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hyd2o HYDROLOGY

Lot 4131 Smiths Beach Road, Yallingup
Urban Water Management Plan

December 2021

Client: Smiths 2014 Pty Ltd

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Executive Summary

This Urban Water Management Plan (UWMP) has been prepared by Hyd2o on behalf of Smiths 2014 Pty Ltd to support planning approval for Lot 4131, Smiths Beach Road, Yallingup (herein referred to as the site) under the Significant Development Applications pathway.

The site is located approximately 250 km south west of the Perth CBD within the City of Busselton (Figure 1). The total area of the site is approximately 40 ha, and is bounded by Smiths Beach Rd and the existing Canal Rocks Apartments and Smiths Beach Resort to the north, Smiths Beach Rd to the east, and Leeuwin-Naturaliste National Park to the west and south. The site is characterised by two landform components, a ridgeline in the western area that falls toward the ocean in a northwesterly direction, and a gently sloping eastern section that rises to the south away from the beach. Elevations within the site rise to approximately 60 mAHD along the southern boundary of the site. The site has a variable geology ranging from shallow rock to sandy soils with high infiltration rates, and good clearance to groundwater in areas of permeable soils. There are no waterways in the site.

This UWMP has considered previous water management planning studies for the site in its development including the Wood & Grieve Engineers (2011b) Proposed Development on Loc 413 Smiths Beach Report on Stormwater Management. Planning has been undertaken consistent with the City of Busselton (2004) Combined Methodologies document recommended approach for stormwater management albeit with amended criteria where applicable to suit revisions in key guideline documents since 2004.

As the project is being considered through the State Development Assessment pathway and is therefore lodging a Development Application, it is important to note the UWMP document also contains details normally addressed in a Local Water Management Strategy (LWMS) to ensure overall water management requirements for the site are addressed in the site masterplan.

This UWMP has been prepared consistent with the guidelines contained in Better Urban Water Management (Western Australian Planning Commission, 2008) and Urban Water Management Plans: Guidelines for Preparing Plans and Complying with Subdivision Conditions (Department of Water, 2008).

This UWMP covers full development within the site acknowledging that detailed engineering drawings and landscape plans will be prepared in future. Where deemed necessary, brief UWMP addendums will be prepared to ensure overall compliance of engineering design with this plan.

The development will be delivered through a Community Title Scheme, with a Community Development Statement submitted to WAPC to seek approval to facilitate the application of a Community Scheme following the determination of the development application. The Community Development Statement will detail how the site will be subdivided and developed, including staging, management and implementation.

This approach will facilitate a coordinated management approach across all aspects of the development, including stormwater infrastructure.

A summary of key elements of the UWMP for the site is detailed in the following table. Better Urban Water Management's Urban Water Management Plan checklist is included as Appendix A.

Urban Water Management Plan Summary

Water Use Sustainability	
Water Efficiency	• Promotion of 6 star building standards (water efficient fixtures and fittings). • Use of water-wise plantings in POS and landscape rehabilitation areas. • Landscaping and masterplan design to retain significant vegetation areas. • Maximise distributed infiltration of stormwater.
Water Supply	• Potable Supply: Water Corporation and rainwater tanks. • Landscape Areas: Recycled wastewater. • Construction: Water cartage.
Wastewater	• Onsite treatment and irrigation reuse.
Stormwater	
Design & Management Principles	• Water quality to be managed through biofiltration treatment of runoff generated by first 15mm of rainfall prior to infiltration. • Stormwater management for larger events to be via infiltration in distributed private road swales and storages, and POS storage within the site. • Development levels to have suitable clearance above perched groundwater and 1% AEP flood levels.
Local Scale Measures	• Soakwells and/or other measures (eg rainwater tanks) to retain and infiltrate first 15 mm rainfall on site within lots. • Minimise clearing and use of water-wise landscaping to retain stormwater and minimise runoff.
Street Scale Measures	• Biofiltration areas and swale in specified locations for water quality treatment. • Distributed storage approach to reduce flow concentration. • Minimisation of pipes drainage with maximised use of swales.
Estate Scale Measures	• Consolidated water quality treatment areas where required for treatment of excess runoff from first 15mm rainfall not able to be managed in swales. • Flood management storage areas within POS to infiltrate larger event flows in accordance with agency requirements. • Use of underground storages to manage runoff from carpark areas. • Post development system performance monitoring and annual reporting.
Groundwater & Environment	
Fill & Subsoil	• Minimal earthworks to maximise vegetation and landscape retention. • Groundwater control via subsoil drainage not required.
ASS & Contam Sites	• The site has no risk of acid sulphate soils (ASS) within 3m of natural surface. • No known contamination or possible impact from contaminated sites in the region.
Wetlands, and PECs	• No Resource Enhancement of Conservation Category Wetlands within the site. • No change in hydrological conditions for identified Priority Ecological Communities.
Implementation	
Process	• Where necessary, UWMP addendums will be prepared to ensure future stages of development and engineering design remains compliant with this UWMP as development proceeds.

1. Introduction

This Urban Water Management Plan (UWMP) has been prepared by Hyd2o on behalf of Smiths 2014 Pty Ltd to support planning approval for Lot 4131, Smiths Beach Road, Yallingup (herein referred to as the site) under the Significant Development Applications pathway.

The site is located approximately 250 km south west of the Perth CBD within the City of Busselton (Figure 1). The total area of the site is approximately 40 ha, and is bounded by Smiths Beach Rd and the existing Canal Rocks Apartments and Smiths Beach Resort to the north, Smiths Beach Rd to the east, and Leeuwin-Naturaliste National Park to the west and south.

The proposed Masterplan for the site is shown in Figure 2, and consists of low density holiday homes, a hotel including wellness centre, campground and a community hub including cafe, bakery, Cape to Cape Welcome Centre & Surf Club. The design of the Masterplan has aimed to retain as much of the sites existing natural vegetation and landform as possible.

As the project is being considered through the State Development Assessment pathway and is therefore lodging a Development Application, it is important to note the UWMP document also contains details normally addressed in a Local Water Management Strategy (LWMS) to ensure overall water management requirements for the site are addressed in the site masterplan.

This UWMP has been prepared consistent with the guidelines contained in Better Urban Water Management (Western Australian Planning Commission, 2008) and Urban Water Management Plans: Guidelines for Preparing Plans and Complying with Subdivision Conditions (Department of Water, 2008).

This UWMP covers full development within the site acknowledging that detailed engineering drawings and landscape plans will be prepared in future. Where deemed necessary, brief UWMP addendums will be prepared to ensure overall compliance of engineering design with this plan.

1.1 Planning Approvals

The majority of the subject site is zoned Tourism under the City of Busselton Local Planning Scheme No. 21 (LPS 21). A portion of the site to the west is zoned Recreation.

The site is also affected by the following considerations under LPS 21 where a range of development requirements apply

- Additional Use Site No. 36 which provides residential density requirements and defers non-residential standards to the adopted structure plan.
- Landscape Value Area which requires development is visually compatible with the existing landscape character.

With respect to stormwater management, planning detailed in this UWMP has been undertaken consistent with the City of Busselton (2004) Combined Methodologies document recommended approach for stormwater management albeit with amended criteria where applicable to suit revisions in key guideline documents since 2004.

A list of the updated stormwater management documents used to guide this UWMP is detailed in Table 1.

Table 1: Updated Stormwater Reference Documents

Previous CoB (2004) Document Reference	Updated Current Reference
Australian Rainfall and Runoff (Institution of Engineers Australia, 1987)	Australian Rainfall and Runoff: A Guide to Flood Estimation (Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), Commonwealth of Australia, 2016).
Interim Position Statement: Urban stormwater management in WA - principles and objectives (WRC, 2003)	Decision Process for Stormwater Management in WA (Department of Water and Environmental Regulation, 2017).
Stormwater Management Manual for WA (WRC, 1998)	Stormwater Management Manual for Western Australia (Department of Environment, 2004).
Draft Australian Runoff Quality Manual (Engineers Australia)	Australian Runoff Quality - A Guide to Water Sensitive Urban Design (Engineers Australia 2006).
Shire of Busselton Drainage Standards	Local Planning Policy No. 6.1 Stormwater Management (City of Busselton, 2021). Water Sensitive Urban Design Guidelines for Individual Lots, Infill Development and Subdivision, (City of Busselton, 2014).
-	Better Urban Water Management (WAPC, 2008).

1.2 Key Documents and Previous Studies

This UWMP uses the following key documents to define its principles, criteria and objectives:

- Decision Process for Stormwater Management in Western Australia (Department of Water and Environmental Regulation, 2017)
- Specification Separation Distances for Groundwater Controlled Urban Development, (Institute of Public Works Engineering Australia (IPWEA), 2016)
- Better Urban Water Management (WAPC, 2008)
- Stormwater Management Manual for WA (Department of Water, 2007)
- Sussex Location 413 Combined Methodologies (City of Busselton, 2004)

2. Design Objectives

Table 2 summarises the urban water management design objectives, based on the key reference documents, with some refinement based on the outcomes of more detailed planning and site investigations reflecting the opportunities and constraints of the site.

The basis for the design presented in this UWMP is provided by these objectives.

Table 2: Urban Water Management Design Objectives

Management Elements & Objectives
Water Conservation and Supply
• Water consumption target of 100 kL/person/yr. • Reduce consumptive use through adoption of waterwise practices. • Apply a "fit for purpose" water supply strategy, and minimise potable water use where drinking quality water is not essential. • Waterwise landscaping and irrigation to be implemented in public open space areas. • Encourage future landowners towards waterwise landscaping. • Encourage the use of rainwater harvesting systems. • Provide a wastewater system which meets agency requirements.
Stormwater Management
• Lots to retain and infiltrate first 15mm on site. • Safely convey and retain stormwater generated within the site. • Water quality to be managed through biofiltration treatment of runoff generated by first 15mm of rainfall prior to infiltration. • Stormwater management for larger events via infiltration in distributed road reserve swales and storages, and POS storage within the site. • Establish minimum habitable floor levels at 0.5m above the 1% AEP flood levels. • To reduce health risks from mosquitos ensure that immobile stormwater is fully infiltrated in a time period not exceeding 96 hours.
Groundwater Management
• Ensure adequate clearance to perched groundwater for dwellings and infiltration structures.
Environmental Management
• Undertake post development compliance monitoring to verify performance with design intent. • Where required, implement management measures to ensure protection of significant vegetation and Priority Ecological Community hydrology.

3. Site Characteristics

3.1 Site Conditions

A site conditions plan is included as Figure 3. The total area of the site is approximately 40 ha, and is bounded by Smiths Beach Rd and the existing Canal Rocks Apartments and Smiths Beach Resort to the north, Smiths Beach Rd to the east, and Leeuwin-Naturaliste National Park to the west and south.

The site is largely vegetated, with scattered tracks and firebreaks, and has an existing artificially created waterhole along its northern boundary adjacent to the Canal Rocks Apartments. Regular rock outcrops are observed at both the eastern and western extents of the site.

The site is characterised by two landform components, a ridgeline in the western area that falls toward the ocean in a northwesterly direction, and a gently sloping eastern section that rises to the south away from the beach. Elevations within the site rise to approximately 60 mAHD along the southern boundary of the site.

3.2 Geotechnical

According to the Geological Survey of WA's 1:50 000 Environmental Geology Map Series Yallingup Sheet 1930 IV and Part Sheet 1830 I (Leonard 1991), the site is characterised as Sand (S7) pale and olive-yellow medium to coarse-grained sub-angular quartz moderately sorted in the east, and medium-grained mesocratic Gneiss (GN) in the west.

A geotechnical investigation for the site was undertaken by Golder Associates in December 2020 and March 2021 (Golder Associates, 2021). The geotechnical report is included as Appendix B. This investigation included drilling of 32 hand augered boreholes (with depths ranging from 0.2 to 3.0 m) and 8 diamond core boreholes (with depths ranging from 6.0 to 16.5m depth). A Perth Sand Penetrometer (PSP) test was also undertaken at each hand auger location and permeability testing undertaken at eight locations. Test locations are shown on Figure 4 and Appendix B.

The ground conditions encountered and inferred from the investigation were considered to be generally consistent with the published geology for the area although Gneiss also occurred along the eastern boundary of the site. The typical soil profile as described by Golder Associates (2021) was delineated into seven areas as follows:

Area 1 - Shallow Rock

- Silty SAND (SM), fine to medium grained, generally about 15% low plasticity fines, generally loose becoming medium dense to dense with depth, brown becoming pale brown orange and pale brown grey, extending to depths of between about 0 m (rock outcrops) and 1.9 m, overlying.

- Inferred GNEISS/GRANITE cobbles, boulders or bedrock, causing refusal at depths between 0.2 m and 1.9 m.

Area 2 - Shallow Clay

• Silty SAND (SM) or Sandy GRAVEL (GP), fine to medium grained sand, fine to coarse lateritised gneiss gravel, generally about 15% low plasticity fines, medium dense to dense with depth, brown, extending to depths of between about 0.4 m and 0.5 m, overlying.

• Sandy CLAY(Cl/CH), medium to high plasticity, very stiff to hard, brown, orange and red, extending to the maximum depth investigated of 1.0 m.

Area 3- Sand

• SAND (SP), fine to medium grained, with silt in parts, loose becoming medium dense to dense with depth, orange brown to red brown, extending to the maximum depth investigated of 3.0 m.

Area 4 - Sand over Clayey Sand

• SAND (SP), fine to medium grained, with silt, loose becoming medium dense to dense with depth, orange brown to grey brown, extending to depths of between about 1.5 m and 2.1 m, overlying.

• Clayey SAND (SC), fine to coarse grained, about 15% to 25% low plasticity fines, dense to very dense, orange brown, orange yellow and yellow grey, containing a sand layer between 2.5 m and 3.0 m at HA31, extending to the maximum depth investigated of 3.0 m.

Area 5 - Silty Sand

• Silty SAND (SP), fine to medium grained, about 10% to 20% low plasticity fines, loose becoming medium dense to dense with depth, red brown to brown, extending to the maximum depth investigated of 2.0 m.

Area 6- Silty Sand over Clay

• SAND/Silty SAND (SP/SM), fine to medium grained, about 10% to 15% low plasticity fines, loose becoming medium dense to dense with depth, brown, extending to depths of between about 0.8 m and 1.4 m, overlying.

• Clayey SAND/Sandy CLAY(SC/Cl/CH), medium to high plasticity, very stiff to hard, brown, orange brown and grey, extremely weathered rock, extending to the maximum depth investigated of 2.6 m.

Area 7 - Shallow Rock

• SAND/Silty SAND/Silty Gravelly SAND (SM), fine to medium grained, generally about 15% to 20% low plasticity fines, generally loose becoming medium dense to dense with depth, brown and red brown, fine to coarse gneiss gravel and cobbles, extending to depths of between about 0 m (rock outcrops) and 1.1 m, overlying.

• Inferred GNEISS/GRANITE cobbles, boulders or bedrock, causing refusal at depths between 0.3 m and 1.3 m.

During Golder Associates field investigation in December, groundwater was not encountered in any of the hand auger boreholes, although the groundwater level was considered to be close to the base of the hole at hand auger HA31. Perched water was however considered to potentially occur during wet periods. Golder Associates (2021) found stormwater was likely to readily infiltrate into the surficial higher permeability materials (sandy soil and highly fractured rock) and then more slowly into the underlying

lower permeability materials (clayey soil and relatively unfractured rock). Depending upon the amount of rainfall, this may result in some perching on the lower permeability soil, at relatively shallow depth over parts of the site.

A geophysical subsurface investigation (GBGMaps, 2020) was also carried out along a 200 metre section of the coastal foreshore and dune system adjacent to the northern boundary of the site. The investigation was carried out to assist in determining the elevation of underlying rock for coastal modelling. A copy of the report in included as Appendix C.

3.2.1 Permeability Testing

Golder Associates (2021) undertook eight in situ permeability tests within the site. Test locations are shown in Figure 4. The tests were performed using the Talsma Hallam method with testing performed at approximately 0.5m below natural surface.

Results of the testing as analysed by Golder Associates (2021) are provided in Table 3. The results of the investigation indicate that across Area 3 the measured permeability varied between 17 m/day and 64 m/day. Across the remainder of site, the near surface sand/silty sand had a measured permeability of 3 m/day to 7 m/day

Hyd2o also conducted permeability testing at the site in November 2020 (Table 3). Four permeability tests were undertaken based on a constant head test using a borehole permeameter. Results from the permeability tests are presented in Appendix D, with values ranging from approximately 1 to 64 m/day, indicating similar variability to that in Golder Associates testing.

Based on the above results, Golder Associates (2021) reported Area 3 sand as free draining and suitable for on-site disposal via soakwells or similar. For drainage design a permeability of 5 m/day to 10 m/day was recommended for the sand in this area.

Table 3: Permeability Test Results

Test Site	Tested By	Tested Material	Measured Permeability K_s m/day
HS1	Hyd2o	Silty Sand	3
HS2	Hyd2o	Sand	64
HS3	Hyd2o	Silty Sand	4
HS4	Hyd2o	Silty Sand	1
HA2	Golder	Silty Sand	3
HA4	Golder	Sand/Silty Sand	7
HA8	Golder	Sand	18
HA9	Golder	Sand	17
HA16	Golder	Sand	28
HA18	Golder	Sand	23
HA25	Golder	Rock - Gneiss	unable to test
HA28	Golder	Sandy Gravel over Sandy Clay	9

Across the remainder of site, Golder Associates (2021) recommended a drainage design permeability of 1 m/day for sand/silty sand areas, and underlying rock and clayey soil was recommended to be considered impermeable. Suitably designed on-site drainage was still considered appropriate in these areas depending upon the depth of sand/silty sand overlying rock or clayey soil.

3.2.2 Acid Sulfate Soils

According to Planning Bulletin 64 Acid Sulphate Soils (WAPC, 2009) the site is classified as no risk of actual or potential acid sulphate soils (ASS) within 3m of natural surface.

3.3 Environment

According to Department of Biodiversity Conservation and Attractions (DBCA), Geomorphic Wetlands Leeuwin Naturaliste Ridge and Donnybrook to Nannup dataset (DBCA-043) the site does not include any categorised wetlands or their buffers (Figure 5). The nearest mapped site is a Palusplain wetland approximately 1 km east of the site adjacent to Gunyulgup Brook.

According to the Department of Water and Environmental Regulation (DWER) Environmentally Sensitive Areas (ESA) Database (2020), the site borders an ESA along its western, northern, and southern boundaries.

Strategen (2020) confirmed the two Priority Ecological Communities (PEC) within the site:

- Low shrublands on acidic grey-brown sands of the Gracetown soil-landscape
- Melaleuca lanceolata forests, Leeuwin Naturaliste Ridge

Mapping of these areas is shown in Figure 5. Both areas are located outside of the proposed development area of the site. Given there is no proposed impact to the PEC by the development, Strategen (2020) considered the extent of regional survey adequate to provide context to the minimal impact on the community.

3.4 Contaminated Sites

According to the DWER Contaminated Sites Database (2021), the site and surrounding areas contain no known contamination.

3.5 Surface Water

Gunyulgup Brook is a seasonally flowing watercourse located approximately 200m northeast of the site, which flows in a north westerly direction to Smiths Beach. The site itself contains no designated watercourses or waterways with rainfall from most events infiltrated on site. During major events any runoff generated from the site would occur as diffuse overland flow.

An old waterhole is present within the proposed development area, in the northern part of the site. The waterhole is approximately 10m in diameter and approximately 1m deep. It is understood the depression in which the waterhole is located is man-made, having been excavated in around 1962 to provide water for livestock (ATA Environmental, 2007). The waterhole is set in granitic bedrock and is likely it receives water by seepage of rainwater along the interface between soil and bedrock. Based on field observations no external drainage to the site flows into this area.

Figure 6 shows the extent of the main surface water catchment relevant to the site. The total contributing catchment area is approximately 55.7 ha of which the site comprises 28.2 ha and 27.5 ha is located upstream.

With respect to the existing Canal Rocks Apartments and Smiths Beach Resort along the northern boundary of the site, both these sites are considered responsible for management of their own stormwater which Hyd2o understand is infiltrated on site consistent with City of Busselton stormwater management guidelines (City of Busselton, 2021). A review of historical aerial photography and site field observations support this position.

Estimates of the predevelopment (existing) flow for the site were undertaken based on application of the Australian Rainfall & Runoff Regional Flood Frequency Estimation (RFFE) method (Ball et al, 2016) and XP-Storm modelling. Modelling results using the two methods are summarised in Table 4, with various technique outputs presented in Appendix E.

Modelling results were also compared to previous Australian Rainfall & Runoff 1987 techniques including the Rational and Flood Index Methods. These estimates are also detailed in Table 4 and Appendix E. It should be noted that in the application of the XP-Storm model, runoff rates and Mannings coefficients for the site were estimated and applied based on the finding of the geotechnical investigation and consider the various soil regions (eg gneiss, clayey sand, and sand) as detailed in Section 3.2.

The methods detailed in Table 4 provide broadly similar estimates of predevelopment flows for the site for various annual exceedance probability (AEP) events providing confidence in the estimates. All this flow occurs as diffuse overland flow toward the coast. Modelling results and parameters via the XP-Storm model are used to inform post development modelling in Section 5.

The XP-Storm model was then modified to estimate flows entering the site at its southern boundary via the catchment upstream of the site with results detailed in Table 4 and Appendix E. This flow also occurs as diffuse flow with no clear evidence of a watercourse entering the site at its southern boundary.

Note that due to the diffuse nature of existing site flows and the site containing no identifiable watercourses, no predevelopment surface water monitoring was able to be undertaken.

Table 4: Pre Development Flow Estimates

Event	20% AEP Event (m^3/s)	1% AEP Event (m^3/s)
Whole Catchment : 55.7 ha		
Method A : ARR 2016 Regional Flood Frequency Estimation	0.08	0.43
Method 8 XP –Storm Modelling	**0.21**	**0.45**
Method C : ARR 1987 Rational Method Flood Index Method	 0.26 0.10	 0.65 0.34
Upstream Catchment : 27.5 ha		
Method 8 XP –Storm Modelling	**0.05**	**0.11**

3.6 Groundwater

3.6.1 Groundwater Levels

The site is located west of the Dunsborough Fault and within the area known as the Leeuwin Complex which is classified as a fractured rock aquifer, where groundwater is restricted to fractures in the crystalline basement rocks (bedrock) and to thin weathered zone sand overlying surficial deposits.

Groundwater levels at the site are also controlled by its proximity to the coast and are therefore located generally well below natural surface in permeable areas.

Figure 7 summarises groundwater data for the site.

There are no long term monitoring bores within the site or its proximity and no nearby regional DWER bores or mapping of groundwater levels for the area. ATA Environmental (2007) reported 35 holes previously drilled over the site for geotechnical mapping and groundwater being encountered at only two locations. This was reported as occurring in sands overlying bedrock at depths greater than 7m below natural surface.

Golder Associates (2021) similarly reported no groundwater encountered during their December 2020 field investigations in any of their 32 hand augered boreholes, although groundwater was considered to be close to the base of the hole at hand auger HA31 at a depth of 3m (inferred as ~5 mAHD based on topographic data). Given groundwater was not encountered in any of the 8 drilled boreholes at depths ranging from 6 to 16.5m below natural surface, including BA4 to 16.5m in proximity to HA31, the groundwater at HA3 is considered to be perched above less permeable strata.

Golder Associates (2010) also reports during previous Douglas Partners investigations in March 2001, groundwater was not encountered in any of their test pits.

A groundwater level was however recorded by Douglas Partners in the excavated waterhole at about 2.5 m below the natural surface level (inferred as ~3.5 mAHD based on topographic data). MP Rogers & Associates in May 2000 also measured a groundwater level of 4.1 m AHD near the waterhole, and noted this to be similar to the waterhole.

The location of the excavated waterhole is shown in Figure 7. The waterhole is approximately 10m in diameter and ATA Environmental (2007) report the waterhole to have been man-made in around 1962 to provide water for livestock, with water being received via the seepage of perched water.

A Hyd2o field investigation on 14 March 2021 provided an estimated level of approximately 3 mAHD at the waterhole based on correlating the observed water level to other known surveyed levels in proximity. This lower level is consistent with the previous Douglas Partners and MP Rogers & Associates recordings, and likely representative of the drying climate of the last 20 years in the area. Based on the extent of reeds and vegetation relative to the observed water level Hyd2o estimate the perched levels in the waterhole would vary around 1 m seasonally.

Based on their investigations, Golders Associates (2021) reported that stormwater will infiltrate into the surficial higher permeability materials (sandy soil and highly fractured rock) and more slowly into the underlying lower permeability materials (clayey soil and

relatively unfractured rock). Depending upon the amount of rainfall, this may result in perching on the lower permeability soil, at relatively shallow depth over parts of the site.

With respect to potential perching, Golder Associates (2021) contains inferred subsurface sections across the site, which show the boundary between the higher and lower permeability soils and the potential flow path for perched water.

These sections indicate that any perched water will be towards the centre of the site from the east, west and south. In the centre of the site any perched water will then move into the deep sand. In the northern parts of the site where lower permeability materials occur at shallower depth, the perched water will move towards the ocean through the area around the waterhole.

3.6.2 Groundwater Quality

Typically predevelopment monitoring is only required by DWER where regional groundwater is within 4 m of natural surface. Notwithstanding, sampling was taken by Hyd2o on 14 March 2021 at the waterhole as a representative expression of the perched water quality at the site.

The sample was sent to a NATA approved laboratory and analysed for physical parameters (electrical conductivity (EC) and pH), nutrients, and heavy metals. The following suite of analyses was performed:

- Total nitrogen (TN), as well as total Kjedahl nitrogen (TKN), ammonia (NH3), nitrate (NO3) and nitrite(NO2);
- Total phosphorus (TP), as well as filterable reactive phosphorus (FRP); and
- Heavy metals including arsenic, cadmium, chromium, copper, nickel, lead, mercury and zinc.

Laboratory reports are contained in Appendix F, and summarised in Table 5 in relation to various guideline values of the Australian and New Zealand Environment and Conservation Council's National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000).

Summarising the results:

- pH is slightly basic (alkaline) but falls within the ANZECC guideline range of 6.5 – 8.0 for wetand ecosystems in south western Australia.
- The EC of 3.6 ms/cm was above the ANZECC guideline range of 0.30 – 1.50. This EC equates to a salinity of approximately 1800 mg/L.
- TN of 6.6 mg/L was relatively high exceeding the ANZECC guideline value of 0.75 mg/L.
- TP of 0.08 was above the ANZECC guideline value of 0.06 mg/L.
- In relation to metals, Cadmium, Chromium, Lead, Mercury, and Nickel concentrations were all below the level of detection. Arsenic, Copper, and Zinc were below the recreational waters guideline values, and only Copper and Zinc were above the 95% target for 95% protection of freshwater species (Zinc within 90% protection level).

With respect to nutrient concentrations, TN and TP concentrations are typical of the expected water quality range in previously rural areas.

