: 12/0						1:20		Sheet 1 of 1
ogged by:			sition:		14767m N.6239212m (MGA 51) Plant: JCB 3CX		<u> </u>	
Checked B	y: PB	Ele	vatior	1:	Contractor: ANH Contracting	1		nsions : 0.50m x 1.80m
Samp	les & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency/ Relative Density	Structure & other observatio
					FILL: SAND: fine to coarse grained, brown; trace fines; trace organics.			
					FILL: SAND: fine to medium grained, dark brown; trace fines.			
			-	-	SP: SAND: fine to medium grained, dark brown; trace fines; trace organics.			
			1 -		SP: SAND and LIMESTONE PINNACLES: fine to medium grained, dark brown; trace fines; trace organics; Limestone, fine to medium grained, yellowish brown to white, low to high strength, pinnacles recovered as cobbles and boulders.	М		
			-					
			-					
					Test pit terminated at 1.80 m			
				-	rest pit terriinateu at 1.00 m			
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			4 -					
	eason: Refusal on							

Termination Reason: Refusal on limestone. Remarks: Groundwater not encountered.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

LO	gged by: I	9/2018 MW	Pos	sition:	E.3	14771m N.6239247m (MGA 51) Plant: JCB 3CX				1:20		Sheet 1 of 1
	necked By			vatior		Contractor: ANH Contr	acting				Dime	nsions : 0.50m x 2.80m
=		es & Insitu Tests	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Per (Blov	amic Co netrome ws/100n	ter nm)	Structure & other observation
	Depth	Type & Results			6			Q ja	Ľ	Ĭ	Ĭ	
	0.1	1 B		-		FILL: SAND: fine to coarse grained, brown; trace fines; trace organics. FILL: SAND: fine to medium grained, dark brown; with gravel; with fines; with organics (<5% by weight).						
	1.0	2 B		1 -		SP: SAND: fine to medium grained, dark brown; with fines; with organics (<5% by weight)		_				
				-			М					
				2 -		at 2.00m, becoming dark yellowish brown.		_				
				-		Test pit terminated at 2.80 m						2.80m: Pit collapse
				3 -								
				-	-							
					- - -							

Termination Reason: Target Depth Reached. Remarks: Groundwater not encountered.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

	ogged by: I			sition:		14876m N.6239365m (MGA 51) Plant: JCB 3CX ANI	l Contra	cting					
С	hecked By	PB	Ele	vation		Contractor:							nsions : 0.50m x 0.70m
		s & Insitu Tests	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	D F (B	ynami Penetro llows/1	c Cor omete 100mi 0 1	m)	Structure & other observation
	Depth	Type & Results			Ü	SP: SAND: fine to medium grained, dark brown; trace fines;		R _O					
				-		trace organics.		VL	1				
				-		at 0.30m, large limestone boulder (1.2m)	М		1				
				-				L	1				
				-	MAN.	Test pit terminated at 0.70 m		+	2				
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Termination Reason: Refusal on hard ground. Remarks: Groundwater not encountered.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

Position: E.314833m N.6239282m (MGA 51) Plant: JCB 3CX Logged by: MW Checked By: PB Elevation: Contractor: ANH Contracting Dimensions: 0.50m x 3.00m Dynamic Cone Penetrometer (Blows/100mm) Groundwate Samples & Insitu Tests Moisture Condition Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components Ê Depth (Structure & other observations చ 10 15 Type & Results FILL: SAND: fine to coarse grained, greyish brown; with gravel, fine to medium grained, sub-rounded.; with fines; 0.1 1 B with organics (<5% by weight). FILL: SAND: fine to medium grained, dark brown; with fines; with organics (<5% by weight), trace gravel; trace manmade MD 0.6 2 B 2 SP: SAND: fine to medium grained, dark brown; with fines; with organics (<5% by weight). L to MD М 2 3 Test pit terminated at 3.00 m

Termination Reason: Target Depth Reached Remarks: Groundwater not encountered.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

Date: 12/09/2018			44004 N.0000005 (MOA.54)	1:20		Sheet 1 of 1
Logged by: MW Checked By: PB	Position: Elevation		14864m N.6239365m (MGA 51) Plant: JCB 3CX Contractor: ANH Contracting		Dimer	nsions : 0.50m x 2.00m
Samples & Insitu Tests Depth Type & Results	RL (m) Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components		Consistency/ Relative Density	Structure & other observation
	-		SP: SAND: fine to medium grained, dark brown; trace fines; trace organics.	М	<u> </u>	
	1-		SP: SAND: fine to coarse grained, dark grey (clean sand).			
	-			M to W		
	2		Test pit terminated at 2.00 m			
	-					
	3					
	-					
mination Reason: Target De	4 -					

Termination Reason: Target Depth Reached Remarks: Groundwater not encountered.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

Date: 12/09/2018				1:20		Sheet 1 of 1
Logged by: MW	Position:		14705m N.6239237m (MGA 51) Plant: JCB 3CX			
Checked By: PB	Elevation	1:	Contractor: ANH Contracting			nsions : 0.50m x 2.40m
Samples & Insitu Tests Depth Type & Results	RL (m) Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observation
			FILL: SAND: fine to coarse grained, brown; trace fines; trace organics GEOGRID: 50mm circles with an internal cross FILL: fine gravel sized clasts of blue metal SP: SAND: fine to medium grained, dark brown; trace fines; trace organics.			
	1-		SC: Clayey SAND: fine to coarse grained, grey and yellowish brown; clay, low			
			to medium plasticity (residual soil of granite).	М		
	2 -					
			Test pit terminated at 2.40 m		_	
		-				
	3 -					
		-				
mination Reason: Target Dep	4 -	-				

Termination Reason: Target Depth Reached Remarks: Groundwater not encountered.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

	gged by: N	9/2018 //W	Pos	sition:	F 3	14752m N.6239195m (MGA 51) Plant: JCB 3CX	1:20		Sheet 1 of 1
	ecked By:			vation:		Contractor: ANH Contracting		Dimer	nsions: 0.80m x 0.50m
		s & Insitu Tests	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observation
-	Depth	Type & Results				SP: SAND: fine to medium grained, dark brown; trace fines; trace organics.		28	
	0.6	1		- - - - - - - -			М		
				-	11.	Test pit terminated at 0.80 m			
				-		rest pit terminated at 0.00 m			
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				3 -					
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				4 —					

Termination Reason: Refusal on cap rock. Remarks: Groundwater not encountered.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

Lammad by the MANA	5	Daaitian	. га	14775m N 6020100m (MCA 51)	1.20		Sileet For F
Logged by: MW Checked By: PB		Position Elevatio		14775m N.6239182m (MGA 51) Plant: JCB 3CX Contractor: ANH Contracting		Dimer	nsions : 1.20m x 0.50m
Samples & Insit				Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	. ≱	Structure & other observations
Зори турк		1 .		FILL: SAND: fine to medium grained, dark brown; trace fines; trace organics; trace limestone cobbles and boulders.	M	ă.	
			-	Test pit terminated at 1.20 m			
			-				
		2 -	-				
			-				
		3 -	- - - - - - -				
			- - - - - -				
			-				

Termination Reason: Refusal on cap rock/limestone boulder.

Remarks: Groundwater not encountered.

BOREHOLE LOG - HA01

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

	Sileet 1 01 1	- d Λ.		.20		Dlas			7m N 6220210m (MCA E1) Hala Diameter: 100mm	76700	E 24	ition		12/09/201		
	er	1a Al	на	ea:	าเ us	Piar				/6/M	E.314			d by: MW ed by: PB		
	tructure & other observations		eter mm)	rome /100r	Penet Blows	E (E	onsistency/ ative Density			Braphic Log	Depth (m)		es & Insitu Tests	Sampl		Mell
Samples & Insitu Tests	ructure & other observations		eter mm)	rome /100r	Penet Blows		Consistency/ Relative Density	/ n;	TOPSOIL: SAND: fine to medium grained, brown; trace fines; trace organics. GEOGRID: 50mm circles with an internal cross. FILL: SAND: fine to coarse grained, yellow to brown; trace gravel, angular, fine grained. SP: SAND: fine to coarse grained, dark brown; trace	Graphic Log	1	RL (m)		Depth	Groundwater	Well

Termination Reason: Refusal on limestone cobble.

Remarks: Groundwater not encountered.

BOREHOLE LOG - HA02

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

		by: MW	Posit		E.31	4773m	n N.6239249m (MGA 51) Hole Diameter: 100mr			Plar	nt use	ed: H	land	Auger
С	hecke	d by: PB	Eleva	ation:			Angle from horizontal:	90°	1	1				
Well	Groundwater		ss & Insitu Tests		Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15				Structure & other observations
	0	Depth	Type & Results		- - -		FILL: Gravelly SAND: fine to coarse grained, brown; gravel, fine to medium grained, sub-rounded to rounded; trace fines.		Rec					
					-		SP: SAND: fine to medium grained, dark brown; with gravel.	М						- - - -
					- -		Borehole terminated at 0.4 m							_ _ _
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					3 -									
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					4 -									- -

Termination Reason: Refusal on limestone cobble.

Remarks: Groundwater not encountered.

BOREHOLE LOG - HA03

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

Logged by: MW Position:						4820m	N.6239274m (MGA 51)	Hole Diameter: 100mm				ed: H	and.	Auger
Logged by: MW Position: E.314820m N.6239274m (MGA 51) Hole Diameter: 100mm Plant used: Hand Auger Checked by: PB Elevation: Angle from horizontal: 90°														
Well		Sample	les & Insitu Tests		Depth (m)	sraphic Log	Material Des Soil Type, Plasticity or Particle Secondary and Minc	lescription icle Characteristics, Colour, linor Components	Moisture Condition	onsistency/ ative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15			Structure & other observations
	Groundwater		es & Insitu Tests Type & Results	RL (m)	(m) the depth (m	Graphic Log	Material Des Soil Type, Plasticity or Particle Secondary and Minc FILL: SAND: fine to coarse g fines; with organics (<5% by SP: SAND: fine to coarse grabrown.	cription Characteristics, Colour, r Components rained, dark brown; with weight).		Consistency/	Dynam Penet (Blows 5	/100mm	n) 5	Structure & other observations 1.20m: Note: Difficult to determine boundary between fill and natural ground due to the homogenous nature of the materials.
			Target Depth Rea		3		Borehole terminal	ed at 2.4 m						

Termination Reason: Target Depth Reached. Remarks: Groundwater not encountered.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

Samples & Institut Tests Page Pa	Lo	ogged	by: MW	Pos		E.31	4839n	N.6239303m (MGA 51) Hole Diameter: 100mm			Plant u	sed: I	Hand	Auger
SP: SAND: fine to coarse grained, brown/grey, trace fines. SP: SAND: fine to coarse grained, brown/grey, trace fines. SP: SAND: fine to coarse grained, brown/grey, trace fines. SP: SAND: fine to coarse grained, brown/grey, trace fines.						(E.	Log	Angle from horizontal: \(\)		ncy/ ensity	Dyna Pene	mic Co	ne er	
SP: SAND: fine to coarse grained, brown/grey, trace fines. SP: SAND: fine to coarse grained, brown/grey, trace fines. SP: SAND: fine to coarse grained, brown/grey, trace fines.	Well	Groundw	Depth	Type & Results	RL (m	Depth (Graphic	Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moistu Conditi	Consiste Relative D	(Blow 5			Structure & other observations
			Depth	Type & Results		2		SP: SAND: fine to coarse grained, brown/grey; trace fines.			1 2 2 2 2 2 2 2 2			between fill and natural ground due to the homogenous nature of the

Termination Reason: Target Depth Reached. Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

Date: 12/09/201										:20		Sheet 1 of 1
Logged by: MW	Positi		E.31	4832n	n N.6239326m (MGA 51)	Hole Diameter: 100mm			Plant us	sed: F	land	Auger
wpunou	es & Insitu Tests	ation:	Depth (m)	Graphic Log	Material Descri Soil Type, Plasticity or Particle C Secondary and Minor	Angle from horizontal: 9 ption haracteristics, Colour, Components	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15			Structure & other observations
Depth	Type & Results		1-	Ga	FILL: SAND: fine to coarse grawith gravel, fine to medium grawith fines; with organics (<5% gravel; trace manmade waste, SP: FILL: SAND: fine to medium gravel; with organics with organics organics organically fines; with organical section of the	ained, greyish brown; ained, sub-rounded. rained, dark brown; by weight), trace old glass.	M	MD	5 4 2 2 2 2 2 1 1 1 1 1 1 2 2 2 2	10		1.00m: Possible transition from fill to natural ground Difficult to tell as material is homogenous.
			3		Borehole terminate	d at 2.4 m						

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

E.314869m N.6239398m (MGA 51) Hole Diameter: 100mm Position: Plant used: Hand Auger Logged by: MW Checked by: PB Angle from horizontal: 90° Elevation: Dynamic Cone Penetrometer (Blows/100mm) **3raphic** Log Samples & Insitu Tests Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components Ê Well Groundw Depth (Structure & other observations 묎 10 15 Depth Type & Results FILL: Gravelly SAND: fine to coarse grained, brown; gravel, fine to medium grained, sub-rounded to rounded; trace fines. FILL: SAND: fine to coarse grained, brown; with MD gravel, fine to medium grained; with fines; with organics (<5% by weight). SP: SAND: fine to coarse grained, yellowish brown, L to MD sub-rounded to rounded. Borehole terminated at 1.4 m 2 3

Termination Reason: Target Depth Reached. Remarks: Groundwater not encountered.

This report must be read in conjunction with accompanying notes and abbreviations.

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

Logged by: MW		on:	E.314	4787m	N.6239262m (MGA 51) Hole Diameter: 100mm) 1		Plant u	sed: Ha	and A	Auger
Checked by: PB	Elevat				Angle from horizontal:						gc.
Mell Sar Sar Sar Sar	ples & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Pene (Blow	amic Cone etrometer vs/100mm	n)	Structure & other observations
			1		TOPSOIL: Silty SAND: fine to medium grained, black; with organics (<5% by weight). GEOGRID: 50mm circles with an internal cross FILL: Gravelly SAND: fine to coarse grained, dark brown; gravel, fine to medium grained, angular. FILL: SAND: fine to medium grained, dark brown; with fines; with organics (<5% by weight). SP: SAND: fine to medium grained, dark brown; with fines; with organics (<5% by weight).	M	MD	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2			1.00m: Possible transitio from fill to natural ground Difficult to tell as materia is homogenous.
			-		Borehole terminated at 2.4 m						
			3								

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

E.314792m N.6239290m (MGA 51) Logged by: MW Position: Hole Diameter: 100mm Plant used: Hand Auger Checked by: PB Elevation: Angle from horizontal: 90° Perth Sand Samples & Insitu Tests Penetrometer (Blows/150mm) Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components Ê Well Depth (Structure & other observations 牊 10 15 Depth Type & Results TOPSOIL: fine to coarse grained, dark brown; with fines; with organics (<5% by weight). FILL: SAND: fine to medium grained, dark brown; trace gravel; with fines; with organics (<5% by weight). MD 4 1 М 5 SP: SAND: fine to coarse grained, dark yellow 5 brown; trace fines. 5 4 2 Borehole terminated at 2.4 m 3 4

Client: Wallcliffe House Pty Ltd Project: Margaret River Development

Location: Margaret River Project ID: PER2018-0309



Date: 12/09/2018 1:20 Sheet 1 of 1

		d by: MW		sition:	E.31	4894m	N.6239348m (MGA 51) Hole Diameter: 100mr	n		Plant us	sed: Ha	and A	Auger
		ed by: PB		vation:			Angle from horizontal:						
Well	Groundwater		es & Insitu Tests	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Dynar Pene (Blows	mic Cone trometer s/100mm	1)	Structure & other observations
	ъ	Depth	Type & Results		1	ō	SP: SAND: fine to medium grained, dark brown; with fines; with organics (<5% by weight). SP: SAND: fine to medium grained, dark yellowish brown; trace fines. Borehole terminated at 1.4 m	M	L to MD	2 2 1 1 2 2 2 2 2 2	10 15		
					3								

Appendix D

Results of the Douglas Partners 2021 Field Work

CLIENT: Wallcliffe House Pty Ltd

PROJECT: On Site Sewage Disposal Assessment LOCATION: 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 22.2 m AHD **BORE No:** 1

EASTING: 314823 **PROJECT No:** 96717.01 **NORTHING:** 6239214 **DATE:** 30-8-2021 **SHEET** 1 OF 1

Description of	Graphic Log				& In Situ Testing		
		Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
Strata		Ту	De	San	Comments		5 10 15 20
FILL/TOPSOIL: SAND SP-SM, fine to medium grained, dark grey, with silt, trace gravel and rootlets, moist.							
SAND SP: fine to medium grained, dark grey, trace silt and rootlets, moist, loose, residual soil, Spearwood System.		D	0.5				
γ^{\perp} - becoming medium dense from 0.3 m depth.							ļ L
- becoming dark brown-brown from 0.8 m depth.							⁻¹ ┍
- becoming yellow-brown from 1.5 m depth.			1.7				
		R					
		Ь	0.0				
- becoming loose between 2.25 m and 2.55 m depth.			2.3				!
							[]
							-3
Bore discontinued at 3.2m (Refusal on possible limestone	1						- 4
rock)							
	dark grey, with silt, trace gravel and rootlets, moist. SAND SP: fine to medium grained, dark grey, trace silt and rootlets, moist, loose, residual soil, Spearwood System. - becoming medium dense from 0.3 m depth. - becoming dark brown-brown from 0.8 m depth. - becoming yellow-brown from 1.5 m depth. - becoming loose between 2.25 m and 2.55 m depth.	dark grey, with silt, trace gravel and rootlets, moist. SAND SP: fine to medium grained, dark grey, trace silt and rootlets, moist, loose, residual soil, Spearwood System. - becoming medium dense from 0.3 m depth. - becoming dark brown-brown from 0.8 m depth. - becoming yellow-brown from 1.5 m depth. - becoming loose between 2.25 m and 2.55 m depth. Bore discontinued at 3.2m (Refusal on possible limestone	dark grey, with silt, trace gravel and rootlets, moist. SAND SP: fine to medium grained, dark grey, trace silt and rootlets, moist, loose, residual soil, Spearwood System. - becoming medium dense from 0.3 m depth. - becoming dark brown-brown from 0.8 m depth. - becoming yellow-brown from 1.5 m depth. Becoming loose between 2.25 m and 2.55 m depth.	dark grey, with silt, trace gravel and rootlets, moist. SAND SP: fine to medium grained, dark grey, trace silt and rootlets, moist, loose, residual soil, Spearwood System. - becoming medium dense from 0.3 m depth. - becoming dark brown-brown from 0.8 m depth. - becoming yellow-brown from 1.5 m depth. Becoming loose between 2.25 m and 2.55 m depth. Bore discontinued at 3.2m (Refusal on possible limestone	dark grey, with silt, trace gravel and rootlets, moist. SAND SP: fine to medium grained, dark grey, trace silt and rootlets, moist, loose, residual soil, Spearwood System. - becoming medium dense from 0.3 m depth. - becoming dark brown-brown from 0.8 m depth. - becoming yellow-brown from 1.5 m depth. BB - becoming loose between 2.25 m and 2.55 m depth. Bore discontinued at 3.2m (Refusal on possible limestone	Comparison of the comparison	SAND SP: fine to medium grained, dark grey, trace silt and rootlets, moist, loose, residual soil, Spearwood System becoming medium dense from 0.3 m depth becoming dark brown-brown from 0.8 m depth becoming yellow-brown from 1.5 m depth becoming loose between 2.25 m and 2.55 m depth Bore discontinued at 3.2m (Refusal on possible limestone

RIG: hand auger DRILLER: GG LOGGED: GG CASING:

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J.

SAMPLING & IN SITU TESTING LEGEND

A Auger sample G Gas
B Bulk sample P Pist
BUK Block sample U, Titul
C Core drilling W Wa
D Disturbed sample P Wa
E Environmental sample W Wa

G & IN SITU TESTING
Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level

LEGEND
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)

Douglas Partners

Geotechnics | Environment | Groundwater

Sand Penetrometer AS1289.6.3.3□ Cone Penetrometer AS1289.6.3.2

CLIENT: Wallcliffe House Pty Ltd

PROJECT: On Site Sewage Disposal Assessment LOCATION: 752 Wallcliffe Road, Margaret River, WA SURFACE LEVEL: 25.9 m AHD BORE No: 2

EASTING: 314866 **PROJECT No:** 96717.01 **NORTHING**: 6239220 **DATE:** 30-8-2021 **DIP/AZIMUTH:** 90°/--SHEET 1 OF 1

		Description	je.		Sam		& In Situ Testing	_	Dia Danatanantan Tart
Ζ	Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
	- 0.1	FILL/TOPSOIL: SAND SP-SM, fine to medium grained, dark grey, with silt, roots and rootlets, moist.	Y)X						L
	-	SAND SP: fine to medium grained, dark grey, with rootlets, trace silt, moist, medium dense, residual soil, Spearwood System.							
25	- -1 - -	- becoming dark brown-brown from 1.1 m depth.							-1 J
	-	- becoming yellow-brown from 1.6 m depth.			1.7				
24	-2 -			В					-2
	-				2.3				
-82	-3 -			D	3.0				3 4
-	- - -								
-8	-4 4.0			—D—	-4.0-				7
-		Bore discontinued at 4.0m (Target depth)							





LOGGED: GG CASING: RIG: hand auger DRILLER: GG

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed. REMARKS: Location coordinates are in MGA94 Zone 50 J.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam

SAMPLING & IN SITU TESTING LEGEND PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: On Site Sewage Disposal Assessment LOCATION: 752 Wallcliffe Road, Margaret River, WA **SURFACE LEVEL:** 27.9 m AHD **BORE No:** 3

PROJECT No: 96717.01 **EASTING**: 314898 **NORTHING**: 6239234 **DATE:** 31-8-2021 **DIP/AZIMUTH:** 90°/--SHEET 1 OF 1

\prod		Description	je		San		& In Situ Testing		Dimamia Danatramatar Tt
	Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
	0.1	FILL/TOPSOIL: SAND SP-SM, fine to medium grained, dark grey, with silt, trace rootlets, moist.	XX						
		SAND SP: fine to medium grained, dark grey, with rootlets, trace silt, moist, medium dense, residual soil, Spearwood System.							
-22 - 1		- becoming dark brown-brown from 0.9 m depth.							
97 - 2	2	- becoming yellow-brown from 1.8 m depth.		В	1.7 2.3				-2
3									-3
	3.3	Bore discontinued at 3.3m (Refusal on possible limestone rock)							þ
-4	ļ								
		A 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			100				





LOGGED: GG CASING: RIG: hand auger DRILLER: GG

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed. REMARKS: Location coordinates are in MGA94 Zone 50 J.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sam

SAMPLING & IN SITU TESTING LEGEND PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: On Site Sewage Disposal Assessment LOCATION: 752 Wallcliffe Road, Margaret River, WA **SURFACE LEVEL:** 30.1 m AHD **BORE No:** 4

EASTING: 314860 **NORTHING:** 6239183 **DIP/AZIMUTH:** 90°/--

PROJECT No: 96717.01 **DATE:** 30-8-2021 SHEET 1 OF 1

			Description	.i		Sam		& In Situ Testing		
R		Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
30	-	0.1	FILL/TOPSOIL: SAND SP-SM, fine to medium grained, dark grey, with silt and rootlets, moist.	XX	D	0.05				
	-		SAND SP: fine to medium grained, dark grey, with rootlets, trace silt, moist, medium dense, residual soil, Spearwood System.							
29	- 1 - 1 		- becoming dark brown-brown from 1.2 m depth.							-1
28	-2		- becoming yellow-brown from 2.0 m depth.		В	2.3				-2
27	-3		- becoming light yellow-brown from 3.0 m depth.							
26	-4 - -	4.0 -	Bore discontinued at 4.0m (Target depth)	1:						7





LOGGED: GG CASING: RIG: hand auger DRILLER: GG

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed. REMARKS: Location coordinates are in MGA94 Zone 50 J.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam

SAMPLING & IN SITU TESTING LEGEND PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: On Site Sewage Disposal Assessment LOCATION: 752 Wallcliffe Road, Margaret River, WA **SURFACE LEVEL:** 31.1 m AHD **BORE No:** 5

EASTING: 314885 **NORTHING:** 6239195 **DIP/AZIMUTH:** 90°/--

PROJECT No: 96717.01 **DATE:** 30-8-2021 SHEET 1 OF 1

		Description	je.		Sam		& In Situ Testing		Di. Dt T
RL	Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
31	- 0.1	FILL/TOPSOIL: SAND SP-SM, fine to medium grained, dark grey, with silt and rootlets, moist.	XX						1
	- - - -	SAND SP: fine to medium grained, dark grey, with rootlets, trace silt, moist, medium dense, residual soil, Spearwood System.							
30	-1 - -	- becoming dark brown-brown from 1.1 m depth.		D	1.3				-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
	- - -	- becoming yellow-brown from 1.5 m depth.		ט	1.3				
	• •				1.7				<u> </u>
29	-2 -			В	0.0				
	- - -				2.3				
	- - - 3	- becoming light yellow-brown from 2.8 m depth.							[[
28	- - - -	- becoming loose from 3.15 m depth.							
-									
27	-4 4.0 - - -	Bore discontinued at 4.0m (Target depth)							1 1
H	-								





LOGGED: GG CASING: RIG: hand auger DRILLER: GG

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed. REMARKS: Location coordinates are in MGA94 Zone 50 J.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: On Site Sewage Disposal Assessment 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 35.9 m AHD **BORE No:** 6

PROJECT No: 96717.01 **EASTING**: 314919 **NORTHING:** 6239183 **DATE:** 31-8-2021 **DIP/AZIMUTH**: 90°/--SHEET 1 OF 1

Depth of Strata O.1 FILL/TOPSOIL: SAND SP-SM, fine to medium grained, dark grey, with rootlets, trace slit, moist, medium dense, residual soil, Spearwood System. - becoming dark brown-brown from 1.4 m depth. - becoming light yellow-brown, dense to very dense from 2.1 m depth. - becoming light yellow-brown from 3.0 m depth. Bord Group of G				DIF	/ A ZII	VIO I I	1. 90 /		SHEET I OF I
Depth (m) of Strata O.1 FILL/TOPSOIL: SAND SP-SM, fine to medium grained, dark grey, with silt, trace rootlets, moist. SAND SP: fine to medium grained, dark grey, with rootlets, trace silt, moist, medium dense, residual soil, Spearwood System. 1 - becoming dark brown-brown from 1.4 m depth. 2 - becoming yellow-brown, dense to very dense from 2.1 m depth. 3 - becoming light yellow-brown from 3.0 m depth. 3 - becoming light yellow-brown from 3.2 m depth. Bore discontinued at 3.3m (Refusal on possible limestone)		Description	<u>.</u> 2		Sam		& In Situ Testing	T	
O.1 FILL/TOPSOIL: SAND SP-SM, fine to medium grained, dark grey, with silt, trace rootlets, moist. SAND SP: fine to medium grained, dark grey, with rootlets, trace silt, moist, medium dense, residual soil, Spearwood System. 1 - becoming dark brown-brown from 1.4 m depth. 2 - becoming yellow-brown, dense to very dense from 2.1 m depth. 3 - becoming light yellow-brown from 3.0 m depth. - trace limestone gravel from 3.2 m depth. Bore discontinued at 3.3m (Refusal on possible limestone	Depth (m)	of	Graph Log	Туре	Depth	Sample	Results & Comments	Wate	(blows per 150mm)
- becoming yellow-brown, dense to very dense from 2.1 m depth. - becoming light yellow-brown from 3.0 m depth. - trace limestone gravel from 3.2 m depth. Bore discontinued at 3.3m (Refusal on possible limestone	- 0.1	\dark grey, with silt, trace rootlets, moist. SAND SP: fine to medium grained, dark grey, with rootlets, trace silt, moist, medium dense, residual soil,	Y) X			•			
- becoming yellow-brown, dense to very dense from 2.1 m depth. 2.3 - becoming light yellow-brown from 3.0 m depth. - trace limestone gravel from 3.2 m depth. Bore discontinued at 3.3m (Refusal on possible limestone		- becoming dark brown-brown from 1.4 m depth.		R	1.7				
- becoming light yellow-brown from 3.0 m depth. 3.3 - trace limestone gravel from 3.2 m depth. Bore discontinued at 3.3m (Refusal on possible limestone	-	- becoming yellow-brown, dense to very dense from 2.1 m depth.			2.3				
Bore discontinued at 3.3m (Refusal on possible limestone rock)		- trace limestone gravel from 3.2 m depth.							-3
	- 4 4	rock)							





LOGGED: GG CASING: RIG: hand auger DRILLER: GG

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed. REMARKS: Location coordinates are in MGA94 Zone 50 J.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level

SAMPLING & IN SITU TESTING LEGEND PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)



Appendix E

GBG Maps Report 70585



Level 1, 2 Sabre Crescent Jandakot, WA 6964 Tel: 08 6436 1599 Email: info@gbgmaps.com.au

A.B.N. 45 129 251 225

GEOPHYSICAL INVESTIGATION FOR SUBSURFACE GEOLOGICAL MAPPING.

WALLCLIFFE HOUSE, 752 WALLCLIFFE ROAD MARGARET RIVER WESTERN AUSTRALIA.

Date: 21 September 2020

Report No.: 70585

Revision: 0

Author:

Reviewed:

Distribution

Douglas Partners



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1. INTRODUCTION

At the request of Douglas Partners, GBGMAPS carried out a geophysical subsurface investigation at Wallcliffe House located on 752 Wallcliffe Road Margaret River, WA in September 2020.

During the investigation Seismic Refraction, Multi-channel Analysis of Surface Waves (MASW) and Ground Penetrating Radar (GPR) datasets were acquired, processed and analysed to provide information on the geology underlying the site. In particular, the depth to the granite and limestone rock was sought as well as the location of any potential karstic features within the limestone.

The geophysical investigation forms part of a broader scope geotechnical investigation being carried out by Douglas Partners as part of planned redevelopment of the site.

2. INVESTIGATION SITE

The geophysical investigation was carried out within an 8500m² area located on the south eastern end of the Wallcliffe House site. The extent of the geophysical investigation is shown in red in Figure 1 below.

Ground conditions at the site were suitable for geophysical data acquisition with most of the surface consisting of short grass. Data acquisition was not carried out where thick vegetation limited the use of the geophysical method. Photographs of the typical conditions at the site are shown in Figure 2.

The near surface lithology within the investigation site consists of dry sand overlying limestone rock which was formed on deeper granitic rock.



Figure 1: The extent of geophysical investigation at Wallcliffe House outlined in red. Imagery from MNG Survey flown May 2020.







Figure 2: Site conditions within the investigation area at Wallcliffe House.

3. GEOPHYSICAL DATA ACQUISITION

Geophysical data acquisition was carried out from the 8th to 10th September 2020 by a two-person team from GBGMAPS consisting of qualified geophysicists.

During the investigation Seismic Refraction, Multi-channel Analysis of Surface Waves (MASW) and Ground Penetrating Radar (GPR) data was acquired along 5 transects with a total length of 442m. Additional GPR data was also acquired on 3 transects totalling 201m in length. The extents of the acquired transects are shown in drawing 70585-01 in Appendix A of this report.

Refer to Appendix B for details on the geophysical methods used during the investigation.

3.1 Seismic Methods (Seismic Refraction and MASW)

Two seismic methods were utilised to obtain the subsurface information relating to the project objectives.

- **Seismic Refraction** acquired for the generation of seismic compressional (p-) wave velocity models to model the depth to the various rock types and areas of reduced velocity.
- MASW acquired for the generation of seismic shear (s-) wave velocity models as a supplementary method to aid in the interpretation of the Seismic Refraction and GPR datasets.

Both seismic methods were acquired simultaneously using an ECHO48/2014 Seismic Unit (Ambrogeo Instruments) connected to an array of 48, 4.5 Hz geophones. Seismic energy was generated using summed sledgehammer impacts onto a metal base plate.

Seismic data was acquired using parameters that enabled inversion of both seismic refraction and MASW datasets. Seismic acquisition parameters are provided in Table 1.

Table 1: Seismic Acquisition Parameters

Geophone spacing	2m
Number of geophones	48
Array length	94



Geophone centre frequency	4.5Hz
Source	Sledgehammer
Record length	2000ms
Sample interval	0.128ms

3.2 Ground Penetrating Radar

GPR was acquired using two systems acquiring radar wave reflection data at multiple frequencies to target shallow and deep geological anomalies relating to karstic features and map top of weathered limestone down to a depth of 10m Below Ground Level (BGL).

- **GSSI DF** system which utilises dual mid-frequency (300MHz and 800MHz) ground coupled antennas.
- **GSSI Sir3000** system which utilises a single low-frequency (120MHz) ground coupled antenna.

Acquisition parameters are provided in Table 2 below.

GPR data acquisition involved moving the cart-based systems over the ground surface at a slow and steady pace along the required profiles. Distances along the profiles were logged by a calibrated distance measuring device attached to the equipment controlling the GPR trigger interval.

Antenna centre frequency 800MHz, 300MHz, 120MHz, Two-way travel time 40ns 80ns 180ns Uncalibrated imaging depth 2.5m 5m 10m Scans per metre 100 100 20 1024 512 Sample number 1024 Sample rate 32 bits 32 bits 16 bits 0.12m/ns 0.12m/ns 0.12m/ns Radar wave velocity

Table 2: GPR Acquisition Parameters

3.3 Spatial Positioning

Spatial positioning of the acquired geophysical transects was achieved using a SF30-40 GNSS receiver (Navcom) with StarFire satellite corrections. Positions have been provided in GDA94, MGA zone 50 for horizontal and mAHD for vertical components. An accuracy of +/- 0.25m is expected for both horizontal and vertical components.



4. DATA PROCESSING AND ANALYSIS

Processing and analysis of the acquired geophysical dataset was carried out by qualified geophysicists using current industry standard software and GBGMAPS processing routines.

4.1 Seismic Refraction

The Seismic Refraction data was processed using Rayfract version 3.35 (Intelligent Resources Inc.) with the following processing flow used:

- 1. First arrivals (first break picks) were manually picked for each channel of each acquired seismic record.
- 2. Source and receiver geometry were applied to first break picks and resulting data imported into Rayfract.
- 3. An initial 1D gradient initial model is generated for each transect
- 4. The initial model was refined with true 2D Wavepath Eikonal Traveltime (WET) tomography over multiple iterations assuming a 2 or 3-layer model.
- 5. Seismic sections were generated showing variations in modelled P-wave velocity in metres per second (m/s) laterally and with level along the transects.

Note: Inversion of seismic refraction data is based on several assumptions including an increase in p-wave velocity with depth. In the presence of a velocity inversion (hard over soft material) the data may be truncated due to the refracted signal being unable to penetrate into a lower density material (Snell's Law), or a higher than expected velocity may present in the modelled data below an isolated hard layer. In the case where an isolated hard layer is identified in borehole logs, deeper p-wave velocities should be used with caution.

4.2 Multi-channel Analysis of Surface Waves

The acquired MASW data was processed using SurfSeis Version 4 (Kansas Geological Survey, 2014). The following processing steps were performed:

- 1. Geometry was applied to the acquired seismic data files including geophone spacing and source offset.
- 2. Phase overtone images were generated for each seismic record giving the ratio intensity of phase velocity versus frequency.
- 3. The maximum intensity across the useful range of frequencies was picked for each phase overtone image resulting in a dispersion curve.
- 4. The dispersion curves were run through a 20-layer inversion algorithm to produce an S-wave velocity sounding.
- 5. Adjacent S-wave velocity soundings along each seismic profile were compiled in order to generate an S-wave velocity section.

The generated S-wave velocity soundings were compiled and gridded using Surfer version 16 (Golden Software, 2016) to produce 2D S-wave velocity cross-sections along the profiles. The sections showed variations in the modelled S-wave velocity laterally along the profiles and with depth below the existing ground level.



4.3 Ground Penetrating Radar

The acquired GPR data was processed and analysed using ReflexW Version 8.5 (Sandmeier Software, 2017). The following processing steps were performed:

- 1. Correct Max Phase Set GPR zero time to the first crossing of the reflection wavelet.
- 2. Manual Gain Apply a gain curve function in the y-direction in order to counter GPR signal attenutation with depth.
- 3. 1D Butterworth Filtering High cut and low cut frequency filter to improve signal to noise ratio.
- 4. 2D Filtering Subtracting average and running average filters to suppress horizontally coherent energy, effectively emphasising signals which vary laterally.

Analysis of the processed GPR data consisted of viewing the processed radar-grams sequentially with consideration to the target depth using a radar-wave velocity of 0.12m/ns, signal amplitude, continuity and phase with identified features interpreted and digitised. An example of a processed radar-gram is shown in Figure 3.

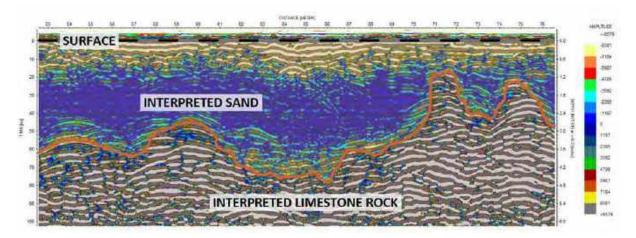


Figure 3: Processed 300MHz radar-gram showing digitised geological interface.

5. RESULTS AND INTERPRETATION

The results of the geophysical investigation carried out at Wallcliffe House, Margaret River WA have been provided as a series of drawings in Appendix A of this report as follows:

- **70585-01** Site map with acquired Seismic and GPR profiles.
- 70585-02 Site map showing shallow limestone rock and low p-wave velocity anomalies.
- **70585-03** Transect 1 Seismic P-wave Velocity model and geological interpretation.
- **70585-04** Transect 2 Seismic P-wave Velocity model and geological interpretation.
- **70585-05** Transect 3 Seismic P-wave Velocity model and geological interpretation.
- 70585-06 Transect 4 Seismic P-wave Velocity model and geological interpretation.
- 70585-07 Transect 5 Seismic P-wave Velocity model and geological interpretation.



5.1 Seismic Refraction and MASW

Seismic p-wave velocity colour contour sections have been generated from the seismic refraction data for each transect. The MASW velocity sections were omitted from the results but were used to aid in the interpretation of the seismic refraction and GPR datasets.

Seismic P-wave Propagation

Seismic P-wave velocity is governed by the elastic properties of the medium it propagates through including bulk modulus, shear modulus and density as shown in the equation below. As such the modelled p-wave velocity provides a useful guide to the subsurface material condition with increasing velocity an indication of increasing material hardness.

Seismic P-wave velocity
$$V_p = \sqrt{\frac{K + \frac{4}{3}G}{\rho}}$$
 where; K = Bulk modulus G = Shear modulus Φ = In-situ material density

Seismic P-wave Sections

At the top of each drawing is the seismic velocity tomographic model showing variations in P-wave velocity of the subsurface material as a contour cross-section with increasing velocity from blue, green, yellow, orange, red then brown. Below the seismic velocity section is a geological section giving the interpreted layering of the subsurface based on detectable p-wave seismic velocity contracts and the anticipated rock type. The calculated seismic velocity values have been classed into four categories representing different subsurface conditions. Theses velocities can be calibrated following planned intrusive borehole testing at the site.

- 1. **Low seismic p-wave velocity** (200-700 m/s) regions with low p-wave seismic wave velocity are interpreted as sand of low to moderate compaction.
- 2. **Moderate seismic p-wave velocity** (700-1200 m/s) Regions with moderate p-wave seismic wave velocity are interpreted as limestone of low rock strength. It is postulated that this class represents a weathered limestone and transitional zone to stronger, less weathered limestone below.
- 3. **Moderate to high seismic p-wave velocity** (1200-4600 m/s) Regions with moderate to high seismic p-wave velocity are interpreted as limestone of moderate rock strength. It is postulated that this class represents unweathered limestone.
- 4. **High to very high seismic p-wave velocity** (>4600 m/s) Regions with high to very high seismic p-wave velocity are interpreted as granite of high rock strength.



Depth to Granite

The first observation that can be made from the seismic refraction sections is in relation to the depth of the granite at the site. Based on current literature, granite is expected to have a seismic p-wave velocity range of 4500-6000 m/s. Using the assumed velocity of 4600 m/s for this investigation, the shallowest granite rock was interpreted to be at a depth of 7m BGL along the western end of transect 1. Granite was also interpreted to exist sporadically along the rest of the transects.

Depth to Limestone

The second observation inferred from the seismic refraction data is the depth to limestone and thickness of sand along the transects acquired. The maximum depth to the limestone rock (thickness of sand) is interpreted to be approximately 7.5m BGL. Given the expected low resolution of the seismic refraction method when imaging abrupt rock level changes such as that exhibited by limestone rock, it is not recommended that this method be used to interpret the locations of limestone pinnacles or rock outcrops (minimum limestone depth). This can be accurately imaged using the GPR method as shown in Figure 3 and discussed in section 5.2.

Regions with Reduced P-wave Velocity

Two areas of reduced seismic p-wave velocity were observed in the seismic refraction data as shown on transect 3 and 5 and drawing 70585-02 in pink. These are interpreted to exist within the limestone rock as weathered/ reduced compaction material. It is recommended that these areas are investigated further using targeted intrusive borehole testing.

5.2 Ground Penetrating Radar

GPR sections were used to interpret the depth to the top of shallow limestone and potential areas of karst features down to a depth of 10m BGL. It should be noted that depths have been calculated using limited calibration. Calibration was carried out by performing a velocity analysis to obtain a bulk radar-wave velocity for the subsurface material at the site. However, it is anticipated that quoted depths may vary by as much as +/-15% due to the various subsurface materials encountered.

Depth to Shallow Limestone

Analysis of the processed GPR data has identified a single reflective interface corresponding to the boundary between the sand and underlying limestone rock.

Drawing **70585-02** shows the location of where limestone rock has been imaged within the top 1.5m BGL of the subsurface. It is interpreted that the shallow limestone within the site is characterised by pinnacles and broken rock outcrops.

Karst

No karst features were interpreted within the top 10m of the subsurface along the acquired GPR transects. Note that this does not preclude the existence of smaller karst features between the acquired GPR transects.



6. CONCLUSIONS

A geophysical subsurface investigation has been carried out by GBGMAPS at Wallcliffe House in Margaret River, Western Australia. During the investigation geophysical testing by way of Seismic Refraction, Multi-channel Analysis of Surface Waves and Ground Penetrating Radar was acquired along several transects within the footprint of proposed future development at the site.

The seismic datasets were processed and inverted to obtain seismic velocity models relating to variations in geology within the site. The GPR data was processed and interpreted to obtain information relating to potential karst features within the site. The depth to granite and limestone was successfully imaged using uncalibrated material velocities. No karst features were interpreted along the acquired transects.

The methods used during the investigation are geophysical and as such the results are based on indirect measurements and the processing and interpretation of radar and seismic wave signals. The findings in this report represent the best professional opinions of the authors, based on experience gained during previous similar investigations and with correlation to known and assumed subsurface ground conditions at the site.

We trust that this report and attached drawings provide you with the information required. If you require clarification on any points arising from this investigation, please do not hesitate to contact the undersigned or Andrew Spyrou on (08) 6436 1599.

For and on behalf of GBGMAPS PTY LTD

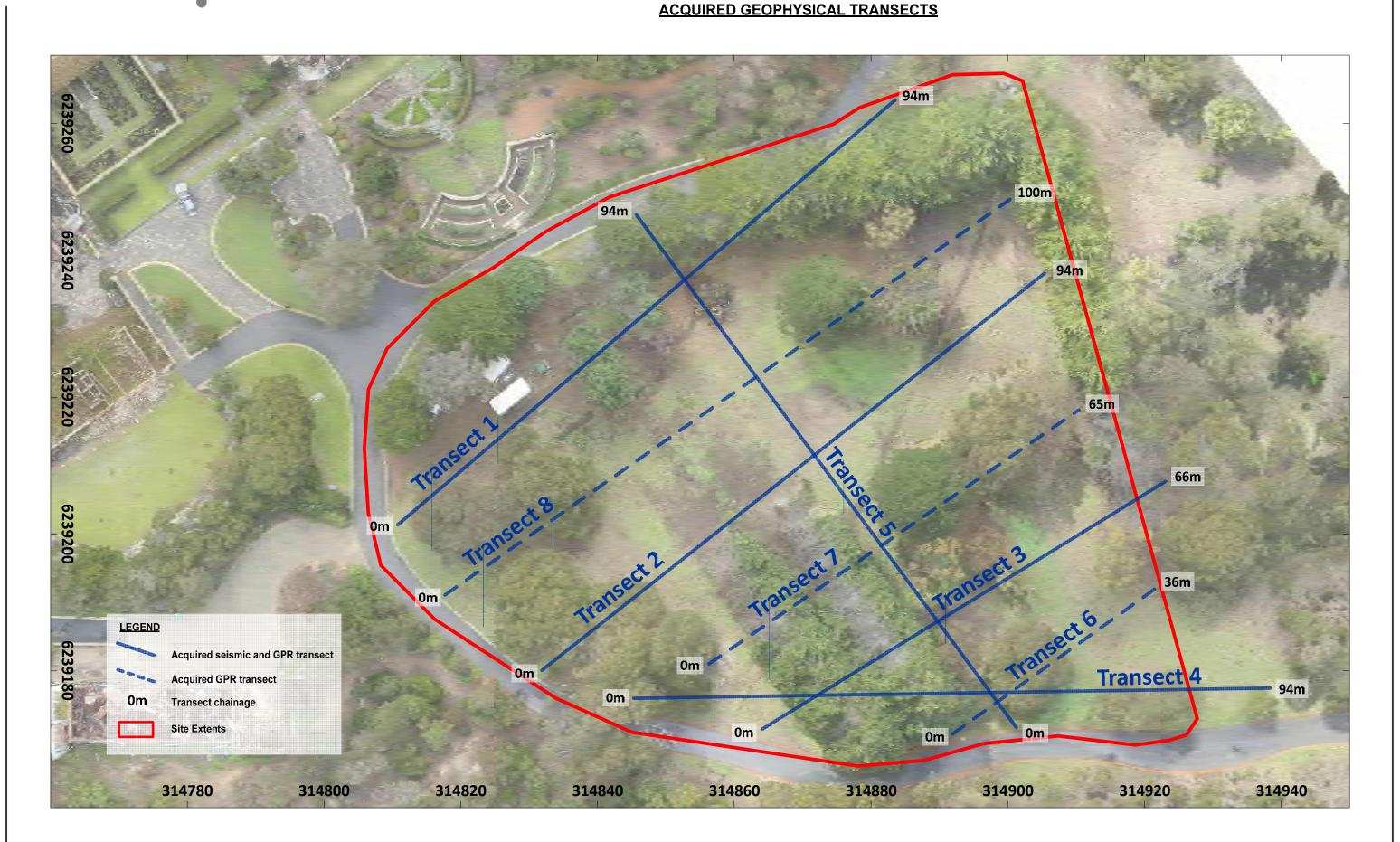




APPENDIX A - RESULT DRAWINGS



752 WALLCLIFFE ROAD, MARGARET RIVER WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION





21 Sep 2020

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Paper Size

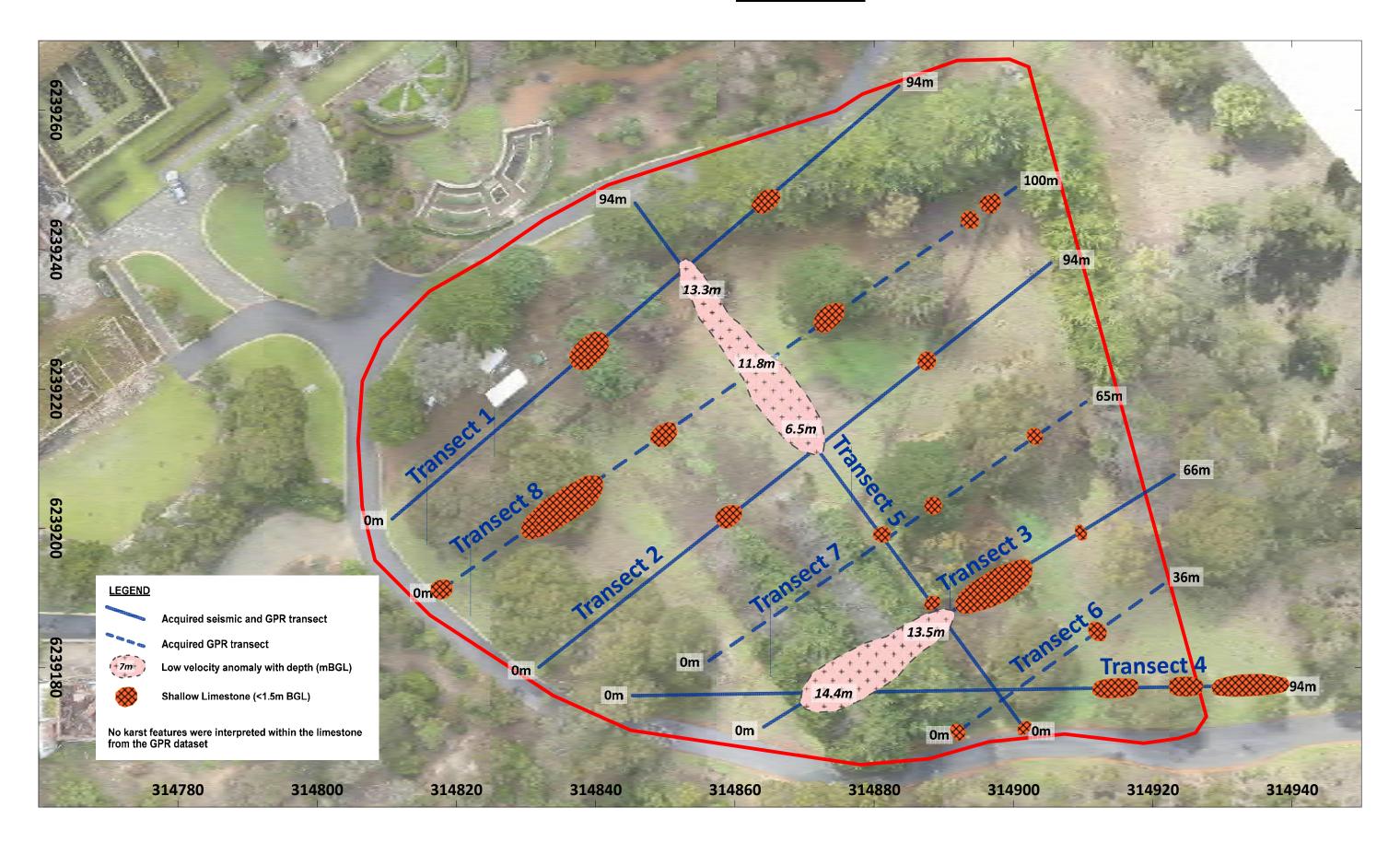
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Revision

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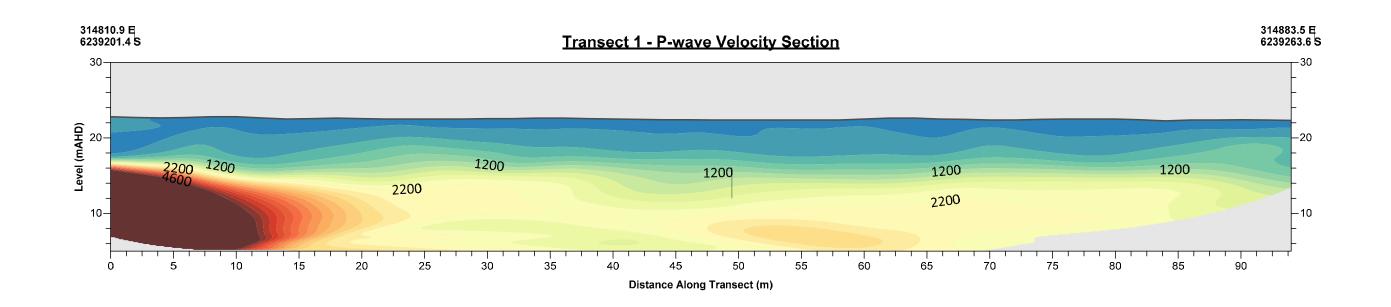
752 WALLCLIFFE ROAD, MARGARET RIVER WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION <u>INTERPRETATION</u>







WALLCLIFFE HOUSE MARGARET RIVER, WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION SEISMIC REFRACTION P-WAVE MODELS



LEGEND

SAND - LOW TO MODERATE COMPACTION P-WAVE VELOCITY 200-700 m/s

LIMESTONE - LOW TO MODERATE ROCK STRENGTH
P-WAVE VELOCITY 700-1200 m/s



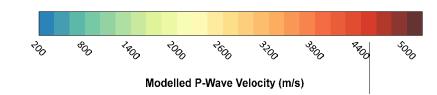
LIMESTONE - MODERATE ROCK STRENGTH P-WAVE VELOCITY 1200-4600 m/s GRANITE - HIGH ROCK STRENGTH P-WAVE VELOCITY >4600 m/s

CLIENT



DOUGLAS PARTNERS

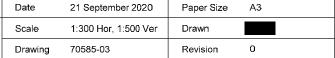
REDUCED VELOCITY REGION - INTERPRETED LOW STRENGTH MATERIAL



NOTES

Drawing to be used in conjunction with Report 70585. Aerial Imagery: MNG Survey, flown May 2020 Map Projection: GDA94 MGA50 Elevation: mAHD

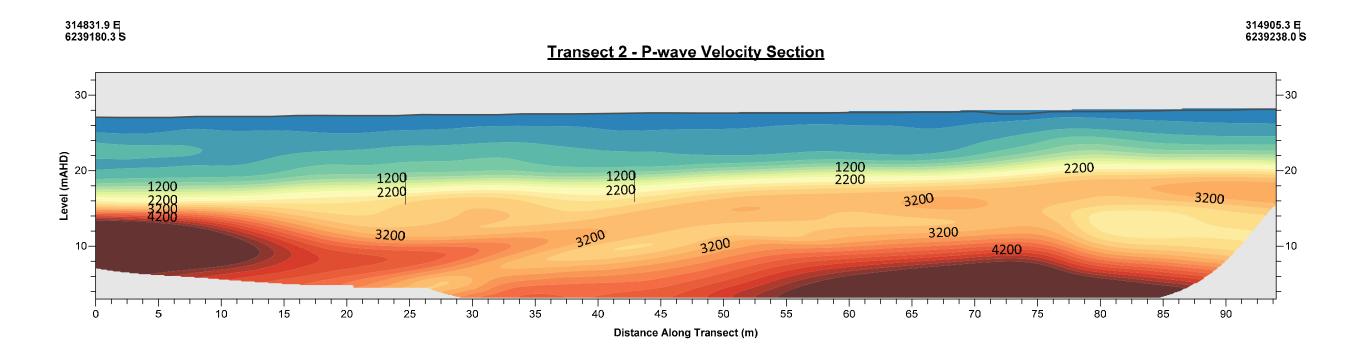
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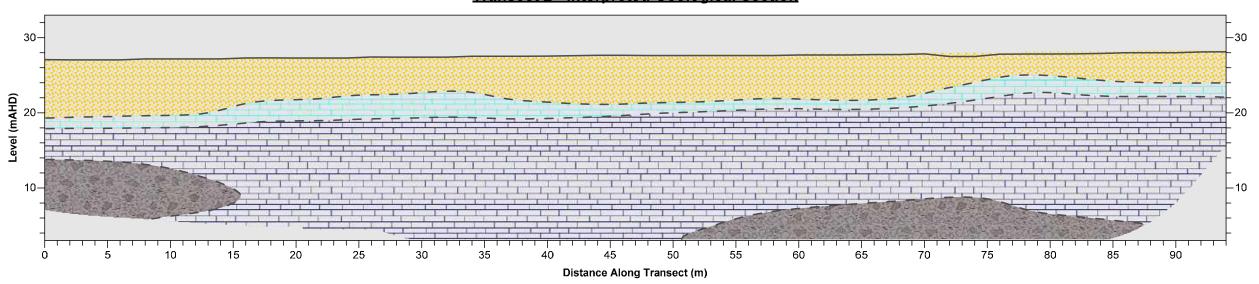




WALLCLIFFE HOUSE MARGARET RIVER, WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION SEISMIC REFRACTION P-WAVE MODELS



Transect 2 - Interpreted Geological Section



LEGEND



SAND - LOW TO MODERATE COMPACTION P-WAVE VELOCITY 200-700 m/s

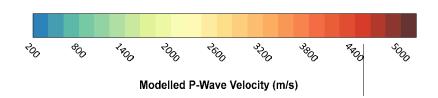
LIMESTONE - LOW TO MODERATE ROCK STRENGTH P-WAVE VELOCITY 700-1200 m/s

LIMESTONE - MODERATE ROCK STRENGTH P-WAVE VELOCITY 1200-4600 m/s GRANITE - HIGH ROCK STRENGTH P-WAVE VELOCITY >4600 m/s

CLIENT



REDUCED VELOCITY REGION - INTERPRETED LOW STRENGTH MATERIAL

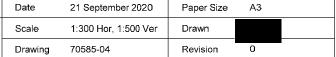


NOTES

Drawing to be used in conjunction with Report 70585. Aerial Imagery: MNG Survey, flown May 2020 Map Projection: GDA94 MGA50 Elevation: mAHD

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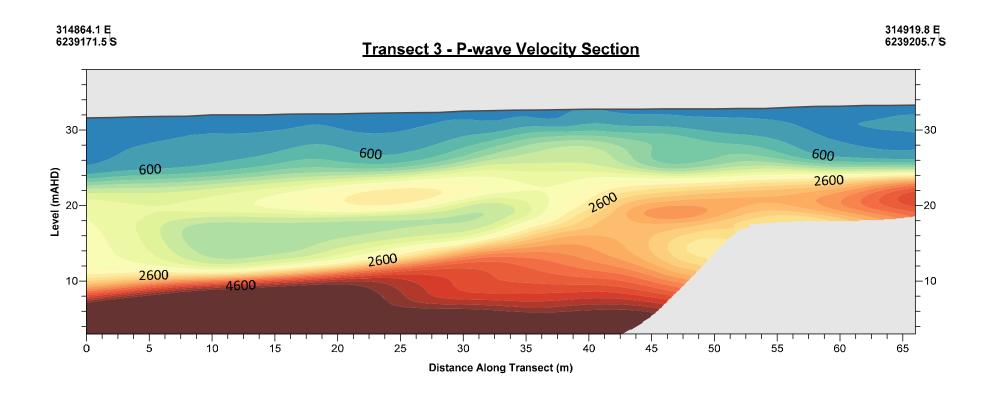
DOUGLAS PARTNERS



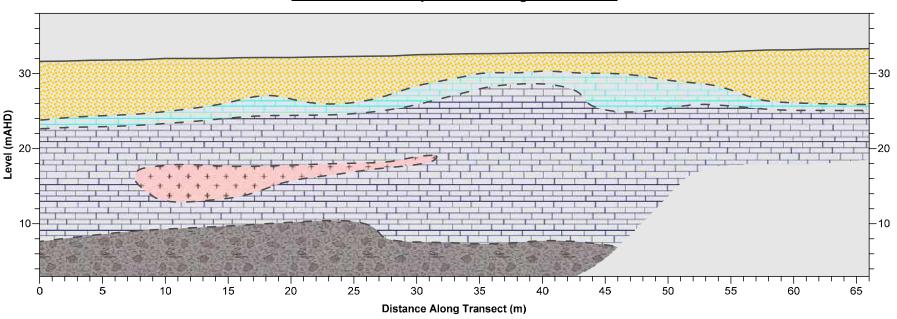




WALLCLIFFE HOUSE MARGARET RIVER, WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION **SEISMIC REFRACTION P-WAVE MODELS**



Transect 3 - Interpreted Geological Section



LEGEND



SAND - LOW TO MODERATE COMPACTION P-WAVE VELOCITY 200-700 m/s



LIMESTONE - LOW TO MODERATE ROCK STRENGTH P-WAVE VELOCITY 700-1200 m/s



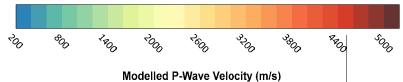
LIMESTONE - MODERATE ROCK STRENGTH P-WAVE VELOCITY 1200-4600 m/s GRANITE - HIGH ROCK STRENGTH P-WAVE VELOCITY >4600 m/s

CLIENT



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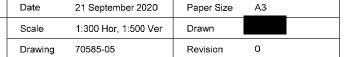
REDUCED VELOCITY REGION - INTERPRETED LOW



<u>NOTES</u>

Drawing to be used in conjunction with Report 70585. Aerial Imagery: MNG Survey, flown May 2020 Map Projection: GDA94 MGA50 Elevation: mAHD

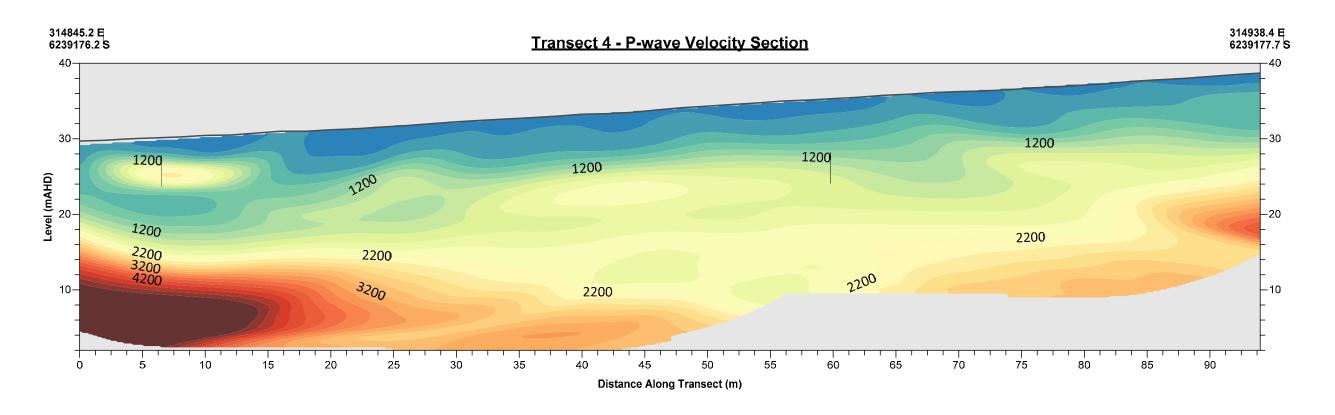
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AUSTRALIA - GEOPHYSICAL INVESTIGATION

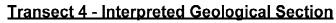


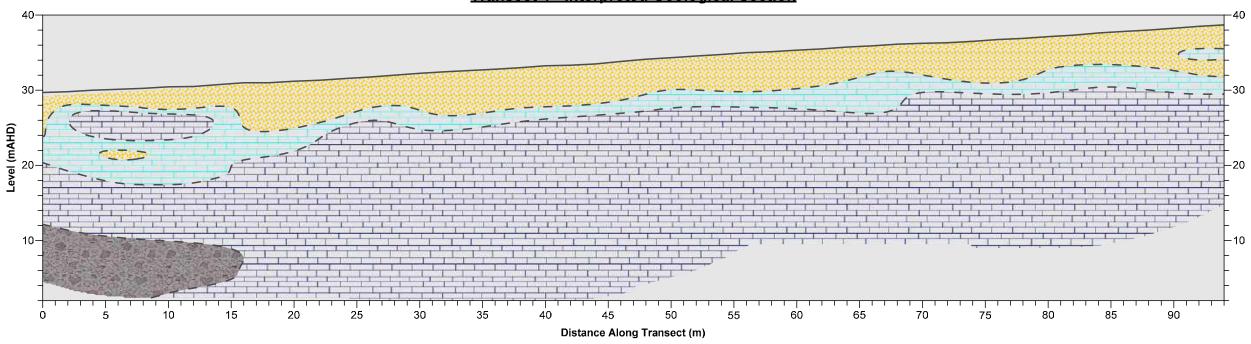




WALLCLIFFE HOUSE MARGARET RIVER, WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION SEISMIC REFRACTION P-WAVE MODELS







LEGEND



SAND - LOW TO MODERATE COMPACTION P-WAVE VELOCITY 200-700 m/s

LIMESTONE - LOW TO MODERATE ROCK STRENGTH P-WAVE VELOCITY 700-1200 m/s

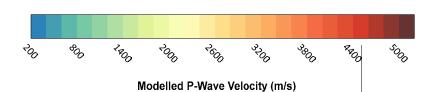


LIMESTONE - MODERATE ROCK STRENGTH P-WAVE VELOCITY 1200-4600 m/s GRANITE - HIGH ROCK STRENGTH P-WAVE VELOCITY >4600 m/s

CLIENT



REDUCED VELOCITY REGION - INTERPRETED LOW STRENGTH MATERIAL



NOTES

Drawing to be used in conjunction with Report 70585. Aerial Imagery: MNG Survey, flown May 2020 Map Projection: GDA94 MGA50 Elevation: mAHD

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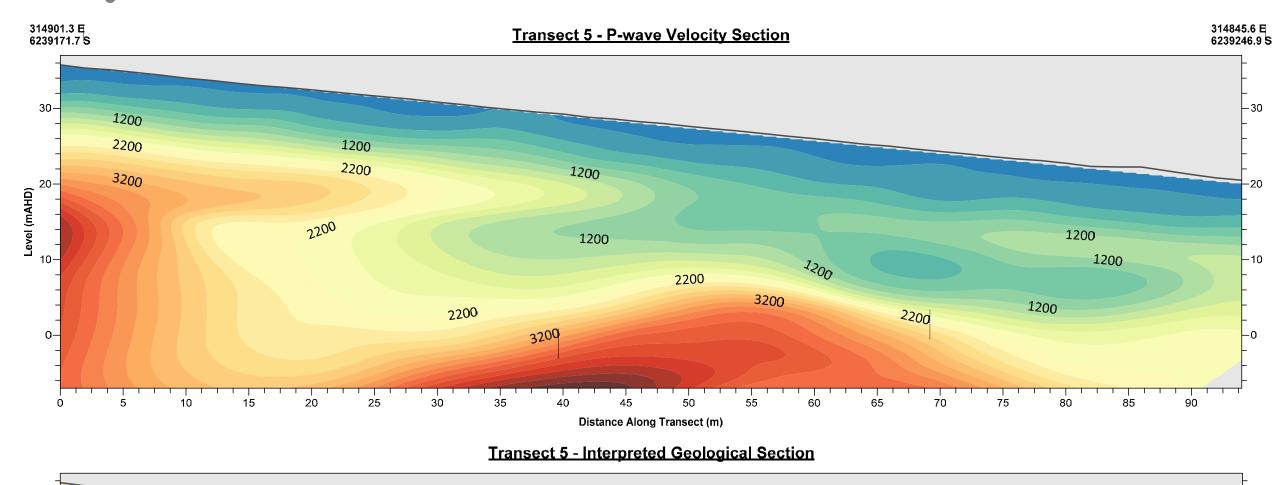
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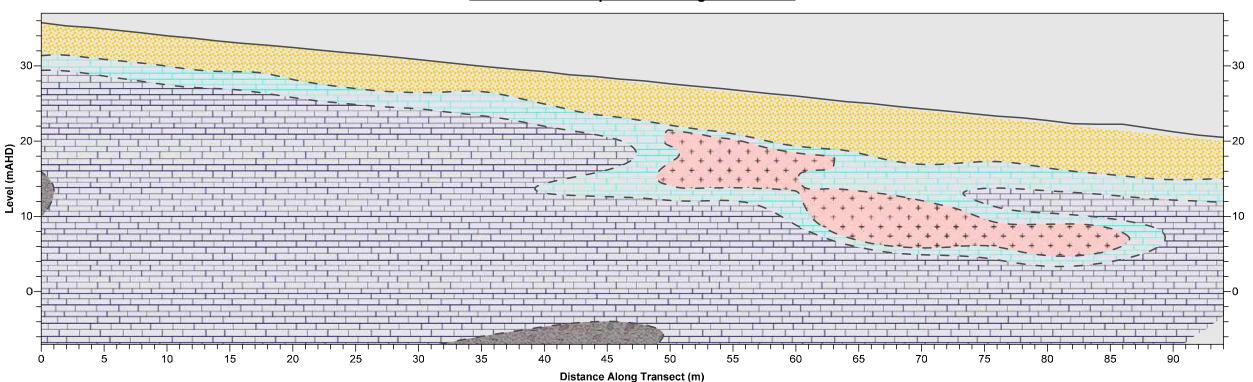
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WALLCLIFFE HOUSE MARGARET RIVER, WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION SEISMIC REFRACTION P-WAVE MODELS





LEGEND

SAND - LOW TO MODERATE COMPACTION
P-WAVE VELOCITY 200-700 m/s

LIMESTONE - LOW TO MODERATE ROCK STRENGTH
P-WAVE VELOCITY 700-1200 m/s

LIMESTONE - MODERATE ROCK STRENGTH P-WAVE VELOCITY 1200-4600 m/s GRANITE - HIGH ROCK STRENGTH P-WAVE VELOCITY >4600 m/s

CLIENT



REDUCED VELOCITY REGION - INTERPRETED LOW STRENGTH MATERIAL

<u>NOTES</u>

Drawing to be used in conjunction with Report 70585. Aerial Imagery: MNG Survey, flown May 2020 Map Projection: GDA94 MGA50 Elevation: mAHD

WALLCLIFFE HOUSE MARGARET RIVER, WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION

DOUGLAS PARTNERS

 Date
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 Paper Size
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 Scale
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 Drawn

 Drawing
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 Revision
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APPENDIX B - GEOPHYSICAL METHODS

SEISMIC REFRACTION



APPLICATIONS

- √ Bedrock mapping
- ✓ Mapping weathered zones
- ✓ Stratigraphic mapping
- ✓ Indicative material hardness for piling, tunnelling and excavation works
- ✓ Identification of fault / fractured zones

METHOD

The Seismic Refraction method involves the measurement of travel times of seismic compressional waves (P-waves) that are generated at the surface, propagate through the subsurface and return to the surface after being refracted at the interface between layers of contrasting seismic velocity. Seismic wave velocities are controlled by the fundamental parameters of elastic strength and density of the material it propagates through.

For near surface investigations seismic energy is generated on the surface using a sledge hammer. More powerful sources such as accelerated drop weight, down-hole airguns, or explosives are required for deeper investigations. The generated seismic waves propagate through the subsurface at a certain velocity. On reaching a geological boundary marked by an increase in seismic velocity, at a specific angle the wave is critically refracted and travels along the top of the lower layer at a greater velocity. This generates head waves in the upper layer which return to the surface where it is detected as vibrations by a linear array of geophones spaced at regular intervals.

By measuring the travel times of these refracted waves from multiple source points to multiple receivers, the seismic refraction method can resolve lateral changes in the depth to the top of a refracting interface as well as the seismic velocity within it. Furthermore being related to elastic strength and density, the velocities calculated from a seismic refraction survey can be a useful guide to the rippability of a rock for excavation.

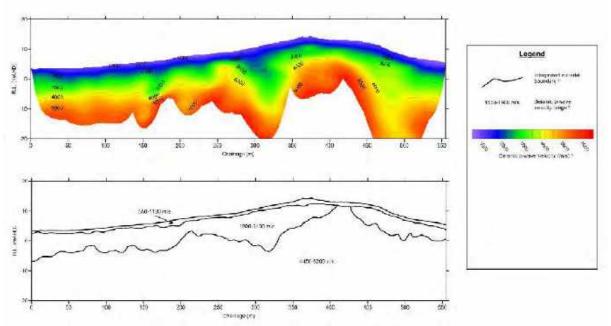




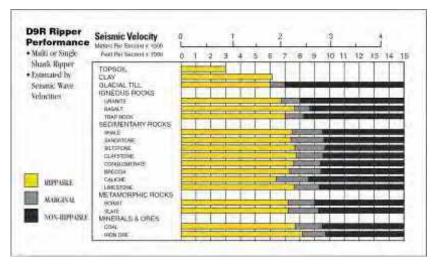
DATA ANALYSIS & PRESENTATION

Processing and analysing seismic refraction data can be carried out using a layered model assuming distinct refractive boundaries or tomographic approach assuming a gradual increase in seismic velocity with depth. Both approaches have benefits and are typically carried out in unison to generate the most detailed geological model possible.

The output is a cross-section showing lateral changes in the depth to the various refracting interfaces and the seismic velocities within them. When correlated with core logs, this information can be related to geological boundaries in the subsurface. This can be particularly useful for planning excavation with the depth to the different layers giving an idea of quantity of rock needed to be removed and the seismic velocities giving an idea of the rock's hardness and hence rippability.



Modelled seismic p-wave velocity section (top) and corresponding layer model section (bottom)



Rippability chart, displays the relationship between rippability and P-wave velocity, taken from Handbook of Ripping, Twelfth Edition, Caterpillar Inc. 2000.

MULTI-CHANNEL ANALYSIS OF SURFACE WAVES



APPLICATIONS

- ✓ Bedrock mapping
- ✓ Degree of sediment compaction
- ✓ Determination of geotechnical parameters (e.g. shear modulus)
- ✓ Void detection
- ✓ Liquefaction potential
- ✓ Subsurface profiling
- √ Imaging velocity inversions (hard layer overlying softer layer)

METHOD

The Multi-channel Analysis of Surface Waves method (MASW) is a non-destructive seismic method which uses the elastic properties of subsurface materials to determine subsurface structure. By analysis of the dispersive properties of varying frequencies from a single seismic source, shear-wave velocity (Vs) and associated geotechnical parameters can be determined.

MASW uses an active seismic source such as a hammer or weight drop impact to produce seismic energy consisting predominantly of Pressure (P-) waves and Shear (S-) waves. MASW uses the S-wave dispersion component to provide information on the shear velocity to a depth determined by frequency range of the energy source and array configuration.

Seismic surface waves have dispersion properties that traditionally utilized body waves lack. Differing wavelengths/frequencies have different depth of penetration, and therefore propagates with different phase velocity, with an increase in wavelength being proportional to increased depth of penetration. As the surface wave is the dominant wave generated from any seismic source, MASW data quality (signal to noise) tends to be higher than other seismic methods such as seismic reflection or refraction.

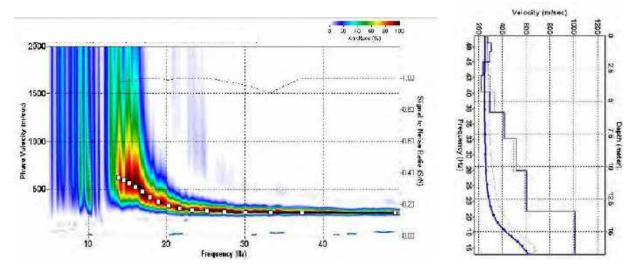


MULTI-CHANNEL ANALYSIS OF SURFACE WAVES

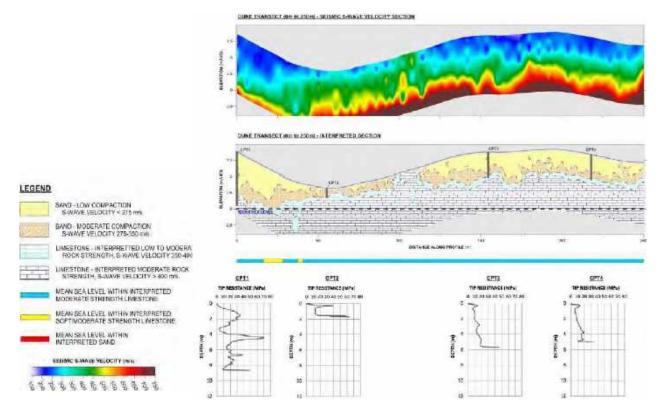


DATA ANALYSIS & PRESENTATION

Analysis of the collected MASW seismic records is concentrated on the S-wave dispersion component. Dispersion curves are extracted for each collected record from the overtone image showing the percentage intensity of phase velocity versus frequency. These curves are then inverted to produce 1D S-wave soundings typically to a depth of up to 30 m. The calculated 1D soundings can then be compiled and gridded to produce 2D sections showing the variation in S-wave velocity both laterally along the profile and with depth.



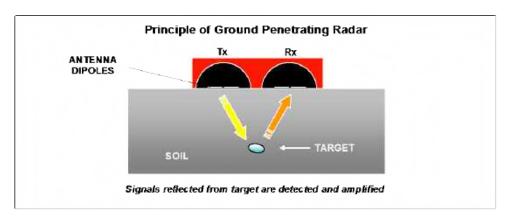
Dispersion curve generated from an MASW sounding (left image), modelled S-wave velocity sounding generated from inversion of the picked dispersion curve



MASW seismic S-wave 2D velocity section with interpretation.

GBGMAPS Pty Ltd Page 2



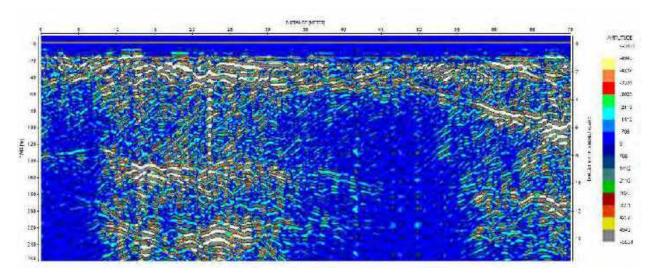


Schematic illustration of the principle behind ground penetrating radar

DATA ANALYSIS & PRESENTATION

A radar-gram profile is built up of continuous scans along a selected line path, see below. These are 2D cross-sections of the subsurface showing variations in reflection amplitude as a colour scale. The recorded reflections can be analysed in terms of shape, phase, travel time and signal amplitude to provide information about a target's size, depth and orientation in relation to the material around it.

The depth of investigation achievable with the GPR method is largely a function of the antenna frequency used. Lower frequencies in the order of 100 MHz are typically used for geological mapping to a maximum depth of approximately 20 m, whilst high frequencies in the order of 1 GHz are used for high resolution investigations of structures including building, bridges and tunnels.



Processed GPR cross-section imaging a karst formation illustrated by the variations in the radar-wave reflection amplitudes. This enables the detailed analysis of voids or caves within limestone bedrock.

GBGMAPS Pty Ltd Page 2

GROUND PENETRATING RADAR



APPLICATIONS

- ✓ Stratigraphic mapping including depth to bedrock
- ✓ Locating karst features, sinkholes, voids or cave systems
- ✓ Depth to water table
- ✓ Archaeology (location of graves and artifacts)
- ✓ Location of underground infrastructure, including UST's and utilities
- ✓ Assessment of internal condition and defects of engineered structures
- ✓ Assessment of road and rail infrastructure, including asphalt and ballast condition
- ✓ Slab thickness, reinforcement placement and void detection

METHOD

Ground Penetrating Radar (GPR) is a non-destructive and non-invasive geophysical technique for rapidly imaging the shallow subsurface and producing high-resolution colour sections in real time. The method works by transmitting electromagnetic energy into the material being tested (most usual the ground). Typically 100,000 impulses per second are transmitted which are of very short duration and contain a wide spectrum of frequencies.

The transmitted electromagnetic energy propagates through the subsurface as a function of the subsurface material's electrical properties, which are in turn dependent on its physical and chemical properties. Reflection of radar energy occurs at boundaries between differing stratigraphic layers or inclusions which have contrasting electrical properties. Conversely, no reflections occur from a homogenous material where there are no internal reflectors. The reflections are detected by the receiving antenna placed adjacent to the transmitter. The depth to the target is proportional to the time (in nanoseconds) taken for the signal to travel from the transmitting antenna at the surface to the target and back to the receiver.



GBGMAPS Pty Ltd Page 1

Appendix F

Results of the Douglas Partners 2022 Field Work

CLIENT: Wallcliffe House Pty Ltd

Proposed Wallcliffe House Re-development PROJECT: 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 15.0 AHD

EASTING: 314784 **NORTHING**: 6239213

PIT No: 1 **PROJECT No:** 96717.02

DATE: 24-1-2022 SHEET 1 OF 1

			Description	ي		Sam	pling &	& In Situ Testing						
묍	De (r	epth m)	of	Graphic Log	e d	ath	ple	Results &	Water	Dyi	namic l (blow	Penetro s per 1	meter ⁻ 50mm)	Γest
9	٠,	.,	Strata	Ō	Туре	Depth	Sample	Results & Comments	>					20
-		0.35	FILL/SAND SP: fine to medium grained, dark grey-brown, trace silt, moist, medium dense, covered with grass. - becoming yellow-brown from 0.1 m depth.									<u> </u>		
41	- 1	0.8 0.9	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace limestone cobbles and gravel, moist, medium dense. Residual Soil, Spearwood System.									<u>:</u>	<u>:</u>	:
· ·			LIMESTONE: fine to medium grained, pale yellow, medium to high strength, dry to moist. Spearwood System.											
3	-2		Pit discontinued at 0.9m (Hard digging, refusal on limestone rock)											
	- 2													
12	- 3													
7	-4													
·														
														<u>:</u>

RIG: 14 tonne excavator, 1000 mm toothed bucket LOGGED: GG WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING & IN SITU TESTING LEGEND A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level

LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

SURVEY DATUM: MGA94



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 15.0 AHD PIT No: 2

EASTING: 314766 **PROJECT No:** 96717.02 **NORTHING**: 6239200 **DATE:** 24-1-2022 SHEET 1 OF 1

			Description	.je		Sam		& In Situ Testing		Dynamic Penetrometer Test
씸		epth m)	of	Graphic Log	Type	Depth	Sample	Results & Comments	Water	(blows per 150mm)
2			Strata	ļ.,			Š	***************************************		5 10 15 20
-		0.6	FILL/SAND SP: fine to medium grained, dark grey-brown, trace silt, moist, medium dense, covered with grass. - becoming yellow-brown and grey from 0.15 m depth.		В	0.5			-	4
- 41	-1	0.8	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace cobbles and gravel, moist, medium dense. Residual Soil, Spearwood System.						-	
			LIMESTONE: fine to medium grained, pale yellow, medium to high strength, dry to moist. Spearwood System.							
13	-2		Pit discontinued at 0.9m (Hard digging, refusal on limestone rock)							
12	3									
	- 4 - 4 									
L	<u> </u>									





RIG: 14 tonne excavator, 1000 mm toothed bucket

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

SURVEY DATUM: MGA94

SAMPLING & IN SITU TESTING LEGEND A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)

LOGGED: GG



CLIENT: Wallcliffe House Pty Ltd

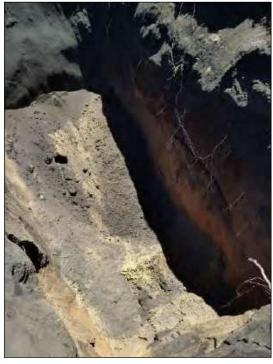
PROJECT: Proposed Wallcliffe House Re-development **LOCATION:** 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 13.0 AHD **PIT No:** 3

EASTING: 314753 **PROJECT No**: 96717.02 **NORTHING**: 6239218 **DATE**: 24-1-2022

SHEET 1 OF 1

Depth of Strata FILL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace gravel, moist, dense. PVC pipe fragments and rubber pieces observed in the fill. SAND SP-SM: fine to medium grained, brown, with silt, trace limestone cobbles and gravel from 1.5 m depth, moist, medium dense. Residual Soil, Spearwood System. Pit discontinued at 2.0m (Hard digging, refusal on limestone rock) Pit discontinued at 2.0m (Hard digging, refusal on limestone rock)	Б "	Description	je _		Sam		& In Situ Testing		Dumor	nia Danatr	omotor	Toot
FILL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace gravel, moist, dense. PVC pipe fragments and rubber pieces observed in the fill. SAND SP-SM: fine to medium grained, brown, with silt, trace limestone cobbles and gravel from 1.5 m depth, moist, medium dense. Residual Soil, Spearwood System. Pit discontinued at 2.0m (Hard digging, refusal on	Depth (m)		Graphic Log	Туре	Depth	ample	Results & Comments	Water		olows per	150mm)	
SAND SP-SM: fine to medium grained, brown, with silt, trace limestone cobbles and gravel from 1.5 m depth, moist, medium dense. Residual Soil, Spearwood System.	-	FILL/SAND SP-SM: fine to medium grained, dark			1	<u></u>				: : : : : : : :		20
Pit discontinued at 2.0m (Hard digging, refusal on	_ 0.85 - - 1 - - - - - - -	trace limestone cobbles and gravel from 1.5 m depth,							-1 -1 			
	-2 2.0 -								2			
-Ø -4	-3											
	-4 -4 											





RIG: 14 tonne excavator, 1000 mm toothed bucket LOGGED: GG SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
B Bulk sample
B Bulk sample
B Bulk Slock sample
C Core drilling
D D isturbed sample
E Environmental sample
W Water sample
W Water seep
Water level

LEGEND
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)

Sand Penetrometer AS1289.6.3.3□ Cone Penetrometer AS1289.6.3.2



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development **LOCATION:** 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 23.0 AHD PIT No: 4

EASTING: 314887 **NORTHING:** 6239262

PROJECT No: 96717.02

DATE: 25-1-2022 **SHEET** 1 OF 1

	Description	ic		Sam	pling &	& In Situ Testing	L	_			
Depth (m)	of	Graphic Log	e e	Ę	ple	Results &	Water	Dynam (bl	iic Pene lows pe	etromet r 150m	er Test m)
(111)	Strata	ტ_	Туре	Depth	Sample	Results & Comments	>	5	10	15	20
0.3	FILL/Gravelly SAND SP-SM: fine to medium grained, dark grey-brown and grey-brown, fine to coarse sized, with silt, dry to moist, very dense. FILL/Gravelly Clayey SAND SC: fine to medium grained, red-brown, fine to coarse sized, low plasticity, dry to moist.										
-1	red-brown, fine to coarse sized, low plasticity, dry to moist. FILL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace gravel, moist. Pit discontinued at 0.6m (Hard digging, refusal on limestone rock)										
-2											
.3											
-4											





RIG: 14 tonne excavator, 1000 mm toothed bucket LOGGED: GG SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

✓ Sand Penetrometer AS1289.6.3.3✓ Cone Penetrometer AS1289.6.3.2

		SAMPLING	I & IN SITU TESTING	L
Α	Auger sample	G	Gas sample	F
В	Bulk sample	Р	Piston sample	F
BLK	Block sample	U.	Tube sample (x mm dia.)	F

P Piston sample
U_x Tube sample (x mm
W Water sample
D Water seep

LEGEND
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 10.0 AHD **PIT No**: 5

EASTING: 314755 **NORTHING**: 6239256 **PROJECT No:** 96717.02 **DATE:** 24-1-2022

SHEET 1 OF 1

			Description	.ie		Sam		& In Situ Testing	_	David David Tab
RL		Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
31	-1	_	FILL/SAND SP-SM: fine to medium grained, dark grey-brown and grey-brown, with silt, trace gravel, moist, medium dense to dense. Brick pieces, concrete tiles observed within the fill. SAND SP-SM: fine to medium grained, brown, with silt, moist, medium dense. Residual Soil, Spearwood System becoming orange-brown, trace silt from 0.9 m depth.		D D	1.0				
	-3		Pit discontinued at 3.0m (Target depth)		—D—	-3.0-				3





RIG: 14 tonne excavator, 1000 mm toothed bucket

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

SURVEY DATUM: MGA94

SAMPLING & IN SITU TESTING LEGEND A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)

LOGGED: GG



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development LOCATION: 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 10.0 AHD **PIT No**: 6

EASTING: 314738 **PROJECT No:** 96717.02 **NORTHING**: 6239247 **DATE:** 24-1-2022 SHEET 1 OF 1

	_		Description	ji _		Sam		& In Situ Testing	_	Dynamic Penetrometer Test
R	Dep (m)		of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	(blows per 150mm)
10	-1	1.5	FILL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace gravel, moist, medium dense. Glass, brick pieces observed within the fill, PVC pipe fragments observed at 1.3 m depth.		D	1.0				
	- - - 2	2.2	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace gravel, moist, medium dense. Possibly fill. SAND SP-SM: fine to medium grained, brown, with silt,							-2 4 -1
	-3	3.0-	moist. Residual Soil, Spearwood System. Pit discontinued at 3.0m (Target depth)							3
9	-4 -4									
	•									





LOGGED: GG RIG: 14 tonne excavator, 1000 mm toothed bucket **SURVEY DATUM: MGA94**

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample

LEGENU
PilD Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development **LOCATION:** 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 21.5 AHD **PIT No:** 7

EASTING: 314792 **PROJECT No**: 96717.02 **NORTHING**: 6239173 **DATE**: 24-1-2022 **SHEET** 1 OF 1

		Description	.ie		Sam		& In Situ Testing		Domania Danatana da Tari
-	Depth (m)	Strata	Graphic	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
	0.3 0.5	FILL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace gravel, moist, dense to very dense. Concrete tiles, building materials observed within the fill.							4
	1	SAND SP: fine to medium grained, yellow-brown, trace limestone cobbles, gravel and silt, moist, very dense. Residual Soil, Spearwood System.							
-		LIMESTONE: fine to medium grained, pale yellow, medium to high strength, dry to moist. Spearwood System.							
	2	Pit discontinued at 0.6m (Hard digging, refusal on limestone rock)							
-	3								
-									
-	4								
-									





RIG: 14 tonne excavator, 1000 mm toothed bucket LOGGED: GG SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

survey plan provided by the client.

Sand Penetrometer AS1289.6.3.3

Cone Penetrometer AS1289.6.3.2

A Auger sample G G G as sample PILO Photo io
B Bulk sample P Piston sample PL(A) Point lo
BLK Block sample U_x Tube sample (x mm dia.)
C Core drilling W Water sample
D Disturbed sample P Water seep S Standa
E Environmental sample W Water level V Shear W

LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development **LOCATION:** 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 21.8 AHD **EASTING**: 314795

NORTHING: 6239193 DIP/AZIMUTH: 90°/-- **BORE No**: 8

PROJECT No: 96717.02 **DATE:** 25-1-2022

SHEET 1 OF 1

П		Description	o		Sam	pling 8	& In Situ Testing		
묍	Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.2	FILL/SAND SP-SM: fine to medium grained, dark grey-brown and grey-brown, with silt, trace gravel, moist, very dense.				O)			<u> </u>
21	0.6-	SAND SP-SM: fine to medium grained, dark grey-brown, trace limestone cobbles, gravel and silt, moist, medium dense to dense. Residual Soil, Spearwood System. - becoming yellow-brown from 0.4 m depth.	1. 7.5.						
		Bore discontinued at 0.6m (Hard digging, refusal on inferred limestone rock)							
50-	-2								
19	-3								
18	-4								

RIG: hand auger DRILLER: GG LOGGED: GG

TYPE OF BORING: 110 mm diameter hand auger borehole **WATER OBSERVATIONS:** No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

☑ Sand Penetrometer AS1289.6.3.3☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

LECEND
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)



CASING:

CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development LOCATION: 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 28.1 AHD

EASTING: 314818 **NORTHING**: 6239167 **PIT No**: 9 **PROJECT No:** 96717.02

DATE: 24-1-2022 SHEET 1 OF 1

П			Description	.e			Sam		& In Situ Testing	Ţ	-	D	-:- D		-4 T4
묍	Dep (m		of Strata	Graphic	Log	lype	Depth	Sample	Results & Comments			Dynar (k	nic Pen blows p	er 150	eter Test mm)
28	. (0.15	FILL/TOPSOIL: SAND SP-SM: fine to medium grained, dark grey-brown and grey-brown, with silt and rootlets, moist, medium dense.	(X) 	X ::			•			-	1			
27	- - - - 1		SAND SP-SM: fine to medium grained, dark grey-brown, with silt, moist, medium dense. Residual Soil, Spearwood System.								-1	4			
792	-2		- becoming brown from 1.3 m depth.			D	1.3				-2				
		2.5	- becoming yellow-brown, trace of low to medium strength limestone cobbles and gravel from 2.2 m depth.												
			Pit discontinued at 2.5m (Hard digging, refusal on limestone rock)												
25	- 3														
4	- 4														
2															
H	-	54.78					/QC1	Ne arn		O LEAST	2,50				<u> </u>





LOGGED: GG RIG: 14 tonne excavator, 1000 mm toothed bucket **SURVEY DATUM: MGA94**

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

SAMPLING & IN SITU TESTING LEGEND LEGENU
PilD Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 21.0 AHD **PIT No:** 10

EASTING: 314760 **NORTHING**: 6239173

PROJECT No: 96717.02 **DATE:** 24-1-2022

SHEET 1 OF 1

			Description	ا <u>ن</u> _		Sam		& In Situ Testing	_	D.	namic P	lanati	om oto	r Toot	
묍		Depth (m)	of	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	D)	(blows				
-			Strata	0	Ĺ	Ď	Sar	Comments			5 1	0	15	20	
			FILL/SAND SP-SM: fine to medium grained, yellow-brown and grey-brown, with gravel and silt, dry to moist, very dense. Brick pieces, concrete tiles, wooden planks, building materials, scrap metals observed within the fill.		В	0.1				-					ŀ
20	- - -1	0.75	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace limestone cobbles and gravel, moist. Possible fill.							-1					
	-		LIMESTONE: fine to medium grained, white, medium strength, dry to moist. Spearwood System.												
	-		Pit discontinued at 1.1m (Hard digging, refusal on limestone rock)												
19	-2														
	-														
18	-3														
	-												:		
17	-4												i		
	-														
Н		erio.						l							\dashv





RIG: 14 tonne excavator, 1000 mm toothed bucket LOGGED: GG **SURVEY DATUM: MGA94**

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 32.2 AHD **PIT No:** 11

EASTING: 314906 **PROJECT No:** 96717.02 **NORTHING**: 6239202 **DATE:** 24-1-2022 SHEET 1 OF 1

			Description	ji _		Sam		& In Situ Testing		Dumamia Danatramatar Taat
씸		epth (m)	of	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
			Strata	0	Ĺ	ď	Sar	Comments		5 10 15 20
- 62	-	0.2	FILL/TOPSOIL: SAND SP-SM: fine to medium grained, dark grey-brown, with silt and rootlets, moist, dense.							
-	-1		SAND SP-SM: fine to medium grained, dark grey-brown, with silt, moist, medium dense to dense. Residual Soil, Spearwood System.							
31	-2		- becoming yellow-brown, trace silt from 1.1 m depth.							
-			- trace of low to medium strength limestone cobbles and gravel from 2.2 m depth. - high strength limestone boulder or pinnacle observed on the northern side of the pit from 2.4 m depth.							
- 60	-3	3.0	Pit discontinued at 3.0m (Target depth)			-3.0-				
28	-									





LOGGED: GG RIG: 14 tonne excavator, 1000 mm toothed bucket **SURVEY DATUM: MGA94**

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

SAMPLING & IN SITU TESTING LEGEND LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 32.1 AHD **PIT No:** 12

EASTING: 314888 **PROJECT No:** 96717.02 **NORTHING**: 6239188 **DATE:** 24-1-2022 SHEET 1 OF 1

	_		Description	ji _		Sam		& In Situ Testing	_	D. m	omio D	- n atrana	eter Test	7
씸		epth m)	of	Graphic Log	Туре	Depth	Sample	Results & Comments	Water			per 150		
			Strata	9	7	De	Sar	Comments		5	10	15	20	
32	-	0.15	FILL/TOPSOIL: SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist.	<i>Y)X</i>										
	-		SAND SP-SM: fine to medium grained, dark grey-brown, with silt, medium dense to dense. Residual Soil, Spearwood System.							· · ·				
31	- - 1 -		- limestone boulder observed at 0.9 m depth.							-1 I	٦			
ŀ	-	1.4	- becoming dark brown from 1.2 m depth.											_
	-		Pit discontinued at 1.4m (Hard digging, refusal on limestone rock)								:	<u>:</u>	<u>:</u>	>>
30	-2													
	-													
29	- - -3 -													
	-													
28	- - -4 -									:	:	:		
	-													
	-									i				
H								l				<u>:</u>	:	\dashv





LOGGED: GG RIG: 14 tonne excavator, 1000 mm toothed bucket **SURVEY DATUM: MGA94**

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level

LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development LOCATION: 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 26.3 AHD

EASTING: 314892 **PROJECT No:** 96717.02 **NORTHING**: 6239241

DATE: 25-1-2022 SHEET 1 OF 1

PIT No: 13

		Description	ji.		Sam		& In Situ Testing		Dunamia Danatana tan Tart
귙	Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
26	0.2	FILL/TOPSOIL: SAND SP-SM: fine to medium grained, dark grey-brown, with silt and rootlets, moist, medium dense.	<i>YY</i>						4
	- - - - -1	SAND SP: fine to medium grained, dark grey-brown, trace silt, moist, medium dense to dense. Residual Soil, Spearwood System.		В	0.5				<u></u>
25	· · · · · ·	- becoming yellow-brown, trace silt from 1.2 m depth.							
24	-2 								2 1
	-3 3.0								3
23		Pit discontinued at 3.0m (Target depth)							
	- - -4								
22	• • • •								
					200	Ne i			





RIG: 14 tonne excavator, 1000 mm toothed bucket

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

SURVEY DATUM: MGA94

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

SAMPLING & IN SITU TESTING LEGEND LEGENU
PilD Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)

LOGGED: GG



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development **LOCATION:** 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 27.2 AHD

EASTING: 314882 **NORTHING:** 6239225

PIT No: 14

PROJECT No: 96717.02 **DATE:** 25-1-2022 **SHEET** 1 OF 1

		Description	nic		Sam		& In Situ Testing		D D T
RL	Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
27	0.2	FILL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, dense. Glass, ceramic pieces, plastic cap observed within the fill. SAND SP-SM: fine to medium grained, dark grey-brown, with silt, moist, medium dense. Residual Soil, Spearwood System.							
26	- 1 - - - -	- becoming brown from 1.1 m depth.							
25	- -2 - - - - -	- becoming yellow-brown, trace silt from 1.7 m depth.		D	2.0				
24	-3 3.(- - - -	Pit discontinued at 3.0m (Target depth)	<u> </u>	—D—	-3.0-				3
23	- 4 - 4 								





RIG: 14 tonne excavator, 1000 mm toothed bucket LOGGED: GG SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

☑ Sand Penetrometer AS1289.6.3.3☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

LEGEND
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (KPa)
S Standard penetration test
V Shear vane (KPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 11.0 AHD **EASTING**: 314792

NORTHING: 6239293 **DIP/AZIMUTH:** 90°/--

BORE No: 15

PROJECT No: 96717.02 **DATE:** 25-1-2022 SHEET 1 OF 1

	Б "	Description	ic _		Sam		& In Situ Testing		Dynamic Penetrometer Test
R	Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	(blows per 150mm) 5 10 15 20
11 10 10 10 10 10 10 10 10 10 10 10 10 1	- 0.25	Strata FILL/SAND SP-SM: fine to medium grained, grey-brown, with silt, trace limestone gravel, moist, medium dense. SAND SP-SM: fine to medium grained, dark grey-brown, with silt, moist, medium dense. Residual Soil, Spearwood System. SAND SP: fine to medium grained, brown, trace silt, moist, medium dense to dense. Residual Soil, Spearwood System. Bore discontinued at 3.0m (Target depth)	5	D D	1.0	Sam	Comments		5 10 15 20
	S.							DOMEST / I	MINE (WINDOW)





DRILLER: GG LOGGED: GG CASING: RIG: hand auger

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam

SAMPLING & IN SITU TESTING LEGEND

G Gas sample P Piston sample PL(A) Point load axial test Is(50) (MPa) Ploto in to add aimertal test Is(50) (MPa) Ploto in test Is(50) (MPa) Plot



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 8.0 AHD EASTING: 314836

NORTHING: 6239310 DIP/AZIMUTH: 90°/--

BORE No: 16

PROJECT No: 96717.02 **DATE:** 25-1-2022 SHEET 1 OF 1

	Ι.		Description	ji _		Sam		& In Situ Testing		Dimamia Danatramatar Taat
씸		Depth (m)	of	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
L			Strata	U	ŕ	۵	Sar	Comments		5 10 15 20
-	-	0.3	medium dense. Metal plate, concrete tiles, pieces of ceramic observed within the fill.							
	-1		SAND SP-SM: fine to medium grained, dark grey-brown, with silt, moist, medium dense. Residual Soil, Spearwood System.							
9	-2		- becoming medium dense to dense from 1.8 m depth.							
-	-	3.0	Bore discontinued at 3.0m (Collapsing conditions)							_
. 4	-4									
F	<u>t_</u>									





LOGGED: GG CASING: RIG: hand auger DRILLER: GG

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

SAMPLING & IN SITU TESTING LEGEND

G Cas sample
P Piston sample
U, Tube sample (xmm dia.)
W Water sample
W Water seep
S S Standard penetration test
Water level
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 2.8 AHD BORE No: 17 **EASTING**: 314849 **PROJECT No:** 96717.02 **NORTHING**: 6239356

DIP/AZIMUTH: 90°/--

DATE: 25-1-2022 SHEET 1 OF 1

		Description	.ဠ		Sam		& In Situ Testing	ي ا			S4		T/
귐	Depth (m)	Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dyr 5	(blows	Penetro s per 1	meter 50mm 15	1 est) 20
	- 0. -	0.1 FILL/TOPSOIL: SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace gravel, moist, medium dense. Possibly fill.	$\mathcal{M}X$					_	-				
,	- - - 1	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace gravel, moist, medium dense. Possibly fill. - becoming grey-brown, wet, from 0.4 m depth.		D	1.3			25-01-22	- - - -1				
	- 1. -	Bore discontinued at 1.5m (Collapsing conditions)		D	1.0				-				
	-2 -												
	-												
	-3 -3												
	-												
	-4												
	- - -												
1	-												





LOGGED: GG CASING: RIG: hand auger DRILLER: GG

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: Groundwater observed at 0.5 m depth.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

G Gas sample
P Piston sample
U Tube sample (x mm dia.)
W Water sample
Water seep
Water



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 2.8 AHD BORE No: 18 **EASTING**: 314848

PROJECT No: 96717.02 **NORTHING**: 6239371 **DATE: 25-1-2022 DIP/AZIMUTH:** 90°/--SHEET 1 OF 1

			DII	/ / /	vio i i	1. 90 /		SHEET I OF I
	Description	. <u>e</u>		Sam		& In Situ Testing	L	
Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
0.3	FILL/TOPSOIL: SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace gravel, moist to wet, medium dense. Possibly fill. SAND SP-SM: fine to medium grained, grey-brown, with silt, trace gravel, wet, medium dense. Possibly fill.	00					25-01-22	
- 1.8 -2	Bore discontinued at 1.8m (Target depth)							
-3								
- 4 								





LOGGED: GG CASING: RIG: hand auger DRILLER: GG

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: Groundwater observed at 0.35 m depth.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

SAMPLING & IN SITU TESTING LEGEND

G Gas sample P Piston sample PL(A) Point load axial test Is(50) (MPa) Ploto in to add aimertal test Is(50) (MPa) Ploto in test Is(50) (MPa) Plot



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 23.5 AHD EASTING: 314901

NORTHING: 6239274 **DIP/AZIMUTH:** 90°/--

BORE No: 19

PROJECT No: 96717.02 **DATE:** 24-1-2022 SHEET 1 OF 1

			Description	i		Sam		& In Situ Testing	_	Dani Bartan ta Tat
RL		Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
3	-	0.5	FILL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt and rootlets, trace gravel, moist, dense. Brick pieces, PACM observed within the fill.							L
2	-	0.5	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, moist, dense. Residual Soil, Spearwood System.							
2	- 1 - -		- becoming grey-brown from 1.0 m depth.							-1 -4
- ``	-		- becoming brown from 1.6 m depth.							
	-2	1.8	Bore discontinued at 1.8m (Hard digging, refusal on inferred limestone rock)							
21	-									
	-3									
20										
	-									
	-4									
. 19	-									
-	-									





LOGGED: GG CASING: RIG: hand auger DRILLER: GG

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

SAMPLING & IN SITU TESTING LEGEND

G Gas sample P Piston sample PL(A) Point load axial test Is(50) (MPa) Ploto in to add aimertal test Is(50) (MPa) Ploto in test Is(50) (MPa) Plot





Douglas Partners Pty Ltd ABN 75 053 980 117 www.douglaspartners.com.au 36 O'Malley Street Osborne Park WA 6017 Phone (08) 9204 3511 Fax (08) 9204 3522

Results of Dynamic Penetrometer Tests

ClientWallcliffe House Pty LtdProject No.96717.02ProjectProposed Redevelopment of Wallcliffe HouseDate25/01/2022Location752 Wallcliffe Road, Margaret River, WAPage No.1 of 1

Location	Z vvalicilli	e Moau, iv	largareti	NVCI, VVA		•	age No.	1 01	•	
Location	20	21	22	23	24	25	26			
Depth (m)				Pe	netration Blows/	Resistar 150 mm	nce			
0.00 – 0.15	-	-	-	-	1	-	-	1	-	-
0.15 – 0.30	2	1	1	2	1	1	3			
0.30 - 0.45	3	3	3	2	1	1	3			
0.45 - 0.60	5	4	4	4	1	3	3			
0.60 - 0.75	5	4	5	5	2	4	3			
0.75 – 0.90	5	5	7	5	2	4	3			
0.90 – 1.05	7	5	6	5	3	5	4			
1.05 – 1.20	9	5	7	5	3	5	5			
1.20 – 1.35	9	5	9	6	5	8	6			
1.35 – 1.50	13	6	10	6	5	8	7			
1.50 – 1.65	16	9	11	7	5	11	7			
1.65 – 1.80	>20	>20	12	7	6	11	7			
1.80 – 1.95			15	8	6	11	12			
1.95 – 2.10			17	>20	6	14	11			
2.10 – 2.25			>20		7	12	11			
2.25 – 2.40					6	17	11			
2.40 – 2.55					6	>20	15			
2.55 – 2.70					6		13			
2.70 – 2.85					6		15			
2.85 – 3.00					6		14			
3.00 – 3.15					6		16			
3.15 – 3.30					5					
3.30 – 3.45					6					
3.45 – 3.60					6					
3.60 – 3.75					7					
3.75 – 3.90					7					
3.90 – 4.05					7					
4.05 – 4.20					6					

Test Method

AS 1289.6.3.2, Cone Penetrometer AS 1289.6.3.3, Sand Penetrometer

 Tested By Checked By

GG SN

CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 16.0 m

COORDINATES: 314777E 6239207N

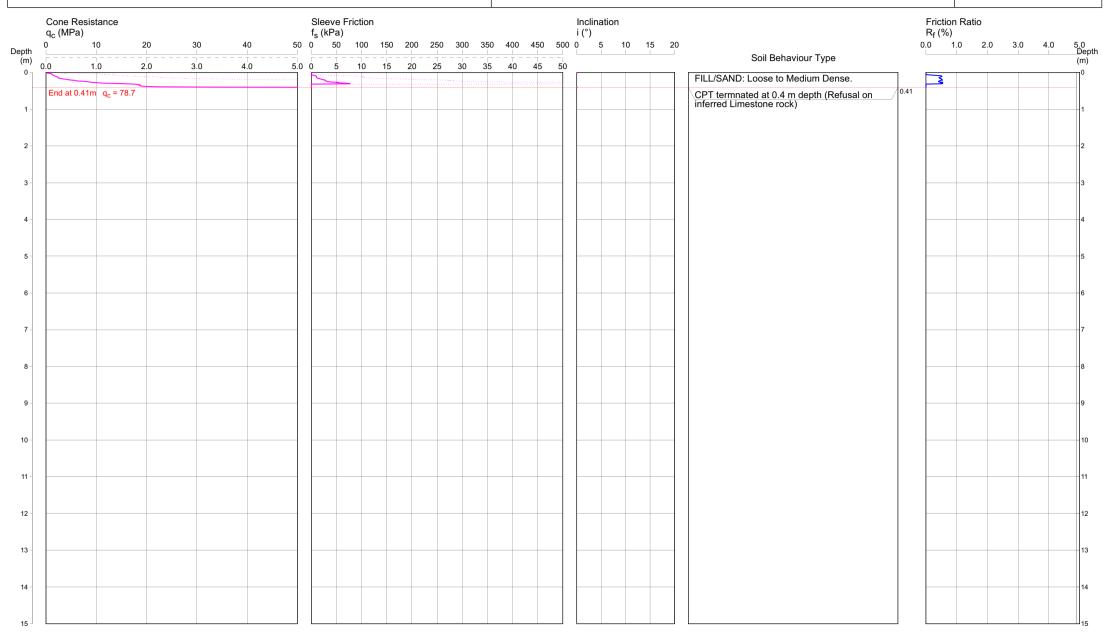
28

DATE

Page 1 of 1

31-01-22

PROJECT No: 96717.02



REMARKS: *Surface level inferred from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\28.CP5
Cone ID: Probedrill
Type: EC28



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 21.3 m

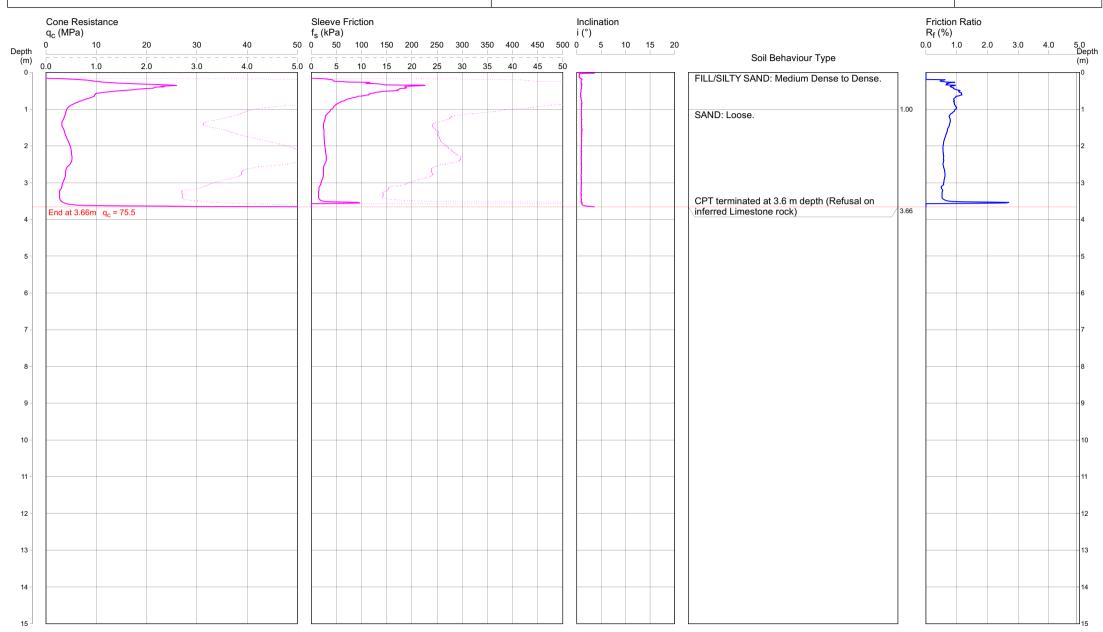
COORDINATES: 314793E 6239201N

29

Page 1 of 1

DATE 31-01-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\29.CP5
Cone ID: Probedrill Type: EC28



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 21.3 m

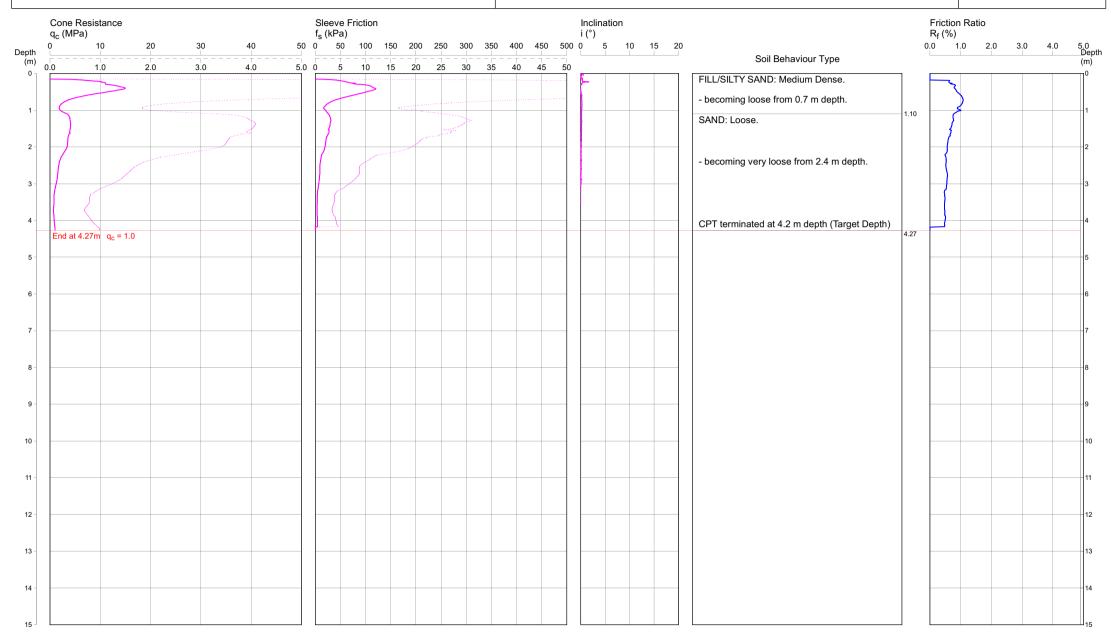
COORDINATES: 314787E 6239194N

30

Page 1 of 1

DATE 31-01-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\30.CP5

Cone ID: Probedrill

Type: EC28



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 25 m

COORDINATES: 314847E 6239213N

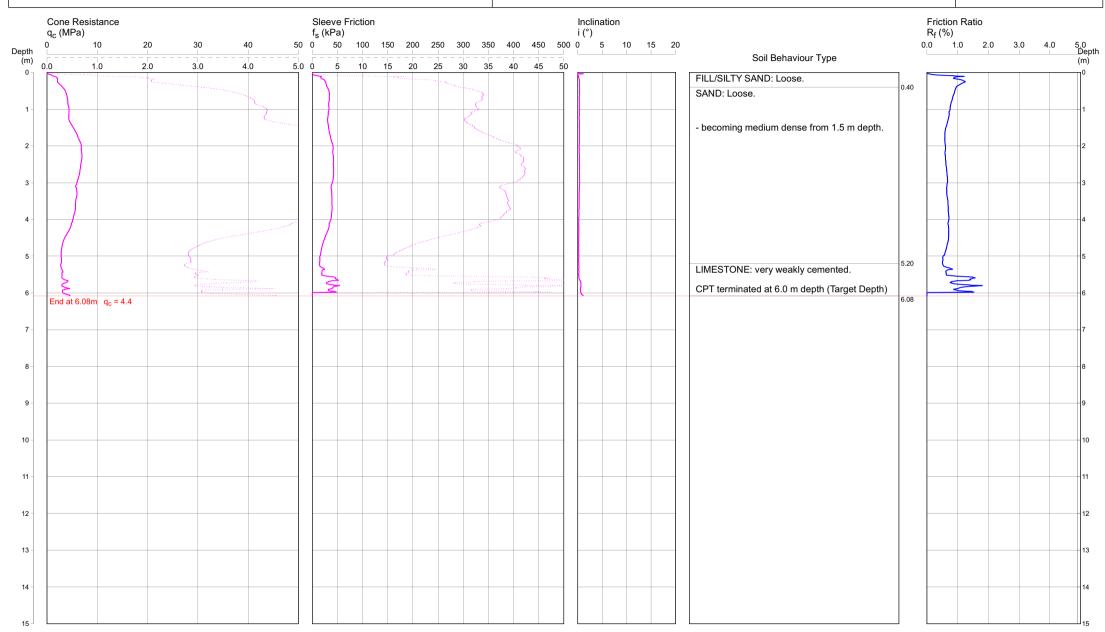
31

Page 1 of 1

DATE

31-01-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\31.CP5

Cone ID: Probedrill

Type: EC28



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 29.3 m

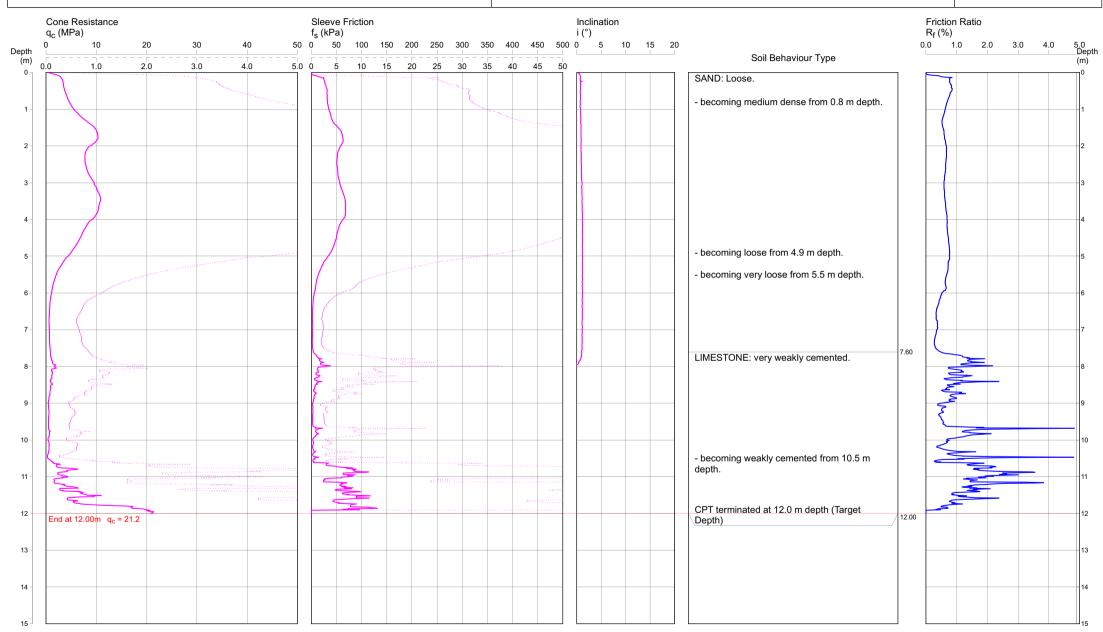
COORDINATES: 314904E 6239228N

32

Page 1 of 1

DATE 31-01-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\32.CP5
Cone ID: Probedrill
Type: EC28



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 28.8 m

COORDINATES: 314874E 6239205N

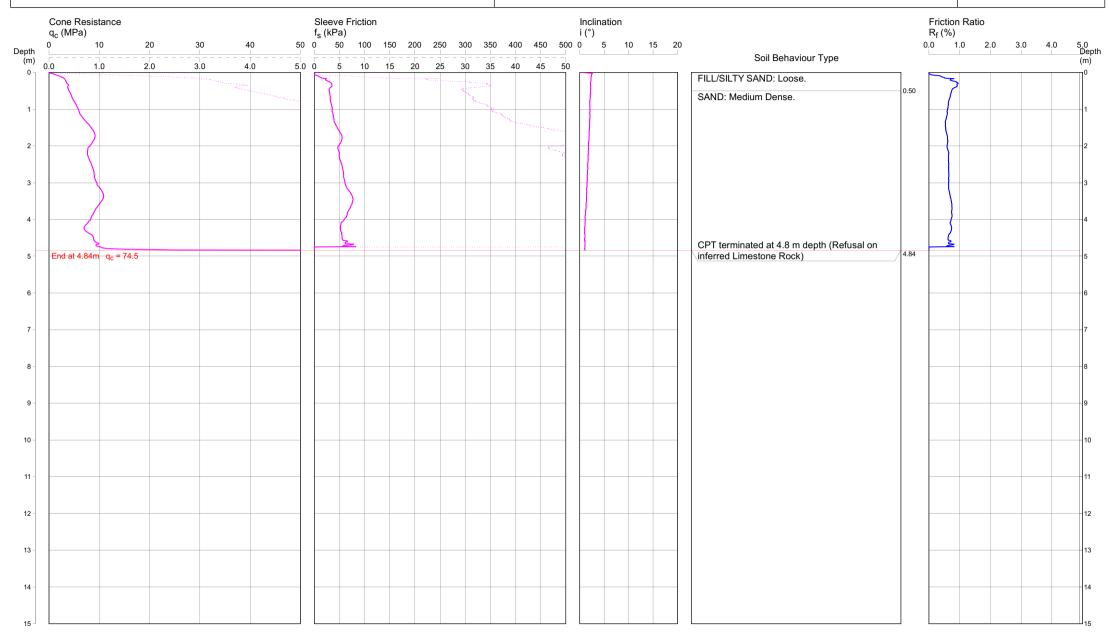
33

Page 1 of 1

DATE

31-01-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\33.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 19.5 m

COORDINATES: 314816E 6239236N

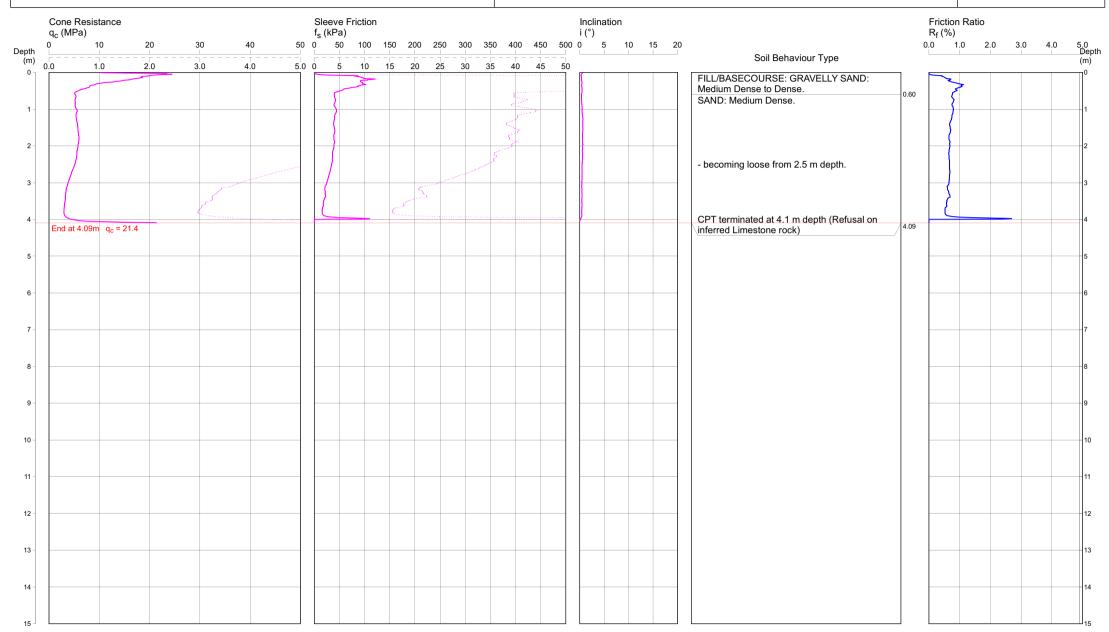
34

Page 1 of 1

DATE

31-01-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\34.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 28.5 m

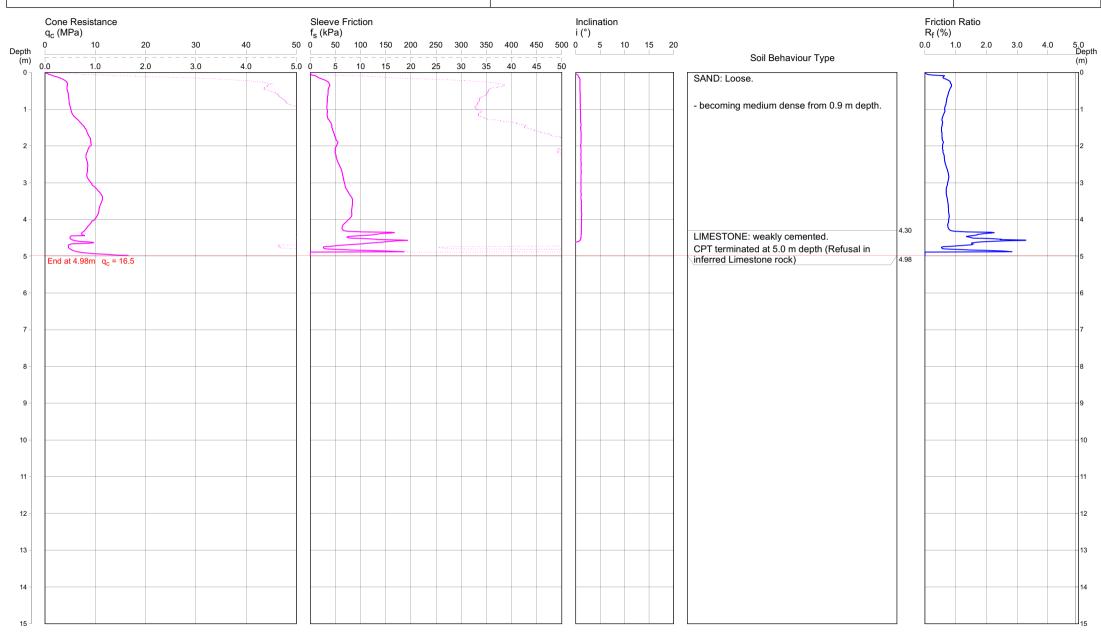
COORDINATES: 314853E 6239190N

35

Page 1 of 1

DATE 31-01-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\35.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 15.5 m

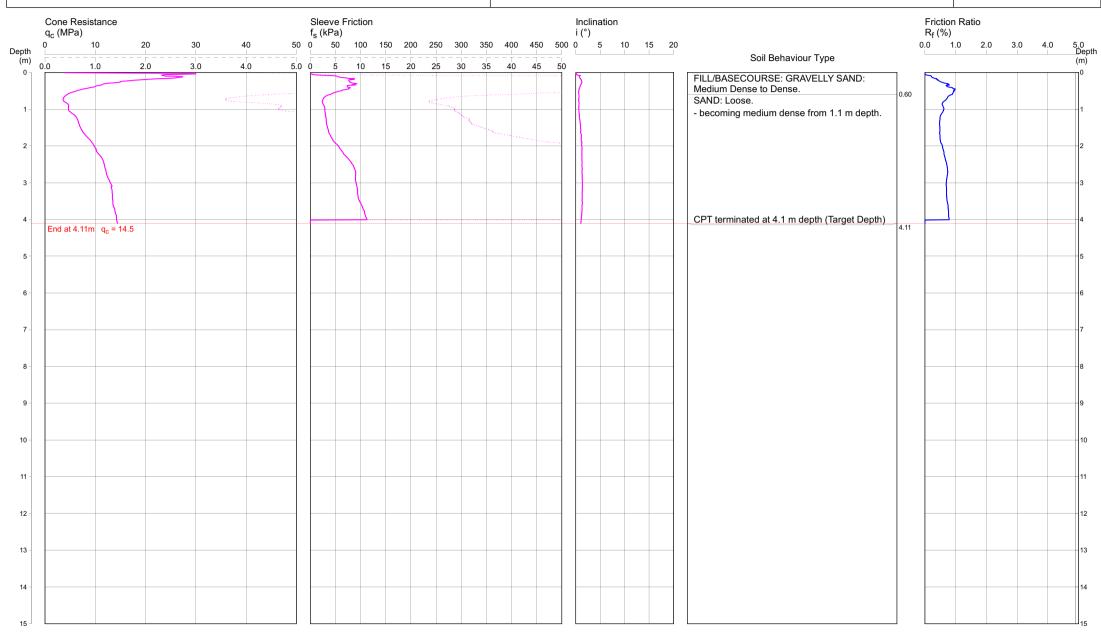
COORDINATES: 314899E 6239342N

36

Page 1 of 1

DATE 31-01-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\36.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 18 m

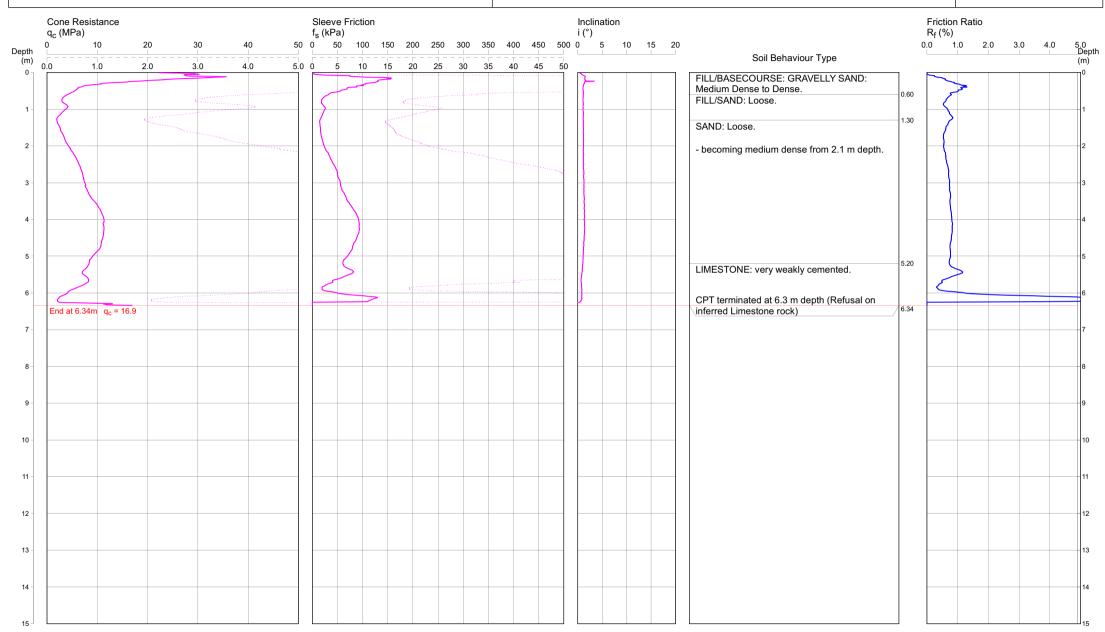
COORDINATES: 314897E 6239317N

37

Page 1 of 1

DATE 31-01-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\37.CP5

Cone ID: Probedrill

Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 6.9 m

COORDINATES: 314771E 6239322N

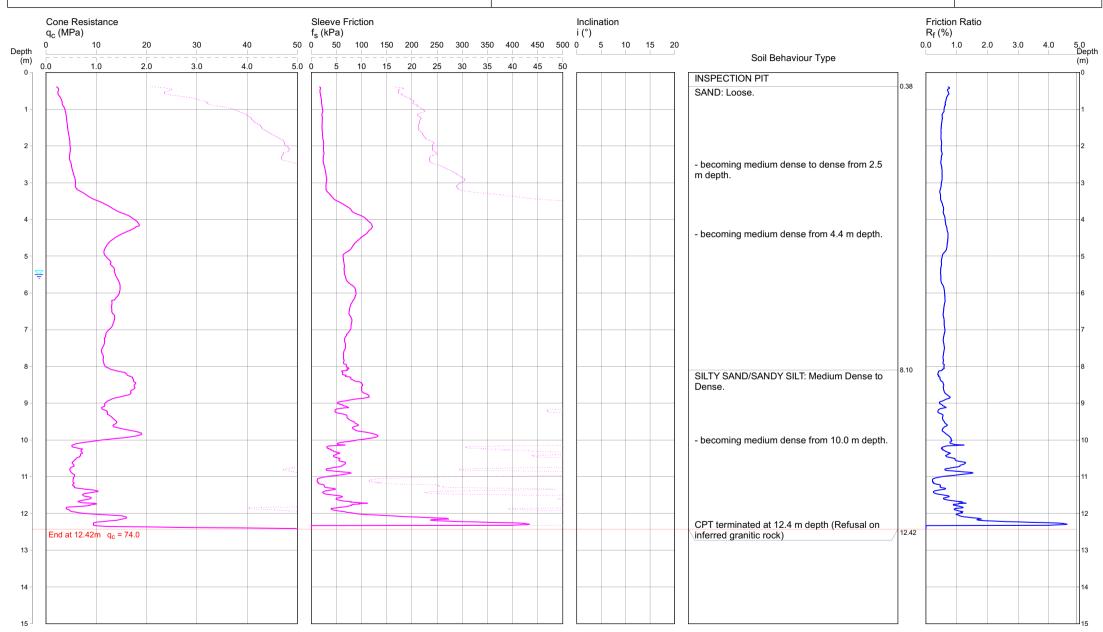
38

Page 1 of 1

DATE

01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\38.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 15.5 m

COORDINATES: 314795E 6239261N

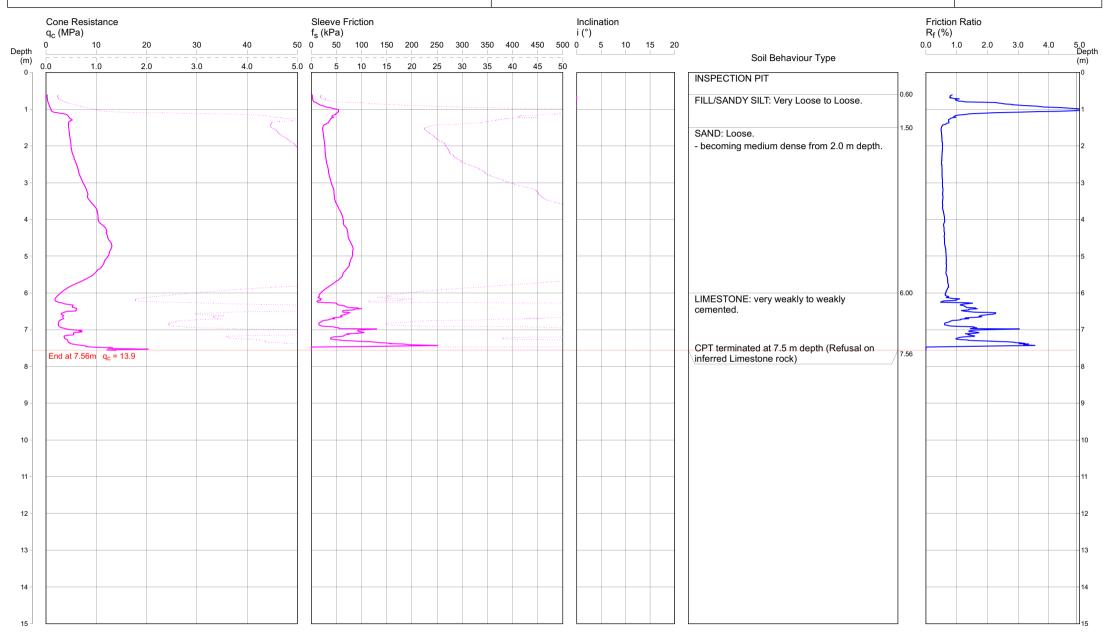
39

Page 1 of 1

DATE

01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\39.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 14.0 m

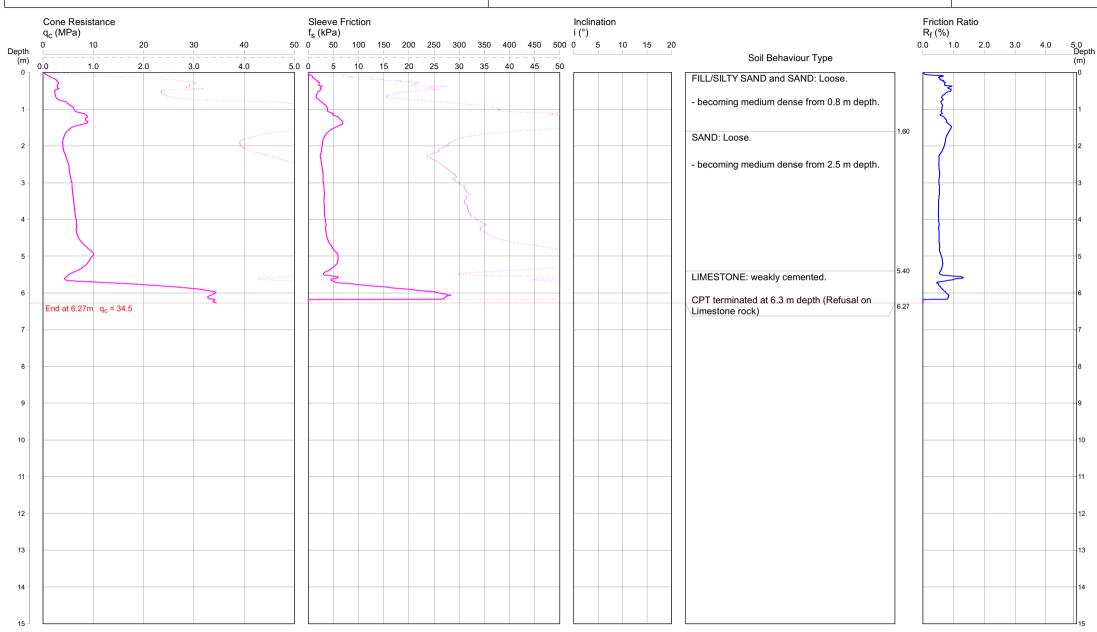
COORDINATES: 314755E 6239237N

40

Page 1 of 1

DATE 01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\40.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 10 m

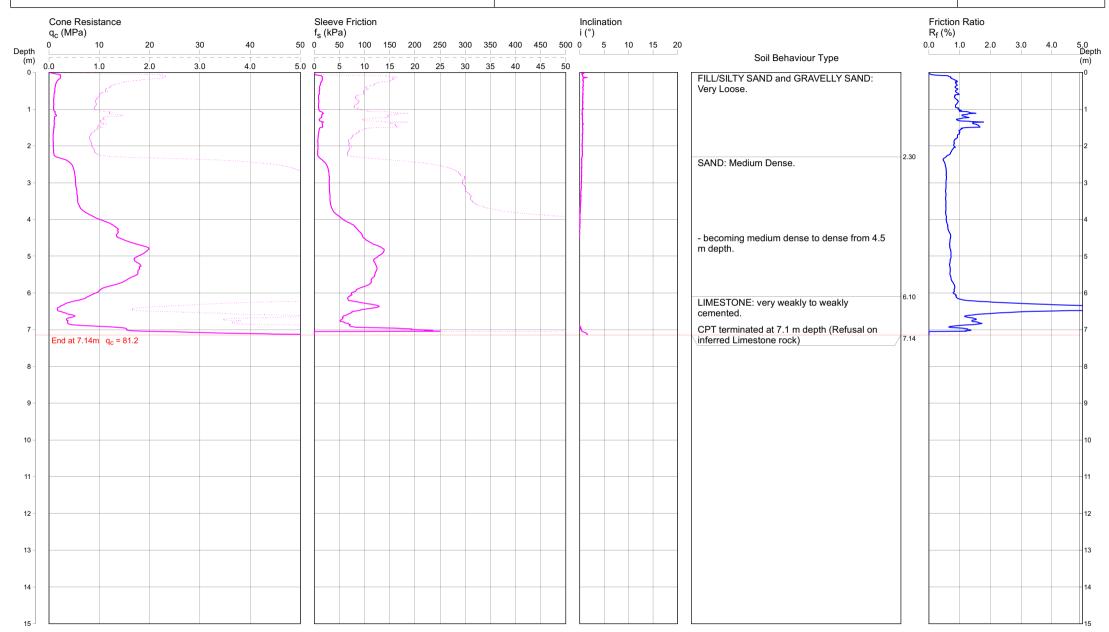
COORDINATES: 314727E 6239236N

41

Page 1 of 1

DATE 01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\41.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 14.2 m

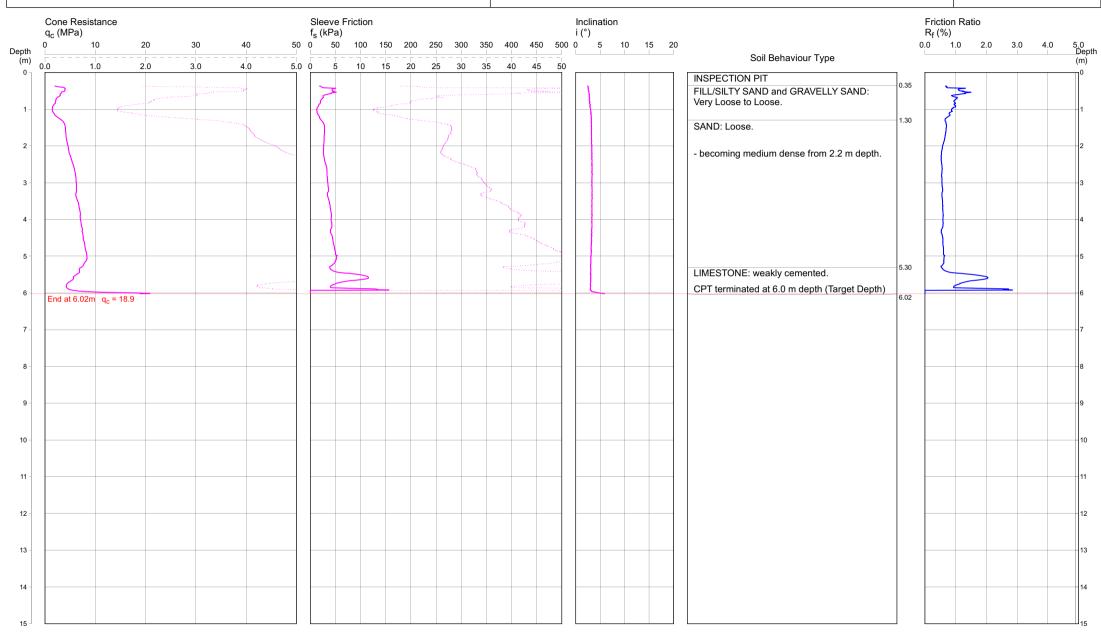
COORDINATES: 314773E 6239248N

42

Page 1 of 1

DATE 01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\42.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 7 m

COORDINATES: 314800E 6239350N

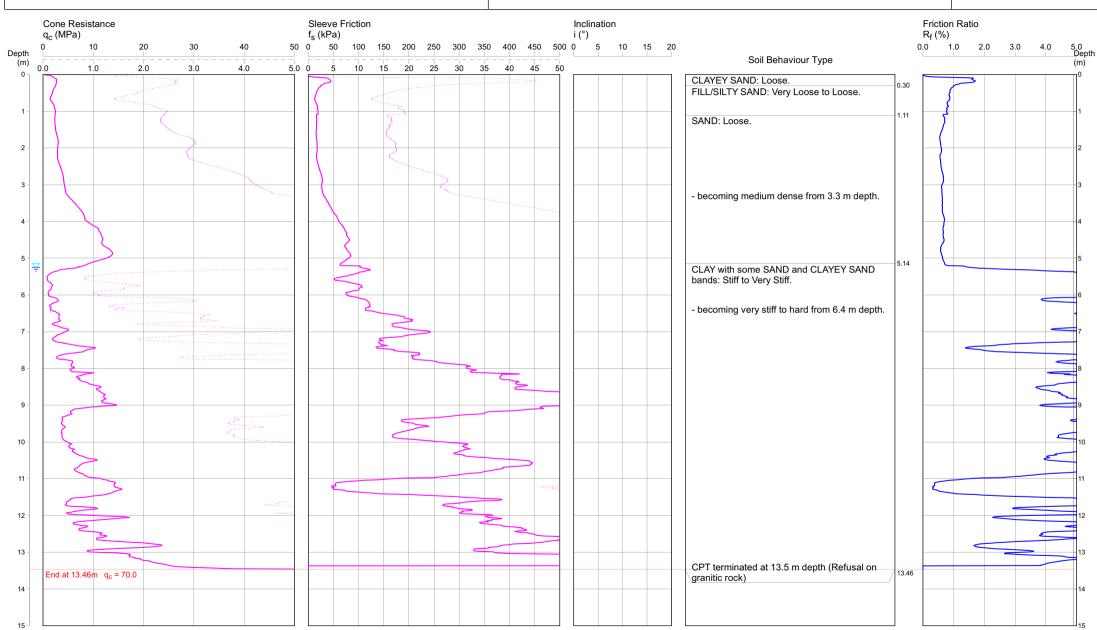
43

Page 1 of 1

DATE

01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\43.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 6.0 m