Table 5: Perched Groundwater Quality

Parameter	Waterhole Sample 14/2/2021	ANZECC (2000) Guideline
pH	8.1	7.0 – 8.5[1]
EC (mS/cm)	3.6	0.13 – 1.50[1]
Total Nitrogen (mg/L)	6.6	0.75[1]
TKN (mg/L)	6.6	-
Ammonia (mg/L)	0.093	0.90[2]
Nitrate (mg/L)	<0.005	0.70[2]
Nitrite (mg/L)	<0.005	0.10[1]
Total Phosphorus (mg/L)	0.08	0.06[1]
Phosphate as P / FRP (mg/L)	<0.005	0.03[1]
Arsenic (mg/L)	0.002	0.024[2] 0.05[3]
Cadmium (mg/L)	<0.0001	0.0002[2] 0.005[3]
Chromium (mg/L)	<0.001	0.001[2] 0.05[3]
Copper (mg/L)	0.017	0.0014[2] 1.0[3]
Lead (mg/L)	<0.001	0.034[2] 0.05[3]
Mercury (mg/L)	<0.00005	0.0006[2] 0.001[3]
Nickel (mg/L)	<0.001	0.011[2] 0.1[3]
Zinc (mg/L)	0.011	0.008[2] 5[3]

1. Default trigger values for wetland ecosystems in south-west Australia
2. Trigger values of the 95% of freshwater species
3. Water quality guidelines for recreational purposes

4. Water Use Sustainability Initiatives

4.1 Water Conservation Strategy

The reduction of scheme water use within the site will be consistent with Water Corporation's Waterwise land development criteria. Conservation measures will include:

- Promotion of use of waterwise practices including water efficient fixtures and fittings.
- Encourage waterwise landscaping at lot scale.
- Consumption target for water of 100 kL/person/year.
- Waterwise POS design and native plantings and irrigation systems.
- Maximising distributed infiltration and retention of stormwater on site.
- Retention of existing natural vegetation and landforms.
- Use of treated wastewater for irrigation at lot scale, and also throughout restricted public open spaces (hotel effluent).

4.2 Fit for Purpose Water Strategy

4.2.1 Domestic Water Supply

Water supply for the site is proposed by an extension of the existing Water Corporation water supply scheme. This decision was based on a detailed assessment of various water supply options for the site conducted by Stantec.

DA Appendix O contains a copy of the Engineering Report (Stantec, 2021) providing further details of the proposed water supply infrastructure.

The use of rainwater tanks to supplement potable water will be encouraged by the developer for incorporation in the design of various elements within the site. Individual builders will manage the incorporation of rainwater tanks for those who wish to use this method to supplement scheme water supply and reduce runoff.

4.2.2 Landscape Areas

DWER's Water Register indicates the site is located in the Busselton–Capel Groundwater Area and Cape to Cape North Sub Area. The aquifer in the area is the Combined Leeuwin Surficial/ Fractured Rock aquifer, which the register reports as having limited information regarding available allocation.

Water Register extracts are contained as Appendix H. It is noted Canal Rocks Apartments and Smiths Beach Resort have an allocation of 27,700 kl/yr from the aquifer, and obtain this water from a bore located on Hemsley Rd, Yallingup (Appendix H).

Based on investigations by Stantec (2021), a number of landscape areas are proposed to be irrigated via the use of recycled wastewater.

Areas are identified in DA Appendix O.

4.3 Wastewater Management

Based on a detailed assessment of alternative wastewater solutions, it was determined there is suitable land area within the site to cater for on-site wastewater treatment and disposal. The most effective on-site solution from a capital, ongoing maintenance and management perspective was found to be low risk secondary treatment systems.

It is therefore proposed that the site will be serviced via onsite wastewater treatment and land application systems, undertaken in accordance with the Government Sewerage Policy (Government of Western Australia, 2019). The site wastewater loading has been assessed based on the uses throughout the development in a conservative nature based on the level of detail provided at this stage of the development.

Further details of the proposed system are contained in DA Appendix O.

A Site and Soil Evaluation for Onsite Wastewater Management for the site is currently being prepared as a separate process to this UWMP in accordance with Department of Health guidelines and the Australian and New Zealand standard: Onsite Domestic Wastewater Management – AS/NZS 1547:2012. This evaluation will confirm site and soil conditions are suitable for installation of an on-site wastewater system, the size of the land application areas, and any physical features requiring setbacks to prevent possible contamination

ATA Environmental (2007) reported Phosphorus Retention Ability (PRI) testing of soil being conducted at eight locations within the site during the drilling program of 2001. The four soil samples taken from the Tamala Limestone soils recorded PRI values of 9, 10, 21, and 52. These values indicate that this soil unit has a moderate ability to retain phosphorus.

The duplex soils reported higher PRI values ranging from 30 for the sandier soils of this unit to a maximum of 180 for clayey soils. The four soil samples returned PRI values of 30, 115, 131 and 180. The PRI value of 180 represents very high phosphorus retention ability.

5. Stormwater Management

Stormwater management has been designed consistent with DWER and City of Busselton water sensitive design practices, and has been based on consideration of the sites environmental setting, and the constraints and opportunities detailed in Section 3. The key elements of the stormwater management strategy are shown in Figure 8 and summarised as follows:

- Retention/management of the first 15 mm of rainfall on holiday home lots. This is assumed to be conducted primarily through the use of soakwells in permeable deep sandy soil areas, and conveyance to road scale retention areas in any areas of rock and/or less permeable materials. Individual lots may also use rainwater tanks to achieve this retention and reduce runoff.
- The provision of swales through the site to manage, convey and infiltrate stormwater runoff from roads. Swales are proposed to be established as biofiltration areas and retain and infiltrate the first 15mm of runoff in situ within the road reserve areas, and convey larger events (20% and 1% AEP) to additional storage areas for infiltration. Note that in areas of less permeable underlying soils, swales would still be provided for conveyance purposes. In areas where slopes mean swales are not feasible a pit/pipe network is to be installed to convey events to storage areas.
- Where swales are not able to retain and treat the first 15mm event, stormwater is to be conveyed to bioretention areas which are to be placed where considered most ideal along the drainage route. Spill over of these areas in to subsurface infiltration cells to sized retain the 20% AEP will occur where considered appropriate.
- The use of underground storage units in the northern carpark area to manage both carpark runoff and any stormwater runoff in excess of swale capacity in the 20% and 1% AEP event. Opportunities for temporary flooding to an acceptable level in this area will also be considered at UWMP stage to optimise the overall storage configuration.
- Management of the upstream predevelopment catchment flow via cut-off swales in the upgraded southern road. Swales are to be established as bioretention areas to treat the first 15mm with flow from major events directed to underground storage sized to retain up to the 1% AEP event.
- With respect to the Community Hub, it is proposed to manage all its own stormwater on site via infiltration using underground storage. This can readily be achieved outside of the foreshore reserve.
- Given the hotel complex is located predominately in an area of shallow rock, a stormwater management principle of maintaining post development flow from this area to the coastal foreshore as diffuse overland flow is proposed. It is important to note that given all other areas of the site are to be fully infiltrated, the flow rates from this area to the coastal foreshore will therefore be less than the predevelopment condition during major events.
- For events greater that the 1% AEP designated flow paths and easements will allow safe conveyance of stormwater to the foreshore.

The above approach has been adopted for the site to minimise the stormwater management impacts on the natural landscape and landform, and reflects best management practice. Figure 8 details the above approach and the key catchments and land use breakdown used for modelling. Note that all swales are proposed to be located on the downgradient side of roads.

Run-off coefficients for various land uses within the site have been applied based on application of Hyd2o's CURRV runoff rate calculator, with consideration of recommended natural catchment runoff rates detailed in the ARR 2016 Data Hub and ARR 1987 Rainfall Loss Models for South West WA. Runoff rates used for modelling are detailed in Appendix I.

Note that the modelling in this report is based on ultimate development requirements. Based on staging, temporary storages may be required. These will be detailed in engineering drawing at the appropriate time if required.

5.1 Stormwater Modelling

Stormwater modelling for the site was undertaken by Hyd2o using XP-Storm and PONDS to determine flood storage requirements and provide an assessment of areas required within the site to manage stormwater post development. PONDS is a program specifically designed for modelling groundwater/surface water interactions for the design of stormwater infiltration areas, based on the finite difference computer program MODFLOW, development by the U.S. Geological Survey.

The design storms modelled by XP-Storm and PONDS were calculated with reference to the methodology in Australian Rainfall and Runoff (AR&R) and the Bureau of Meteorology Computerised Design IFD Rainfall System (CDIRS). The rainfall temporal pattern was assumed to be spatially uniform across the catchment. Storm durations modelled ranged from 10 minutes to 72 hours.

Permeability rates were adopted for different site areas based on the various test results detailed in Section 3.2.1, ranging from 5 m/day adopted for design in sand areas to 1 m/day in areas of silty sand. Areas of shallow rock were considered impermeable for modelling purposes. These rates are considered conservative and are inclusive of any long term clogging effects.

Modelling results are shown in Figure 8 and Tables 6 to 8, with more detailed modelling outputs contained in Appendix J. Overall stormwater management is able to be readily accommodated within the available spaces of the development without using retained vegetation areas.

Given the storage sizes and functional permeability rates, modelling indicates all stormwater on site will be readily infiltrated within the 96 hours to reduce health risks from mosquitos and other nuisance insects.

Consistent with DWER's Stormwater Management Manual (DoW, 2007) minimum habitable floor levels will be set in accordance with the following:

- 0.5 m above the 1% AEP event flood storage area levels and
- 0.3 m above the 1% AEP event flood level in local drainage network.

Sample cross sections for proposed swales are provided in Appendix K to inform design.

Table 6: Post Development Stormwater Management – Holiday Home & Camping Area

Catchment Land Use Summary	
Holiday Home & Camping Area (ha)	7.97
Holiday Home & Camping Area – Shallow Rock & Clay (ha)	3.25
Private Roads (ha)	3.01
Carpark (ha)	0.88
Retained Vegetation (ha)	7.23
Retained Vegetation – Shallow Rock & Clay (ha)	2.53
Total Area (ha)	24.88
Equivalent Impervious Area (15mm event) – Roads & Carpark Only (ha)	2.33
Equivalent Impervious Area (1% AEP) (ha)	9.11
15 mm Event Water Quality Management	
Roadside Swales – Bioretention Section/Portion (1m base, 0.35m deep)	
Side Slopes (v:h)	1:3 & 1:4
K Adopted for Design (m/day)	2.5
Approximate Total Length of Swales (m)	660
TWL – Infiltration Area (m^2)	2280
Storage per Linear Metre (m^3/m) @ 0.35m depth	0.78
Total Swale Storage (m^3) @ 0.35m depth	515
Other Bioretention Areas (0.3m deep)	
Side Slopes (v:h)	1:3
K Adopted for Design (m/day)	2.5 m/day
TWL – Infiltration Area (m^2)	833
Total Storage (m^3)	190
20% AEP Flood Management (in addition to bioretention areas along on North-South road)	
Subsurface Infiltration Cells (Assumed 1m Deep Cells)	
Side Slopes (v:h)	1:0
K Adopted for Design (m/day)	5
TWL – Infiltration Area (m^2)	50
Total Storage (m^3)	50
1% AEP Flood Management (in addition to roadside swales, bioretention areas and subsurface infiltration cells)	
Underground Storage (Assumed 1m Deep Cells)	
Side Slopes (v:h)	1:0
K Adopted for Design(m/day)	5 m/day
TWL Area (m^2)	2750
Volume (m^3)	2750
Critical Duration (hr)	3

Table 7: Post Development Stormwater Management – Hotel

Catchment Land Use Summary	
Hotel : Impervious (ha)	0.83
Hotel : Landscape/Vegetation (ha)	2.03
Total Area (ha)	2.86
Equiv Imp Area (1% AEP) (ha)	1.84
1% AEP Flood Management Diffuse Overland Flow (less than predevelopment)	
Peak Discharge (m^3/s)	0.28
Critical Duration (hr)	1

Table 8: Post Development Stormwater Management – Community Hub

Catchment Land Use Summary	
Community Hub: Impervious (ha)	0.51
Community Hub: Landscape/Vegetation (ha)	0.15
Total Area (ha)	0.66
Equiv Imp Area (1% AEP) (ha)	0.36
1% AEP Flood Management Underground Storage (1m depth cells)	
K Adopted for Design(m/day)	1
TWL Area (m^2)	280
Volume (m^3)	280
Critical Duration (hr)	3

Table 9: Post Development Stormwater Management – Upstream Catchment

Catchment Land Use Summary	
Upstream Road (ha)	0.97
Upstream Vegetation (ha)	23.45
Total Area (ha)	24.42
Equiv Imp Area (1% AEP) (ha)	4.30
15 mm Event Water Quality Management	
Roadside Swales – Bioretention Section (1m base, 0.35m deep)	
Side Slopes (v:h)	1:3 & 1:4
K Adopted for Design (m/day)	2.5
Approximate Total Length of Swales (m)	325
TWL – Infiltration Area (m^2)	1121
Storage per Linear Metre (m^3/m)	0.78
Swale Retention Storage (m^3)	253
1% AEP Flood Management	
Underground Storage (Assumed 1m Deep Cells)	
Side Slopes (v:h)	1:0
K Adopted for Design(m/day)	5
TWL Area (m^2)	760
Volume (m^3)	760
Critical Duration (hr)	3

6. Groundwater Management

The earthworks concept plan for the site is detailed in DA Appendix O.

Due to the clearance to groundwater, relatively high infiltration over the majority of the site, and a desire to maintain as much of the existing vegetation on site as possible, no imported fill or subsoil drainage to control groundwater will be required.

This outcome is assisted by the stormwater management strategy for the site which has considered the variable surface geology of the site in developing its approach.

7. Management of Subdivision Works

7.1 Dewatering and Acid Sulphate Soil

According to Planning Bulletin 64 Acid Sulphate Soils (WAPC, 2009) the site is classified as having no risk of actual or potential acid sulphate soils (ASS) occurring within 3m of natural surface.

No dewatering is likely to be required for services installation.

7.2 Dust, Sediment and Erosion Control

The construction contractor will be responsible for preparing and implementing appropriate best management practices for the construction of the subdivision. Construction management will be undertaken consistent with the Local Government Guidelines for Subdivision Development (Institute of Public Works Engineering Australia 2011).

Water for construction purposes will be the responsibility of the site contractor, and will likely be undertaken via water cartage. Should a groundwater bore be proposed for this purpose, licencing and associated construction will similarly be the responsibility of the site contractor.

Earthworks at the site will be carried out in accordance with AS 3798-2007 Earthworks for Residential and Commercial Developments. Temporary measures such as sedimentation basins and/or fences to locally control sediment and erosion during the construction phases of the project may require implementation.

8. Monitoring Program

8.1 Pre Development Monitoring

As outlined in Department of Water (2012), groundwater monitoring should be undertaken where regional groundwater has a close interaction with the surface. No further predevelopment monitoring is necessary for the site in relation to this requirement.

Notwithstanding the above, additional site perched water modelling and geotechnical investigations for winter permeability are currently being developed to further support and refine the design as a part of the detailed design process.

8.2 Post Development Monitoring

Given the clearance to groundwater at the site, no post development groundwater monitoring is proposed.

Similarly, as all surface flows are proposed to be retained and infiltrated via distributed biofiltration areas during frequently occurring storm events, monitoring of surface water quality is also not considered relevant.

On this basis, an alternative monitoring program of stormwater system performance is recommended for the site against a standardised proforma which would assess the performance of the system against its design. The program will consider processes such as vegetation health, scour, erosion, deposition, and water levels and retention periods within the bioretention area.

This monitoring is designed to operate for the first two years following construction and be undertaken a minimum of four times during winter.

The program may need to be modified as data is collected, to increase or decrease the monitoring effort in a particular area, or to alter the scope of the program itself. Any modification to the program would be identified through review of the collected data and would require the agreement of all parties – DWER, City of Busselton, and developer.

A brief letter report will be prepared on completion of the monitoring program.

9. Implementation Plan

9.1 Roles, Responsibilities, and Funding for Implementation

Roles and responsibilities for implementation are detailed in Table 10 below.

The development will be delivered through a Community Title Scheme, with a Community Development Statement submitted to WAPC to seek approval to facilitate the application of a Community Scheme following the determination of the development application. The Community Development Statement will detail how the site will be subdivided and developed, including staging, management and implementation.

This approach will facilitate a coordinated management approach across all aspects of the development, including stormwater infrastructure.

Long term maintenance of stormwater infrastructure will be the responsibility of the Community Scheme. Maintenance will include but not be limited to street sweeping to reduce particulate build up, removal of sediment and rubbish in manholes and storage area, removal of debris to prevent stormwater blockages, checks on drainage function, and replacement of water quality treatment vegetation.

Table 10: Actions and Responsibilities

Action	Responsibility			
	Lot Owner/ Community Scheme	Developer	Department of Water and Environmental Regulation	City of Busselton
Preparation of UWMP (this document)		✓		
Review and Assessment of UWMP			✓	✓
Implementation of water supply, water efficiency, and wastewater measures		✓		
Construction of stormwater system and WSUD measures		✓		
Stormwater system maintenance post construction until handover		✓		
Long-term stormwater system operation and maintenance	✓			
Wastewater system operation & maintenance	✓			

10. References

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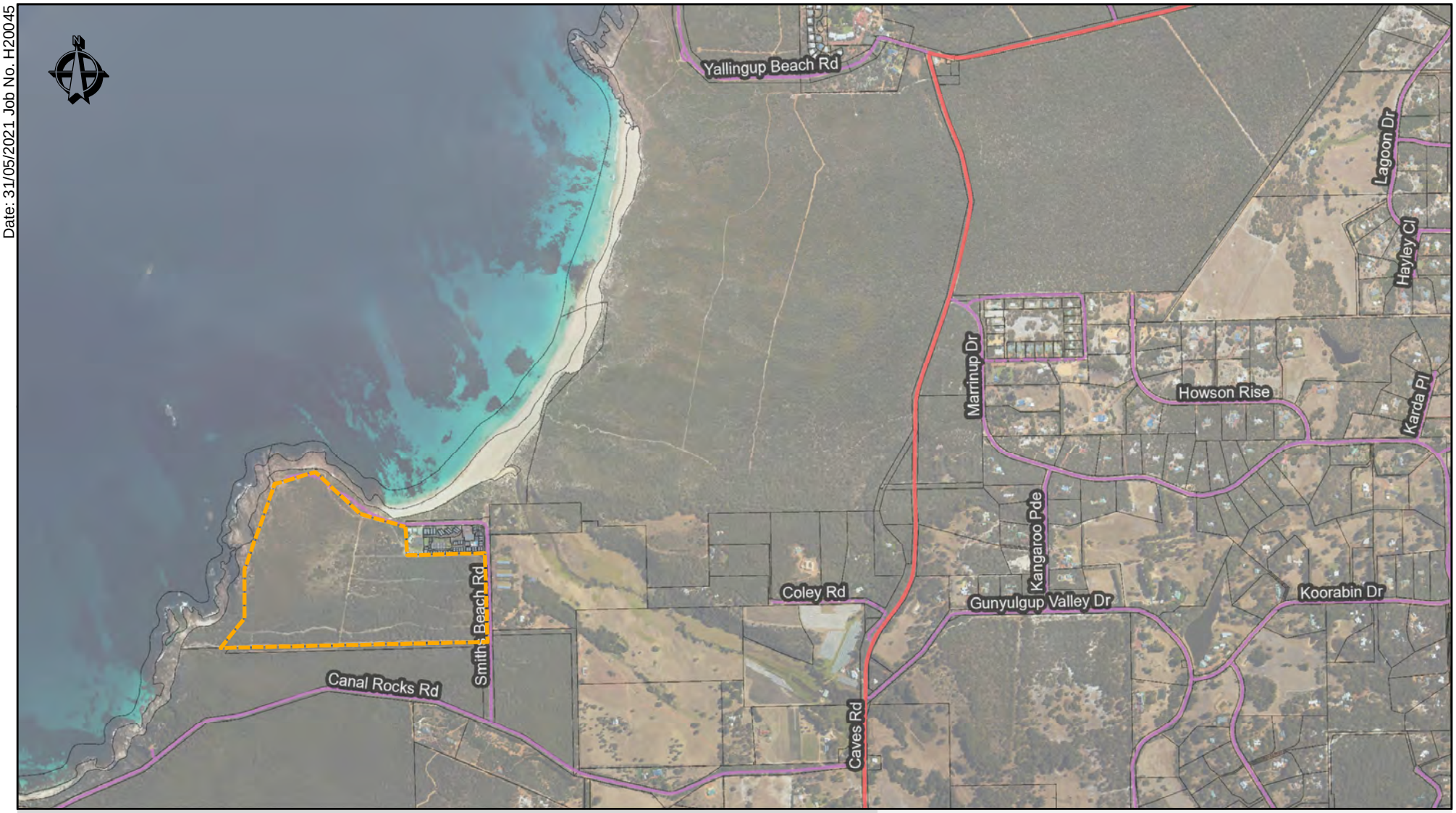
FIGURES

Date: 31/05/2021 Job No. H20045



Site

0 250 500 750 1,000 Meters

hyd2o

Smiths Beach Urban Water Management Plan

Location Plan

Figure 1

Date : 8/12/2021 Job No: H20045

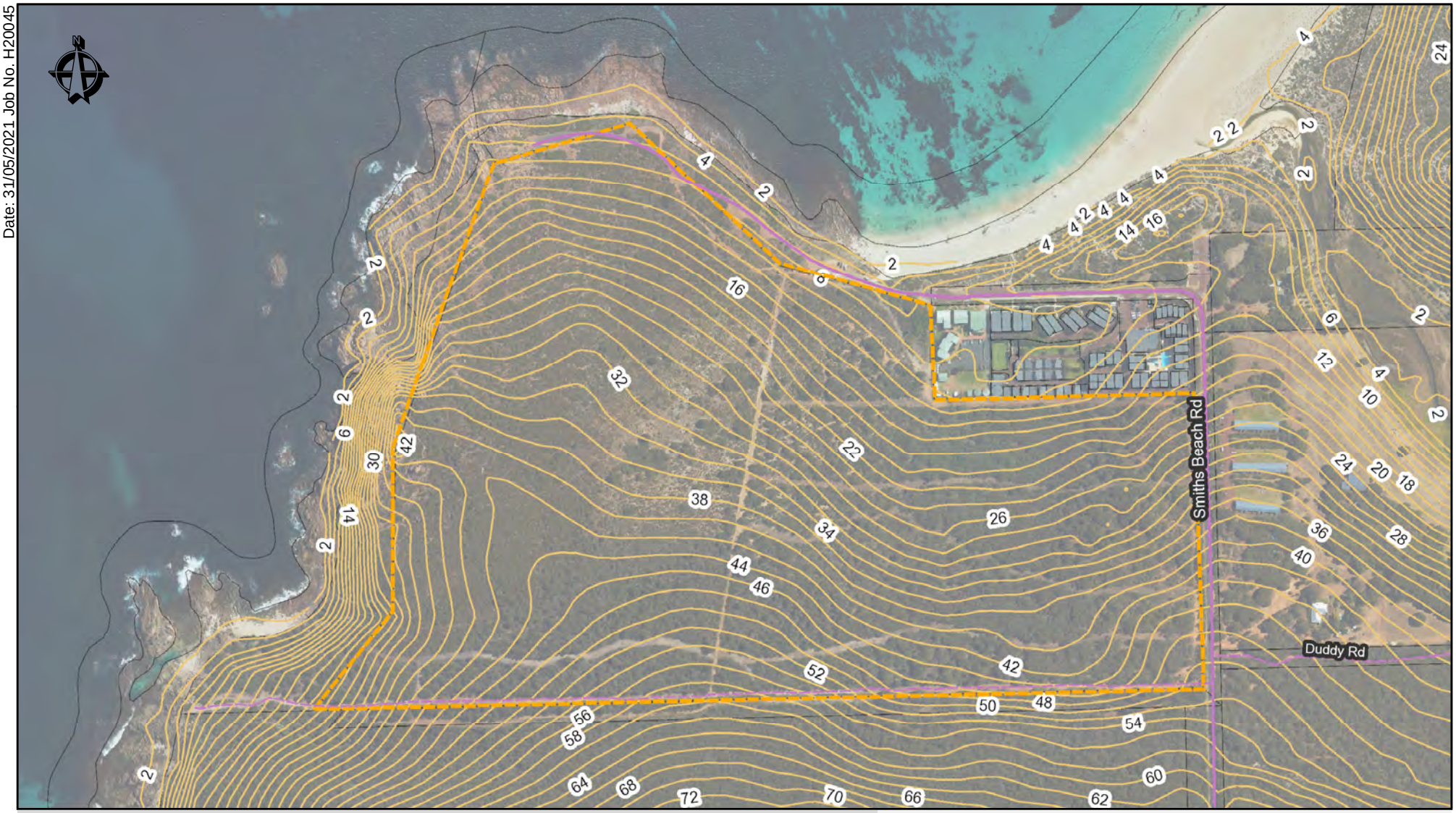
hyd2o

Smiths Beach Urban Water Management Plan

Site Masterplan

Figure 2

Date: 31/05/2021 Job No. H20045



Site

0 60 120 180 240
Meters

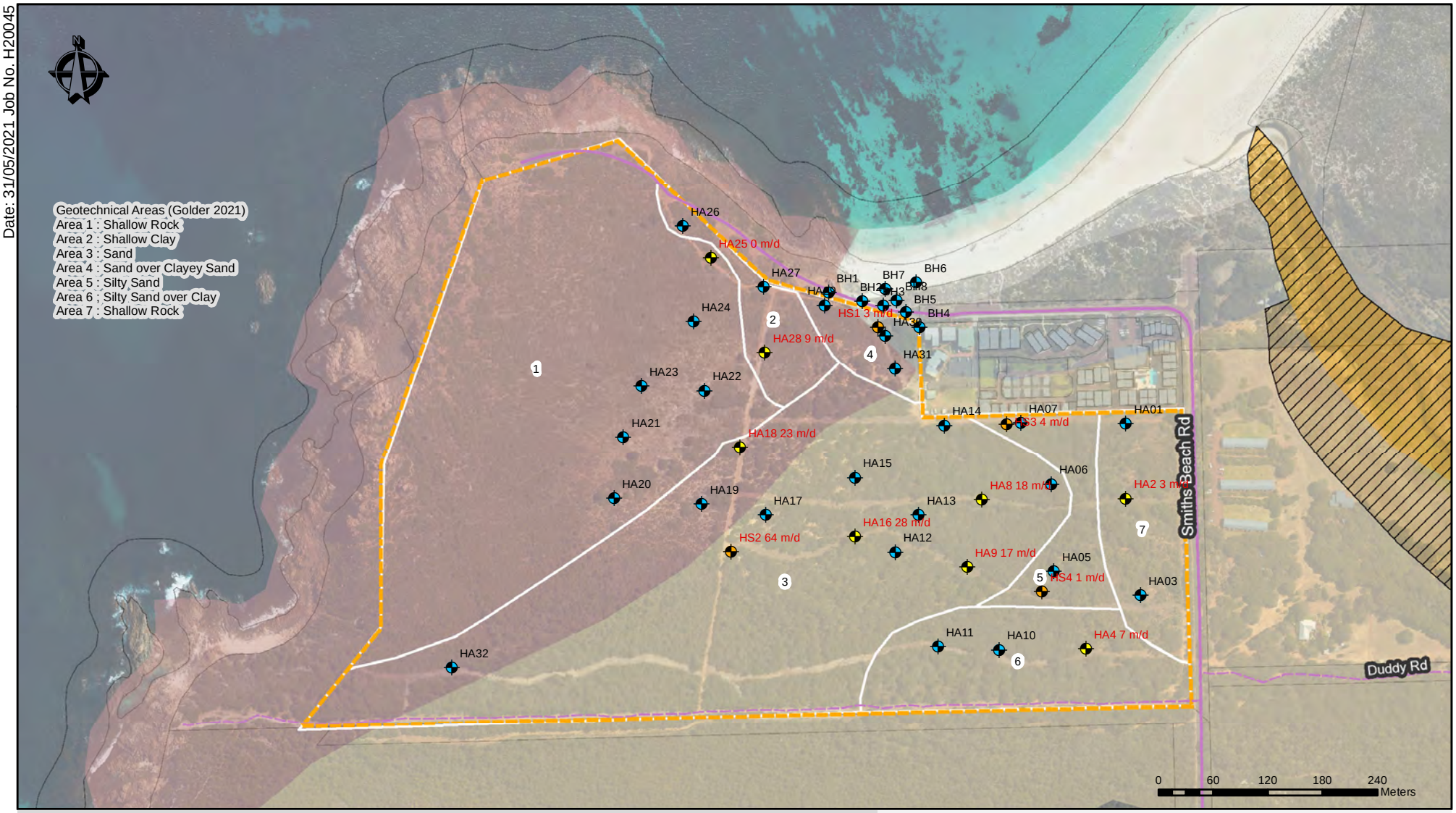
hyd2o

Smiths Beach Urban Water Management Plan

Site Condition Plan

Figure 3

Date: 31/05/2021 Job No. H20045



Site

Geotechnical Areas (Golder 2021)