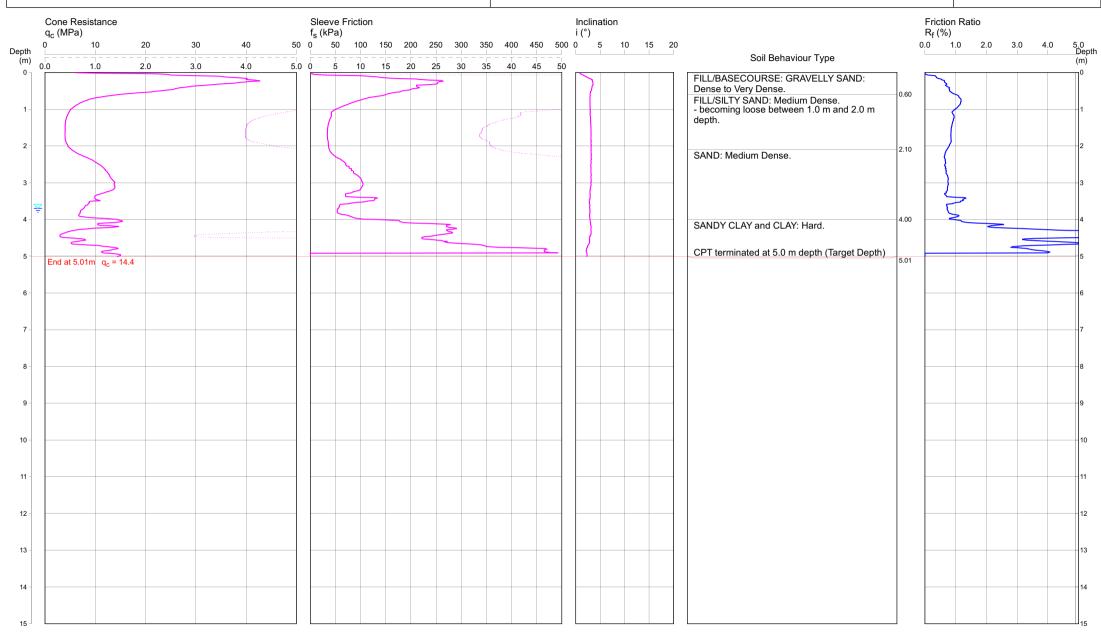
COORDINATES: 314860E 6239390N

44

Page 1 of 1

DATE 01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\44.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 10.8 m

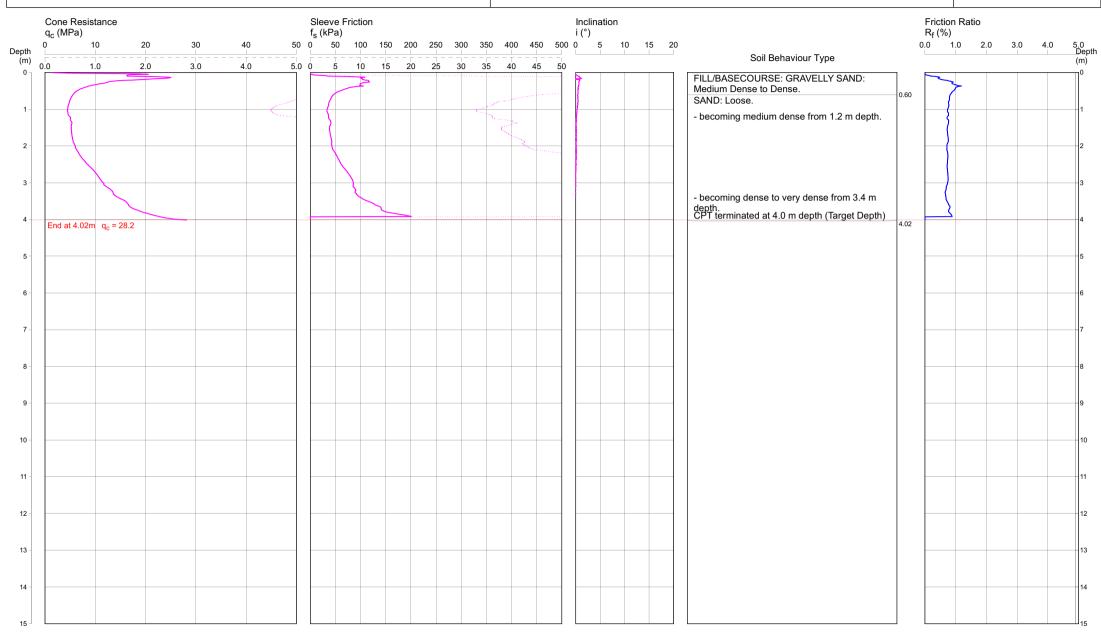
COORDINATES: 314883E 6239378N

45

Page 1 of 1

DATE 01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\45.CP5

Cone ID: Probedrill

Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 7.2 m

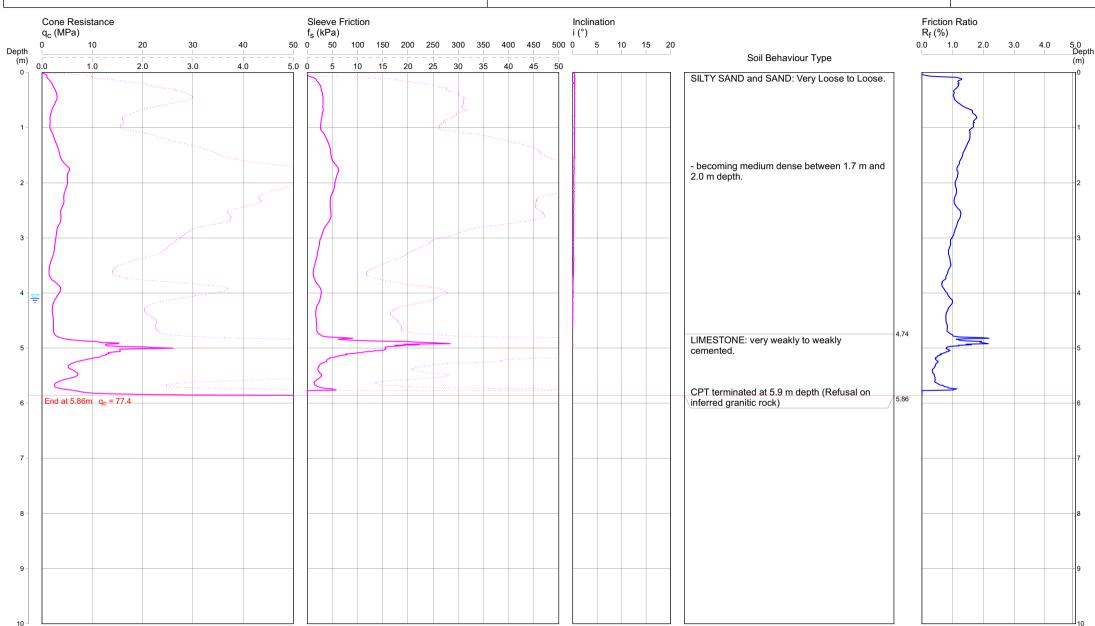
COORDINATES: 314854E 6239320N

46

Page 1 of 1

DATE 01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\46.CP5
Cone ID: Probedrill
Type:

CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 7.5 m

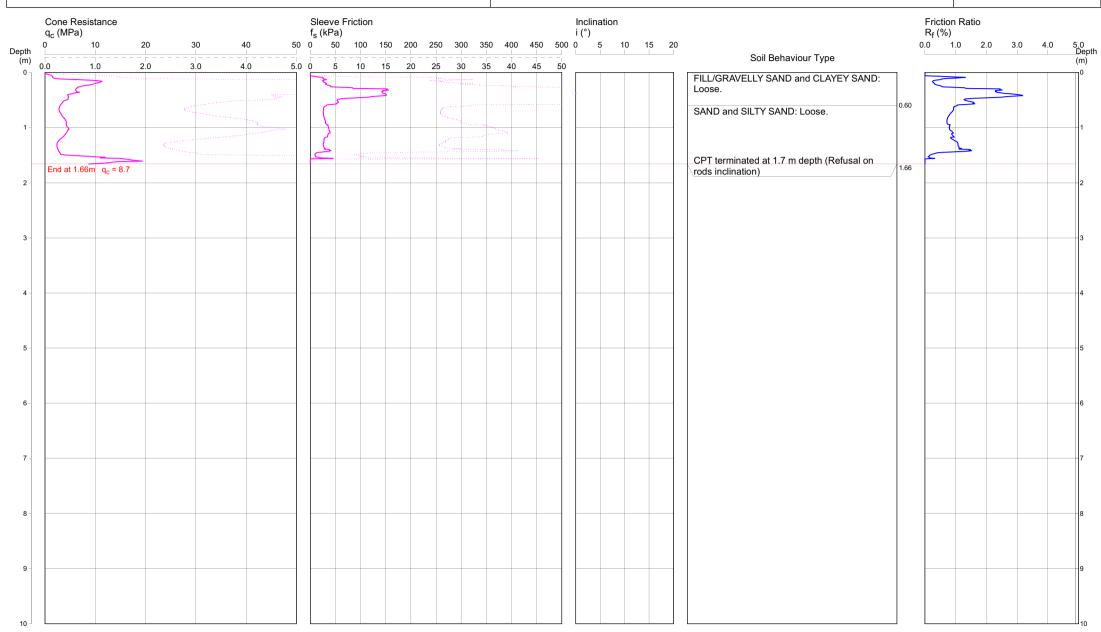
COORDINATES: 314828E 6239320N

47

Page 1 of 1

DATE 01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\47.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 15.5 m

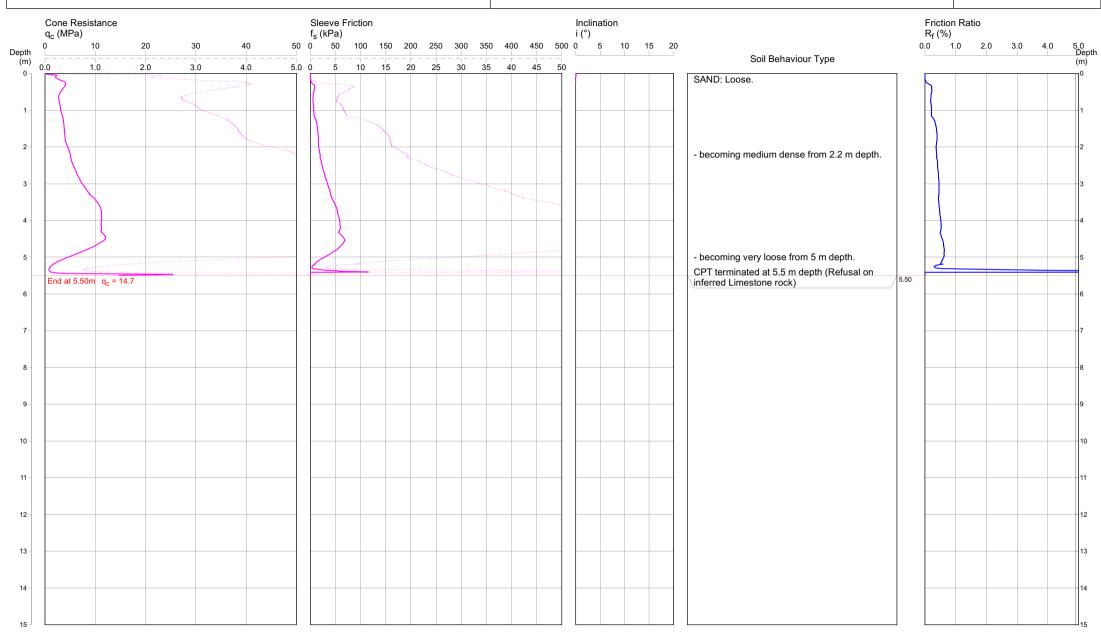
COORDINATES: 314816E 6239275N

48

Page 1 of 1

DATE 01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\48.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 5.5 AHD

EASTING: 314835 **NORTHING**: 6239356

DIP/AZIMUTH: 90°/--

BORE No: 49

PROJECT No: 96717.02

DATE: 2-2-2022 **SHEET** 1 OF 4

		Description	Degree of Weathering .≌	Rock Strength	Fracture	Discontinuities				n Situ Testing
2	Depth (m)	of	Weathering Side of Sid	Strength Nedium High Kery	Spacing (m)	B - Bedding J - Joint	Туре	ore %	RQD %	Test Results &
	` '	Strata	WH W W R H	Kery Very Very Very Very Very Very Very V	0.05 0.10 1.00	S - Shear F - Fault	5	S &	Z °	Comments
6	0.5	FILL/BASECOURSE: Sandy GRAVEL GP-GC: fine to medium sized, orange-brown, fine to coarse grained, with clay (logged from surface) CORE LOSS				0.5m: CORE LOSS: 500mm	С	33		
	1 1.0	Silty SAND SM: fine to medium grained, dark brown, with fine to medium sized gravel. Alluvium.								
4 -	1.5	Silty Gravelly SAND SM: fine to coarse grained, brown, fine sized, low plasticity. Alluvium. SAND SP: fine to coarse grained, propage brown, with gravel, trace cilt.								
-	1.95	orange-brown, with gravel, trace silt, medium dense. Residual Soil, Spearwood System.					S	100		2,4,6 N = 10
	2.75	Croughly SAND SD modium to				1.95m: CORE LOSS: 800mm	С	24		
-	2.85 3	Gravelly SAND SP: medium to coarse grained, orange-brown, fine to medium sized, trace silt. Residual Soil, Spearwood System.								
-		Clayey SAND SC: fine to coarse grained, green-grey, orange, low plasticity, loose. Residual Soil, Leeuwin Complex.		▼ 2.52			S	100		2,3,3 N = 6
1-	4 40						С	52		
-	4 4.0	CORE LOSS				4m: CORE LOSS: 500mm				
	4.5 - 4.85 -	Clayey SAND SC: fine to coarse grained, green-grey, orange, low plasticity, medium dense. Residual Soil, Leeuwin Complex.			 		S	100		4,11,8 N = 19

RIG: Hydrapower Scout Mark V

DRILLER: Precision Drilling

LOGGED: SN

CASING:

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: Groundwater measured at 3.3 m depth.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING	& IN SITU	TESTING	LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D D isturbed sample
E Environmental sample
W Water sample
W Water sample
W Water level



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 5.5 AHD

EASTING: 314835

NORTHING: 6239356 DIP/AZIMUTH: 90°/-- **BORE No**: 49

PROJECT No: 96717.02

DATE: 2-2-2022 **SHEET** 2 OF 4

П		Description	Degree of	Rock 의 Strength	Fracture	Discontinuities	Sa	amplii	ng & I	n Situ Testing
귚	Depth	of	Weathering	Graphic Log Ex Low Medium High Ex High Weigh Water Carlotter Ex High Water Carlotter C	Spacing (m)	B - Bedding J - Joint	φ	e %	۵	Test Results
	(m)	Strata	MW SW FR	Gri Ex Low Medium Medium High Ex High		S - Shear F - Fault	Туре	R S	RQD %	& Comments
	5.5	Clayey Sandy GRAVEL GC: fine to medium sized, green-grey, orange, pink, fine to coarse grained, low plasticity, medium dense. Residual Soil, Leeuwin Complex. (continued) becoming green-grey, orange from 5.3 m depth. CORE LOSS				5.5m: CORE LOSS: 500mm	С	52		
	6 6.0	Clayey Sandy GRAVEL GC: fine to medium sized, green-grey, orange, pink, fine to coarse grained, low plasticity, medium dense. Residual Soil, Leeuwin Complex.					s	100		10,11,13 N = 24
	6.45 6.65	Sandy SILT ML: low plasticity, dark brown, fine to medium grained. Residual Soil, Leeuwin Complex. CORE LOSS				6.65m: CORE LOSS: 850mm				
	7.5						С	19		
	7.3	Clayey Sandy GRAVEL GC: fine to medium sized, green-grey, orange, pink, fine to coarse grained, low plasticity, medium dense. Residual Soil, Leeuwin Complex.					s	100		9,13,11 N = 24
	7.95	Sandy CLAY CL: low plasticity, dark brown, fine grained. Residual Soil, Leeuwin Complex. - becoming brown, pale white, orange, with fine sized gravel from								
- ep -	9 9.0	\8.1 m depth. CORE LOSS				8.3m: CORE LOSS: 700mm	С	33		
		Sandy CLAY CL: low plasticity, brown, pale white, orange, fine grained, very stiff. Residual Soil, Leeuwin Complex.					s	100		4,9,11 N = 20
-4-	9.45	CORE LOSS				9.45m: CORE LOSS: 1050mm	С	0		

RIG: Hydrapower Scout Mark V

DRILLER: Precision Drilling

LOGGED: SN

CASING:

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: Groundwater measured at 3.3 m depth.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

|--|

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D D isturbed sample
E Environmental sample
W Water sample
W Water sample
W Water level



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 5.5 AHD

EASTING: 314835

NORTHING: 6239356 **D DIP/AZIMUTH:** 90°/-- **S**

BORE No: 49

PROJECT No: 96717.02

DATE: 2-2-2022 **SHEET** 3 OF 4

		Description	Degree of	ပ	Rock Strength	Fracture	Discontinuities	Sa	ampli	ng & l	In Situ Testing
귒	Depth (m)	of	Weathering	raph	Strength Str	Spacing (m)	B - Bedding J - Joint	Туре	e	RQD %	Test Results
	()	Strata	EW HW SW SW FR	Ō	Ex Low Very Low Low Medium High Kex High Ex High	0.01 0.10 0.10 1.00	S - Shear F - Fault	Ţ	ပြလည်	RC %	& Comments
-2-	- - - - 10.5	CORE LOSS (continued)						С	0		
	-	Sandy CLAY CL: low plasticity, brown, grey, orange, fine grained, stiff. Residual Soil, Leeuwin Complex.						S	100		2,4,8 N = 12
	10.95 - 11 - - 11.25	Clayey SAND SC: fine to medium grained, grey, brown, orange, low plasticity. Residual Soil, Leeuwin Complex.	-								
 	- 11.4- 	Clayey Sandy GRAVEL GC: fine to medium sized, dark brown, pink, green, fine to coarse grained, low plasticity. Residual Soil, Leeuwin Complex. CORE LOSS					11.4m: CORE LOSS: 600mm	С	43		
	-12 12.0 ·	Clayey SAND SC: fine to coarse grained, grey, orange-brown, pink, low plasticity, with gravel, dense. Residual Soil, Leeuwin Complex.						S	100		16,21,21 N = 42
2-	12.45 12.5 12.7 12.7 12.9	CORE LOSS Gravelly Clayey SAND SC: fine to coarse grained, green, brown, orange, fine sized, low plasticity. Residual Soil, Leeuwin Complex. GRANITE: coarse grained, green, orange, pink, granular, massive, was severed to set the set to severe the set of the set o		+++++++++++++++++++++++++++++++++++++++			12.45m: CORE LOSS: 50mm 12.8m: J, 20°, Ir, R, Gr, fl - 10 mm 13m: J, 30°, Pl, SR, Cn	С	95	52	
	- - 13.3 · -	very low strength, extremely weathered. Leeuwin Complex. GRANULITE: medium grained, brown, pale white, grey, pink, granular, foliated, extremely low strength, extremely weathered. Leeuwin Complex.					13111. J, 30 , FI, 3N, GI				
	13.55	GRANITE: coarse grained, green, orange, pink, granular, massive, medium to high strength, highly weathered to moderately weathered, fragmented. Leeuwin Complex. GRANULITE: medium grained, orange, pale white, grey, pink, granular, foliated, extremely low strength, extremely weathered. Leeuwin Complex. CORE LOSS		+ + + + + + + + + + + + + + + + + + +			13.65m: J, 30°, PI, SR, Cn 13.73m: J, 70°, PI, SR, Cn 14.2m: J, 30°, PI, SR, Sd, Gr, Fi - 30 mm 14.35m: CORE LOSS:	С	57	48	PL(D) = 0.01
- 6-	- - - - - 15.0	55.1E 2000					650mm				R

RIG: Hydrapower Scout Mark V

Coring

DRILLER: Precision Drilling

LOGGED: SN CASING:

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: Groundwater measured at 3.3 m depth.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING	& IN	SITU	TESTING	LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D D isturbed sample
E Environmental sample
W Water sample
W Water sample
W Water level



Wallcliffe House Pty Ltd **CLIENT:**

Proposed Wallcliffe House Re-development PROJECT: LOCATION:

752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 5.5 AHD

PROJECT No: 96717.02 **EASTING**: 314835

NORTHING: 6239356 **DATE: 2-2-2022 DIP/AZIMUTH:** 90°/--SHEET 4 OF 4

BORE No: 49

		Description	Degree of Weathering	. <u>o</u>	Rock Strength	Fracture	Discontinuities	Sa	amplii	ng & I	n Situ Testing
귙	Depth (m)	of	Weathering	raph	Strength Low Medium High Ex High Water Water	Spacing (m)	B - Bedding J - Joint	Type	ore c.%	RQD %	Test Results &
		Strata	EW HW EW	0	Kary High High Kery Very Very Kery Kery Kery Kery Kery Kery Kery K	0.05	S - Shear F - Fault			ĕ̈́	Comments
- 10		GRANULITE: medium grained, orange, pale white, grey, pink, granular, foliated, extremely low strength, extremely weathered. Leeuwin Complex.		+ + + + + + + + + + + + + + + + + + + +				S	82	61	refusal 70 mm penetration
	15.85 - 16 - 16.15 - 16.25 - 16.5	Sandy GRAVEL GP-GC: fine to medium sized, orange-brown, grey, pink, fine to coarse grained, with clay. GRANULITE: medium grained, orange, pale white, grey, granular, foliated, very low strength, extremely weathered. Leeuwin Complex. CORE LOSS		+5:0:0:0:0:0:0:0:0:0:0:0:0:0:0:0:0:0:0:0			16.25m: CORE LOSS: 250mm		52		Pl (D) = 0.04
	- 10.5 - - - 17	GRANULITE: medium grained, orange, pale white, grey, pink, granular, foliated, very low strength, extremely weathered. Leeuwin Complex.		+ + + + + +							PL(D) = 0.01
-12		- becoming low to medium strength, highly weathered, from 17.6 m depth.		+ + + + + + + + + + + + + + + + + + + +			17.37m: J, 20°, PI, SR, Sd, Cl, Fi - 20 mm	С	100	100	PL(D) = 0.3
	- - 18 - -	- becoming dark grey, medium strength, fresh, from 17.9 m depth. - becoming grey, orange, low to medium strength, highly weathered, from 18.1 m depth. - becoming very low strength.		+ + + + + + + +			18.1m: J, 40°, PI, SR, Cn				PL(D) = 0.72
-13	- - - - - 19	extremely weathered, from 18.3 m depth.		+++++++			18.65m: J, 30°, Pl, SR, Sd, Gr, Cl, Fi - 50 mm	С	100	95	PL(D) = 0.06
-14	- - - 19.3 - -	Bore discontinued at 19.3m (Target Depth)		+ + + + +			19.14m: J, 60°, PI, SR, Cn				
	- -										

DRILLER: Precision Drilling LOGGED: SN CASING: RIG: Hydrapower Scout Mark V

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: Groundwater measured at 3.3 m depth.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam
E Environmental Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level Core drilling
Disturbed sample
Environmental sample





Photo 1 - Box 1: 0.5 m to 5.5 m



Photo 2 - Box 2: 5.5 m to 10.5 m

	Core Photographs - Boxes 1 and 2	PROJECT:	96717.02
Douglas Partners	Proposed Wallcliffe House Re-development	PLATE:	1
Geotechnics Environment Groundwater	Test Location 49	REV:	Α
	CLIENT: Wallcliffe House Pty Ltd	DATE:	4 Feb 2022



Photo 3 - Box 3: 10.5 m to 15.5 m



Photo 4 - Box 4: 15.5 m to 19.3 m



Core Photographs - Boxes 3 and 4	PROJECT:	96717.02
Proposed Wallcliffe House Re-development	PLATE :	2
Test Location 49	REV:	A
CLIENT: Wallcliffe House Pty Ltd	DATE:	4 Feb 2022

SURFACE LEVEL: 14.0 AHD

EASTING: 314807

CLIENT: Wallcliffe House Pty Ltd

Proposed Wallcliffe House Re-development PROJECT: LOCATION:

752 Wallcliffe Road, Margaret River, WA **NORTHING**: 6239267 **DIP/AZIMUTH:** 90°/-- **BORE No:** 50

PROJECT No: 96717.02

DATE: 3-2-2022 SHEET 1 OF 4

		Description	Degree of Weathering	<u>.</u>	Rock Strength	Fracture	Discontinuities	Sa	ampling &	In Situ Testing
씸	Depth (m)	of		Log	Strength Nedium High High Kery High Kery High Kery High Kery High Kery High Water	Spacing (m)	B - Bedding J - Joint	Туре	Core Rec. %	Test Results &
4	` '		EW HW EW	S X	Very Low Medium High Very High Ex High	0.05 0.10 0.50 1.00	S - Shear F - Fault	Тy	12 % N.	Comments
13		SAND SP-SM: fine to medium grained, dark brown, with silt. Residual Soil, Spearwood System.						С	66	
	- - -	orange-brown, trace silt, loose. Residual Soil, Spearwood System.						s	100	2,2,3 N = 5
111		CORE LOSS					1.95m: CORE LOSS: 1050mm	С	0	
	-3 3.0 ·	SAND SP: fine to coarse grained, orange-brown, trace silt, loose. Residual Soil, Spearwood System.						S	100	2,3,4 N = 7
-10-	- 3.8 4 	CORE LOSS					3.8m: CORE LOSS: 700mm	С	33	
		SAND SP: fine to coarse grained, orange-brown, trace silt, medium dense. Residual Soil, Spearwood System.						S	100	3,4,6 N = 10
\Box	4.95			\times			1			

CASING: RIG: Hydrapower Scout Mark V **DRILLER:** Precision Drilling LOGGED: SN

TYPE OF BORING: HQ Diamond Coring WATER OBSERVATIONS: Standpipe not dipped.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING	3 & IN SITU	TESTING	LEGE	END
G	Gas sample		PID	Phot

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level



Wallcliffe House Pty Ltd CLIENT:

Proposed Wallcliffe House Re-development PROJECT: LOCATION:

752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 14.0 AHD

EASTING: 314807

NORTHING: 6239267 **DIP/AZIMUTH:** 90°/-- **BORE No:** 50

PROJECT No: 96717.02

DATE: 3-2-2022 SHEET 2 OF 4

	_	Description	Degree of Weathering	<u>:</u>	Rock Strength	Į.	Fracture	Discontinuities				n Situ Testing
RL	Depth (m)	of Strata	Weathering A A A A A A A A A A A A A A A A A A A	Graphi Log	Strength Very Low High High Ex High	Wate	Spacing (m)	B - Bedding J - Joint S - Shear F - Fault	Туре	Core Rec. %	RQD %	Test Results & Comments
	- - - - 5.5	SAND SP: fine to coarse grained, orange-brown, trace silt, medium dense. Residual Soil, Spearwood System.						^L 4.95m: CORE LOSS: 550mm	С	48		Commence
	-6 - - - 6.4	- becoming yellow-brown from 5.95 m depth.							s	100	-	2,4,6 N = 10
2		Silty Sandy GRAVEL GM: fine to coarse sized, brown, pale white, orange, fine to coarse grained, low plasticity. Residual Soil, Spearwood System. LIMESTONE (CALCARENITE): fine to medium grained, pale orange-brown, granular, strongly cemented, high strength, fragmented to 7.07 m depth. Spearwood System. CORE LOSS				<<		\7.12m: J, 20°, Ir, SR, Cn 7.15m: CORE LOSS: 1450mm	С	67	0	
9		CORE LOSS							С	27	0	
	- 8.6 - -	LIMESTONE (CALCARENITE): fine to medium grained, pale white, orange, granular, strongly cemented, high strength. Spearwood System.				<<		8.69m: J, Ir, SR, Cn				
- 2-	-9 9.0 - - - 9.3 9.35	8.87 m depth. CORE LOSS SAND SP: fine to coarse grained,						8.93m: J, 10°, Ir, SR, Cn 9m: CORE LOSS: 300mm				
	- - - - - 10.0	orange-brown, trace silt. Residual Soil, Spearwood System. LIMESTONE (CALCARENITE): fine to medium grained, pale white, orange, granular, strongly cemented, high strength. Spearwood System.						9.5m: J, 30°, PI, SR, Cn 9.6m: J, 0°, PI, SR, Cn	С	80	43	

CASING: RIG: Hydrapower Scout Mark V **DRILLER:** Precision Drilling LOGGED: SN

TYPE OF BORING: HQ Diamond Coring WATER OBSERVATIONS: Standpipe not dipped.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING	3 & IN SITU	TESTING	LEGE	END
G	Gas sample		PID	Phot

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam
E Environmental Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level Core drilling
Disturbed sample
Environmental sample



CLIENT: Wallcliffe House Pty Ltd

Proposed Wallcliffe House Re-development PROJECT: 752 Wallcliffe Road, Margaret River, WA LOCATION:

EASTING: 314807 **NORTHING**: 6239267 **DIP/AZIMUTH:** 90°/--

SURFACE LEVEL: 14.0 AHD

BORE No: 50

PROJECT No: 96717.02 **DATE:** 3-2-2022

SHEET 3 OF 4

							AZIIVIU I II.	90 /		E1 3	<i>.</i>	•
	5	Description	Degree of Weathering	ie I	Rock Strength	<u>~</u>	Fracture	Discontinuities	Sa			n Situ Testing
R	Depth (m)	of Strata	Weathering	Graph	Strength Strength Ned India Ne	Wate	Spacing (m)	B - Bedding J - Joint S - Shear F - Fault	Туре	Core Rec. %	RQD %	Test Results & Comments
-	-	SAND SP: fine to coarse grained, yellow-brown, trace silt, medium dense. Residual Soil, Spearwood System.							С	80	43	
-	- - -					 			s	100		6,9,10 N = 19
- 3-	-11 - -	- becoming pale white, with silt (SP-SM) from 11.1 m depth.										
	11.35 - - - 11.7	LIMESTONE (CALCARENITE): fine to medium grained, pale white, granular, weakly cemented, very low to low strength. Spearwood System.						11.5m: J, 60°, Pl, R, Cn	С	100	33	PL(D) = 0.08
2	- - -12	SAND SP-SM: fine to coarse grained, pale white, with silt, medium dense. Residual Soil, Spearwood System.										
	- - -	- becoming yellow-brown from 12.3 m depth.				 			S	100		3,8,12 N = 20
	- 12.7 - 12.8 - 13 	LIMESTONE (CALCARENITE): fine to medium grained, pale white, granular, moderately cemented, medium to high strength. Spearwood System. SAND SP-SM: fine to coarse grained, pale white, with silt, medium dense. Residual Soil, Spearwood System.						12.76m: J, 0°-30°, Ir, SR, Cn	С	100	0	PL(D) = 1.16
	- - -	- becoming orange-brown from 13.3 m depth becoming pale white from 13.5 m depth becoming orange-brown from 13.75 m depth.				 			S	100		3,9,16 N = 25
- 0	- 14 - - - 14.35 - 14.4 - 14.5 - - - -	LIMESTONE (CALCARENITE): fine to medium grained, orange-brown, granular, weakly cemented, low strength. Spearwood System. Clayey SAND SC: fine to medium grained, grey, orange, low plasticity, very dense. Residual Soil, Leeuwin Complex.				 		14.5m: CORE LOSS: 500mm	С	52	0	R

CASING: RIG: Hydrapower Scout Mark V **DRILLER: Precision Drilling** LOGGED: SN

TYPE OF BORING: HQ Diamond Coring WATER OBSERVATIONS: Standpipe not dipped.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING & IN SITU TESTING	i LEGI	ΞND
G Gas sample	PID	Pho

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level P U_x W



Wallcliffe House Pty Ltd CLIENT:

PROJECT: Proposed Wallcliffe House Re-development LOCATION:

752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 14.0 AHD

BORE No: 50 **PROJECT No:** 96717.02 **EASTING**: 314807

NORTHING: 6239267 **DATE:** 3-2-2022 **DIP/AZIMUTH:** 90°/--SHEET 4 OF 4

		Description	Degree of Weathering	Rock Strengt	ا ا h	Fracture	Discontinuities	Sa	amplii	ng & I	n Situ Testing
귐	Depth (m)	of	Weathering	Graph Log Ex Low Very Low Low Medium High	Water Water	Spacing (m)	B - Bedding J - Joint	Туре	ore c.%	RQD %	Test Results &
<u>+</u>		Strata	N N N N N N N N N N N N N N N N N N N	High Kery III	Kery EX H	0.05	S - Shear F - Fault	ŕ	ဝမှု	œ °	Comments refusal
	- 15.15 15.5 - 15.5 16 16.0	brown, grey, orange, brown, fine grained, hard. Residual Soil, Leeuwin Complex. GRANULITE: medium grained, dark grey, pale white, pink, granular, foliated, very low to low strength, extremely weathered to highly weathered. Leeuwin Complex. CORE LOSS		+			15.5m: CORE LOSS: 500mm	C	63	0	150 mm penetration
	-	GRANULITE: medium grained, dark grey, pink, granular, foliated, low to medium strength, moderately weathered to slightly weathered, fragmented to 16.26 m depth. Leeuwin Complex.					16.35m: J, 30°, PI, SR, Cn 16.42m: J, 30°, PI, SR, Cn				PL(D) = 0.29 PL(D) = 0.41
	- - - - 17 -	- fragmented between 16.65 m and 16.87 m depth.		+			17.03m: J, 30°, Pl, SR, Sd, Cl, Gr, Fi - 110 mm				
	- - - 17.5 - -	- fragmented from 17.4 m depth. CORE LOSS		+			17.15m: J, 80°, PI, SR, Cn 17.23m: J, 20°, PI, SR, Cn 17.28m: J, 80°, Un, SR, Cn 17.5m: CORE LOSS: 500mm	С	66	28	
-4-	- -18 18.0 - - - - -	Bore discontinued at 18.0m (Target Depth)									
- φ	- -19 - - - - - -										

DRILLER: Precision Drilling LOGGED: SN **CASING:** RIG: Hydrapower Scout Mark V

TYPE OF BORING: HQ Diamond Coring WATER OBSERVATIONS: Standpipe not dipped.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPL	ING	& IN	SITU	TESTING	LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam
E Environmental Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level Core drilling
Disturbed sample
Environmental sample





Photo 5 - Box 1: 0.5 m to 5.5 m



Photo 6 - Box 2: 5.5 m to 10.5 m

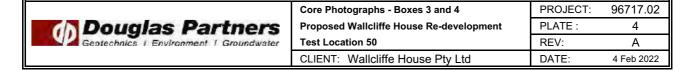
	Core Photographs - Boxes 1 and 2	PROJECT:	96717.02
Douglas Partners	Proposed Wallcliffe House Re-development	PLATE:	3
Geotechnics Environment Groundwater	Test Location 50	REV:	Α
	CLIENT: Wallcliffe House Pty Ltd	DATE:	4 Feb 2022



Photo 7 - Box 3: 10.5 m to 15.5 m



Photo 8 - Box 4: 15.5 m to 18.0 m



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development **LOCATION:** 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 14.0 AHD **BORE No:** 51

EASTING: 314761 **PROJECT No**: 96717.02 **NORTHING**: 6239221 **DIP/AZIMUTH**: 90°/-- **SHEET** 1 OF 5

П			Degree of	Rock		Discourt III	_	"		la Otta T - "
	Depth	Description	Degree of Weathering	Strength p	Fracture Spacing	Discontinuities	Sa	amplii	ng &	In Situ Testing
Ζ	(m)	of	Tab	Ex Low Low Low Medium High Ex	(m)	B - Bedding J - Joint	Type	ore c.%	RQD %	Test Results &
4			WH WW RA RE	K Kery High Med Will K	0.01 0.10 0.50 1.00	S - Shear F - Fault	F	O &	מ"	Comments
-	0.3	FILL/Silty SAND SM: fine to medium grained, dark brown.								
13	-1	FILL/SAND SP-SM: fine to medium grained, dark brown, with silt.					С	67		
	1.5	SAND SP: fine to coarse grained, orange-brown, trace silt, loose. Residual Soil, Spearwood System.					s	100		1,2,2 N = 4
-2-	1.95 -2	CORE LOSS				1.95m: CORE LOSS:				•
	2.2	SAND SP: fine to coarse grained,				250mm				
	2.6	orange-brown, trace silt. Residual Soil, Spearwood System.					С	76	22	
	-3	LIMESTONE (CALCARENITE): fine to medium grained, pale white, granular, strongly cemented, high to very high strength. Spearwood System. - becoming very weakly cemented,								
		very low strength from 2.8 m depth.					s	100		4,3,2 N = 5
		CORE LOSS				3.45m: CORE LOSS: 550mm		FO	0	
	-4 4.0	LIMESTONE (CALCARENITE): fine to medium grained, pale white, granular, strongly cemented, high strength, fragmented. Spearwood System.			1		С	52	0	
	4.5	CORE LOSS				4.5m: CORE LOSS: 850mm	s	0		1,1,3 N = 4

RIG: Hydrapower Scout Mark V DRILLER: Precision Drilling LOGGED: SN CASING:

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: Groundwater measured at 10.7 m depth.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D D isturbed sample
E Environmental sample
W Water sample
W Water sample
W Water level



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development **LOCATION:** 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 14.0 AHD **BORE No:** 51

EASTING: 314761 **PROJECT No**: 96717.02 **NORTHING**: 6239221 **DIP/AZIMUTH**: 90°/-- **SHEET** 2 OF 5

	_	Description	Degree of Weathering .≅	Rock Strength	Fracture	Discontinuities				n Situ Testing
귐	Depth (m)	of	Weathering oider	Ex Low Needium High Nery High Ex High Water	Spacing (m)	B - Bedding J - Joint	Туре	».e	RQD %	Test Results &
	()	Strata	WH WW WE WE DO NOT THE PROPERTY OF THE PROPERT	Ex Lo Very L Wedir Very Ex High	0.05 0.10 0.50 1.00	S - Shear F - Fault	Ţ			α Comments
	5.35	CORE LOSS (continued)					С	62	33	
	5.45	Soil, Spearwood System. LIMESTONE (CALCARENITE): fine to medium grained, pale white, orange, granular, strongly cemented, high to very high strength. Spearwood System.				5.5m: J, 80°, PI, SR, Sd, Fi - 130 mm 5.65m: J, 0°, PI, SR, Cn 5.83m: J, 0°, PI, SR, Cn	С	62	33	PL(D) = 4.31
	6.3 6.4	Sandy GRAVEL GP: fine to coarse sized, orange-brown, fine to coarse grained, trace silt. Residual Soil, Spearwood System. LIMESTONE (CALCARENITE): fine to medium grained, pale white, granular, moderately cemented, medium to high strength.				6.4m: CORE LOSS: 1100mm				
	-7 -7	Spearwood System. CORE LOSS					С	27	7	
	7.5	SAND SP: fine to coarse grained, pale white, trace silt, dense. Residual Soil, Spearwood System.					S	100		10,16,17 N = 33
-9-	7.95	CORE LOSS				7.95m: CORE LOSS: 250mm				
. [. [8.2	SAND SP: fine to coarse grained, orange-brown, trace silt. Residual Soil, Spearwood System.					С	76	28	
	8.6	LIMESTONE (CALCARENITE): fine to medium grained, orange-brown, granular, weakly cemented, low to medium strength. Spearwood System.				8.66m: J, 20°, Ir, SR, Cn 8.83m: J, 20°, Ir, SR, Cn				PL(D) = 0.24 R
- 2-	- y 					8.96m: J, 30°, Ir, SR, Cn	s	100		refusal 150 mm
		SAND SP: fine to coarse grained, orange-brown, trace silt. Residual Soil, Spearwood System.				9.25m: J, 10°, PI, SR, Cn 9.32m: J, 10°, PI, SR, Cn	С	100	63	penetration PL(D) = 0.7
	9.8	to medium grained, orange-brown, granular, weakly cemented, very low			' 					

RIG: Hydrapower Scout Mark V DRILLER: Precision Drilling LOGGED: SN CASING:

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: Groundwater measured at 10.7 m depth.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING	& IN	SITU '	TESTING	LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D D isturbed sample
E Environmental sample
W Water sample
W Water sample
W Water level



CLIENT: Wallcliffe House Pty Ltd

Proposed Wallcliffe House Re-development PROJECT: 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 14.0 AHD

PROJECT No: 96717.02 **EASTING**: 314761 **NORTHING**: 6239221 **DATE:** 1 - 2/2/2022 **DIP/AZIMUTH:** 90°/--SHEET 3 OF 5

BORE No: 51

			Description	N N	Dec	gree	e of	ا.ن			St	rer	ck	th			Frac		Ī	Discontinuities	Sa	ampli	ng & I	n Situ Testing
귐	Depth (m)		of	[]	. 50			Graphic	Log	≱ 1		Ţ	 -	티티	님.	Water	Spa (n	. •		B - Bedding J - Joint	be De	e %.	RQD %	Test Results
	()		Strata	×	≥ 3	A A	S 5	بار <u>ت</u>		NI.	§ §	Ved EI			≝ 3	>				S - Shear F - Fault	Туре	ပြိမ္တ	SR.	& Comments
4			strength. Spearwood System.			1			:	1	1		T			Ť		Ť						
-	- 10 - -		SAND SP: fine to coarse grained, orange-brown, trace silt. Residual Soil, Spearwood System becoming pale white from 9.95 m depth.	- 																	С	100	63	PL(D) = 0.45
-	- 10: - -).5	SAND SP: fine to coarse grained, pale white, trace silt. Residual Soil, Spearwood System.	\ \				Λ		/					7	Ţ Ţ	\ \ \ !!		7	10.5m: CORE LOSS: 1000mm				
3	- - -11 - -		LIMESTONE (CALCARENITE): fine to medium grained, pale white, granular, weakly to moderately cemented, low to medium strength. Spearwood System. CORE LOSS	 					$\left\langle \left \right \right\rangle$	1 1 1 1 1 1	\\\\/	X				03-02-25					С	33	7	
t	-	اء		Vi		i	 	\bigvee	V	/ ₁				 	\setminus	И	/ 	- \	\setminus					
-	- 11. - -	.5	SAND SP: fine to coarse grained, pale white, trace silt. Residual Soil, Spearwood System.														11							
-	- 11		LIMESTONE (CALCARENITE): fine	{ ¦				Ь			1	İ				ľ								PL(D) = 0.75
	-12 12 - - -		to medium grained, pale white, granular, weakly cemented, low to medium strength. Spearwood System.	7		+X	 		/		+-\\\	 	+/					11		12m: CORE LOSS: 500mm				12(5) 0.10
ŀ	-				/		1	\bigvee	\setminus	/	/		1	N			$\mathbb{Z}_{\mathbb{H}}$							
-	- 12 - - - - -13	7	LIMESTONE (CALCARENITE): fine to medium grained, pale white, granular, moderately cemented, low to medium strength. Spearwood System. fragmented between 12.75 m and 12.83 m depth.			· 										\ 				12.66m: J, 10°, PI, SR, Cn	С	66	37	PL(D) = 0.12
-	13.0 - 13.1		Sandy SILT ML: low plasticity, orange-brown, fine to medium				 	I										• 						
	- 13.2 -		grained. Residual Soil, Leeuwin Complex.				 	E	+		للم		 			ŀ				13.2m: J, 20°, Ir, SR, Cn				
-	-		GRANITE: coarse grained, grey, orange, granular, massive, low strength, highly weathered. Leeuwin						- - - -											13.36m: J, 20°, Ir, Sd, Gr, Si, Fi - 80 mm				PL(D) = 0.04
	- - -		GRANULITE: medium grained, orange, grey, dark grey, granular, foliated, very low strength, highly				 	T T	+ - + - +					 						13.6m: J, 10°, Pl, SR, Sd, Gr, Cl, Fi - 80 mm				
-0	13.9 - 14	95	weathered. Leeuwin Complex. GRANITE: coarse grained, pale	["			þ	-	ľ	ا ل ا		-	Ц			ļſ			13.92m: J, 30°, PI, SR, Sd, Gr, Cl, Fi - 40 mm				
-	- - -		white, grey, granular, massive, extremely low strength, extremely weathered. Leeuwin Complex.				1 	 	- ' - + - + - +		1						[14.09m: J, 20°, Pl, SR, Sd, Gr, Cl, Fi - 100 mm	С	66	47	PL(D) = 0.03
	- 14.4 - 14 - -		GRANULITE: medium grained, orange, dark grey, granular, foliated, very low strength, extremely weathered. Leeuwin Complex.			- 			_#											14.5m: CORE LOSS: 1500mm				

CASING: RIG: Hydrapower Scout Mark V **DRILLER:** Precision Drilling LOGGED: SN

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: Groundwater measured at 10.7 m depth.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturb Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level Core drilling
Disturbed sample
Environmental sample



CLIENT: Wallcliffe House Pty Ltd

Proposed Wallcliffe House Re-development PROJECT: 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 14.0 AHD **BORE No:** 51

EASTING: 314761

PROJECT No: 96717.02 **NORTHING**: 6239221 **DATE:** 1 - 2/2/2022 **DIP/AZIMUTH:** 90°/--SHEET 4 OF 5

П		Description	Degree of Weathering	Rock Strength	Fracture	Discontinuities	Sa	ampli	ng & I	n Situ Testing
귐	Depth (m)	of	Wodalomig	Graphic Log Ex Low Very Low Very Low Medium High Kx High Ex High XVery	Spacing (m)	B - Bedding J - Joint	Туре	ore c. %	RQD %	Test Results &
_	` ,		EW H W H EW H EW H EW H EW H EW H EW H	Media Low Lery Lery Lery Lery Lery Lery Lery Lery	0.05	S - Shear F - Fault	Ţ	S §	X°	Comments
	-16 16.0-	CORE LOSS (continued) SAND SP: medium to coarse					С	33	0	
	16.2 -	grained, pale white, trace silt. Residual Soil, Leeuwin Complex. Sandy SILT ML: low plasticity, green-grey, purple, orange, fine to medium grained, dense.								
					 		S	100		10,19,26 N = 45
	-17 17.05-	GRANULITE: medium grained, orange, green-grey, pale white, purple, granular, foliated, extremely low to very low strength, extremely weathered. Leeuwin Complex.					С	100	90	PL(D) = 0.02
				- +		18.82m: J, 70°, PI, SR, Cn	С	100	100	PL(D) = 0.02
				+						PL(D) = 0.07
	19.7 - 19.95 -	- becoming very low to low strength, highly weathered from 19.5 m depth. GRANITE: coarse grained, pink, grey, orange, granular, massive, very low strength, moderately weathered. Leeuwin Complex.		- +		19.55m: J, 20°, PI, SR, Cn 19.62m: J, 10°, PI, SR, Cn	С	100	0	PL(D) = 0.04

CASING: RIG: Hydrapower Scout Mark V **DRILLER:** Precision Drilling LOGGED: SN

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: Groundwater measured at 10.7 m depth.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING 8	IN SITU	TESTING LEGEN	5

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam
E Environmental Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level Core drilling
Disturbed sample
Environmental sample



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development **LOCATION:** 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 14.0 AHD **BORE No:** 51

EASTING: 314761 **PROJECT No**: 96717.02 **NORTHING**: 6239221 **DIP/AZIMUTH**: 90°/-- **SHEET** 5 OF 5

		Description	Degree of Weathering	o	Rock Strength	Fracture Discontinuities S			Sampling & In Situ Testing			
귒	Depth (m)	of	vveautering	aphi	Strength Low Medium High Ex High Ex High On 1	Spacing (m)	B - Bedding J - Joint					
	(111)	Strata	EW MW SW FS	ტ_	Very Low Low Ligh Ligh Ligh Ligh Ligh Ligh Ligh Ligh	0.05	S - Shear F - Fault	Type	8 8	RQD %	& Comments	
۴	20.4	\- fragmented from 19.8 m depth.		+				С	100	_		
2-	- 20.1 	GRANULITE: medium grained, orange, green-grey, granular, foliated, low strength, highly weathered, fragmented. Leeuwin Complex. (continued) Bore discontinued at 20.1m (Target Depth)										
- 8-	- - - - - - - - - - -											
- 6-	23 											
-10-	- - - - 24 - - -											

RIG: Hydrapower Scout Mark V DRILLER: Precision Drilling LOGGED: SN CASING:

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: Groundwater measured at 10.7 m depth.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
B Bulk sample
B Bulk Slock sample
C Core drilling
D D D D D Sturbed sample
E Environmental sample
W Water sample
W Water sample
W Water level





Photo 9 - Box 1: 0.5 m to 5.45 m



Photo 10 - Box 2: 5.45 m to 10.5 m

	Core Photographs - Boxes 1 and 2	PROJECT:	96717.02
Douglas Partners	Proposed Wallcliffe House Re-development	PLATE:	5
Geotechnics Environment Groundwater	Test Location 51	REV:	Α
	CLIENT: Wallcliffe House Pty Ltd	DATE:	4 Feb 2022



Photo 11 - Box 3: 10.5 m to 15.5 m



Photo 12 - Box 4: 15.5 m to 20.1 m

	Core Photographs - Boxes 3 and 4	PROJECT:	96717.02
Douglas Partners	Proposed Wallcliffe House Re-development	PLATE:	6
Geotechnics Environment Groundwater	Test Location 51	REV:	Α
	CLIENT: Wallcliffe House Pty Ltd	DATE:	4 Feb 2022

CLIENT: Wallcliffe House Pty Ltd

Proposed Wallcliffe House Re-development PROJECT: LOCATION:

752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 26.1 AHD **BORE No:** 52

PROJECT No: 96717.02 **EASTING**: 314867

NORTHING: 6239219 **DATE:** 1-2-2022 **DIP/AZIMUTH:** 90°/--SHEET 1 OF 3

П			Description	Degree of Weathering	. <u>o</u>	Rock Strength	Fracture	Discontinuities	Sa	amplii	ng & I	n Situ Testing
귐	De _l (m	pth	of		raph	Strength Strength Plant I have been seen a s	Spacing (m)	B - Bedding J - Joint	Туре	e	RQD %	Test Results
	('	Strata	EW HW EW SW REW	Ō	Ex Low Very Low Medium High Very High Ex High		S - Shear F - Fault	Tyl	ပြိမ္တ	RC %	& Comments
- 5	- - -		Silty SAND SP-SM: fine to medium grained, dark brown. Residual Soil, Spearwood System.									
25	- - - -1 - -	1.5 -	SAND SP: fine to coarse grained,						С	67		
	- - - -		orange-brown, trace silt, loose. Residual Soil, Spearwood System.						S	100		2,3,4 N = 7
- 54	- - - -	2.5 -	CORE LOSS		\ /			2.5m: CORE LOSS: 500mm	С	28		
23	- - - -3	3.0	SAND SP: fine to coarse grained, orange-brown trace silt loose									
	-	3.45	orange-brown, trace silt, loose. Residual Soil, Spearwood System.						S	100		2,3,4 N = 7
22	- · · · · · · · · · · · · · · · · · · ·	4.5 -	CORE LOSS					3.45m: CORE LOSS: 1050mm	С	0		
	- - -	5.0	SAND SP: fine to coarse grained, orange-brown, trace silt. Residual Soil, Spearwood System.						S	100		1,2,3 N = 5

CASING: RIG: Hydrapower Scout Mark V **DRILLER:** Precision Drilling LOGGED: SN

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: No free groundwater measured.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam
E Environmental Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level Core drilling
Disturbed sample
Environmental sample



CLIENT: Wallcliffe House Pty Ltd

Proposed Wallcliffe House Re-development PROJECT: LOCATION:

752 Wallcliffe Road, Margaret River, WA **NORTHING**: 6239219 **DIP/AZIMUTH:** 90°/--

SURFACE LEVEL: 26.1 AHD **BORE No:** 52 **EASTING**: 314867

PROJECT No: 96717.02

DATE: 1-2-2022 SHEET 2 OF 3

	Б ;;	Description	Degree of Weathering	ŋ 을_ Strength 뉴	Fracture	Discontinuities			,	n Situ Testing
R	Depth (m)	of Strata	EW HW MW SW FS	Srapt Country	Spacing (m) (m)	B - Bedding J - Joint S - Shear F - Fault	Туре	Core ec. %	RQD %	Test Results & Comments
21	5.6	SAND SP: fine to coarse grained, orange-brown, trace silt, very loose to loose. Residual Soil, Spearwood				5m: CORE LOSS: 600mm	С	38		Confinents
20	-6	System.					S	100		1,2,2 N = 4
	6.45	CORE LOSS				6.45m: CORE LOSS: 550mm	С	48	0	
- 19	7.28	LIMESTONE (CALCARENITE): fine to medium grained, pale white, granular, moderately cemented, medium to high strength, fragmented to 7.15 m depth. Spearwood System.				7.2m: J, 20°, Pl, SR, Cn 7.28m: J, 20°, Pl, SR, Cn		40	0	
		(CALCARENITE)/SAND SP: fine to coarse grained, pale white and orange-brown, granular, weakly cemented, very low strength. Spearwood System.					S	100		1,2,6 N = 8
18	-8	SAND SP: fine to coarse grained, orange-brown, trace silt, loose. Residual Soil, Spearwood System.				7.95m: CORE LOSS: 500mm				
	8.45	LIMESTONE (CALCARENITE): fine to medium grained, pale pink, grey, granular, strongly cemented, high to very high strength. Spearwood System.				8.5m: J, 20°, Ir, R, Cn 8.62m: J, 10°- 80°, Pl, R, Cn 8.72m: J, 0°, Pl, R, Cn 8.84m: J, 20°, Pl, R, Cn	С	52	35	PL(D) = 4.78
- 11	-9 9.0·	CORE LOSS				9m: CORE LOSS: 1500mm	С	0	0	

DRILLER: Precision Drilling CASING: RIG: Hydrapower Scout Mark V LOGGED: SN

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: No free groundwater measured.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam
E Environmental Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level Core drilling
Disturbed sample
Environmental sample



CLIENT: Wallcliffe House Pty Ltd

Proposed Wallcliffe House Re-development PROJECT: LOCATION:

752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 26.1 AHD **BORE No:** 52

PROJECT No: 96717.02 **EASTING**: 314867

NORTHING: 6239219 **DATE:** 1-2-2022 **DIP/AZIMUTH:** 90°/--SHEET 3 OF 3

П		Description	Degree of Weathering		Rock		Fracture	Discontinuities	S	amnli	na &	n Situ Testing
占	Depth	Description of	Weathering	og b	Strength Very Low High Very High Ex High	ate	Spacing					
ľ	(m)	Strata	2 2 2 2 ~	g L	Figure 1 Color	Š	0.01 0.050 1.00 (m)	B - Bedding J - Joint S - Shear F - Fault	Туре	Core	RQD %	&
Н		CORE LOSS (continued)	WH WW SE A	\ /		\forall	3 30 37 			<u> </u>		Comments
	- - - - 10.5								С	0	0	
-	- -	SAND SP: fine to coarse grained, orange-brown, trace silt, very loose. Residual Soil, Spearwood System.							S	100		2,1,1 N = 2
	- 10.95 - 11	LIMESTONE (CALCARENITE): fine to medium grained, pale pink, grey, granular, strongly cemented, high to very high strength. Spearwood System. - fragmented between 11.33 m and 11.5 m depth.				<<		10.97m: J, 80°, Pl, SR, Cn 11m: J, 10°, Ir, SR, Cn 11.19m: J, 10°, Ir, SR, Cn 11.24m: J, 10°, Pl, SR, Cn 11.33m: J, 10°, Pl, SR, Cn 11.58m: J, 40°, Ir, R, Cn 11.68m: J, 10°, Ir, SR, Cn 11.8m: J, 10°, Ir, SR, Cn 11.91m: J, 20°, Pl, SR, Cn	С	100	51	PL(D) = 2.05
- 1	-13							Cn 12.06m: J, 80°, Pl, SR, Cn 12.11m: J, 20°, Pl, SR, Cn 12.16m: J, 10°, Ir, SR, Cn 12.29m: J, 10°-30°, Un, SR, Cn 12.37m: J, 0°, Pl, SR, Sd, Gr, Fi - 40 mm 12.77m: J, 0°-20°, Un, SR, Sd, Gr, Fi - 30 mm	С	100	81	PL(D) = 4.08
12	- - - -14 - -	- becoming moderately cemented, medium strength from 14.25 m depth.						14.23m: J, 10°, lr, SR, Gr, Fi - 20 mm	С	100	100	PL(D) = 3.83
	14.55 ·	Bore discontinued at 14.55m (Target Depth)										

CASING: RIG: Hydrapower Scout Mark V **DRILLER:** Precision Drilling LOGGED: SN

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: No free groundwater measured.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam
E Environmental Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level Core drilling
Disturbed sample
Environmental sample





Photo 13 - Box 1: 0.5 m to 6.0 m



Photo 14 - Box 2: 6.0 m to 11.0 m

	Core Photographs - Boxes 1 and 2	PROJECT:	96717.02
Douglas Partners	Proposed Wallcliffe House Re-development	PLATE:	7
Geotechnics Environment Groundwater	Test Location 52	REV:	Α
	CLIENT: Wallcliffe House Pty Ltd	DATE:	4 Feb 2022

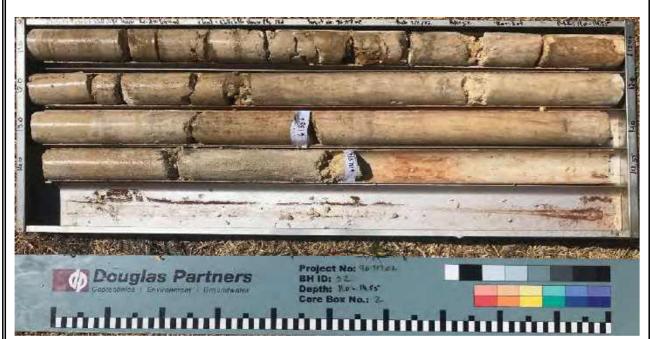


Photo 15 - Box 3: 11.0 m to 14.55 m

(D)	Douglas	Partners
G G	eotechnics i Enviro	nment Groundwater

Core Photographs - Box 3	PROJECT:	96717.02
Proposed Wallcliffe House Re-development	PLATE:	8
Test Location 52	REV:	Α
CLIENT: Wallcliffe House Pty Ltd	DATE:	4 Feb 2022

Appendix G

Douglas Partners 2021 Laboratory Test Results

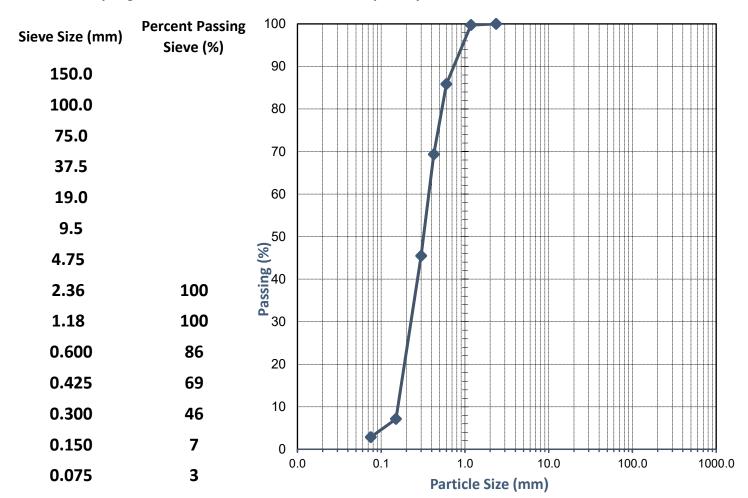


	SOIL	AGGREGATE	CONCRETE	CRUSH	IING
TEST REPORT - AS 1289.3.6.1					
Client:	Wallcliffe	e House Pty Ltd		Ticket No.	S4193
Client Address:	-			Report No.	WG21/12060_1_PSD
Project:	Proposed	d On Site Sewage Dispo	sal	Sample No.	WG21/12060
Location:	752 Wall	752 Wallcliffe Road, Margaret River, WA			30-08-2021
Sample Identificatio	n: BH1, 1.7	-2.3m		Date Tested:	7/09 - 8/09/2021

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name:

Date: 08-September-2021

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WG_AS 1289.3.6.1_TR_2

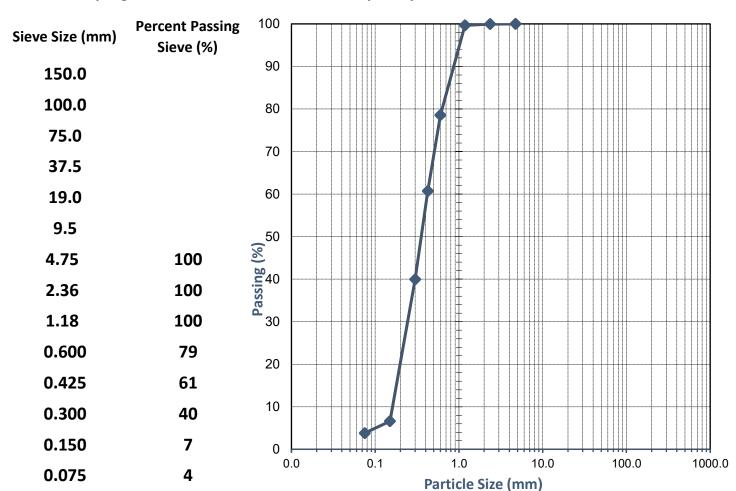


	SOIL		AGGREGATE	CONCRET	TE CR	CRUSHING		
			TEST REPO	ORT - AS 1289.3.6	5.1			
Client:	Wallcl	iffe H	ouse Pty Ltd		Ticket N	0.	S4193	
Client Address:	-				Report N	lo.	WG21/12061_1_PSD	
Project:	Propos	Proposed On Site Sewage Disposal			Sample N	lo.	WG21/12061	
Location:	752 W	752 Wallcliffe Road, Margaret River, WA			Date Samp	oled:	30-08-2021	
Sample Identification	n: BH2, 1	7-2.3	3m		Date Test	ed:	7/09 - 8/09/2021	

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Corell

Name: Date: 08-September-2021



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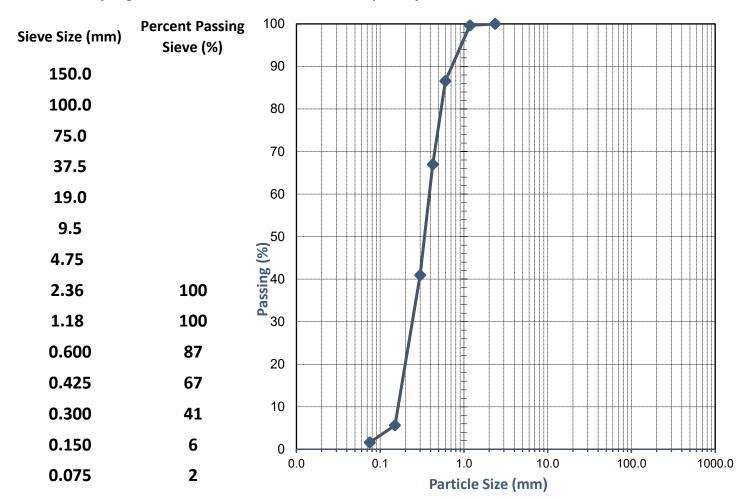
WG_AS 1289.3.6.1_TR_2



	SOIL	AGGREGATE	CONCRETE	CRUSH	IING
		TEST REPO	ORT - AS 1289.3.6.1		
Client:	Wallcliffe	House Pty Ltd		Ticket No.	S4193
Client Address:	-			Report No.	WG21/12062_1_PSD
Project:	Proposed	l On Site Sewage Dispo	sal	Sample No.	WG21/12062
Location:	752 Wall	cliffe Road, Margaret F	River, WA	Date Sampled:	30-08-2021
Sample Identification	n: BH3, 1.7-	-2.3m		Date Tested:	7/09 - 8/09/2021

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

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Name: Date: 08-September-2021



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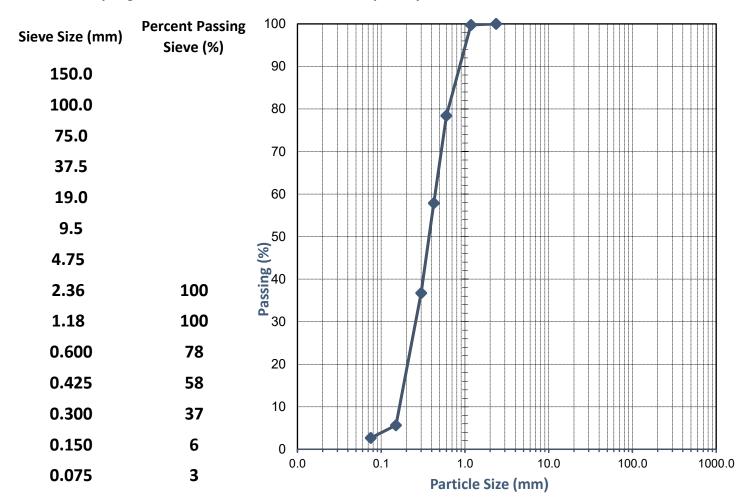
WG_AS 1289.3.6.1_TR_2



	SOIL AGGR	EGATE	CONCRETE	CRUSH	ING
		TEST REPOR	RT - AS 1289.3.6.1		
Client:	Wallcliffe House Pt	y Ltd		Ticket No.	S4193
Client Address:	-			Report No.	WG21/12063_1_PSD
Project:	Proposed On Site S	ewage Dispos	al	Sample No.	WG21/12063
Location:	752 Wallcliffe Road	, Margaret Riv	ver, WA	Date Sampled:	30-08-2021
Sample Identificatio	n: BH4, 1.7-2.3m			Date Tested:	7/09 - 8/09/2021

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

· Coxed

Date: 08-September-2021



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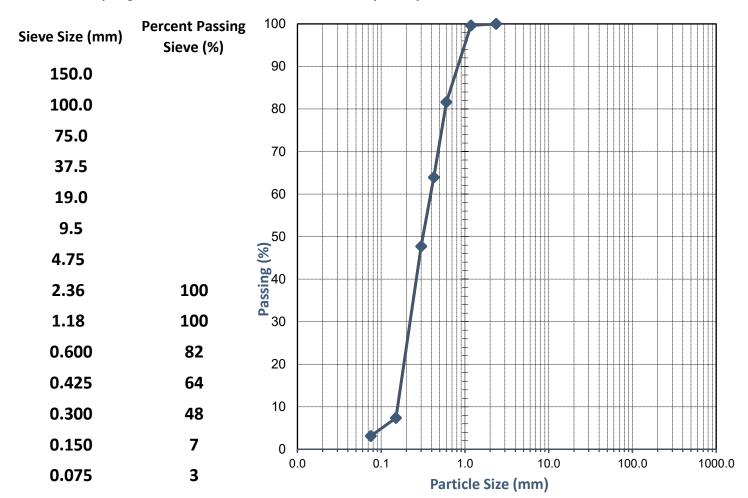
WG_AS 1289.3.6.1_TR_2



	SOIL	AGC	GREGATE	CONC	RETE	CRUSH	IING
			TEST REP	ORT - AS 128	9.3.6.1		
Client:	Wallcl	iffe House	Pty Ltd			Ticket No.	S4193
Client Address:	-					Report No.	WG21/12064_1_PSD
Project:	Propos	sed On Sit	e Sewage Disp	osal		Sample No.	WG21/12064
Location:	752 W	752 Wallcliffe Road, Margaret River, WA				Date Sampled:	30-08-2021
Sample Identification	n: BH5, 1	7-2.3m				Date Tested:	7/09 - 8/09/2021

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

tory: Corcello

Date: 08-September-2021



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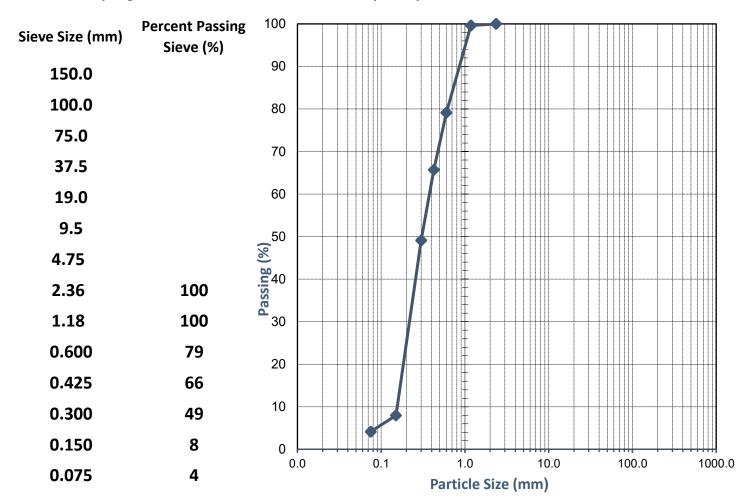
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	SOIL	AG	GREGATE	CONC	RETE	CRUSH	IING
			TEST REP	ORT - AS 1289	9.3.6.1		
Client:	Wallcl	iffe Hous	e Pty Ltd			Ticket No.	S4193
Client Address:	-					Report No.	WG21/12065_1_PSD
Project:	Propos	sed On Si	te Sewage Disp	osal		Sample No.	WG21/12065
Location:	752 W	752 Wallcliffe Road, Margaret River, WA				Date Sampled:	30-08-2021
Sample Identification	n: BH6, 1	. 7-2.3 m				Date Tested:	7/09 - 8/09/2021

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

atory: Corcett

Date: 08-September-2021



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Appendix H

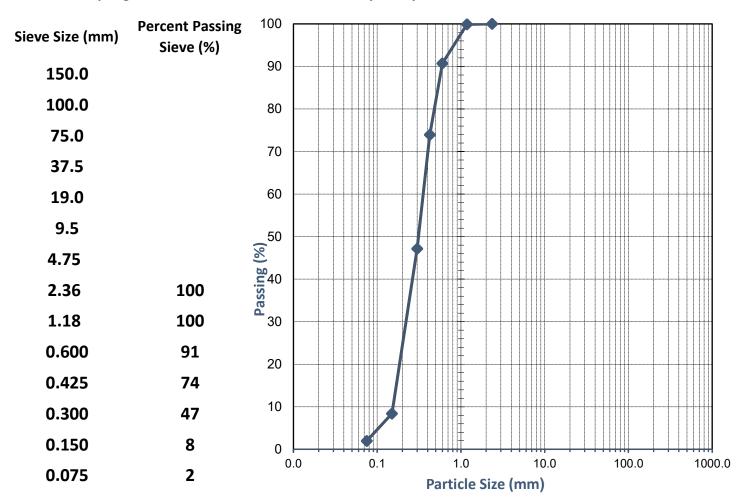
Douglas Partners 2022 Laboratory Test Results



	SOIL AGGREGATE CONCRETE	CRUSH	IING
	TEST REPORT - AS 1289.3.6.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	S5445
Client Address:	-	Report No.	WG22.2223_1_PSD
Project:	Proposed Wallcliffe House Re-development	Sample No.	WG22.2223
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	08/02/2022
Sample Identification:	2, 0.5m	Date Tested:	11/2-14/2/22

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Corcell

Name: Date: 14/February/2022

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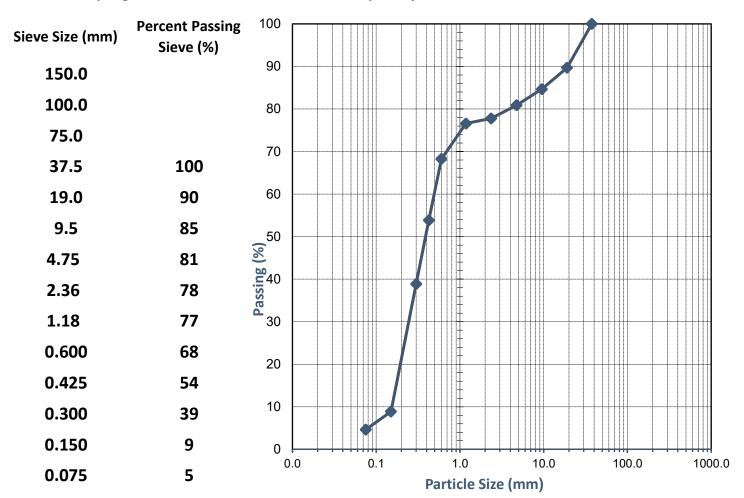
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	soil aggregate concre	ETE CRUSHING
	TEST REPORT - AS 1289.3	.6.1
Client:	Wallcliffe House Pty Ltd	Ticket No. S5445
Client Address:	-	Report No. WG22.2224_1_PSD
Project:	Proposed Wallcliffe House Re-development	Sample No. WG22.2224
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled: 08/02/2022
Sample Identification:	10, 0.1m - 0.3m	Date Tested: 11/2-14/2/222

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name:

Correll

Date: 14/February/2022



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	SOIL AGGREGATE CONCRETE	E CRUSHING
	TEST REPORT - AS 1289.3.6.1	
Client:	Wallcliffe House Pty Ltd	Ticket No. S5445
Client Address:	-	Report No. WG22.2225_1_PSD
Project:	Proposed Wallcliffe House Re-development	Sample No. WG22.2225
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled: 08/02/2022
Sample Identification:	13, 0.5m	Date Tested: 11/2-14/2/22

Sampling Method:

Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)	100					
150.0		90					
100.0		80					
75.0		70					
37.5		70					
19.0		60					
9.5		_50					
4.75		%) 81					
2.36	100	Passing (%)	 	<u> </u>			
1.18	100	30					
0.600	88	20					
0.425	66						
0.300	37	10					
0.150	7	0		1.0	10.0	100.0	1000.0
0.075	3	0.		1.0 Particle S i	10.0 ize (mm)	100.0	1000.0

Comments:

Approved Signatory:

Date: 14/February/2022

Name:



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	SOIL AGGREGATE CONCRETE	CRUSH	ING
	TEST REPORT - AS 1289.3.6.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	S5445
Client Address:	-	Report No.	WG22.2226_1_PSD
Project:	Proposed Wallcliffe House Re-development	Sample No.	WG22.2226
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	08/02/2022
Sample Identification:	20, 1m	Date Tested:	11/2-14/2/22

Sampling Method:

Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)	100					
150.0		90					
100.0		80					
75.0		70					
37.5							
19.0		60					
9.5		50					
4.75		Passing (%)					
2.36	100	assir					
1.18	100	30					
0.600	81	20					
0.425	50	40	/	-			
0.300	25	10					
0.150	6	0	.0 0.1	1.0	10.0	100.0	1000.0
0.075	4	0.	0.1	Particle Siz		100.0	1000.0

Comments:

Approved Signatory:

Date: 14/February/2022



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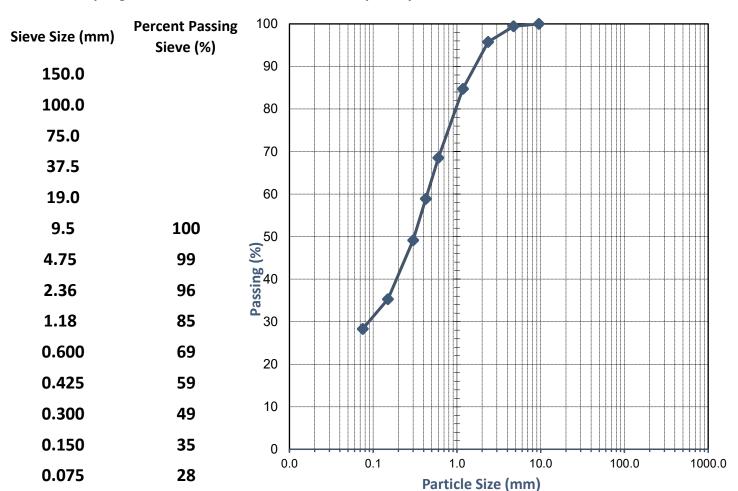
08 9472 3465



	SOIL AGGREGATE CONCRETE	CRUSH	IING
	TEST REPORT - AS 1289.3.6.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	S5445
Client Address:	-	Report No.	WG22.2227_1_PSD
Project:	Proposed Wallcliffe House Re-development	Sample No.	WG22.2227
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	08/02/2022
Sample Identification:	49, 3.0m-3.6m	Date Tested:	11/2-14/2/22

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Corello

Date: 14/February/2022

Name:

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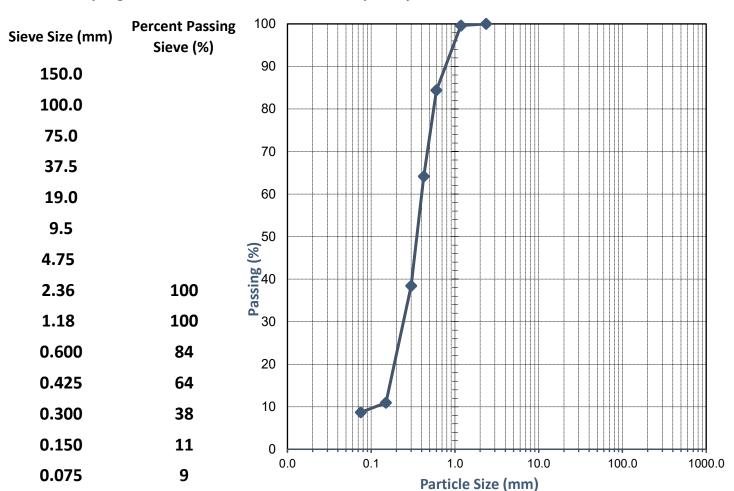
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	SOIL AGGREGATE CONCRETE	CRUSH	IING
	TEST REPORT - AS 1289.3.6.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	S5445
Client Address:	-	Report No.	WG22.2230_1_PSD
Project:	Proposed Wallcliffe House Re-development	Sample No.	WG22.2230
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	08/02/2022
Sample Identification:	51, 0.5m-1.5m	Date Tested:	11/2-14/2/22

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Correcto

Date: 14/February/2022



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	SOIL AGGREGATE CONCRETE	E CRUSHING			
TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1					
Client:	Wallcliffe House Pty Ltd	Ticket No. S5445			
Client Address:	-	Report No. WG22.2227_1_PI			
Project:	Proposed Wallcliffe House Re-development	Sample No. WG22.2227			
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled: 8/02/2022			
Sample Identification:	49, 3.0m-3.6m	Date Tested: 14/02/2022			

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method: Sampled by Client, Tested as Received

History of Sample: Oven Dried <50°C

Method of Preparation: Dry Sieved

AS 1289.3.1.1	Liquid Limit (%)	32
AS 1289.3.2.1	Plastic Limit (%)	22
AS 1289.3.3.1	Plasticity Index (%)	10
AS 1289.3.4.1	Linear Shrinkage (%)	4.0
AS 1289.3.4.1	Length of Mould (mm)	250

Condition of Dry Specimen:

Comments:

Approved Signatory:

AS 1289.3.4.1

Name:

Date: 15/February/2022



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	SOIL AGGREGATE CONCRE	TE CRUSI	HING
	TEST REPORT - AS 1289.5.2	.1	
Client:	Wallcliffe House Pty Ltd	Ticket No.	S5445
Client Address:	-	Report No.	WG22.2223_1_MMDD
Project:	Proposed Wallcliffe House Re-development	Sample No.	WG22.2223
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	8-02-2022
Sample Identification:	2, 0.5m	Date Tested:	11-02-2022

TEST RESULTS - Modified Maximum Dry Density

Sampling Method:

Sampled by Client, Tested as Received

Sample Curing Time:

2 hours

Method used to Determine Liquid Limit:

Visual / Tactile Assessment by Competent Technician

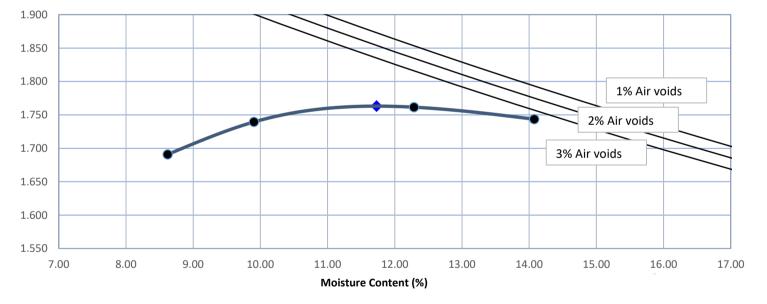
Material + 19.0mm (%):

0

Material + 37.5mm (%)

Moisture Content (%)	8.6	9.9	12.3	14.1	
Dry Density (t/m³)	1.691	1.739	1.762	1.744	





Modified Maximum Dry Density (t/m³)

1.76

Optimum Moisture Content (%)

Name:

11.5

Comments: The above air void lines are derived from a calculated apparent particle density of 2.431 t/m³

Approved Signatory:

Date: 14-February-2022

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WG_AS 1289.5.2.1_TR_4



	SOIL AGGREGATE CONCRE	TE CRUSI	HING
	TEST REPORT - AS 1289.5.2.	1	
Client:	Wallcliffe House Pty Ltd	Ticket No.	S5445
Client Address:	-	Report No.	WG22.2224_1_MMDD
Project:	Proposed Wallcliffe House Re-development	Sample No.	WG22.2224
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	8-02-2022
Sample Identification:	10, 0.1m - 0.3m	Date Tested:	11-02-2022

TEST RESULTS - Modified Maximum Dry Density

Sampling Method:

Sampled by Client, Tested as Received

Sample Curing Time:

Material + 19.0mm (%):

2 hurs

Material + 37.5mm (%)

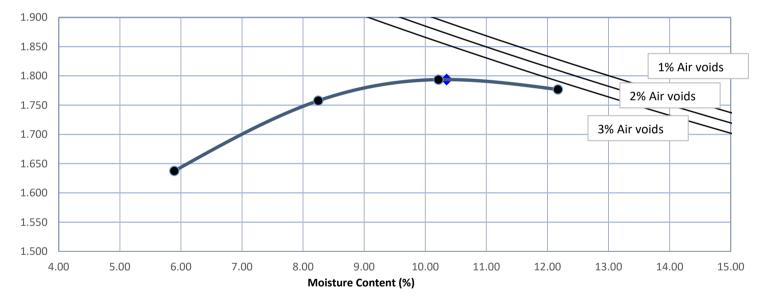
Method used to Determine Liquid Limit:

Visual / Tactile Assessment by Competent Technician

Moisture Content (%)	5.9	8.2	10.2	12.2	
Dry Density (t/m³)	1.637	1.758	1.794	1.777	

11

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³)

1.79

Optimum Moisture Content (%)

10.5

Comments: The above air void lines are derived from a calculated apparent particle density of 2.382 t/m³

Approved Signatory:

Name:

Date: 14-February-2022

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WG_AS 1289.5.2.1_TR_4



	SOIL AGGREGATE CONCRET	E CRUSH	HING
	TEST REPORT - AS 1289.5.2.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	S5445
Client Address:	-	Report No.	WG22.2225_1_MMDD
Project:	Proposed Wallcliffe House Re-development	Sample No.	WG22.2225
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	8-02-2022
Sample Identification:	13, 0.5m	Date Tested:	11-02-2022

TEST RESULTS - Modified Maximum Dry Density

Sampling Method:

Sampled by Client, Tested as Received

Sample Curing Time:

2 hours

Method used to Determine Liquid Limit:

Visual / Tactile Assessment by Competent Technician

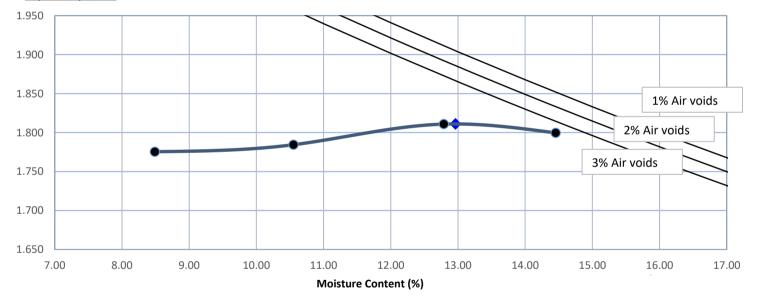
Material + 19.0mm (%):

0

Material + 37.5mm (%)

Moisture Content (%)	8.5	10.6	12.8	14.5	
Dry Density (t/m³)	1.775	1.784	1.811	1.800	

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³)

1.81

Optimum Moisture Content (%)

13.0

Comments: The above air void lines are derived from a calculated apparent particle density of 2.564 t/m³

Approved Signatory:

Name

Date: 14-February-2022

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	SOIL AGGREGATE CONCRETE	CRUSHING	
	TEST REPORT - AS 1289.6.1.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	S5445
Client Address:	-	Report No.	WG22.2223_1_SCBR
Project:	Proposed Wallcliffe House Re-development	Sample No.	WG22.2223
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	8/02/2022
Sample Identification:	2, 0.5m	Date Tested:	11/2-18/2/22

TEST RESULTS - CALIFORNIA BEARING RATIO

Sample Description:

Sand

Sampling Method:

Sampled by Client, Tested as Received

3.0	Load Pene	tration Cur	ve
3.0			
2.5			
2.0	1		
Load (kN)			
Foad			
1.0			
	†		
1.0	+		
0.5	Ī		
	<i></i>		
0.0	<i>†</i>		
0.0	.0 5. Pen	0 10 etration (mn).0 n)

Compaction Details					
Compaction Method	AS 1289.5.2.1	Hammer Type	Modified		
Plasticity Determined by	Estimated	Curing Time (Hours)	2.0		
% Retained 19.0mm	0	Excluded/Replaced	Excluded		
Maximum Dry Density (t/m³)	1.76	Optimum Moisture (%)	11.5		
Target Dry Density Ratio (%)	95	Target Moisture Ratio (%)	100		

Specimen Conditions At Compaction				
Dry Density (t/m3)	1.67	Moisture Content (%)	11.8	
Density Ratio (%)	94.5	Moisture Ratio (%)	100.5	

Specimen Conditions After Soak			
Soaked or Unsoaked	Soaked	Soaking Period (days)	4
Surcharges Applied (kg)	4.50	Measured Swell (%)	0.0
Dry Density (t/m³)	1.67	Dry Density Ratio (%)	94.5
Moisture Content (%)	14.2	Moisture Ratio (%)	121.5

Specimen Conditions After Test				
Top 30mm Moisture (%)	12.8	Remaining Depth (%)	13.6	

Correction applied to Penetration: 0.2mm

Determined at a Penetration of: 5.0mm

California Bearing Ratio (CBR): 12%

Comments:

Approved Signatory:

Name
Date: 22/February/2022

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WG_AS 1289.6.1.1_TR_3 Page 1 of 1



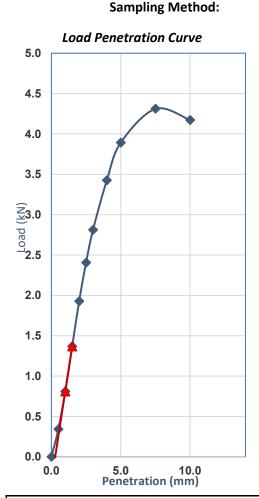
	SOIL AGGREGATE CONCRETE TEST REPORT - AS 1289.6.1.1	CRUSHINC	ì
Client:	Wallcliffe House Pty Ltd	Ticket No.	S5445
Client Address:	-	Report No.	WG22.2224_1_SCBR
Project:	Proposed Wallcliffe House Re-development	Sample No.	WG22.2224
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	8/02/2022
Sample Identification:	10, 0.1m - 0.3m	Date Tested:	11/02 - 18/02/2022

TEST RESULTS - CALIFORNIA BEARING RATIO

Sample Description:

Sand with Gravel

Sampled by Client, Tested as Received



Compaction Details			
Compaction Method	AS 1289.5.2.1	Hammer Type	Modified
Plasticity Determined by	Estimated	Curing Time (Hours)	2.0
% Retained 19.0mm	11	Excluded/Replaced	Excluded
Maximum Dry Density (t/m³)	1.79	Optimum Moisture (%)	10.5
Target Dry Density Ratio (%)	95	Target Moisture Ratio (%)	100

Specimen Conditions At Compaction				
Dry Density (t/m3)	1.72	Moisture Content (%)	10.0	
Density Ratio (%)	95.5	Moisture Ratio (%)	96.5	

Specimen Conditions After Soak			
Soaked or Unsoaked	Soaked	Soaking Period (days)	4
Surcharges Applied (kg)	4.50	Measured Swell (%)	0.0
Dry Density (t/m³)	1.71	Dry Density Ratio (%)	95.5
Moisture Content (%)	13.6	Moisture Ratio (%)	132.0

Specimen Conditions After Test				
Top 30mm Moisture (%)	12.8	Remaining Depth (%)	14.3	

Correction applied to Penetration: 0.3mm

Determined at a Penetration of: 2.5mm

California Bearing Ratio (CBR): 20%

Comments:

Approved Signatory:

Name:

Date: 22/February/2022



Accreditation No. 20599

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WG_AS 1289.6.1.1_TR_3 Page 1 of 1



	SOIL AGGREGATE CONCRETE	CRUSHING	
	TEST REPORT - AS 1289.6.1.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	S5445
Client Address:	-	Report No.	WG22.2225_1_SCBR
Project:	Proposed Wallcliffe House Re-development	Sample No.	WG22.2225
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	8/02/2022
Sample Identification:	13, 0.5m	Date Tested:	14/02 - 18/02/2022

TEST RESULTS - CALIFORNIA BEARING RATIO

Sample Description:

Sand

Sampling Method:

Sampled by Client, Tested as Received

	Load Pene	etration Cur	ve
5.0			
4.5			
4.0		-	•
3.5			
<u>≥</u> 3.0			
(N3.0 peol 2.5	7		
2.0	/		
1.5			
1.0			
0.5			
0.0	.0 5	.0 10 netration (mr	0.0
	Per	netration (mr	n)

Compaction Details			
Compaction Method	AS 1289.5.2.1	Hammer Type	Modified
Plasticity Determined by	Estimated	Curing Time (Hours)	2.0
% Retained 19.0mm	0	Excluded/Replaced	Excluded
Maximum Dry Density (t/m³)	1.81	Optimum Moisture (%)	13.0
Target Dry Density Ratio (%)	95	Target Moisture Ratio (%)	100

Specimen Conditions At Compaction			
Dry Density (t/m3)	1.71	Moisture Content (%)	13.3
Density Ratio (%)	94.0	Moisture Ratio (%)	102.5

Specimen Conditions After Soak			
Soaked or Unsoaked	Soaked	Soaking Period (days)	4
Surcharges Applied (kg)	4.50	Measured Swell (%)	0.0
Dry Density (t/m³)	1.71	Dry Density Ratio (%)	94.0
Moisture Content (%)	15.8	Moisture Ratio (%)	121.5

Spec	cimen Condi	tions After Test	
Top 30mm Moisture (%)	14.8	Remaining Depth (%)	15.7

Correction applied to Penetration: 0.8mm

Determined at a Penetration of: 5.0mm

California Bearing Ratio (CBR): 15%

Comments:

Approved Signatory:

Name:

Date: 22/February/2022



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Project: Proposed Wallcliffe House Re-development Walcliffe House Pty Ltd Client: Date: 08-02-22

Project No. 96717.02 Tested by: Page:

i roject ivo.				rested by.				ı age.	-	
Bore	Depth (m)	Rock Type	Diameter of core (mm)	Length of Core (mm)	Failure Load (kN)		Uncorrected Point Load Strength	Correction Factor	Point Load Strength	Estimated Strength
			d	L	Р	d ²	$Is = (Px1000)/d^2$	$F = (d/50)^{0.45}$	Is ₍₅₀₎ = F x Is	
	13.80 - 13.90		57	110	0.04	3249	0.01	1.06	0.01	EL
	15.60 - 15.70		57	100	0.01	3249	0.00	1.06	0.00	EL
49	16.50 - 16.55	Granulite	57	60	0.03	3249	0.01	1.06	0.01	EL
49	17.65 - 17.80	Granunte	58	170	0.95	3364	0.28	1.07	0.30	М
	17.95 - 18.00		59	60	2.32	3481	0.67	1.08	0.72	М
	18.90 - 19.00		57	110	0.18	3249	0.06	1.06	0.06	VL

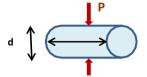




Project:Proposed Wallcliffe House Re-developmentClient:Walcliffe House Pty LtdDate:08-02-22

Project No. 96717.02 Tested by:

Project No.	307 17:02			rested by.				raye.	1	
Bore	Depth (m)	Rock Type	Diameter of core (mm)	Length of Core (mm)	Failure Load (kN)		Uncorrected Point Load Strength	Correction Factor	Point Load Strength	Estimated Strength
			d	L	Р	d^2	Is = $(Px1000)/d^2$	$F = (d/50)^{0.45}$	$Is_{(50)} = F x Is$	
	11.50 - 11.60	Limestone	55	100	0.22	3025	0.07	1.04	0.08	VL
50	12.70 - 12.80	Limestone	58	70	3.66	3364	1.09	1.07	1.16	Н
50	16.40 - 16.45		59	60	0.95	3481	0.27	1.08	0.29	L
	16.55 - 16.65	Granulite	58	100	1.28	3364	0.38	1.07	0.41	M



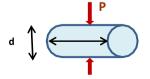
for valid tests L > d



Project:Proposed Wallcliffe House Re-developmentClient:Walcliffe House Pty LtdDate:08-02-22

Project No. 96717.02 Tested by:

0,000 110.	90717.02			rested by.				raye.	1	
Bore	Depth (m)	Rock Type	Diameter of core (mm)	Length of Core (mm)	Failure Load (kN)		Uncorrected Point Load Strength	Correction Factor	Point Load Strength	Estimated Strength
			d	L	Р	d^2	$Is = (Px1000)/d^2$	$F = (d/50)^{0.45}$	$Is_{(50)} = F \times Is$	
	5.80 - 5.95		58	140	13.57	3364	4.03	1.07	4.31	VH
	8.65 - 8.70		57	80	0.75	3249	0.23	1.06	0.24	L
	9.15 - 9.25		57	90	2.14	3249	0.66	1.06	0.70	М
	10.25 - 10.45	Limestone	57	170	1.37	3249	0.42	1.06	0.45	М
	11.90 - 12.00		58	80	2.35	3364	0.70	1.07	0.75	М
	12.65 - 12.70		56	90	0.35	3136	0.11	1.05	0.12	L
51	13.40 - 13.50	Granulite	56	90	0.11	3136	0.04	1.05	0.04	VL
	14.20 - 14.35	Granite	58	130	0.08	3364	0.02	1.07	0.03	EL
	17.25 - 17.35		58	90	0.05	3364	0.01	1.07	0.02	EL
	18.35 - 18.45		58	80	0.07	3364	0.02	1.07	0.02	EL
	19.25 - 19.35	Granulite	58	90	0.1	3364	0.03	1.07	0.03	VL
	19.55 - 19.60		59	65	0.24	3481	0.07	1.08	0.07	VL
	19.70 - 19.80		58	80	0.13	3364	0.04	1.07	0.04	VL



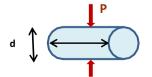
for valid tests L > d



Project:Proposed Wallcliffe House Re-developmentClient:Walcliffe House Pty LtdDate:08-02-22

Project No. 96717.02 Tested by: Page: 1

Project No.	307 17.02			rested by.				raye.	I	
Bore	Depth (m)	Rock Type	Diameter of core (mm)	Length of Core (mm)	Failure Load (kN)		Uncorrected Point Load Strength	Correction Factor	Point Load Strength	Estimated Strength
			d	L	Р	d^2	Is = $(Px1000)/d^2$	$F = (d/50)^{0.45}$	$Is_{(50)} = F x Is$	
	8.73 - 8.83		58	100	15.03	3364	4.47	1.07	4.78	VH
52	11.25 - 11.35	Limestone	58	90	6.45	3364	1.92	1.07	2.05	Н
52	12.90 - 13.00	Limestone	58	120	12.84	3364	3.82	1.07	4.08	VH
	14.00 - 14.20		58	220	12.04	3364	3.58	1.07	3.83	VH



for valid tests L > d

20/02/2022

WGEO

EPLab

N/A

2.40

0.00

0.01





Test Method: AS4133 4.2.1

Client: Western Geotechnical Lab Services

Walcliffe House Redevelopment

Client ID: **BH50**

Project:

Lab ID: WG22_2229_UCS

1.50 - 1.95 Depth (m):

Tested by:

Checked by:

Length/Diameter Ratio: 2.47 **Correction Applied:**

Failure Mode: **Intact Shear**

147.21 Length (mm): Diameter (mm): 59.70

Before Test



After Test

Date Tested:

Lab:

EP Lab Job Number:

Sample Description:

Testing Temperature:

Moisture Content (%):

Loading Rate (mm/min):

Bulk Density (t/m³):

Room Temperature at Test: 19°C



UCS (MPa)	29.29	Bedding Angle (deg)	N/A
Failure Angle (deg)	21.6		

Notes: Accredited for compliance with ISO/IEC 17025-TESTING

Stored and Tested the Sample as received

Samples supplied by the Client

NATA: 19078 **Authorised Signatory (Geotechnical Engineer):**





The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87

20/02/2022

WGEO

EPLab

0.00

0.01





EP Lab Job Number:

Sample Description:

Moisture Content (%):

Loading Rate (mm/min):

Lab:

UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS4133 4.2.1

Client: Western Geotechnical Lab Services Date Tested:

Project: Walcliffe House Redevelopment

Client ID: BH51

Lab ID: WG22_2231_UCS

Depth (m): 2.60 - 2.80 Room Temperature at Test: 19°C

Tested by:

Checked by:

* <u>Testing Temperature:</u> N/A Length/Diameter Ratio: 2.41 Bulk Density (t/m³): 2.43

Correction Applied: N

Failure Mode: Intact Shear

Length (mm): 146.09

Diameter (mm): 60.52

After Test





UCS (MPa)	26.07	Bedding Angle (deg)	N/A
Failure Angle (deg)	22.1		

Notes: Accredited for compliance with ISO/IEC 17025-TESTING

Stored and Tested the Sample as received

Samples supplied by the Client

NATA: 19078 Authorised Signatory (Geotechnical Engineer):



The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87





N/A

UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS4133 4.2.1

Client: Western Geotechnical Lab Services Date Tested: 20/02/2022

Project: Walcliffe House Redevelopment EP Lab Job Number: **WGEO** Client ID: BH51 Lab: **EPLab**

Lab ID: WG22_2232_UCS

9.35 - 9.50 Depth (m): Room Temperature at Test: 19°C

Tested by: Sample Description:

Length/Diameter Ratio: 2.05

Bulk Density (t/m³): 1.98 **Correction Applied: Moisture Content (%):** 12.50

Failure Mode: **Intact Shear**

Length (mm): 123.55 Loading Rate (mm/min): 0.01

Diameter (mm): 60.15

Before Test

Checked by:





Testing Temperature:



UCS (MPa)	1.90	Bedding Angle (deg)	N/A
Failure Angle (deg)	24.6		

Notes: Accredited for compliance with ISO/IEC 17025-TESTING

Stored and Tested the Sample as received

Samples supplied by the Client

NATA: 19078 **Authorised Signatory (Geotechnical Engineer):**





The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87





UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS4133 4.2.1

Client: Western Geotechnical Lab Services Date Tested:

Project: Walcliffe House Redevelopment

Client ID: **BH52**

Lab ID: WG22_2234_UCS

Depth (m): 8.85 - 9.00

Tested by:

Checked by:

Length/Diameter Ratio: 2.14 **Correction Applied:**

Failure Mode: **Intact Shear**

129.32 Length (mm): Diameter (mm): 60.35

20/02/2022

EP Lab Job Number: **WGEO** Lab: **EPLab**

Room Temperature at Test: 19°C Sample Description:

Testing Temperature: N/A

Bulk Density (t/m³): 2.54 0.00

Moisture Content (%):

Loading Rate (mm/min):

0.01

Before Test



After Test



UCS (MPa)	53.14	Bedding Angle (deg)	N/A
Failure Angle (deg)	25.1		

Notes: Accredited for compliance with ISO/IEC 17025-TESTING

Stored and Tested the Sample as received

Samples supplied by the Client

NATA: 19078 **Authorised Signatory (Geotechnical Engineer):**



The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87



Envirolab Services (WA) Pty Ltd trading as MPL Laboratories

ABN 53 140 099 207 16-18 Hayden Court Myaree WA 6154 ph 08 9317 2505 fax 08 9317 4163 lab@mpl.com.au www.mpl.com.au

CERTIFICATE OF ANALYSIS 276561

Client Details		
Client	Western Geotechnical & Laboratory Services	
Attention		
Address	235 Bank Street, Welshpool, WA, 6101	

Sample Details	
Your Reference	<u>\$5445</u>
Number of Samples	3 Soil
Date samples received	10/02/2022
Date completed instructions received	10/02/2022

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.

Report Details				
Date results requested by	16/02/2022			
Date of Issue	15/02/2022			
NATA Accreditation Number 2901. This document shall not be reproduced except in full.				
Accredited for compliance with ISC	0/IEC 17025 - Testing. Tests not covered by NATA are denoted with *			

Results Approved By

Authorised By

MPL Reference: 276561 Revision No: R00



Miscellaneous Inorg - soil							
Our Reference		276561-1	276561-2	276561-3			
Your Reference	UNITS	WG22.2228 - 50, 1.5m-1.95m	WG22.2230 - 51, 0.5m-1.5m	WG22.2233 - 52, 1.5m-1.95m			
Type of sample		Soil	Soil	Soil			
Date prepared	-	14/02/2022	14/02/2022	14/02/2022			
Date analysed	-	14/02/2022	14/02/2022	14/02/2022			
рН	pH Units	8.4	7.5	7.6			
Sulphate	mg/kg	<10	47	<10			
Chloride	mg/kg	22	37	34			

MPL Reference: 276561 Revision No: R00

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-081	Anions - a range of anions are determined by Ion Chromatography based on APHA latest edition Method 4110-B. Soils and other sample types reported from a water extract unless otherwise specified (standard soil extract ratio 1:5).

MPL Reference: 276561 Page | **3 of 6**

Revision No: R00

QUALITY CONTROL: Miscellaneous Inorg - soil				Duplicate			Spike Recovery %			
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			14/02/2022	[NT]	[NT]	[NT]	[NT]	14/02/2022	
Date analysed	-			14/02/2022	[NT]	[NT]	[NT]	[NT]	14/02/2022	
рН	pH Units		INORG-001	[NT]	[NT]	[NT]	[NT]	[NT]	103	
Sulphate	mg/kg	10	INORG-081	<10	[NT]	[NT]	[NT]	[NT]	102	
Chloride	mg/kg	10	INORG-081	<10	[NT]	[NT]	[NT]	[NT]	105	

 MPL Reference:
 276561
 Page | 4 of 6

 Revision No:
 R00

Result Definiti	ons
NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

MPL Reference: 276561 Page | 5 of 6

Revision No: R00

Quality Control	ol 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.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from "2018 TLVs and BEIs", as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

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: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-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.

Measurement Uncertainty estimates are available for most tests upon request.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

MPL Reference: 276561 Page | 6 of 6 R00

Revision No:

Appendix I

GBG Maps Report 70670



Level 1, 2 Sabre Crescent Jandakot, WA 6964 Tel: 08 6436 1599 Email: info@gbgmaps.com.au

A.B.N. 45 129 251 225

GEOPHYSICAL INVESTIGATION FOR SUBSURFACE GEOLOGICAL MAPPING.

WALLCLIFFE HOUSE, 752 WALLCLIFFE ROAD MARGARET RIVER WESTERN AUSTRALIA.

Date: 21 February 2022 Report No.: 70670

Revision: 2

Author:

Reviewed:

Distribution

Douglas Partners



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1. INTRODUCTION

At the request of Douglas Partners, GBGMAPS carried out a geophysical subsurface investigation at the site of Wallcliffe House, 752 Wallcliffe Road Margaret River, WA in January 2022

During the investigation Seismic Refraction, Electric Resistivity Tomography (ERT) and Ground Penetrating Radar (GPR) datasets were acquired, processed and analysed to provide information on the geology underlying the site. In particular, the objectives of the investigation were to:

- Derive the ground profile to depths of between approximately 10 m and 20 m
- · Likely assess depth to groundwater, in particular within low parts of the site
- · Possibly identify fresh groundwater from salty groundwater

The geophysical investigation forms part of a broader scope geotechnical investigation being carried out by Douglas Partners as part of planned redevelopment of the site.

2. INVESTIGATION SITE

The geophysical investigation was carried out along four (4) transects within the site boundaries as shown in pink lines in Figure 1 below. Transects from the previous geophysical investigation carried out by GBGMAPS in September 2020 are shown in blue.



Figure 1: Geophysical transects acquired at Wallcliffe House including the January 2022 investigation (pink lines) and the September 2020 investigation (blue lines).

Ground conditions at the site were suitable for geophysical data acquisition consisting of cleared areas, grass and maintained gardens. Photographs of the typical conditions at the site are shown in Figure 2. Geophysical data was not acquired where surface obstructions were present such as existing buildings and steep topography.

GBGMAPS Pty Ltd Page 3





Figure 2: Site conditions during the geophysical investigation at Wallcliffe House including Transect 1 (top left), Transect 2 (top right), Transect 3 (bottom left) and Transect 4 (bottom right).

3. GEOPHYSICAL TESTING

Geophysical data acquisition was carried out from the 24 to 26 January 2022 by qualified geophysicists from GBGMAPS.

3.1 SEISMIC REFRACTION

Seismic data was acquired using an ECHO-2014 (AmbroGeo Instruments) multi-channel seismograph connected to an array of 4.5Hz centre frequency, vertical geophones placed at 5m intervals along the required transects. Seismic energy was generated using summed sledgehammer impacts onto a metal base plate at regular intervals within the seismic array.

Seismic acquisition parameters were set to enable the inversion of both seismic refraction and Multi-Channel Analysis of Surface Waves (MASW) datasets. Acquisition parameters are provided in Table 1.



Table 1: Seismic Acquisition Parameters

Geophone spacing	5m				
Number of geophones	<48				
Source	Sledgehammer				
Source interval	10m				
Source stacks	5				
Record length	2000ms				
Sample interval	0.128ms				

The Seismic Refraction data was processed using Rayfract (Intelligent Resources Inc.) for inversion using Wave Path Eikonal Traveltime Tomography and the generation of seismic velocity sections showing the variation in modelled seismic compressional (P-) wave velocity along the transects and with level.

Initial processing of the MASW data was carried out using SurfSeis (Kansas Geological Survey). MASW processing was not finalised as the results of the seismic refraction was deemed to provide a better representation of the subsurface conditions at the site.

3.2 ELECTRICAL RESISTIVITY TOMOGRAPHY

ERT data was acquired using a Syscal KID Switch-24 (Iris Instruments) connected to an array of electrodes placed at 5m intervals along the required transects. Data was acquired using a preprogrammed automated control sequence that controlled which pair of electrodes along the array were used for current injection with the resulting potential difference measured across multiple electrode pairs.

ERT acquisition parameters are provided in Table 2.

Table 2: ERT Acquisition Parameters

Electrode spacing	5m
Number of electrodes	<24
Acquisition array type	Wenner
Injection on/off time	2s / 2s
Min. / Max. stacks	4/8
Quality factor	10%
Quadripoles per array	84
Electrode roll along	12

The ERT data was processed using ProsysII (Iris Instruments) for filtering and generation of apparent resistivity pseudo-sections. These were inverted with Earth Imager 2D (AGI) using the smoothness-constrained least-squares technique for the generation of electrical resistivity sections showing the variation in modelled electrical resistivity along the transects and with level.



3.3 GROUND PENETRATING RADAR

GPR data was acquired using a DF (GSSI) system which utilises dual frequency 300MHz and 800MHz ground coupled antennas. Data was acquired by moving the cart-based system as a series of transects over accessible parts of the site.

GPR acquisition parameters are provided in Table 3.

Antenna centre frequency	800 MHz, 300MHz
Two-way travel time	80ns, 140ns
Uncalibrated imaging depth	5m, 8m
Scans per metre	100
Sample number	1024
Sample rate	32 bits
Radar wave velocity	0.12m/ns

Table 3: GPR Acquisition Parameters

The GPR data was processed and analysed using ReflexW Version 9.5 (Sandmeier Software, 2020) with manual gains, and 1D and 2D filters being applied. Continuous and isolated reflection interfaces relating to subsurface features were identified and digitised. An example GPR reflection sections from this investigation is shown in Figure 3.

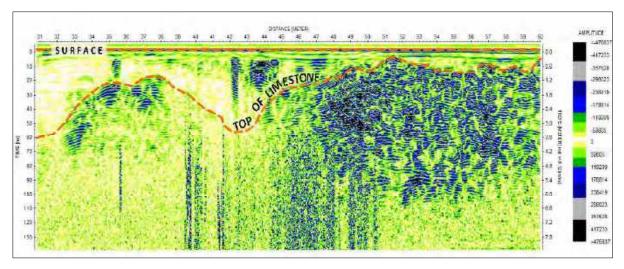


Figure 3: Example interpreted 300MHz radar gram section showing top of limestone rock.

3.4 SPATIAL POSITIONING

Spatial positioning of the acquired geophysical transects was achieved using a Hemisphere S631 GNSS receiver with Atlas satellite corrections. An accuracy of +/- 0.25m is expected for both horizontal and vertical components.

Positions have been provided in GDA2020, MGA zone 50 for the horizontal component and mAHD for the vertical component.



4. RESULTS AND INTERPRETATION

The results of the geophysical investigation carried out at Wallcliffe House, Margaret River WA have been provided as a series of drawings in Appendix A of this report as follows:

- **70670-01** Site map with acquired geophysical transects.
- 70670-02 Transects 1 and 2 Seismic P-wave Velocity section and geological interpretation.
- 70670-03 Transects 3 and 4 Seismic P-wave Velocity section and geological interpretation.
- 70670-04 Transects 1 to 4 Electrical Resistivity Sections with interpreted depth to water table.

4.1 SEISMIC REFRACTION

Seismic P-wave velocity colour contour sections have been generated from the seismic refraction data for each transect. The MASW velocity sections were omitted from the results but were used to aid in the interpretation of the seismic refraction and GPR datasets.

Seismic P-wave Propagation

Seismic P-wave velocity is governed by the elastic properties of the medium it propagates through including bulk modulus, shear modulus and density as shown in the equation below. As such the modelled p-wave velocity provides a useful guide to the subsurface material condition with increasing velocity an indication of increasing material hardness.

Seismic P-wave velocity
$$V_p = \sqrt{\frac{K + \frac{4}{3}G}{\rho}}$$

where; K = Bulk modulus G = Shear modulus $\rho = \text{In-situ material density}$

Seismic P-wave Sections

At the top of each drawing is the seismic velocity tomographic model showing variations in P-wave velocity of the subsurface material as a contour cross-section with increasing velocity from blue, green, yellow, orange, red then brown.

Below the seismic velocity section is a geological section giving the interpreted layering of the subsurface based on detectable P-wave seismic velocity contracts and the interpretation of intrusive geotechnical data. The calculated seismic velocity values have been classed into five categories representing different subsurface conditions. The seismic velocity boundaries for these classes have been calibrated with the provided intrusive testing including logged boreholes, CPT, hand augers and test pits.

1. **Low seismic P-wave velocity** (200-1000 m/s) Yellow hatch – this class is interpreted as SAND of low to moderate compaction and is observed at the surface to shallow depth.



- Moderate seismic P-wave velocity (1000-2200 m/s) Orange cross hatch occurring close
 to the southern bank of Margaret River, this is interpreted as extremely weathered
 GRANULITE typically being recovered as CLAY
- 3. Moderate seismic P-wave velocity (1000-2200 m/s) Light blue brick hatch occurring further away from the southern bank of Margaret River, this is interpreted as interbedded sediments (SAND, Silty SAND, Gravelly SAND and GRAVEL) and LIMESTONE of low rock strength. The modelled seismic velocity range for this class is the same as Class 2 (extremely weathered GRANULITE) and has been differentiated from the results of the geotechnical testing.
- 4. **Moderate to high seismic P-wave velocity** (2200-4000 m/s) Dark blue brick hatch this class is interpreted as slightly weathered to fresh LIMESTONE of moderate rock strength and moderately to highly weathered GRANULITE.
- 5. **High to very high seismic P-wave velocity** (>4000 m/s) Brown arrow hatch this class is interpreted as GRANITE of high rock strength.

Depth to top of Rock

The depth to limestone, granite and granulite rock has been interpreted based on the modelled seismic velocities and using the intrusive geotechnical data provided. Some overlap between the seismic velocity boundaries of the three rock types is expected. For example, weathered granite and granulite is expected to have similar P-wave velocity values to moderately strength limestone. Nonetheless, a general correlation was observed between the intrusive results and the interpreted seismic velocity sections.

CLAY (Extremely weathered GRANULITE)

The extremely weathered GRANULITE layer occurring as a clay has been interpreted from the intrusive testing acquired near the southern bank of Margaret River. This unit shares the same velocity boundaries (1000-2200 m/s) as the interbedded sediments and LIMESTONE of low rock strength but is restricted to the lower lying areas of the site. Where these velocities have been modelled in the upper parts of the site they have been interpreted to be interbedded sediments and LIMESTONE of low rock strength.

Gravel Lenses

The borehole data provided shows lenses of gravel occurring within the interpreted limestone layers. It is postulated that this gravel is a result of the weathering of fresh limestone and is expected to have a reduced seismic P-wave velocity. However, the inversion of seismic refraction data is based on the assumption of an increase in p-wave velocity with depth. In the presence of a velocity inversion (hard over soft material) the data may be truncated due to the refracted signal being unable to penetrate into a lower density material (as defined by Snell's Law), or a higher than expected velocity may be present in the modelled data below an isolated hard layer.



4.2 ELECTRICAL RESISTIVITY TOMOGRAPHY

The geo-electrical sections for each acquired ERT transect are presented in drawing 70670-04 in Appendix A. The sections show the variation in modelled electrical resistivity of the subsurface material in Log₁₀ Ohm metres (Ω m) as per the colour scale.

The modelled resistivity values for this investigation ranged from 5 Ω m to 3000 Ω m. The ERT method was used to map the groundwater level across the transects. The groundwater level was interpreted from the ERT data and calibrated with the intrusive geotechnical testing provided. This has been shown as a white solid squares line across the transects.

Note the differentiation between fresh and saline groundwater was not possible from the modelled electrical resistivity data.

4.3 GROUND PENETRATING RADAR

GPR sections were used to interpret potential areas of karst features to a depth of 8m BGL. It is anticipated that quoted depths may vary by as much as +/-15% due to the various subsurface materials encountered.

No karst features were interpreted within the top 8m of the subsurface along the acquired GPR transects. Note that this does not preclude the existence of smaller karst features between the acquired GPR transects.



5. CONCLUSIONS

A geophysical subsurface investigation has been carried out by GBGMAPS at Wallcliffe House Margaret River, Western Australia. During the investigation geophysical testing by way of Seismic Refraction, Electrical Resistivity Tomography and Ground Penetrating Radar was acquired along several transects as specified by the client.

The Seismic Refraction datasets were processed and inverted to obtain seismic velocity models relating to variations in geology within the site including the interpreted boundaries of limestone and granite/granulite.

The Electrical Resistivity datasets were processed and inverted to map the top of groundwater (water table). Note the differentiation between saline and fresh water could not be made from the resistivity models.

The Ground Penetrating Radar data was processed and interpreted to obtain information relating to potential karst features within the site. No karst features were interpreted along the acquired transects.

The methods used during the investigation are geophysical and as such the results are based on indirect measurements and the processing and interpretation of radar, electrical and seismic wave signals. The findings in this report represent the professional opinions of the authors, based on experience gained during previous similar investigations and with correlation to known and assumed subsurface ground conditions at the site.

We trust that this report and attached drawings provide you with the information required. If you require clarification on any points arising from this investigation, please do not hesitate to contact the undersigned or Baqir Al asadi on (08) 6436 1599.





APPENDIX A - RESULT DRAWINGS

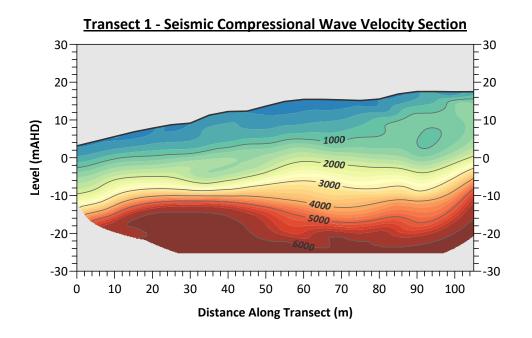


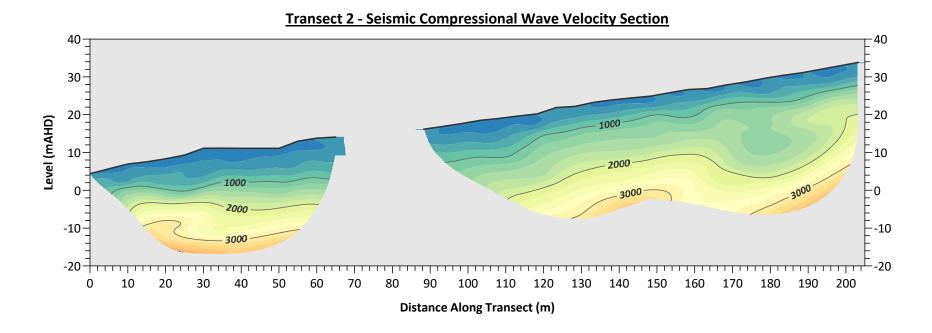
GEOPHYSICAL INVESTIGATION SITE MAP

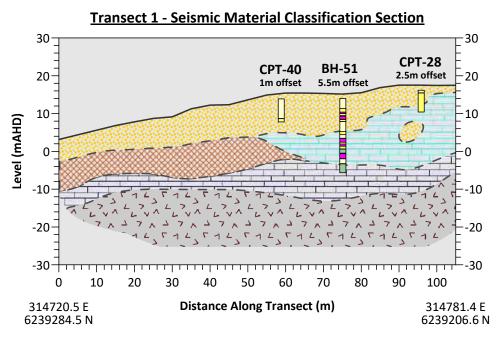


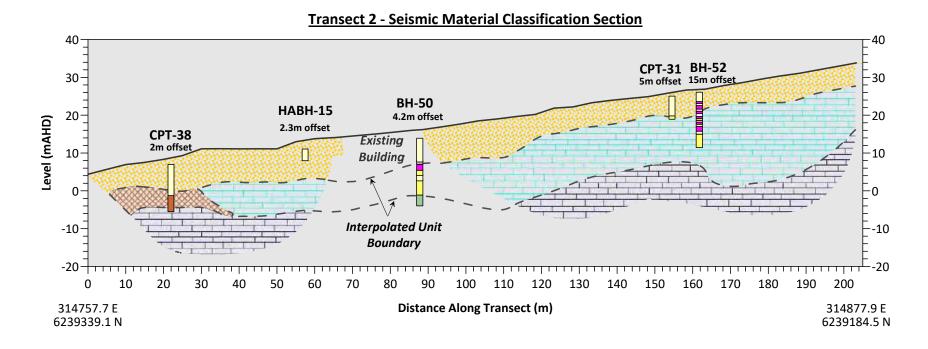


SEISMIC REFRACTION TESTING









LEGEND

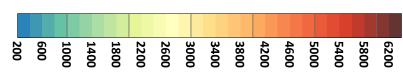
SAND - LOW TO MODERATE COMPACTION
P-WAVE VELOCITY 200-1000 m/s

LOW STRENGTH LIMESTONE - HIGHLY WEATHERED (OCCURS AWAY FROM RIVER)
P-WAVE VELOCITY 1000-2200 m/s

EXTREMELY WEATHERED GRANULITE (OCCURS AS CLAY NEAR RIVER)
P-WAVE VELOCITY 1000-2200 m/s
LIMESTONE - MODERATE ROCK STRENGTH / GRANULITE - MODERATELY TO HIGHLY WEATHERED

GRANITE - HIGH ROCK STRENGTH
P-WAVE VELOCITY >4000 m/s

P-WAVE VELOCITY 2200-4000 m/s



Modelled Compressional (P-) wave velocity (m/s)

Borehole Recovered material type (simplified) Sediment, fine - SILT, SAND LIMESTONE GRAVEL CLAY GRANITE / GRANULITE Core loss

IOTES

Drawing to be used in conjunction with Report 70670 Rev2. Coordinates given are in GDA2020, MGA50.

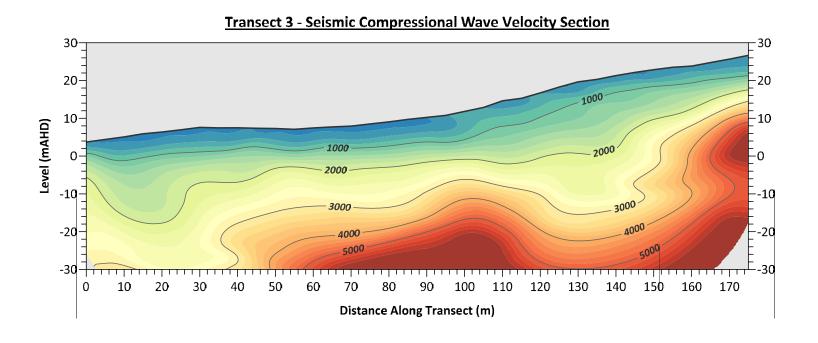
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	752 WALLCLIFFE ROAD MARGARET RIVER WA.	Drawing	70670-02	Revision	1

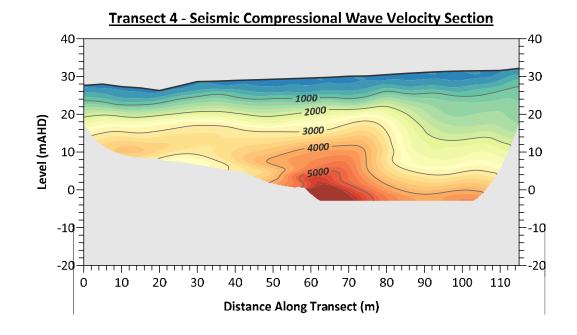


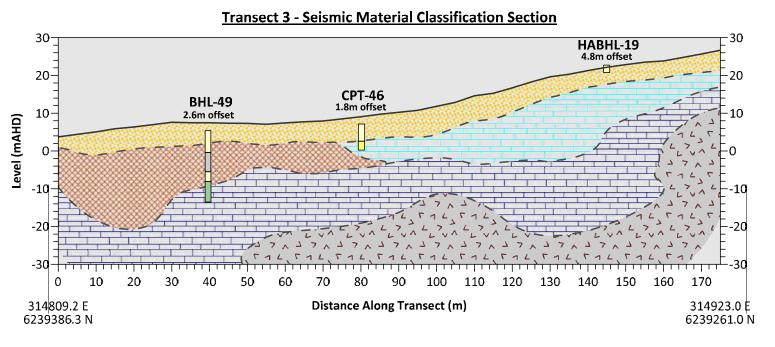
vel 1, 2 Sabre Crescent, Jandakot WA 6164 PO Box 3526, Success WA 6964 Telephone: (08) 6436 1599 Email: info@gbgmaps.com.au



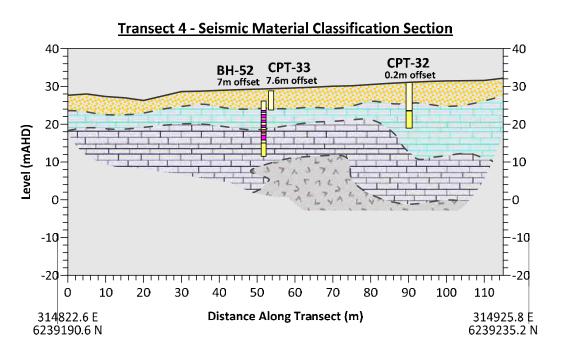
SEISMIC REFRACTION TESTING







CLIENT



LEGEND

SAND - LOW TO MODERATE COMPACTION

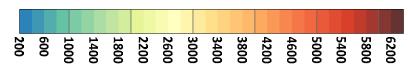
P-WAVE VELOCITY 200-1000 m/s

LOW STRENGTH LIMESTONE - HIGHLY WEATHERED (OCCURS AWAY FROM RIVER) P-WAVE VELOCITY 1000-2200 m/s

EXTREMELY WEATHERED GRANULITE (OCCURS AS CLAY NEAR RIVER) P-WAVE VELOCITY 1000-2200 m/s

LIMESTONE - MODERATE ROCK STRENGTH / GRANULITE - MODERATELY TO HIGHLY WEATHERED P-WAVE VELOCITY 2200-4000 m/s

GRANITE - HIGH ROCK STRENGTH P-WAVE VELOCITY >4000 m/s



Modelled Compressional (P-) wave velocity (m/s)

Recovered material type (simplified) Sediment, fine - SILT, SAND LIMESTONE **GRAVEL** CLAY **GRANITE / GRANULITE** Core loss

NOTES	
Drawing to be used in co	onjunction with Report 70670 Rev2.
Coordinates given are in	GDA2020, MGA50.

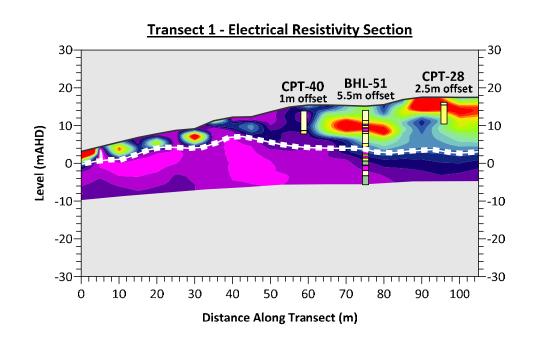
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752 WALLCLIFFE ROAD MARGARET RIVER WA.	Drawing	70670-03	Revision	2

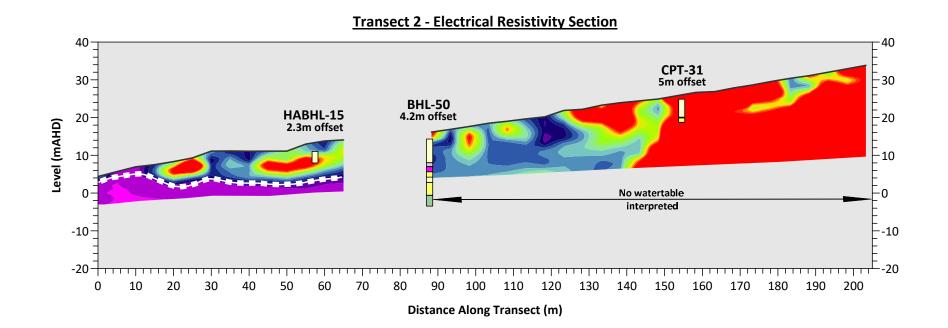


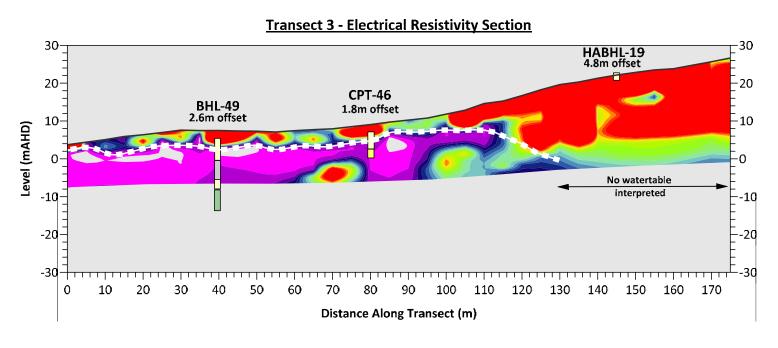
Borehole

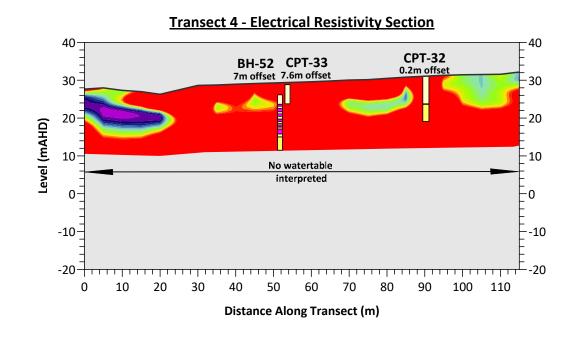


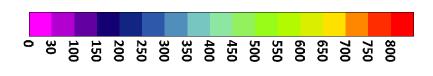
ELECTRICAL RESISTIVITY TOMOGRAPHY











Electrical Resistivity (Log10 Ohm.metres)

INTERPRETED WATER TABLE

Borehole
Recovered material type (simplified)
Sediment, fine - SILT, SAND
LIMESTONE
GRAVEL
GRANITE / GRANULITE
Core loss

OTES

Drawing to be used in conjunction with Report 70670 Rev2. Coordinates given are in GDA2020, MGA50.

GEOPHYSICAL INVESTIGATION FOR WALLCLIFFE HOUSE
REDEVELOPMENT PROJECT.
752 WALLCLIFFE ROAD MARGARET RIVER WA.

CLIENT

 Date
 21 February 2022
 Paper Size
 A3

 Scale
 1:1000
 Drawn

 Drawing
 70670-04
 Revision
 1



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Report on Geotechnical Investigation

Potential Treated Water Infiltration Areas 752 Wallcliffe Road, Margaret River, WA

Prepared for Wallcliffe House Pty Ltd

Project 96717.04 March 2023





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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		24 March 2023
Reviewer		24 March 2023



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Douglas Partners 2021 Laboratory Test Results

Douglas Partners 2023 Laboratory Test Results



Report on Geotechnical Investigation Potential Treated Water Infiltration Areas 752 Wallcliffe Road, Margaret River, WA

1. Introduction

This report presents the results of a geotechnical assessment carried out by Douglas Partners to assist with the selection of an infiltration area of treated water, regarding the proposed Wallcliffe House re-development at 752 Wallcliffe Road in Margaret River, WA. This work was commissioned by Mr Duncan Haslam of Wallcliffe House Pty Ltd in an email dated 7 February 2023, and was undertaken in accordance with Douglas Partners' proposal referenced P96717.04 and dated 6 February 2023.

It is understood that six infiltration areas (labelled as Potential Infiltration Areas 1 to 6 in Drawing 1 in Appendix B) are currently being considered within a portion of the Wallcliffe House site for the disposal of treated water.

The aims of the investigation were to:

- assess the ground conditions beneath the abovementioned potential infiltration areas, including notably:
 - o depth of possible limestone rock, and
 - soil permeability, notably near the base of proposed infiltration systems (assumed to be between
 1.5 m to 2 m depth).
- assess the permeability of the shallow sand occurring in the lower portion of the Wallcliffe House site. This information will assist in understanding hydrogeological conditions and possible constraints downgradient of the proposed infiltration areas; and
- attempt a preliminary assessment of the limestone rock permeability.

It is also understood that the above listed information will be used by the Project Team to select a suitable location for the proposed infiltration area.

The Douglas Partners 2023 investigation included the performance of fifteen cone penetration tests (CPTs), the excavation of six test pits, the drilling of four hand auger boreholes, eleven in situ infiltration tests and laboratory testing of selected samples. The details of the field work are presented in this report, together with comments and recommendations on the items listed above.

2. Site Description

The six potential infiltration areas are located within a vacant area of approximately 0.9 ha at the south-western corner of the Wallcliffe House site. The area is bordered by access roads with the Wallcliffe House's grounds beyond to the north and southwest, an access road with bushland beyond to the south and bushland elsewhere.



At the time of the investigation, the surface cover across the potential infiltration areas mainly comprised grass and sand, with rows of stumps (previously limbed trees) and groups of trees within or in the vicinity of these areas (see Photo 1 below).



Photo 1: View of the potential infiltration areas from test location 3 looking south.

The surface cover within the testing area in the lower portion of the Wallcliffe House site comprised grass bordered by groups of trees with the Margaret River and Wallcliffe House's grounds beyond to the north, west and south and bushland elsewhere.

Based on a level survey plan provided by the client, surface levels within the assessment areas generally slope down from:

- potential infiltration areas: RL 33 at the south-eastern corner of the Potential Infiltration Area 1, to a RL 21 along the northern boundary of the Potential Infiltration Area 5; and
- lower portion of the Wallcliffe House site: RL 7 at its south-eastern end to RL 5 at its north-western end (closest to the Margaret River).

The Cowaramup-Mentelle 1:50,000 Regolith Landform sheet 1930-III and part of 1830-II indicates that the assessment areas are underlain by bedrock of the Leeuwin Complex of the Cowaramup System comprising fresh to weathered granulite and granite. The Quindalup System (calcareous sand) and the Spearwood System (quartz sand overlying calcarenite, ie limestone) are shown immediately adjacent



to the south and approximately 250 m to the northwest of the potential infiltration areas. The above geological setting is shown in Figure 1 below.

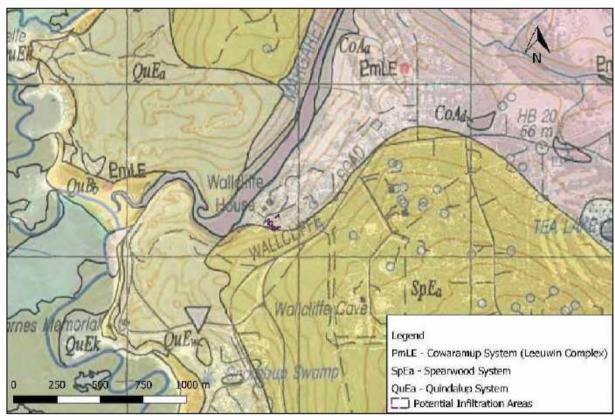


Figure 1: Geological Setting (Base Map is the Cowaramup-Mentelle 1:50,000 Regolith Landform sheet 1930-III and part of 1830-II).

However, results of intrusive investigations (see Section 5.1) indicate that the assessment areas are underlain by the Spearwood System (sand overlying limestone), overlying soils and rock of the Leeuwen Complex bedrock.

3. Previous Studies (September 2020 to January/February 2022)

Previous geotechnical investigations were carried out by Douglas Partners (2020, 2021 and 2022) partially within or in proximity of the assessment areas, and included:

- Douglas Partners, 2020 (Potential Infiltration Areas):
 - o a geophysical investigation comprising the acquisition and interpretation of the following data:
 - Seismic Refraction: for the generation of seismic compressional (p-) wave velocity models to interpret the depth to the various rock types and areas of reduced velocity;
 - Ground Penetrating Radar (GPR): to target shallow and deep geological anomalies relating to karstic features and interpret the depth to rock, to a depth of 10 m below existing site levels; and



- Multi-channel Analysis of Surface Waves (MASW): for the generation of seismic shear (s-) wave velocity models as a supplementary method to aid in the interpretation of the Seismic Refraction and GPR.
- Emerge Associates, 2021 (Potential Infiltration Areas and Lower Portion of the Wallcliffe House Site):
 - o drilling of two boreholes (MW02 and MW05), and installation of groundwater monitoring wells within the boreholes.
- Douglas Partners, 2021 (Potential Infiltration Areas):
 - the drilling of three hand auger boreholes (test locations 2, 4 and 5);
 - Perth sand penetrometer tests adjacent to the abovementioned boreholes; and
 - six in-situ infiltration tests.
- Douglas Partners, 2022 (Potential Infiltration Areas and Lower Portion of the Wallcliffe House Site):
 - a geophysical investigation, undertaken by Douglas Partners partially within the potential infiltration areas in September 2020, comprising the acquisition and interpretation of the following data:
 - Seismic Refraction: for the generation of seismic compressional (p-) wave velocity models to interpret the depth to the various rock types and areas of reduced velocity;
 - Ground Penetrating Radar (GPR): to target shallow and deep geological anomalies relating to karstic features and interpret the depth to rock, to a depth of 8 m below existing site levels;
 - Multi-channel Analysis of Surface Waves (MASW): for the generation of seismic shear (s-) wave velocity models as a supplementary method to aid in the interpretation of the Seismic Refraction and GPR; and
 - Electrical Resistivity Tomography (ERT): to map the groundwater level.
 - o the drilling of one borehole using diamond coring drilling techniques (test location 52);
 - the performance of seven cone penetration tests (three CPT's, test locations 31, 33 and 35, within potential infiltration areas and four CPTU's, test locations 38, 43, 46 and 47 within the lower portion of the Wallcliffe House site); and
 - the excavation of four test pits (three test locations (4, 11 and 12) within the potential infiltration areas and one test location (16) within the lower portion of the Wallcliffe House site).

Relevant CPT traces, test pit and borehole logs from the 2021 and 2022 investigations are included in Appendices C and D and the test locations, including the location of the 2020 and 2022 geophysical investigation survey lines, are shown on Drawing 2 in Appendix B. The results of the 2020 and 2022 geophysical surveys are included in the GBG Maps Reports 70585 and 70670 in Appendices E and F. The results from these former investigations were considered for this study and in particular were incorporated in the description of the ground conditions and soil model outlined in Section 5.1 and the groundwater observations in Section 5.2.



4. Field Work Methods (February 2023)

Field work was carried out on 15 and 16 February 2023 and supervised by a geotechnical engineer from Douglas Partners. The field work comprised:

- the performance of fifteen cone penetration tests within the potential infiltration areas;
- the excavation of six test pits within the potential infiltration areas;
- the drilling of four hand auger boreholes within the lower portion of the Wallcliffe House site;
- Perth sand penetrometer testing adjacent to the abovementioned test pits and boreholes;
- eleven in situ infiltration tests (seven within the potential infiltration areas and four within the lower portion of the Wallcliffe House site);
- falling head tests within an existing monitoring well; and
- laboratory testing of selected soil samples.

The cone penetration tests (CPTs, test locations 1 to 15) were carried out by using a 36 mm diameter instrumented cone with a following 130 mm long friction sleeve attached to rods of the same diameter, pushed continuously at a rate of 2 cm/sec into the soil by hydraulic thrust from a truck rig. Strain gauges in the cone and sleeve measure resistance to penetration and this data allows the assessment of the type and condition of the materials penetrated. The cone penetration tests were pushed to depths of between 0.6 m and 10 m below existing ground levels, where refusal on excessive rods inclination or on inferred limestone rock was experienced. Upon withdrawing the CPT probe, each location was "dipped" to measure any groundwater level.

The test pits were excavated using an 8 tonne excavator equipped with a 0.5 m wide toothed bucket and the boreholes drilled using a 110 mm hand auger, to a target depth of 2 m below existing ground levels. The test pits and boreholes were logged in accordance with AS 1729-2017 by an engineer from Douglas Partners.

PSP tests were carried out adjacent to the abovementioned test pits and boreholes in accordance with AS 1289.6.3.3 to depths up to 2.5 m. Results of PSP testing were used to assess the in situ density of the shallow soils.

In-situ infiltration tests were performed using the constant head and falling head methods. The location, depths of testing, and results are discussed in detail in Section 5.3.

Falling head tests were also performed within a monitoring well installed within the borehole at test location 52 during the Douglas Partners 2022 investigation and results are discussed in detail in Section 5.3.

Test locations were determined using GPS coordinates and site features, and are marked on Drawing 3 in Appendix B. Surface elevations at test locations were measured using a differential GPS with a reported accuracy of ±0.1 m and are quoted relative to Australian Height Datum (AHD).



5. Field Work Results

5.1 Ground Conditions

Detailed CPT traces and test pit and borehole logs from the 2023 investigation are presented in Appendix G, together with notes defining descriptive terms and classification methods used in Appendix A.

The ground conditions encountered at the test locations during the various Douglas Partners investigations (2020-2023) can be summarised with the following ground model:

• Potential Infiltration Areas

- Unit 0: SANDY TOPSOIL (SAND SP-SM and Gravelly SAND SP-SM) 100 mm to 200 mm thick, fine to medium grained, grey-brown, with silt and various amounts of gravel, roots and rootlets, encountered at some test locations.
- Unit 1: Local SANDY FILL (SAND SP/SP-SM and Silty SAND SM) encountered to depths up to 1.6 m, variably compacted, fine to medium grained, grey-brown, with various amounts of silt, at several test locations. Some of this fill is possibly in situ disturbed soils from previous land usage. Locations of the encountered fill are indicated in Table 1 on page 9.
 - The fill included some Gravelly SAND SP-SM and Gravelly Clayey SAND SC layers from surface at test location 4 (2022 investigation) to a depth of 0.4 m below existing ground level.
- O Unit 2: Residual Sand of Spearwood System (SAND SP) fine to medium grained, grey-yellow-orange-brown, trace silt, limestone cobbles and gravel, encountered to depths of between 0.5 m (refusal on limestone rock) and 9.5 m below existing ground levels at all deeper (diamond core borehole and CPTs) test locations during the 2022 and 2023 investigations.

The natural sand was generally medium dense to dense, however very loose to loose zones between 0.3 m and 6 m in thickness were recorded at some test locations to depths of between 1.5 m and 9.5 m below existing ground levels (refer to Table 1 on page 9 for thicknesses and levels of loose zones)

A zone of very low density (possible void within very weakly cemented sand) was measured between 4.5 m and 4.7 m depth at test location 14 during the 2023 investigation, however is inferred to be localised without any significance on the proposed development.

Unit 3: Limestone of the Spearwood System – very weakly to strongly cemented, very low to very high strength, underlying the sand of Unit 2, encountered to the limit of 2022 investigation up to 14.5 m depth. Depth and levels of encountered limestone are provided in Table 1 on page 9 and shown on Drawings 4 and 5 in Appendix B.

Sand zones approximately varying between 0.6 m and 2.3 m in thickness, were recorded at various depths within the limestone rock.

A possible void or rock discontinuity, likely infilled with very loose sand (see comments on page 13), was interpreted over a 0.6 m depth interval at test location 5 during the 2023



investigation, from 6.6 m depth. This inferred localised feature does not impact the proposed development.

Lower Portion of the Wallcliffe House Site

- O Unit 0: SANDY TOPSOIL (SAND SP-SM) 150 mm and 200 mm thick, fine to medium grained, grey-brown, with silt, trace rootlets, encountered at all 2023 investigation test locations.
- Unit 1: SANDY FILL (SAND SP-SM and Silty SAND SM) generally very loose to loose, fine to medium grained, grey-brown, with various amounts of silt, encountered to depths up to 1.1 m at some test locations. Some of this fill is possibly disturbed soils from previous land usage. Locations of the encountered fill zones are indicated in Table 1 on page 9.

The fill included some Gravelly SAND SP-SM and Clayey SAND SC layers, recorded from surface at test locations 43 and 47 (2022 investigation), to depths of 0.3 m and 0.6 m below existing ground levels, respectively.

Unit 2: Residual Sand of Spearwood System (SAND SP/SP-SM) – fine to medium grained, grey-orange-brown, with various amounts of silt, encountered to depths of between 4.7 m and 8.1 m below existing ground levels at all test locations.

The natural sand was generally very loose to loose, becoming medium dense to dense, with depth (refer to Table 1 on page 9 for thicknesses and levels of loose zones).

- Unit 3: Limestone of the Spearwood System very weakly to strongly cemented, encountered at test location 46 (upper portion of the assessment area during the 2022 investigation) underlying the sand of Unit 2, from a depth of 4.7 m below existing ground level.
 Depth and level of encountered limestone are provided in Table 1 on page 9.
- O Unit 4: Residual Soils of the Leeuwin Complex (Clayey SAND SC, Sandy SILT ML, Silty SAND SM and CLAY) stiff to hard and medium dense to dense, encountered at 5 m and 8 m depth underlying the Unit 2 sand within the lower portions of the assessment area (test locations 38 and 43 respectively, during the 2022 investigation), to depths of 12.4 m and 13.4 m (refusal on inferred granitic rock) below existing ground levels.
- O Unit 5: Granulite and Granite of the Leeuwin Complex (inferred) refusals experienced during the 2022 investigation CPT testing at test locations 38 and 43, observations from other tests (ie diamond core boreholes) in the vicinity of the abovementioned test locations and local experience, strongly suggest the occurrence of granitic bedrock underlying Unit 4. The depths and relative levels of inferred granitic rock surface are summarised in Table 1 on page 9.

A schematic ground model of the ground conditions anticipated beneath the potential infiltration and lower portions of the Wallcliffe House site assessment areas, is shown in Figure 1 next page.



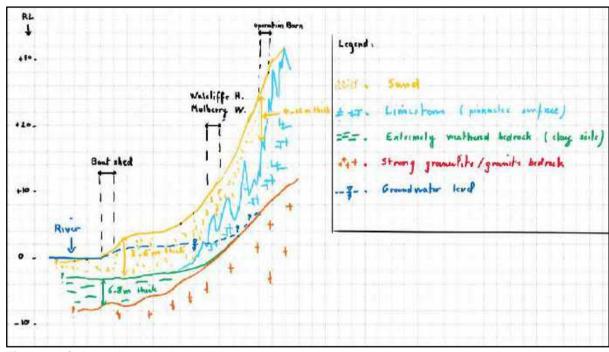


Figure 1: Schematic ground model.