Moderate to Low Risk of ASS within 3m

Geotech Pits

Permeability Test Sites (m/d)

Golder

Hyd2o

Regional Surface Geology Mapping

GN Gneiss

Msc1 Clayey Sandy Silt

S1 Calcanenous Sand (with pebbles)

S2 Calcanenous Sand

S7 Sand

Sgm2 Silty Gravelly Sands

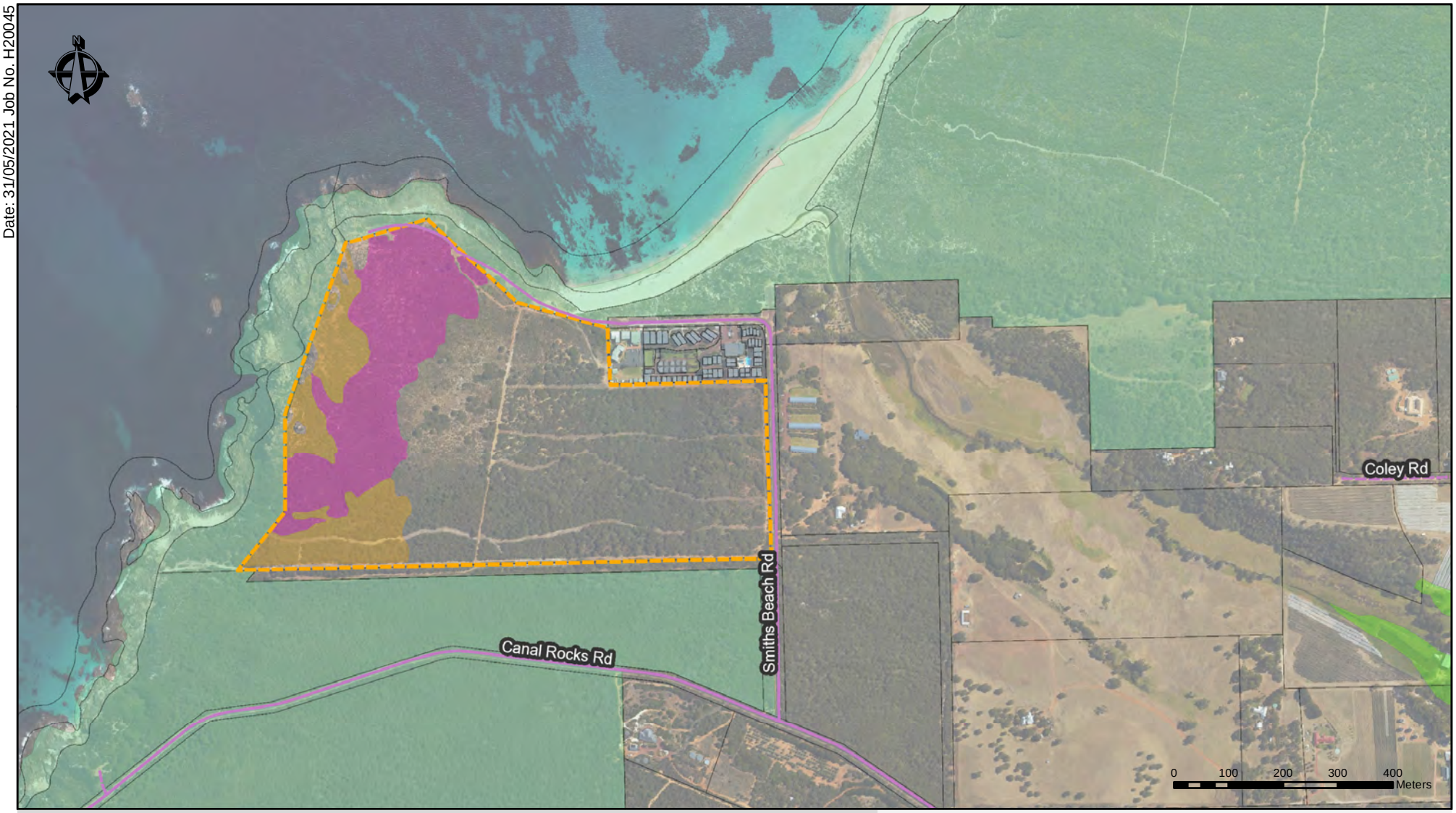
hyd2o

Smiths Beach Urban Water Management Plan

Geotechnical Plan

Figure 4

Date: 31/05/2021 Job No. H20045



Site

Priority Ecological Community (Strategen 2020)

Low Shrublands on Acidic Grey-Brown Sands

Malaleuca Lanceolata Forests, Leeuwin Naturaliste Ridge

Clearing Regulations - Environmentally Sensitive Areas

Geomorphic Wetlands Leeuwin Naturaliste Ridge

Palusplain

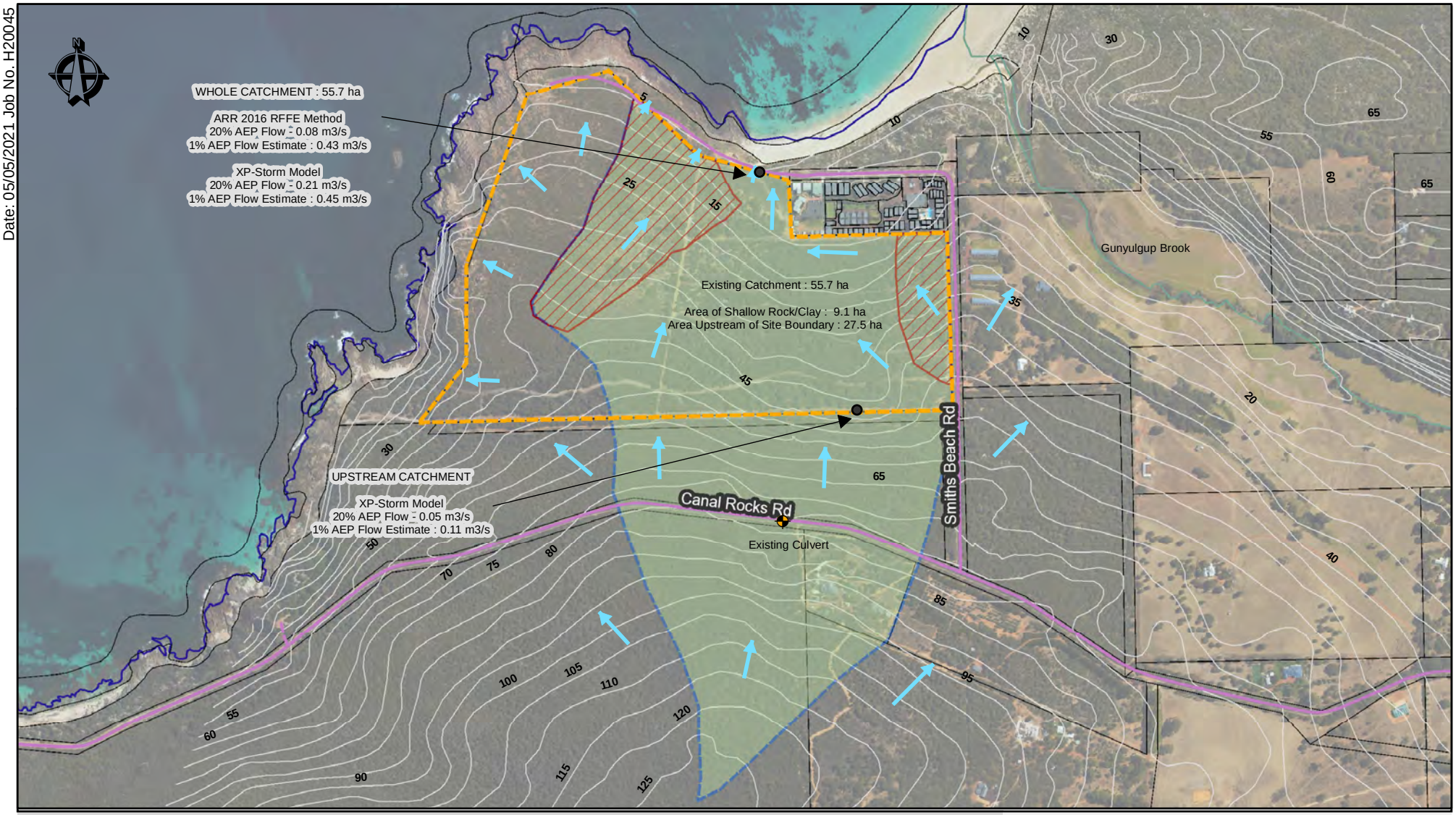
hyd2o

Smiths Beach Urban Water Management Plan

Environmental Plan

Figure 5

Date: 05/05/2021 Job No. H20045



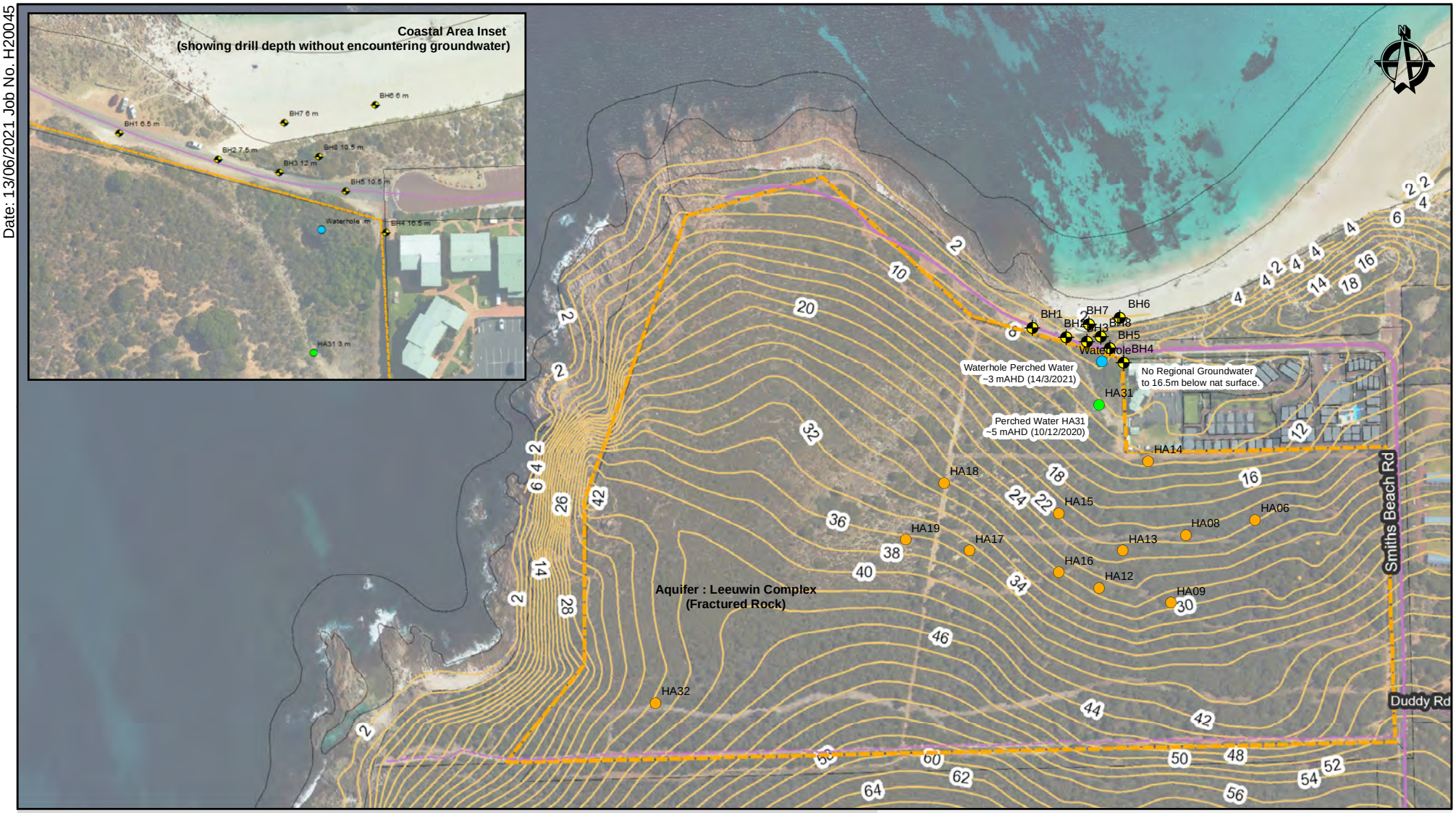
hyd2o

Smiths Beach Urban Water Management Plan

Surface Water Plan

Figure 6

Date: 13/06/2021 Job No. H20045



Site

Installed Bores (Name, Total drill depth)

Manmade Waterhole

Test Pit HA31 (Perched Water)

Test Pits to 3m Depth without Groundwater

Note : Groundwater not encountered in any test pits.
Deeper pits to 3m shown on plan as indicator of minimum groundwater depth in areas not subject to shallow perching.

0 60 120 180 240 Meters

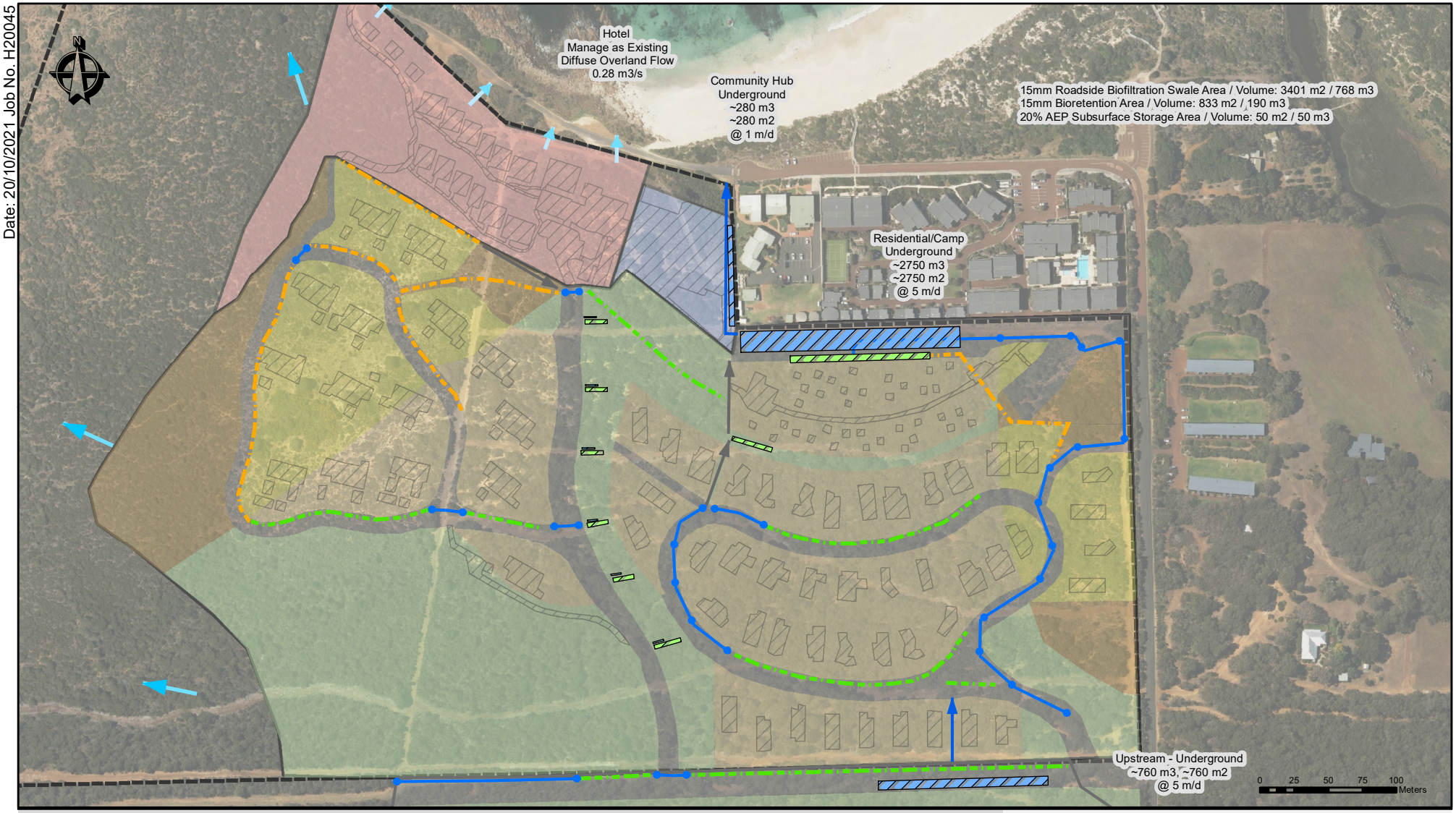
hyd2o

Smiths Beach Urban Water Management Plan

Groundwater Plan

Figure 7

Date: 20/10/2021 Job No. H20045



Catchments
1% AEP Storage
20% AEP Storage
15mm Bioretention
Road Biofiltration Swales
Conveyance Only Swales
Pit/Pipe
Connector
Diffuse Flow
Overflow Path (>1% AEP Event Safe Passage)
Holiday Homes & Camp
Holiday Homes w R&C
Hotel
Community Hub
Roof/Track/Path
Vegetation
Vegetation w R&C
Road/Car Park

hyd2o

Smiths Beach Urban Water Management Plan

Stormwater Management Plan - 1% AEP Event

Figure 8

APPENDIX A
UWMP Checklist

Checklist for integrated water cycle management assessment of application for subdivision or urban water management plan

1. Tick the status column for items for which information is provided.
2. Enter N/A in the status column if the item is not appropriate and enter the reason in the comments column.
3. Provide brief comments on any relevant issues.
4. Provide brief description of any proposed best management practices, eg. multi-use corridors, community based-social marketing, water re-use proposals.

UWMP Item	Deliverable	☑	Comments
Executive summary			
Development design elements and compliance with design objectives	Table 1: Design elements and compliance	☑	Executive Summary Section 2
Key design requirements for detailed design – critical control points and elements	Table 2: Design requirements for critical control points		Section 2
Introduction and planning approval			
Location plan, adjoining lots, key landscape features and roads. Local Water Management Strategy. Structure plan, zoning and land use. Subdivision plan and/or approval	Location plan Site context plan Subdivision layout plan Or combination of above	☑	Section 1 Introduction Figs. 1, 2
Design objectives			
Agreed design objectives and demonstration of compliance		☑	Executive Summary Section 2
Site characteristics			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		☑	Section 3 Site Characteristics
Site Conditions - existing topography/contours, aerial photo underlay, major physical features	Site condition plan	☑	Section 3.1 Site Conditions, Fig. 3
Geotechnical - topography, test pit locations, soil zones and descriptions, site classification zones, proposed earthworks and approximate finished contour levels	Geotechnical plan	☑	Section 3.2 Geotechnical, Fig. 4 Appendix B,C,D
Environmental - sensitive or significant vegetation areas, wetlands and buffers, waterways and buffers, contaminated sites		☑	Section 3.3 Environment Fig.5
Surface Water – topography, 100 year floodways and flood fringe areas, 100 year proposed flow paths, water quality of flows entering and leaving (if applicable)		☑	Section 3.4 Surface Water Fig 6 , Appendix E,F
Groundwater – topography, test bore locations, groundwater pre development, groundwater post development, water quality details, groundwater variation hydrograph	Groundwater Plan	☑	Section 3.5 Groundwater, Fig.7
Landscape - proposed public open space areas, water source, bore(s), lake details (if applicable), approx watering requirements and water balance, indicative irrigation schedule. Demonstrate compliance with DoW Constructed Lakes Position Statement if applicable		☑	Section 4.2.2 Appendix G
Water use sustainability initiatives			
Water supply and efficiency measures		☑	Section 4.1 Water Conservation Strategy
Fit-for-purpose strategy and agreed actions. If non-potable supply, support with water balance		☑	Section 4.2 Fit-For-Purpose Water Strategy
Wastewater management		☑	Section 4.3 Wastewater Appendix G

UWMP Item	Deliverable	☑	Comments
Stormwater and groundwater management design			Section 5 and Section 6
Flood protection - peak flow rates, top water levels at control points,100 year flow paths - floodways and flood fringe zones and/or along roads and reserves, 100 year inundation areas and volumes	100yr event plan	☑ ☑	Section 5 Stormwater Management Figure 8
Stormwater management system - storage areas, flows and hydraulic grade lines for both major and minor events including controlling inverts (critical control points). Locations and arrangements for agreed structural and non-structural best management practices and treatment trains supported by sizing criteria, areas of inundation, flow paths and cross sections. Show integration with landscaping	Section 5, Appendix D	☑ ☑ ☑	Section 5 Stormwater Management Figure 8, Appendix I,J,K
Post development groundwater levels and fill requirements (including existing and final surface levels), outlet controls, and any subsoils (showing drawdown/impacts near sensitive environments). Describe modelling assumptions.		☑ ☑	Section 6 Groundwater Management
Actions to address acid sulfate soils or contamination		☑	Section 7 Subdivision Works Management
Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages		☑	Section 3.3, Section 5
Management of disease vector and nuisance insects		☑	Section 5
Management of subdivisional works			
Management of construction activities including dewatering, acid sulfate soils, constructed best management practices, and dust, sediment and erosion control – timing and possible staging		☑	Section 7 Subdivisional Works Management
Monitoring program			
Sampling and assessment plan including duration and arrangements for ongoing actions		☑	Section 8 Monitoring Program
Implementation plan			
Roles, responsibilities, funding for implementation		☑	Section 9 Implementation, Table 10
Maintenance arrangements as agreed		☑	Section 9 Implementation
Assessment and review		☑	Section 9 Implementation

APPENDIX B
Geotechnical Report

REPORT

Smiths Beach Development

Preliminary Geotechnical and Pavement Investigation

Submitted to:

Smiths 2014 Pty Ltd
Level 3/338 Barker Road
SUBIACO WA 6008

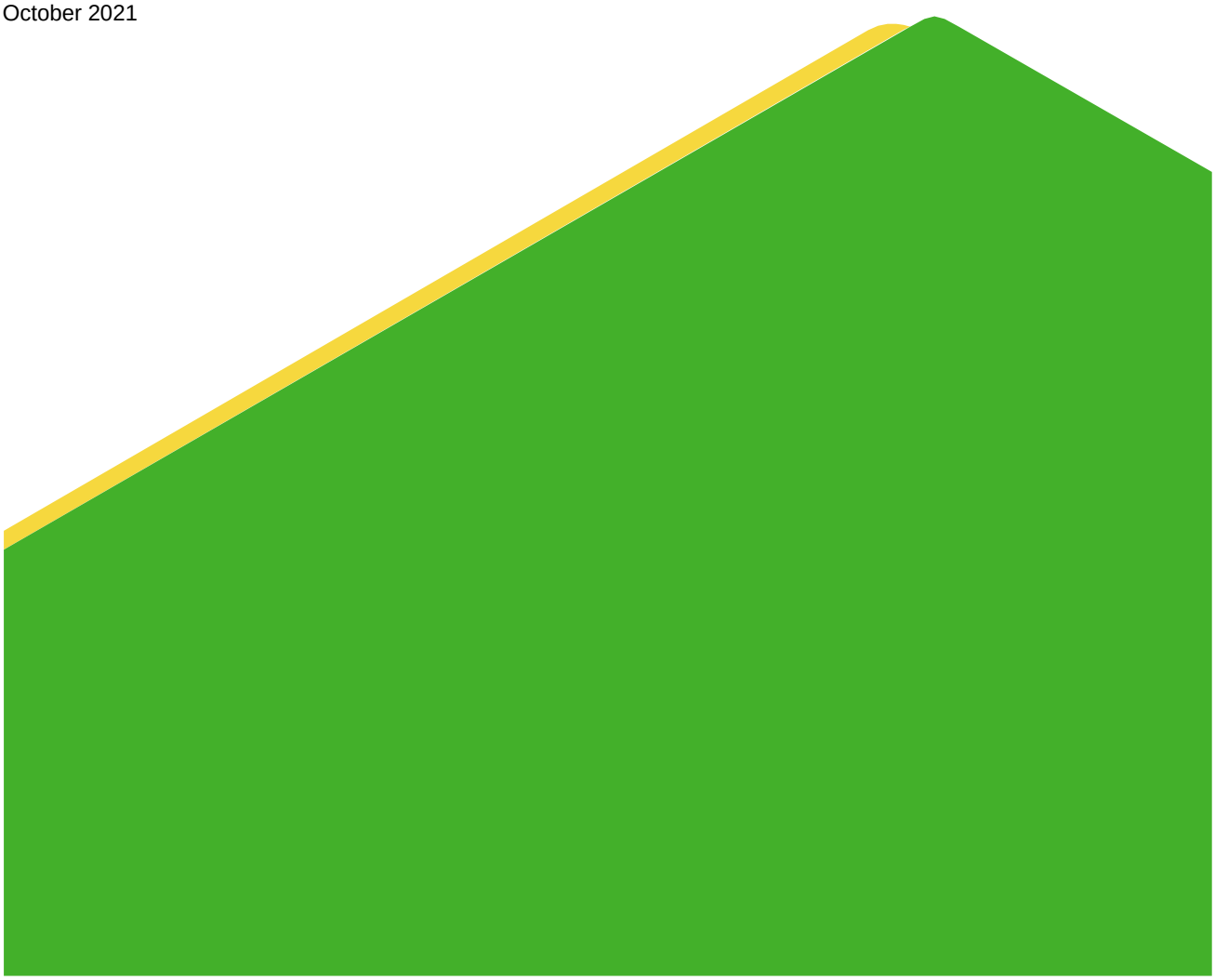
Submitted by:

Golder Associates Pty Ltd
Level 4, 45 Francis Street, Northbridge Western Australia 6003, Australia

+61 8 9213 7600

20435097-001-R-Rev0

October 2021



Distribution List

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APPENDIX C
Borehole Report

APPENDIX D
Pavement Dipping Report

APPENDIX E
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1.0 INTRODUCTION

This report presents the results of a preliminary geotechnical and pavement investigation carried out by Golder Associates Pty Ltd (Golder) for the proposed development at Smiths Beach, Yallingup. The approximate location of the site in relation to the surrounding area is presented on Figure 1. The scope of work was outlined in Golder proposal P20435097-001-L-Rev1 and P20435097-002-L-Rev0, and authorised by Smiths 2014 Pty Ltd.

The proposed development will comprise tourism, community infrastructure and holiday homes. The development area is about 20 hectares in size and presently covered with variably dense remnant bushland, with firebreaks around the perimeter and on various alignments through the site. Regular rock outcrops occur near the western and eastern extents of the site (Area 1 and Area 7 as discussed in Section 6.2). Figure 2 provides aerial imagery of the site.

The ground surface level varies from about 5 m AHD close to the coast, to a maximum of about 60 m AHD near the southern extent.

2.0 OBJECTIVES

The objectives of the investigation were as follows:

Development Area

- Assess surface and subsurface conditions and soil profile, subsurface soil layer thicknesses, strength, and other geotechnical characteristics.
- Assess the preliminary site classification for the development.
- Provide earthworks recommendations working with *in situ* materials and imported material as appropriate.
- Assess suitability of excavated material for fill.
- Assess areas and depths of unsuitable material and possible reuse of this unsuitable material on site.
- Assess groundwater levels and any perched water table levels, including sub-surface flow paths.
- Assess soil permeability and potential for stormwater disposal by soakage.
- Provide earth pressure coefficients for granular backfill to earth retaining structures.
- Assess the pavement design CBR for the development.
- Assess the site suitability and foundation requirements for residential and commercial type development (noting building pad requirements) and recommendations of disposal of roof stormwater.
- Assess soil permeability and soil classification for design loading rate calculations, in accordance with AS/ANZ 1547, suitable for supporting approvals for on-site disposal of effluent generated from on-site ATU's.
- Provide recommendations for further work based on the outcomes of the investigation.

Smiths Beach Road Pavement

- Assess the existing pavement condition, profile, and deflection characteristics along Smiths Beach Road between Canal Rocks Road and the road termination.
- Provide pavement rehabilitation requirements if the existing pavement is considered inadequate for the expected traffic loading.

- Provide a design subgrade California Bearing Ratio (CBR) and pavement design for Smiths Beach Road.
- Provide comment on any other factors that may influence pavement construction or performance.

Rock Durability near the Coast Line

- Assess the surface level of the rock near the coastline that is considered to have sufficient durability to withstand the action of the ocean in the coming century.

3.0 PREVIOUS INVESTIGATIONS

Various reports containing relevant information have previously been undertaken at the site. The relevant test locations from these investigations are shown on Figure 2 and Figure 3.

The previous investigations comprise:

- Rock Exploration Drilling by MP Rogers & Associates (MRA) in May 2000.
- A geotechnical investigation by Douglas Partners in March 2001. The results are provided in report Ref: Project 22180 dated May 2001. The relevant work comprised excavation of ten test pits and associated laboratory testing. The test pit locations are shown on Figure 2 and Figure 3. Test pit reports and laboratory test results are provided in Appendix A.
- Permeability testing completed by hyd2o at four locations. The test locations and results are shown on Figure 2 and Figure 3.
- A Geophysical Investigation by GBG Maps in March 2019. The results are provided in report Ref: 70492 Rev1 dated 24 September 2020.

4.0 FIELDWORK

4.1 Geotechnical Investigation

The geotechnical investigation was completed between 10 December 2020 and 12 March 2021 and comprised:

- Drilling of hand auger boreholes at 32 locations, HA01 to HA32, extending to depths between 0.2 m and 3.0 m.
- Perth sand penetrometer (PSP) or dynamic cone penetrometer (DCP) testing adjacent to each hand auger borehole, extending to a depth of 2 m or shallower refusal.
- Diamond core boreholes at eight locations, BH1 to BH8, extending to depths of between 6.0 m and 16.5 m.
- *In situ* permeability testing at eight hand auger locations.
- Collection of samples for geotechnical laboratory testing.

The test positions were located using a hand-held GPS, typically accurate to within about 5 m. The test locations are shown on Figure 2 and Figure 3. A summary of the test locations is provided in Table 1.

Table 1: Summary of Geotechnical Investigation Test Locations

Test ID	Approximate Coordinates (GDA94)		Termination Depth (m)	Termination Remark	Inferred Refusal Material
	Easting (m)	Northing (m)			
Current Golder Investigation					
HA01	315991	6273479	0.50	Refusal	Gneiss
HA02	315991	6273397	0.65	Refusal	Gneiss

Test ID	Approximate Coordinates (GDA94)		Termination Depth (m)	Termination Remark	Inferred Refusal Material
	Easting (m)	Northing (m)			
HA03	316007	6273291	0.30	Refusal	Gneiss
HA04	315947	6273232	2.60	Refusal	Hard Clay
HA05	315912	6273317	1.30	Refusal	Gneiss
HA06	315909	6273413	3.0	Target Depth	-
HA07	315876	6273480	2.00	Refusal	Very dense Silty Sand
HA08	315833	6273396	3.00	Target Depth	-
HA09	315817	6273322	3.00	Target Depth	-
HA10	315852	6273231	1.30	Refusal	Hard Clay
HA11	315785	6273235	1.50	Refusal	Hard Clay
HA12	315738	6273338	3.00	Target Depth	-
HA13	315764	6273379	3.00	Target Depth	-
HA14	315792	6273477	3.00	Target Depth	-
HA15	315694	6273420	3.00	Target Depth	-
HA16	315694	6273355	3.00	Target Depth	-
HA17	315596	6273379	3.00	Target Depth	-
HA18	315568	6273453	3.00	Target Depth	-
HA19	315526	6273391	3.00	Target Depth	-
HA20	315430	6273397	1.90	Refusal	Gneiss
HA21	315440	6273464	1.10	Refusal	Gneiss
HA22	315529	6273515	1.00	Refusal	Gneiss
HA23	315460	6273520	0.90	Refusal	Gneiss
HA24	315517	6273591	0.40	Refusal	Gneiss
HA25	315536	6273661	0.20	Refusal	Gneiss
HA26	315505	6273696	0.80	Refusal	Hard Clay
HA27	315594	6273629	0.70	Refusal	Hard Clay
HA28	315595	6273557	1.00	Refusal	Hard Clay
HA29	315661	6273609	1.90	Refusal	Very dense Clayey Sand
HA30	315727	6273575	2.20	Refusal	Very dense Clayey Sand
HA31	315738	6273539	3.00	Target Depth	-
HA32	315252	6273212	3.00	Target Depth	-
BH1	315665	6273623	6.50	Target Depth	-
BH2	315702	6273613	7.50	Target Depth	-
BH3	315725	6273608	12.00	Target Depth	-
BH4	315765	6273585	16.50	Target Depth	-
BH5	315750	6273601	10.50	Target Depth	-
BH6	315761	6273634	6.0	Target Depth	-
BH7	315727	6273627	6.0	Target Depth	-
BH8	315740	6273614	10.5	Target Depth	-
Previous Douglas Partners Investigation					
TP1	-	-	1.1	Refusal	Granite boulders
TP2	-	-	1.2	Refusal	Granite
TP3	-	-	2.2	Target Depth	-
TP4	-	-	2.0	Target Depth	-
TP5	-	-	1.3	Refusal	Granite
TP6	-	-	1.4	Refusal	Granite
TP7	-	-	2.5	Target Depth	-
TP7A	-	-	0.6	Refusal	Calcarenite
TP8	-	-	2.0	Target Depth	-
TP8A	-	-	1.2	Refusal	Granite

The hand auger borehole reports are provided in Appendix B along with a list of the notes and abbreviations used on the reports, and the method of soil description adopted.

PSP/DCP testing was conducted in accordance with AS 1289.6.2-1997 and 1289.6.3-1997. The results of the PSP/DCP tests are provided on the hand auger reports included in Appendix B.

The boreholes were drilled using HQ3 diamond core techniques by a GDR 650 truck mounted drill rig owned and operated by OzDrill. The borehole reports are presented in Appendix C along with a list of notes and abbreviations, and a method of soil description used on the reports.

The *in situ* permeability testing was carried out using the 'Talsma Hallam' method described in AS 1547:2012, Appendix G. In accordance with the standard, the test was conducted at 0.5 m depth. The test results are provided in Table 2.

Table 2: Permeability Test Results

Location	Area	Material Type	Permeability (m/day)
Current Golder Investigation			
HA2	Area 7	Silty Sand	3
HA4	Area 6	Sand/Silty Sand	7
HA8	Area 3	Sand	18
HA9	Area 3	Sand	17
HA16	Area 3	Sand	28
HA18	Area 3	Sand	23
HA25	Area 1	Rock – Gneiss	Shallow rock – unable to perform test
HA28	Area 2	Sandy Gravel over Sandy Clay	9
Previous hyd2o Investigation			
-	Area 5	Silty Sand	4
-	Area 5	Silty Sand	1
-	Area 3	Sand	64
-	Area 4	Sand/Silty Sand	3

Personnel from Golder selected the borehole locations, advanced the hand auger boreholes, carried out the DCP/PSP and permeability testing, logged the materials encountered, and collected samples for laboratory testing.

4.2 Pavement Investigation

The pavement investigation was completed between 18 and 22 December 2020 and comprised:

- Visual assessment of the pavement and surfacing condition.
- Pavement dippings at six locations, PD01 to PD06, extending to depths of between 0.41 m and 1.00 m.
- PSP/DCP testing at subgrade level within each dipping.
- Collection of samples for geotechnical laboratory testing.
- Falling Weight Deflectometer (FWD) testing on both lanes at intervals of 25 m along Smiths Beach Road between Canal Rocks Road and the road termination.

The pavement dipping positions were located using a hand-held GPS, typically accurate to within about 5 m. The test locations are shown on Figure 3. A summary of the test location is provided in Table 3.

Table 3: Summary of Pavement Dipping Locations

Test ID	Approximate Coordinates (GDA94)		Termination Depth (m)
	Easting (m)	Northing (m)	
PD01	316075	6273013	0.52
PD02	316075	6273130	0.41

Test ID	Approximate Coordinates (GDA94)		Termination Depth (m)
	Easting (m)	Northing (m)	
PD03	316074	6273292	0.49
PD04	316065	6273444	0.87
PD05	316063	6273536	1.00
PD06	315906	6273603	0.75

The visual assessment of the existing pavement and surfacing condition was undertaken during a walkover and is further discussed in Section 8.1.

The pavement dippings were excavated using a 150 m diameter corer and jackhammer operated by Qualcon Laboratory. Pavement dipping logs are presented in Appendix D.

FWD testing was carried out by Specialist Testing and Technical Services (STATS). The results of the FWD testing are presented in Appendix E. The outcomes of the testing are further discussed in Section 8.3.

A geotechnical engineer from Golder undertook the visual assessment of the pavement condition, positioned the test locations, supervised the pavement dippings, conducted the PSP/DCP testing, logged the materials encountered, and collected the samples for laboratory testing. The pavement dipping holes were backfilled with basecourse material and the pavement surfacing was reinstated with compacted cold mix asphalt and the site left in a tidy condition.

5.0 LABORATORY TESTING

Samples were submitted for laboratory testing at Golder's NATA-accredited laboratory and Qualcon's NATA-accredited laboratory. The laboratory testing comprised:

- Moisture content on 13 samples
- Particle size distribution on 13 samples
- Atterberg limits and linear shrinkage on 13 samples
- Dry density/moisture content relationship on three samples
- Soaked CBR on three samples
- Point Load Index on 11 rock core samples.

The geotechnical laboratory test certificates are presented in Appendix F. The test methods followed are shown on the test reports. A summary of the laboratory test results is presented in Table 4 and Table 5.

Table 4: Summary of Laboratory Test Results – Soil

Test ID	Material Description	Depth (m)	Particle Size Distribution (% passing)			LL (%)	PI (%)	LS (%)	MC (%)	MMDD (t/m^3)	OMC (%)	CBR (%)	Swell (%)
			Gravel	Sand	Fines								
HA04	Sandy CLAY	1.4-1.8	0.7	62	37	75	58	12.0	19.1	-	-	-	-
HA05	Silty SAND	0.5-0.7	0.0	80	20	SIB	ND	NO	4.8	1.98	10.5	50	0.0
HA07	Silty SAND	1.8-2.0	4.3	79	16	SIB	ND	NO	6.9	-	-	-	-
HA19	SAND	1.8-2.0	0.0	95	5	SIB	ND	NO	2.6	-	-	-	-
HA21	Silty SAND	0.8-1.0	0.8	84	15	SIB	ND	NO	4.4	-	-	-	-
HA28	Sandy CLAY	0.6-1.0	6	52	42	50	29	9.5	25.4	-	-	-	-
HA30	Clayey SAND	2.0-2.2	0.0	82	18	27	15	3.0	12.5	-	-	-	-
PD01	Sandy GRAVEL	0.04-0.16	59	35	6	NO	NP	NO	5.6	-	-	-	-
PD02	Gravelly SAND	0.2-0.4	33	64	3	NO	NP	NO	6.9	1.93	11.0	13	0.0
PD03	Clayey Gravelly SAND	0.30-0.49	28	52	20	20	4	1.0	3.3	-	-	-	-
PD04	Clayey SAND	0.49-0.99	12	62	26	30	12	5.0	11.9	-	-	-	-
PD06	Clayey Sandy GRAVEL	0.03-0.29	54	31	15	21	5	2.5	8.0	-	-	-	-
PD06	SAND	0.1-0.3	2	95	3	NO	NP	NO	2.5	1.64	16.5	17	0.0

Notes: Gravel – material passing the 63 mm sieve and retained on the 2.36 mm sieve, Sand – material passing the 2.36 mm sieve and retained on the 0.075 mm sieve, Fines – material passing the 0.075 mm sieve, LL – liquid limit, PI – plasticity index, LS – linear shrinkage, MC – moisture content, OMC – optimum moisture content, MMDD – modified maximum dry density, CBR – soaked California bearing ratio, Swell – swell measured in CBR test, NP – non-plastic, ND – not determined, NO – not obtainable

Table 5: Summary of Laboratory Test Results – Rock Strength Testing

Test Location	Sample Depth	Test Direction	Point Load Test Results Is50 (MPa)	Inferred Strength (Approx.)
BH1	2.75	Axial	1.7	High
BH1	4.50	Diametral	9.8	Very High to Extremely High
BH2	3.40	Diametral	1.9	High
BH2	4.60	Axial	0.65	Medium
BH3	4.60	Axial	0.25	Low
BH3	6.15	Axial	0.47	Medium
BH3	8.60	Diametral	1.1	Medium to High
BH3	10.40	Axial	0.67	Medium
BH5	6.40	Diametral	0.2	Low
BH5	7.65	Axial	0.42	Medium
BH5	8.15	Diametral	4.8	Very High
BH6	4.80	Diametral	0.34	Medium
BH6	5.15	Axial	0.89	Medium
BH6	5.85	Axial	3.3	Very High
BH7	2.10	Diametral	0.87	Medium
BH7	3.25	Diametral	3.4	Very High
BH7	4.50	Diametral	2.1	High
BH8	6.05	Diametral	0.07	Very Low
BH8	7.45	Diametral	0.14	Low
BH8	8.55	Diametral	0.55	Medium
BH8	9.20	Diametral	0.18	Low
BH8	9.80	Axial	0.21	Low
BH8	10.10	Diametral	0.64	Medium

6.0 SITE CONDITIONS

6.1 Geological Setting

The Geological Survey of Western Australia 1:50,000 scale Geological Map of Yallingup is reproduced on Figure 4. The map indicates that the site is in an area underlain by the following geological units:

- SAND derived from Tamala Limestone – white to pale and olive-yellow, medium to coarse grained, sub-angular quartz; moderately sorted.
- GNEISS – medium grained mesocratic gneiss.

The results of the investigation suggest the geology map broadly represents conditions at the site, except that Gneiss also occurs along the eastern boundary of the site.

6.2 Subsurface Conditions – Development Area

The subsurface conditions across the area are relatively variable. Based on the investigation results and the site walkover, the site has been divided into areas of inferred similar subsurface conditions, as shown on Figure 5. The area boundaries must be considered preliminary and indicative only due to the variability of the conditions and the limitations of an investigation using hand techniques only.

The subsurface conditions in each area are discussed in the following sections.

6.2.1 Area 1 – Shallow Rock

The subsurface conditions encountered in this area may be generalised as comprising:

- Silty SAND (SM), fine to medium grained, generally about 15% low plasticity fines, generally loose becoming medium dense to dense with depth, brown becoming pale brown orange and pale brown grey, extending to depths of between about 0 m (rock outcrops) and 1.9 m, overlying
- Inferred GNEISS/GRANITE cobbles, boulders, or bedrock, causing refusal at depths between 0.2 m and 1.9 m.

6.2.2 Area 2 – Shallow Clay

The subsurface conditions encountered in this area may be generalised as comprising:

- Silty SAND (SM) or Sandy GRAVEL (GP), fine to medium grained sand, fine to coarse lateritised gneiss gravel, generally about 15% low plasticity fines, medium dense to dense with depth, brown, extending to depths of between about 0.4 m and 0.5 m, overlying
- Sandy CLAY(CI/CH), medium to high plasticity, very stiff to hard, brown, orange, and red, extending to the maximum depth investigated of 1.0 m.

6.2.3 Area 3 – Sand

The subsurface conditions encountered in this area may be generalised as comprising:

- SAND (SP), fine to medium grained, with silt in parts, loose becoming medium dense to dense with depth, orange brown to red brown, extending to the maximum depth investigated of 3.0 m.

6.2.4 Area 4 – Sand over Clayey Sand

The subsurface conditions encountered in this area may be generalised as comprising:

- SAND (SP), fine to medium grained, with silt, loose becoming medium dense to dense with depth, orange brown to grey brown, extending to depths of between about 1.5 m and 2.1 m, overlying
- Clayey SAND (SC), fine to coarse grained, about 15% to 25% low plasticity fines, dense to very dense, orange brown, orange yellow and yellow grey, containing a sand layer between 2.5 m and 3.0 m at HA31, extending to the maximum depth investigated of 3.0 m.

6.2.5 Area 5 – Silty Sand

The subsurface conditions encountered in this area may be generalised as comprising:

- Silty SAND (SP), fine to medium grained, about 10% to 20% low plasticity fines, loose becoming medium dense to dense with depth, red brown to brown, extending to the maximum depth investigated of 2.0 m.

6.2.6 Area 6 – Silty Sand over Clay

The subsurface conditions encountered in this area may be generalised as comprising:

- SAND/Silty SAND (SP/SM), fine to medium grained, about 10% to 15% low plasticity fines, loose becoming medium dense to dense with depth, brown, extending to depths of between about 0.8 m and 1.4 m, overlying
- Clayey SAND/Sandy CLAY(SC/CI/CH), medium to high plasticity, very stiff to hard, brown, orange brown and grey, extremely weathered rock, extending to the maximum depth investigated of 2.6 m.

6.2.7 Area 7 – Shallow Rock

The subsurface conditions encountered in this area may be generalised as comprising:

- SAND/Silty SAND/Silty Gravelly SAND (SM), fine to medium grained, generally about 15% to 20% low plasticity fines, generally loose becoming medium dense to dense with depth, brown and red brown, fine to coarse gneiss gravel and cobbles, extending to depths of between about 0 m (rock outcrops) and 1.1 m, overlying
- Inferred GNEISS/GRANITE cobbles, boulders, or bedrock, causing refusal at depths between 0.3 m and 1.3 m.

6.3 Subsurface Conditions – Foreshore Area

Figure 6 and Figure 7 provide a section showing the inferred subsurface conditions encountered within the boreholes located near the coastline on the northern edge of the proposed development. The subsurface conditions may be summarised as follows:

- SAND/Silty SAND/Clayey SAND (SP/SM/SC), fine to coarse grained sand, with some Gneiss boulders, extending to depths of between about 1.5 m and 7.2 m, overlying
- Clayey SAND/Sandy CLAY/CLAY (SC/CI), medium plasticity, very stiff to hard, variably cemented with iron cementation, encountered at BH4 and BH6 only, extending to a depth of 4.5 m at BH6 and the depth investigated of 16.5 m at BH4, overlying
- GNEISS, medium to coarse grained, mottled pale red, brown, grey, and pale blue, distinctly weathered and very low to low strength in parts near the surface of the unit, becoming slightly weathered to fresh and medium to very high strength, extending to the depths investigated of between 6.5 m and 12.0 m.

6.4 Existing Pavement Condition

The pavement profile encountered along Smiths Beach Road can be generalised as follows:

- **Asphalt –** thickness varies from 25 mm to 40 mm, overlying
- **Basecourse –** Sandy GRAVEL/Gravelly SAND (GP-SP), fine to medium grained, sub-rounded to sub-angular gravel, brown, fine to coarse grained sand, trace non plastic fines, thickness ranging from 120 mm to 270 mm, overlying
- **Subgrade** – SAND/Gravelly SAND (SP), fine to coarse grained, pale brown to brown, fine to medium gravel, trace non plastic fines.

A variation to the above profile was observed in pavement dipping PD01 located approximately 180 m south of Duddy Road where a gravelly sand limestone sub-base layer was encountered. Another variation was observed at pavement dipping PD05 located approximately 50 m north of the transition from granite to laterite asphalt surfacing, as follows:

- **Asphalt –** 30 mm thickness.
- **Basecourse** – Sandy GRAVEL (GP), fine to medium grained, sub-rounded to sub-angular gravel, brown, fine to coarse grained sand, trace fines, 190 mm thickness, overlying
- **Sub-base** – Sandy GRAVEL (GP), fine to medium grained, sub-rounded to sub-angular gravel, grey-brown, fine to coarse grained sand, trace fines, 70 mm thickness, overlying
- **Subgrade** – Silty SAND (SM), fine to medium grained, dark brown, trace fine to medium gravel. At 800 mm depth, the material transitions into a red brown Silty Clayey SAND (SM/SC) with low to medium plasticity fines.

6.5 Groundwater

During our investigation in December, groundwater was not encountered in the hand auger boreholes, although the groundwater level was considered to be close to the base of the hole at hand auger HA31.

During the previous investigation conducted by Douglas Partners in March 2001, groundwater was not encountered in any of the test pits. However, the groundwater level in the soak was about 2.5 m below the natural surface level.

During the previous investigation conducted by MRA in May 2000, groundwater was measured at about RL 4.1 m AHD near the soak, which was noted to be similar to the level in the soak.

Perched water may occur during wet periods. Stormwater will readily infiltrate into the surficial higher permeability materials (sandy soil and highly fractured rock) and more slowly into the underlying lower permeability materials (clayey soil and relatively unfractured rock). Depending upon the amount of rainfall, this may result in some water perching on the lower permeability soil, at relatively shallow depth over parts of the site.

Figure 8 to Figure 11 present inferred subsurface sections across the site, which show the boundary between the higher and lower permeability soils and the potential flow path for any perched water. They indicate that if present, any perched water will move towards the centre of the site from the east, west and south. In the centre of the site any perched water will move into the deep sand. In the northern parts of the site where lower permeability materials occur at shallower depth, any perched water will be directed towards the ocean through the area around the wetland. The artificial soak is considered to be a surface expression of perched water flowing towards the ocean.

7.0 DEVELOPMENT AREA DISCUSSION

7.1 Main Geotechnical Issues

The geotechnical issues requiring consideration include:

- *The variability in subsurface conditions.* Relatively variable subsurface conditions occur at the site due to:
  - the transition between geological units (sand derived from Tamala Limestone and Gneiss)
  - the presence of varying thicknesses of colluvial soil including large boulders
  - variable weathering of the bedrock, which sometimes occurs as extremely weathered rock (soil comprising medium to high plasticity sandy clay) and sometimes as shallow relatively fresh rock.
- *The shrink swell potential of the clayey soils within the zone of significant moisture fluctuation.* The presence of relatively shallow clayey soil in some areas will result in seasonal surface movement. Although the movement may be mitigated by placement of imported granular soil, this may not be appropriate at this site as sand pads may be undesirable.
- *Near surface soils with a relatively low permeability.* Although much of the site is overlain by a significant thickness of highly permeable sand, where shallow clayey soil or rock is present these will have a relatively low permeability and act as a barrier to stormwater and effluent infiltration. In addition, whilst not as impermeable as the clayey soil and rock discussed above, at some locations the silty sand will have a lower permeability compared to the free draining sand present over much of the site.

- *The presence of shallow rock in some areas.* Where shallow massive rock or large boulders occur, the material is often relatively fresh and will be difficult to excavate.
- *Relatively loose near-surface sand over parts of the site*. As for many typical sand sites, conventional proof rolling using a heavy vibratory roller is required to improve the density of the near surface sand/silty sand.

7.2 Preliminary Site Classification

AS 2870-2011 defines site classification on the basis of a characteristic surface movement associated with the surface movements of soils. At this site, the site classification is primarily influenced by:

- The presence of clayey soil within the depth of seasonal moisture variation over parts of the site.
- The shrink swell characteristics of the clayey soil.
- The thickness of inert *in situ* sand/silty sand, or imported fill sand (inert soil) overlying clayey soil.

We have assessed the classification for the site and consider that provided the site preparation measures provided in Section 7.3 are adopted, the preliminary site classifications discussed below are applicable:

- Area 1 and Area 7 – 'Class S' – While a 'Class A' may be applicable for much of these areas where silty sand overlies relatively shallow rock, a preliminary classification of 'Class S' is recommended due to the variable weathering characteristics of the rock and the presence of boulders which may appear as massive rock in the hand auger boreholes. These factors may result in relatively shallow medium to high plasticity clay being present in some areas. Should this occur a 'Class M' classification may be appropriate for isolated areas.
- Area 2 – 'Class M' – Based on the presence of relatively shallow medium to high plasticity sandy clay a 'Class M' is considered appropriate. The sandy clay may have varying shrink swell potential; however, based on the currently available information, a 'Class H1' may be appropriate if no inert soil is present over the clay, and where about 1.0 m of inert soil is present over clay a 'Class S' may be appropriate.
- Area 3 – 'Class A' – Based on the presence of deep sand a 'Class A' is considered appropriate.
- Area 4 – 'Class S' – Based on the presence of clayey sand within the depth of seasonal moisture variation, a 'Class S' is considered appropriate.
- Area 5 – 'Class S' – While a 'Class A' may be applicable for parts of this area where silty sand overlies relatively shallow rock, a preliminary classification of 'Class S' is recommended due to the variable ground conditions and the possible presence of clayey soil within the depth of seasonal moisture variation.
- Area 6 – 'Class M' – Based on the presence of relatively shallow high plasticity sandy clay a 'Class M' is considered appropriate, although other classifications may be applicable in some areas. The sandy clay may have varying shrink swell potential; however, based on the currently available information, if less than about 0.5 m of inert soil is present over the clay a 'Class H1' may be appropriate, and where about 1.2 m of inert soil is present over clay a 'Class S' may be appropriate.