Table 1: Depth and Levels of Selected Ground Features

	Potential	Douglas			F	ill	Loose Soils			Top of Limestone		Top of Residual Soils of the Leeuwin Complex		Top of Granulite / Granitic Bedrock		
Location	Infiltration Area	Partners Investigation	Test Location	Surface Level (m AHD)	Depth to Base	Level of Base	Dept	h (m)	Dept	h (m)	Depth	Level	Depth	Level	Depth	Level
					(m)	(m AHD)	From	То	From	То	(m)	(m AHD)	(m)	(m AHD)	(m)	(m AHD)
		2022	11	32.2 ^[1]	NE	NE	NE	NE	NE	NE	2.4 ^[3]	29.6 ^[3]	NE	NE	NE	NE
		2022	12	32.1 ^[1]	NE	NE	NE	NE	NE	NE	1.4	30.7	NE	NE	NE	NE
			10	31.6 ^[2]	0.9	30.7	GL	1.4	31.6	30.2	6.4	25.2	NE	NE	NE	NE
	1		11	31.8 ^[2]	0.2	31.6	GL	1.5	31.8	30.3	9.5	22.3	NE	NE	NE	NE
			12	34.0 ^[2]	1.1	32.9	GL	1.1	34.0	32.9	3.5	30.5	NE	NE	NE	NE
Areas		2023	20	34.0 ^[2]	1.3	32.7	NE	NE	NE	NE	>2.0	<32.0	NE	NE	NE	NE
Potential Infiltration Areas			19	31.0 ^[2]	NE	NE	NE	NE	NE	NE	>2.0	<29.0	NE	NE	NE	NE
ıtial Ir			4	30.1 ^[1]	NE	NE	NE	NE	NE	NE	>4.0	<26.1	NE	NE	NE	NE
Poter		2021	5	31.1 ^[1]	NE	NE	3.15	>4.2	27.95	<26.9	>4.0	<27.1	NE	NE	NE	NE
			33	28.8 ^[1]	0.5	28.3	GL	0.5	28.8	3.8 28.3 4.8 24.0	24.0	NE	NE	NE	NE	
	2	2022	35	28.5 ^[1]	NE	NE	GL	0.9	28.5	27.6	4.3	24.2	NE	NE	NE	NE
				20. 4[2]		00.4	GL	0.5	29.4	28.9	2.0	20.0				1:
		2023	8	29.4 ^[2]	1.3	28.1	6.0	6.6	23.4	22.8	6.6	22.8	NE	NE	NE	NE
Niete (4)			9	29.9[2]	1.3	28.6	GL	0.6	29.9	29.3	2.4	27.5	NE	NE	NE	NE

Note [1]: Surface elevation interpolated from a survey plan provided by the client.

^{[2]:} Surface elevation measured using a differential GPS with a reported accuracy of ±0.1 m or ±1 m.

^{[3]:} Limestone pinnacle.

NE: Not Encountered.



Table 1 (continued): Depth and Levels of Selected Ground Features

	Potential	Douglas			F	ill		Loose	Soils		Top of	Limestone	of the	esidual Soils Leeuwin emplex		Granulite / c Bedrock
Location	Infiltration Area	Partners Investigation	Test Location	Surface Level (m AHD)	Depth to Base	Level of Base	Depth (m)		Depth (m)		Depth	Level	Depth	Level	Depth	Level
					(m)	(m AHD)	From	То	From	То	(m)	(m AHD)	(m)	(m AHD)	(m)	(m AHD)
			6	27.0 ^[2]	NE	NE	GL	0.7	27.0	26.3	2.4	24.6	NE	NE	NE	NE
		2023	7	27.0 ^[2]	1.0	26.0	GL	1.0	27.0	26.0	4.7	22.3	NE	NE	NE	NE
	3		18	27.0 ^[2]	NE	NE	NE	NE	NE	NE	>2.0	<25.0	NE	NE	NE	NE
							GL	7.0	26.1	19.1						NE
			52	26.1 ^[1]	NE	NE	7.5	8.45	18.6	17.65	7.0	19.1	NE	NE	NE	
		2022					9.0	10.95	17.1	15.15						
			31	25.0 ^[1]	0.4	24.6	GL	1.5	25.0	23.5	5.2	19.8	NE	NE	NE	NE
			31	25.013	0.4	24.6	4.0	>6.0	21.0	<19.0	5.2	19.8	NE	NE	NE	NE
	4		4	23.5 ^[2]	1.0	22.5	GL	1.4	23.5	22.1	2.4	21.1	NE	NE	NE	NE
s ea s		2023	5	24.0 ^[2]	NE	NE	GL	0.9	24.0	23.1	6.3	17.7	NE	NE	NE	NE
n Are		2023	5	24.0	INE	INE	5.4	6.3	18.6	17.4	6.3	17.7	INE	INE	INE	
Potential Infiltration Areas			17	24.0 ^[2]	NE	NE	NE	NE	NE	NE	>2.0	<22.0	NE	NE	NE	NE
al Infi			1	19.6 ^[2]	1.1	18.5	0.8	1.4	18.8	18.2	7.2	12.4	NE	NE	NE	NE
otentii				19.0	1.1	10.5	2.0	7.2	17.6	12.4	1.2	12.4	INE	INE	INE	
A A							GL	1.5	21.7	20.2						
	5	2023	2	21.7 ^[2]	1.2	20.5	5.1	6.5	16.6	15.2	6.5	15.2	NE	NE	NE	NE
							7.7	10.0	14.0	11.7						
			3	21.2 ^[2]	1.6	19.6	GL	1.6	21.2	19.6	7.2	14.0	NE	NE	NE	NE
			16	21.0 ^[2]	1.4	19.6	NE	NE	NE	NE	>2.0	<19.0	NE	NE	NE	NE
		2022	4	23.0 ^[1]	0.6	22.4	NE	NE	NE	NE	0.6	22.4	NE	NE	NE	NE
			13	21.0 ^[2]	1.2	19.8	GL	1.2	21.0	19.8	5.4	15.6	NE	NE	NE	NE
	6	0000	14	20.6 ^[2]	1.1	19.5	0.6	6.3	20.0	14.3	6.3	14.3	NE	NE	NE	NE
		2023	15	20.3 ^[2]	0.5	19.8	NE	NE	NE	NE	0.5	19.8	NE	NE	NE	NE
Note [1]:			21	22.0 ^[2]	1.1	20.9	NE	NE	NE	NE	1.6 ^[3]	20.4 ^[3]	NE	NE	NE	NE

Note [1]: Surface elevation interpolated from a survey plan provided by the client.

^{[2]:} Surface elevation measured using a differential GPS with a reported accuracy of ±0.1 m or ±1 m.

^{[3]:} Limestone pinnacle.

NE: Not Encountered.



Table 1 (continued): Depth and Levels of Selected Ground Features

	Douglas		Surface Level (m AHD)	Fill			Loose	e Soils Top of			Limestone	of the	esidual Soils Leeuwin mplex	Top of Granulite Granitic Bedroc	
Location	Partners Investigation			Depth to Base (m)	Level of Base	Dept	Depth (m)	Depth (m)		Depth Level		Depth	Level	Depth	Level
					(m AHD)	From	То	From	То	(m)	(m AHD)	(m)	(m AHD)	Depth (m) Leve (m AF) NE NE 12.4 -5.5 13.5 -6.5 5.8 1.4 NE NE NE NE	(m AHD)
	2022	16	8.0 ^[1]	0.3	7.7	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
		38	6.9 ^[1]	NE	NE	GL	2.5	6.9	4.4	NE	NE	8.1	-1.2	12.4	-5.5
		43	7.0 ^[1]	1.1	5.9	GL	3.3	7.0	3.7	NE	NE	5.1	1.9	13.5	-6.5
		46	7.2 ^[1]	NE	NE	GL	4.7	7.2	2.5	4.7	7.2	NE	NE	5.8	1.4
Lower Portion of the		47	7.5 ^[1]	0.6	6.9	GL	1.7	7.5	5.8	NE	NE	NE	NE	NE	NE
Wallcliffe House Site		22	4.0	NE	NE	NE	NE	NE	NE	NE	NE	>2.0	<2.0	NE	NE
	2023	23	8.0	0.7	7.3	NE	NE	NE	NE	NE	NE	>2.0	<6.0	NE	NE
		24	7.0	NE	NE	NE	NE	NE	NE	NE	NE	>2.0	<5.0	NE	NE
		25	7.0	NE	NE	NE	NE	NE	NE	>2.0	<5.0	NE	NE	NE	NE

Note [1]: Surface elevation interpolated from a survey plan provided by the client.

^{[2]:} Surface elevation measured using a differential GPS with a reported accuracy of ±0.1 m or ±1 m.

^{[3]:} Limestone pinnacle.

NE: Not Encountered.



Geophysical sections and associated interpreted geological sections from the Douglas Partners 2020 and 2022 geophysical surveys along each transect within or in the vicinity of the potential infiltrations areas are included in the GBG Maps Reports 70585 (Drawings 70585-03 to 70670-07, Appendix A) and 70670 (Drawings 70670-02 and 70670-03, Appendix A) in Appendices E and F.

Selected interpretations from the 2020 and 2022 geophysical surveys are listed below:

- The interpreted depth to the top of limestone rock (ie thickness of soil overlying limestone rock) varies between less than 1.5 m (see Drawings 4 and 5 in Appendix B) within and in the vicinity of the potential infiltration areas, to approximately 8 m below existing site levels. These results are consistent with the results of a comprehensive amount of intrusive testing (CPT, drilling and test pitting) undertaken in this area and proving depth to limestone.
- The depth to the top of granulite and granitic bedrock were interpreted at depths of generally 18 m to 22 m beneath the Potential Infiltration Areas 1 to 5. The bedrock surface trends downwards from about RL 14 beneath the uphill Potential Infiltration Area 1 to RL 2 beneath the downhill Potential Infiltration Area 5, approximately following the site topography above. The depth to granulite and granitic bedrock beneath Potential Infiltration Area 6 is not accurately assessed (less than RL 8, more than 14 m depth). Despite the above downslope trend approximately following the hill topography, some notable variation in bedrock levels parallel to the hillslope were noted as discussed in the following two bullet points.
- Bedrock level is interpreted to increase eastwards along Potential Infiltration Area 1, from RL 10 at its western end to RL 18 at its eastern end.
- A notable increase in bedrock surface level was interpreted to the east of Potential Infiltration
 Areas 4 and 5, increasing from about RL 2 to RL 5 (about 22 m depth) beneath these infiltration
 areas, to RL 10 (12 m depth) within a distance of about 10 m to 20 m to the east of these infiltration
 areas.

It is emphasised that levels and depths interpreted from geophysical data should be considered indicative, because geophysical surveys comprise indirect measurement (ie no visual inspection) of the ground conditions and are sporadically calibrated using intrusive (direct) tests. In particular, no results from intrusive drilling are available in the area of the proposed infiltration systems to confirm the geophysical interpreted levels of bedrock, and therefore geophysical results have been calibrated using geotechnical drilling outside this area. Indicatively, a level of accuracy of at least 5 m is suggested regarding the geophysical interpreted results regarding bedrock levels.

5.2 Groundwater

Groundwater levels measurements in standpipes installed at test locations MW02 and MW05 during the Emerge Associates 2021 investigation and at test location 52 during the Douglas Partners 2022 investigation, are summarised in Table 3 next page. The presence of groundwater within testing depth was assessed from interpreted pore pressure measurements at some of the CPTU test locations during the Douglas Partners 2022 investigation, and CPT probeholes were dipped after testing during the 2023 investigation.

In summary, no groundwater was recorded within testing depth (RL 11.7 minimum) beneath the infiltration areas during the various investigations. Groundwater was observed within testing depth in



the lower part of the Walcliffe House site. A detail of the measurements is provided in Table 3 below and next page.

Table 3: Summary of Groundwater Observations (all investigations)

Potential Infiltration Area	Investigation	Test Location	Surface Level (m AHD)	Date of Observation	Groundwater Depth (m)	Approximate Groundwater Level (m AHD)
		11	32.2 ^[2]		>3.0	<29.2
	Douglas Partners 2022	12	32.1 ^[2]	24January 2022	>1.4	<30.7
		10	31.6 ^[3]		>6.2	<25.4
1		11	31.8 ^[3]	15 February 2023	>4.9	<26.9
	December Destroys 0000	12	34.0 ^[3]		>5.5	<28.5
	Douglas Partners 2023	20	34.0 ^[3]]	>2.0	<32.0
		19	31.0 ^[3]	16 February 2023	>2.0	<29.0
		4	30.1 ^[2]		>4.0	<26.1
2	Douglas Partners 2022	5	31.1 ^[2]	30 August 2021	>4.0	<27.1
		8	29.4 ^[3]		>7.7	<21.7
	Douglas Partners 2023	9	29.9 ^[3]]	>1.2	<28.7
		6	27.0 ^[3]	15 February 2023	>1.2	<25.8
	Douglas Partners 2023	7	27.0 ^[3]		>1.3	<25.7
3		18	27.0 ^[3]	16 February 2023	>2.0	<25.0
	Douglas Partners 2022	52	26.10 ^[2]	3 February 2022	>14.4	<11.7
		4	23.5 ^[3]	16 February 2023	>3.8	<19.7
4	Douglas Partners 2023	5	24.0 ^[3]	15 February 2023	>4.3	<19.7
		17	24.0 ^[3]	16 February 2023	>2.0	<22.0
	Emerge Associates 2021	MW05	21.89 ^[1]	2 September 2021	>6.00	<15.9
		1	19.6 ^[3]	40.51	>4.8	<14.8
5	D 1 D 1 0000	2	21.7 ^[3]	16 February 2023	>7.7	<14.0
	Douglas Partners 2023	3	21.2 ^[3]	15 February 2023	>3.5	<17.7
		16	21.0 ^[3]	16 February 2023	>2.0	<19.0
	Douglas Partners 2022	4	23.0 ^[2]	25 January 2022	>0.6	<22.4
6		13	21.0 ^[3]		>5.1	<15.9
6	Douglas Partners 2023	14	20.6 ^[3]	16 February 2023	>6.0	<14.6
		21	22.0 ^[3]		>2.0	<20.0

Note

- [1] Surface level provided by Emerge Associates.
- [2] Surface level interpolated based on a survey plan provided by the client.
- [3]: Surface elevation measured using a differential GPS with a reported accuracy of ±0.1 m or ±1 m.
- [4] Results suggest that groundwater is perched on clay layer within the soil profile.



Table 3 (continued): Summary of Groundwater Observations

Location	Investigation	Test Location	Surface Level (m AHD)	Date of Observation	Groundwater Depth (m)	Approximate Groundwater Level (m AHD)
	Emerge Associates 2021	MW02	7.38 ^[1]	2 September 2021	6.03	1.35
		38	6.90 ^[2]		5.50	1.4
	Douglas Partners 2022	43	7.00 ^[2]	1 February 2022	5.25	1.75 (perched ^[4])
Lower Portion of the		46	7.20 ^[2]		4.10	3.1
Wallcliffe House Site		22	4.0 ^[3]		>2.0	<2.0
		23	8.0 ^[3]		>2.0	<6.0
	Douglas Partners 2023	24	7.0 ^[3]	15 February 2023	>2.0	<5.0
		25	7.0 ^[3]		>2.0	<5.0

- Note [1] Surface level provided by Emerge Associates.
 - [2] Surface level interpolated based on a survey plan provided by the client.
 - [3]: Surface elevation measured using a differential GPS with a reported accuracy of ±0.1 m or ±1 m.
 - [4] Results suggest that groundwater is perched on clay layer within the soil profile.

It should be noted that groundwater levels are affected by various factors such as climatic conditions, land usage and the Margaret River and ocean levels (which is impacted by tides, storm surges and longterm sea level rise) and will therefore vary with time.

An attempt was made to interpret results of the 2022 geophysical survey to inform on groundwater levels. However, owing to conflicts between interpreted data and groundwater observations, it was recommended that the results of the 2022 geophysical survey be disregarded.

5.3 **Results of Infiltration Testing**

A total of three in-situ infiltration tests using a falling head method were carried out during the Douglas Partners 2021 investigation in the vicinity of the potential infiltration areas, within the shallow sand of Unit 2 at a depth of 2 m below existing ground levels. Eleven in-situ infiltration tests were also carried out during the Douglas Partners 2023 investigation, as follows:

- seven in situ infiltration tests using the constant head testing method in accordance with AS 1547, across the potential infiltration areas, with:
 - two tests undertaken in the shallow sandy soils (dark coloured sand) of anticipated lower permeability at depths of 0.5 m and 0.6 m; and
 - five tests undertaken in soils similar to the soils anticipated beneath the base of proposed infiltration areas (Unit 2 soils), at depths of between 1.5 m and 1.8 m.
- four in situ infiltration tests using a falling head method in the lower portion of the Wallcliffe House site (ie downgradient of the potential infiltration areas), at a depth of 2 m below existing ground levels. The objective of this testing was to assess possible different ground permeability in the lower portions of the site, which could interfere with infiltrated groundwater flows downgradient of the infiltration areas.



Field permeability values were estimated in accordance with AS 1547 Appendix 4.1F and using a method based on Hvorslev (1951). Permeability can also be estimated from particle size distribution test results from samples taken from the same depths at infiltration test locations, using the Hazen's formula. The Hazen's formula provides an indication of the permeability for clean sand with rounded particle shape in loose conditions, and therefore its applicability to the site conditions should be considered with caution. Table 4 below summarises the permeability results.

Table 4: Summary of In Situ Permeability Testing

Location /	ocation /			Measured Pe	ermeability	Derived Per	meability ^[3]	
Potential Infiltration Area	Investigation	Test Location	Depth (m)	(m/s)	(m/day)	(m/s)	(m/day)	In Situ Condition of the Tested Material
		20 ^[1]	0.6	1.2 x 10 ⁻⁴	11	3.2 x 10 ⁻⁴	>25	Unit 1: FILL/SAND SP-SM, dark grey-brown, with silt, medium dense
1	Douglas Partners 2023	20**	1.5	5.4 x 10 ⁻⁴	>25	2.6 x 10 ⁻⁴	22	Unit 2: SAND SP, brown, trace silt, medium dense
		19 ^[1]	1.8	3.7 x 10 ⁻⁴	>25			Unit 2: SAND SP, orange-brown, trace silt, medium dense
2	Davidos Portnero 2024	4 ^[2]	2.0	5.7 x 10 ⁻⁵	4.9		25	Unit 2: SAND SP, yellow-brown,
	Douglas Partners 2021	5 ^[2]	2.0	9.8 x 10 ⁻⁵	8.5	2.9 x 10 ⁻⁴		trace silt, medium dense
3	Douglas Partners 2023	18 ^[1]	1.6	3.1 x 10 ⁻⁴	>25			Unit 2: SAND SP, orange-brown, trace silt, medium dense
	Douglas Partners 2021	2 ^[2]	2.0	3.0 x 10 ^{-5[4]}	2.6 ^[4]			Unit 2: SAND SP, yellow-brown, trace silt, medium dense
4		17 ^[1]	0.5	1.6 x 10 ⁻⁴	14	3.2 x 10 ⁻⁴	>25	Unit 2: SAND SP-SM, dark grey- brown, with silt, medium dense
5		16 ^[1]	1.6	2.1 x 10 ⁻⁴	18	2.9 x 10 ⁻⁴	25	Unit 2: SAND SP, brown, trace silt, medium dense
6		21 ^[1]	1.6	2.6 x 10 ⁻⁴	22	2.6 x 10 ⁻⁴	22	Unit 2: SAND SP, orange-brown,
	Douglas Partners 2023	22 ^[2]	2.0	7.9 x 10 ⁻⁴	>25	3.2 x 10 ⁻⁴	>25	trace silt, medium dense
Lower Portion of the	2020 Tarrior 2020	23 ^[2]	2.0	3.5 x 10 ⁻⁴	>25	2.6 x 10 ⁻⁴	22	Unit 2: SAND SP, brown, trace silt, medium dense to dense
Wallcliffe		24 ^[2]	2.0	1.2 x 10 ⁻⁴	10	3.2 x 10 ⁻⁴	>25	Unit 2: SAND SP, brown, trace silt, medium dense
House Site		25 ^[2]	2.0	1.0 x 10 ⁻⁴	9	2.9 x 10 ⁻⁴	25	Unit 2: SAND SP-SM, dark grey- brown, with silt, medium dense

Note: [1] Constant head method.

- [2] Falling head method.
- [3] Hazen's formula (assumes sand in loose condition, with rounded sand particles).
- [4] Lower infiltration rates during testing possibly from localised ground anomalies at testing depth.

A preliminary assessment of the limestone rock permeability at one location beneath the potential infiltration areas was also carried out during the 2023 investigation, by performing a falling head tests within the groundwater monitoring well installed during the Douglas Partners 2022 investigation at test location 52. The monitoring well was measured to be dry to its base (14.5 m deep at RL 11.6 m) prior to performing the tests and was 50 mm in diameter with a 3 m long slotted section (screen) at its base.



Based on the results of the 2022 investigation, the abovementioned slotted section is entirely into limestone of Unit 3.

The falling head tests were performed by filling of the monitoring well with water and measure the time required for water to drain out of the monitoring well (ie to almost reach the base of the monitoring well).

Preliminary field permeability values were estimated using a method based on Ritzema (1994) and are summarised in Table 5 below.

Table 5: Summary of Falling Head Tests Within the Monitoring Well at Test Location 52

Potential Infiltration	Test Location	Test Number	Measured Permeability (Preliminary)				
Area			(m/s)	(m/day)			
		1	1.3 x 10⁴	11			
3 and 4	52	2	1.4 x 10 ⁻⁴	12			
o and 4		3	1.1 x 10 ⁻⁴	9			
		4	9.6 x 10 ⁻⁵	8			

The results of the falling head tests (graphs showing the variation of the water levels above the base of the monitoring well with time) are presented in Appendix G.

It is emphasised that the permeability values in Table 5 above are representative of the test location and depth tested within the limestone. Further information on the permeability of the limestone rock (say the drilling boreholes together with water pressure 'Lugeon' tests at various depths) could be considered to further assess limestone permeability once the location of the preferred potential infiltration area is known.

6. Laboratory Testing

A geotechnical laboratory testing programme was carried out by a NATA registered laboratory during the 2023 investigation and comprised:

- the particle size distribution of eleven soil samples;
- organic content of four soil samples;
- modified maximum dry density and optimum moisture content of seven soil samples; and
- laboratory permeability of seven remoulded laboratory samples compacted to 95% MMDD, using the constant head permeability test in accordance with AS 1289.5.2.1.

The detailed test report sheets are given in Appendices H and I, with the results summarised in Tables 6 and 7 next pages, together with some relevant results from the Douglas Partners 2021 investigation.



Table 6: Summary of Laboratory Testing for Soil Characterisation

Location / Potential Infiltration Area	Investigation	Test Location	Depth (m)	Fines (%)	Sand (%)	Gravel (%)	D ₁₀ (mm	D ₆₀ (mm	oc (%)	Material
			0.6	4	96	0	0.18	0.48	2.6	Unit 1: FILL/SAND SP, trace silt
1	Douglas Partners	20	1.5	2	98	0	0.16	0.40	-	
	2023	19	2.0	3	98	0	0.17	0.43	-	
2	Douglas Partners	4		3	97	0	0.17	0.43	1	
	2021	5	1.7-2.3	3	97	0	0.17	0.40	1	
3	Douglas Partners 2023	18	1.6	3	97	0	0.17	0.40	0.9	
	Douglas Partners 2021	2	1.7-2.3	4	96	0	0.17	0.40	-	Unit 2: SAND SP, trace silt
4		17	0.5	5	95	0	0.18	0.49	3.3	
5	Douglas Partners 2023	16	1.8	4	96	0	0.17	0.40	-	
6	2023	21	1.8	3	97	0	0.16	0.36	-	
Lower Portion		22	2.0	3	97	0	0.18	0.50	1	
of the	Douglas Partners	23	2.0	4	96	0	0.16	0.40	1	
Wallcliffe	2023	24	2.0	4	96	0	0.18	0.44	0.6	
House Site		25	2.0	6	94	0	0.17	0.47	-	Unit 2: SAND SP-SM, with silt

Notes Fines are particles smaller than 75 µm.

Sand is particles larger than 75 μm and smaller than 2.36 mm.

Gravel is particles larger than 2.36 mm and smaller than 63 mm.

A D_{10} of 0.18 mm means that 10% of the sample particles are less than 0.14 mm.

A D_{60} of 0.50 mm means that 60% of the sample particles are less than 0.50 mm.

OC: Organic Content.

'-' means not tested.



Table 7: Summary of Remoulded Permeability Testing

Location / Potential	la continution	Test	Depth	Material Tons	омс	MMDD	Permeability	
Infiltration Area	Investigation	Location	(m)	Material Type	(%)	(t/m³)	(m/s)	m/day
	Douglas Partners 2023	20	0.6	Unit 1: FILL/SAND SP, trace silt	12.5	1.79	7.4 x 10 ⁻⁵	6.4
1		19	2.0		12.5	1.79	6.1 x 10 ⁻⁵	5.2
2	Douglas Partners 2021	4	1.7 – 2.3		13.5	1.84	6.6 x 10 ⁻⁵	5.7
	Douglas Partners 2023	18	1.6		14.0	1.77	6.6 x 10 ⁻⁵	5.7
3	Douglas Partners 2021	2	1.7 – 2.3	Unit 2: SAND SP, trace silt	14.0	1.84	6.0 x 10 ⁻⁵	5.1
4		17	0.5		14.5	1.77	7.5 x 10 ⁻⁵	6.4
5		16	1.8		12.5	1.81	6.6 x 10 ⁻⁵	5.7
6	Douglas Partners 2023	21	1.8		12.0	1.82	6.2 x 10 ⁻⁵	5.7
Lower Portion of the Wallcliffe House Site		24	2.0		14.5	1.79	7.2 x 10 ⁻⁵	6.2

Notes: OMC: Optimum moisture content.

MMDD: Modified maximum dry density. Samples compacted at 95% of MMDD.

7. Comments

7.1 Appreciation of the Ground and Groundwater Conditions

Ground conditions beneath the potential infiltration areas comprise sand of relatively high permeability and various thicknesses (up to about 9 m across the area), overlying limestone (locally near existing surface levels) with a pinnacle surface, in turn overlying impervious bedrock at depth (indicatively around 20 m depth). Groundwater was not encountered to a depth of 14.4 m (RL 11.7) within the potential infiltration areas and is inferred, based on the geological context of the site, to possibly occur, at least seasonally, as perched groundwater or seepage at the base of the limestone and above the bedrock, whose surface generally trends downwards towards the Margaret River.

Based on the available information, the ground conditions are favourable for on-site infiltration systems at some locations within the area of the proposed infiltration systems, where limestone is deep. The main constraint includes the occurrence of shallow limestone rock within several prospective infiltration footprints, which limits or precludes the suitability of such systems at these locations. Depth to limestone rock will therefore control the suitability or otherwise of proposed infiltration systems in this part of the site.

Given the thickness of sand of Unit 2 (generally about 5 m to 6 m based on available information), its permeability (Table 4 in Section 5.3) and depth to groundwater (ie between 4 m and 6 m below existing



ground levels) within the lower portion of the Wallcliffe House site, no specific ground constraints were identified within this portion of the site (downgradient of the potential infiltration areas). It is noted that clayey soil of significantly lower permeability than sand, underlies the sand in this part of the site.

7.2 Ground Permeability

Results of the field and laboratory permeability testing indicate that the sand permeability is favourable for infiltration, both in the upper part of the Wallcliffe House site (potential infiltration areas) and in its lower part.

Based on the available results, the following sand permeability values are considered representative of the encountered ground conditions:

- An average 20 m/day for the natural yellow coloured (brown, orange-brown, yellow-brown) sand of Unit 2 in its in-situ condition, encountered in the area of the proposed infiltration systems in the upper part of the Wallcliffe House site. Such yellow coloured sand was typically encountered below 1.5 m depth (below existing surface levels) and is therefore anticipated beneath the base of the proposed infiltration systems.
- 5 m/day for the abovementioned yellow-coloured natural sand following compaction, for instance following some possible ground preparation of the base of the proposed infiltration systems;
- 10 m/day for the natural sand in its in-situ condition, encountered in the lower part of the Wallcliffe House site.
- 5 m/day for the shallow dark grey sand in its in-situ condition. These dark coloured sands include fill and disturbed soil that form Unit 1 and the upper zone of Unit 2, typically encountered within 1.2 m of existing surface levels and therefore occurring above the anticipated level of the base of the proposed infiltration systems.

From the above, it is recommended that the bases of the proposed infiltration systems penetrate yellow coloured natural sand of Unit 2 encountered beneath shallower dark coloured sand, typically below 1.2 m depth. Any dark coloured sand encountered during construction at founding levels of the proposed infiltration systems should be over excavated to expose lighter coloured sand. Also, compaction negatively impacts (decreases) sand permeability. Therefore, it is recommended that compaction at the base of the infiltration systems be minimised if possible.

Limestone is typically considered impervious at small scale, however dissolution features and other karst features inherent to Tamala Limestone allow some infiltration at a larger scale. The infiltration test undertaken over an interval depth of about 3 m within limestone rock at test location 52 indicate some reasonable infiltration of the limestone at this location, with permeability values greater than 8 m/day derived based on available data.

7.3 Potential Infiltration Areas Ranking

An attempt to rank the potential infiltration areas was made by Douglas Partners, mostly considering the main geotechnical constraint (ie shallow limestone) on suitable performance of infiltration systems. The potential infiltration systems were ranked 1, 3 or 5, with 1 meaning 'Not Recommended', 3 meaning 'Moderate Constraint' and 5 meaning 'Preferred', and are summarised in Table 8 next page.



Furthermore, owing to the significant variation in limestone depths over short horizontal distances, as demonstrated by the various investigations (2020-2023), a further subdivision of the potential infiltration areas was made during the abovementioned ranking.

Table 8: Potential Infiltration Areas Ranking

Potential Infiltration Area		Ranking 1: 'Not Recommended', 3: 'Moderate Constraint' 5: 'Preferred' (see text above)	Comment				
	Western 20 m	5	Top of Limestone 6 m to 9 m depth.				
1	Remaining 30 m	1	Shallow Limestone (within 1.5 m of ground surface).				
0	Western half	3	Top of Limestone at about 4 m depth.				
2	Eastern half	1	Shallow Limestone (within 2.5 m of ground surface).				
3	Entire area	1	Shallow Limestone (within 2.5 m for ground surface, possibly shallower based on geophysical results).				
	Western half	1	Shallow Limestone (within 2.5 m of ground surface).				
4	Eastern half (and possibly further west beyond currently proposed envelope)	5	Top of Limestone 5 m to 6 m depth.				
5	Entire area	5	Top of Limestone 6 m to 7 m depth.				
6	Entire area	1	Shallow Limestone (within 0.5 m of ground surface).				

8. References

AS 1289. (2014). Methods of testing soils for engineering purposes. Standards Ausralia.

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AS 1726. (2017). Geotechnical Site Investigations. Standards Australia.

Hvorslev, M. J. (1951). *Time lag and soil permeability in groundwater observations.* US Army Corps of Engineers Waterways Experiment Observation Station, Bulletin 36, Vicksburg, Mississippi.

Douglas Partners (2020). Memorandum report '*Proposed Wallcliffe House Re-development*', referenced 96717.00.R.001.Rev0 and dated 29 September 2020.

Douglas Partners (2021). Memorandum report 'Potential Treated Water Infiltration Areas', referenced 96717.01.R.001.Rev0 and dated 22 October 2021.

Douglas Partners (2022). Report on Geotechnical Investigation 'Proposed Wallcliffe House Redevelopment', referenced 96717.02.R.001.Rev0 and dated 2 March 2022.



9. Limitations

Douglas Partners has prepared this report for a geotechnical assessment to assist with the selection of an infiltration area of treated water at 752 Wallcliffe Road, Margaret River, WA in accordance with Douglas Partners' proposal referenced P96717.04 and dated 6 February 2023 and acceptance received from Mr Duncan Haslam of Wallcliffe House Pty Ltd in an email dated 7 February 2023. The work was carried out under Douglas Partners' Conditions of Engagement. This report is provided for the exclusive use of Wallcliffe House Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of Douglas Partners, does so entirely at its own risk and without recourse to Douglas Partners for any loss or damage. In preparing this report Douglas Partners has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after Douglas Partners' field testing has been completed.

Douglas Partners' advice is based upon the conditions encountered during the Doulas Partners 2020-2023 investigations. The accuracy of the advice provided by Douglas Partners in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical component set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. Douglas Partners cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by Douglas Partners. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

 In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes.
 They may not be the same at the time of construction as are indicated in the report;
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions.
 The potential for this will depend partly on borehole or pit spacing and sampling frequency:
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Soil Descriptions

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Туре	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Туре	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded a good representation of all particle sizes
- Poorly graded an excess or deficiency of particular sizes within the specified range
- Uniformly graded an excess of a particular particle size
- Gap graded a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

in line grained soils (235% lines)		
Term	Proportion	Example
	of sand or	
	gravel	
And	Specify	Clay (60%) and
		Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace
		sand

In coarse grained soils (>65% coarse)

- with clavs or silts

Term	Proportion	Example
	of fines	
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace
		clay

In coarse grained soils (>65% coarse)

- with coarser fraction

- With Coarser Haction		
Term	Proportion of coarser	Example
	fraction	
And	Specify	Sand (60%) and
		Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace
		gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with 'Mix of Soil and Cobbles/Boulders' with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	Н	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil derived from in-situ weathering of the underlying rock;
- Extremely weathered material formed from in-situ weathering of geological formations.
 Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil deposited by streams and rivers;

- Estuarine soil deposited in coastal estuaries;
- Marine soil deposited in a marine environment;
- Lacustrine soil deposited in freshwater lakes;
- Aeolian soil carried and deposited by wind;
- Colluvial soil soil and rock debris transported down slopes by gravity;
- Topsoil mantle of surface soil, often with high levels of organic material.
- Fill any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.

Soil tends to stick together.

Sand forms weak ball but breaks easily.

Wet (W) Soil feels cool, darkened in colour.

Soil tends to stick together, free water forms when handling.

Moisture Condition - Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w <PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w >PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈LL' (i.e. near the liquid limit).
- 'Wet' or 'w >LL' (i.e. wet of the liquid limit).

Rock Descriptions

Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $Is_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

Strength Term	Abbreviation	Unconfined Compressive Strength MPa	Point Load Index * Is ₍₅₀₎ MPa
Very low	VL	0.6 - 2	0.03 - 0.1
Low	L	2 - 6	0.1 - 0.3
Medium	М	6 - 20	0.3 - 1.0
High	Н	20 - 60	1 - 3
Very high	VH	60 - 200	3 - 10
Extremely high	EH	>200	>10

^{*} Assumes a ratio of 20:1 for UCS to $ls_{(50)}$. It should be noted that the UCS to $ls_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

RQD % = <u>cumulative length of 'sound' core sections ≥ 100 mm long</u> total drilled length of section being assessed

where 'sound' rock is assessed to be rock of low strength or stronger. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes	
Thinly laminated	< 6 mm	
Laminated	6 mm to 20 mm	
Very thinly bedded	20 mm to 60 mm	
Thinly bedded	60 mm to 0.2 m	
Medium bedded	0.2 m to 0.6 m	
Thickly bedded	0.6 m to 2 m	
Very thickly bedded	> 2 m	

Symbols & Abbreviations

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

Diamond core - 81 mm dia

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
	D: 1 04 !!

Water

PQ

\triangleright	Water seep
∇	Water level

Sampling and Testing

	•	5
Α		Auger sample
В		Bulk sample
D		Disturbed sample
Ε		Environmental sample
U_{50}		Undisturbed tube sample (50mm)
W		Water sample
pp		Pocket penetrometer (kPa)
PID		Photo ionisation detector
PL		Point load strength Is(50) MPa
S		Standard Penetration Test

Description of Defects in Rock

Shear vane (kPa)

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

DOI COL	י אף כי
В	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination

Parting

Sheared Zone

V Vein

Ρt

Sz

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
V	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
СО	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

ро	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Talus

Graphic Symbols for Soil and Rock				
General Sedimentary Rocks				
	Asphalt	QQ4	Boulder conglomerate	
$\circ Q_{\sigma} \sim 0$	Road base		Conglomerate	
4444	Concrete	0	Conglomeratic sandstone	
	Filling		Sandstone	
Soils			Siltstone	
000	Topsoil		Laminite	
	Peat		Mudstone, claystone, shale	
	Clay		Coal	
	Silty clay		Limestone	
	Sandy clay	Metamorphic	Rocks	
	Gravelly clay		Slate, phyllite, schist	
////	Shaly clay	+ + + + + +	Gneiss	
	Silt	3 S	Quartzite	
	Clayey silt	Igneous Roc	ks	
	Sandy silt	+++++	Granite	
	Sand	<	Dolerite, basalt, andesite	
	Clayey sand	× × ×;	Dacite, epidote	
* • • • • • * • • • • • •	Silty sand	\vee \vee \vee	Tuff, breccia	
	Gravel		Porphyry	
	Sandy gravel			
S SS	Cobbles, boulders			

Sampling Methods

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thinwalled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the insitu soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low

reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

 In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

> 4,6,7 N=13

In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

15, 30/40 mm

Sampling Methods

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Cone Penetration Tests



Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

•	Cone tip resistance	qc
•	Sleeve friction	f_s
•	Inclination (from vertical)	i
•	Depth below ground	Z

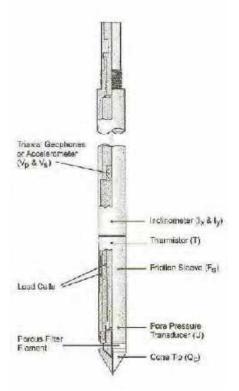


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.



Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Туре	Measures
Standard	Basic parameters (qc, fs, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V _s), compression wave velocity (V _p), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration Tests

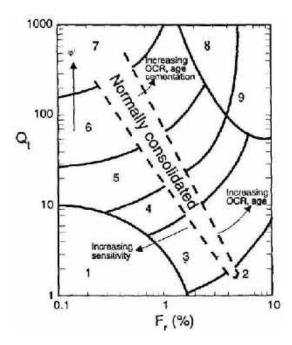


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation. The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G₀. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

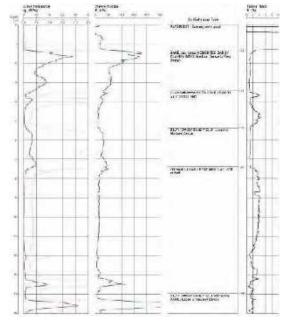


Figure 4: Sample Cone Plot

Appendix B

Drawings











Appendix C

Results of the Douglas Partners 2021 Field Work

CLIENT: Wallcliffe House Pty Ltd

PROJECT: On Site Sewage Disposal Assessment LOCATION: 752 Wallcliffe Road, Margaret River, WA SURFACE LEVEL: 25.9 m AHD BORE No: 2

EASTING: 314866 **PROJECT No:** 96717.01 **NORTHING**: 6239220 **DIP/AZIMUTH:** 90°/--

DATE: 30-8-2021 SHEET 1 OF 1

			Description of Strata	.je		Sam		& In Situ Testing	_	Dimensia December at Total
R	Dept (m)			Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	- (-	0.1	FILL/TOPSOIL: SAND SP-SM, fine to medium grained, dark grey, with silt, roots and rootlets, moist.	<i>Y</i>) <i>X</i>						L
25	- - - -		SAND SP: fine to medium grained, dark grey, with rootlets, trace silt, moist, medium dense, residual soil, Spearwood System.							
	- 1 - - - -		- becoming dark brown-brown from 1.1 m depth.							f1
- 42	-		- becoming yellow-brown from 1.6 m depth.			1.7				
- "	-2 -				В	2.2				-2
	- - - -					2.3				
23	- -3 -				D	3.0				-3 -
22	- - - -		Bore discontinued at 4.0m (Target depth)							
-	-4 4 - -	4.0		<u> </u>	_D_	 4.0				4
Ł										





LOGGED: GG CASING: RIG: hand auger DRILLER: GG

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed. REMARKS: Location coordinates are in MGA94 Zone 50 J.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam

SAMPLING & IN SITU TESTING LEGEND PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: On Site Sewage Disposal Assessment LOCATION: 752 Wallcliffe Road, Margaret River, WA **SURFACE LEVEL:** 30.1 m AHD **BORE No:** 4

EASTING: 314860 **NORTHING**: 6239183 **DIP/AZIMUTH**: 90°/--

PROJECT No: 96717.01 DATE: 30-8-2021 SHEET 1 OF 1

	_		Description	je		Sam		& In Situ Testing	_	Dynamic Penetrometer Test		
R) D	epth m)	OI	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	(blows per 150mm)		
30	-	0.1	Strata FILL/TOPSOIL: SAND SP-SM, fine to medium grained,	XX	D	0.05	Š			5 10 15 20		
-	-		\dark grey, with silt and rootlets, moist.									
	-		SAND SP: fine to medium grained, dark grey, with rootlets, trace silt, moist, medium dense, residual soil, Spearwood System.									
29	- -1 - - -		- becoming dark brown-brown from 1.2 m depth.			1.7						
28	-2		- becoming yellow-brown from 2.0 m depth.		В	2.3				-2		
27	-3		- becoming light yellow-brown from 3.0 m depth.									
26	-4 -	4.0	Bore discontinued at 4.0m (Target depth)	11						ļ*		





LOGGED: GG CASING: RIG: hand auger DRILLER: GG

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed. REMARKS: Location coordinates are in MGA94 Zone 50 J.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam

SAMPLING & IN SITU TESTING LEGEND PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: On Site Sewage Disposal Assessment LOCATION: 752 Wallcliffe Road, Margaret River, WA **SURFACE LEVEL:** 31.1 m AHD **BORE No:** 5

EASTING: 314885 **NORTHING:** 6239195 **DIP/AZIMUTH:** 90°/--

PROJECT No: 96717.01 **DATE:** 30-8-2021 SHEET 1 OF 1

			Description	.je		Sam		& In Situ Testing		Dominio Dominio Data		
R		epth n)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)		
31	-	0.1	FILL/TOPSOIL: SAND SP-SM, fine to medium grained, dark grey, with silt and rootlets, moist.	V) X								
	- - - -		SAND SP: fine to medium grained, dark grey, with rootlets, trace silt, moist, medium dense, residual soil, Spearwood System.									
30	-1 - - -		- becoming dark brown-brown from 1.1 m depth.		D	1.3				-1		
	-		- becoming yellow-brown from 1.5 m depth.			1.7						
29	-2 - -				В	2.3				-2		
	-											
28	- -3 -		- becoming light yellow-brown from 2.8 m depth.							-3 _		
	- - - -		- becoming loose from 3.15 m depth.									
27	- 4 - - -	4.0	Bore discontinued at 4.0m (Target depth)	1						├ ⁴ -दे		





LOGGED: GG CASING: RIG: hand auger DRILLER: GG

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed. REMARKS: Location coordinates are in MGA94 Zone 50 J.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)





Appendix D

Results of the Douglas Partners 2022 Field Work

TEST PIT LOG

CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 23.0 AHD

EASTING: 314887 **PROJECT No:** 96717.02 **NORTHING**: 6239262

DATE: 25-1-2022

PIT No: 4

SHEET 1 OF 1

	D "	Description	jic _		Sam		& In Situ Testing] <u>,</u>	Dynam	io Dono	tromoto	or Toot	٦
R	Depth (m)	OI	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)				
8		Strata	0	ŕ	De	Sar	Comments		5	10	15	20	
- "	0.	FILL/Gravelly SAND SP-SM: fine to medium grained, dark grey-brown and grey-brown, fine to coarse sized, with silt, dry to moist, very dense.							-				Þ
	0.	FILL/Gravelly Clayey SAND SC: fine to medium grained, red-brown, fine to coarse sized, low plasticity, dry to moist.											_
22	- 1	FILL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace gravel, moist.											
		Pit discontinued at 0.6m (Hard digging, refusal on limestone rock)											
-21	- 2												
- "									:				
20	-3												
									:				
19	-4												
									:				
H													٦





LOGGED: GG RIG: 14 tonne excavator, 1000 mm toothed bucket **SURVEY DATUM: MGA94**

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

SAMPLING & IN SITU TESTING LEGEND

LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)



TEST PIT LOG

CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development LOCATION: 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 32.2 AHD

EASTING: 314906 **PROJECT No:** 96717.02 **NORTHING**: 6239202 **DATE:** 24-1-2022 SHEET 1 OF 1

PIT No: 11

		Description	je je		Sam		& In Situ Testing		Dominio Dominio Tork
묍	Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
32	· 0.	FILL/TOPSOIL: SAND SP-SM: fine to medium grained.	<i>YY</i>]	S			5 10 15 20
		SAND SP-SM: fine to medium grained, dark grey-brown, with silt, moist, medium dense to dense. Residual Soil, Spearwood System.							b
31	-1	- becoming yellow-brown, trace silt from 1.1 m depth.							
30	-2	- trace of low to medium strength limestone cobbles and gravel from 2.2 m depth. - high strength limestone boulder or pinnacle observed on the northern side of the pit from 2.4 m depth.							-2 [
29	-3 3.	Pit discontinued at 3.0m (Target depth)	1	<u></u> —D—	 3.0				3
28	- 4 - 4 								
	· 				P		57		





LOGGED: GG RIG: 14 tonne excavator, 1000 mm toothed bucket **SURVEY DATUM: MGA94**

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)



TEST PIT LOG

CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development **LOCATION:** 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 32.1 AHD **PIT No:** 12

EASTING: 314888 **PROJECT No**: 96717.02 **NORTHING**: 6239188 **DATE**: 24-1-2022

SHEET 1 OF 1

		Description of Strata	. <u>S</u>	Sampling & In Situ Testing			& In Situ Testing	_	Dimamia Danatramatar Teat				
	Depth (m)		Graph	Type	Depth	ample	Results & Comments	Wate	Dynamic Penetrometer Test (blows per 150mm)				
	0.15		<i>Y)X</i>			0)							
		SAND SP-SM: fine to medium grained, dark grey-brown, with silt, medium dense to dense. Residual Soil, Spearwood System.											
-1	1	- limestone boulder observed at 0.9 m depth.							-1 7				
	1.4	Pit discontinued at 1.4m (Hard digging, refusal on	<u> :::::</u>										
-2	2												
-3	3												
- 4 - 4	4												
		0.15	Depth (m) Of Strata FILL/TOPSOIL: SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist. SAND SP-SM: fine to medium grained, dark grey-brown, with silt, medium dense to dense. Residual Soil, Spearwood System. - limestone boulder observed at 0.9 m depth. - becoming dark brown from 1.2 m depth. Pit discontinued at 1.4m (Hard digging, refusal on limestone rock)	Depth (m) Of Strata O.15 FILL/TOPSOIL: SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist. SAND SP-SM: fine to medium grained, dark grey-brown, with silt, medium dense to dense. Residual Soil, Spearwood System. - Iimestone boulder observed at 0.9 m depth. - becoming dark brown from 1.2 m depth. Pit discontinued at 1.4m (Hard digging, refusal on limestone rock)	FILL/TOPSOIL: SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist. SAND SP-SM: fine to medium grained, dark grey-brown, with silt, medium dense to dense. Residual Soil, Spearwood System. - limestone boulder observed at 0.9 m depth. - becoming dark brown from 1.2 m depth. Pit discontinued at 1.4m (Hard digging, refusal on limestone rock)	Depth (m) Strata O.15 FILL/TOPSOIL: SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist. SAND SP-SM: fine to medium grained, dark grey-brown, with silt, medium dense to dense. Residual Soil, Spearwood System. - Iimestone boulder observed at 0.9 m depth. - becoming dark brown from 1.2 m depth. Pit discontinued at 1.4m (Hard digging, refusal on limestone rock)	Depth (m) Strata O.15 FILL/TOPSOIL: SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist. SAND SP-SM: fine to medium grained, dark grey-brown, with silt, medium dense to dense. Residual Soil, Spearwood System. - Iimestone boulder observed at 0.9 m depth. - becoming dark brown from 1.2 m depth. Pit discontinued at 1.4m (Hard digging, refusal on limestone rock)	Depth (m) Strata FILL/TOPSOIL: SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist. SAND SP-SM: fine to medium grained, dark grey-brown, with silt, medium dense to dense. Residual Soil, Spearwood System. I becoming dark brown from 1.2 m depth. Pit discontinued at 1.4m (Hard digging, refusal on limestone rock) Pit discontinued at 1.4m (Hard digging, refusal on limestone rock)	Depth (m) of Strata FILL/TOPSOIL: SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist. SAND SP-SM: fine to medium grained, dark grey-brown, with silt, medium dense to dense. Residual Soil, Spearwood System. - limestone boulder observed at 0.9 m depth. - becoming dark brown from 1.2 m depth. Pit discontinued at 1.4m (Hard digging, refusal on limestone rock) Results & Comments Pit dis Comments Pit discontinued at 1.4m (Hard digging, refusal on limestone rock)				





RIG: 14 tonne excavator, 1000 mm toothed bucket LOGGED: GG SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING & IN SITU TESTING LEGEND

SAMPLING & IN SITU TESTING

A Auger sample G G sas sample
BLK Block sample U, Tube sample (x mm dia.)

C Core drilling W Water sample
D Disturbed sample D Water seep
Water level

LEGEND
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)

☑ Sand Penetrometer AS1289.6.3.3☑ Cone Penetrometer AS1289.6.3.2



CLIENT: Wallcliffe House Pty Ltd

Proposed Wallcliffe House Re-development PROJECT: LOCATION: 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 8.0 AHD EASTING: 314836 **NORTHING**: 6239310

DIP/AZIMUTH: 90°/--

DATE: 25-1-2022 SHEET 1 OF 1

PROJECT No: 96717.02

BORE No: 16

Sampling & In Situ Testing Description Graphic Log Dynamic Penetrometer Test Depth 굽 of (blows per 150mm) Sample Results & Comments Strata FILL/SAND SP-SM: fine to medium grained, dark grey-brown and grey-brown, with silt, trace gravel, moist, medium dense. Metal plate, concrete tiles, pieces of ceramic observed within the fill. SAND SP-SM: fine to medium grained, dark grey-brown, with silt, moist, medium dense. Residual Soil, Spearwood System. - becoming medium dense to dense from 1.8 m depth. 2 Bore discontinued at 3.0m (Collapsing conditions)





RIG: hand auger DRILLER: GG LOGGED: GG CASING:

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample

SAMPLING & IN SITU TESTING LEGEND LEGENU
PilD Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 25 m

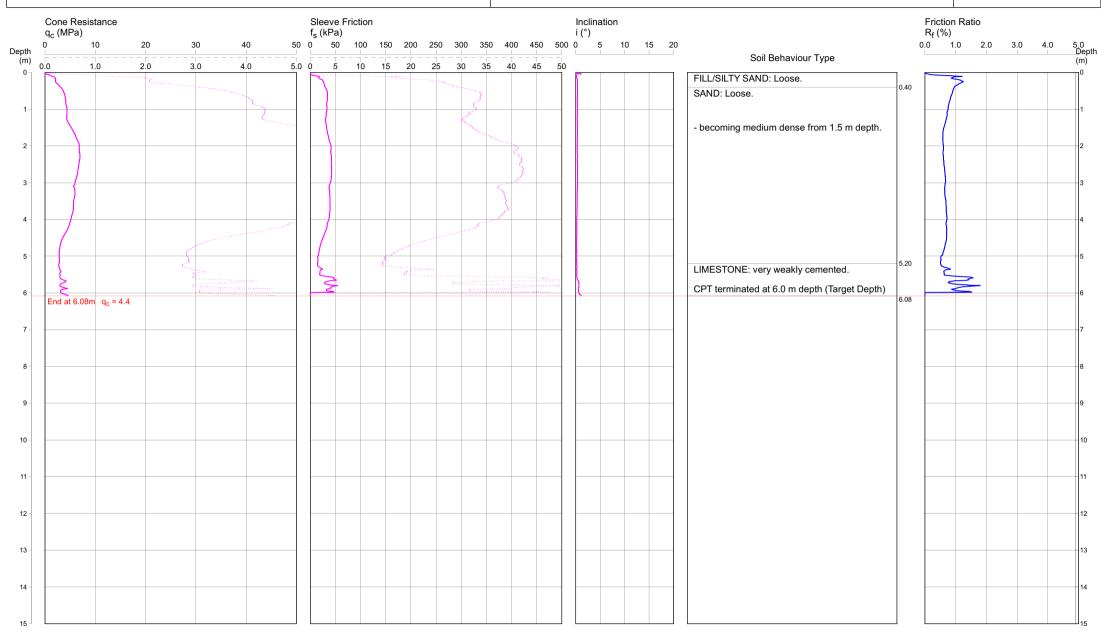
COORDINATES: 314847E 6239213N

31

Page 1 of 1

DATE 31-01-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\31.CP5
Cone ID: Probedrill
Type: EC28



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 28.8 m

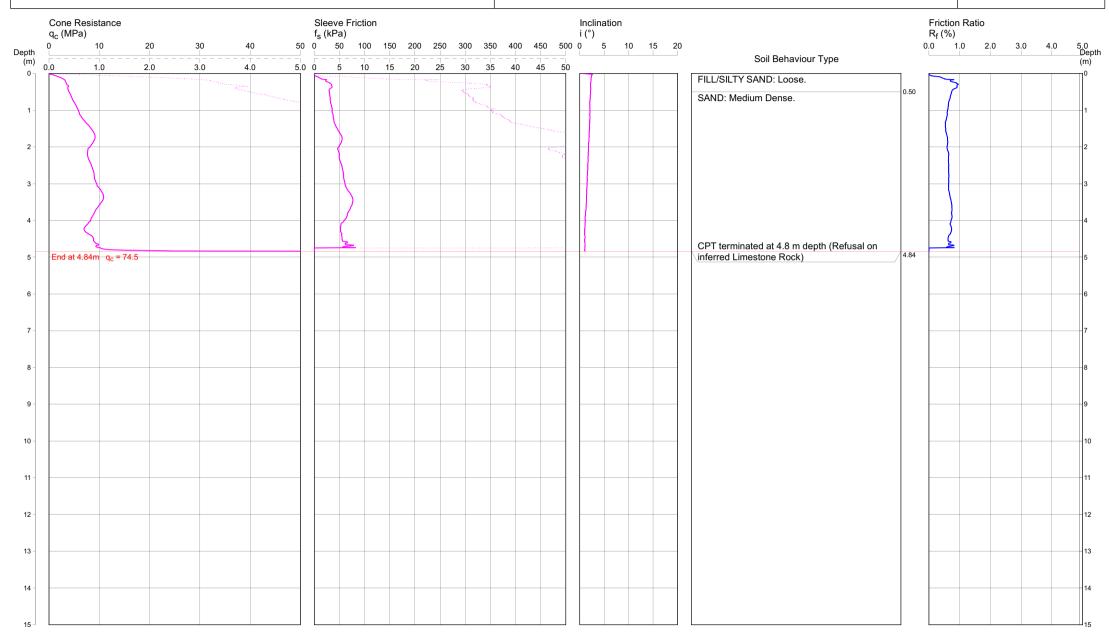
COORDINATES: 314874E 6239205N

33

Page 1 of 1

DATE 31-01-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\33.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 28.5 m

COORDINATES: 314853E 6239190N

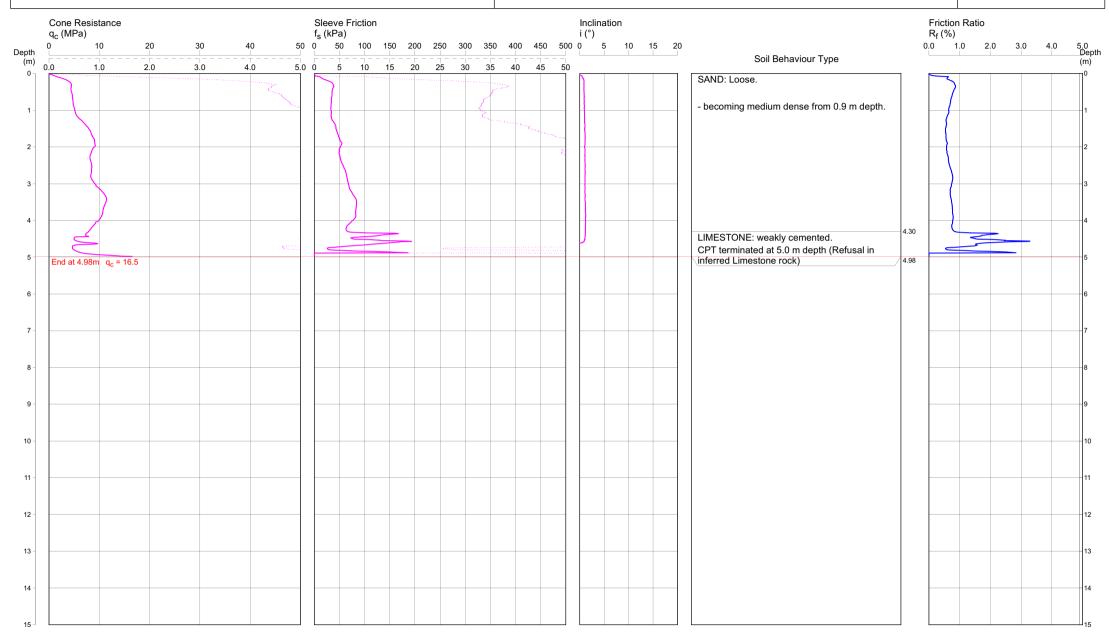
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Page 1 of 1

DATE

31-01-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\35.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 6.9 m

COORDINATES: 314771E 6239322N

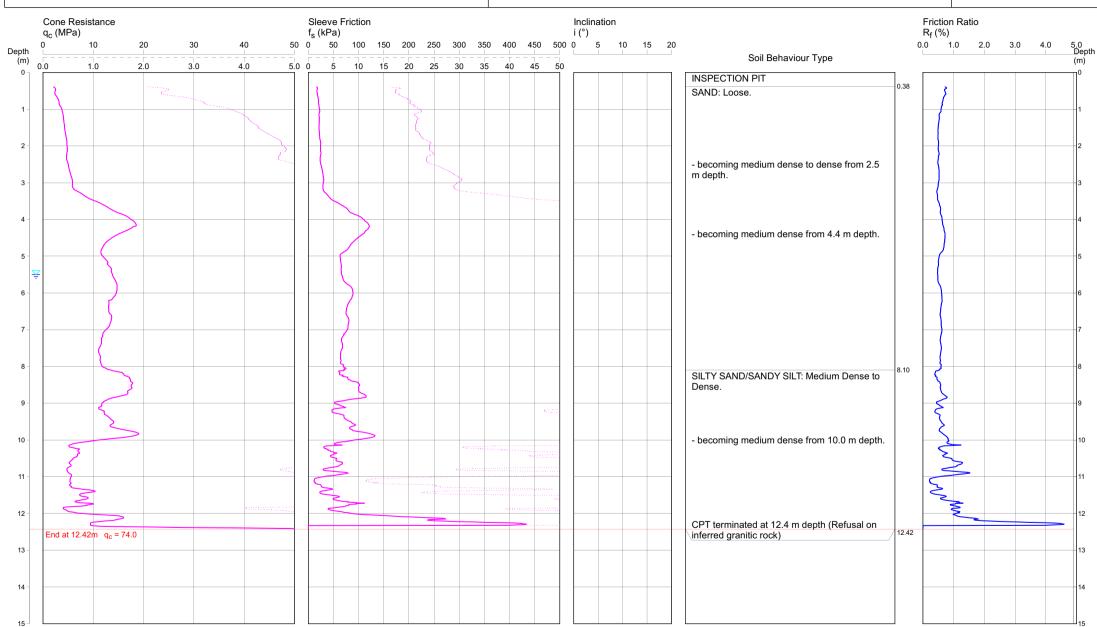
38

Page 1 of 1

DATE

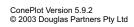
01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

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Cone ID: Probedrill
Type:





CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 7 m

COORDINATES: 314800E 6239350N

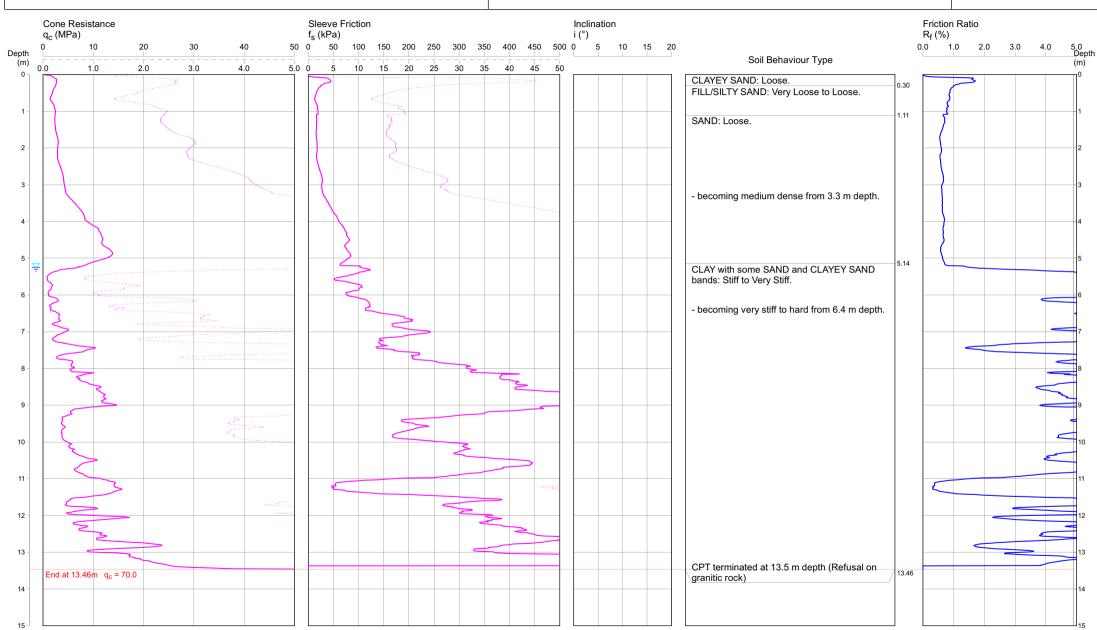
43

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DATE

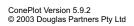
01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\43.CP5
Cone ID: Probedrill
Type:





CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

752 Wallcliffe Road, Margaret River, WA LOCATION:

REDUCED LEVEL: RL 7.2 m

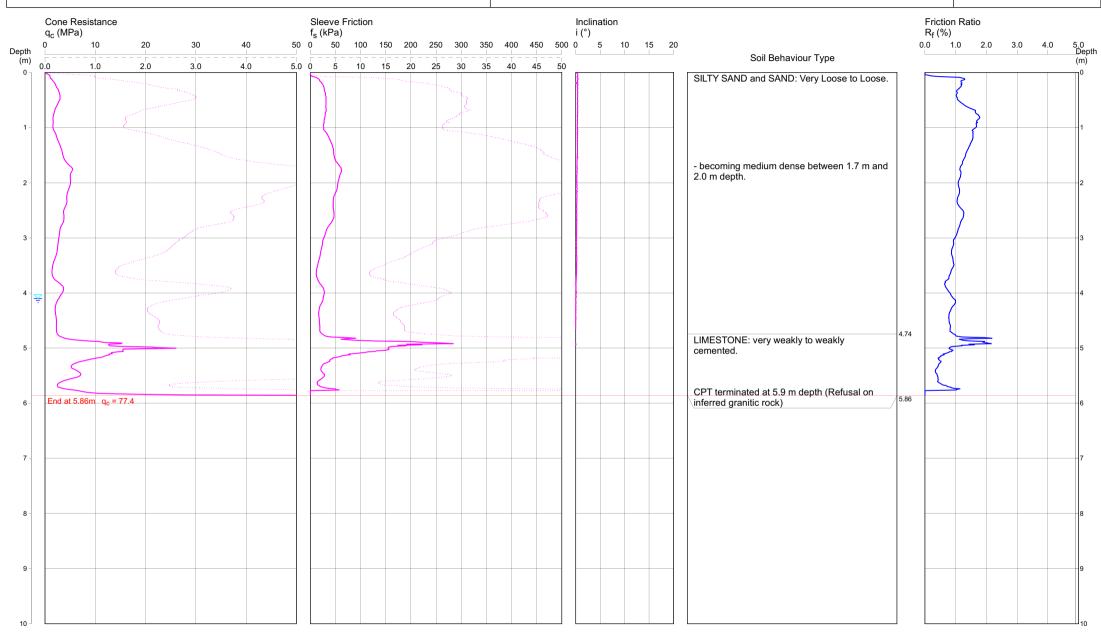
COORDINATES: 314854E 6239320N 46

Page 1 of 1

DATE

01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\46.CP5 Cone ID: Probedrill



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

REDUCED LEVEL: RL 7.5 m

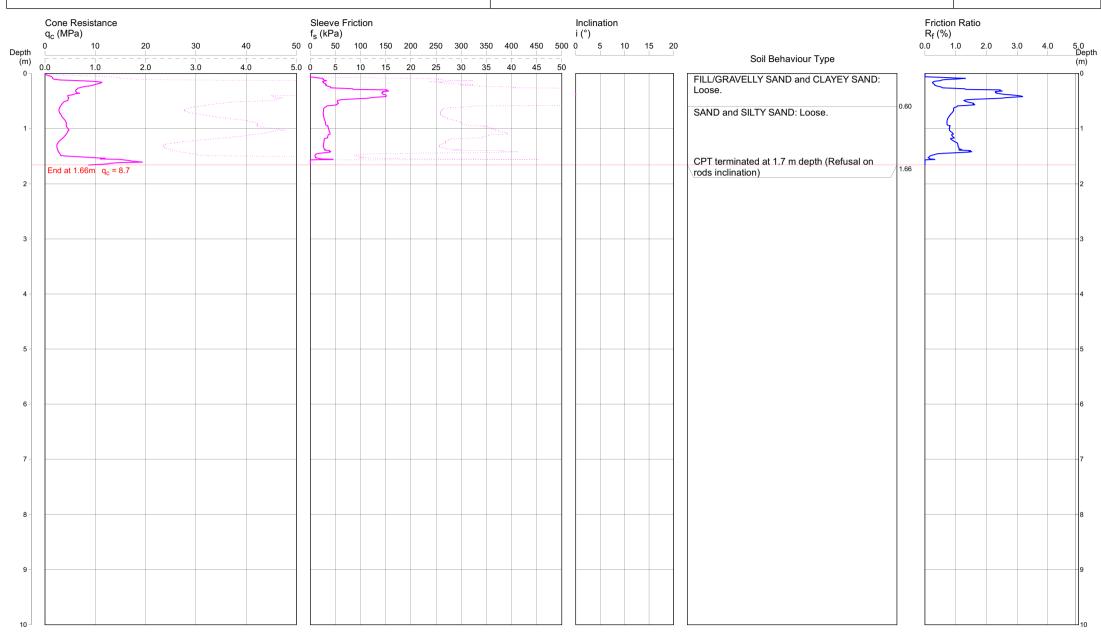
COORDINATES: 314828E 6239320N

47

Page 1 of 1

DATE 01-02-22

PROJECT No: 96717.02



REMARKS: *Surface level interpolated from a survey plan provided by the client.

File: P:\96717.02 - MARGARET RIVER, Wallcliffe Rd - Investig\4.0 Field Work\CPTs\DP\47.CP5
Cone ID: Probedrill
Type:



CLIENT: Wallcliffe House Pty Ltd

Proposed Wallcliffe House Re-development PROJECT: LOCATION:

752 Wallcliffe Road, Margaret River, WA **NORTHING**: 6239219

DIP/AZIMUTH: 90°/--

EASTING: 314867

SURFACE LEVEL: 26.1 AHD

BORE No: 52

PROJECT No: 96717.02

DATE: 1-2-2022 SHEET 1 OF 3

П		Description	Degree of Weathering	. <u>o</u>	Rock Strength		Fracture	Discontinuities	Sa	ampli	ng & l	n Situ Testing
뭅	Depth (m)	of		raph	Strength New Low High	जिल्ला Vate	Spacing (m)	B - Bedding J - Joint	Туре	se %	RQD %	Test Results &
	. ,	Strata	EW HW EW	Ö	Kery Low High		0.05 0.10 0.50 1.00	S - Shear F - Fault	Ļ	ပိမ္တ	R.	Comments
25 26 28		Silty SAND SP-SM: fine to medium grained, dark brown. Residual Soil, Spearwood System.							С	67		
24	1.5-	SAND SP: fine to coarse grained, orange-brown, trace silt, loose. Residual Soil, Spearwood System.							S	100		2,3,4 N = 7
	2.5-	CORE LOSS						2.5m: CORE LOSS: 500mm	С	28		
23	3.45	SAND SP: fine to coarse grained, orange-brown, trace silt, loose. Residual Soil, Spearwood System.				 - - - -			s	100		2,3,4 N = 7
25	-4	CORE LOSS						3.45m: CORE LOSS: 1050mm	С	0		
	4.5	SAND SP: fine to coarse grained, orange-brown, trace silt. Residual Soil, Spearwood System.							S	100		1,2,3 N = 5

DRILLER: Precision Drilling RIG: Hydrapower Scout Mark V

LOGGED: SN

CASING:

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: No free groundwater measured.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam
E Environmental Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level Core drilling
Disturbed sample
Environmental sample

LEGEND
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)



BOREHOLE LOG

CLIENT: Wallcliffe House Pty Ltd

PROJECT: Proposed Wallcliffe House Re-development

LOCATION: 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 26.1 AHD

EASTING: 314867 **NORTHING**: 6239219 **DIP/AZIMUTH**: 90°/--

DATE: 1-2-2022 **SHEET** 2 OF 3

PROJECT No: 96717.02

BORE No: 52

	- ·	Description	Degree of Weathering	Rock 의 Strength	Fracture	Discontinuities				n Situ Testing
묍	Depth (m)	of Strata	EW HW SW FS	Srapk Log Low Low High High High	Spacing (m) 00:00:00:00:00:00:00:00:00:00:00:00:00:	B - Bedding J - Joint S - Shear F - Fault	Туре	Core ec. %	RQD %	Test Results & Comments
21	- - - - 5.6	SAND SP: fine to coarse grained, orange-brown, trace silt, very loose to loose. Residual Soil, Spearwood System.		W > 13 > T > W		5m: CORE LOSS: 600mm	С	38		Comments
20	-6						s	100		1,2,2 N = 4
19	- - 7.28 -	tragmented to 7.15 m depth. Spearwood System.				6.45m: CORE LOSS: 550mm 7.2m: J, 20°, PI, SR, Cn 7.28m: J, 20°, PI, SR, Cn	С	48	0	
	-	LIMESTONE (CALCARENITE)/SAND SP: fine to coarse grained, pale white and orange-brown, granular, weakly cemented, very low strength. Spearwood System.					s	100		1,2,6 N = 8
- 18	-8	SAND SP: fine to coarse grained, orange-brown, trace silt, loose. Residual Soil, Spearwood System. CORE LOSS LIMESTONE (CALCARENITE): fine to medium grained, pale pink, grey, granular, strongly cemented, high to very high strength. Spearwood System.				7.95m: CORE LOSS: 500mm 8.5m: J, 20°, Ir, R, Cn 8.62m: J, 10°- 80°, PI, R, Cn 8.72m: J, 0°, PI, R, Cn	С	52	35	PL(D) = 4.78
	- 9 9.0 	CORE LOSS				8.84m: J, 20°, Pl, R, Cn 9m: CORE LOSS: 1500mm	С	0	0	

RIG: Hydrapower Scout Mark V DRILLER: Precision Drilling LOGGED: SN CASING:

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: No free groundwater measured.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D D isturbed sample
E Environmental sample
W Water sample
W Water sample
W Water level

LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)



BOREHOLE LOG

CLIENT: Wallcliffe House Pty Ltd

Proposed Wallcliffe House Re-development PROJECT: LOCATION:

752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 26.1 AHD

PROJECT No: 96717.02 **EASTING**: 314867

NORTHING: 6239219 **DATE:** 1-2-2022 **DIP/AZIMUTH:** 90°/--SHEET 3 OF 3

BORE No: 52

	5 "	Description	Degree of Weathering	Rock Strength	Fracture	Discontinuities				n Situ Testing
묍	Depth (m)	of Strata	Weathering	Sraph Loc	Spacing (m)	B - Bedding J - Joint S - Shear F - Fault	Туре	Core ec. %	RQD %	Test Results &
16-	-	CORE LOSS (continued)	WH WW W S S S S	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	0.000		С	0	0	Comments
	- 10.5 · - - -	SAND SP: fine to coarse grained, orange-brown, trace silt, very loose. Residual Soil, Spearwood System.					S	100		2,1,1 N = 2
15	- 10.95 - 11 10.95 	LIMESTONE (CALCARENITE): fine to medium grained, pale pink, grey, granular, strongly cemented, high to very high strength. Spearwood System. - fragmented between 11.33 m and 11.5 m depth.				10.97m: J, 80°, PI, SR, Cn 11m: J, 10°, Ir, SR, Cn 11.19m: J, 10°, Ir, SR, Cn 11.24m: J, 10°, PI, SR, Cn 11.33m: J, 10°, PI, SR, Cn 11.58m: J, 40°, Ir, R, Cn 11.68m: J, 10°, Ir, SR, Cn 11.8m: J, 10°, Ir, SR, Cn 11.91m: J, 20°, PI, SR,	С	100	51	PL(D) = 2.05
- 1	-12 - - - - - - - - - - - - - - - - - -					Cn 12.06m: J, 80°, PI, SR, Cn -12.11m: J, 20°, PI, SR, Cn -12.16m: J, 10°, Ir, SR, Cn -12.29m: J, 10°-30°, Un, SR, Cn -12.37m: J, 0°, PI, SR, Sd, Gr, Fi - 40 mm 12.77m: J, 0°-20°, Un, SR, Sd, Gr, Fi - 30 mm	С	100	81	PL(D) = 4.08
12	- - - - - - - -	- becoming moderately cemented, medium strength from 14.25 m depth.				14.23m: J, 10°, Ir, SR, Gr, Fi - 20 mm	С	100	100	PL(D) = 3.83
	14.55 · - - - -	Bore discontinued at 14.55m (Target Depth)								

CASING: RIG: Hydrapower Scout Mark V **DRILLER:** Precision Drilling LOGGED: SN

TYPE OF BORING: HQ Diamond Coring

WATER OBSERVATIONS: No free groundwater measured.