7.3 Site Preparation Procedures

The site preparation requirements identified below are directed towards:

- Densification of loose surficial sand and silty sand zones that may occur across the site.
- Removal of rock relatively close to finished level to create a uniform bearing layer at least 0.3 m thick under footings and ground slabs. The presence of a variable mix of rock and soil below footings and ground slabs could otherwise create alternate 'hard' and 'soft' points below footings and ground slabs, which may lead to significant differential settlement and cracking or distortion of masonry structures. It may also be prudent to provide a blanket of soil, free of rock to improve drainage and into which footing excavations and service excavations can be made.
- Providing good drainage to reduce the risk of excessive seasonal movement associated with wetting of clayey soil.

The following site preparation procedures will be required to prepare the site for development:

- Remove any other trees not being retained as part of the development, including grubbing out roots.
- Remove all topsoil, roots and other unsuitable or deleterious material from the area. These materials should be stockpiled separately and are not suitable for re-use as structural fill in their current condition. Based on the findings of the site investigation, an average topsoil thickness of about 200 mm is present.
- If required, excavate to the required depth. Granular soils removed during this process should be stockpiled for later re-use as structural fill (refer Section 7.5).
- Where rock may be present within 0.3 m of footings and ground slabs, over-excavate to remove the rock within this zone. Deeper excavation of rock, or placement of structural fill may be desirable for non-geotechnical reasons.
- Proof-compact the exposed surface by moisture conditioning the soil well and applying at least eight overlapping passes with a minimum 10 tonne vibratory roller. Wetting of silty sand will be important prior to compaction to break soil bonds and allow re-orientation of the sand particles and densification of the soil.
- If clayey soils are present following excavation, measures must be undertaken to minimise any exposure of clayey soils to changes in moisture (rain, surface water run-off etc.) to reduce the risk of softening of the clayey soils during construction. Therefore, if excavations are proposed, earthworks should preferably be undertaken during dry periods, as the clayey soils present will be difficult to work when wet. Should the clayey soil become wet and soften it must be removed and replaced with compacted structural fill.
- Where clayey soils are present near surface below structures, the surface of the clayey soil will need to be graded to allow drainage to appropriately designed drains. The drains must be designed to collect water permeating through the granular fill and discharge it clear of the site.
- Where fill is required to achieve the required levels, place and compact approved free draining granular fill, as outlined in Section 7.5, in layers of no greater than 0.3 m loose thickness to the level of compaction specified in Section 7.4. The amount of granular fill required will be dependent on the desired site classification and drainage design.
- Confirm that the specified level of compaction has been achieved to a depth of 0.9 m by testing to the quantities required in AS 3798-2007.

Although the coverage of the site is reasonable on the basis of accepted field investigation practices, the occurrence of undetected unsuitable fill cannot be dismissed. Any deleterious material must be removed from beneath the site and replaced with compacted structural fill.

7.4 Compaction

The required level of compaction for fill and *in situ* soils is outlined below:

- Structural sand fill and *in situ* sand with less than about 5% fines should be compacted to achieve a Perth sand penetrometer (PSP) blow count of at least 8 blows per 300 mm in accordance with AS 1289 6.3.3. If difficulties are experienced with achieving this blow count, then *in situ* density testing may be required to confirm the correlation between Perth sand penetrometer blow count and relative density.
- Materials other than sand should be moisture conditioned and compacted to achieve a Modified dry density ratio of at least 95% in accordance with AS 1289 5.2.1. This is likely to apply where sandy/silty sand contains more than about 5% fines or where fill material comprising both sand and gravel to cobble size pieces is used.

Over excavation and replacement of loose or weak materials may be required where the minimum density cannot be achieved.

Care will need to be taken when compacting in the vicinity of existing buildings, roads, and underground services. This is particularly important if vibratory compaction is being carried out. Tynan (1973)[1] provides assistance with the selection of compaction equipment for use adjacent to structures.

7.5 Structural Fill

7.5.1 Imported Fill

Imported granular fill must comply with the material requirements as stated in AS 3798-2007, “Guidelines on Earthworks for Commercial and Residential Developments”. The fill should comprise clean sand, with less than about 5% fines, that is free of deleterious materials and organic matter.

7.5.2 *In Situ* Soils

The *in situ* sand (other than the topsoil encountered at the surface) present across Area 3 is considered generally suitable for re-use as fill provided that any roots, organic matter and deleterious materials are removed.

The silty sand and gravelly silty sand present over the remainder of the site are considered suitable for re-use as fill provided it is recognised that these materials may not be free draining and the materials may be more difficult to compact as they may be more sensitive to moisture. These materials must not be used where free draining soil is required.

7.6 Excavations

Excavation above the hand auger borehole and test pit refusal depths (refer Table 1) should generally be achieved using standard earthmoving equipment such as a 20-tonne excavator. This is likely to be the case for excavations over most of the site, except in Area 1 and Area 7, and to a lesser extent Area 2, Area 5, and Area 6. Excavation of the relatively shallow granite/gneiss in these areas is expected to generally require a hydraulic rock breaker.

[1] Tynan (1973) Ground Vibration and Damage Effects on Buildings, Australia Road Research Board, Special Report No. 11.

It is not possible to infer whether the rock is massive or a cobble/boulder from hand auger refusal, however at this stage it is recommended that where refusal has occurred it is assumed that massive rock, or large boulders requiring use of a rock breaker for excavation are present.

Excavations in sand and silty sand are particularly prone to instability. Care must be exercised in such excavations and appropriate safety measures adopted where necessary. A short-term excavation slope angle of 1V:1.5H is recommended provided there are no structures or surcharges located behind the slope crest.

Excavations along or close to boundaries may require installation of temporary retention structures to support the ground. It has been our experience that noticeable ground movements nearly always occur behind temporary and permanent retention structures, and care must be taken to ensure adjacent infrastructure or buried services are not damaged.

7.7 Earthwork Bulking Factors

Once excavated, the *in situ* materials are anticipated to bulk up and increase in volume. When placed and compacted the loose volume is anticipated to reduce. Indicative bulking factors are provided in Table 6.

Table 6: Bulking Factors

Soil Type	Bank (*In Situ* Soil)	Stockpiled Materials (Loose Condition)	Compacted Materials
Cohesive Soils	1.0	1.4	0.9
Silty Sand/Sand	1.0	1.2	0.8
Gravel	1.0	1.4	1.0
Rock	1.0	1.6	1.3

The bulking factors are approximate and will depend on the method of excavation and variations of grading of the materials.

7.8 Stormwater Disposal

In situ permeability testing was carried out at the site. The results are summarised in Table 2.

The results of the investigation indicate that across Area 3 the sand present is free draining and suitable for on-site disposal via soakwells or similar. The measured permeability varied between 17 m/day and 64 m/day, which will reduce following compaction due to earthworks or trafficking. For drainage design a permeability of 5 m/day to 10 m/day is considered appropriate for the sand in this area.

Across the remainder of site, the near surface sand/silty sand has a measured permeability of about 3 m/day to 7 m/day, which will reduce where trafficking or compaction occurs. For drainage design a permeability of 1 m/day is considered appropriate for the silty sand. The permeability of the underlying rock and clayey soil may be variable but should be considered to be relatively impermeable for stormwater disposal design, particularly for relatively small drainage features such as soakwells. Suitably designed on-site drainage may be appropriate depending upon the depth of sand/silty sand overlying rock or clayey soil.

Drainage design must allow for clogging of sands with fine particles through ongoing infiltration.

7.9 Pavements

Across Area 3, and also where at least 200 mm of imported sand fill forms the subgrade, a design CBR of 12% is considered appropriate. The sand subgrade in these areas should be compacted to a modified dry density ratio of at least 96% in accordance with AS 1289 5.2.1.

Across the remainder of the site where the *in situ* silty sand forms the subgrade a design CBR of 10% may be adopted. The silty sand subgrade should be compacted to a modified dry density ratio of at least 92% in accordance with AS 1289.5.2.1.

7.10 Effluent Disposal

In situ permeability testing in accordance with AS/ANZ 1547, was carried out at the site. The results are summarised in Table 2.

The results of the investigation indicate the following in accordance with Table 5.1 of AS/NZS 1547:2012:

- Area 3 – The soil in this area extends to significant depth and is considered to be 'Category 1 – Gravels and sands – Structureless (Massive)'.
- Remainder of site – The near surface silty sand/sand across the remainder of the site is considered to be 'Category 2 – Sandy loams – Massive'. The soil extends to varying depth as follows:
  - Area 1 and Area 7 – Rock outcrops occur regularly and at the test locations the silty sand extended to depths of between 0.2 m and 1.9 m. Design will need to consider the presence of relatively shallow rock in some areas that may be relatively impermeable.
  - Area 2 – Relatively shallow sandy clay occurs in this area. At the test locations the silty sand or sandy gravel extended to depths of between 0.4 m and 0.5 m. Design will need to consider the presence of relatively shallow sandy clay that is considered to be 'Category 6 – Medium to heavy clays – Moderately structured'.
  - Area 4 – Relatively deep sand/silty sand occurs in this area. At the test locations the sand/silty sand extended to depths of between 1.5 m and 2.1 m. The underlying clayey sand is considered to be 'Category 4 – Clay loam – Massive'.
  - Area 5 – At the test locations in this area the silty sand extended to depths of at least 1.3 m and 2.0 m.
  - Area 6 – At the test locations in this area the sand/silty sand extended to depths of between 0.8 m and 1.4 m. The underlying clayey sand/sandy clay is considered to be 'Category 5 – Light clays – Massive'.

7.11 Retaining Structures

Retaining structures should be designed in accordance with AS 4678-2002 "Earth-Retaining Structures". Backfill behind retaining structures should be free draining with a fines content of less than 5%. Where retaining structures are required at the site, the parameters provided in Table 7 can be used.

Table 7: Retaining Structure Parameters

Material Type	Unfactored Friction Angle ϕ	Coefficient of Earth Pressure at Rest, K_o	Coefficient of Drained Active Earth Pressure, K_a		Coefficient of Drained Passive Earth Pressure, K_p		Bulk Density kN/m^3
			Wall Friction = 0	Wall Friction = 0.5ϕ'	Wall Friction = 0	Wall Friction = 0.5ϕ'	
Medium dense SAND/Compacted SAND FILL	35°	0.43	0.27	0.24	3.7	6.1	18

Earth pressure coefficients are provided for conditions of zero friction between the wall and the soil. The retaining wall designer should make an independent assessment of the parameters appropriate to the construction method to be used, including alternative values of wall friction. A horizontal ground surface behind the wall has been assumed.

Compaction plant can increase the lateral earth pressures acting on retaining walls. Handheld compaction equipment is recommended within 2 m of any such walls to minimise compaction pressures.

8.0 PAVEMENT DISCUSSION

8.1 Visual Assessment

The existing pavement surfacing along Smiths Beach Road is observed to comprise two types:

- 10 mm laterite Dense Graded Asphalt (DGA) extending from the termination of the road to approximately 100 m south of the eastern carpark, transitioning to,
- 14 mm DGA thereafter until the intersection with Canal Rocks Road.

Deformation of the pavement surface is an important element of pavement condition due to the direct influence it has on the riding quality of a pavement and is often indicative of a pavement's underlying structural inadequacies. As such, surface shape typically governs the nature of the remediation required for a pavement, depending on the magnitude and frequency of estimated future traffic volumes. The shape of pavement along Smiths Beach Road was noted to be in satisfactory condition and no noticeable deformation or structural defects were recorded during the visual assessment.

Although the pavement appears structurally sound, defects relating to the surface texture of the pavement were observed during the visual assessment. Minor to moderate ravelling was recorded in both lanes, mainly outside the wheel paths and at proximity to joints, with a higher frequency of ravelling observed along the northbound lane. Pinhole sized defects are also generally widespread throughout the pavement, which suggests that aggregate has been plucked out of the asphalt surfacing by the traffic movement. The asphalt mix appears to be segregated, which indicates a lack of adhesion and insufficient mix temperature during the original construction. As the asphalt is observed to be relatively new (inferred around two years of age), the early ravelling and pinhole surface defects may also be associated with construction during wet or cold weather.

Other localised defects were noted as follows:

- Minor ravelling observed at the intersection stub of Canal Rocks Road and Smiths Beach Road, on the wheel path of the left turning northbound lane.
- Minor pumping of fines at the joint along the sprayed seal widened edge of the intersection stub. Pumping of fines are generally associated with moisture ingress through cracking or poor joint sealing. No cracking was observed; however, waterproofing was not evident along the joints.
- Minor edge break/drop off on the spray sealed widened section of the intersection stub (northbound side). It was inferred that water drains towards the direction of the sealed section and as it sheds off the edge of pavement, a gradual erosion of the basecourse material causes the observed edge defects, particularly if the basecourse contains non plastic to low plasticity fines.
- Minor potholes on the outer wheel path and adjacent to the inner wheel path of the northbound lane approximately 210 north of the intersection with Canal Rocks Road, and on the edge of the northbound lane pavement approximately 270 m north of the intersection.
- Minor cracking at various locations (longitudinal, transverse, and meandering cracks).
- Minor flushing observed in the wheel paths, predominantly on the southbound lane along the bend of Smiths Beach Road. Despite the tendency for laterite asphalt to crack early during the design life (as the mix is generally stiffer than granite asphalt), minimal to no cracking was noted along the laterite asphalt section of Smiths Beach Road. This suggests that a higher binder content mix may have been used to compensate for the risk of early cracking. As such, the pavement is more prone to flushing, especially in sections of high traffic volume or high turning stresses such as that observed.

Selected photographs and a description of the observed defects are presented in Appendix G.

8.2 Design Traffic

The design traffic for Smiths Beach Road has been assessed using traffic count data supplied by Cardno. The data was collected by Matrix using tube counters installed at six locations along the road. It is noted that the data was collected during the peak holiday season between 16 December 2020 and 6 January 2021 when traffic volumes are higher than normal, and as such the traffic calculated is conservative.

The parameters used in the assessment are as follows:

- Percentage of heavy vehicle using the design lane – 100% (one lane each direction)
- Assumed linear traffic growth rate of 1%
- Pavement design life of 40 years for permanent subgrade deformation and 15 years for fatigue in thin asphalt surfacing in accordance with ERN9.

An axle equivalency factor for commercial vehicle by class was assumed based on available MRWA information for rural main and secondary roads and calculated against the distribution of heavy vehicles (Austroads Class 3 to Class 12 inclusive) provided with the traffic count data. The design traffic calculation can be referred to in Appendix H. We have not considered the carpark access data due to the anomaly in the heavy vehicle count, which may have been caused by an error in the classification of the larger vehicles accessing the carpark. The design traffic calculated from the supplied data has been adopted as follows:

- 1.22×10^5 ESAs for a 15-year design life
- 3.70×10^5 ESAs for a 40-year design life.

8.3 Subgrade Design CBR

Based on the geotechnical laboratory information and our experience with similar material, we consider that a subgrade design CBR value of 12% is appropriate for the existing road.

8.4 Falling Weight Deflectometer

Falling Weight Deflectometer (FWD) testing was carried out by Specialist Testing and Technical Services (STATS) using a trailer-mounted FWD at a target drop stress of 566 kPa. The results of the FWD testing are provided in Appendix E.

Deflection values were assessed using the method outlined in Austroads Guide to Pavement Technology Part 5: Pavement Evaluation and Treatment Design (AGPT05). Due to the variance in the data and in accordance with the Austroads Guide, a selection of homogenous sections was conducted and summarised in Table 8.

Table 8: Falling Weight Deflectometer Results (566 kPa Drop Stress)

Section	No. Tests	Deflection[1] (mm)		
		Mean	Std. Deviation	Characteristic
Northbound				
CH 0.0 – CH 0.527	22	0.398	0.09	0.521
CH 0.527 – CH 0.677	4	0.687	0.17	0.875[2]
CH 0.677 – CH 0.993	14	0.420	0.10	0.555
Southbound				
CH 0.990 – CH 0.665	13	0.286	0.07	0.376
CH 0.665 – CH 0.465	5	0.727	0.18	0.969[2]
CH 0.465 – CH 0.015	15	0.355	0.09	0.472

Notes: Chainage reference commences at CH 0.0 at the intersection of Smiths Beach Road and Canal Rocks Road

[1] Values include FWD deflection standardisation factor of 1.1. Outliers have been excluded from the assessment.

[2] Characteristic deflection equals to maximum deflection as the section has less than 10 test points.

Based on the assessed design traffic volume in Section 8.2 and the Austroads criteria, a design deflection of 1.32 mm has been calculated. As the characteristic deflections within each section and lanes are less than the design deflection, an overlay is not required to strengthen the existing pavement.

8.5 Pavement Design (New and Existing Pavements)

An empirical and mechanistic assessment of the required pavement thickness for the design traffic loading has been conducted. The empirical design method followed Austroads Guidelines and assesses the required cover over the subgrade. The mechanistic design assesses the fatigue life of the asphalt surfacing. The mechanistic design was undertaken using the pavement design program CIRCLY 6.0. A posted speed of 40 km/h (design speed of 30 km/h) was assumed for the site. The asphalt fatigue life was assessed with the 15-year design traffic loading for the following surfacing type:

- 30 mm thickness – 10 mm Dense Graded Asphalt with C170 binder
- 40 mm thickness – 10 mm Dense Graded Asphalt with C170 binder.

The assumed flexible pavement and subgrade material properties are summarised in Table 9.

Table 9: Summary of Assumed Material Properties

Material	Vertical Modulus of Elasticity (MPa) at 29°C	Poisson's Ratio (ν)	Degree of Anisotropy
Dense graded asphalt[(1)] (C170, 10 mm, 30 km/h)	2,310	0.40	1.0
Granular Basecourse	500	0.35	2.0
Granular Sub-base	250	0.35	2.0
Subgrade (CBR 12%)	120 (10 × CBR)	0.35	2.0

Notes: CBR – California Bearing Ratio

(1) to match the existing pavement, dense graded laterite asphalt may be used if preferred.

The mechanistic assessment indicated that a minimum granular pavement thickness of 140 mm is required to satisfy the asphalt fatigue requirements for the 30 mm thick surfacing option, which is already achieved by the existing pavement thickness. Where a 40 mm thick surfacing may be required to match existing pavement levels, a minimum granular thickness of 165 mm will be required, which is achieved at all pavement dipping locations except for PD02. The pavement design outputs are included in Appendix I.

The empirical design requires a minimum pavement thickness of 205 mm for the design traffic. The pavement dipping PD02 indicated a deficiency in the granular thickness of 55 mm (pavement thickness 150 mm). The empirical assessment was conducted using a subgrade design CBR of 12% and the soaked subgrade CBR measured during the laboratory testing varied between 13% to 17%, which indicates that the subgrade strength is higher than the design assumption. There is also a level of conservatism in the design traffic due to the availability of data and the expected significantly lower traffic outside of peak holiday season. On this basis and supported by the observed condition of the existing pavement, the deficiency in pavement thickness observed at pavement dipping PD02 is not considered to require remediation at this stage. It should be noted however that there is a higher risk of shape loss at this location especially if there is an increase in future traffic loading (such as during construction of the redevelopment).

As the existing pavement is observed to be structurally sound, a resurfacing design is presented as an option if a new pavement surfacing is preferred for the proposed development. It may also be necessary to provide new pavements to accommodate possible geometry changes during the proposed development. Due to the proposed development plan, we have not provided a design for the intersection of Smiths Beach Road and Canal Rocks Road. The recommended midblock granular pavement design is shown in Table 10.

Table 10: Summary of Granular Pavement Requirements

Layer	Pavement and Surfacing Requirement (mm)
New Pavement (In areas of new pavement and widening)	
10 mm dense graded asphalt(2) with C170 binder	30
Prime, 2 coat bitumen emulsion seal (CRS170/60, 10 mm/5 mm) or 7 mm emulsion seal	Nominal thickness
Granular Basecourse (Crushed Rock(1), Laterite Gravel or Bitumen Stabilised Limestone)	205
Resurfacing (Existing Pavements)	
10 mm dense graded asphalt(2) with C170 binder	30 or 40
Prime, 2 coat bitumen emulsion seal (CRS170/60, 10 mm/5 mm) or 7 mm emulsion seal (Where basecourse is exposed). or SAMI (where existing asphalt surfacing remains)	Nominal thickness
Existing Pavement	150 to greater than 480

Notes: (1) It may be difficult to achieve the compaction requirements for placement of crushed rock directly on the subgrade. A sub-base layer may be required.

(2) to match the existing pavement, dense graded laterite asphalt may be used if preferred.

8.6 Sealing

Preliminary seal application rates for the new pavement design are presented in Table 11. The preliminary rates will need to be adjusted to suit the aggregate used and site conditions. The seal should be applied in warm and dry weather with no cutter used in the binder. A 10/5 mm emulsion seal is recommended below asphalt. A 7 mm single coat emulsion seal could also be considered; however, a single coat seal will be more prone to damage from the paver during application of the asphalt. Any damage to the seal must be repaired during construction.

If due to traffic management requirements a cut back prime is not preferred, an emulsion prime such as Bioprime/Ecoprime or omission of the prime could be considered. The following should be noted however:

- Our experience is that emulsion primes may not penetrate as well as cut-back primes and the level of penetration will be highly dependent upon the basecourse material finish and basecourse type. Further information should be sought from the supplier on the selected emulsion prime's expected performance for the basecourse material proposed.
- The omission of the prime does increase the risk of an inadequate bond forming between the seal and basecourse. If this option is preferred the basecourse should be adequately swept to expose the gravel particles and the applied seal must be an emulsion seal. Each seal coat should receive a minimum of 15 roller passes to assist in bedding down the aggregate.

Emulsion primes should be cured in accordance with the manufacturer's instructions. We understand a curing period of about 24 hours is typical, depending on weather conditions. A cutback prime should be allowed to cure for a minimum period of three days of warm, dry weather prior to application of the seal.

Table 11: Preliminary Bituminous Surfacing Application Rates

Treatment Type	Binder Type	Aggregate Size	BAR/EAR (L/m^2 at 15°C)	ASR(2) (m^2/m^3)
Prime	40/60 Bitumen (C170)/ Medium curing cutter or Bioprime/Ecoprime	Not Applicable	0.6(1) (total application rate)	Not Applicable
Single coat seal	CRS 170/60	7 mm	1.4	160-180
Double/double bitumen emulsion seal	CRS 170/60	1st coat 10 mm	0.9	120-140
		2nd coat 5 mm	1.1	200-250

Treatment Type	Binder Type	Aggregate Size	BAR/EAR (L/m^2 at 15°C)	ASR[2] (m^2/m^3)
Strain Alleviating Membrane Interlayer	S20E	10 mm	1.5	120-160

Notes: BAR – binder application rate, ASR – aggregate spread rate, EAR – emulsion application rate (CRS170/60)

(1) The emulsion prime application rate should be confirmed with the supplier

(2) Preliminary aggregate spread rates will need to be adjusted to suit aggregate properties

8.7 Pavement Joints

Pavement joints should be in accordance with standard MRWA joint drawings where applicable.

8.8 Pavement Rehabilitation

The pavement and surfacing condition on Smiths Beach Road were generally observed to be in satisfactory condition and relatively early in its design life. Based on the visual and FWD assessment, we anticipate the pavement to be in serviceable condition for about another five to ten years (or possibly longer with routine maintenance) under the current traffic loading. However, the pavement and surfacing will need to be monitored due to the anticipated increase in traffic loading during the construction of the development and provision for localised repairs should be made.

As discussed in Section 8.5, a section approximately 70 m south of Duddy Road is inferred to have insufficient granular thickness, as indicated by pavement dipping PD02. Monitoring of this section is recommended as there is a risk that the pavement will develop shape loss.

We further recommend that the observed surface defects such as cracking and potholes be repaired under the methods outlined in the following sub-sections. As discussed in Section 8.1, the observed edge break and drop-off along the sealed widening of the intersection is inferred to have occurred due to concentrated stormwater flow and the non-plastic to low plasticity of the basecourse gravel. We recommend a top up and rework of the unsealed basecourse in this section to prevent further erosion of the material.

8.8.1 Pothole and Small Defect Repair

It is our experience that potholes can deteriorate rapidly, requiring further repairs. As such, localised repairs may be required where potholes and small defects are observed.

The following methodology is recommended for potholes, particularly in areas subject to heavy vehicle movements:

- Cut the pavement outside the edges of the pothole to form a rectangular area with vertical sides.
- Remove loose material from the sides and base of the pothole to leave a flat base.
- Clean the pothole by sweeping, blowing with air or another suitable method to remove loose material that may affect adhesion of the asphalt.
- Apply a tack coat of bitumen emulsion to the base and sides of the pothole and allow to break (turn black).
- Backfill with hot mix (preferred) or high-quality cold-mix asphalt (such as Fulton Hogan EZ Street) and compact with appropriate plant. Our experience is that hand compacted asphalt can settle under traffic and therefore the repaired area should be left proud of the surrounding pavement to allow for this.

Thin layers of asphalt should not be used to make up minor level differences as they can delaminate, particularly if the surface is dusty.

8.8.2 Crack Sealing

A pavement work tip produced by Austroads outlines the recommended treatment for cracking and is included in Appendix J.

8.8.3 Edge and Shoulder Maintenance

The following methodology is recommended for the remediation of the observed edge defect at the Canal Rocks Road and Smiths Beach Road intersection stub.

- Clear vegetation from the existing shoulder if required.
- Scarify the existing shoulder material to at least 50 mm depth to facilitate bonding with the top-up material.
- Add basecourse material as required, and using a grader blade or similar, redistribute the shoulder material towards the existing seal and leave slightly proud of the existing seal level.
- Moisture condition and compact the shoulder. The final level of the shoulder should be approximately level with the existing seal level and provide crossfall for drainage. If the shoulder is proud of the seal it may restrict drainage or promote channelisation, leading to scour. In this case it should be graded flush with the seal, taking care not to damage the existing seal.

Our experience is that shoulder material with low fines content or low plasticity fines may be more susceptible to erosion. If available, a slightly higher-plasticity material should be used for these works.

9.0 PAVEMENT SPECIFICATIONS AND CONSTRUCTION

9.1 Specifications

The following MRWA specifications may be relevant for the design and rehabilitation options provided in this report. Alternatively, the City of Busselton may have specifications (such as WALGA Specifications) preferred for this project.

- Specification 501 – Pavements
- Specification 503 – Bituminous Surfacing
- Specification 504 – Asphalt Wearing Course
- Specification 508 – Cold Planing
- Specification 509 – Polymer Modified Bituminous Surfacing
- Specification 511 – Materials for Bituminous Treatments.

9.2 Compaction and Dryback

In areas of new pavement, it is essential that all granular pavement layers are well compacted and dried back prior to priming and sealing. It should be noted that failure to allow pavement layers to adequately dry back is a significant cause of pavement defects.

Minimum compaction and dryback requirements are presented in Table 12.

Table 12: Compaction and Dryback Requirements

Material Type	Density Specification Limit (%)*	Dry Back Moisture Ratio (%)*
Sub-base – Crushed Limestone	94	85
Granular Basecourse – Bitumen Stabilised Limestone or Natural Gravel	98	70
Granular Basecourse – Crushed Rock	99	60

Note: * Modified Compactive Effort

9.3 Asphalt

A nominal 30 mm thickness of 10 mm dense graded asphalt with C170 binder is recommended for Smiths Beach Road. Localised sections of the road more frequently exposed to turning vehicle movements (such as the bend, south of the public carpark) may experience earlier pavement defects compared to the remaining sections of the road. However, due to the relatively low heavy vehicle traffic and climate conditions at the site, we do not consider the use of a polymer modified binder such as A15E as necessary.