REMARKS: *Surface level interpolated from a survey plan provided by the client.

SAMPLING	& IN SITU TESTING LEGEN	ND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sam
E Environmental Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level Core drilling
Disturbed sample
Environmental sample

LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)





Photo 13 - Box 1: 0.5 m to 6.0 m



Photo 14 - Box 2: 6.0 m to 11.0 m

Core Photographs - Boxes 1 and 2		PROJECT:	96717.02
Douglas Partners	Proposed Wallcliffe House Re-development	PLATE:	7
Geotechnics Environment Groundwater	Test Location 52	REV:	Α
	CLIENT: Wallcliffe House Pty Ltd	DATE:	4 Feb 2022

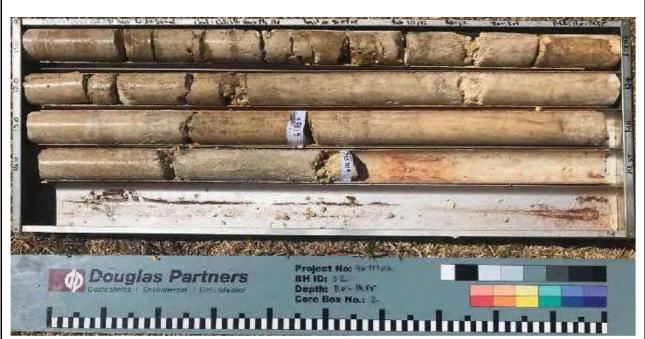


Photo 15 - Box 3: 11.0 m to 14.55 m

Douglas Partners
Geotechnics Environment Groundwater

Core Photographs - Box 3	PROJECT:	96717.02	
Proposed Wallcliffe House Re-development	PLATE:	8	
Test Location 52	REV:	Α	
CLIENT: Wallcliffe House Pty Ltd	DATE:	4 Feb 2022	

Appendix E

GBG Maps Report 70585



Level 1, 2 Sabre Crescent Jandakot, WA 6964 Tel: 08 6436 1599

Email: info@gbgmaps.com.au A.B.N. 45 129 251 225

GEOPHYSICAL INVESTIGATION FOR SUBSURFACE GEOLOGICAL MAPPING.

WALLCLIFFE HOUSE, 752 WALLCLIFFE ROAD MARGARET RIVER WESTERN AUSTRALIA.

Date: 21 September 2020

Report No.: 70585

Revision: 0

Author Reviewed:

Distribution

Douglas Partners



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1. INTRODUCTION

At the request of Douglas Partners, GBGMAPS carried out a geophysical subsurface investigation at Wallcliffe House located on 752 Wallcliffe Road Margaret River, WA in September 2020.

During the investigation Seismic Refraction, Multi-channel Analysis of Surface Waves (MASW) and Ground Penetrating Radar (GPR) datasets were acquired, processed and analysed to provide information on the geology underlying the site. In particular, the depth to the granite and limestone rock was sought as well as the location of any potential karstic features within the limestone.

The geophysical investigation forms part of a broader scope geotechnical investigation being carried out by Douglas Partners as part of planned redevelopment of the site.

2. INVESTIGATION SITE

The geophysical investigation was carried out within an 8500m² area located on the south eastern end of the Wallcliffe House site. The extent of the geophysical investigation is shown in red in Figure 1 below.

Ground conditions at the site were suitable for geophysical data acquisition with most of the surface consisting of short grass. Data acquisition was not carried out where thick vegetation limited the use of the geophysical method. Photographs of the typical conditions at the site are shown in Figure 2.

The near surface lithology within the investigation site consists of dry sand overlying limestone rock which was formed on deeper granitic rock.



Figure 1: The extent of geophysical investigation at Wallcliffe House outlined in red. Imagery from MNG Survey flown May 2020.







Figure 2: Site conditions within the investigation area at Wallcliffe House.

3. GEOPHYSICAL DATA ACQUISITION

Geophysical data acquisition was carried out from the 8th to 10th September 2020 by a two-person team from GBGMAPS consisting of qualified geophysicists.

During the investigation Seismic Refraction, Multi-channel Analysis of Surface Waves (MASW) and Ground Penetrating Radar (GPR) data was acquired along 5 transects with a total length of 442m. Additional GPR data was also acquired on 3 transects totalling 201m in length. The extents of the acquired transects are shown in drawing 70585-01 in Appendix A of this report.

Refer to Appendix B for details on the geophysical methods used during the investigation.

3.1 Seismic Methods (Seismic Refraction and MASW)

Two seismic methods were utilised to obtain the subsurface information relating to the project objectives.

- **Seismic Refraction** acquired for the generation of seismic compressional (p-) wave velocity models to model the depth to the various rock types and areas of reduced velocity.
- MASW acquired for the generation of seismic shear (s-) wave velocity models as a supplementary method to aid in the interpretation of the Seismic Refraction and GPR datasets.

Both seismic methods were acquired simultaneously using an ECHO48/2014 Seismic Unit (Ambrogeo Instruments) connected to an array of 48, 4.5 Hz geophones. Seismic energy was generated using summed sledgehammer impacts onto a metal base plate.

Seismic data was acquired using parameters that enabled inversion of both seismic refraction and MASW datasets. Seismic acquisition parameters are provided in Table 1.

Table 1: Seismic Acquisition Parameters

Geophone spacing	2m
Number of geophones	48
Array length	94



Geophone centre frequency	4.5Hz
Source	Sledgehammer
Record length	2000ms
Sample interval	0.128ms

3.2 Ground Penetrating Radar

GPR was acquired using two systems acquiring radar wave reflection data at multiple frequencies to target shallow and deep geological anomalies relating to karstic features and map top of weathered limestone down to a depth of 10m Below Ground Level (BGL).

- **GSSI DF** system which utilises dual mid-frequency (300MHz and 800MHz) ground coupled antennas.
- **GSSI Sir3000** system which utilises a single low-frequency (120MHz) ground coupled antenna.

Acquisition parameters are provided in Table 2 below.

GPR data acquisition involved moving the cart-based systems over the ground surface at a slow and steady pace along the required profiles. Distances along the profiles were logged by a calibrated distance measuring device attached to the equipment controlling the GPR trigger interval.

Antenna centre frequency 800MHz, 300MHz, 120MHz, Two-way travel time 40ns 80ns 180ns Uncalibrated imaging depth 2.5m 5m 10m Scans per metre 100 100 20 1024 Sample number 1024 512 Sample rate 32 bits 32 bits 16 bits 0.12m/ns 0.12m/ns 0.12m/ns Radar wave velocity

Table 2: GPR Acquisition Parameters

3.3 Spatial Positioning

Spatial positioning of the acquired geophysical transects was achieved using a SF30-40 GNSS receiver (Navcom) with StarFire satellite corrections. Positions have been provided in GDA94, MGA zone 50 for horizontal and mAHD for vertical components. An accuracy of +/- 0.25m is expected for both horizontal and vertical components.



4. DATA PROCESSING AND ANALYSIS

Processing and analysis of the acquired geophysical dataset was carried out by qualified geophysicists using current industry standard software and GBGMAPS processing routines.

4.1 Seismic Refraction

The Seismic Refraction data was processed using Rayfract version 3.35 (Intelligent Resources Inc.) with the following processing flow used:

- 1. First arrivals (first break picks) were manually picked for each channel of each acquired seismic record.
- 2. Source and receiver geometry were applied to first break picks and resulting data imported into Rayfract.
- 3. An initial 1D gradient initial model is generated for each transect
- 4. The initial model was refined with true 2D Wavepath Eikonal Traveltime (WET) tomography over multiple iterations assuming a 2 or 3-layer model.
- 5. Seismic sections were generated showing variations in modelled P-wave velocity in metres per second (m/s) laterally and with level along the transects.

Note: Inversion of seismic refraction data is based on several assumptions including an increase in p-wave velocity with depth. In the presence of a velocity inversion (hard over soft material) the data may be truncated due to the refracted signal being unable to penetrate into a lower density material (Snell's Law), or a higher than expected velocity may present in the modelled data below an isolated hard layer. In the case where an isolated hard layer is identified in borehole logs, deeper p-wave velocities should be used with caution.

4.2 Multi-channel Analysis of Surface Waves

The acquired MASW data was processed using SurfSeis Version 4 (Kansas Geological Survey, 2014). The following processing steps were performed:

- 1. Geometry was applied to the acquired seismic data files including geophone spacing and source offset.
- 2. Phase overtone images were generated for each seismic record giving the ratio intensity of phase velocity versus frequency.
- 3. The maximum intensity across the useful range of frequencies was picked for each phase overtone image resulting in a dispersion curve.
- 4. The dispersion curves were run through a 20-layer inversion algorithm to produce an S-wave velocity sounding.
- 5. Adjacent S-wave velocity soundings along each seismic profile were compiled in order to generate an S-wave velocity section.

The generated S-wave velocity soundings were compiled and gridded using Surfer version 16 (Golden Software, 2016) to produce 2D S-wave velocity cross-sections along the profiles. The sections showed variations in the modelled S-wave velocity laterally along the profiles and with depth below the existing ground level.



4.3 Ground Penetrating Radar

The acquired GPR data was processed and analysed using ReflexW Version 8.5 (Sandmeier Software, 2017). The following processing steps were performed:

- Correct Max Phase Set GPR zero time to the first crossing of the reflection wavelet.
- 2. Manual Gain Apply a gain curve function in the y-direction in order to counter GPR signal attenutation with depth.
- 3. 1D Butterworth Filtering High cut and low cut frequency filter to improve signal to noise ratio.
- 4. 2D Filtering Subtracting average and running average filters to suppress horizontally coherent energy, effectively emphasising signals which vary laterally.

Analysis of the processed GPR data consisted of viewing the processed radar-grams sequentially with consideration to the target depth using a radar-wave velocity of 0.12m/ns, signal amplitude, continuity and phase with identified features interpreted and digitised. An example of a processed radar-gram is shown in Figure 3.

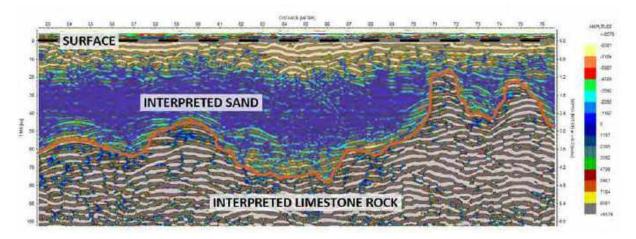


Figure 3: Processed 300MHz radar-gram showing digitised geological interface.

5. RESULTS AND INTERPRETATION

The results of the geophysical investigation carried out at Wallcliffe House, Margaret River WA have been provided as a series of drawings in Appendix A of this report as follows:

- **70585-01** Site map with acquired Seismic and GPR profiles.
- 70585-02 Site map showing shallow limestone rock and low p-wave velocity anomalies.
- **70585-03** Transect 1 Seismic P-wave Velocity model and geological interpretation.
- **70585-04** Transect 2 Seismic P-wave Velocity model and geological interpretation.
- **70585-05** Transect 3 Seismic P-wave Velocity model and geological interpretation.
- 70585-06 Transect 4 Seismic P-wave Velocity model and geological interpretation.
- **70585-07** Transect 5 Seismic P-wave Velocity model and geological interpretation.



5.1 Seismic Refraction and MASW

Seismic p-wave velocity colour contour sections have been generated from the seismic refraction data for each transect. The MASW velocity sections were omitted from the results but were used to aid in the interpretation of the seismic refraction and GPR datasets.

Seismic P-wave Propagation

Seismic P-wave velocity is governed by the elastic properties of the medium it propagates through including bulk modulus, shear modulus and density as shown in the equation below. As such the modelled p-wave velocity provides a useful guide to the subsurface material condition with increasing velocity an indication of increasing material hardness.

Seismic P-wave velocity
$$V_p = \sqrt{\frac{K + \frac{4}{3}G}{\rho}}$$
 where; K = Bulk modulus G = Shear modulus Φ = In-situ material density

Seismic P-wave Sections

At the top of each drawing is the seismic velocity tomographic model showing variations in P-wave velocity of the subsurface material as a contour cross-section with increasing velocity from blue, green, yellow, orange, red then brown. Below the seismic velocity section is a geological section giving the interpreted layering of the subsurface based on detectable p-wave seismic velocity contracts and the anticipated rock type. The calculated seismic velocity values have been classed into four categories representing different subsurface conditions. Theses velocities can be calibrated following planned intrusive borehole testing at the site.

- 1. **Low seismic p-wave velocity** (200-700 m/s) regions with low p-wave seismic wave velocity are interpreted as sand of low to moderate compaction.
- 2. **Moderate seismic p-wave velocity** (700-1200 m/s) Regions with moderate p-wave seismic wave velocity are interpreted as limestone of low rock strength. It is postulated that this class represents a weathered limestone and transitional zone to stronger, less weathered limestone below.
- 3. **Moderate to high seismic p-wave velocity** (1200-4600 m/s) Regions with moderate to high seismic p-wave velocity are interpreted as limestone of moderate rock strength. It is postulated that this class represents unweathered limestone.
- 4. **High to very high seismic p-wave velocity** (>4600 m/s) Regions with high to very high seismic p-wave velocity are interpreted as granite of high rock strength.



Depth to Granite

The first observation that can be made from the seismic refraction sections is in relation to the depth of the granite at the site. Based on current literature, granite is expected to have a seismic p-wave velocity range of 4500-6000 m/s. Using the assumed velocity of 4600 m/s for this investigation, the shallowest granite rock was interpreted to be at a depth of 7m BGL along the western end of transect 1. Granite was also interpreted to exist sporadically along the rest of the transects.

Depth to Limestone

The second observation inferred from the seismic refraction data is the depth to limestone and thickness of sand along the transects acquired. The maximum depth to the limestone rock (thickness of sand) is interpreted to be approximately 7.5m BGL. Given the expected low resolution of the seismic refraction method when imaging abrupt rock level changes such as that exhibited by limestone rock, it is not recommended that this method be used to interpret the locations of limestone pinnacles or rock outcrops (minimum limestone depth). This can be accurately imaged using the GPR method as shown in Figure 3 and discussed in section 5.2.

Regions with Reduced P-wave Velocity

Two areas of reduced seismic p-wave velocity were observed in the seismic refraction data as shown on transect 3 and 5 and drawing 70585-02 in pink. These are interpreted to exist within the limestone rock as weathered/ reduced compaction material. It is recommended that these areas are investigated further using targeted intrusive borehole testing.

5.2 Ground Penetrating Radar

GPR sections were used to interpret the depth to the top of shallow limestone and potential areas of karst features down to a depth of 10m BGL. It should be noted that depths have been calculated using limited calibration. Calibration was carried out by performing a velocity analysis to obtain a bulk radar-wave velocity for the subsurface material at the site. However, it is anticipated that quoted depths may vary by as much as +/-15% due to the various subsurface materials encountered.

Depth to Shallow Limestone

Analysis of the processed GPR data has identified a single reflective interface corresponding to the boundary between the sand and underlying limestone rock.

Drawing **70585-02** shows the location of where limestone rock has been imaged within the top 1.5m BGL of the subsurface. It is interpreted that the shallow limestone within the site is characterised by pinnacles and broken rock outcrops.

Karst

No karst features were interpreted within the top 10m of the subsurface along the acquired GPR transects. Note that this does not preclude the existence of smaller karst features between the acquired GPR transects.



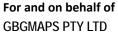
6. CONCLUSIONS

A geophysical subsurface investigation has been carried out by GBGMAPS at Wallcliffe House in Margaret River, Western Australia. During the investigation geophysical testing by way of Seismic Refraction, Multi-channel Analysis of Surface Waves and Ground Penetrating Radar was acquired along several transects within the footprint of proposed future development at the site.

The seismic datasets were processed and inverted to obtain seismic velocity models relating to variations in geology within the site. The GPR data was processed and interpreted to obtain information relating to potential karst features within the site. The depth to granite and limestone was successfully imaged using uncalibrated material velocities. No karst features were interpreted along the acquired transects.

The methods used during the investigation are geophysical and as such the results are based on indirect measurements and the processing and interpretation of radar and seismic wave signals. The findings in this report represent the best professional opinions of the authors, based on experience gained during previous similar investigations and with correlation to known and assumed subsurface ground conditions at the site.

We trust that this report and attached drawings provide you with the information required. If you require clarification on any points arising from this investigation, please do not hesitate to contact the undersigned or Andrew Spyrou on (08) 6436 1599.





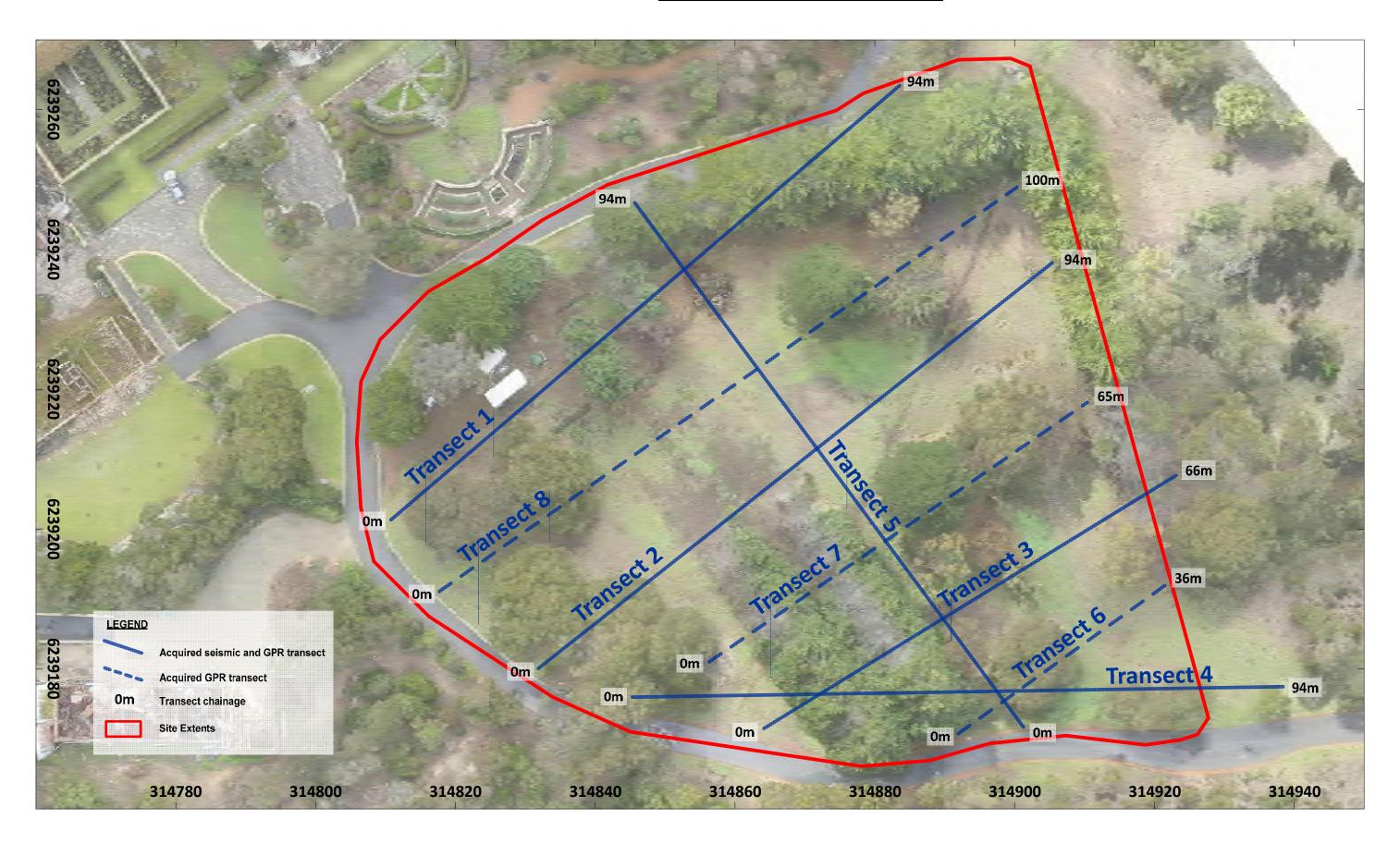


APPENDIX A - RESULT DRAWINGS



752 WALLCLIFFE ROAD, MARGARET RIVER WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION

ACQUIRED GEOPHYSICAL TRANSECTS

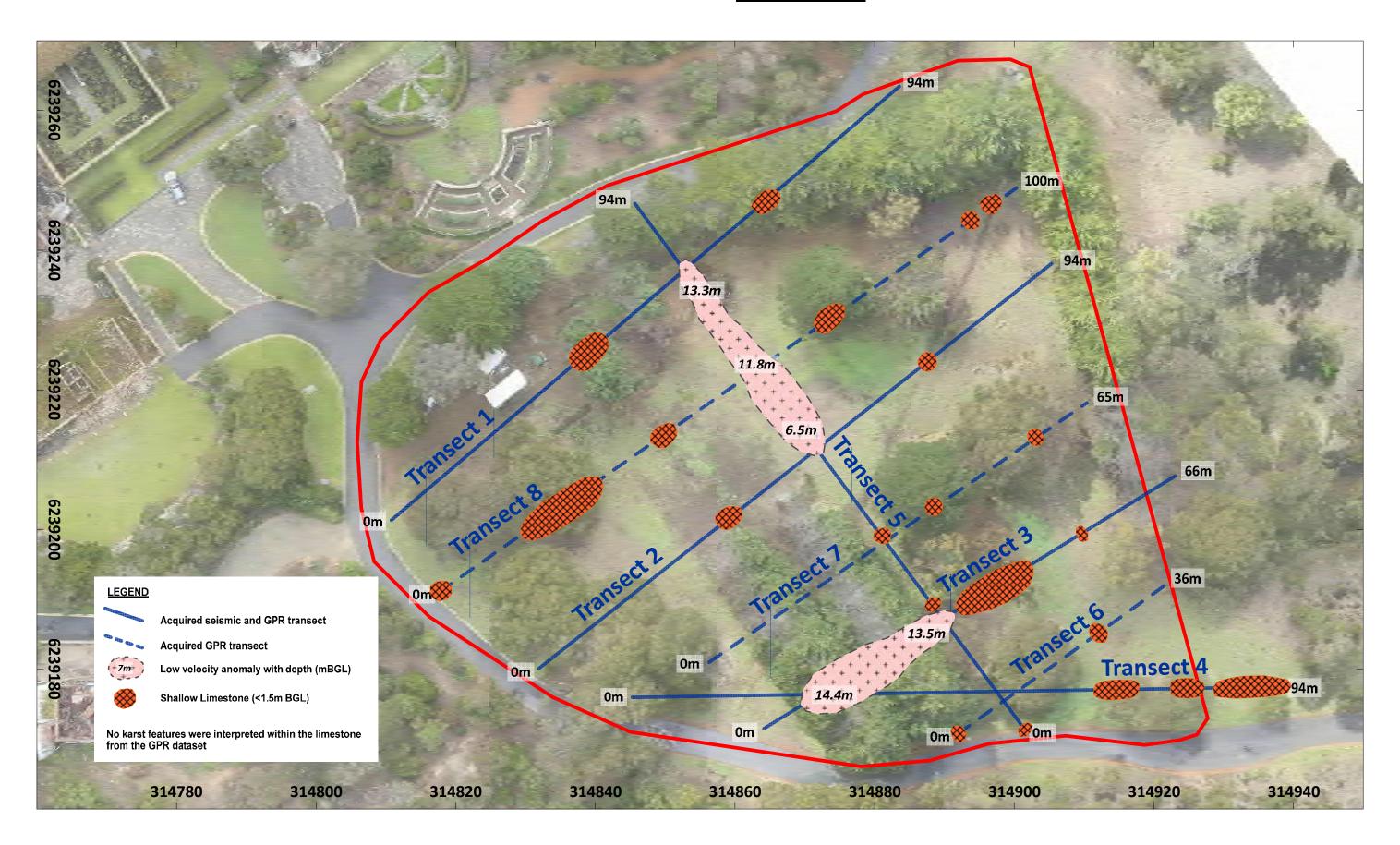




CLIENT

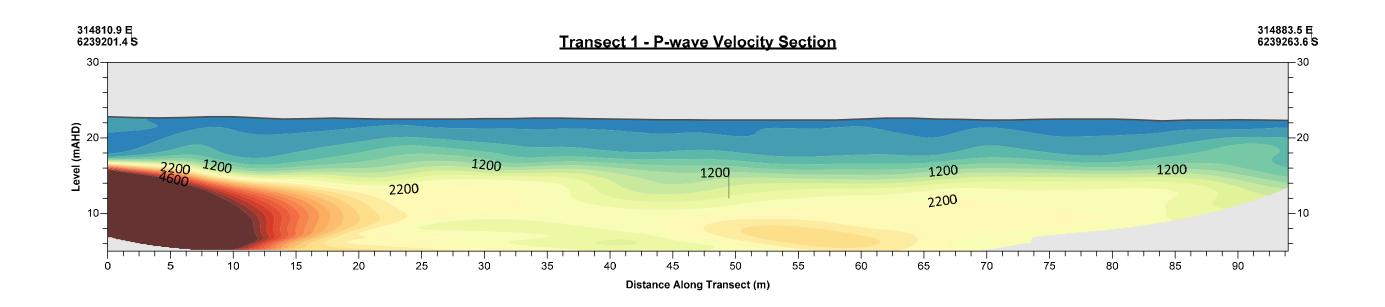


752 WALLCLIFFE ROAD, MARGARET RIVER WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION <u>INTERPRETATION</u>









LEGEND

SAND - LOW TO MODERATE COMPACTION P-WAVE VELOCITY 200-700 m/s

LIMESTONE - LOW TO MODERATE ROCK STRENGTH
P-WAVE VELOCITY 700-1200 m/s



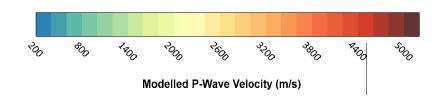
LIMESTONE - MODERATE ROCK STRENGTH P-WAVE VELOCITY 1200-4600 m/s GRANITE - HIGH ROCK STRENGTH P-WAVE VELOCITY >4600 m/s

CLIENT



DOUGLAS PARTNERS

REDUCED VELOCITY REGION - INTERPRETED LOW STRENGTH MATERIAL



<u>NOTES</u>

Drawing to be used in conjunction with Report 70585. Aerial Imagery: MNG Survey, flown May 2020 Map Projection: GDA94 MGA50 Elevation: mAHD

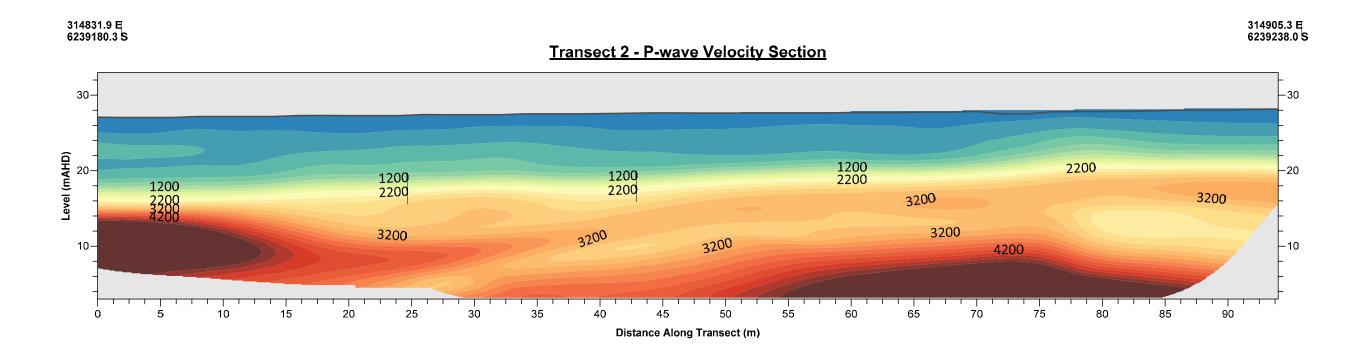
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 Date
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 Paper Size
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 Scale
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 Drawn

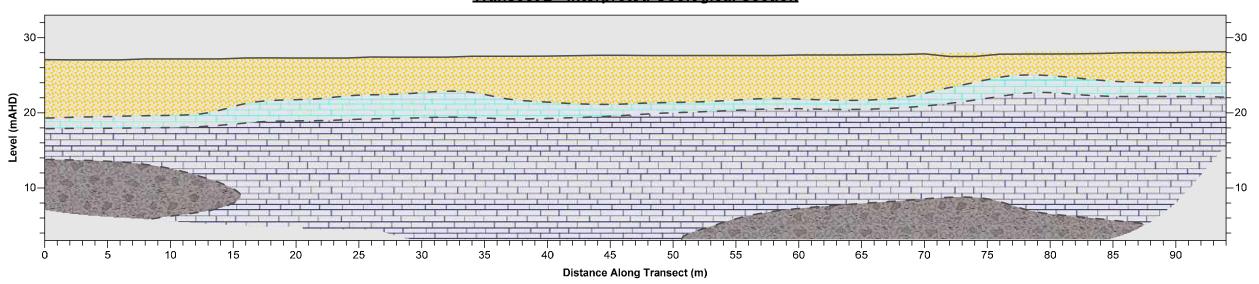
 Drawing
 70585-03
 Revision
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Transect 2 - Interpreted Geological Section



LEGEND



SAND - LOW TO MODERATE COMPACTION P-WAVE VELOCITY 200-700 m/s

P-WAVE VELOCITY 700-1200 m/s

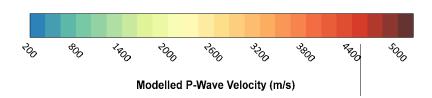
LIMESTONE - LOW TO MODERATE ROCK STRENGTH

LIMESTONE - MODERATE ROCK STRENGTH P-WAVE VELOCITY 1200-4600 m/s GRANITE - HIGH ROCK STRENGTH P-WAVE VELOCITY >4600 m/s

CLIENT



REDUCED VELOCITY REGION - INTERPRETED LOW STRENGTH MATERIAL

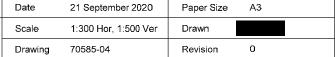


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Drawing to be used in conjunction with Report 70585. Aerial Imagery: MNG Survey, flown May 2020 Map Projection: GDA94 MGA50 Elevation: mAHD

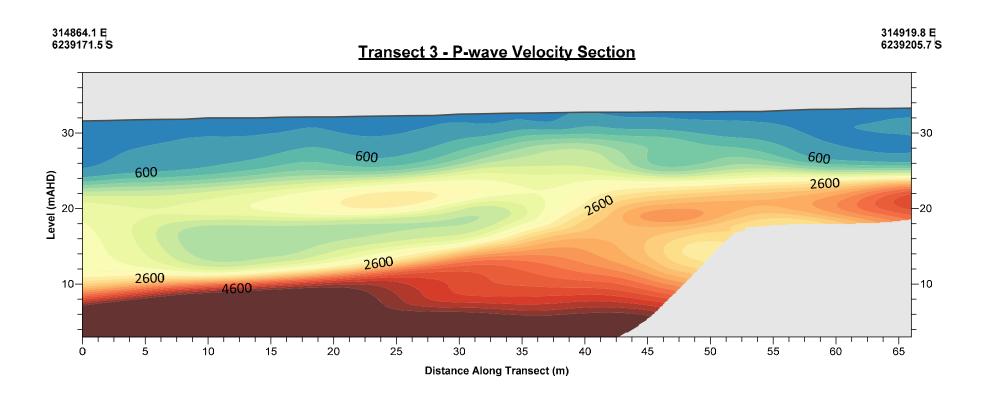
WALLCLIFFE HOUSE MARGARET RIVER, WESTERN
AUSTRALIA - GEOPHYSICAL INVESTIGATION

DOUGLAS PARTNERS

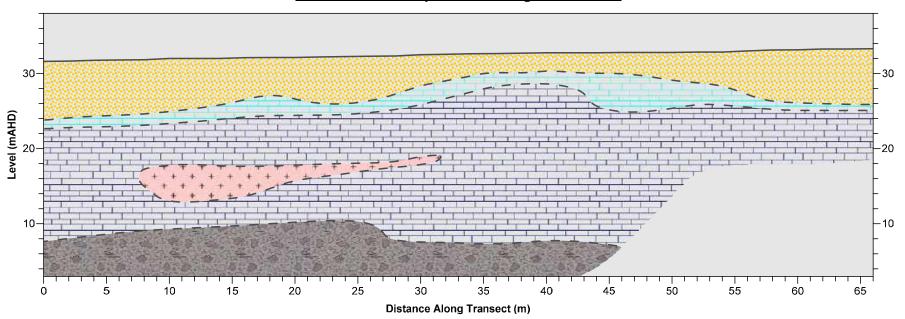








Transect 3 - Interpreted Geological Section



LEGEND

SAND - LOW TO MODERATE COMPACTION P-WAVE VELOCITY 200-700 m/s

LIMESTONE - LOW TO MODERATE ROCK STRENGTH P-WAVE VELOCITY 700-1200 m/s

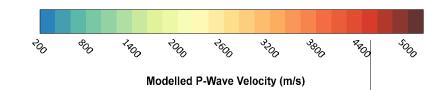
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LIMESTONE - MODERATE ROCK STRENGTH P-WAVE VELOCITY 1200-4600 m/s GRANITE - HIGH ROCK STRENGTH P-WAVE VELOCITY >4600 m/s

CLIENT



REDUCED VELOCITY REGION - INTERPRETED LOW STRENGTH MATERIAL



NOTES

Drawing to be used in conjunction with Report 70585. Aerial Imagery: MNG Survey, flown May 2020 Map Projection: GDA94 MGA50 Elevation: mAHD

WALLCLIFFE HOUSE MARGARET RIVER, WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION

DOUGLAS PARTNERS

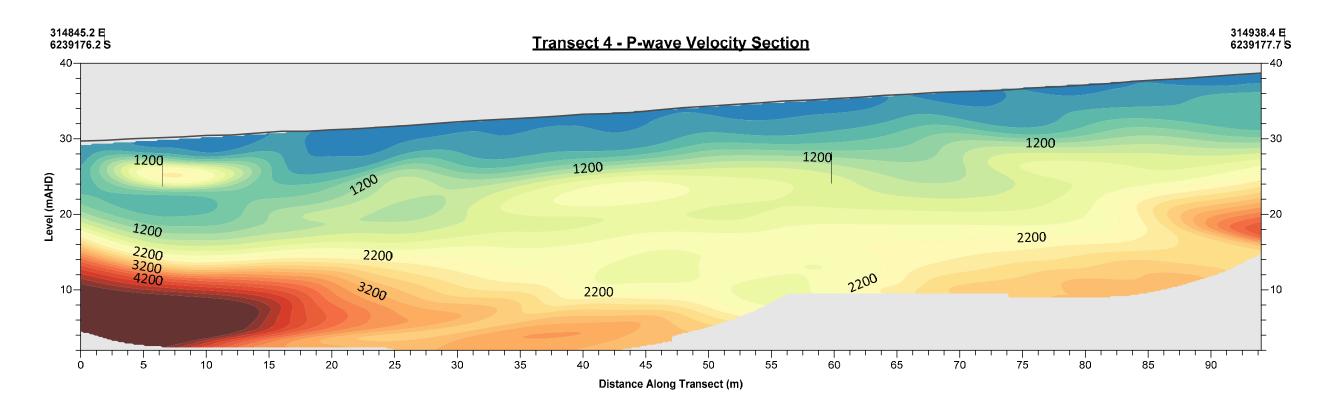
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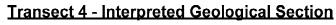
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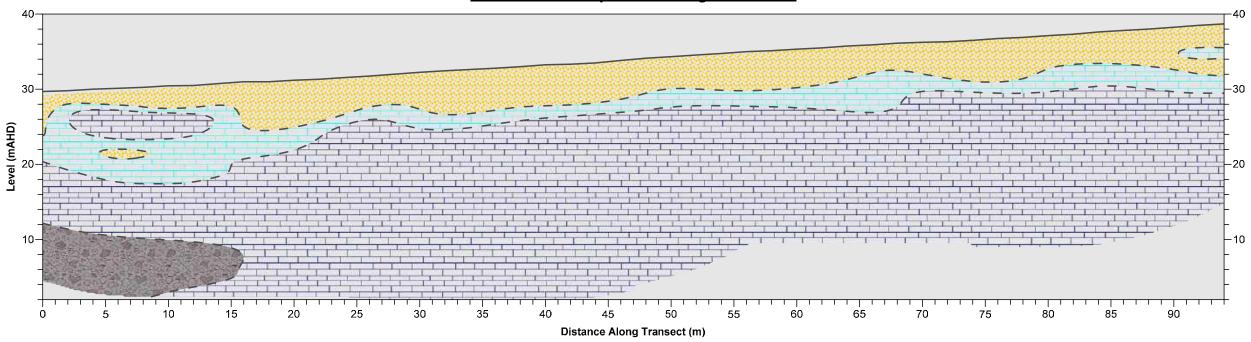
 Drawing
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 Revision
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LEGEND



SAND - LOW TO MODERATE COMPACTION P-WAVE VELOCITY 200-700 m/s

LIMESTONE - LOW TO MODERATE ROCK STRENGTH P-WAVE VELOCITY 700-1200 m/s



LIMESTONE - MODERATE ROCK STRENGTH
P-WAVE VELOCITY 1200-4600 m/s

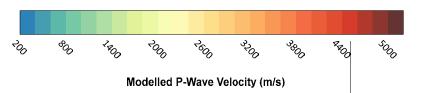
GRANITE - HIGH ROCK STRENGTH
P-WAVE VELOCITY >4600 m/s

CLIENT



DOUGLAS PARTNERS

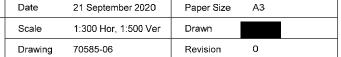
REDUCED VELOCITY REGION - INTERPRETED LOW STRENGTH MATERIAL



NOTES

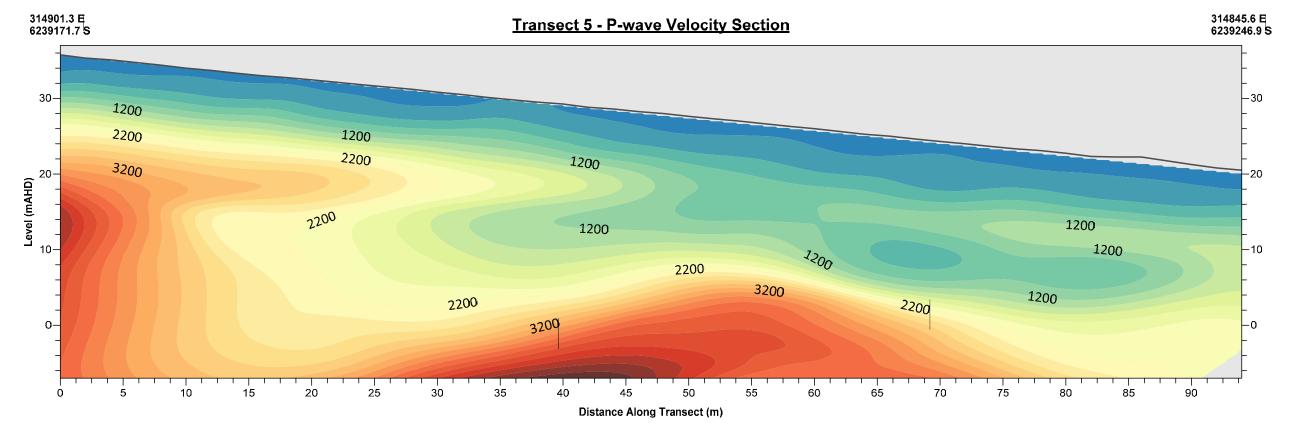
Drawing to be used in conjunction with Report 70585. Aerial Imagery: MNG Survey, flown May 2020 Map Projection: GDA94 MGA50 Elevation: mAHD

W
WALLCLIFFE HOUSE MARGARET RIVER, WESTERN
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AUSTRALIA - GEOPHYSICAL INVESTIGATION

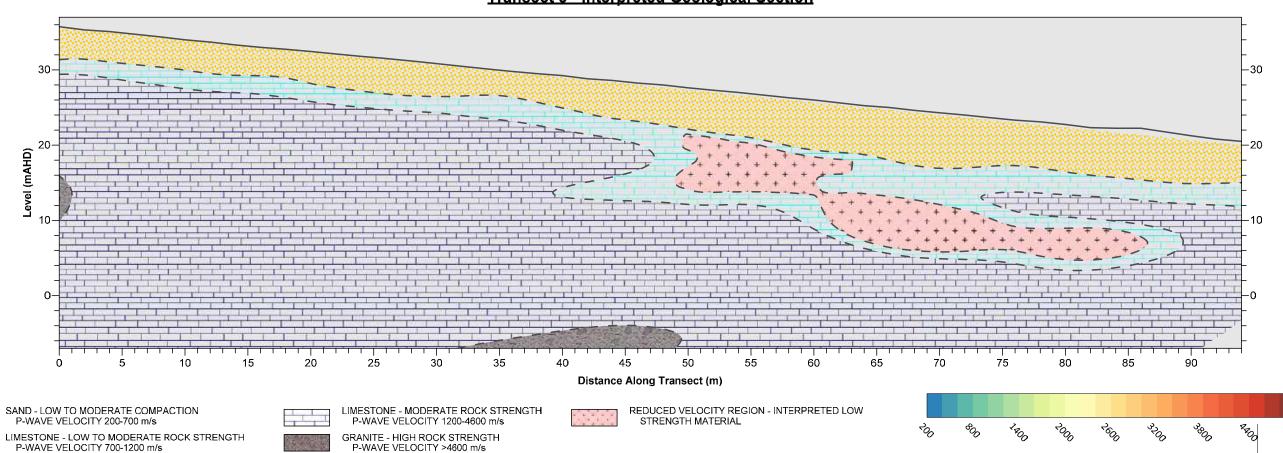








Transect 5 - Interpreted Geological Section

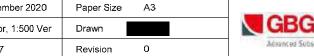


LEGEND

NOTES

Drawing to be used in conjunction with Report 70585.
Aerial Imagery: MNG Survey, flown May 2020
Map Projection: GDA94 MGA50
Elevation: mAHD

CLIENT	DOUGLAS PARTNERS	Date	21 Septen
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AUSTRALIA - GEOPHYSICAL INVESTIGATION	Drawing	70585-07	



Modelled P-Wave Velocity (m/s)



APPENDIX B - GEOPHYSICAL METHODS

SEISMIC REFRACTION



APPLICATIONS

- √ Bedrock mapping
- ✓ Mapping weathered zones
- ✓ Stratigraphic mapping
- ✓ Indicative material hardness for piling, tunnelling and excavation works
- ✓ Identification of fault / fractured zones

METHOD

The Seismic Refraction method involves the measurement of travel times of seismic compressional waves (P-waves) that are generated at the surface, propagate through the subsurface and return to the surface after being refracted at the interface between layers of contrasting seismic velocity. Seismic wave velocities are controlled by the fundamental parameters of elastic strength and density of the material it propagates through.

For near surface investigations seismic energy is generated on the surface using a sledge hammer. More powerful sources such as accelerated drop weight, down-hole airguns, or explosives are required for deeper investigations. The generated seismic waves propagate through the subsurface at a certain velocity. On reaching a geological boundary marked by an increase in seismic velocity, at a specific angle the wave is critically refracted and travels along the top of the lower layer at a greater velocity. This generates head waves in the upper layer which return to the surface where it is detected as vibrations by a linear array of geophones spaced at regular intervals.

By measuring the travel times of these refracted waves from multiple source points to multiple receivers, the seismic refraction method can resolve lateral changes in the depth to the top of a refracting interface as well as the seismic velocity within it. Furthermore being related to elastic strength and density, the velocities calculated from a seismic refraction survey can be a useful guide to the rippability of a rock for excavation.

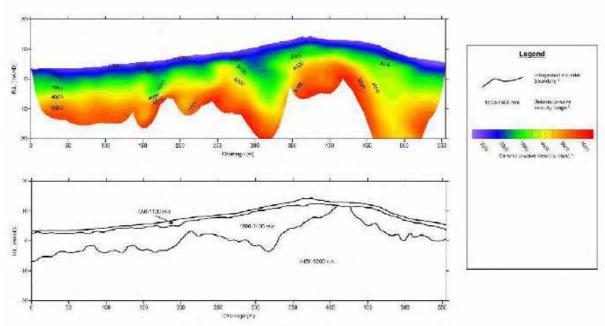




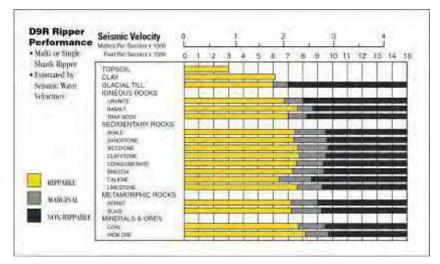
DATA ANALYSIS & PRESENTATION

Processing and analysing seismic refraction data can be carried out using a layered model assuming distinct refractive boundaries or tomographic approach assuming a gradual increase in seismic velocity with depth. Both approaches have benefits and are typically carried out in unison to generate the most detailed geological model possible.

The output is a cross-section showing lateral changes in the depth to the various refracting interfaces and the seismic velocities within them. When correlated with core logs, this information can be related to geological boundaries in the subsurface. This can be particularly useful for planning excavation with the depth to the different layers giving an idea of quantity of rock needed to be removed and the seismic velocities giving an idea of the rock's hardness and hence rippability.



Modelled seismic p-wave velocity section (top) and corresponding layer model section (bottom)



Rippability chart, displays the relationship between rippability and P-wave velocity, taken from Handbook of Ripping, Twelfth Edition, Caterpillar Inc. 2000.

MULTI-CHANNEL ANALYSIS OF SURFACE WAVES



APPLICATIONS

- √ Bedrock mapping
- ✓ Degree of sediment compaction
- ✓ Determination of geotechnical parameters (e.g. shear modulus)
- ✓ Void detection
- ✓ Liquefaction potential
- ✓ Subsurface profiling
- √ Imaging velocity inversions (hard layer overlying softer layer)

METHOD

The Multi-channel Analysis of Surface Waves method (MASW) is a non-destructive seismic method which uses the elastic properties of subsurface materials to determine subsurface structure. By analysis of the dispersive properties of varying frequencies from a single seismic source, shear-wave velocity (Vs) and associated geotechnical parameters can be determined.

MASW uses an active seismic source such as a hammer or weight drop impact to produce seismic energy consisting predominantly of Pressure (P-) waves and Shear (S-) waves. MASW uses the S-wave dispersion component to provide information on the shear velocity to a depth determined by frequency range of the energy source and array configuration.

Seismic surface waves have dispersion properties that traditionally utilized body waves lack. Differing wavelengths/frequencies have different depth of penetration, and therefore propagates with different phase velocity, with an increase in wavelength being proportional to increased depth of penetration. As the surface wave is the dominant wave generated from any seismic source, MASW data quality (signal to noise) tends to be higher than other seismic methods such as seismic reflection or refraction.

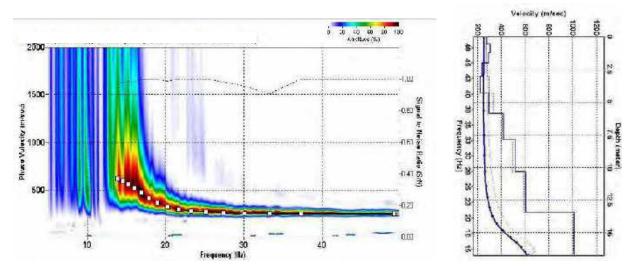


MULTI-CHANNEL ANALYSIS OF SURFACE WAVES

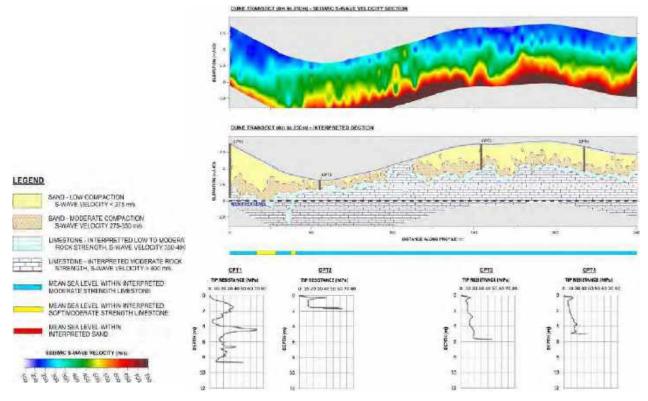


DATA ANALYSIS & PRESENTATION

Analysis of the collected MASW seismic records is concentrated on the S-wave dispersion component. Dispersion curves are extracted for each collected record from the overtone image showing the percentage intensity of phase velocity versus frequency. These curves are then inverted to produce 1D S-wave soundings typically to a depth of up to 30 m. The calculated 1D soundings can then be compiled and gridded to produce 2D sections showing the variation in S-wave velocity both laterally along the profile and with depth.

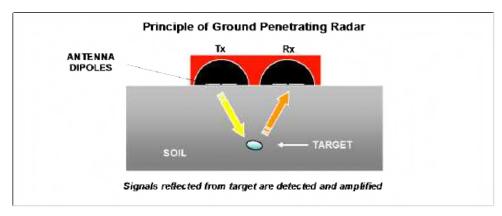


Dispersion curve generated from an MASW sounding (left image), modelled S-wave velocity sounding generated from inversion of the picked dispersion curve



MASW seismic S-wave 2D velocity section with interpretation.



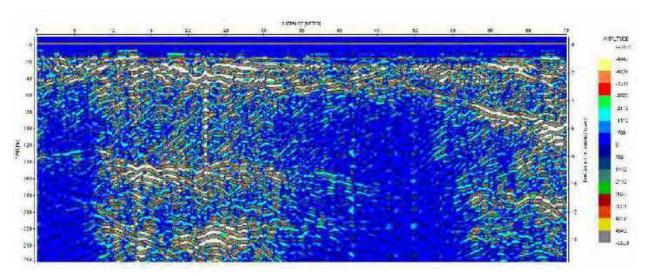


Schematic illustration of the principle behind ground penetrating radar

DATA ANALYSIS & PRESENTATION

A radar-gram profile is built up of continuous scans along a selected line path, see below. These are 2D cross-sections of the subsurface showing variations in reflection amplitude as a colour scale. The recorded reflections can be analysed in terms of shape, phase, travel time and signal amplitude to provide information about a target's size, depth and orientation in relation to the material around it.

The depth of investigation achievable with the GPR method is largely a function of the antenna frequency used. Lower frequencies in the order of 100 MHz are typically used for geological mapping to a maximum depth of approximately 20 m, whilst high frequencies in the order of 1 GHz are used for high resolution investigations of structures including building, bridges and tunnels.



Processed GPR cross-section imaging a karst formation illustrated by the variations in the radarwave reflection amplitudes. This enables the detailed analysis of voids or caves within limestone bedrock.

GROUND PENETRATING RADAR



APPLICATIONS

- ✓ Stratigraphic mapping including depth to bedrock
- ✓ Locating karst features, sinkholes, voids or cave systems
- ✓ Depth to water table
- ✓ Archaeology (location of graves and artifacts)
- ✓ Location of underground infrastructure, including UST's and utilities
- ✓ Assessment of internal condition and defects of engineered structures
- ✓ Assessment of road and rail infrastructure, including asphalt and ballast condition
- ✓ Slab thickness, reinforcement placement and void detection

METHOD

Ground Penetrating Radar (GPR) is a non-destructive and non-invasive geophysical technique for rapidly imaging the shallow subsurface and producing high-resolution colour sections in real time. The method works by transmitting electromagnetic energy into the material being tested (most usual the ground). Typically 100,000 impulses per second are transmitted which are of very short duration and contain a wide spectrum of frequencies.

The transmitted electromagnetic energy propagates through the subsurface as a function of the subsurface material's electrical properties, which are in turn dependent on its physical and chemical properties. Reflection of radar energy occurs at boundaries between differing stratigraphic layers or inclusions which have contrasting electrical properties. Conversely, no reflections occur from a homogenous material where there are no internal reflectors. The reflections are detected by the receiving antenna placed adjacent to the transmitter. The depth to the target is proportional to the time (in nanoseconds) taken for the signal to travel from the transmitting antenna at the surface to the target and back to the receiver.



Appendix F

GBG Maps Report 70670



Level 1, 2 Sabre Crescent Jandakot, WA 6964 Tel: 08 6436 1599 Email: info@gbgmaps.com.au

A.B.N. 45 129 251 225

GEOPHYSICAL INVESTIGATION FOR SUBSURFACE GEOLOGICAL MAPPING.

WALLCLIFFE HOUSE, 752 WALLCLIFFE ROAD MARGARET RIVER WESTERN AUSTRALIA.

Date: 25 February 2022 Report No.: 70670

Revision: 3

Author

Reviewed:

Distribution

Douglas Partners



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1. INTRODUCTION

At the request of Douglas Partners, GBGMAPS carried out a geophysical subsurface investigation at the site of Wallcliffe House, 752 Wallcliffe Road Margaret River, WA in January 2022

During the investigation Seismic Refraction, Electric Resistivity Tomography (ERT) and Ground Penetrating Radar (GPR) datasets were acquired, processed and analysed to provide information on the geology underlying the site. In particular, the objectives of the investigation were to:

- Derive the ground profile to depths of between approximately 10 m and 20 m
- · Likely assess depth to groundwater, in particular within low parts of the site
- · Possibly identify fresh groundwater from salty groundwater

The geophysical investigation forms part of a broader scope geotechnical investigation being carried out by Douglas Partners as part of planned redevelopment of the site.

2. INVESTIGATION SITE

The geophysical investigation was carried out along four (4) transects within the site boundaries as shown in pink lines in Figure 1 below. Transects from the previous geophysical investigation carried out by GBGMAPS in September 2020 are shown in blue.



Figure 1: Geophysical transects acquired at Wallcliffe House including the January 2022 investigation (pink lines) and the September 2020 investigation (blue lines).

Ground conditions at the site were suitable for geophysical data acquisition consisting of cleared areas, grass and maintained gardens. Photographs of the typical conditions at the site are shown in Figure 2. Geophysical data was not acquired where surface obstructions were present such as existing buildings and steep topography.





Figure 2: Site conditions during the geophysical investigation at Wallcliffe House including Transect 1 (top left), Transect 2 (top right), Transect 3 (bottom left) and Transect 4 (bottom right).

3. GEOPHYSICAL TESTING

Geophysical data acquisition was carried out from the 24 to 26 January 2022 by qualified geophysicists from GBGMAPS.

3.1 SEISMIC REFRACTION

Seismic data was acquired using an ECHO-2014 (AmbroGeo Instruments) multi-channel seismograph connected to an array of 4.5Hz centre frequency, vertical geophones placed at 5m intervals along the required transects. Seismic energy was generated using summed sledgehammer impacts onto a metal base plate at regular intervals within the seismic array.

Seismic acquisition parameters were set to enable the inversion of both seismic refraction and Multi-Channel Analysis of Surface Waves (MASW) datasets. Acquisition parameters are provided in Table 1.



Table 1: Seismic Acquisition Parameters

Geophone spacing	5m
Number of geophones	<48
Source	Sledgehammer
Source interval	10m
Source stacks	5
Record length	2000ms
Sample interval	0.128ms

The Seismic Refraction data was processed using Rayfract (Intelligent Resources Inc.) for inversion using Wave Path Eikonal Traveltime Tomography and the generation of seismic velocity sections showing the variation in modelled seismic compressional (P-) wave velocity along the transects and with level.

Initial processing of the MASW data was carried out using SurfSeis (Kansas Geological Survey). MASW processing was not finalised as the results of the seismic refraction was deemed to provide a better representation of the subsurface conditions at the site.

3.2 ELECTRICAL RESISTIVITY TOMOGRAPHY

ERT data was acquired using a Syscal KID Switch-24 (Iris Instruments) connected to an array of electrodes placed at 5m intervals along the required transects. Data was acquired using a preprogrammed automated control sequence that controlled which pair of electrodes along the array were used for current injection with the resulting potential difference measured across multiple electrode pairs.

ERT acquisition parameters are provided in Table 2.

Table 2: ERT Acquisition Parameters

Electrode spacing	5m
Number of electrodes	<24
Acquisition array type	Wenner
Injection on/off time	2s / 2s
Min. / Max. stacks	4/8
Quality factor	10%
Quadripoles per array	84
Electrode roll along	12

The ERT data was processed using ProsysII (Iris Instruments) for filtering and generation of apparent resistivity pseudo-sections. These were inverted with Earth Imager 2D (AGI) using the smoothness-constrained least-squares technique for the generation of electrical resistivity sections showing the variation in modelled electrical resistivity along the transects and with level.



3.3 GROUND PENETRATING RADAR

GPR data was acquired using a DF (GSSI) system which utilises dual frequency 300MHz and 800MHz ground coupled antennas. Data was acquired by moving the cart-based system as a series of transects over accessible parts of the site.

GPR acquisition parameters are provided in Table 3.

Antenna centre frequency	800 MHz, 300MHz
Two-way travel time	80ns, 140ns
Uncalibrated imaging depth	5m, 8m
Scans per metre	100
Sample number	1024
Sample rate	32 bits
Radar wave velocity	0.12m/ns

Table 3: GPR Acquisition Parameters

The GPR data was processed and analysed using ReflexW Version 9.5 (Sandmeier Software, 2020) with manual gains, and 1D and 2D filters being applied. Continuous and isolated reflection interfaces relating to subsurface features were identified and digitised. An example GPR reflection sections from this investigation is shown in Figure 3.

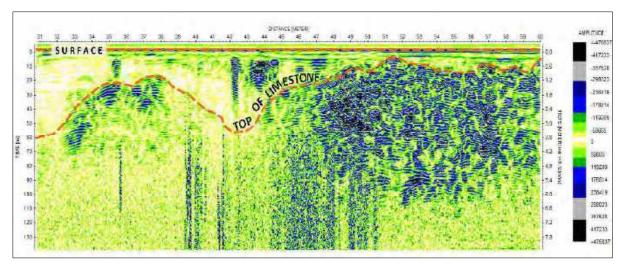


Figure 3: Example interpreted 300MHz radar gram section showing top of limestone rock.

3.4 SPATIAL POSITIONING

Spatial positioning of the acquired geophysical transects was achieved using a Hemisphere S631 GNSS receiver with Atlas satellite corrections. An accuracy of +/- 0.25m is expected for both horizontal and vertical components.

Positions have been provided in GDA2020, MGA zone 50 for the horizontal component and mAHD for the vertical component.



4. RESULTS AND INTERPRETATION

The results of the geophysical investigation carried out at Wallcliffe House, Margaret River WA have been provided as a series of drawings in Appendix A of this report as follows:

- **70670-01** Site map with acquired geophysical transects.
- **70670-02** Transects 1 and 2 Seismic P-wave Velocity section and geological interpretation.
- **70670-03** Transects 3 and 4 Seismic P-wave Velocity section and geological interpretation.
- 70670-04 Transects 1 to 4 Electrical Resistivity Sections with interpreted depth to water table.

4.1 SEISMIC REFRACTION

Seismic P-wave velocity colour contour sections have been generated from the seismic refraction data for each transect. The MASW velocity sections were omitted from the results but were used to aid in the interpretation of the seismic refraction and GPR datasets.

Seismic P-wave Propagation

Seismic P-wave velocity is governed by the elastic properties of the medium it propagates through including bulk modulus, shear modulus and density as shown in the equation below. As such the modelled p-wave velocity provides a useful guide to the subsurface material condition with increasing velocity an indication of increasing material hardness.

Seismic P-wave velocity
$$V_p = \sqrt{\frac{K + \frac{4}{3}G}{\rho}}$$

where; K = Bulk modulus G = Shear modulus $\rho = \text{In-situ material density}$

Seismic P-wave Sections

At the top of each drawing is the seismic velocity tomographic model showing variations in P-wave velocity of the subsurface material as a contour cross-section with increasing velocity from blue, green, yellow, orange, red then brown.

Below the seismic velocity section is a geological section giving the interpreted layering of the subsurface based on detectable P-wave seismic velocity contracts and the interpretation of intrusive geotechnical data. The calculated seismic velocity values have been classed into five categories representing different subsurface conditions. The seismic velocity boundaries for these classes have been calibrated with the provided intrusive testing including logged boreholes, CPT, hand augers and test pits.

1. **Low seismic P-wave velocity** (200-1000 m/s) Yellow hatch – this class is interpreted as SAND of low to moderate compaction and is observed at the surface to shallow depth.



- 2. **Moderate seismic P-wave velocity** (1000-2200 m/s) Orange cross hatch occurring close to the southern bank of Margaret River, this is interpreted as extremely weathered GRANULITE typically being recovered as CLAY
- 3. Moderate seismic P-wave velocity (1000-2200 m/s) Light blue brick hatch occurring further away from the southern bank of Margaret River, this is interpreted as interbedded sediments (SAND, Silty SAND, Gravelly SAND and GRAVEL) and LIMESTONE of low rock strength. The modelled seismic velocity range for this class is the same as Class 2 (extremely weathered GRANULITE) and has been differentiated from the results of the geotechnical testing.
- 4. **Moderate to high seismic P-wave velocity** (2200-4000 m/s) Dark blue brick hatch this class is interpreted as slightly weathered to fresh LIMESTONE of moderate rock strength and moderately to highly weathered GRANULITE.
- 5. **High to very high seismic P-wave velocity** (>4000 m/s) Brown arrow hatch this class is interpreted as GRANITE of high rock strength.

Depth to top of Rock

The depth to limestone, granite and granulite rock has been interpreted based on the modelled seismic velocities and using the intrusive geotechnical data provided. Some overlap between the seismic velocity boundaries of the three rock types is expected. For example, weathered granite and granulite is expected to have similar P-wave velocity values to moderately strength limestone. Nonetheless, a general correlation was observed between the intrusive results and the interpreted seismic velocity sections.

CLAY (Extremely weathered GRANULITE)

The extremely weathered GRANULITE layer occurring as a clay has been interpreted from the intrusive testing acquired near the southern bank of Margaret River. This unit shares the same velocity boundaries (1000-2200 m/s) as the interbedded sediments and LIMESTONE of low rock strength but is restricted to the lower lying areas of the site. Where these velocities have been modelled in the upper parts of the site they have been interpreted to be interbedded sediments and LIMESTONE of low rock strength.

Gravel Lenses

The borehole data provided shows lenses of gravel occurring within the interpreted limestone layers. It is postulated that this gravel is a result of the weathering of fresh limestone and is expected to have a reduced seismic P-wave velocity. However, the inversion of seismic refraction data is based on the assumption of an increase in p-wave velocity with depth. In the presence of a velocity inversion (hard over soft material) the data may be truncated due to the refracted signal being unable to penetrate into a lower density material (as defined by Snell's Law), or a higher than expected velocity may be present in the modelled data below an isolated hard layer.



4.2 ELECTRICAL RESISTIVITY TOMOGRAPHY

The geo-electrical sections for each acquired ERT transect are presented in drawing 70670-04 in Appendix A. The sections show the variation in modelled electrical resistivity of the subsurface material in Log₁₀ Ohm metres (Ω m) as per the colour scale.

The modelled resistivity values for this investigation ranged from 5 Ω m to 3000 Ω m. The ERT method was used to map the groundwater level across the transects. The groundwater level was interpreted from the ERT data and calibrated with the intrusive geotechnical testing provided. This has been shown as a white solid squares line across the transects.

Note the differentiation between fresh and saline groundwater was not possible from the modelled electrical resistivity data.

4.3 GROUND PENETRATING RADAR

GPR sections were used to interpret potential areas of karst features to a depth of 8m BGL. It is anticipated that quoted depths may vary by as much as +/-15% due to the various subsurface materials encountered.

No karst features were interpreted within the top 8m of the subsurface along the acquired GPR transects. Note that this does not preclude the existence of smaller karst features between the acquired GPR transects.



5. CONCLUSIONS

A geophysical subsurface investigation has been carried out by GBGMAPS at Wallcliffe House Margaret River, Western Australia. During the investigation geophysical testing by way of Seismic Refraction, Electrical Resistivity Tomography and Ground Penetrating Radar was acquired along several transects as specified by the client.

The Seismic Refraction datasets were processed and inverted to obtain seismic velocity models relating to variations in geology within the site including the interpreted boundaries of limestone and granite/granulite.

The Electrical Resistivity datasets were processed and inverted to map the top of groundwater (water table). Note the differentiation between saline and fresh water could not be made from the resistivity models.

The Ground Penetrating Radar data was processed and interpreted to obtain information relating to potential karst features within the site. No karst features were interpreted along the acquired transects.

The methods used during the investigation are geophysical and as such the results are based on indirect measurements and the processing and interpretation of radar, electrical and seismic wave signals. The findings in this report represent the professional opinions of the authors, based on experience gained during previous similar investigations and with correlation to known and assumed subsurface ground conditions at the site.

We trust that this report and attached drawings provide you with the information required. If you require clarification on any points arising from this investigation, please do not hesitate to contact the undersigned or Baqir Al asadi on (08) 6436 1599.

For and on behalf of GBGMAPS PTY LTD





APPENDIX A - RESULT DRAWINGS



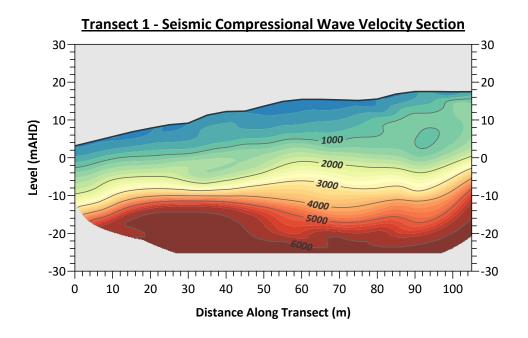
GEOPHYSICAL INVESTIGATION SITE MAP

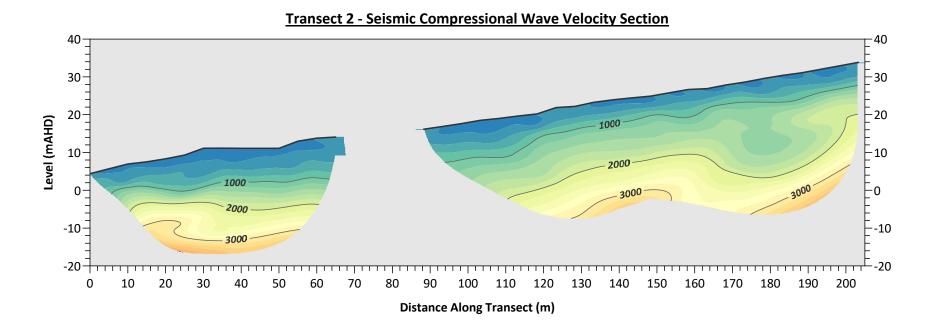


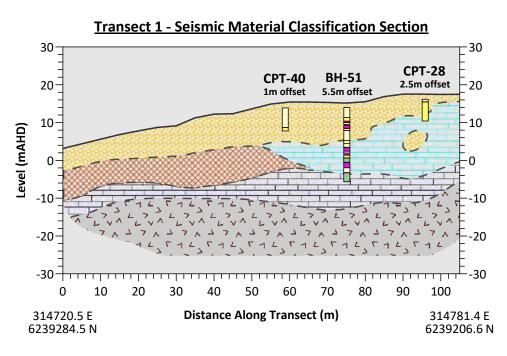
Distance (metres)

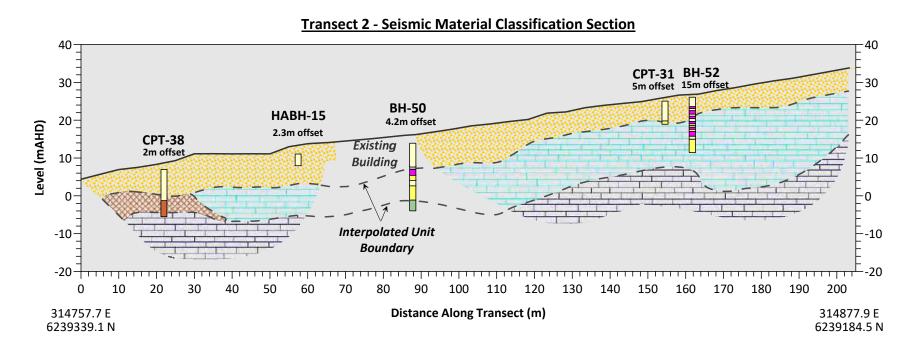


SEISMIC REFRACTION TESTING









LEGEND

SAND - LOW TO MODERATE COMPACTION P-WAVE VELOCITY 200-1000 m/s

> LOW STRENGTH LIMESTONE - HIGHLY WEATHERED (OCCURS AWAY FROM RIVER) P-WAVE VELOCITY 1000-2200 m/s

EXTREMELY WEATHERED GRANULITE (OCCURS AS CLAY NEAR RIVER) P-WAVE VELOCITY 1000-2200 m/s

LIMESTONE - MODERATE ROCK STRENGTH / GRANULITE NEAR RIVER- MODERATELY TO HIGHLY WEATHERED P-WAVE VELOCITY 2200-4000 m/s

GRANULITE / GRANITE - HIGH ROCK STRENGTH P-WAVE VELOCITY >4000 m/s

2600 3400 3800 4600

Modelled Compressional (P-) wave velocity (m/s)

Recovered material type (simplified) Sediment, fine - SILT, SAND **LIMESTONE GRAVEL** CLAY **GRANULITE / GRANITE** Core loss

Drawing to be used in conjunction with Report 70670 Rev3. Coordinates given are in GDA2020, MGA50.