It is recommended that the MRWA Specification 504 be used as a basis for asphalt mix design. It is also recommended that approved asphalt mixes registered by MRWA be used if practicable.

9.4 Construction Advice

If it is anticipated that construction vehicles will be allowed to traffic Smiths Beach Road throughout the proposed development of the site, we highly recommend scheduling the pavement repairs and upgrades towards the end of construction. Excessive heavy vehicle use of the road must be avoided due to the high risk of shoving and rutting on a newly constructed or resurfaced pavement.

It is further recommended that pavement works be conducted in dry conditions to avoid complications with dry back and compaction. In situations where construction takes place over several days or if inclement weather is forecasted during construction, the construction should be staged as to minimise exposure to external moisture conditions.

9.5 Pavement Drainage

Performance of granular pavements is highly sensitive to the in-service moisture content. It is essential that adequate crossfall and drainage is provided to remove water from pavements, particularly in low-lying areas of the site.

10.0 ROCK DURABILITY DISCUSSION

The subsurface conditions encountered along the coastline on the northern edge of the proposed development are summarised in Section 6.3, and Figures 6 and 7 provide sections showing the inferred profile.

The section shows the thickness of soil and very low to low strength (weak) rock, overlying medium to high strength rock. The soil and weak rock are considered to be susceptible to erosion by the action of the ocean in the coming century, while the underlying medium to high strength rock is considered to have sufficient durability to withstand erosion.

As shown on Figure 6, the thickness of the soil and weak rock increases gradually towards the south-east, extending to between about RL 4.5 m AHD at BH1 and about RL -1 m AHD at BH5. Between BH5 and BH4 the underlying rock surface falls away significantly and soil extends to below RL -10 m AHD at BH4.

11.0 IMPORTANT INFORMATION

Your attention is drawn to the document titled – “Important Information Relating to this Report”, which is included in Appendix K of this report. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Golder has under the contract between it and its client.

Signature Page

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1:250,000 METRES

NOTE:
1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE:
1. IMAGE SOURCED FROM GEOSCIENCE AUSTRALIA 1:250,000 TOPOGRAPHIC MAPPING.

CLIENT
SMITHS 2014 PTY LTD

PROJECT
PROPOSED SMITHS BEACH DEVELOPMENT

CONSULTANT
GOLDER

YYYY-MM-DD	2021.10.19
DESIGNED	TC
PREPARED	AM / JRP
REVIEWED	DJK
APPROVED	DJK

TITLE
LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
20435097	001 R	0	1

PATH: B:\Hesperia\Yallingup\99_PROJECTS\20435097_Proposed_Smiths_Beach_Development\02_PRODUCTION\MXD\001-R\Rev0\20435097-001-R-F001-Rev0.mxd PRINTED ON: 2021-10-19 AT: 2:36:01 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A4

25mm

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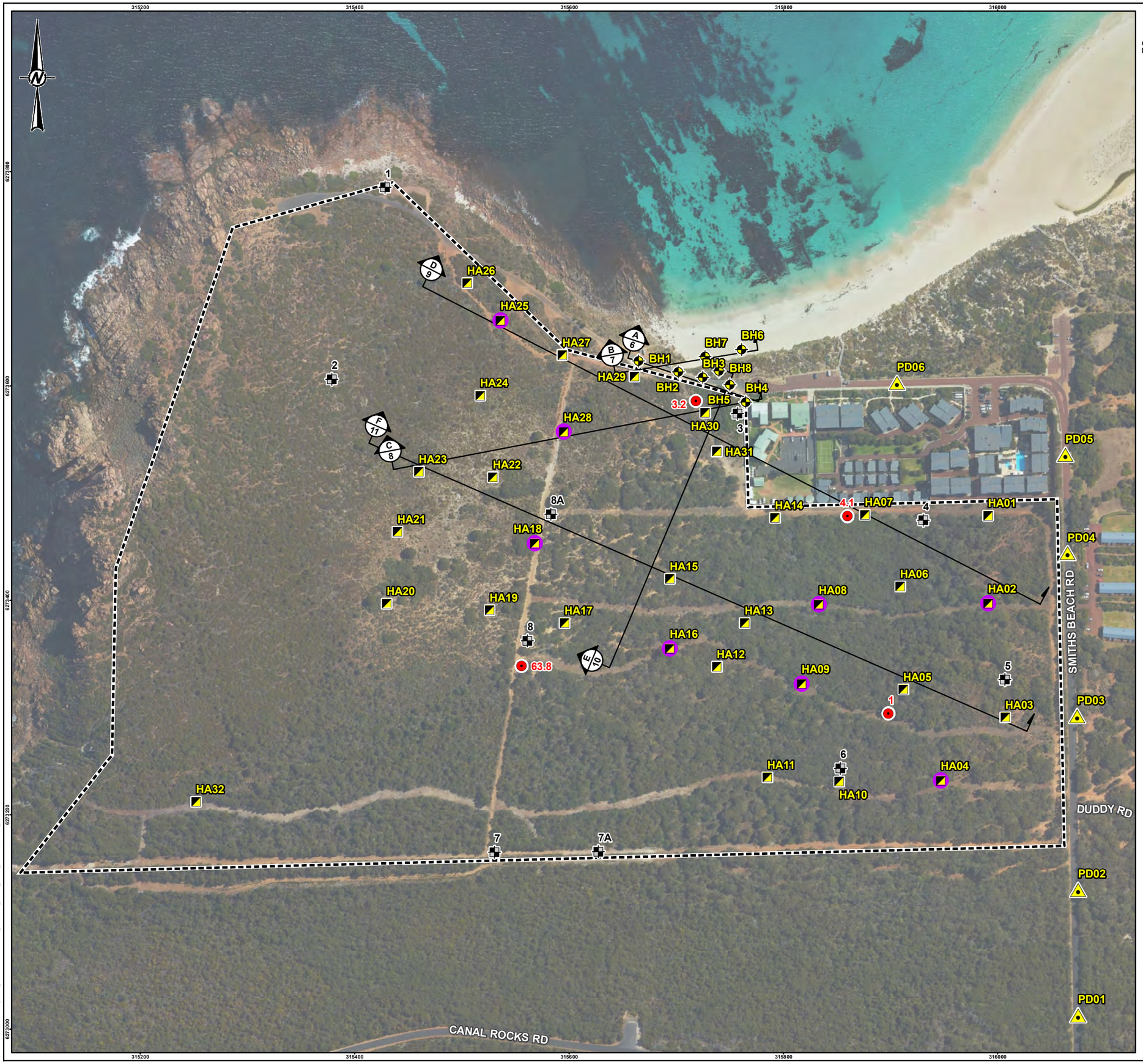


LEGEND

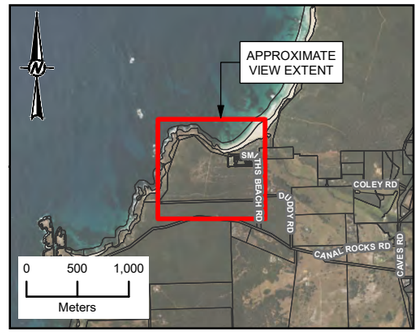
- CADASTRE
- APPROXIMATE SITE BOUNDARY

TEST INVESTIGATION

- BOREHOLE LOCATION
- HAND AUGER LOCATION
- HAND AUGER AND PERMEABILITY TEST LOCATION
- PAVEMENT DIPPING LOCATION

PREVIOUS INVESTIGATION

- TEST PIT - DOUGLAS PARTNERS 2009
- PERMEABILITY TEST LOCATION - hyd2o
- 4.1 PERMEABILITY (m/DAY)



0 100 200

1:3,500 METRES

NOTE:
1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE:
1. CADASTRE AND AERIAL IMAGERY BASED ON INFORMATION PROVIDED BY AND WITH THE PERMISSION OF THE WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2020).

CLIENT
SMITHS 2014 PTY LTD

PROJECT
PROPOSED SMITHS BEACH DEVELOPMENT

TITLE
SITE PLAN

CONSULTANT
GOLDER

YYYY-MM-DD	2021-10-19
DESIGNED	TC
PREPARED	AM
REVIEWED	DJK
APPROVED	DJK

PROJECT NO.	CONTROL	REV.	FIGURE
20435097	001 R	0	2

PATH: B:\Hesperia\Yallingup\99_PROJECTS\20435097_Proposed_Smiths_Beach_Development\02_PRODUCTION\MXD\001-R\Rev0\20435097-001-R-F002-Rev0.mxd PRINTED ON: 2021-10-19 AT: 2:43:25 PM
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0 25mm

315640 315660 315680 315700 315720 315740 315760 315780

6271660 6271640 6271620 6271600 6271580 6271560 6271540

BH1 BH2 BH3 BH4 BH5 BH6 BH7 BH8

HA29 HA30 HA31

3.2

3

A 6

B 7

SMITHS BEACH RD

ARTIFICIAL SOAK

SECTION C

SECTION D

SECTION E

LEGEND

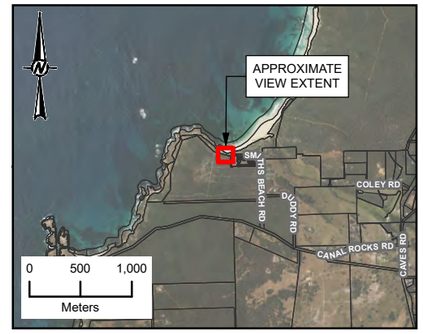
- CADASTRE
- APPROXIMATE SITE BOUNDARY

TEST INVESTIGATION

- BOREHOLE LOCATION
- HAND AUGER LOCATION
- HAND AUGER AND PERMEABILITY TEST LOCATION
- INFILTRATION TEST
- PAVEMENT DIPPING LOCATION

PREVIOUS INVESTIGATION

- TEST PIT - DOUGLAS PARTNERS 2009
- PERMEABILITY TEST LOCATION - hyd2o
- 4.1 PERMEABILITY (m/DAY)



0 10 20

1:500 METRES

NOTE:
1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCES:
1. CADASTRE AND AERIAL IMAGERY BASED ON INFORMATION PROVIDED BY AND WITH THE PERMISSION OF THE WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2021).
2. SITE LAYOUT OVERLAY PROVIDED BY CLIENT (PDF FORMAT). DRAWING FILE: SMITHS DRAFT MASTERPLAN DECEMBER 2020.PDF

CLIENT
SMITHS 2014 PTY LTD

PROJECT
PROPOSED SMITHS BEACH DEVELOPMENT

TITLE
SITE PLAN – NORTH EAST CORNER

CONSULTANT
GOLDER

YYYY-MM-DD	2021-10-19
DESIGNED	TC
PREPARED	AM / JRP
REVIEWED	DJK
APPROVED	DJK

PROJECT NO.	CONTROL	REV.	FIGURE
20435097	001 R	0	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3 25mm 0

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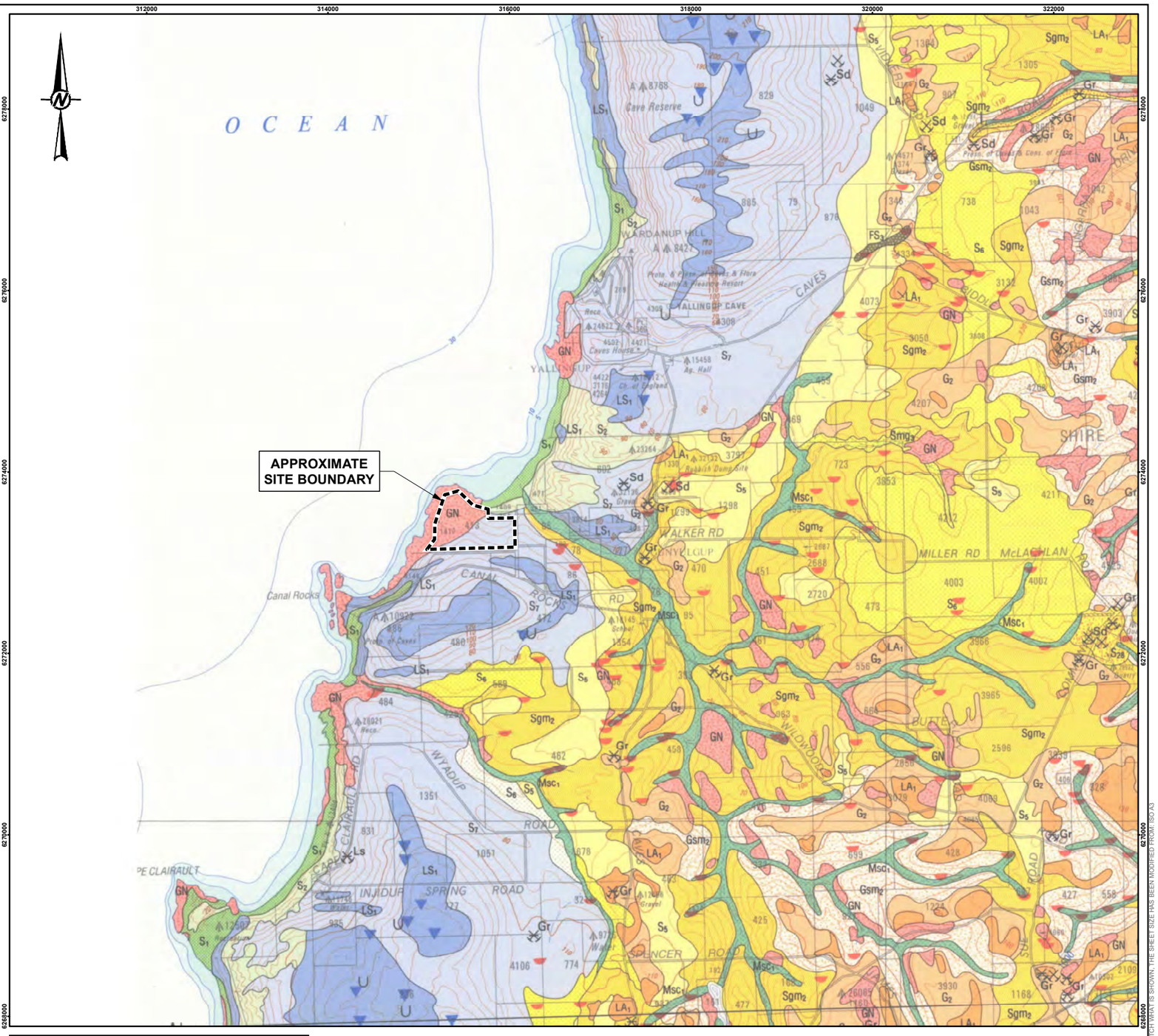
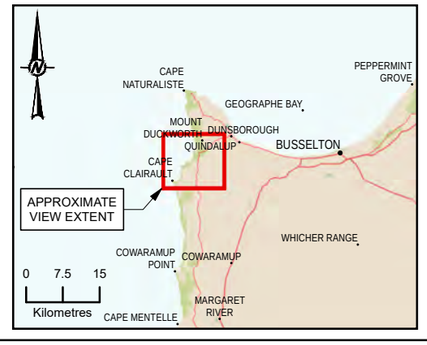
GENERAL FEATURES:

Map unit[1] Unconsolidated material[2]	Map unit[1] Rock[2]	Description
Spc_1		CLAYEY PEATY SAND — grey to black quartz sand with variable organic content; minor clays
S_1		CALCAREOUS SAND — white, fine- to coarse-grained, sub-rounded quartz and shell debris; also sub-rounded lithic pebbles
S_2		CALCAREOUS SAND — white, fine- to medium-grained, sub-rounded quartz and shell debris
S_{13}		CALCAREOUS SAND — white, medium-grained, rounded quartz and shell debris; well sorted
S_{26}		CALCAREOUS SAND — as S_{13}, modified by estuarine and marine processes
S_{27}		SAND — as S_{26} as a relatively thin layer of quartz and calcareous sand over variably thick estuarine silts and gley clays
M_6		SILT — brownish grey, calcareous in part, soft; some fine sand and shell debris in places, minor clay content
M_5		CALCAREOUS SILT — dark greyish brown silts and minor clays; some organic matter, shells and shell fragments and limestone are locally common
Sm_1		SILTY SAND — strong brown to reddish brown, fine- to medium-grained quartz; variable silt content
Msc_1		CLAYEY SANDY SILT — pale brown, angular to rounded sand; low cohesion; of alluvial origin
Smg_3		GRAVELLY SILTY SAND — very pale yellow to yellowish grey, mottled, fine- to medium-grained, quartz; locally high concentrations of pisoliths, variable silt content
G_1		GRAVEL — red-brown gravels set in silty matrix overlying ironstones, cemented limonitic gravels, and coarse sands
	FS_1	IRONSTONE — red-brown limonitic gravel cemented in a limonite quartz-sand matrix
Sm_{12}		SILTY SAND — yellowish brown to reddish brown, fine- to medium-grained quartz; some pisolithic gravels, variable silt content
Smg_4		GRAVELLY SILTY SAND — moderate brown to dark yellowish brown, fine- to coarse-grained, poorly sorted quartz variable silt content
S_7		SAND — white to pale and olive-yellow, medium- to coarse-grained, sub-angular quartz; moderately sorted
	LS_7	LIMESTONE — light yellowish brown, fine- to coarse-grained, sub-angular to well-rounded quartz with shell, coral and, less commonly, crinoid debris; often overlain by S_7
	LS_1	LIMESTONE — light yellowish brown, fine- to coarse-grained, sub-angular to well-rounded quartz, with shell debris and a trace of feldspar; kankar at surface common
S_8		SAND — very light grey at surface, yellow at depth, fine- to medium-grained, sub-rounded quartz; moderately well sorted; local concentrations of heavy minerals, local development of coffee rock
S_{10}		SAND over SILT and SANDY SILT — sand as S_8 overlying Ms_2
Ms_2		SANDY SILT — strong brown to mid-grey, mottled, blocky, disseminated fine sand, hard when dry
Sm_2		SILTY SAND — brown to yellow-grey, fine- to medium-grained quartz sand with variable silt content
S_{12}		SAND — white, medium- to very coarse-grained, sub-rounded to rounded quartz; well sorted; local concentrations of heavy minerals
S_5		SAND — very pale brown, medium- to coarse-grained, well sorted, sub-angular to rounded quartz and feldspar
S_6		SAND — light grey, fine- to coarse-grained, angular to sub-rounded quartz with some feldspar; moderately sorted, loose
S_{28}		SAND — white, coarse- to very coarse-grained, rounded quartz, occasional pebble and cobble beds
Sgm_2		SILTY GRAVELLY SANDS — moderate brown to reddish brown, mottled, fine- to coarse-grained quartz; trace feldspar, pisolithic gravels, variable silt content
Gsm_2		SILTY SANDY GRAVELS — moderate brown, mottled, pisolithic gravels and quartz; variable silt content, often thinly overlying gneiss (GN)
Smg_5		GRAVELLY SILTY SAND — dark reddish brown, mottled fine- to coarse-grained, quartz and feldspar and gneiss gravels; thinly developed over gneiss (GN)
G_2		GRAVEL — brown to reddish brown, ferruginous, pisolithic; occasionally cemented in a clay-silt matrix, moderately sorted
	LA_1	LATERITE — massive and cemented, occasionally vesicular, up to 4m in thickness; overlies mottled and/or pallid clays, sometimes overlain by a ferruginous gravel set in a clay-sand matrix
	LA_3	LATERITE — massive, indurated, nodular and vesicular, iron-cemented, contains abundant fine- to medium-grained sub-angular quartz; developed over Leederville Formation
Cms_1		SANDY SILTY CLAY — pale yellow to red, mottled; grades into weathered gneissic rock (GN) at depth, often overlain by pisolithic gravels
Smc_3		CLAYEY SILTY SAND — off-white to brown, mottled, fine- to coarse-grained, sub-rounded sand with local concentrations of clay; variable silt content
	GN	GNEISS — medium-grained mesocratic gneiss





NOTE:
1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCE:
YALLINGUP
SHEET 1930 IV AND PART SHEET 1830 I
1:50000 ENVIRONMENTAL GEOLOGY SERIES
© WESTERN AUSTRALIA 1991

CLIENT
SMITHS 2014 PTY LTD

CONSULTANT
GOLDER

YYYY-MM-DD	2021-10-19
DESIGNED	TC
PREPARED	AM / JRP
REVIEWED	DJK
APPROVED	DJK

PROJECT
PROPOSED SMITHS BEACH DEVELOPMENT

TITLE
GEOLOGY MAP

PROJECT NO.	CONTROL	REV.	FIGURE
20435097	001 R	0	4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3
0 25mm

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315200 315400 315600 315800 316000

6271800 6271600 6271400 6271200 6271000

1 2 3 4 5 6 7 8A 8

HA01 HA02 HA03 HA04 HA05 HA06 HA07 HA08 HA09 HA10 HA11 HA12 HA13 HA14 HA15 HA16 HA17 HA18 HA19 HA20 HA21 HA22 HA23 HA24 HA25 HA26 HA27 HA28 HA29 HA30 HA31 HA32

BH1 BH2 BH3 BH4 BH5 BH6 BH7 BH8

PD01 PD02 PD03 PD04 PD05 PD06

3.2 4.1 63.8 1

SMITHS BEACH RD

DUDDY RD

CANAL ROCKS RD

PATH: B:\Hesperia\Yallingup\99_PROJECTS\20435097_Proposed_Smiths_Beach_Development\02_PRODUCTION\MXD\001-R\Rev0\20435097-001-R-F005-Rev0.mxd PRINTED ON: 2021-10-19 AT: 2:36:18 PM

LEGEND

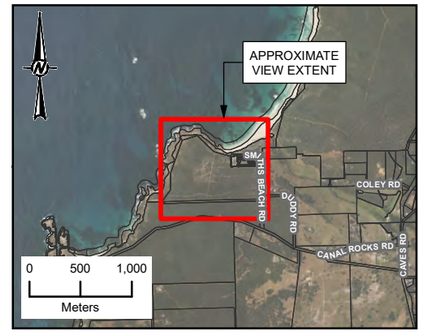
- CADASTRE
- APPROXIMATE SITE BOUNDARY
- PRELIMINARY GEOTECHNICAL AREAS

TEST INVESTIGATION

- BOREHOLE LOCATION
- HAND AUGER LOCATION
- HAND AUGER AND PERMEABILITY TEST LOCATION
- PAVEMENT DIPPING LOCATION

PREVIOUS INVESTIGATION

- TEST PIT - DOUGLAS PARTNERS 2009
- PERMEABILITY TEST LOCATION - hyd2o
- 4.1 PERMEABILITY (m/DAY)



0 100 200

1:3,500 METRES

NOTE:
1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

REFERENCES:
1. CADASTRE AND AERIAL IMAGERY BASED ON INFORMATION PROVIDED BY AND WITH THE PERMISSION OF THE WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2020).
2. SITE LAYOUT OVERLAY PROVIDED BY CLIENT (PDF FORMAT). DRAWING FILE: SMITHS DRAFT MASTERPLAN DECEMBER 2020.PDF

CLIENT
SMITHS 2014 PTY LTD

PROJECT
PROPOSED SMITHS BEACH DEVELOPMENT

TITLE
PRELIMINARY GEOTECHNICAL AREAS

CONSULTANT
GOLDER

YYYY-MM-DD	2021-10-19
DESIGNED	TC
PREPARED	AM
REVIEWED	DJK
APPROVED	DJK

PROJECT NO.	CONTROL	REV.	FIGURE
20435097	001 R	0	5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

0 25mm

NORTH-WEST

SOUTH-EAST

APPROXIMATE GROUND LEVEL

BH1 (0 m)

BH2 (3 m)

BH3 (5 m)

BH5 (6 m)

BH4 (4 m)

SOIL

VL-L STRENGTH

M-H STRENGTH (HIGH DURABILITY)

SOIL

M-H STRENGTH (HIGH DURABILITY)

M

H

VH - EH

VL - M

VL

M - H

VL - M

L

M

M - H

M

M

L

M

VH

N=25

N=12

N=38

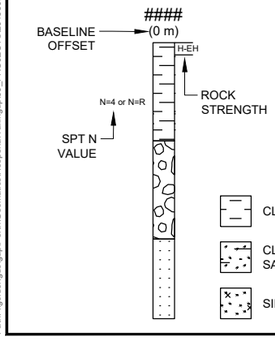
ELEVATION (m AHD)

8
6
4
2
0
-2
-4
-6
-8
-10
-12

0
20
40
60
80
100
120

DISTANCE (m)

LEGEND



CLAY
SAND
SOIL
CLAYEY SAND
GNEISS
VL-L STRENGTH
SILTY SAND
CORE LOSS
M-H STRENGTH (HIGH DURABILITY)

0 2.5 5
1:100 V METRES

0 10 20
1:400 H METRES

NOTES

1. MATERIAL BOUNDARIES SHOWN ARE CONJECTURAL AND ARE BASED ON GEOLOGICAL INTERPRETATION.

CLIENT
SMITHS 2014 PTY LTD

PROJECT
PROPOSED SMITHS BEACH DEVELOPMENT

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-19
DESIGNED	TC
PREPARED	JRP
REVIEWED	DJK
APPROVED	DJK

TITLE
INFERRED SUBSURFACE SECTION A

PROJECT NO.	CONTROL	REV.	FIGURE
20435097	001 R	0	6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

0 25 mm

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SOUTH-WEST

NORTH-EAST

ELEVATION (m AHD)

10
8
6
4
2
0
-2
-4
-6
-8
-10

0
20
40
60
80
100
120

DISTANCE (m)

BH1
(8 m)

BH2
(-8 m)

BH7
(2 m)

BH6
(3 m)

SOIL

APPROXIMATE
GROUND LEVEL

VL-L STRENGTH

M-H STRENGTH
(HIGH DURABILITY)

SP

N=41

SC/CI

CI

SOIL

M-H STRENGTH
(HIGH DURABILITY)

LEGEND

BASELINE OFFSET ####
(0 m)

H-EH

ROCK STRENGTH

N=4 or N=R

SPT N VALUE

CLAY
CLAYEY SAND
SILTY SAND
SAND
GNEISS
CORE LOSS
SOIL
VL-L STRENGTH
M-H STRENGTH (HIGH DURABILITY)

0 2.5 5
1:100 V METRES

0 10 20
1:400 H METRES

NOTES

1. MATERIAL BOUNDARIES SHOWN ARE CONJECTURAL AND ARE BASED ON GEOLOGICAL INTERPRETATION.

CLIENT
SMITHS 2014 PTY LTD

PROJECT
PROPOSED SMITHS BEACH DEVELOPMENT

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-19
DESIGNED	TC
PREPARED	JRP
REVIEWED	DJK
APPROVED	DJK

TITLE
INFERRED SUBSURFACE SECTION B

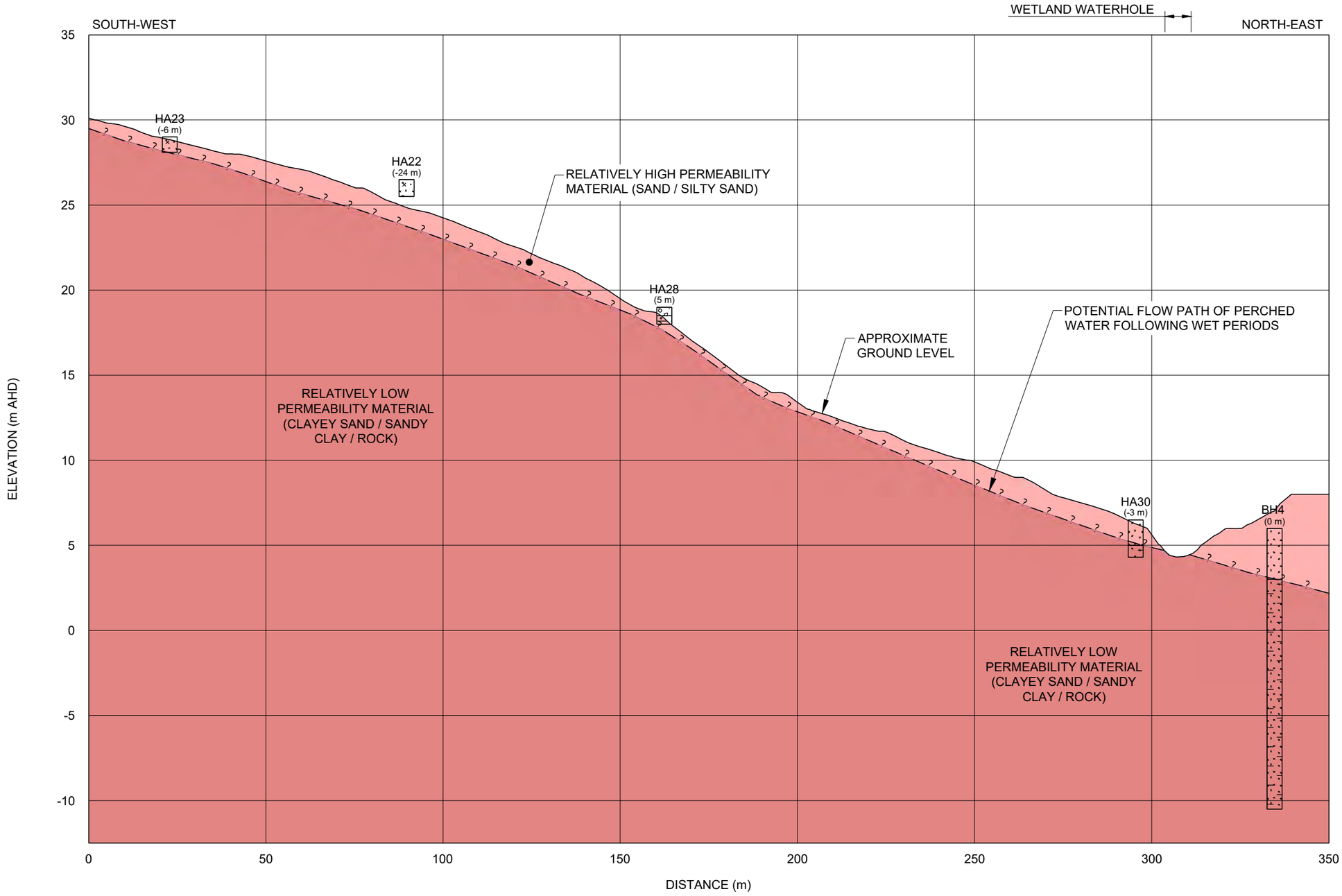
PROJECT NO.	CONTROL	REV.	FIGURE
20435097	001 R	0	7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

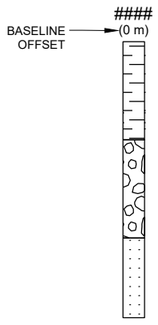
25 mm

0

Path: \\golder.gds\gap\Perth\Geomatics\Hesperia\Yallingup\99_PROJECTS\20435097_Proposed_Smiths_Beach_Development\02_PRODUCT\CN\FIGURES\ | File Name: 20435097-001-R-006-011.dwg | Last Edited By: jpellis Date: 2021-10-19 Time:2:16:19 PM. | Printed By: jpellis Date: 2021-10-19 Time:2:18:01 PM.



LEGEND



- SANDY GRAVEL
- SAND
- CLAYEY SAND
- SANDY CLAY
- SILTY SAND
- RELATIVELY HIGH PERMEABILITY MATERIAL (SAND / SILTY SAND)
- RELATIVELY LOW PERMEABILITY MATERIAL (CLAYEY SAND / SANDY CLAY / ROCK)

0 5 10
1:250 V METRES

0 30 60
1:1200 H METRES

NOTES

1. MATERIAL BOUNDARIES SHOWN ARE CONJECTURAL AND ARE BASED ON GEOLOGICAL INTERPRETATION.

CLIENT
SMITHS 2014 PTY LTD

PROJECT
PROPOSED SMITHS BEACH DEVELOPMENT

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-19
DESIGNED	TC
PREPARED	JRP
REVIEWED	DJK
APPROVED	DJK

TITLE
INFERRED SUBSURFACE SECTION C

PROJECT NO.	CONTROL	REV.	FIGURE
20435097	001 R	0	8

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25 mm

0

Path: \\golder.gds\gal\Perth\Geomatics\Hesperia\Yallingup\99_PROJECTS\20435097_Proposed_Smiths_Beach_Development\02_PRODUCTION\FIGURES\ | File Name: 20435097-001-R-006-011.dwg | Last Edited By: jpellis Date: 2021-10-19 Time:2:16:19 PM | Printed By: jpellis Date: 2021-10-19 Time:2:18:11 PM

NORTH-WEST

SOUTH-EAST

ELEVATION (m AHD)

30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0

HA02
(+22 m)

APPROXIMATE
GROUND LEVEL

HA26
(22 m)

HA25
(5 m)

HA27
(3 m)

POTENTIAL FLOW PATH OF PERCHED
WATER FOLLOWING WET PERIODS

HA14
(-42 m)

HA29
(16 m)

HA31
(-11 m)

HA30
(16 m)

RELATIVELY LOW
PERMEABILITY MATERIAL
(CLAYEY SAND / SANDY CLAY / ROCK)

RELATIVELY HIGH PERMEABILITY
MATERIAL (SAND / SILTY SAND)

RELATIVELY LOW PERMEABILITY MATERIAL
(CLAYEY SAND / SANDY CLAY / ROCK)

0 100 200 300 400 500 600

DISTANCE (m)

LEGEND

BASELINE OFFSET ####(0 m)

Sandy CLAY
CLAYEY SAND
SILTY SAND
SAND
TOPSOIL

RELATIVELY HIGH PERMEABILITY MATERIAL (SAND / SILTY SAND)

RELATIVELY LOW PERMEABILITY MATERIAL (CLAYEY SAND / SANDY CLAY / ROCK)

0 2.5 5
1:150 V METRES

0 50 100
1:2,000 H METRES

NOTES

1. MATERIAL BOUNDARIES SHOWN ARE CONJECTURAL AND ARE BASED ON GEOLOGICAL INTERPRETATION.

CLIENT
SMITHS 2014 PTY LTD

PROJECT
PROPOSED SMITHS BEACH DEVELOPMENT

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-19
DESIGNED	TC
PREPARED	JRP
REVIEWED	DJK
APPROVED	DJK

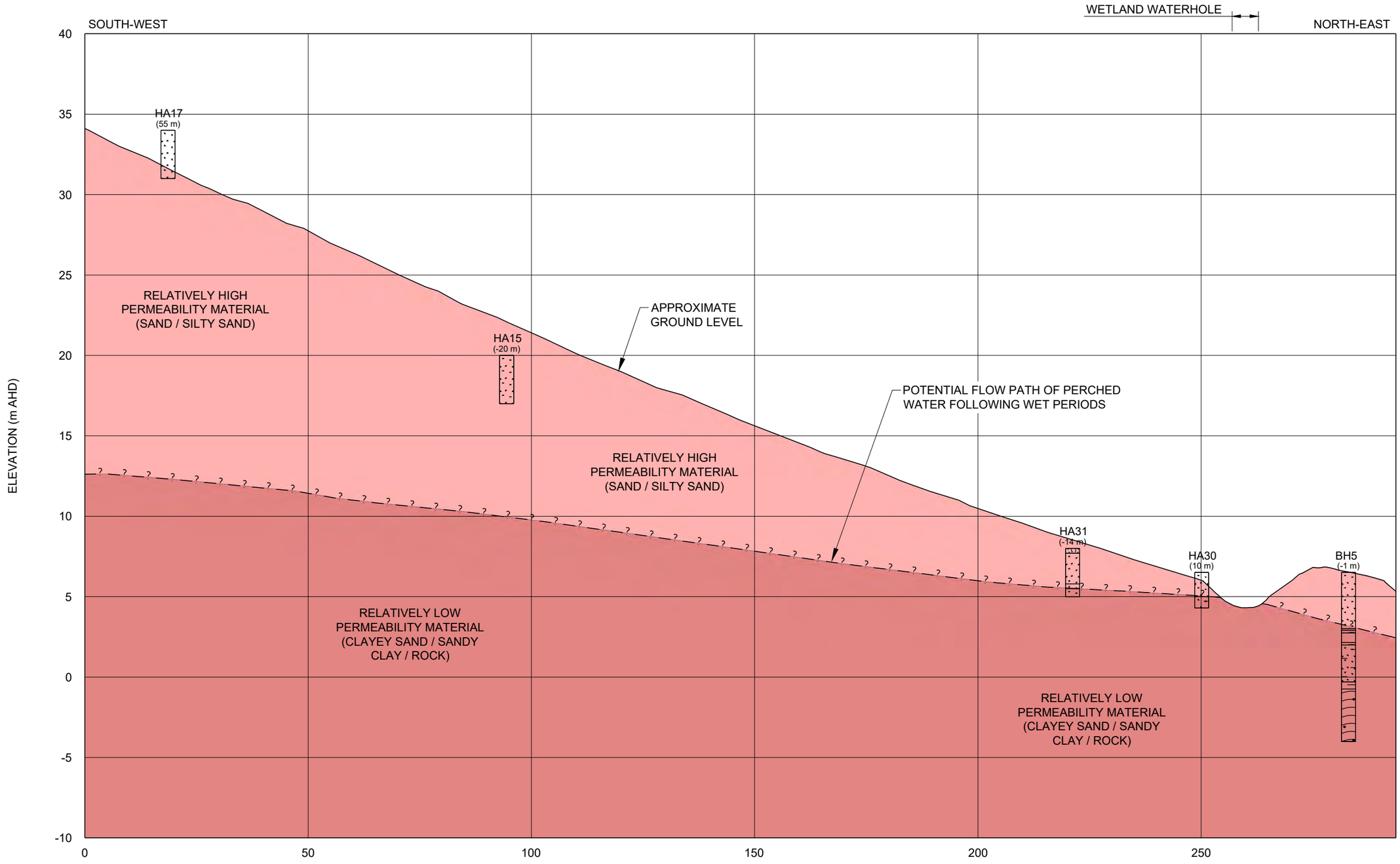
TITLE
INFERRED SUBSURFACE SECTION D

PROJECT NO.	CONTROL	REV.	FIGURE
20435097	001 R	0	9

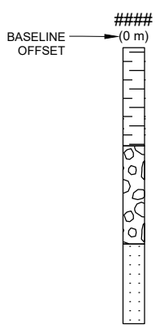
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25 mm 0

Path: \\golder.gds\gap\Perth\Geomatics\Hesperia\Yallingup\99_PROJECTS\20435097_Proposed_Smiths_Beach_Development\02_PRODUCTION\FIGURES\ | File Name: 20435097-001-R-006-011.dwg | Last Edited By: jpellis Date: 2021-10-19 Time:2:18:21 PM
Printed By: jpellis Date: 2021-10-19 Time:2:16:19 PM



LEGEND



- CLAY
- SAND
- CLAYEY SAND
- GNEISS
- TOPSOIL
- CORE LOSS
- RELATIVELY HIGH PERMEABILITY MATERIAL (SAND / SILTY SAND)
- RELATIVELY LOW PERMEABILITY MATERIAL (CLAYEY SAND / SANDY CLAY / ROCK)

0 5 10
1:250 V METRES

0 15 30
1:900 H METRES

NOTES

1. MATERIAL BOUNDARIES SHOWN ARE CONJECTURAL AND ARE BASED ON GEOLOGICAL INTERPRETATION.

CLIENT
SMITHS 2014 PTY LTD

PROJECT
PROPOSED SMITHS BEACH DEVELOPMENT

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-19
DESIGNED	TC
PREPARED	JRP
REVIEWED	DJK
APPROVED	DJK

TITLE
INFERRED SUBSURFACE SECTION E

PROJECT NO.	CONTROL	REV.	FIGURE
20435097	001 R	0	10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25 mm

0

Path: \\golder.gds\gap\Perth\Geomatics\Hesperia\Yallingup\99_PROJECTS\20435097_Proposed_Smiths_Beach_Development\02_PRODUCTION\FIGURES\ | File Name: 20435097-001-R-006-011.dwg | Last Edited By: joelilla Date: 2021-10-19 Time:2:16:19 PM. | Printed By: joelilla Date: 2021-10-19 Time:2:18:31 PM.

NORTH-WEST

SOUTH-EAST

ELEVATION (m AHD)

42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12

0
100
200
300
400
500
600

HA23
(-6 m)

HA22
(17 m)

HA18
(-24 m)

TP08A
(8 m)

HA15
(-3 m)

HA13
(-13 m)

HA08
(30 m)

HA05
(-10 m)

HA03
(4 m)

POTENTIAL FLOW PATH OF PERCHED WATER FOLLOWING WET PERIODS

APPROXIMATE GROUND LEVEL

RELATIVELY LOW PERMEABILITY MATERIAL (CLAYEY SAND / SANDY CLAY / ROCK)

RELATIVELY HIGH PERMEABILITY MATERIAL (SAND / SILTY SAND)

RELATIVELY LOW PERMEABILITY MATERIAL (CLAYEY SAND / SANDY CLAY / ROCK)

LEGEND

BASELINE OFFSET ####(0 m)

SILTY GRAVELLY SAND

SAND

SILTY SAND

GNEISS

RELATIVELY HIGH PERMEABILITY MATERIAL (SAND / SILTY SAND)

RELATIVELY LOW PERMEABILITY MATERIAL (CLAYEY SAND / SANDY CLAY / ROCK)

0 2.5 5
1:150 V METRES

0 50 100
1:2,000 H METRES

NOTES

1. MATERIAL BOUNDARIES SHOWN ARE CONJECTURAL AND ARE BASED ON GEOLOGICAL INTERPRETATION.

CLIENT
SMITHS 2014 PTY LTD

PROJECT
PROPOSED SMITHS BEACH DEVELOPMENT

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-19
DESIGNED	TC
PREPARED	JRP
REVIEWED	DJK
APPROVED	DJK

TITLE
INFERRED SUBSURFACE SECTION F

PROJECT NO.	CONTROL	REV.	FIGURE
20435097	001 R	0	11

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25 mm

0

Path: \\golder.gds\gap\Perth\Geomatics\Hesperia\Yallingup\99_PROJECTS\20435097_Proposed_Smiths_Beach_Development\02_PRODUCTION\FIGURES\ | File Name: 20435097-001-R-006-011.dwg | Last Edited By: jpellis Date: 2021-10-19 Time:2:16:19 PM. | Printed By: jpellis Date: 2021-10-19 Time:2:18:41 PM.

APPENDIX A

Previous Investigation Results – Douglas Partners

TEST PIT REPORT

CLIENT: Canal Rocks Pty Ltd
PROJECT: Smith's Beach Development
LOCATION: Yallingup, WA

DATE: 15 March 2001
PROJECT No.: 22180
SURFACE LEVEL: 5.3m

PIT No: 1
SHEET 1 of 1

Depth (m)	Description of Strata	RL	Graphic Log	Sampling & Testing: Type	Sampling & Testing: Depth (m)	Sampling & Testing: Results	Water
0.0	BOULDERS & SANDY GRAVEL – high strength granite boulders (30%) ranging from 200–500mm in a matrix of medium dense, dark brown, fine to medium grained, rounded sandy gravel (70%), containing roots to 0.15m.	5					
0.7	BOULDERS AND SILTY SAND – high strength granite boulders (30%) in a matrix of medium dense, light grey, fine to coarse grained silty sand.	4.6		D	0.7 0.9	%Fines = 17	
1.1	TEST PIT DISCONTINUED @ 1.1m due to refusal on granite boulders.	4.2					

Form No. LOG-4

EQUIPMENT: Case Turbo 580SK (600mm Bucket)
LOGGED: A GANE

GROUND WATER OBSERVATIONS: No free ground water encountered.

REMARKS: Surface level interpolated from contour plan supplied by Wood & Grieve. Location of soakage area B.

SAMPLING & IN SITU TESTING LEGEND

D disturbed soil sample	I_p plasticity index
B bulk sample	w_L liquid limit
M moisture content	LS linear shrinkage
U_x tube sample (x mm dia.)	pp pocket penetrometer

CHECKED	
Initials:	
Date:	15/5/01

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT REPORT

CLIENT: Canal Rocks Pty Ltd
PROJECT: Smith's Beach Development
LOCATION: Yallingup, WA

DATE: 15 March 2001
PROJECT No.: 22180
SURFACE LEVEL: 25.7m

PIT No: 2
SHEET 1 of 1

Depth (m)	Description of Strata	RL	Graphic Log	Sampling & Testing: Type	Sampling & Testing: Depth (m)	Sampling & Testing: Results	Water
0.2	TOPSOIL – loose, dark grey, fine grained sand containing shallow, minor roots.	25.5					
	GRANITE – extremely low to very low strength, extremely weathered, mottled grey, white and brown, fine to coarse grained weathered *in situ* granite with zones of material excavated as sandy gravel.			D	0.5		
1.2	TEST PIT DISCONTINUED @ 1.2m due to refusal.	24.5					

Form No. L08-4

EQUIPMENT: Case Turbo 580SK (600mm Bucket)

LOGGED: A GANE

GROUND WATER OBSERVATIONS: No free groundwater encountered.

REMARKS: Surface level interpolated from contour plan supplied by Wood & Grieve. Location of soakage area A.

SAMPLING & IN SITU TESTING LEGEND

D disturbed soil sample	I_p plasticity index
B bulk sample	w_L liquid limit
M moisture content	LS linear shrinkage
U_x tube sample (x mm dia.)	pp pocket penetrometer

CHECKED
Initials: CH
Date: 1/5/01

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT REPORT

CLIENT: Canal Rocks Pty Ltd
PROJECT: Smith's Beach Development
LOCATION: Yallingup, WA

DATE: 15 March 2001
PROJECT No.: 22180
SURFACE LEVEL: 6.0m

PIT No: 3
SHEET 1 of 1

Depth (m)	Description of Strata	RL	Graphic Log	Sampling & Testing: Type	Sampling & Testing: Depth (m)	Sampling & Testing: Results	Water
0.1	FILL – loose, yellow, fine to medium grained sand with some gravel to 20mm.	5.9					
	SAND – loose to medium dense, light grey, fine to medium grained calcareous sand, containing minor roots. becoming grey from 0.2m. becoming light brown, damp and free of roots from 0.6m.			D	0.6 0.8		
1.7	CLAYEY SAND – medium dense, greenish brown, fine to medium grained, moist clayey sand.	4.3		D	2.0 2.1	%Fines = 20	
2.2	TEST PIT DISCONTINUED @ 2.2m	3.8					

Form No. LOG-4

EQUIPMENT: Case Turbo 580SK (600mm Bucket)

LOGGED: A GANE

GROUND WATER OBSERVATIONS: No free groundwater encountered.

REMARKS: Surface level interploated from contour plan supplied by Wood & Grieve. Location of soakage area C.

SAMPLING & IN SITU TESTING LEGEND

D disturbed soil sample	I_p plasticity index
B bulk sample	w_L liquid limit
M moisture content	LS linear shrinkage
U_x tube sample (x mm dia.)	pp pocket penetrometer

CHECKED
Initials:
Date: 1/05/01

Douglas Partners
Geotechnics • Environment • Groundwater

TEST PIT REPORT

CLIENT: Canal Rocks Pty Ltd
PROJECT: Smith's Beach Development
LOCATION: Yallingup, WA

DATE: 15 March 2001
PROJECT No.: 22180
SURFACE LEVEL: 11.2m

PIT No: 4
SHEET 1 of 1

Depth (m)	Description of Strata	RL	Graphic Log	Sampling & Testing: Type	Sampling & Testing: Depth (m)	Sampling & Testing: Results	Water
0.0	TOPSOIL – loose to medium dense, dark brown, fine grained silty sand containing roots to 30mm.						
0.4	SLIGHTLY CLAYEY SAND – medium dense, reddish brown, fine to coarse grained, damp, slightly clayey sand containing some fine gravel.	10.8		D	1.1 1.2	%Fines = 13	
2.0	TEST PIT DISCONTINUED @ 2.0m	9.2					

Form No. LOG-4

EQUIPMENT: Case Turbo 580SK (600mm Bucket)

LOGGED: A GANE

GROUND WATER OBSERVATIONS: No free groundwater encountered.

REMARKS: Surface level interpolated from contour plan supplied by Wood & Grieve.

SAMPLING & IN SITU TESTING LEGEND

D disturbed soil sample	I_p plasticity index
B bulk sample	w_L liquid limit
M moisture content	LS linear shrinkage
U_x tube sample (x mm dia.)	pp pocket penetrometer

CHECKED
Initials:
Date: 1/5/01

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT REPORT

CLIENT: Canal Rocks Pty Ltd
PROJECT: Smith's Beach Development
LOCATION: Yallingup, WA

DATE: 15 March 2001
PROJECT No.: 22180
SURFACE LEVEL: 33.5m

PIT No: 5
SHEET 1 of 1

Depth (m)	Description of Strata	RL	Graphic Log	Sampling & Testing: Type	Sampling & Testing: Depth (m)	Sampling & Testing: Results	Water
	TOPSOIL – medium dense, grey, fine grained sand, containing minor roots.						
0.25	SAND – medium dense to dense, brown, fine to coarse grained sand containing some fine gravel	33.2					
	becoming reddish brown from 0.7m.						
1.1	GRANITE – very low strength, extremely weathered, mottled white, yellow brown, and grey, fine to coarse grained weathered *in situ* granite,	32.4					
1.3	with zones of material excavated as sandy gravel. TEST PIT DISCONTINUED @ 1.3m due to refusal	32.2					

Form No. LOG-4

EQUIPMENT: Case Turbo 580SK (600mm Bucket)

LOGGED: A GANE

GROUND WATER OBSERVATIONS: No free ground water encountered.

REMARKS: Surface level interpolated from contour plan supplied by Wood & Grieve.

SAMPLING & IN SITU TESTING LEGEND

D disturbed soil sample	I_p plasticity index
B bulk sample	w_L liquid limit
M moisture content	LS linear shrinkage
U_x tube sample (x mm dia.)	pp pocket penetrometer

CHECKED
Initials:
Date: 1/5/01

Douglas Partners
Geotechnics • Environment • Groundwater

TEST PIT REPORT

CLIENT: Canal Rocks Pty Ltd
PROJECT: Smith's Beach Development
LOCATION: Yallingup, WA

DATE: 15 March 2001
PROJECT No.: 22180
SURFACE LEVEL: 33.7m

PIT No: 6
SHEET 1 of 1

Depth (m)	Description of Strata	RL	Graphic Log	Sampling & Testing: Type	Sampling & Testing: Depth (m)	Sampling & Testing: Results	Water
0.6	TOPSOIL – loose, dark brown, fine to medium grained sand containing roots ranging from 10–100mm.	33.1					
0.9	SAND – medium dense, reddish brown, fine to coarse grained sand containing a trace of gravel.	32.8					
	GRANITE/SANDY CLAY – extremely weathered granite excavated as a stiff to hard, brown with grey, yellow and white mottling, sandy clay of medium plasticity and with fine to coarse grained sand.			D	1.1 1.3	I_p = 38% LS = 14%	
1.4	TEST PIT DISCONTINUED @ 1.4m due to refusal	32.3					

Form No. LOG-4

EQUIPMENT: Case Turbo 580SK (600mm Bucket)

LOGGED: A GANE

GROUND WATER OBSERVATIONS: No free groundwater encountered.

REMARKS: Surface level interpolated from contour plan supplied by Wood & Grieve.

SAMPLING & IN SITU TESTING LEGEND

D disturbed soil sample	I_p plasticity index
B bulk sample	w_L liquid limit
M moisture content	LS linear shrinkage
U_x tube sample (x mm dia.)	pp pocket penetrometer

CHECKED
Initials:
Date: 1/5/01

Douglas Partners
Geotechnics • Environment • Groundwater

TEST PIT REPORT

CLIENT: Canal Rocks Pty Ltd
PROJECT: Smith's Beach Development
LOCATION: Yallingup, WA

DATE: 15 March 2001
PROJECT No.: 22180
SURFACE LEVEL: 58.5m

PIT No: 7
SHEET 1 of 1

Depth (m)	Description of Strata	RL	Graphic Log	Sampling & Testing: Type	Sampling & Testing: Depth (m)	Sampling & Testing: Results	Water
0.0	TOPSOIL – loose, grey, fine to medium grained sand containing some minor roots.						
0.5	SAND – medium dense, yellow brown, fine to medium grained sand.	58.0	58				
	becoming yellow at 1.8m.	57					
	limestone cobbles from 2.3m.						
2.5	TEST PIT DISCONTINUED @ 2.5m	56.0	56				

Form No. LOG-4

EQUIPMENT: Case Turbo 580SK (600mm Bucket)
LOGGED: A GANE
GROUND WATER OBSERVATIONS: No free groundwater encountered.
REMARKS: Surface level interpolated from countour plan supplied by Wood & Grieve.

SAMPLING & IN SITU TESTING LEGEND

D disturbed soil sample	I_p plasticity index
B bulk sample	w_L liquid limit
M moisture content	LS linear shrinkage
U_x tube sample (x mm dia.)	pp pocket penetrometer

CHECKED
Initials:
Date: 1/5/01

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT REPORT

CLIENT: Canal Rocks Pty Ltd
PROJECT: Smith's Beach Development
LOCATION: Yallingup, WA

DATE: 15 March 2001
PROJECT No.: 22160
SURFACE LEVEL: 55.0m

PIT No: 7A
SHEET 1 of 1

Depth (m)	Description of Strata	RL	Graphic Log	Sampling & Testing: Type	Sampling & Testing: Depth (m)	Sampling & Testing: Results	Water
	TOPSOIL – loose, dark brown, fine to medium grained sand and gravel, containing some cobbles of limestone.	55					
0.3	CALCARENITE – very low to low strength, fine to medium grained, light brown calcarenite.	54.7					
0.6	TEST PIT DISCONTINUED @ 0.6m	54.4					

Form No. LOG-4

EQUIPMENT: Case Turbo 580SK (600mm Bucket)

LOGGED: A GANE

GROUND WATER OBSERVATIONS: No free groundwater encountered.

REMARKS: Surface level interpolated from contour plan supplied by Wood & Grieve.