CLIENT **DOUGLAS PARTNERS** Date GEOPHYSICAL INVESTIGATION FOR WALLCLIFFE HOUSE Scale REDEVELOPMENT PROJECT. 752 WALLCLIFFE ROAD MARGARET RIVER WA. Drawing 70670-02

25 February 2022 Paper Size A3 1:1000 Drawn Revision

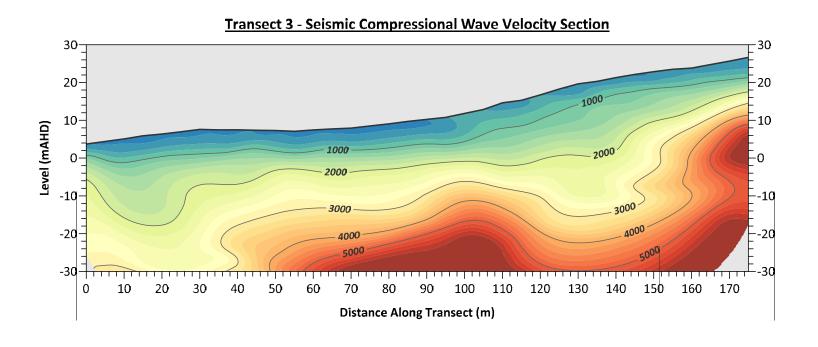


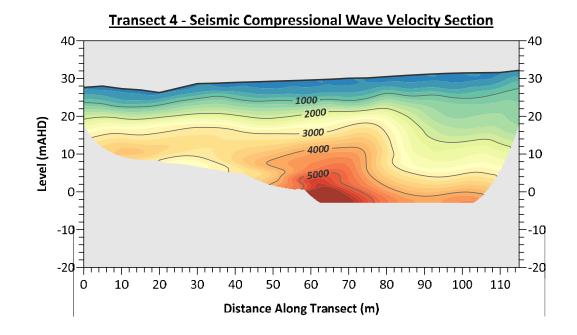
Borehole

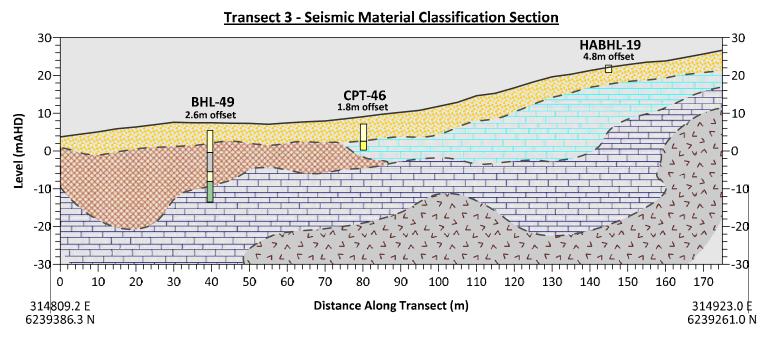
vel 1, 2 Sabre Crescent, Jandakot WA 6164 PO Box 3526, Success WA 6964 Telephone: (08) 6436 1599 Email: info@gbgmaps.com.au

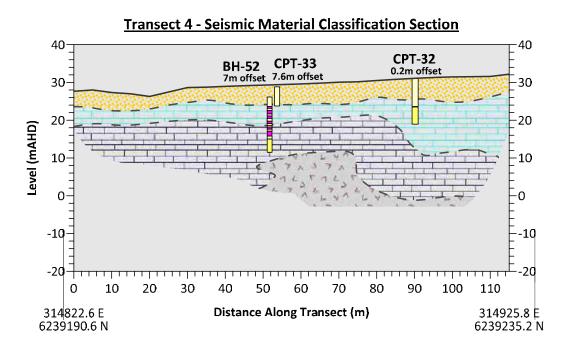


SEISMIC REFRACTION TESTING









LEGEND

SAND - LOW TO MODERATE COMPACTION

P-WAVE VELOCITY 200-1000 m/s

LOW STRENGTH LIMESTONE - HIGHLY WEATHERED (OCCURS AWAY FROM RIVER) P-WAVE VELOCITY 1000-2200 m/s

EXTREMELY WEATHERED GRANULITE (OCCURS AS CLAY NEAR RIVER) P-WAVE VELOCITY 1000-2200 m/s

LIMESTONE - MODERATE ROCK STRENGTH / GRANULITE NEAR RIVER - MODERATELY TO HIGHLY WEATHERED P-WAVE VELOCITY 2200-4000 m/s

GRANULITE / GRANITE - HIGH ROCK STRENGTH P-WAVE VELOCITY >4000 m/s

3000

2600

Modelled Compressional (P-) wave velocity (m/s)

3400

4200 3800

4600



Borehole

LIMESTONE

GRAVEL

Core loss

CLAY

Recovered material type (simplified)

Sediment, fine - SILT, SAND

GRANULITE / GRANITE

vel 1, 2 Sabre Crescent, Jandakot WA 6164 PO Box 3526, Success WA 6964 Telephone: (08) 6436 1599 Email: info@gbgmaps.com.au

Drawing to be used in conjunction with Report 70670 Rev3. Coordinates given are in GDA2020, MGA50.

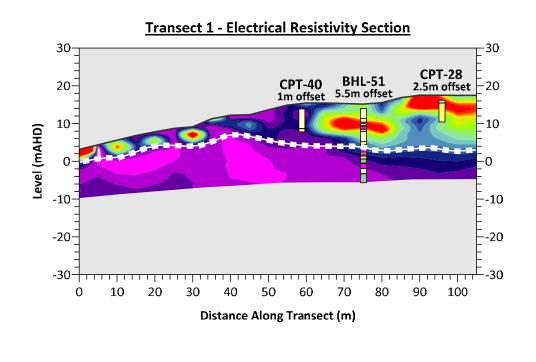
CLIENT **DOUGLAS PARTNERS** Date GEOPHYSICAL INVESTIGATION FOR WALLCLIFFE HOUSE REDEVELOPMENT PROJECT.
752 WALLCLIFFE ROAD MARGARET RIVER WA.

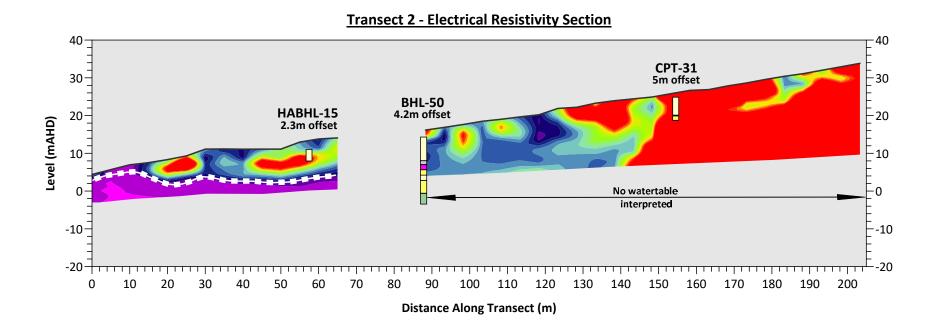
25 February 2022 Paper Size Scale Drawn Drawing 70670-03 Revision 3

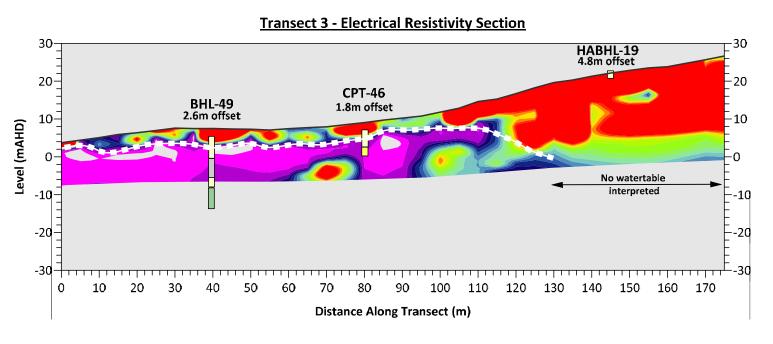
A3

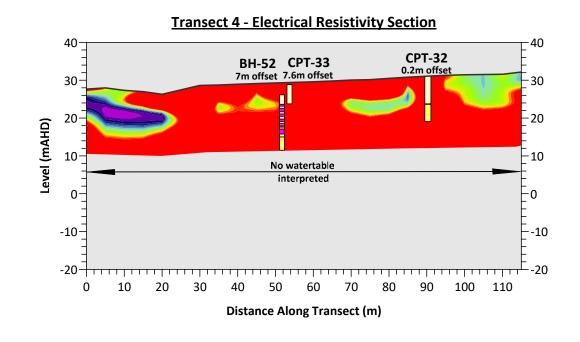


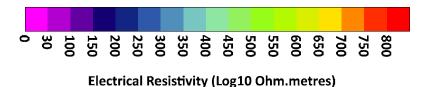
ELECTRICAL RESISTIVITY TOMOGRAPHY



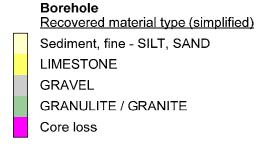








INTERPRETED WATER TABLE



Drawing to be used in conjunction with Report 70670 Rev3. Coordinates given are in GDA2020, MGA50.

CLIENT **DOUGLAS PARTNERS** Date GEOPHYSICAL INVESTIGATION FOR WALLCLIFFE HOUSE Scale REDEVELOPMENT PROJECT.
752 WALLCLIFFE ROAD MARGARET RIVER WA. Drawing

25 February 2022 Paper Size A3 1:1000 Drawn 70670-04 Revision



1, 2 Sabre Crescent, Jandakot WA 6164 PO Box 3526, Success WA 6964 Telephone: (08) 6436 1599 Email: info@gbgmaps.com.au

Appendix G

Douglas Partners 2023 Field Work

CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

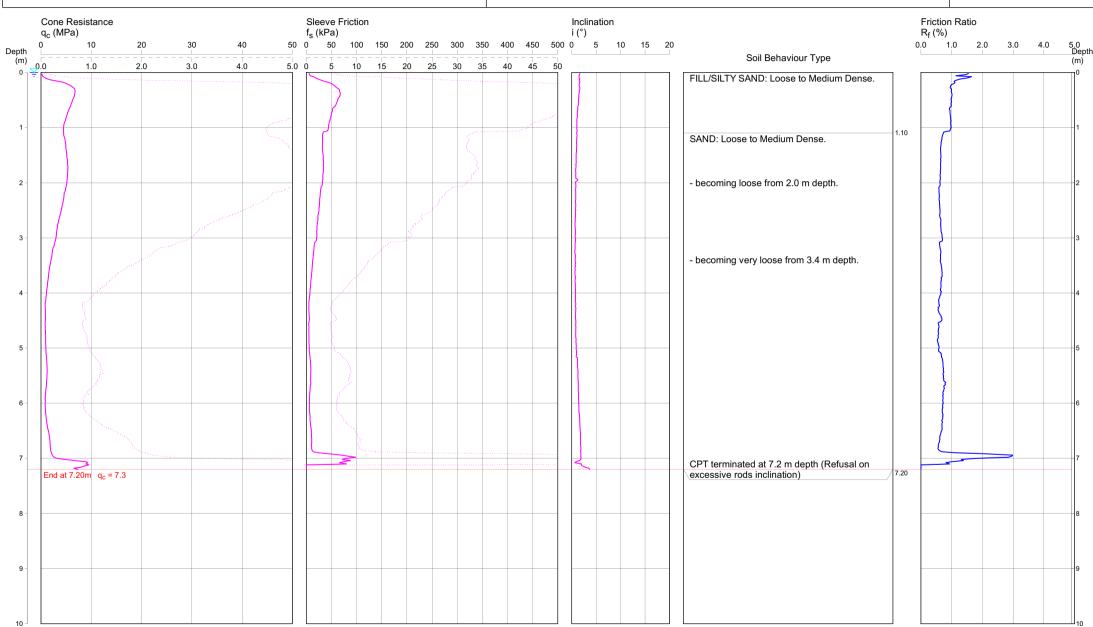
REDUCED LEVEL: RL 19.6 m

COORDINATES: 314820E 6239233N

Page 1 of 1

DATE 16-02-23

PROJECT No: 96717.04



of +/- 0.1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\1.CP5 Cone ID: Probedrill Type: EC19



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

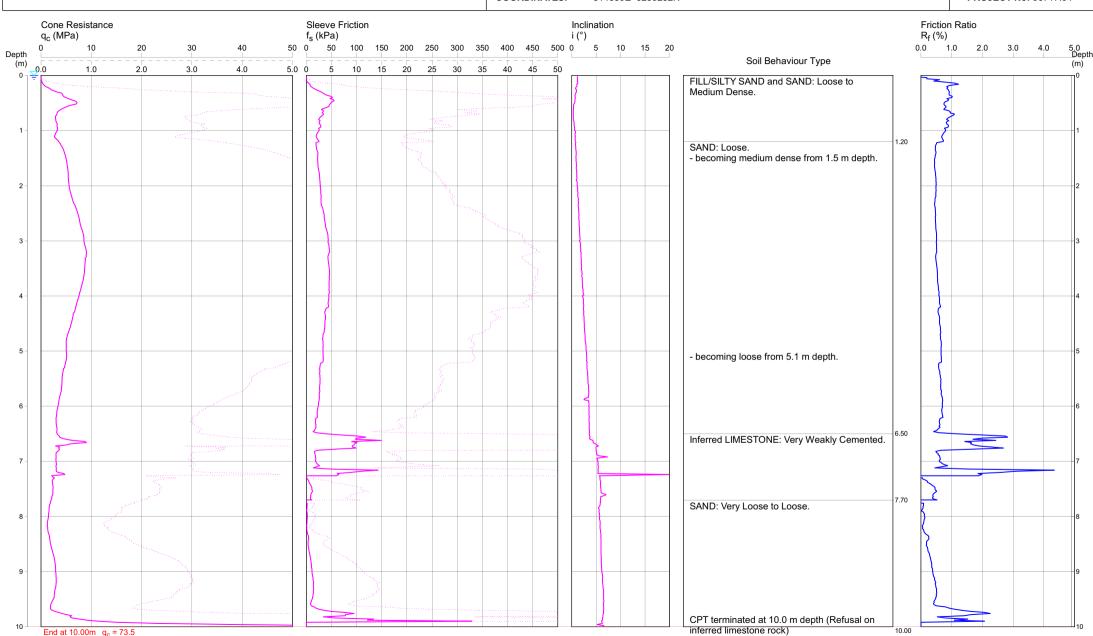
REDUCED LEVEL: RL 21.7 m

COORDINATES: 314839E 6239232N

Page 1 of 1

DATE 16-02-23

PROJECT No: 96717.04



REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\2.CP5 Cone ID: Probedrill



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

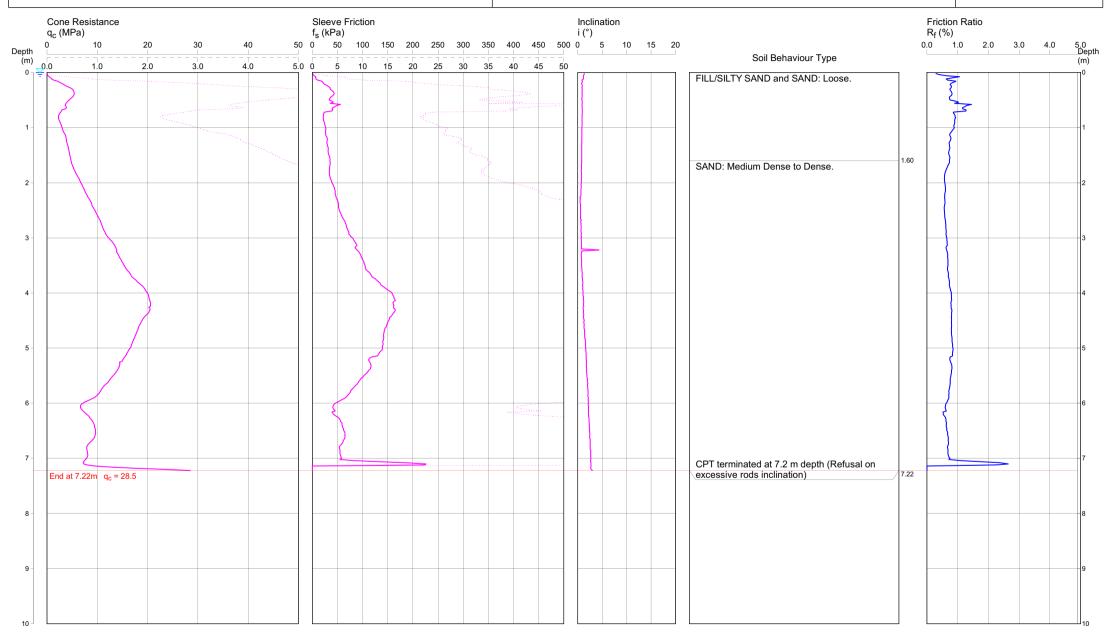
REDUCED LEVEL: RL 21.2 m

COORDINATES: 314843E 6239240N

Page 1 of 1

DATE 15-02-23

PROJECT No: 96717.04



of +/- 0.1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\3.CP5 Cone ID: Probedrill



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

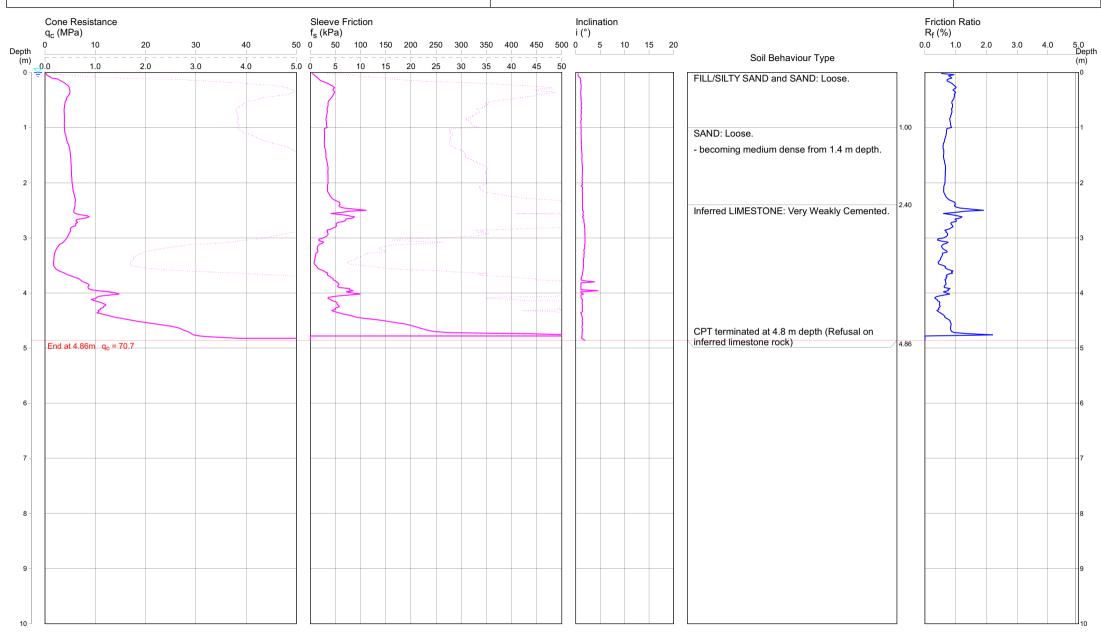
REDUCED LEVEL: RL 23.5 m

COORDINATES: 314837E 6239216N

Page 1 of 1

DATE 16-02-23

PROJECT No: 96717.04



of +/- 0.1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\4.CP5 Cone ID: Probedrill

ConePlot Version 5.9.2



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

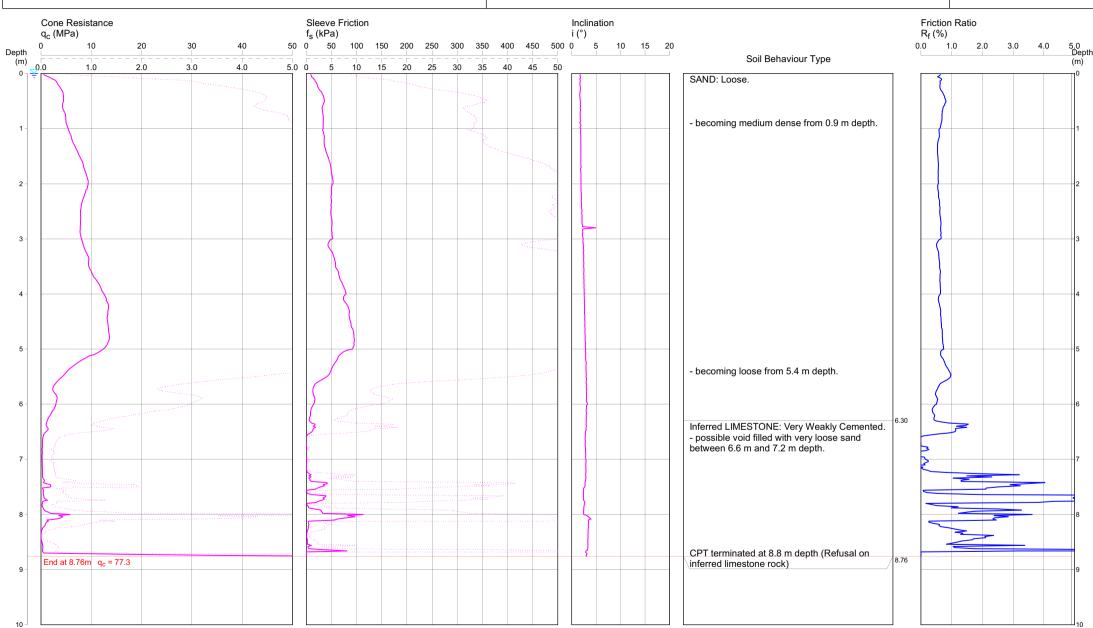
REDUCED LEVEL: RL 24.0 m

COORDINATES: 314861E 6239230N

Page 1 of 1

DATE 15-02-23

PROJECT No: 96717.04



of +/- 0.1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\5.CP5 Cone ID: Probedrill



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

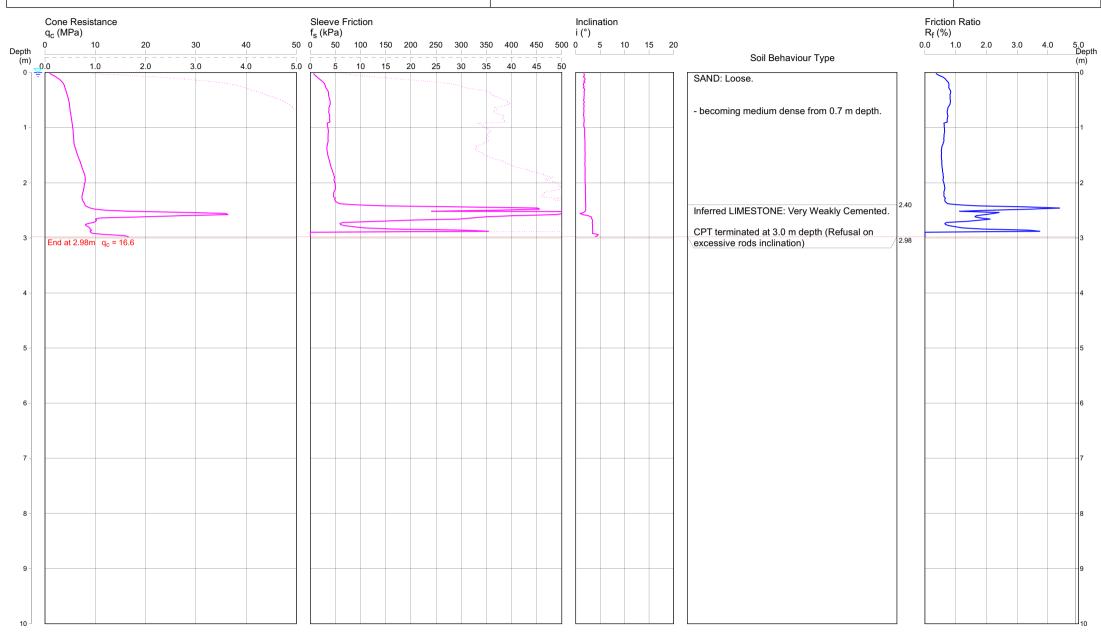
REDUCED LEVEL: RL 27.0 m

COORDINATES: 314850E 6239200N 6

Page 1 of 1

DATE 15-02-23

PROJECT No: 96717.04



of +/- 0.1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\6.CP5 Cone ID: Probedrill



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

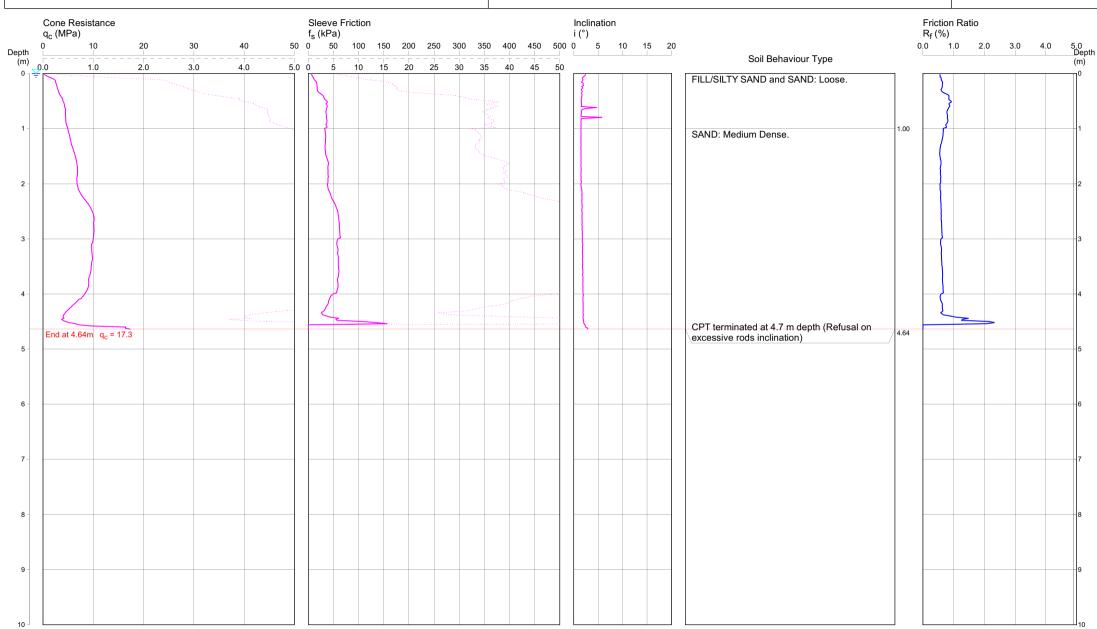
REDUCED LEVEL: RL 27.0 m

COORDINATES: 314865E 6239211N

Page 1 of 1

DATE 15-02-23

PROJECT No: 96717.04



of +/- 0.1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\7.CP5 Cone ID: Probedrill



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

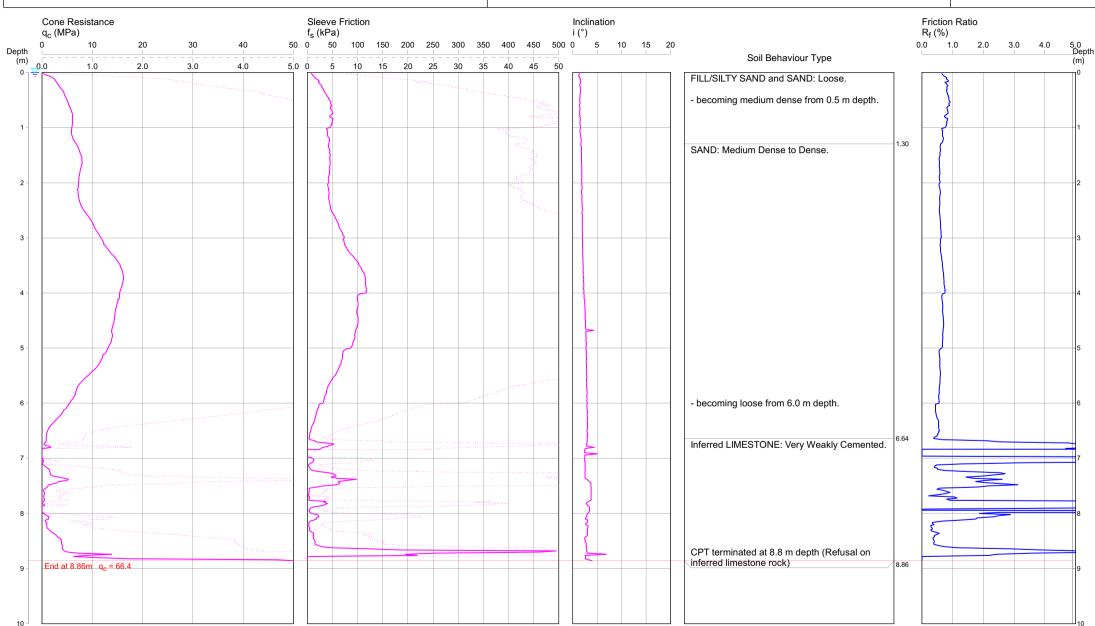
REDUCED LEVEL: RL 29.4 m

COORDINATES: 314860E 6239187N 8

Page 1 of 1

DATE 15-02-23

PROJECT No: 96717.04



of +/- 0.1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\8.CP5 Cone ID: Probedrill



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

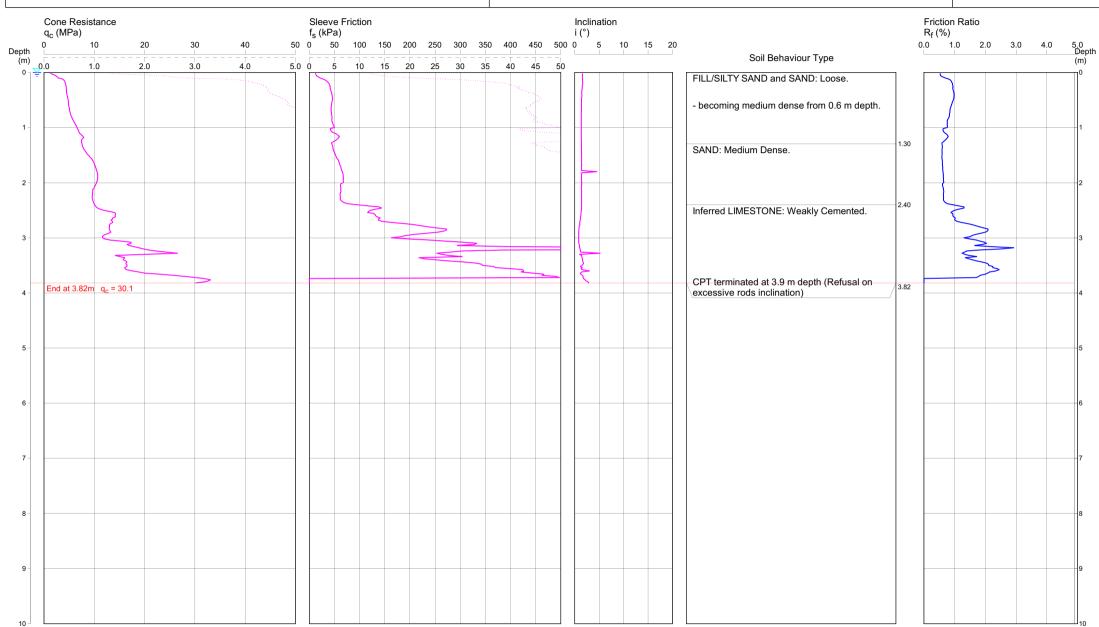
REDUCED LEVEL: RL 29.9 m

COORDINATES: 314879E 6239198N 9

Page 1 of 1

DATE 15-02-23

PROJECT No: 96717.04



of +/- 0.1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\9.CP5 Cone ID: Probedrill

CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

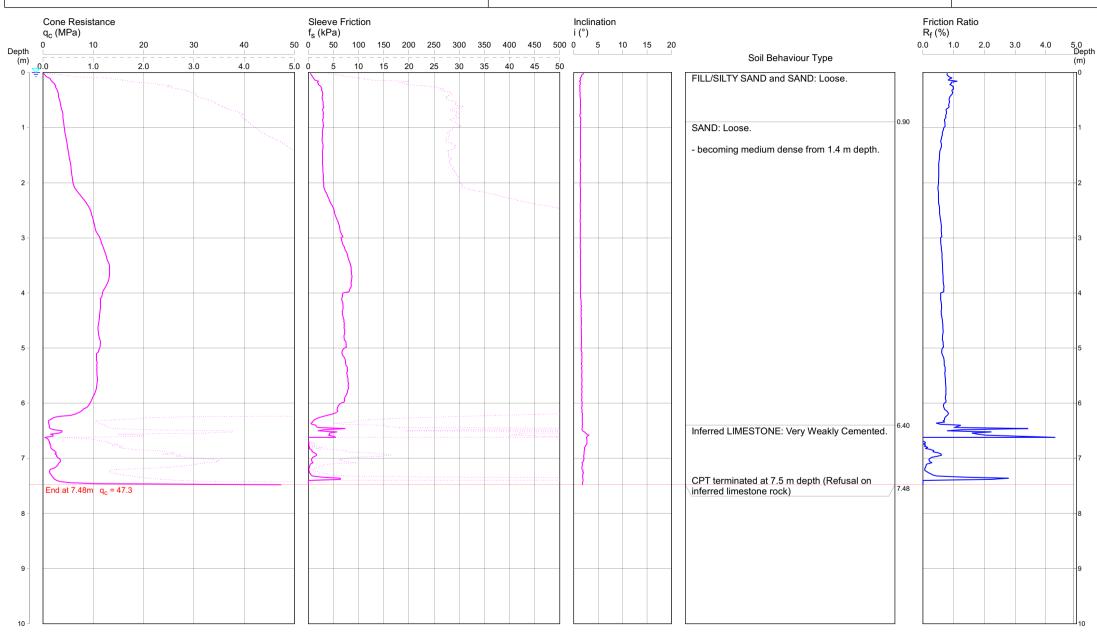
REDUCED LEVEL: RL 31.6 m

COORDINATES: 314869E 6239175N 10

Page 1 of 1

DATE 15-02-23

PROJECT No: 96717.04



of +/- 0.1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\10.CP5 Cone ID: Probedrill



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

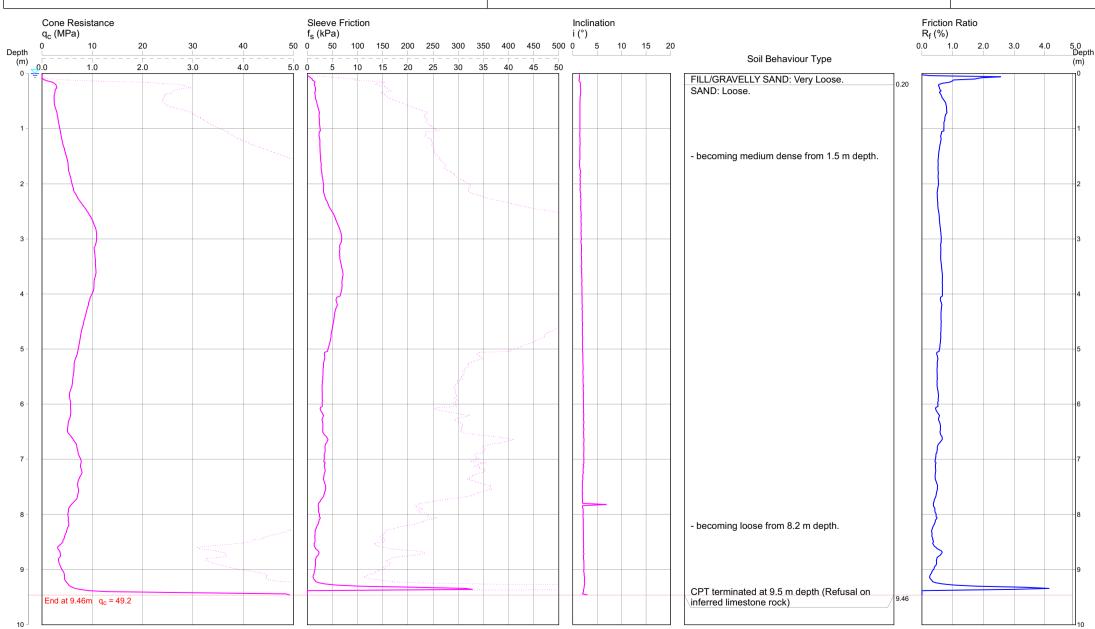
REDUCED LEVEL: RL 31.8 m

COORDINATES: 314884E 6239186N 11

Page 1 of 1

DATE 15-02-23

PROJECT No: 96717.04



of +/- 0.1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\11.CP5 Cone ID: Probedrill



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

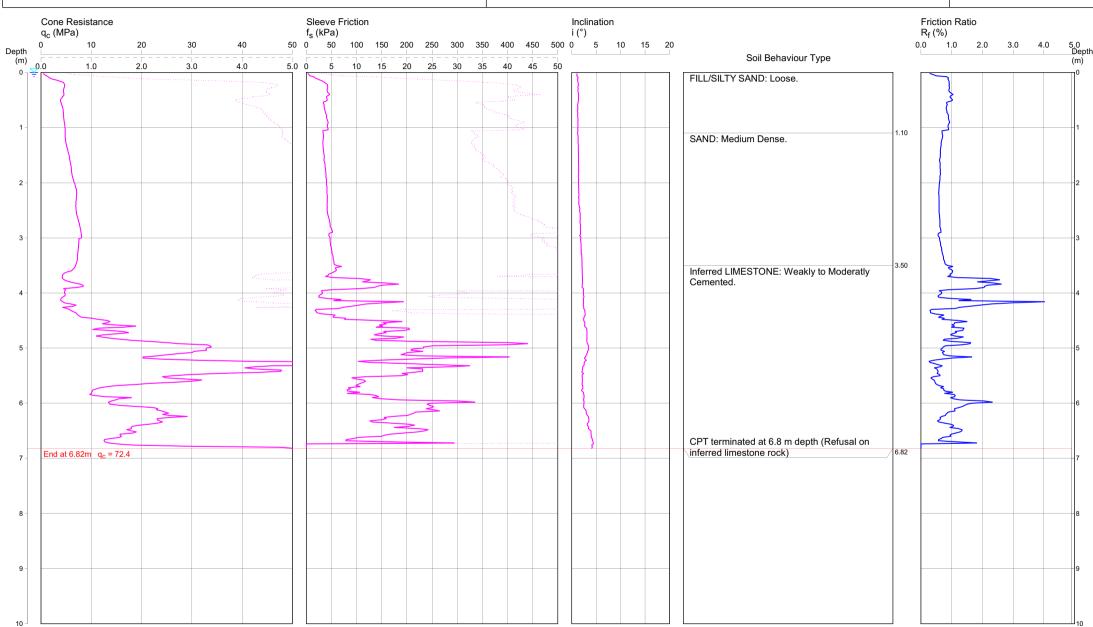
REDUCED LEVEL: RL 34.0 m

COORDINATES: 314904E 6239200N 12

Page 1 of 1

DATE 16-02-23

PROJECT No: 96717.04



of +/- 1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\12.CP5 Cone ID: Probedrill



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

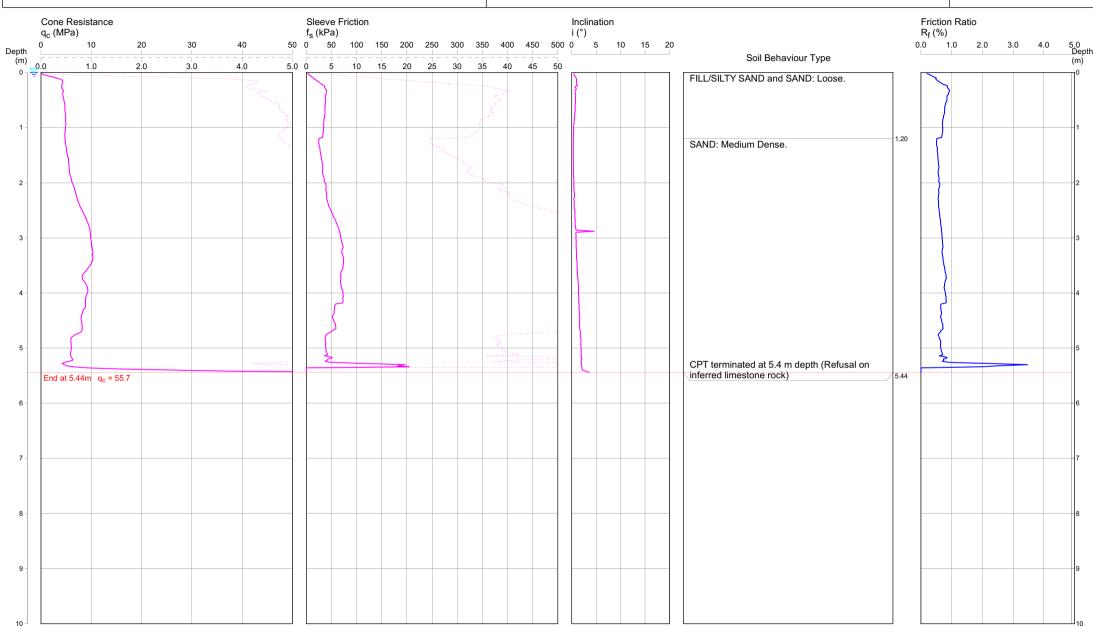
REDUCED LEVEL: RL 21.0 m

COORDINATES: 314886E 6239252N 13

Page 1 of 1

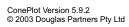
DATE 16-02-23

PROJECT No: 96717.04



of +/- 1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\13.CP5 Cone ID: Probedrill



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

REDUCED LEVEL: RL 20.6 m

COORDINATES: 314889E 6239261N 14

Douglas Partners

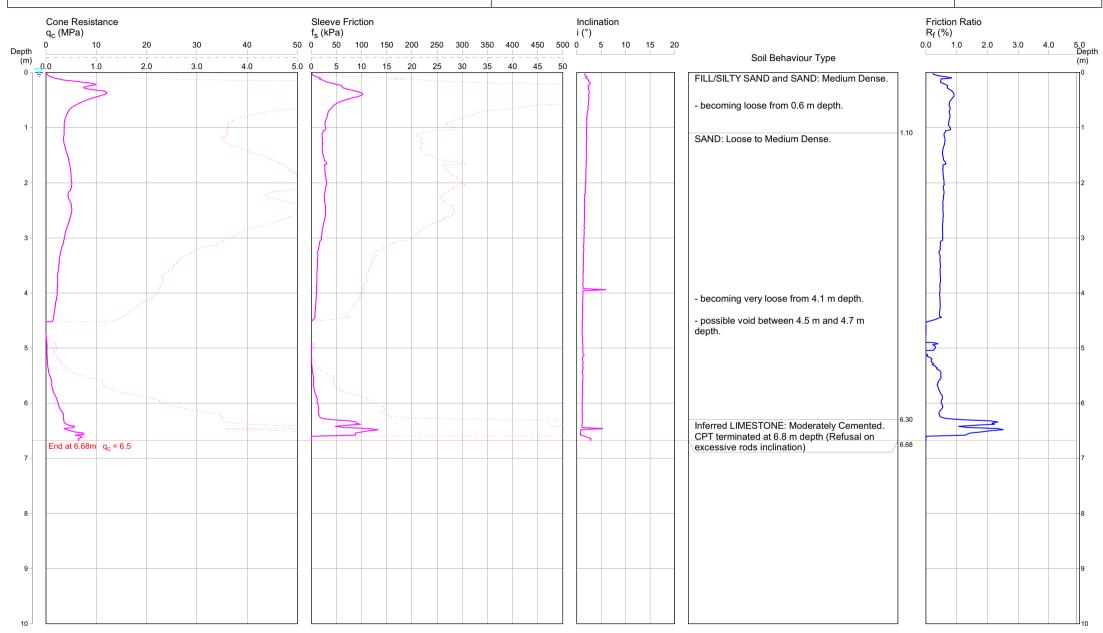
Geotechnics | Environment | Groundwater

Page 1 of 1

DATE

16-02-23

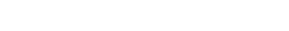
PROJECT No: 96717.04



of +/- 1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\14.CP5 Cone ID: Probedrill

> ConePlot Version 5.9.2 © 2003 Douglas Partners Pty Ltd



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Potential Treated Water Infiltration Areas Assessment

752 Wallcliffe Road, Margaret River, WA LOCATION:

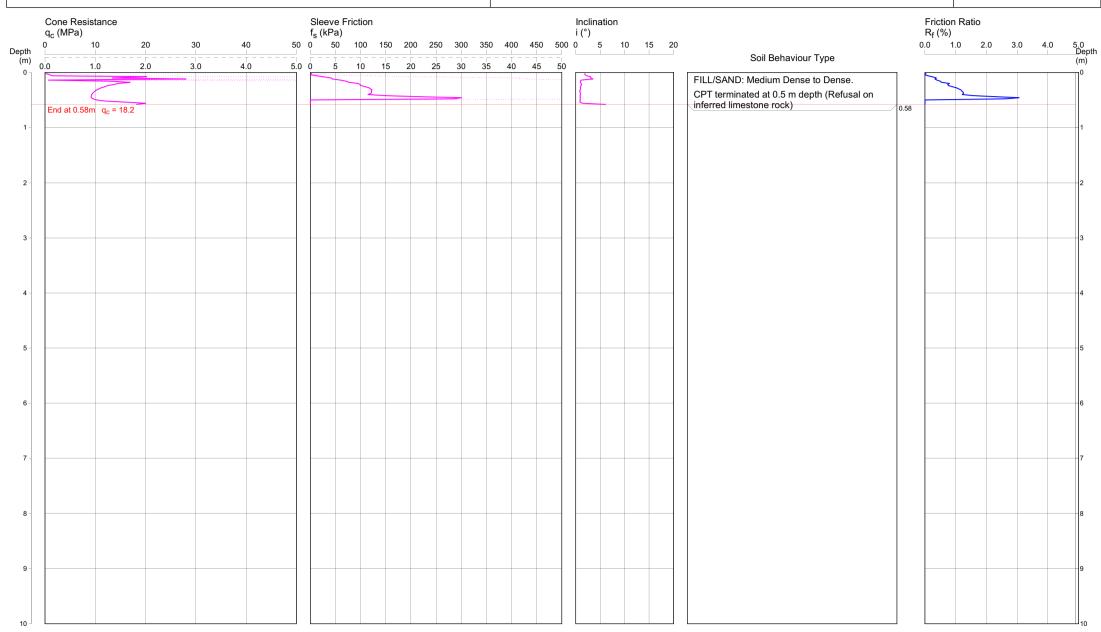
REDUCED LEVEL: RL 20.3 m

COORDINATES: 314896E 6239269N 15

Page 1 of 1

DATE 16-02-23

PROJECT No: 96717.04



of +/- 1 m.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy File: P:\96717.04 - MARGARET RIVER, Wallcliffe Rd - Assessme\4.0 Field Work\CPT\DP\15.CP5 Cone ID: Probedrill



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Treated Water Infiltration Areas Assessment 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 21 m AHD*

EASTING: 314846 **NORTHING**: 6239242 **PIT No:** 16

PROJECT No: 96717.04 **DATE:** 16/2/2023 SHEET 1 OF 1

		Description	ic		Sam	pling &	& In Situ Testing	L				<u> </u>
묍	Depth (m)	of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynar (k	nic Pene lows pe	etrometo r 150mi	er lest m)
20 20	- 0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, roots and rootlets, dry to moist. FILL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt and rootlets, dry to moist, medium dense.		D	0.05	8			-1			
	- 1.4 - - - - - 2 2.0	SAND SP: fine to medium grained, brown, trace silt, moist, medium dense. Residual sand of Spearwood System. - becoming orange-brown from 1.7 m depth.		В	1.8				-			
	- 2.0	Pit discontinued at 2.0m (Target depth)										





RIG: 8 tonne excavator, equipped with 500 mm toothed bucket

LOGGED: GG SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample B Bulk sample BLK Block sample Core drilling
Disturbed sample
Environmental sample

SAMPLING & IN SITU TESTING LEGEND

G Gas sample
P Piston sample
U Tube sample (x mm dia).
W Water sample
D Water seep
S Standard penetration test
Water level
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Treated Water Infiltration Areas Assessment 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 24 m AHD*

EASTING: 314855 **PROJECT No:** 96717.04 **NORTHING**: 6239224 **DATE:** 16/2/2023 SHEET 1 OF 1

PIT No: 17

Γ			Description	. <u>S</u>		San	npling &	& In Situ Testing	L	
ā	2	Depth (m)	of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
-	.7	0.15	TOPSOIL/Gravelly SAND SP-SM: fine to medium grained, yellow-brown, fine to coarse sized, with silt, dry to moist.							
	23	1	SAND SP: fine to medium grained, dark grey-brown, trace silt, roots and rootlets, dry to moist, medium dense. Residual sand of Spearwood System.		В	0.5				-1
	-	1.5	SAND SP: fine to medium grained, brown, trace silt, moist. Residual sand of Spearwood System.							
-8	7.7	2 2.0	Pit discontinued at 2.0m (Target depth)	<u> </u>						2





RIG: 8 tonne excavator, equipped with 500 mm toothed bucket

LOGGED: GG SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample B Bulk sample BLK Block sample Core drilling
Disturbed sample
Environmental sample

SAMPLING & IN SITU TESTING LEGEND

G Gas sample
P Piston sample
U, Tube sample (x mm dia)
W Water sample
W Water seep
Water level
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Treated Water Infiltration Areas Assessment 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 27 m AHD*

EASTING: 314854 **NORTHING**: 6239202 **PIT No:** 18

PROJECT No: 96717.04 **DATE:** 16/2/2023 SHEET 1 OF 1

			Description	. <u>S</u>		Sam	. •	& In Situ Testing	L.	Dani Bartan ta Tat
7 RL		Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
2	-	0.2	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt and rootlets, dry to moist.							-
	- - - - -		SAND SP: fine to medium grained, dark grey-brown, with rootlets, trace silt, dry to moist, medium dense. Residual sand of Spearwood System.							-1
	2	1.2	SAND SP: fine to medium grained, brown and orange-brown, trace silt, moist, medium dense. Residual sand of Spearwood System.		В	1.6				
-	-	2.0	Pit discontinued at 2.0m (Target depth)							





RIG: 8 tonne excavator, equipped with 500 mm toothed bucket

LOGGED: GG SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

 Sand Penetrometer AS1289.6.3.3 ☐ Cone Penetrometer AS1289.6.3.2

A Auger sample B Bulk sample BLK Block sample

Core drilling
Disturbed sample
Environmental sample

SAMPLING & IN SITU TESTING LEGEND

G Gas sample
P Piston sample
U, Tube sample (x mm dia)
W Water sample
W Water seep
Water level
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Treated Water Infiltration Areas Assessment **LOCATION:** 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 31 m AHD*

EASTING: 314882 **NORTHING:** 6239193

PIT No: 19

PROJECT No: 96717.04 **DATE:** 16/2/2023 **SHEET** 1 OF 1

			Description	. <u>o</u>		Sam	pling &	& In Situ Testing	L	
R		epth m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
. 34	-		TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, roots and rootlets, dry to moist.				Ö			5 10 15 20
30	- - - - - -1	0.2	SAND SP: fine to medium grained, dark grey-brown, trace silt, dry to moist, medium dense. Residual sand of Spearwood System.							
	-	1.4	SAND SP: fine to medium grained, orange-brown, trace silt, moist, medium dense. Residual sand of Spearwood System. - becoming pale yellow-brown from 1.8 m depth.							
29	- -2	2.0	Pit discontinued at 2.0m (Target depth)		—В—	-2.0-				2
	-		rit discontinued at 2.011 (Target depth)							





RIG: 8 tonne excavator, equipped with 500 mm toothed bucket

LOGGED: GG SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy of \pm 0.1 m.

⊠ Sand Penetrometer AS1289.6.3.3
 □ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

G Gas sample
P Piston sample
Tube sample (x mm dia.)
W Water sample
Water seep
Water level

LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Treated Water Infiltration Areas Assessment **LOCATION:** 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 34 m AHD*

EASTING: 314906 **NORTHING**: 6239196

PIT No: 20

PROJECT No: 96717.04 **DATE:** 16/2/2023 **SHEET** 1 OF 1

			Description	ē		Sam	ipling &	& In Situ Testing	L			 	- .
귐		Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dyr 5	(blows		er Test n)
। ह	-	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace roots and rootlets, dry to moist. FILL/SAND SP: fine to medium grained, dark grey-brown, trace silt, dry to moist, medium dense.		В	0.6	S			-			
- 33	- - - - -	1.3	SAND SP: fine to medium grained, brown, trace silt, moist, medium dense. Residual sand of Spearwood System.		В	1.5				- -1 - - -			
32	- 2	2 2.0	- limestone pinnacle observed from 1.6 m depth. Pit discontinued at 2.0m (Target depth)							2			





RIG: 8 tonne excavator, equipped with 500 mm toothed bucket

LOGGED: GG SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy of +/- 1 m.

☑ Sand Penetrometer AS1289.6.3.3☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

ING & IN STITUTESTING
G Gas sample
P Piston sample (x mm dia.)
W Water sample
Water seep
Water level

LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Treated Water Infiltration Areas Assessment **LOCATION:** 752 Wallcliffe Road, Margaret River, WA

SURFACE LEVEL: 22 m AHD*

EASTING: 314894 **NORTHING:** 6239253

PIT No: 21

PROJECT No: 96717.04 **DATE:** 16/2/2023 **SHEET** 1 OF 1

			Description	oje.		Sam		& In Situ Testing		Dunamia Danataan T
2 R		Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	-		TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, roots and rootlets, dry to moist.		D	0.05				
21	-	0.2 I 1.1	FILL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, dry to moist, medium dense.							-1
-	-	1.1	SAND SP: fine to medium grained, orange-brown, trace silt, moist. Residual sand of Spearwood System. - limestone pinnacle observed from 1.6 m depth.							
-	•				В	1.8				
	- 2 - - -	2 2.0	Pit discontinued at 2.0m (Target depth)	•						2





RIG: 8 tonne excavator, equipped with 500 mm toothed bucket

LOGGED: GG SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level surveyed using a differential GPS with a reported accuracy of +/- 1 m.

☑ Sand Penetrometer AS1289.6.3.3☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND
er sample G Gas sample PID Pho

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

ING & IN STITUTESTING
G Gas sample
P Piston sample (x mm dia.)
W Water sample
Water seep
Water level

LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Treated Water Infiltration Areas Assessment 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 4 m AHD*

EASTING: 314775 **NORTHING**: 6239325 **DIP/AZIMUTH:** 90°/-- BORE No: 22

PROJECT No: 96717.04 **DATE:** 15-2-2023

SHEET 1 OF 1

			Description	.ie		Sam		& In Situ Testing	۰	D D T
RL		epth m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
3	- - - - - -1	0.15 -	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, dry to moist. SAND SP: fine to medium grained, dark grey-brown, trace silt, dry to moist, medium dense. Residual sand of Spearwood System.							- - - - - - - - - - - - - - -
	- - - - - - - -	2.0 -	silt, moist, medium dense. Residual sand of Spearwood System. Bore discontinued at 2.0m (Target depth)		D	2.0				



LOGGED: GG RIG: hand auger DRILLER: GG CASING:

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level surveyed using a differential GPS with

a reported accuracy of +/- 1 m.

☐ Cone Penetrometer AS1289.6.3.2



A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Treated Water Infiltration Areas Assessment 752 Wallcliffe Road, Margaret River, WA LOCATION:

EASTING: 314808 **NORTHING**: 6239337 **DIP/AZIMUTH:** 90°/--

SURFACE LEVEL: 8 m AHD*

PROJECT No: 96717.04 **DATE:** 15-2-2023

SHEET 1 OF 1

BORE No: 23

			Description	.i		Sam	pling &	& In Situ Testing	L	
R	Dept (m)		of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
-	0.	.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, dry to moist.							
-	-	0.7	FILL/SAND SP-SM: fine to medium grained, grey-brown and dark grey-brown, with gravel and silt, dry to moist, very dense.							
	- - -1 -		SAND SP: fine to medium grained, dark grey-brown, trace silt, moist, dense. Residual sand of Spearwood System.							-1
-	- - - -	1.3	SAND SP: fine to medium grained, brown, trace silt, moist, medium dense to dense. Residual sand of Spearwood System.							
-9	-2 2	2.0	Bore discontinued at 2.0m (Target depth)	124,724	—В—	 2.0				



LOGGED: GG RIG: hand auger DRILLER: GG CASING:

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level surveyed using a differential GPS with

a reported accuracy of +/- 1 m.

☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

SAMPLING & IN SITU TESTING LEGEND Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level

LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

PROJECT: Treated Water Infiltration Areas Assessment 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 7 m AHD* **EASTING**: 314802

NORTHING: 6239364 **DIP/AZIMUTH:** 90°/--

BORE No: 24

PROJECT No: 96717.04 **DATE:** 15-2-2023 SHEET 1 OF 1

		Description	. <u>e</u>		Sam	pling 8	& In Situ Testing	L	
RL	Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
-	- 0.1	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, dry to moist.				U)			- 1
9		SAND SP-SM: fine to medium grained, dark grey-brown, with silt, dry to moist, medium dense. Residual sand of Spearwood System.							-1
	- 1.º	SAND SP: fine to medium grained, brown, trace silt, moist, medium dense. Residual sand of Spearwood System.							
5	-2 2.0 - - -	Bore discontinued at 2.0m (Target depth)	<u> </u>	В	2.0				2



LOGGED: GG RIG: hand auger DRILLER: GG CASING:

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level surveyed using a differential GPS with

a reported accuracy of +/- 1 m.

☐ Cone Penetrometer AS1289.6.3.2

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample

SAMPLING & IN SITU TESTING LEGEND Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level

PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
Standard penetration test
V Shear vane (kPa)



CLIENT: Wallcliffe House Pty Ltd

Treated Water Infiltration Areas Assessment PROJECT: 752 Wallcliffe Road, Margaret River, WA LOCATION:

SURFACE LEVEL: 7 m AHD* **EASTING**: 314839

NORTHING: 6239319 **DIP/AZIMUTH:** 90°/--

BORE No: 25

PROJECT No: 96717.04 **DATE:** 15-2-2023 SHEET 1 OF 1

			Description	. <u>e</u>		Sam	pling &	& In Situ Testing	L	
R		Depth (m)	of Strata	Graphic Log	Туре	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm) 5 10 15 20
-	-	0.2	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, dry to moist.							-
- 9		1	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, dry to moist, medium dense. Residual sand of Spearwood System.							
-	- 	2 2.0	Bore discontinued at 2.0m (Target depth)	•	—В—	-2.0-				



LOGGED: GG RIG: hand auger DRILLER: GG CASING:

TYPE OF BORING: 110 mm diameter hand auger borehole WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level surveyed using a differential GPS with

a reported accuracy of +/- 0.1 m.

☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A Auger sample
B Bulk sample
BLK Block sample
C Core drilling
D Disturbed sample
E Environmental sample Gas sample
Piston sample
Tube sample (x mm dia.)
Water sample
Water seep
Water level LEGENU
PID Photo ionisation detector (ppm)
PL(A) Point load axial test Is(50) (MPa)
PL(D) Point load diametral test Is(50) (MPa)
pp Pocket penetrometer (kPa)
S standard penetration test
V Shear vane (kPa)





'FALLING HEAD TEST' RESULTS

 Client:
 Wallcliffe House Pty Ltd
 Project No:
 96717.04

 Project:
 Potential Treated Water Infiltration Areas
 Date:
 16/02/2023

 Location:
 752 Wallcliffe Road, Margaret River, WA
 Tested by:
 GG

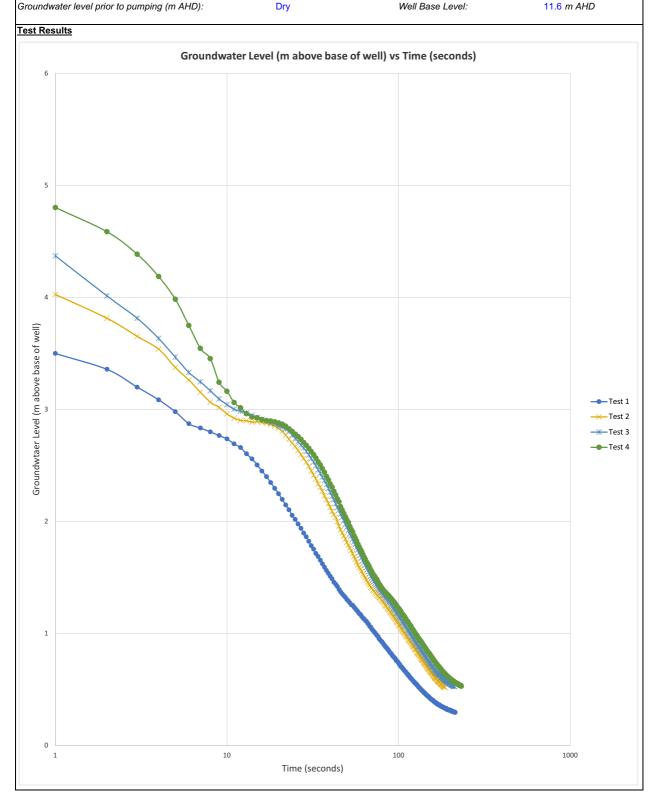
Test Location

 Description:
 Test Location 52
 Easting:
 314867 m

 Weather during test: Dry
 Northing
 6239219 m

 Groundwater level prior to pumping (m below ground level):
 Dry
 Surface Level:
 26.1 m AHD

 Groundwater level prior to pumping (m AHD):
 Dry
 Well Base Level:
 11.6 m AHD



Appendix H

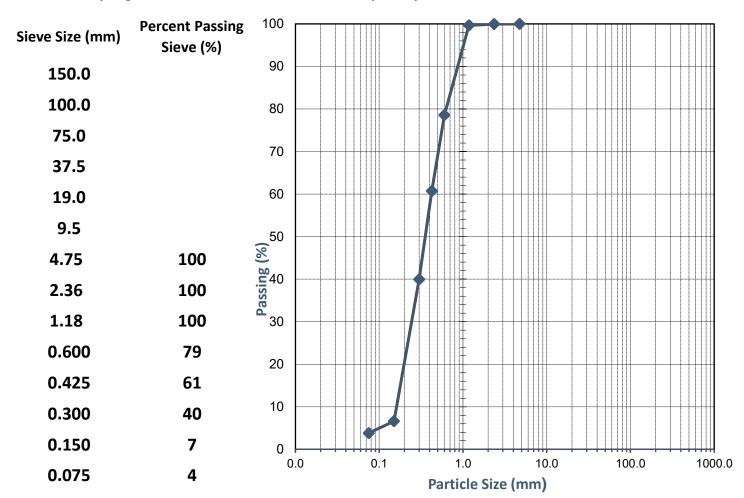
Douglas Partners 2021 Laboratory Test Results



	SOIL	A	AGGREGATE	CONCRETE	E CRU	ISHING
			TEST REPO	ORT - AS 1289.3.6.	1	
Client:	Wallcli	iffe Ho	ouse Pty Ltd		Ticket No.	S4193
Client Address:	-				Report No.	WG21/12061_1_PSD
Project:	Propos	sed Or	n Site Sewage Dispo	osal	Sample No	. WG21/12061
Location:	752 W	allcliff	e Road, Margaret I	River, WA	Date Sample	ed: 30-08-2021
Sample Identification	n: BH2, 1	.7-2.3	m		Date Tested	d: 7/09 - 8/09/2021

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Coredo

Date: 08-September-2021



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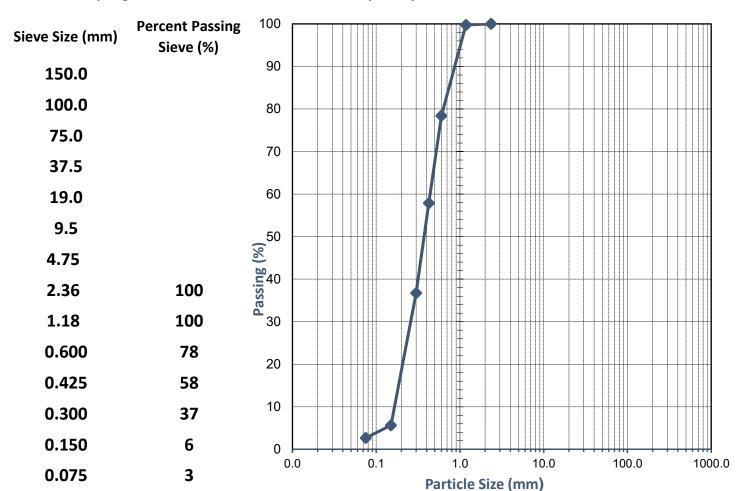
08 9472 3465



	SOIL AGGR	EGATE	CONCRETE	CRUSH	ING
		TEST REPOR	RT - AS 1289.3.6.1		
Client:	Wallcliffe House Pt	y Ltd		Ticket No.	S4193
Client Address:	-			Report No.	WG21/12063_1_PSD
Project:	Proposed On Site S	ewage Dispos	al	Sample No.	WG21/12063
Location:	752 Wallcliffe Road	, Margaret Riv	ver, WA	Date Sampled:	30-08-2021
Sample Identificatio	n: BH4, 1.7-2.3m			Date Tested:	7/09 - 8/09/2021

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name:

Correll

Date: 08-September-2021



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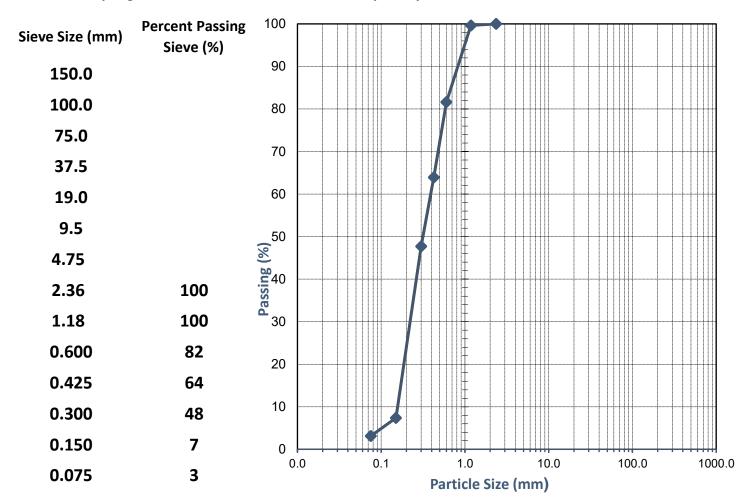
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	SOIL	AGGREGA	TE CON	NCRETE	CRUSH	IING
		TES	T REPORT - AS 1	289.3.6.1		
Client:	Wallcli	iffe House Pty Ltd			Ticket No.	S4193
Client Address:	-				Report No.	WG21/12064_1_PSD
Project:	Propos	sed On Site Sewage	Disposal		Sample No.	WG21/12064
Location:	752 W	/allcliffe Road, Mar	garet River, WA		Date Sampled:	30-08-2021
Sample Identification	n: BH5, 1	7-2.3m			Date Tested:	7/09 - 8/09/2021

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Correll

Name: Date: 08-September-2021



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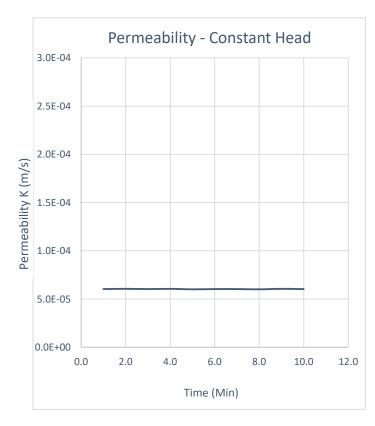
WG_AS 1289.3.6.1_TR_2



	SOIL AGGREGATE CONCRETE	CRUSHI	NG
	TEST REPORT - AS 1289.6.7.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	S4193
Client Address:	-	Report No.	WG21/12061_1_CHPERM
Project:	Proposed On Site Sewage Disposal	Sample No.	WG21/12061
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	30-08-2021
Sample Identification:	BH2, 1.7-2.3m	Date Tested:	6/09 - 7/09/2021

Sampling Method:

Sampled by Client, Tested as Received



Compaction Details						
Compaction Method	AS 1289.5.2.1					
Hammer Type	Modified					
% Retained on 19.0mm	0					
Maximum Dry Density (t/m3)	1.84					
Optimum Moisture (%)	13.8					
Target Dry Density Ratio	95					
Target Moisture Ratio	100					

Specimen Conditions at Compaction						
Laboratory Density Ratio (%)	94.8					
Laboratory Moisture Ratio (%)	101.8					
Surcharge (kPa)	3.0					
Hydraulic Gradient 0.7						

Coefficient of Permeability K₂₀ (m/s): 6.04E-05

Comments:

Approved Signatory:

Date: 09-September-2021

Name:



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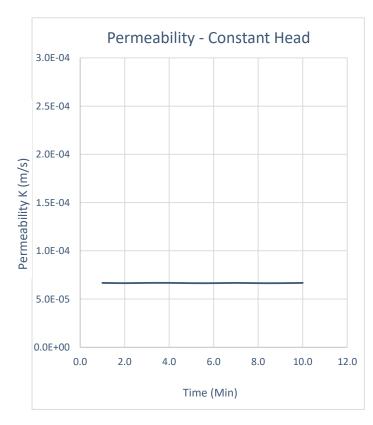
08 9472 3465



	SOIL AGGREGATE CONCRETE	CRUSHI	NG
	TEST REPORT - AS 1289.6.7.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	S4193
Client Address:	-	Report No.	WG21/12063_1_CHPERM
Project:	Proposed On Site Sewage Disposal	Sample No.	WG21/12063
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	30-08-2021
Sample Identification:	BH4, 1.7-2.3m	Date Tested:	6/09 - 7/09/2021

Sampling Method:

Sampled by Client, Tested as Received



Compaction Details						
Compaction Method	AS 1289.5.2.1					
Hammer Type	Modified					
% Retained on 19.0mm	0					
Maximum Dry Density (t/m3)	1.841					
Optimum Moisture (%)	13.7					
Target Dry Density Ratio	95					
Target Moisture Ratio	100					

Specimen Conditions at Compaction						
Laboratory Density Ratio (%)	95.2					
Laboratory Moisture Ratio (%)	97.9					
Surcharge (kPa)	3.0					
Hydraulic Gradient 0.7						

Coefficient of Permeability K₂₀ (m/s): 6.66E-05

Comments:

Approved Signatory:

Name:

Date: 09-September-2021



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Appendix I

Douglas Partners 2023 Laboratory Test Results



	SOIL AGGREGATE CONCRETE	CRUSHING	
	TEST REPORT - AS 1289.3.6.1		
Client:	Wallcliffe House Pty Ltd	Ticket No. \$8833	
Client Address:	-	Report No. WG23.3697	_1_PSD
Project:	Treated Water Infiltration Area Assessment	Sample No. WG23.3697	
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled: 15/02 - 16/0)2/2023
Sample Identification:	TP16, 1.8m	Date Tested: 27/02 - 28/0	02/2023

Sampling Method:

Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)	100					
150.0		90					
100.0		80					
75.0							
37.5		70					
19.0		60		7			
9.5		50					
4.75		%) Bassing (%) 30					
2.36	100	40					
1.18	100	30					
0.600	80	20					
0.425	62	20					
0.300	39	10					
0.150	7	0					
0.075	4	0.0	0 0.1	1.0 Particle Si	10.0 ze (mm)	100.0	1000.0

Comments:

Approved Signatory:

Name: Date: 28/February/2023

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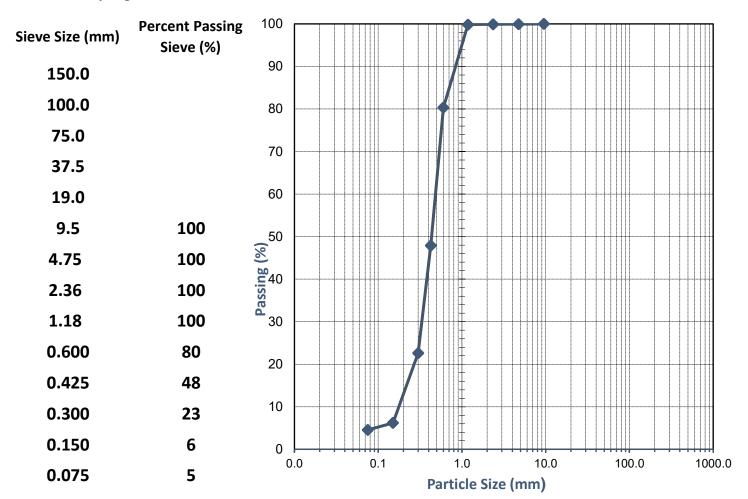
08 9472 3465



	SOIL AGGREGATE CONCRETE	CRUSH	HING
	TEST REPORT - AS 1289.3.6.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	S8833
Client Address:	-	Report No.	WG23.3698_1_PSD
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3698
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP17, 0.5m	Date Tested:	27/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Date: 28/February/2023

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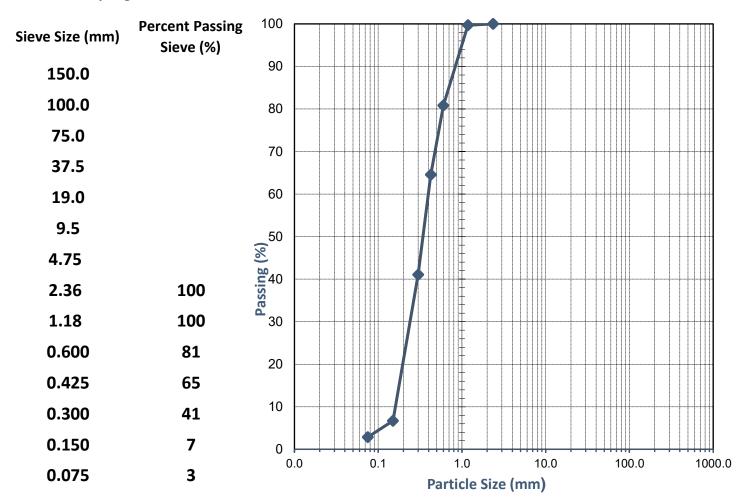
08 9472 3465



	SOIL AGGREGATE CONCRETE	CRUSH	HING
	TEST REPORT - AS 1289.3.6.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	S8833
Client Address:	-	Report No.	WG23.3699_1_PSD
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3699
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP18, 1.6m	Date Tested:	27/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name:

Date: 28/February/2023



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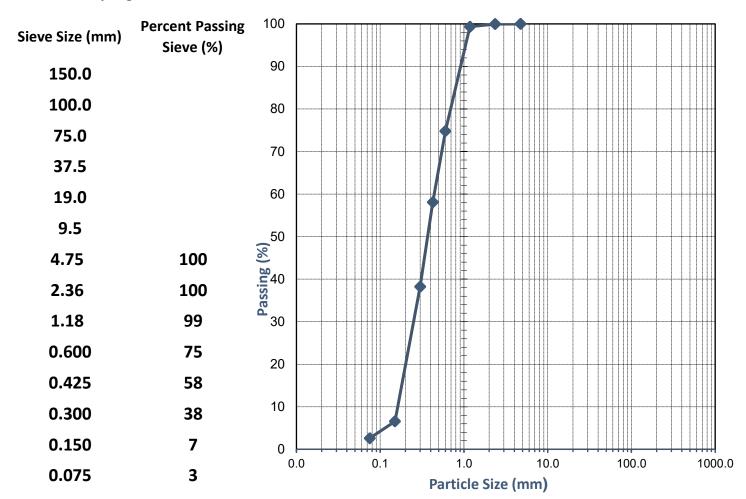
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	SOIL AGGREGATE CONCRETE	CRUSH	HING
	TEST REPORT - AS 1289.3.6.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	\$8833
Client Address:	-	Report No.	WG23.3700_1_PSD
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3700
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP19, 2.0m	Date Tested:	27/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

natory:

Date: 28/February/2023



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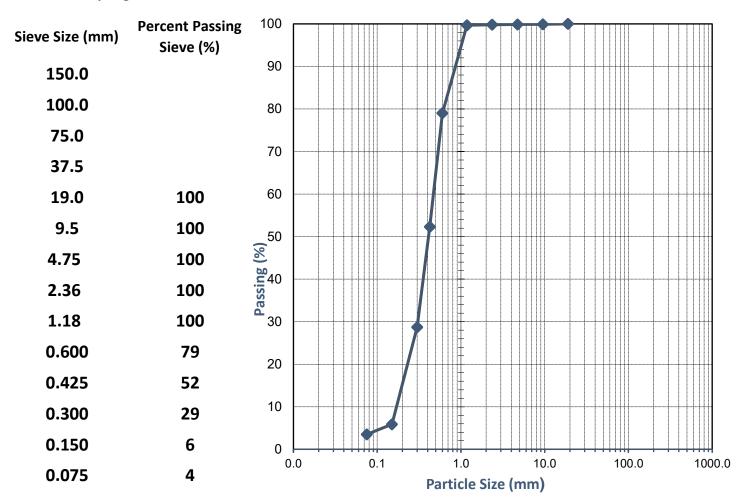
WG_AS 1289.3.6.1_TR_2 Page 1 of 1



	SOIL AGGREGATE CONCRETE	CRUSH	HING
	TEST REPORT - AS 1289.3.6.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	\$8833
Client Address:	-	Report No.	WG23.3701_1_PSD
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3701
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP20, 0.6m	Date Tested:	27/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

natory:
Name:

Date: 28/February/2023



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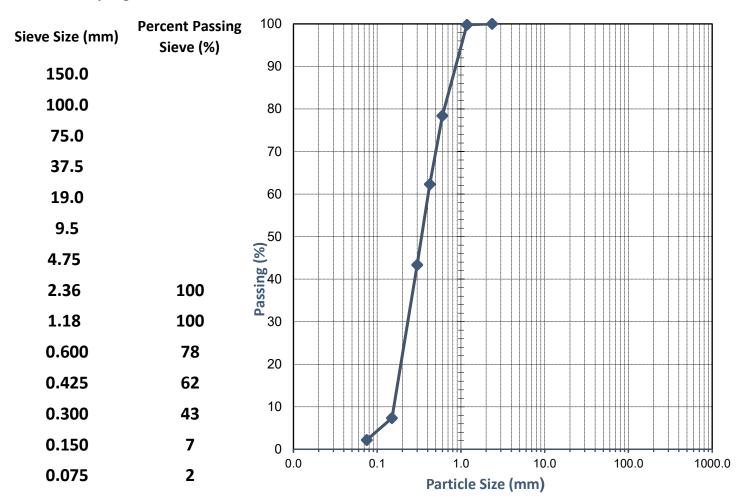
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	SOIL AGGRE	GATE CON	CRETE CRUS	HING
		TEST REPORT - AS 12	89.3.6.1	
Client:	Wallcliffe House Pty Ltd		Ticket No.	\$8833
Client Address:	-		Report No.	WG23.3702_1_PSD
Project:	Treated Water Infiltration	n Area Assessment	Sample No.	WG23.3702
Location:	752 Wallcliffe Road, Marg	garet River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP20, 1.5m		Date Tested:	27/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name:
Date: 28/February/2023

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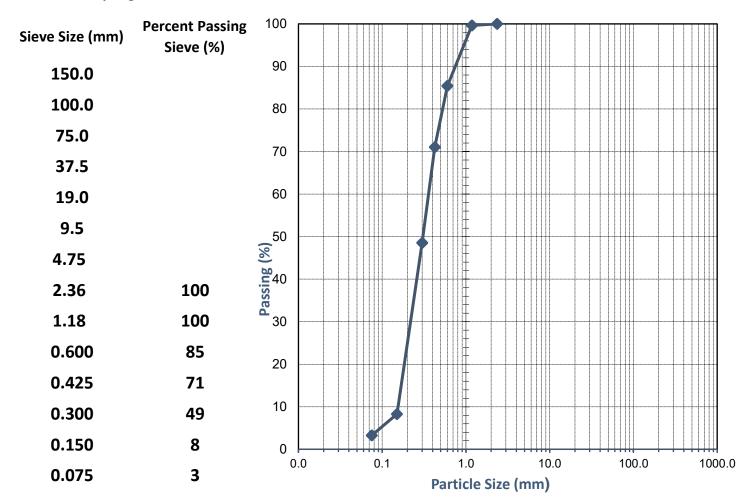
WG_AS 1289.3.6.1_TR_2 Page 1 of 1



	SOIL AGGREGATE CONCRETE	CRUSHIN	1G
	TEST REPORT - AS 1289.3.6.1		
Client:	Wallcliffe House Pty Ltd	Ticket No. S	8833
Client Address:	-	Report No. V	VG23.3703_1_PSD
Project:	Treated Water Infiltration Area Assessment	Sample No. V	VG23.3703
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled: 1	5/02 - 16/02/2023
Sample Identification:	TP21, 1.8m	Date Tested: 2	7/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Date: 28/February/2023

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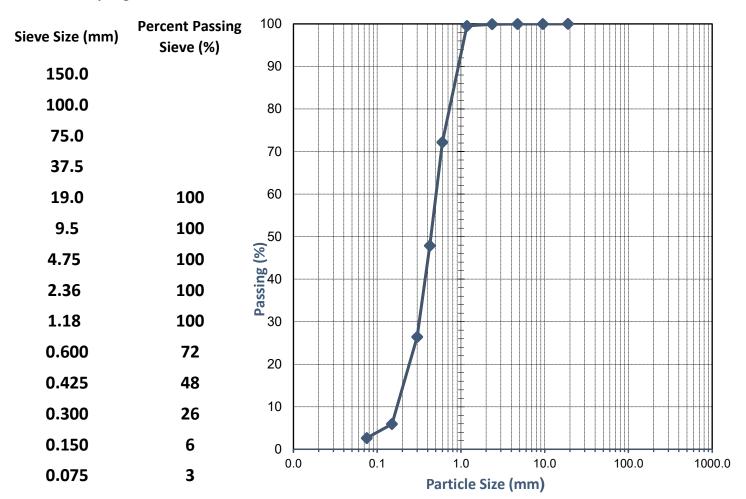
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	SOIL AGGREGATE CONCRETE	CRUSH	ING
	TEST REPORT - AS 1289.3.6.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	\$8833
Client Address:	-	Report No.	WG23.3704_1_PSD
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3704
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	BH22, 2.0m	Date Tested:	27/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name:
Date: 28/February/2023

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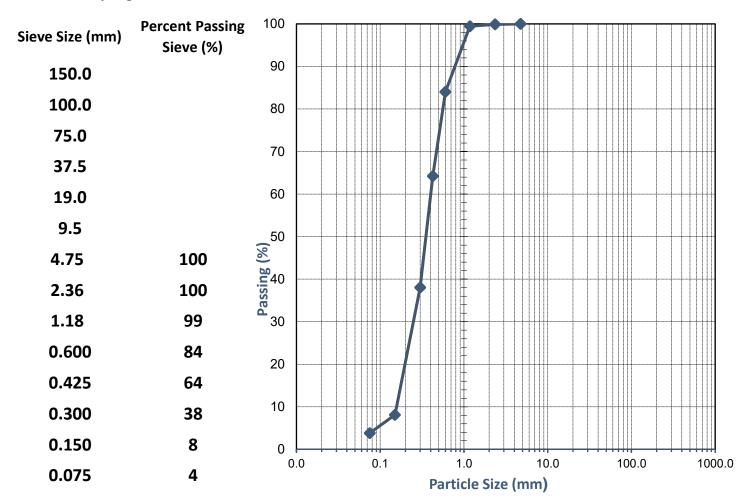
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	SOIL	AGGREGATE	CONCRETE	CRUSH	HING
		TEST REPO	ORT - AS 1289.3.6.1		
Client:	Wallcliffe H	ouse Pty Ltd		Ticket No.	S8833
Client Address:	-			Report No.	WG23.3705_1_PSD
Project:	Treated Wa	Treated Water Infiltration Area Assessment			WG23.3705
Location:	752 Wallclif	752 Wallcliffe Road, Margaret River, WA		Date Sampled:	15/02 - 16/02/2023
Sample Identification:	BH23, 2.0m			Date Tested:	27/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Comments:

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Name:
Date: 28/February/2023

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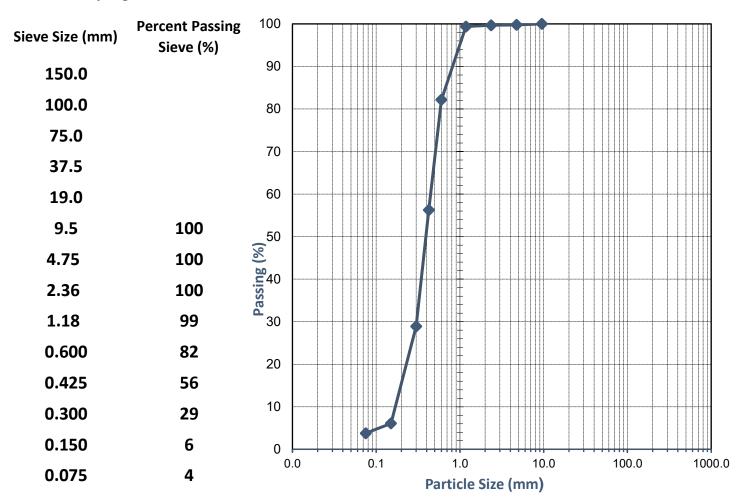
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	SOIL AGGREGATE CONCRE	TE CRUSHING
	TEST REPORT - AS 1289.3.6	6.1
Client:	Wallcliffe House Pty Ltd	Ticket No. S8833
Client Address:	-	Report No. WG23.3706_1_PSD
Project:	Treated Water Infiltration Area Assessment	Sample No. WG23.3706
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled: 15/02 - 16/02/2023
Sample Identification:	BH24, 2.0m	Date Tested: 27/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name:
Date: 28/February/2023



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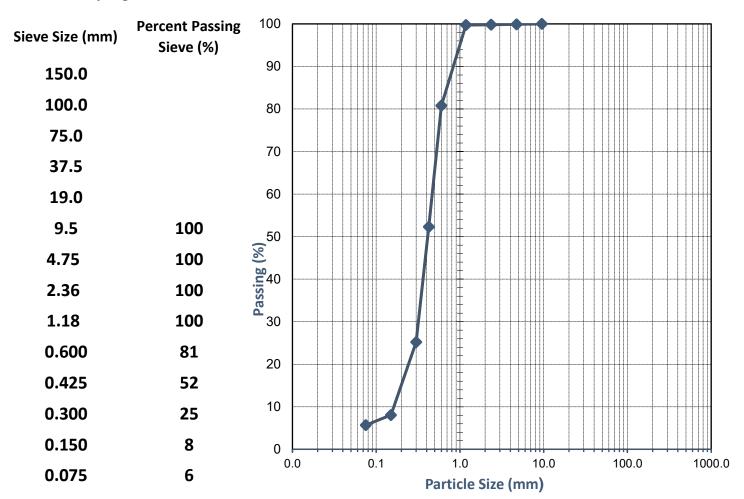
WG_AS 1289.3.6.1_TR_2 Page 1 of 1



	SOIL AGGREGATE CONCI	RETE CRUSHING
	TEST REPORT - AS 1289	.3.6.1
Client:	Wallcliffe House Pty Ltd	Ticket No. S8833
Client Address:	-	Report No. WG23.3707_1_PSD
Project:	Treated Water Infiltration Area Assessment	Sample No. WG23.3707
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled: 15/02 - 16/02/2023
Sample Identification:	BH25, 2.0m	Date Tested: 27/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name:

Date: 28/February/2023



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	SOIL AGGREGATE CONCRETE	CRUSHING	
	TEST REPORT - AS 1289.5.2.	1	
Client:	Wallcliffe House Pty Ltd	Ticket No.	\$8833
Client Address:	-	Report No.	WG23.3697_1_MMDD
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3697
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP16, 1.8m	Date Tested:	23/02/2023

Sampling Method:

Sampled by Client, Tested as Received

Sample Curing Time (Hours):

2

Method used to Determine Liquid Limit:

Visual / Tactile Assessment by Competent Technician

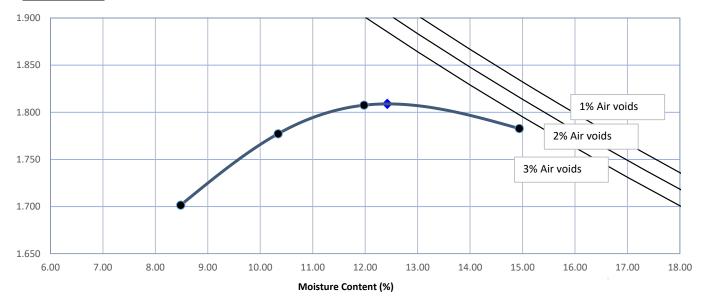
Material + 19.0mm (%):

0

Material + 37.5mm (%)

Moisture Content (%)	8.5	10.3	12.0	14.9	
Dry Density (t/m³)	1.702	1.777	1.808	1.783	

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³)

1.81

Optimum Moisture Content (%)

12.5

Comments: The above air void lines are derived from a calculated apparent particle density of 2.562 t/m³

Approved Signatory:

Name:

Date: 24/February/2023

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	TEST REPORT - AS 1289.5.2.	1	
Client:	Wallcliffe House Pty Ltd	Ticket No.	S8833
Client Address:	-	Report No.	WG23.3698_1_MMDD
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3698
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP17, 0.5m	Date Tested:	23/02/2023

Sampling Method:

Sampled by Client, Tested as Received

Sample Curing Time (Hours):

2

Method used to Determine Liquid Limit:

Visual / Tactile Assessment by Competent Technician

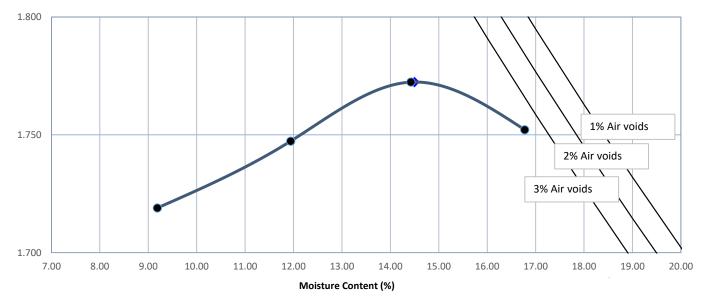
Material + 19.0mm (%):

0

Material + 37.5mm (%)

Moisture Content (%)	9.2	11.9	14.4	16.8	
Dry Density (t/m³)	1.719	1.747	1.772	1.752	

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³)

1.77

Optimum Moisture Content (%)

14.5

Comments: The above air void lines are derived from a calculated apparent particle density of 2.621 t/m³

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Name:

Date: 24/February/2023

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	SOIL AGGREGATE CONCRETE	CRUSHING	
	TEST REPORT - AS 1289.5.2.	1	
Client:	Wallcliffe House Pty Ltd	Ticket No.	\$8833
Client Address:	-	Report No.	WG23.3699_1_MMDD
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3699
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP18, 1.6m	Date Tested:	23/02/2023

Sampling Method:

Sampled by Client, Tested as Received

Sample Curing Time (Hours):

2

Method used to Determine Liquid Limit:

Visual / Tactile Assessment by Competent Technician

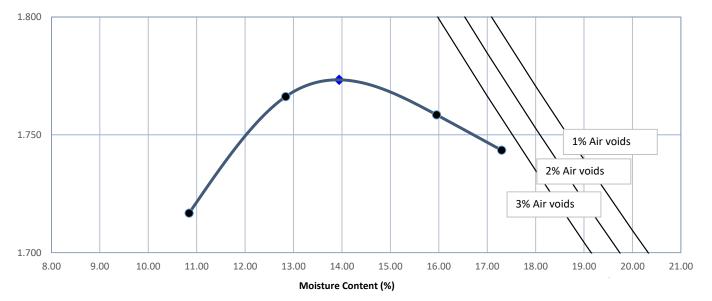
Material + 19.0mm (%):

0

Material + 37.5mm (%)

Moisture Content (%)	10.8	12.8	16.0	17.3	
Dry Density (t/m³)	1.717	1.766	1.759	1.743	

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³)

1.77

Optimum Moisture Content (%)

14.0

Comments: The above air void lines are derived from a calculated apparent particle density of 2.638 t/m³

Approved Signatory:

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Name:

Date: 24/February/2023

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	SOIL AGGREGATE CONCRETE	CRUSHING	
	TEST REPORT - AS 1289.5.2	.1	
Client:	Wallcliffe House Pty Ltd	Ticket No.	\$8833
Client Address:	-	Report No.	WG23.3700_1_MMDD
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3700
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP19, 2.0m	Date Tested:	23/02/2023

Sampling Method:

Sampled by Client, Tested as Received

Sample Curing Time (Hours):

2

Method used to Determine Liquid Limit:

Visual / Tactile Assessment by Competent Technician

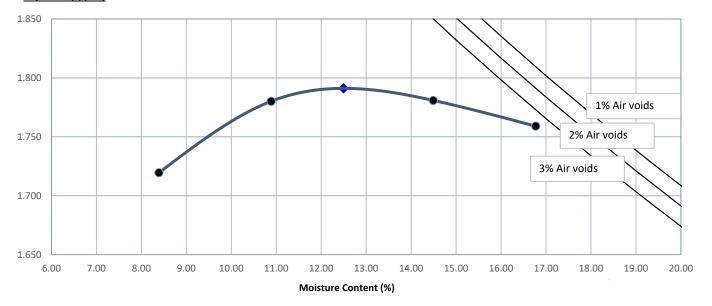
Material + 19.0mm (%):

0

Material + 37.5mm (%)

Moisture Content (%)	8.4	10.9	14.5	16.8	
Dry Density (t/m³)	1.720	1.780	1.781	1.759	

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³)

1.79

Optimum Moisture Content (%)

12.5

Comments: The above air void lines are derived from a calculated apparent particle density of 2.636 t/m³

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Name:

Date: 24/February/2023

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	SOIL AGGREGATE CONCRETE	E CRUSHING
	TEST REPORT - AS 1289.	5.2.1
Client:	Wallcliffe House Pty Ltd	Ticket No. \$8833
Client Address:	-	Report No. WG23.3701_1_MMDD
Project:	Treated Water Infiltration Area Assessment	Sample No. WG23.3701
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled: 15/02 - 16/02/2023
Sample Identification:	TP20, 0.6m	Date Tested: 23/02/2023

Sampling Method:

Sampled by Client, Tested as Received

Sample Curing Time (Hours):

2

Method used to Determine Liquid Limit:

Visual / Tactile Assessment by Competent Technician

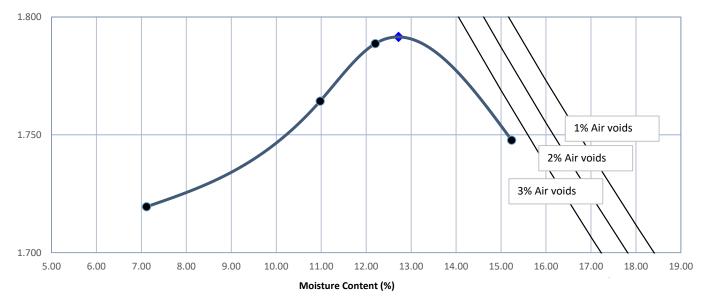
Material + 19.0mm (%):

0

Material + 37.5mm (%)

Moisture Content (%)	7.1	11.0	12.2	15.2	
Dry Density (t/m³)	1.719	1.764	1.789	1.748	

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³)

1.79

Optimum Moisture Content (%)

12.5

Comments: The above air void lines are derived from a calculated apparent particle density of 2.51 t/m³

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Name:

Date: 24/February/2023

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	SOIL AGGREGATE CONCRETE	CRUSHING	
	TEST REPORT - AS 1289.5.2.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	S8833
Client Address:	-	Report No.	WG23.3703_1_MMDD
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3703
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP21, 1.8m	Date Tested:	23/02/2023

Sampling Method:

Sampled by Client, Tested as Received

Sample Curing Time (Hours):

2

Method used to Determine Liquid Limit:

Visual / Tactile Assessment by Competent Technician

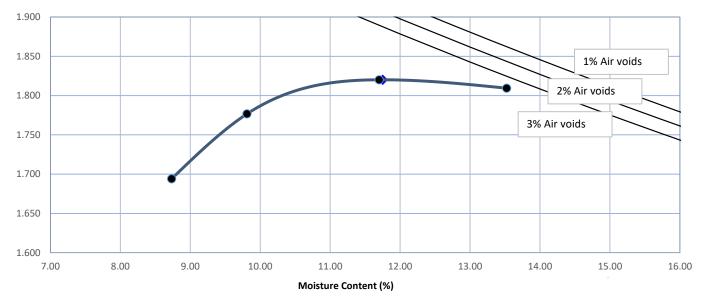
Material + 19.0mm (%):

0

Material + 37.5mm (%)

Moisture Content (%)	8.7	9.8	11.7	13.5	
Dry Density (t/m³)	1.694	1.777	1.820	1.809	

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³)

1.82

Optimum Moisture Content (%)

12.0

Comments: The above air void lines are derived from a calculated apparent particle density of 2.523 t/m³

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Date: 24/February/2023

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	SOIL AGGREGATE CONCRETE	CRUSHING	
	TEST REPORT - AS 1289.5.2.	1	
Client:	Wallcliffe House Pty Ltd	Ticket No.	\$8833
Client Address:	-	Report No.	WG23.3706_1_MMDD
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3706
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	BH24, 2.0m	Date Tested:	23/02/2023

Sampling Method:

Sampled by Client, Tested as Received

Sample Curing Time (Hours):

2

Method used to Determine Liquid Limit:

Visual / Tactile Assessment by Competent Technician

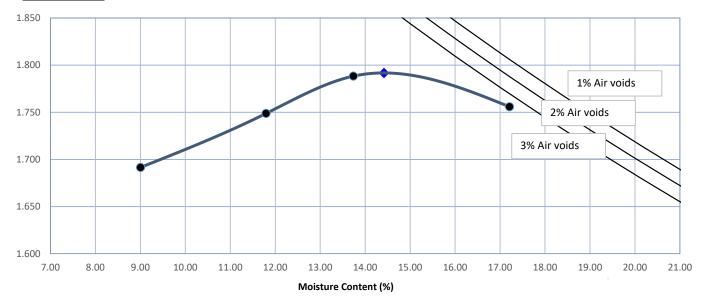
Material + 19.0mm (%):

0

Material + 37.5mm (%)

Moisture Content (%)	9.0	11.8	13.7	17.2	
Dry Density (t/m³)	1.692	1.749	1.788	1.756	

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³)

1.79

Optimum Moisture Content (%)

14.5

Comments: The above air void lines are derived from a calculated apparent particle density of 2.659 t/m³

Approved Signatory:

Name:

Date: 24/February/2023

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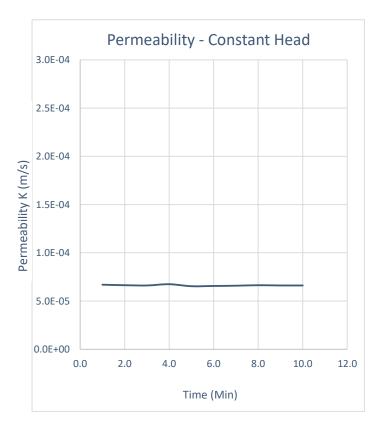
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	SOIL AGGREGATE CONCRETE	CRUSHI	NG
	TEST REPORT - AS 1289.6.7.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	\$8833
Client Address:	-	Report No.	WG23.3697_1_CHPERM
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3697
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP16, 1.8m	Date Tested:	23/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Compaction Details			
Compaction Method AS 1289.5.2.1			
Hammer Type	Modified		
% Retained on 19.0mm	0		
Maximum Dry Density (t/m3)	1.809		
Optimum Moisture (%)	12.4		
Target Dry Density Ratio	95		
Target Moisture Ratio	100		

Specimen Conditions at Compaction				
Laboratory Density Ratio (%) 95.1				
Laboratory Moisture Ratio (%) 100.4				
Surcharge (kPa) 3.0				
Hydraulic Gradient 0.7				

Coefficient of Permeability K₂₀ (m/s): 6.62E-05

Comments:

Approved Signatory:

Name: Date: 01/March/2023



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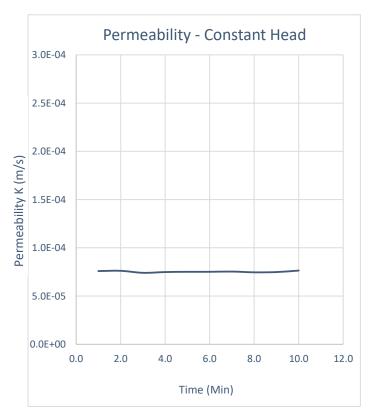
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	SOIL AGGREGATE CONCRETE	CRUSH	ING
	TEST REPORT - AS 1289.6.7.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	\$8833
Client Address:	-	Report No.	WG23.3698_1_CHPERM
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3698
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP17, 0.5m	Date Tested:	23/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Compaction Details		
Compaction Method	AS 1289.5.2.1	
Hammer Type	Modified	
% Retained on 19.0mm	0	
Maximum Dry Density (t/m3)	1.772	
Optimum Moisture (%)	14.5	
Target Dry Density Ratio	95	
Target Moisture Ratio	100	

Specimen Conditions at Compaction			
Laboratory Density Ratio (%) 95.0			
Laboratory Moisture Ratio (%) 99.8			
Surcharge (kPa) 3.0			
Hydraulic Gradient 0.7			

Coefficient of Permeability K₂₀ (m/s): 7.52E-05

Comments:

Approved Signatory:

Name:

Date: 01/March/2023

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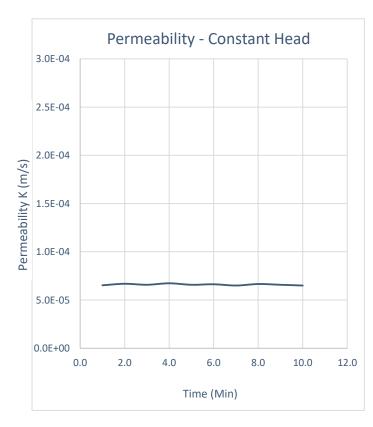
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	SOIL AGGREGATE CONCRETE	CRUSH	NG
	TEST REPORT - AS 1289.6.7.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	\$8833
Client Address:	-	Report No.	WG23.3699_1_CHPERM
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3699
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP18, 1.6m	Date Tested:	23/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Compaction Details			
Compaction Method AS 1289.5.2.1			
Hammer Type	Modified		
% Retained on 19.0mm	0		
Maximum Dry Density (t/m3)	1.773		
Optimum Moisture (%)	13.9		
Target Dry Density Ratio	95		
Target Moisture Ratio	100		

Specimen Conditions at Compaction			
Laboratory Density Ratio (%) 95.8			
Laboratory Moisture Ratio (%) 96.3			
Surcharge (kPa) 3.0			
Hydraulic Gradient 0.7			

Coefficient of Permeability K₂₀ (m/s): 6.61E-05

Comments:

Approved Signatory:

Name:

Date: 01/March/2023



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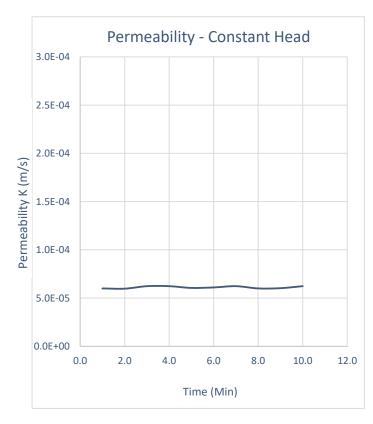
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	SOIL AGGREGATE CONCRETE	CRUSHI	NG
	TEST REPORT - AS 1289.6.7.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	S8833
Client Address:	-	Report No.	WG23.3700_1_CHPERM
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3700
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP19, 2.0m	Date Tested:	23/2 - 28/2/23

Sampling Method:

Sampled by Client, Tested as Received



Compaction Details			
Compaction Method AS 1289.5.2.1			
Hammer Type	Modified		
% Retained on 19.0mm	0		
Maximum Dry Density (t/m3)	1.791		
Optimum Moisture (%)	12.5		
Target Dry Density Ratio	95		
Target Moisture Ratio	100		

Specimen Conditions at Compaction			
Laboratory Density Ratio (%) 94.6			
Laboratory Moisture Ratio (%) 101.4			
Surcharge (kPa) 3.0			
Hydraulic Gradient 0.7			

Coefficient of Permeability K₂₀ (m/s): 6.12E-05

Comments:

Approved Signatory:

Name:

Date: 01/March/2023

235 Bank Street, Welshpool WA 6106



08 9472 3465

Accreditation No. 20599
Accredited for compliance
with ISO/IEC 17025 - Testing

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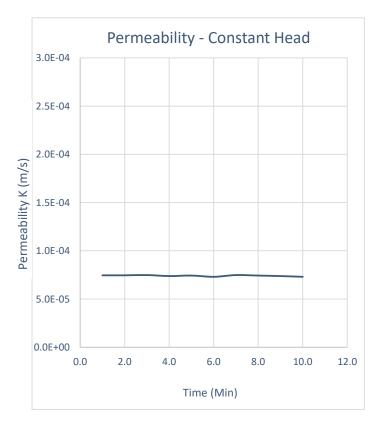
WG_AS 1289.6.7.1_TR_3 Page 1 of 1



	SOIL AGGREGATE CONCRETE	CRUSHI	ING
	TEST REPORT - AS 1289.6.7.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	\$8833
Client Address:	-	Report No.	WG23.3701_1_CHPERM
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3701
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP20, 0.6m	Date Tested:	23/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Compaction Details			
Compaction Method	AS 1289.5.2.1		
Hammer Type	Modified		
% Retained on 19.0mm	0		
Maximum Dry Density (t/m3)	1.792		
Optimum Moisture (%)	12.7		
Target Dry Density Ratio	95		
Target Moisture Ratio	100		

Specimen Conditions at Compaction			
Laboratory Density Ratio (%)	95.1		
Laboratory Moisture Ratio (%) 99.6			
Surcharge (kPa)	3.0		
Hydraulic Gradient 0.7			

Coefficient of Permeability K₂₀ (m/s): 7.41E-05

Comments:

Approved Signatory:

Name: Date: 01/March/2023



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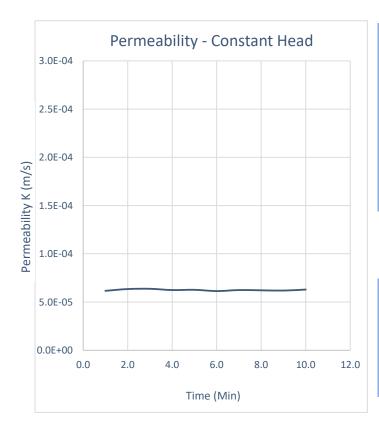
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	SOIL AGGREGATE CONCRETE	CRUSHI	NG
	TEST REPORT - AS 1289.6.7.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	\$8833
Client Address:	-	Report No.	WG23.3703_1_CHPERM
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3703
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	TP21, 1.8m	Date Tested:	23/2 - 28/2/23

Sampling Method:

Sampled by Client, Tested as Received



Compaction Details				
Compaction Method AS 1289.5.2.1				
Hammer Type	Modified			
% Retained on 19.0mm	0			
Maximum Dry Density (t/m3)	1.82			
Optimum Moisture (%)	11.8			
Target Dry Density Ratio	95			
Target Moisture Ratio	100			

Specimen Conditions at Compaction			
Laboratory Density Ratio (%)	94.8		
Laboratory Moisture Ratio (%) 101.7			
Surcharge (kPa)	3.0		
Hydraulic Gradient 0.7			

Coefficient of Permeability K₂₀ (m/s): 6.26E-05

Comments:

Approved Signatory:

Name: Date: 01/March/2023

Accreditation No. 20599 Accredited for compliance with ISO/IEC 17025 - Testing

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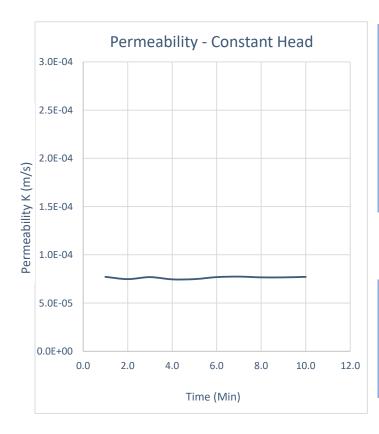
08 9472 3465



	SOIL AGGREGATE CONCRETE	CRUSHI	NG
	TEST REPORT - AS 1289.6.7.1		
Client:	Wallcliffe House Pty Ltd	Ticket No.	\$8833
Client Address:	-	Report No.	WG23.3706_1_CHPERM
Project:	Treated Water Infiltration Area Assessment	Sample No.	WG23.3706
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled:	15/02 - 16/02/2023
Sample Identification:	BH24, 2.0m	Date Tested:	23/02 - 28/02/2023

Sampling Method:

Sampled by Client, Tested as Received



Compaction Details			
Compaction Method	AS 1289.5.2.1		
Hammer Type	Modified		
% Retained on 19.0mm	0		
Maximum Dry Density (t/m3)	1.792		
Optimum Moisture (%)	14.4		
Target Dry Density Ratio	95		
Target Moisture Ratio	100		

Specimen Conditions at Compaction			
Laboratory Density Ratio (%)	94.9		
Laboratory Moisture Ratio (%) 99.7			
Surcharge (kPa)	3.0		
Hydraulic Gradient 0.7			

Coefficient of Permeability K₂₀ (m/s): 7.62E-05

Comments:

Approved Signatory:

Name: Date: 01/March/2023

Accreditation No. 20599 Accredited for compliance with ISO/IEC 17025 - Testing

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	SOIL AGGREGATE CONCRE	TE CRUSHING		
TEST REPORT - ASTM D2974-14 (Test Method C)				
Client: Wallcliffe House Pty Ltd Ticket No. S8833				
Client Address:	-	Report No. WG23.3698-3706_1_ORG		
Project:	Treated Water Infiltration Area Assessment	Sample No. WG23.3698-3706		
Location:	752 Wallcliffe Road, Margaret River, WA	Date Sampled: 15/02 - 16/02/2023		
Sample Identification:	Various - See below	Date Tested: 23/02/2023		

TEST RESULTS - Organic Content

Sampling Method: Sampled by Client, Tested as Received

Testing Completed By: WGLS - LC

Furnace Temperature (°C): 440

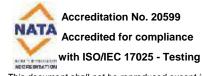
Sample Number	Sample Identification	Ash Content (%)	Organic Content (%)
WG23.3698	TP17, 0.5m	96.7	3.3
WG23.3699	TP18, 1.6m	99.1	0.9
WG23.3701	TP20, 0.6m	97.4	2.6
WG23.3706	BH24, 2.0m	99.4	0.6

Comments:

Approved Signatory:

atory: Contents

Date: 24/February/2023



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Appendix C

Pump Test – Western Irrigation 2022





15 March 2022

Emerge Associates Suite 4, 26 Railway Road SUBIACO WA 6008

Attention:	
Dea	BORE ASSESSMENT – WALLCLIFFE HOUSE SITE

Western Irrigation is pleased to present its completion report for works under this contract for your review.

Exec mmary:

Western Irrigation was commissioned to undertake testing and assessment of two existing irrigation water supply bores at Wallcliffe House, with site works being undertaken during January 2022.

Site works involved:

- val of existing pump equipment and inspection of bores using down-hole camera equipment
- installation of temporary test pump equipment; step and constant rate testing of the bores.
- collection of water samples for laboratory analysis
- reigen en equipment.

Key control increased knowledge of:

- the fragility of the pumping environment, with the water pumped from both bores increasing in salinity with pumping time.
- issues associated with root penetration into the bore structure (PB1) and apparent measures to with root penetration into the bore structure (PB1) and apparent measures to with root penetration into the bore structure (PB1) and apparent measures

Western Irrigation recommends against the use of the existing infrastructure as part of the irrigation water proposed future landscape on the site.

New groundwater sources, designed to access the upper (fresher) portion of the aquifer, suit the permanent installation of modern submersible pumping equipment, and located to minimise risk of both higher calinity water and root intrusion issues, will provide a far more reliable source of irrigation values are project.





Background:

In September 2019 Western Irrigation responded to an enquiry for testing of two existing 100mm production bores in Prevally.

Subsequent discussions revealed the location of the bores as Wallcliffe House, and the suggestion that these bores may be used as the source of water for irrigating the landscape associated with a proposed redevelopment of the site.

A meeting with on-site personnel indicated that while the bores had worked successfully for "many years", there was little to no existing knowledge of the bore construction, water quality, pumping rates, sustainable yield, etc.

Works undertaken:

Western Irrigation's crew mobilised to site on 17 January 2022. The existing pump equipment in bore PB1 was tested for operational status, while the pump in bore PB2 was unable to be tested as there was no power at that site.

Existing pump equipment was removed from both bores, then each bore was bailed and dimensions recorded. A Laval 1000XLT down-hole camera was run into each hole to enable visual assessment of the condition of casing and screens.

Each bore was test pumped at a range of different flow rates (step tested), then subjected to a constant rate test of 8 hours duration. Western Irrigation crew worked in conjunction with Emerge Associates personnel during this time, as Emerge used down-hole loggers for monitoring of waterlevel, temperature and salinity for their purposes.

Water samples were collected at intervals during bore testing (step test, 15 minutes into constant rate test, at end of 8 hour constant rate test) to enable broad assessment of any change in salinity during the test process.

The existing pump equipment was restored to each bore, and bore PB1 was recommissioned into service. PB2 could not be recommissioned, as there was no live power supply available at the bore site.

Bore information – PB1 (East, near sump):

Static water level:	~ 2.2 metres below ground level
Top of screen:	~ 2.7 metres below ground level
Bottom of screen:	~ 8.7 metres below ground level.
Casing:	~100mm ID PVC
Existing pump:	2.2kW three phase Signature 2000 Starite 9055HT-02, installed on 7 metres of 40mm metric poly pump column.
Observations:	Tree roots found on poly column during pump removal – from 1.9m to 3.2m. Camera inspection found many tree roots just below rest water level, with many roots growing through openings in the stainless steel screen. Visibility became poor at 6m below ground level, and approximately 0.25m of mud / silt was found in the base of the borehole.

Bore information – PB2 (West, near base of stairs):

Static water level:	~ 2.55 metres below ground level
Top of holes in casing liner:	~ 12 metres below ground level
Total depth:	~ 13.65 metres below ground level.
Casing:	~86mm ID PVC casing (~2mm wall thickness)
Existing pump:	Single phase Grundfos SQ7-55N model B, installed on 11.85 metres of 32mm rural poly pump column.
Observations:	Original ~100mm ID PVC casing has been lined with 80mm (~86mm ID) PVC casing (~2mm wall thickness). Camera inspection shows the 80 PVC liner is structurally distorted in several places. The PVC liner has holes estimated at 15mm to 20mm diameter drilled in it, from approximately 12 metres below ground level to the base of the borehole. Encrusted bore screen is clearly visible through the holes in the PVC liner. Approximately 100mm of mud / silt was found in the base of the borehole.

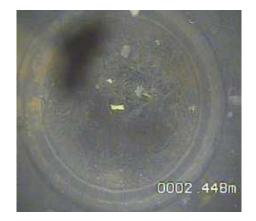
Down-hole camera inspection:

Each bore was visually inspected using a Laval 1000XLT down-hole camera. The full digital record of inspection can be accessed via

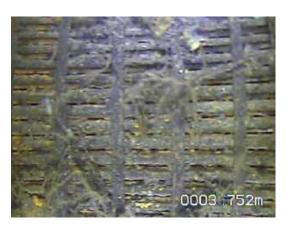
https://www.dropbox.com/sh/bdsht822w9fp9gz/AADp9YNITMgOUne1gaG10jb9a?dl=0

Bore PB1 (East)

This bore contains lots of tree roots, and a screen which is clearly heavily encrusted. The bottom of the borehole is about 8.6 metres below the top of casing.



Looking down – roots inside casing



Side view – roots growing through screen



Looking down – roots inside casing



Side view – encrustation on bore screen

Bore PB2 (West):

This bore has been lined with 80mm PVC casing. That 80mm PVC casing has holes cut in it from 12m downwards to the base of hole at about 13.68 metres below top of casing. Looking through those cutouts one can clearly see heavily encrusted screen behind the PVC casing.

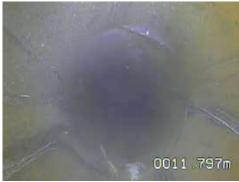
It is suspected that the 80mm PVC lining has been installed as a means of countering the impact of tree roots. This is at least partially successful, although it does seem the 80mm liner is being "strangled" and distorted at around 5.8m below top of casing, as well various other places.



0006.438m

Distorted bore casing

Distorted bore casing







Holes in bore casing water entry into bore



Side view through hole in casing



Side view through hole in casing

Bore testing:

Each bore was subjected to a series of step tests, undertaken in order to gauge the likely performance of the bore.

After recovery, each bore was subject to an 8 hour constant rate test, enabling monitoring of water level and quality under constant pumping conditions.

Water samples were collected during step testing, at 15 minutes into each constant rate test, and just prior to the end of each constant rate test.

Results of bore testing and water analysis are enclosed.

Results:

The results of testing and water analysis are attached for your records.

PB1:

Was step tested at 1L/s, 1.6L/s and 2.03L/s then allowed to recover fully before being tested at a constant rate of 1.5L/s for 8 hours.

The significant reduction in specific yield with increasing flow rate (from 1L/s/m at a flow rate of 1 L/s, to 0.41L/s/m at 2L/s flow rate) is indicative of the greater difficulty water has in entering the bore as the pumping rate increases. Whether this is due to bore or aquifer issues is not clear, however the blockage of screen by roots and encrustation is likely to be a significant contributing factor.

The 1.5L/s rate chosen for the 8 hour constant rate test was selected on the basis of the step test results, and was intended to provide an almost "sustainable yield" with drawdown stabilising during the pumping period. In fact drawdown continued to slowly increase during the 8 hour pumping period.

The salinity of water from bore PB1 increased very marginally during testing of bore, suggesting a possible connection with the river, or upconing of higher salinity water from lower levels of the aquifer. However salinity levels remained quite low reaching 820mg/L at the maximum during this test.

Interestingly the iron content was at its highest in the step tests, and reduced in each of the constant rate samples. This may be indicative of the initial yield of water drawing from the top of the aquifer (perhaps containing more iron amongst organics in the water), with water drawn later in the test coming from lower in the aquifer.

Western Irrigation recommend this bore not be pumped at rates higher than 1.5L/s in the short term and be replaced in the medium – longer term.

PB2:

Was step tested at 0.5L/s, 1.0L/s, 2.07L/s and 2.22L/s then allowed to recover fully before being tested at a constant rate of 2.25L/s for 8 hours.

The reduction in specific yield with increasing flow rate (from 0.86L/s/m at a flow rate of 0.5 L/s, to 0.75L/s/m at 2.25L/s flow rate) is indicative of the greater difficulty water has in entering the bore as the pumping rate increases. Whether this is due to bore or aquifer issues is not clear, however the blockage of the original screen by roots and encrustation outside the 80mm PVC liner is likely to be a significant contributing factor.

The 2.25L/s rate chosen for the 8 hour constant rate test was selected on the basis of the step test results, and was intended to test the measure of the bore with much greater available drawdown than PB1. Again, drawdown continued to slowly increase during the 8 hour pumping period. It is interesting to note that 3 hours after cessation of pumping, the water level in PB2 had still not recovered to its pre-test level.

The salinity of water from bore PB2 increased during testing of bore from 1080mg/L TDS to 1200mg/L TDS. This elevated of salinity may arise from the greater depth of penetration into the shallow aquifer (with more saline water typically present at lower levels, especially adjacent to a seasonally saline river). It may also arise from a more direct hydraulic connection to the river (and is also much nearer to the river than Bore PB1).

Interestingly the iron content was again at its highest in the step tests, and reduced in each of the constant rate samples. This may be indicative of the initial yield of water drawing from the top of the aquifer (perhaps containing more iron amongst organic content in the water), with water drawn later in the test coming from lower in the aquifer.

Western Irrigation recommend this bore not be considered for use as part of the future irrigation system.

Observations:

In Western Irrigation's opinion, neither of the bores tested during this project are suitable for use as the source of irrigation water for the proposed redevelopment of the site.

Bore PB1 is badly afflicted by root entrusion and encrustation, and is of such small diameter that a pump shroud cannot be fitted to ensure motor cooling in accordance with submersible motor manufacturer's recommendations.

Bore PB2 has been lined with thin-wall PVC casing which is showing clear signs of structural failure (distortion) – possibly from tree roots growing around it. Viewing through the holes in the PVC-liber reveal heavily encrusted screen. The 80mm casing diameter prevents use of standard submersible pumping equipment – with or without the manufacturer's recommended cooling shroud for pumps installed within the screened section of a bore.

Future:

Proper hydrogeological analysis of the site, in conjunction with assessment of the geotechnical information available for the site, will determine the maximum sustainable supply likely to be available from a new borefield to be constructed on the site. Supplementation of natural aquifer recharge, for example by recharge of appropriately-treated wastewater, may be necessary to achieve the required volume of irrigation water for the site.

Appropriate bore design will include minimal penetration below the surface of the aquifer, and construction at as large a diameter as practicable. This approach will minimise the risk of upconing of higher salinity water from deeper in the aquifer, yet maximise the open area of the bore screen (and hence minimise drawdown for a given pumping rate). It will also facilitate installation of shrouded pump equipment suitable for ongoing reliable operation on the site.

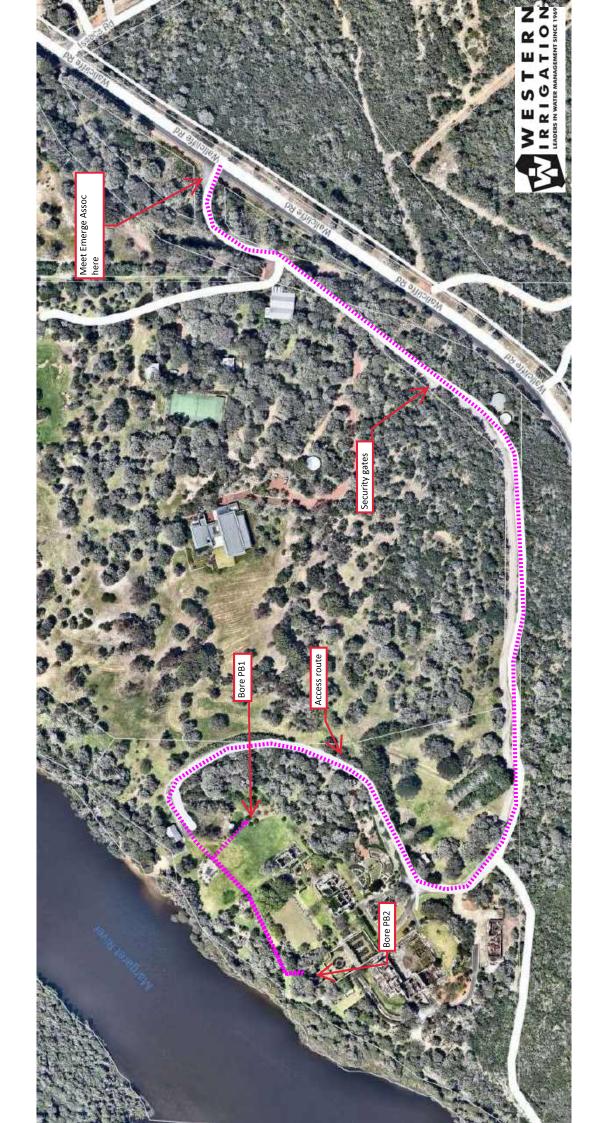
Important:

In our opinion, any dewatering on this site will have the potential to upset the delicate balance of salt and fresh water existing in the shallow aquifer below the site. Once upset it may take years to regain that balance (through multiple seasons of Winter rainfall). Serious consideration should be given to modifying any construction approach which necessitates dewatering on this site.

If there are any queries regarding this information, in the first instance please contact the undersigned.



Enclosure





TEST PUMPING BORE - STEP TESTS

Location:	Wallcliffe House - PB1				
Date:	18/01/2022	Work Docket No:	B85697		
Operator:					
SWL (m)	2.5	Total Depth (m)	8.7		
Packer (m)	Inline	I.D. (mm)	100		

	Step 1	Step 2	Step 3	Recovery
Flow rate	1.0 L/s	1.6 L/s	2.03 L/s	0 L/s
Time (minutes)	Water Level (m)	Water Level (m)	Water Level (m)	Water Level (m)
1	3.38	4.20	7.18	2.58
2	3.48	4.27	7.07	253.00
3	3.48	4.29	7.15	2.53
4	3.48	4.30	7.19	2.53
5	3.48	4.30	7.05	2.53
6	3.48	4.31	7.08	2.50
7	3.48	4.32	7.17	2.50
8	3.48	4.32	7.20	2.50
9	3.48	4.33	7.23	2.50
10	3.48	4.33	7.25	2.50
11	3.48	4.33	7.27	2.50
12	3.48	4.33	7.29	
13	3.48	4.34	7.30	
14	3.48	4.34	7.32	
15	3.48	4.34	7.34	
20	3.48	4.36	7.30	
25	3.48	4.37	7.36	
30	3.48	4.37	7.35	2.50
35	3.48			
40	3.48			
45	3.48			
50	3.48			
55	3.49			
60	3.49			

Comments: Measurement reference point 0 mm above ground level. Top of casing is 450mm bgl. Trace \192.168.0.2\Western Irrigation\Data\WD Scans\80000-89999\85000-85999\B85697 Wallcliffe House - bore testing\WD info\ results PB1.xlsx Step test



TEST PUMPING BORE - CONSTANT RATE

Location:	Wallcliffe House - PB1			
Date:	20/01/2022	Work Docket No:	B85697	
Operator:				
SWL (m)	2.45	Total Depth (m)	8.7	
Packer (m)	Inline	I.D. (mm)	100	

Elapsed time	L/s	L/s	Elapsed time	Flow	Pumping
(minutes)	(L/s)	Level (m)	(minutes)	(L/s)	Level (m)
1	1.5	3.80	105	1.5	3.98
2		3.86	120		3.98
3		3.89	135		3.99
4		3.89	150		3.99
5		3.90	165		4.00
6		3.90	180		4.00
7		3.90	210		4.01
8		3.91	240		4.02
9		3.91	270		4.03
10		3.91	300		4.04
11		3.92	330		4.04
12		3.92	360		4.04
13		3.92	390		4.05
14		3.92	420		4.05
15 **		3.92	450 **		4.05
30		3.93	480		4.05
45		3.94	510		
60	1.5	3.96	540		
75		3.97	570		
90		3.97	600		

Comments: Water samples collected at **

Measurement reference point 0 mm above ground level

Trace \\192.168.0.2\Western Irrigation\Data\WD Scans\80000-89999\85000-85999\B85697 Wallcliffe House - bore testing\WD info\ results PB1.xlsx Constant rate



TEST PUMPING BORE - RECOVERY

Location:	Wallcliffe House - PB1				
Date:	20/01/2022 Work Docket No: B85697				
Operator:					
SWL (m)	2.5	Total Depth (m)	8.7		
Packer (m)	Inline	I.D. (mm)	100		

Elapsed time	L/s	L/s	Elapsed time	Flow	Pumping
(minutes)	(L/s)	Level (m)	(minutes)	(L/s)	Level (m)
1	0.0	2.52	105		
2		2.52	120		
3		2.52	135		
4		2.52	150		
5		2.51	165		
6			180		
7			210		
8			240		
9			270		
10		2.50	300		
11			330		
12			360		
13			390		
14			420		
15		2.50	450		
30		2.50	480		
45			510		
60			540		
75			570		
90			600		

Comments: Measurement reference point 0 mm above ground level

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TEST PUMPING BORE - STEP TESTS

Location:	Wallcliffe House - PB2				
Date:	18/01/2022 Work Docket No: B85697				
Operator:					
SWL (m)	2.6	Total Depth (m)	13.65		
Packer (m)	Inline (sleeved)	I.D. (mm)	86		

	Step 1	Step 2	Step 3	Step 4	Recovery
Flow rate	0.5 L/s	1.0 L/s	2.07 L/s	2.22 L/s	0 L/s
Time (minutes)	Water Level (m)				
1	2.93	3.91	5.04	5.41	2.89
2	3.14	3.82	5.15	5.41	283.00
3	3.16	3.82	5.16	5.41	2.82
4	3.16	3.79	5.16	5.41	2.78
5	3.16	3.80	5.16	5.42	2.78
6	3.17	3.81	5.16	5.42	2.78
7	3.17	3.82	5.16	5.42	2.77
8	3.17	3.82	5.17	5.42	2.77
9	3.17	3.81	5.16	5.42	2.76
10	3.17	3.81	5.16	5.42	2.76
11	3.17	3.81	5.17	5.42	2.75
12	3.17	3.81	5.17	5.42	2.74
13	3.17	3.82	5.17	5.42	2.74
14	3.17	3.82	5.17	5.43	2.74
15	3.17	3.82	5.17	5.43	2.73
20	3.18	3.82	5.18	5.44	2.73
25	3.18	3.82	5.18	5.44	2.72
30	3.18	3.82	5.18	5.46	2.71
35					
40					
45					
50					
55					
60					

Comments: Measurement reference point 350 mm below ground level.

Trace \192.168.0.2\Western Irrigation\Data\WD Scans\80000-89999\85000-85999\B85697 Wallcliffe House - bore testing\WD info\ results PB2.xlsx Step test



TEST PUMPING BORE - CONSTANT RATE

Location:	Wallcliffe House - PB2			
Date:	19/01/2022	Work Docket No:	B85697	
Operator:				
SWL (m)	2.61	Total Depth (m)	13.65	
Packer (m)	Inline (sleeved)	I.D. (mm)	86	

Elapsed time	L/s	L/s	Elapsed time	Flow	Pumping
(minutes)	(L/s)	Level (m)	(minutes)	(L/s)	Level (m)
1	2.25	5.12	105		5.44
2		5.19	120	2.25	5.45
3		5.23	135		5.46
4		5.26	150		5.47
5		5.27	165		5.48
6		5.28	180		5.49
7		5.29	210		5.50
8		5.30	240		5.52
9		5.30	270		5.54
10		5.31	300	2.25	5.55
11		5.33	330		5.56
12		5.35	360		5.57
13		5.33	390		5.58
14		5.32	420		5.59
15 **		5.33	450 **	2.25	5.60
30	2.25	5.38	480		5.61
45		5.42	510		
60		5.41	540		
75		5.43	570		
90		5.44	600		

Meter start: 38.5kL; meter finish 103.9kL. 8hr pumped volume = 65.4kL. Average 2.27L/s.

Comments: Water samples collected at **

Measurement reference point 350 mm below ground level

Trace \\192.168.0.2\Western Irrigation\Data\WD Scans\80000-89999\85000-85999\B85697 Wallcliffe House - bore testing\WD info\ results PB2.xlsx Constant rate



TEST PUMPING BORE - RECOVERY

Location:	Wallcliffe House - PB2			
Date:	19/01/2022 Work Docket No: B85697			
Operator:				
SWL (m)	2.6	Total Depth (m)	13.65	
Packer (m)	Inline (sleeved)	I.D. (mm)	86	

Elapsed time	L/s	L/s	Elapsed time	Flow	Pumping
(minutes)	(L/s)	Level (m)	(minutes)	(L/s)	Level (m)
1	0.0	3.14	105	0.0	2.82
2		3.08	120		2.81
3		3.04	135		2.79
4		3.03	150		2.78
5		3.02	165		2.77
6		3.01	180		2.76
7		3.00	210		
8		2.99	240		
9		2.98	270		
10		2.97	300		
11		2.97	330		
12		2.97	360		
13		2.96	390		
14		2.96	420		
15		2.96	450		
30		2.98	480		
45		2.89	510		
60		2.89	540		
75		2.85	570		
90		2.83	600		

Comments: Measurement reference point 0 mm above ground level

 $\label{thm:local_constraint} Trace $$192.168.0.2\Western\ Irrigation\Data\WD\ Scans\80000-89999\85000-85999\B85697\ Wallcliffe\ House\ -\ bore\ testing\WD\ info\ results\ PB2.xlsx\ Recovery$





Final Report

Job No: B2201-0279

Date Issued: 25-Jan-2022
Report Number: 136467

Report Number:

Attention:

Western Irrigation

Purchase Order:

Date Received:

B157067

Client: Address: Date Sampled:

24-Jan-2022

The following sample was analysed:

Sample ID

B22-0006370 Your Reference

Product

Water

Bore 2

Description Step Test Wallcliffe House

Arrival Temp (°C) 7.2

Analysis of this sample conducted between 24-Jan-2022 and 25-Jan-2022

Analysis Results

	Determinant	Result Value
General Appearan	ce (N/A) ^	
B22-0006370	Appearance	Colourless
B22-0006370	Odour	Odourless
Total Alkalinity (T	P_WA/007)	
B22-0006370	Alkalinity (to pH 4.5@25degC)	240 mg CaCO3/L
B22-0006370	Bicarbonate	290 mg/L
Electrical Conduc	tivity (TP_WA/009)	
B22-0006370	Electrical Conductivity	1.96 mS/cm
Dissolved Carbon	dioxide (Calculated)	
B22-0006370	Dissolved Carbon Dioxide	29 mg/L
Hardness (TP_WA	A/008)	
B22-0006370	Hardness	390 mg CaCO3/L
pH (TP_WA/010)		
B22-0006370	рН	7.2
TDS (calculation)	(Calculated) ^	
B22-0006370	Total Dissolved Salts	1080 mg/L
Iron (UV/Vis) ^		
B22-0006370	Iron	0.23 mg/L

Note: All samples are analysed on an as received basis.

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Please refer to the following link for the measurement of uncertainty values for all NATA accredited analysis

mailto://services.awta.com.au/AFTMeasurementUncertainty/index.php





Final Report

Job No:

B2201-0279

Date Issued: 25-Jan-2022

Report Number: 136467

Attention: Purchase Order: B157067

Client: Western Irrigation Date Sampled:

Address: Date Received: 24-Jan-2022

Please Note: If this sample was taken greater than 24 hours prior to the commencement of testing; the integrity of the sample may have been affected which may have influenced the final results.

^ - NATA Accreditation does not cover the performance of this test/Component.

The sample(s) referred to in this report were analysed for the following determinant(s):

Analysis		Laboratory
General Appearance	N/A	Agro Nutritional Laboratory
Total Alkalinity	TP_WA/007	Agro Nutritional Laboratory
Electrical Conductivity	TP_WA/009	Agro Nutritional Laboratory
Dissolved Carbon dioxide	Calculated	Agro Nutritional Laboratory
Hardness	TP_WA_008	Agro Nutritional Laboratory
рН	TP_WA/010	Agro Nutritional Laboratory
TDS (calculation)	Calculated	Agro Nutritional Laboratory
Iron	UV/Vis	Agro Nutritional Laboratory

The results in this report were authorised by:

Name	Title		





Final Report

 Job No:
 B2201-0279

 Date Issued:
 25-Jan-2022

Report Number: 136467

Attention: Purchase Order: B157067

Western Irrigation Date Sampled:

Address: Date Received: 24-Jan-2022

The following sample was analysed:

Sample ID

Client:

B22-0006371 Your Reference Bore 2

Product Water

Description Constant Rate 15 mins Wallcliffe House

Arrival Temp (°C) 7.2

Analysis of this sample conducted between 24-Jan-2022 and 25-Jan-2022

Analysis Results

	Determinant	Result Value
General Appearan	ce (N/A) ^	
B22-0006371	Appearance	Colourless
B22-0006371	Odour	Odourless
Total Alkalinity (T	P_WA/007)	
B22-0006371	Alkalinity (to pH 4.5@25degC)	225 mg CaCO3/L
B22-0006371	Bicarbonate	275 mg/L
Electrical Conduc	tivity (TP_WA/009)	
B22-0006371	Electrical Conductivity	2.10 mS/cm
Dissolved Carbon	dioxide (Calculated)	
B22-0006371	Dissolved Carbon Dioxide	28 mg/L
Hardness (TP_W/	A/008)	
B22-0006371	Hardness	410 mg CaCO3/L
pH (TP_WA/010)		
B22-0006371	pH	7.2
TDS (calculation)	(Calculated) ^	
B22-0006371	Total Dissolved Salts	1160 mg/L
Iron (UV/Vis) ^		
B22-0006371	Iron	0.05 mg/L

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Final Report

 Job No:
 B2201-0279

 Date Issued:
 25-Jan-2022

Report Number: 136467

Attention: Purchase Order: B157067

Client: Western Irrigation Date Sampled:

Address: Date Received: 24-Jan-2022

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The sample(s) referred to in this report were analysed for the following determinant(s):

Analysis		Laboratory	
General Appearance	N/A	Agro Nutritional Laboratory	
Total Alkalinity	TP_WA/007	Agro Nutritional Laboratory	
Electrical Conductivity	TP_WA/009	Agro Nutritional Laboratory	
Dissolved Carbon dioxide	Calculated	Agro Nutritional Laboratory	
Hardness	TP_WA_008	Agro Nutritional Laboratory	
рН	TP_WA/010	Agro Nutritional Laboratory	
TDS (calculation)	Calculated	Agro Nutritional Laboratory	
Iron	UV/Vis	Agro Nutritional Laboratory	

The results in this report were authorised by:

Name Title





Final Report

 Job No:
 B2201-0279

 Date Issued:
 25-Jan-2022

Report Number: 136467

Attention: Purchase Order: B157067

Client: Western Irrigation Date Sampled:

Address: Date Received: 24-Jan-2022

The following sample was analysed:

Sample ID

B22-0006372 Your Reference Bore 2

Product Water

Description Constant Rate 8 Hrs Wallcliffe House

Arrival Temp (°C) 7.2

Analysis of this sample conducted between 24-Jan-2022 and 25-Jan-2022

Analysis Results

	Determinant	Result Value
General Appearan	ce (N/A) ^	
B22-0006372	Appearance	Colourless
B22-0006372	Odour	Odourless
Total Alkalinity (T	P_WA/007)	
B22-0006372	Alkalinity (to pH 4.5@25degC)	235 mg CaCO3/L
B22-0006372	Bicarbonate	285 mg/L
Electrical Conduc	tivity (TP_WA/009)	
B22-0006372	Electrical Conductivity	2.19 mS/cm
Dissolved Carbon	dioxide (Calculated)	
B22-0006372	Dissolved Carbon Dioxide	28 mg/L
Hardness (TP_WA	A/008)	
B22-0006372	Hardness	450 mg CaCO3/L
pH (TP_WA/010)		
B22-0006372	рН	7.2
TDS (calculation)	(Calculated) ^	
B22-0006372	Total Dissolved Salts	1200 mg/L
Iron (UV/Vis) ^		
B22-0006372	Iron	0.02 mg/L

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Final Report

 Job No:
 B2201-0279

 Date Issued:
 25-Jan-2022

Report Number: 136467

Attention: Purchase Order: B157067

Client: Western Irrigation Date Sampled:

Address: Date Received: 24-Jan-2022

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^ - NATA Accreditation does not cover the performance of this test/Component.

The sample(s) referred to in this report were analysed for the following determinant(s):

Analysis		Laboratory	
General Appearance	N/A	Agro Nutritional Laboratory	
Total Alkalinity	TP_WA/007	Agro Nutritional Laboratory	
Electrical Conductivity	TP_WA/009	Agro Nutritional Laboratory	
Dissolved Carbon dioxide	Calculated	Agro Nutritional Laboratory	
Hardness	TP_WA_008	Agro Nutritional Laboratory	
рН	TP_WA/010	Agro Nutritional Laboratory	
TDS (calculation)	Calculated	Agro Nutritional Laboratory	
Iron	UV/Vis	Agro Nutritional Laboratory	

The results in this report were authorised by:

Name	Title		





Final Report

B2201-0279 Job No: Date Issued: 25-Jan-2022

B157067

136467 Report Number:

Attention:

Western Irrigation Date Sampled:

Purchase Order:

Client: Address:

24-Jan-2022 Date Received:

The following sample was analysed:

Sample ID

B22-0006373 Your Reference Bore 1

> Product Water

Description Step Test Wallcliffe House

7.2 Arrival Temp (°C)

Analysis of this sample conducted between 24-Jan-2022 and 25-Jan-2022

Analysis Results

	Determinant	Result Value
General Appearan	ce (N/A) ^	
B22-0006373	Appearance	Colourless
B22-0006373	Odour	Odourless
Total Alkalinity (T	P_WA/007)	
B22-0006373	Alkalinity (to pH 4.5@25degC)	215 mg CaCO3/L
B22-0006373	Bicarbonate	260 mg/L
Electrical Conductivity (TP_WA/009)		
B22-0006373	Electrical Conductivity	1.47 mS/cm
Dissolved Carbon dioxide (Calculated)		
B22-0006373	Dissolved Carbon Dioxide	16 mg/L
Hardness (TP_WA	A/008)	
B22-0006373	Hardness	320 mg CaCO3/L
pH (TP_WA/010)		
B22-0006373	рН	7.4
TDS (calculation) (Calculated) ^		
B22-0006373	Total Dissolved Salts	810 mg/L
Iron (UV/Vis) ^		
B22-0006373	Iron	0.07 mg/L

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measurementUncertainty/index.php





25-Jan-2022

ANALYSIS REPORT

Final Report

Date Issued:

Job No: B2201-0279

Report Number: 136467

Attention: Purchase Order: B157067

Client: Western Irrigation Date Sampled:

Address: Date Received: 24-Jan-2022

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The sample(s) referred to in this report were analysed for the following determinant(s):

Analysis	· ·	Laboratory
General Appearance	N/A	Agro Nutritional Laboratory
Total Alkalinity	TP_WA/007	Agro Nutritional Laboratory
Electrical Conductivity	TP_WA/009	Agro Nutritional Laboratory
Dissolved Carbon dioxide	Calculated	Agro Nutritional Laboratory
Hardness	TP_WA_008	Agro Nutritional Laboratory
рН	TP_WA/010	Agro Nutritional Laboratory
TDS (calculation)	Calculated	Agro Nutritional Laboratory
Iron	UV/Vis	Agro Nutritional Laboratory

The results in this report were authorised by:

Name	Title





Final Report

Job No: B2201-0279

Date Issued: 25-Jan-2022 Report Number: 136467

Attention: Purchase Order: B157067

Client: Western Irrigation Date Sampled:

Address: Date Received: 24-Jan-2022

The following sample was analysed:

Sample ID

B22-0006374 Your Reference Bore 1

Product Water

Description Constant Rate 15 mins Wallcliffe House

Arrival Temp (°C) 7.2

Analysis of this sample conducted between 24-Jan-2022 and 25-Jan-2022

Analysis Results

	Determinant	Result Value
General Appearan	ce (N/A) ^	
B22-0006374	Appearance	Colourless
B22-0006374	Odour	Odourless
Total Alkalinity (T	P_WA/007)	
B22-0006374	Alkalinity (to pH 4.5@25degC)	220 mg CaCO3/L
B22-0006374	Bicarbonate	265 mg/L
Electrical Conductivity (TP_WA/009)		
B22-0006374	Electrical Conductivity	1.44 mS/cm
Dissolved Carbon dioxide (Calculated)		
B22-0006374	Dissolved Carbon Dioxide	17 mg/L
Hardness (TP_WA	A/008)	
B22-0006374	Hardness	320 mg CaCO3/L
pH (TP_WA/010)		
B22-0006374	рН	7.4
TDS (calculation) (Calculated) ^		
B22-0006374	Total Dissolved Salts	790 mg/L
Iron (UV/Vis) ^		
B22-0006374	Iron	0.03 mg/L

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Accredited for compliance v ISO/IEC 17025 - Testing

Final Report

 Job No:
 B2201-0279

 Date Issued:
 25-Jan-2022

 Report Number:
 136467

Attention: Purchase Order: B157067

Client: Western Irrigation Date Sampled:

Address: Date Received: 24-Jan-2022

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^ - NATA Accreditation does not cover the performance of this test/Component.

The sample(s) referred to in this report were analysed for the following determinant(s):

Analysis		Laboratory
General Appearance	N/A	Agro Nutritional Laboratory
Total Alkalinity	TP_WA/007	Agro Nutritional Laboratory
Electrical Conductivity	TP_WA/009	Agro Nutritional Laboratory
Dissolved Carbon dioxide	Calculated	Agro Nutritional Laboratory
Hardness	TP_WA_008	Agro Nutritional Laboratory
рН	TP_WA/010	Agro Nutritional Laboratory
TDS (calculation)	Calculated	Agro Nutritional Laboratory
Iron	UV/Vis	Agro Nutritional Laboratory

The results in this report were authorised by:

Name Title





Final Report

Purchase Order:

B2201-0279 Job No:

Date Issued: 25-Jan-2022 136467

Report Number:

B157067

Attention:

Western Irrigation Date Sampled:

24-Jan-2022 Address: Date Received:

The following sample was analysed:

Sample ID

Client:

B22-0006375 Your Reference Bore 1

> Product Water

Description Constant Rate 8 Hrs Wallcliffe House

Arrival Temp (°C)

Analysis of this sample conducted between 24-Jan-2022 and 25-Jan-2022

Analysis Results

	Determinant	Result Value
General Appearan	ce (N/A) ^	
B22-0006375	Appearance	Colourless
B22-0006375	Odour	Odourless
Total Alkalinity (T	P_WA/007)	
B22-0006375	Alkalinity (to pH 4.5@25degC)	215 mg CaCO3/L
B22-0006375	Bicarbonate	260 mg/L
Electrical Conductivity (TP_WA/009)		
B22-0006375	Electrical Conductivity	1.49 mS/cm
Dissolved Carbon dioxide (Calculated)		
B22-0006375	Dissolved Carbon Dioxide	16 mg/L
Hardness (TP_WA	N/008)	
B22-0006375	Hardness	330 mg CaCO3/L
pH (TP_WA/010)		
B22-0006375	рН	7.4
TDS (calculation) (Calculated) ^		
B22-0006375	Total Dissolved Salts	820 mg/L
Iron (UV/Vis) ^		
B22-0006375	Iron	0.01 mg/L

Note: All samples are analysed on an as received basis.

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measurementUncertainty/index.php





Final Report

 Job No:
 B2201-0279

 Date Issued:
 25-Jan-2022

Report Number: 136467

B157067

Attention: Purchase Order:

Client: Western Irrigation Date Sampled:

Address: Date Received: 24-Jan-2022

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The sample(s) referred to in this report were analysed for the following determinant(s):

Analysis	· ·	Laboratory
General Appearance	N/A	Agro Nutritional Laboratory
Total Alkalinity	TP_WA/007	Agro Nutritional Laboratory
Electrical Conductivity	TP_WA/009	Agro Nutritional Laboratory
Dissolved Carbon dioxide	Calculated	Agro Nutritional Laboratory
Hardness	TP_WA_008	Agro Nutritional Laboratory
рН	TP_WA/010	Agro Nutritional Laboratory
TDS (calculation)	Calculated	Agro Nutritional Laboratory
Iron	UV/Vis	Agro Nutritional Laboratory

The results in this report were authorised by:

Name Title