SAMPLING & IN SITU TESTING LEGEND

D disturbed soil sample	I_p plasticity index
B bulk sample	w_L liquid limit
M moisture content	LS linear shrinkage
U_x tube sample (x mm dia.)	pp pocket penetrometer

CHECKED
Initials:
Date: 1/5/01

Douglas Partners
Geotechnics • Environment • Groundwater

TEST PIT REPORT

CLIENT: Canal Rocks Pty Ltd
PROJECT: Smith's Beach Development
LOCATION: Yallingup, WA

DATE: 15 March 2001
PROJECT No.: 22180
SURFACE LEVEL: 38.0m

PIT No: 8
SHEET 1 of 1

Depth (m)	Description of Strata	RL	Graphic Log	Sampling & Testing: Type	Sampling & Testing: Depth (m)	Sampling & Testing: Results	Water
	TOPSOIL – loose, grey, fine to medium grained sand.	38					
0.2	SAND – loose to medium dense, yellow, fine to medium grained sand.	37.8					
1		37					
2	2.0 TEST PIT DISCONTINUED @ 2.0m	36.0	36				

Form No. LOG-4

EQUIPMENT: Case Turbo 580SK (600mm Bucket)

LOGGED: A GANE

GROUND WATER OBSERVATIONS: No free groundwater encountered.

REMARKS: Surface level interpolated from countour plan supplied by Wood & Grieve.

SAMPLING & IN SITU TESTING LEGEND

D disturbed soil sample	I_p plasticity index
B bulk sample	w_L liquid limit
M moisture content	LS linear shrinkage
U_x tube sample (x mm dia.)	pp pocket penetrometer

CHECKED
Initials:
Date: 1/5/01

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT REPORT

CLIENT: Canal Rocks Pty Ltd
PROJECT: Smith's Beach Development
LOCATION: Yallingup, WA

DATE: 15 March 2001
PROJECT No.: 22180
SURFACE LEVEL: 24.5m

PIT No: 8A
SHEET 1 of 1

Depth (m)	Description of Strata	RL	Graphic Log	Sampling & Testing: Type	Sampling & Testing: Depth (m)	Sampling & Testing: Results	Water
0.3	TOPSOIL – loose to medium dense, grey, fine to medium grained sand. light grey from 0.3m.	24.2					
0.6	SAND & GRAVEL – medium dense, brown, fine to medium grained sand and fine to coarse grained sub-rounded gravel.	23.9					
1.0	GRANITE – low strength, extremely weathered, mottled reddish brown, yellow brown, grey and white, fine to medium grained weathered *in situ* granite.	23.5					
1.2	TEST PIT DISCONTINUED @ 1.2m due to refusal.	23.3					

Form No. LOG-4

EQUIPMENT: Case Turbo 580SK (600mm Bucket)

LOGGED: A GANE

GROUND WATER OBSERVATIONS: No free groundwater encountered.

REMARKS: Steep inclination. Outcropping granite encountered 30m to north. Surface level interpolated from contour plan supplied by Wood & Greive.

SAMPLING & IN SITU TESTING LEGEND

D disturbed soil sample	I_p plasticity index
B bulk sample	w_L liquid limit
M moisture content	LS linear shrinkage
U_x tube sample (x mm dia.)	pp pocket penetrometer

CHECKED
Initials:
Date: 1/5/01

Douglas Partners
Geotechnics · Environment · Groundwater

SRC
A Division of AMEC Engineering Pty Limited ABN 73 003 066 715
34 Walters Drive, Osborne Park WA 6017
Telephone: (08) 9244 1199 Facsimile: (08) 9244 1457
E-mail: src@amecaust.com.au

TEST CERTIFICATE

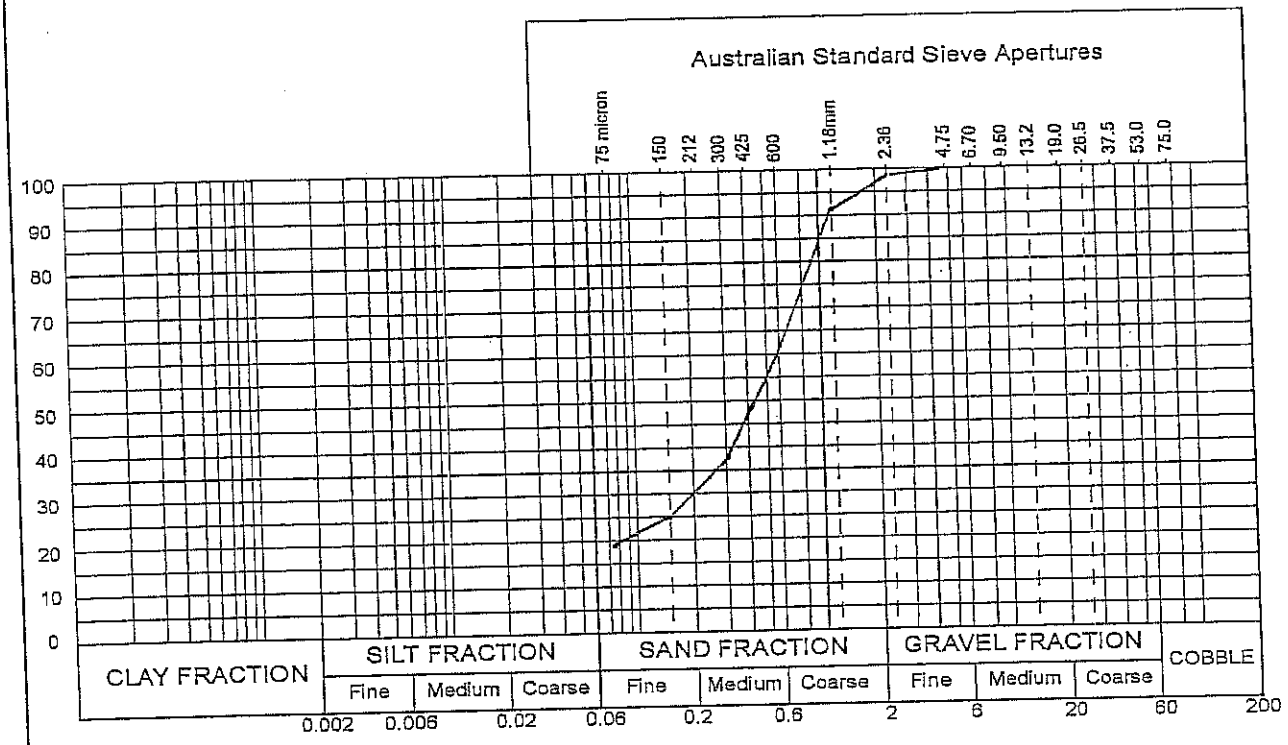
Client: DOUGLAS PARTNERS PTY LTD
Project: SMITH'S BEACH, YALLINGUP WA - PROJECT NO. 22180
Sample ID: 1, 0.7-0.9

Sheet No.: 2 OF 6
Job No.: S8170
Date Tested: 07.04.01

Particle Size Distribution of a Soil

Standard Method of Analysis by Sieving: AS 1289.3.6.1

Sieving				Sieving			
Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing
150.0mm		1.18 mm	91				
75.0mm		600 micron	62				
37.5 mm		425 micron	49				
19.0 mm		300 micron	38				
9.50 mm		150 micron	25				
4.75 mm	100	75 micron	19				
2.36mm	99						



Remarks: Sampling Method/s - Submitted by client

This laboratory is accredited by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with its terms of accreditation. This document shall not be reproduced except in full.

Approved:

W Rozmianiec

Date: 23.04.01

SRC

A Division of AMEC Engineering Pty Limited ABN 73 003 066 715
34 Walters Drive, Osborne Park WA 6017
Telephone: (08) 9244 1199 Facsimile: (08) 9244 1457
E-mail: src@amecaust.com.au

TEST CERTIFICATE

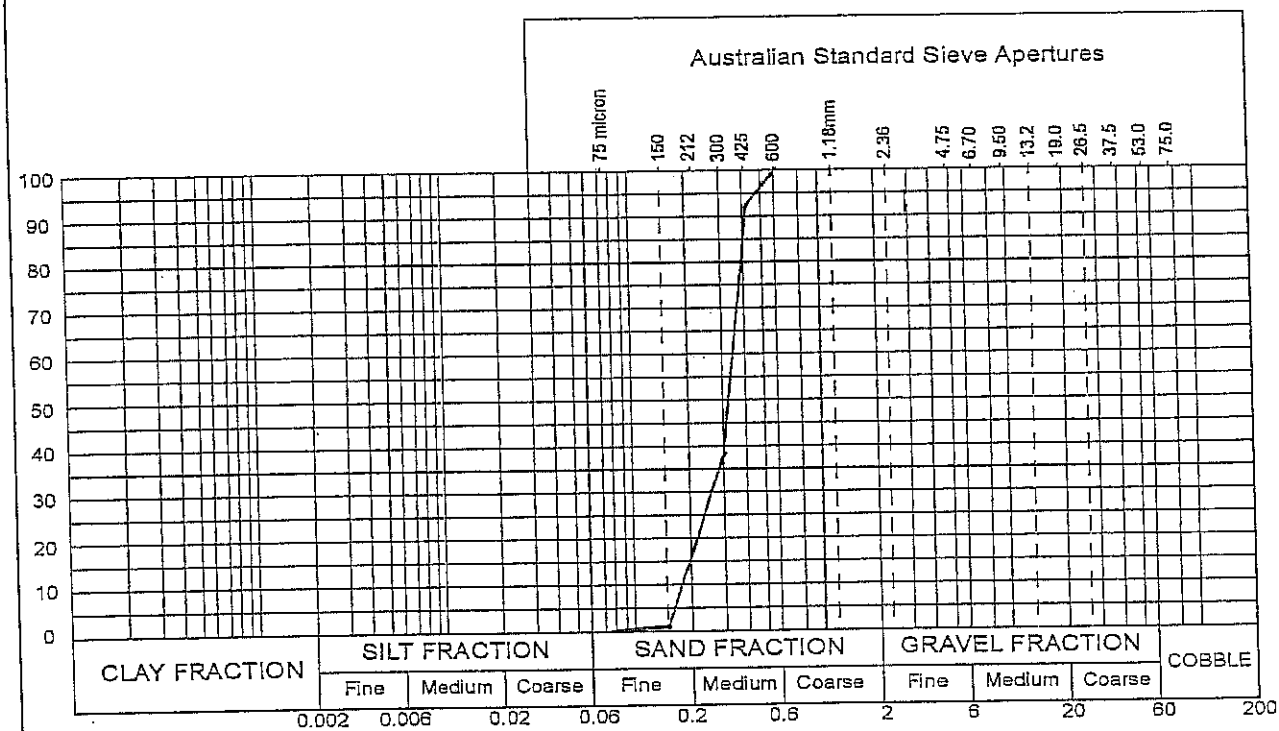
Client: DOUGLAS PARTNERS PTY LTD
Project: SMITH'S BEACH, YALLINGUP WA - PROJECT NO. 22180
Sample ID: 3, 0.6-0.8

Sheet No.: 3 OF 6
Job No.: S8170
Date Tested: 07.04.01

Particle Size Distribution of a Soil

Standard Method of Analysis by Sieving: AS 1289.3.6.1

Sieving				Sieving			
Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing
150.0mm		1.18 mm					
75.0mm		600 micron	100				
37.5 mm		425 micron	92				
19.0 mm		300 micron	38				
9.50 mm		150 micron	1				
4.75 mm		75 micron	0				
2.36mm							



Remarks: Sampling Method/s - Submitted by client

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Approved:

W Rozmianiec

Date: 23.04.01

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TEST CERTIFICATE

Client: DOUGLAS PARTNERS PTY LTD
Project: SMITH'S BEACH, YALLINGUP WA - PROJECT NO. 22180

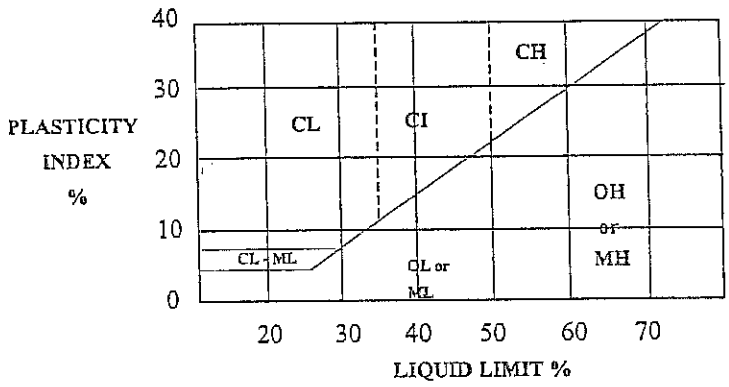
Sheet No.: 4 OF 6
Job No.: S8170
Date Tested: 08.04.01

Plastic Properties - Casagrande Method

AS 1289.3.1.1, .3.2.1, .3.3.1, .3.4.1, .2.1.1

Test No.		1
Sample ID		6 1.1-1.3
Liquid Limit	%	63
Plastic Limit	%	25
Plasticity Index	%	38
Linear Shrinkage	%	14.0

PLASTICITY CHART: AS 1726



History of Sample: Cool Oven Dried
Method of Preparation: Dry Sieved
Remarks: Sampling Method/s - Submitted by client.

Length of Linear Shrinkage Mould: 250 mm
Nature of Shrinkage: Normal

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Approved: W Rozmianiec

Date: 23.04.01

SRC

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TEST CERTIFICATE

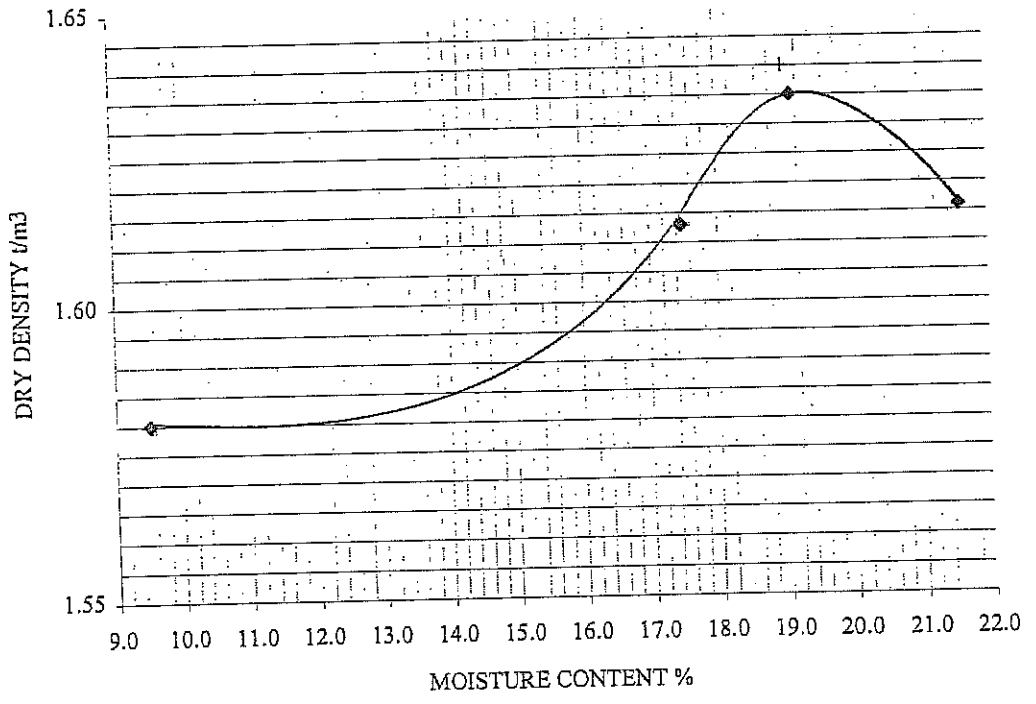
Client: DOUGLAS PARTNERS PTY LTD
Project: SMITH'S BEACH, YALLINGUP WA - PROJECT NO. 22180
Sample ID: 3, 0.6-0.8
Description: SAND

Sheet No.: 5 OF 6
Job No.: S8170
Date Tested: 04.04.01

Dry Density / Moisture Content Relationship

AS 1289.5.1.1

Standard Maximum Dry Density	1.64	t/m^3
Optimum Moisture Content	19.0	%
Retained on 19.0mm Sieve	0	%
Retained on 37.5mm Sieve	N/A	%



Remarks: Sampling Method/s - Submitted by client

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Approved: W Rozmianiec

Date: 23.04.01

SRC
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Telephone: (08) 9244 1199 Facsimile: (08) 9244 1457
E-mail: src@amecaust.com.au

TEST CERTIFICATE

Client: DOUGLAS PARTNERS PTY LTD
Project: SMITH'S BEACH, YALLINGUP WA - PROJECT NO. 22180
Sample ID: 3, 0.6-0.8

Sheet No.: 6 OF 6
Job No.: S8170
Date Tested: 08.01.01

Falling Head Permeability

Laboratory Work in Soil Mechanics - Second Edition by Brian Vickers

Sample Preparation

Required Dry Density Ratio:	95 %
Required Moisture Content Ratio:	100 %
Maximum Dry Density: (AS 1289 .5.1.1 Standard)	1.64 t/m^3
Optimum Moisture Content:	19.0 %
Achieved Dry Density:	1.56 t/m^3
Achieved Dry Density Ratio:	95 %
Achieved Moisture Content: (AS 1289.2.1.1)	19.0 %
Achieved Moisture Content Ratio:	100 %
Average Coefficient of Permeability:	4.9×10^{-5} m/sec

Remarks: Sample submitted by client.

Approved: W Rozmianiec

Date: 23.04.01

Douglas Partners Pty Ltd
ACN 053 980 117

182 Bennett Street, East Perth WA 6004
Phone: (08) 9325 4774
Fax: (08) 9325 4771

RESULTS OF MATERIALS FINER THAN 75µm

Sample Details:	Test No.	Test Pit	Depth (m)
	1	1	0.7 – 0.9
	2	3	2.0 – 2.1
	3	4	1.1 – 1.2

% passing 75µm:	Test No.	Result (%)
	1	17
	2	20
	3	13

Method of drying: Oven Dried

Client: Canal Rocks Pty Ltd
Project: Smith's Beach Development
Location: Yallingup, WA

Test Method: AS.1141.12 - 1996

Project No: 22180
Report No: -
Page: 1 of 1
Date Reported: 2 April 2001

Tested by: A. Gane
Checked by: C. Waterton

Laboratory: Perth

APPENDIX B

Hand Auger Borehole Report

GOLDER
MEMBER OF WSP

METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT REPORTS

SYMBOLS


FILL


GRAVEL (GW, GP, GM or GC)


SAND (SW, SP, SM or SC)


SILT (ML or MH)


CLAY (CL, CI or CH)


ORGANIC SOILS (OL, OH or Pt)


COBBLES or BOULDERS

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay.

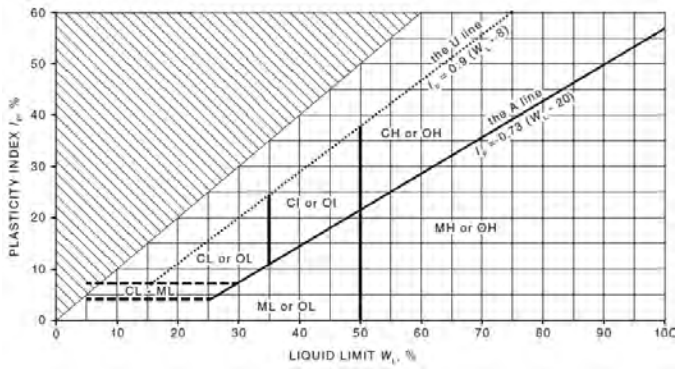
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil and Rock is classified and described in Reports of Boreholes and Test Pits using the preferred method given in AS1726-2017. The material properties are assessed in the field by visual/tactile methods.

Particle Size

Soil Group	Sub Division	Particle Size
BOULDERS		> 200 mm
COBBLES		63 to 200 mm
GRAVEL	Coarse	19 to 63 mm
	Medium	6.7 to 19 mm
	Fine	2.36 to 6.7 mm
SAND	Coarse	0.6 to 2.36 mm
	Medium	0.21 to 0.6 mm
	Fine	0.075 to 0.21 mm
SILT		0.002 to 0.075 mm
CLAY		< 0.002 mm

Plasticity Properties



MOISTURE CONDITION

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays and silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in dry condition and may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sand and gravels tend to cohere.

Moisture condition for fine grained soils is described relative to the plastic limit or liquid limit as specified in AS1726-2017.

CONSISTENCY AND DENSITY

Fine Grained Soils

Symbol	Term	Undrained Shear Strength
VS	Very Soft	0 to 12 kPa
S	Soft	12 to 25 kPa
F	Firm	25 to 50 kPa
St	Stiff	50 to 100 kPa
VSt	Very Stiff	100 to 200 kPa
H	Hard	Above 200 kPa
Fr	Friable	-

Coarse Grained Soils

Symbol	Term	Density Index (%)	SPN "N" *
VL	Very Loose	Less than 15	0 to 4
L	Loose	15 to 35	4 to 10
MD	Medium Dense	35 to 65	10 to 30
D	Dense	65 to 85	30 to 50
VD	Very Dense	Above 85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.

* SPT correlations are not stated in AS1726-2017, and may be subject to corrections for overburden pressure and equipment type.

CEMENTATION

Weakly Cemented	The soil may be easily disaggregated by hand in air or water.
Moderately Cemented	Effort is required to disaggregate the soil by hand in air or water.

EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT REPORTS

DRILLING/EXCAVATION METHOD

ADH	Hollow auger drilling	EX	Excavator	PQ3	Diamond core - 83 mm
ADT	Auger drilling with tc-bit	HA	Hand auger	PT	Push tube sampling
ADV	Auger drilling with v-bit	HAND	Excavated by hand	RAB	Rotary air blast
AIRCORE	Aircore	HMLC	methods Diamond core - 63	RC	Reverse circulation
AT	Air track	HQ3	mm Diamond core - 61 mm	RT	Rock roller
BH	Backhoe bucket Cable	JET	Jetting	SONIC	Sonic drilling
CT	tool rig	MZ	Mazier tube sampling	SPT	Standard penetration
DTC	Diatube coring Existing	NDD	Non-destructive digging	U	testing Undisturbed tube
EE	excavation Extruded	NMLC	Diamond core - 52 mm	WB	sampling Washbore drilling
EPT	push tube	NQ3	Diamond core - 45 mm		

PENETRATION/EXCAVATION RESISTANCE

L	**Low resistance.** Rapid penetration possible with little effort from the equipment used.
M	**Medium resistance.** Excavation/possible at an acceptable rate with moderate effort from the equipment used.
H	**High resistance** to penetration/excavation. Further penetration is possible at a slow rate and requires significant effort from the equipment.
R	**Refusal or Practical Refusal.** No further progress possible without the risk of damage or unacceptable wear to the digging implement or machine.

These assessments are subjective and are dependent on many factors including the equipment power, weight, condition of excavation or drilling tools, and the experience of the operator.

WATER

▽	Water level at date shown	◁	Partial water loss
▷	Water inflow	◀	Complete water loss

GROUNDWATER NOT OBSERVED	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.
GROUNDWATER NOT ENCOUNTERED	The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following 150mm seating
30/80 mm	Where practical refusal occurs, the blows and penetration for that interval are reported
RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB	Hammer double bouncing on anvil
DS	Disturbed sample
BDS	Bulk disturbed sample
G	Gas Sample
W	Water Sample
FP	Field permeability test over section noted
FV	Field vane shear test expressed as uncorrected shear strength (sv = peak value, sr = residual
PID	value) Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket penetrometer test expressed as instrument reading in kPa
U63	Thin walled tube sample - number indicates nominal sample diameter in millimetres
WPT	Water pressure test
DCP	Dynamic cone penetration test
CPT	Cone penetration test
CPTu	Cone penetration test with pore pressure (u) measurement

RANKING OF VISUALLY OBSERVABLE CONTAMINATION AND ODOUR (for specific soil contamination assessment projects)

R = 0	No visible evidence of contamination	R = A	No non-natural odours identified
R = 1	Slight evidence of visible	R = B	Slight non-natural odours identified
R = 2	contamination Visible contamination	R = C	Moderate non-natural odours identified
R = 3	Significant visible contamination	R = D	Strong non-natural odours identified

ROCK CORE RECOVERY

TCR = Total Core Recovery (%)	RQD = Rock Quality Designation (%)	SCR = Solid Core Recovery (%)	F = Fracture Frequency
$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100$	$= \frac{\sum \text{Axial lengths of core} > 100\text{ mm}}{\text{Length of core run}} \times 100$	$= \frac{\sum \text{Length of cyclindrical core recovered}}{\text{Length of core run}} \times 100$	$= \frac{\text{No. of defects}}{\text{Length of zone (m)}}$

GOLDER
MEMBER OF WSP

TERMS FOR ROCK MATERIAL STRENGTH & WEATHERING AND ABBREVIATIONS FOR DEFECT DESCRIPTIONS

STRENGTH

Symbol	Term	UCS (MPa)	Field Guide
VL	Very Low	0.6 to 2	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm can be broken by finger pressure.
L	Low	2 to 6	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	6 to 20	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High	20 to 60	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.
VH	Very High	60 to 200	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>200	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Material with strength less than 'Very Low' shall be described using soil characteristics. The presence of an original rock structure, fabric or texture should be noted, if relevant.

ROCK MATERIAL WEATHERING

Symbol		Term	Field Guide
RS		Residual Soil	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.
XW		Extremely Weathered	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.
	HW	Highly Weathered	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 recognizable. 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.
	MW	Moderately Weathered	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 recognizable, but shows little or no change of strength from fresh rock.
SW		Slightly Weathered	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
FR		Fresh	Rock shows no sign of decomposition of individual minerals or colour changes.

ABBREVIATIONS FOR DEFECT TYPES AND DESCRIPTIONS

Defect Type	
P	Parting
X	Foliation
L	Cleavage
C	Contact
J	Joint
SSu	Sheared Surface
SS	Sheared Seam
SZ	Sheared Zone
CS	Crushed Seam
IS	Infilled Seam
EWS	Extremely Weathered Seam
V	Vein

Coating or Infilling	
Cn	Clean
Sn	Stain
Ve	Veneer
Ct	Coating
In	Infill

Planarity	
Pl	Planar
Cv	Curved
Un	Undulating
St	Stepped
Ir	Irregular

Roughness	
VRo	Very Rough
Ro	Rough
Sm	Smooth
Po	Polished
Sl	Slickensided

Vertical Boreholes – The dip (inclination from horizontal) of the defect is given.

Inclined Boreholes – The inclination is measured as the acute angle between the core axis and the vertical direction.

REPORT OF HAND AUGERED BOREHOLE: HA01

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315991 m E 6273479 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 0.50 m

LOGGED: TC DATE: 10-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
HA	L		0.0	0.30				SM	Silty SAND fine to medium grained, dark brown, about 15% silt, with rootlets	D	MD - D		0 5 10 15 20 25
	M-H								fine to coarse grained, red brown, with fine gravel				
	R		0.5						END OF HAND AUGER @ 0.50 m REFUSAL GROUNDWATER NOT ENCOUNTERED			Inferred refusal on Gneiss	
			1.0										
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

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REPORT OF HAND AUGERED BOREHOLE: HA02

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315991 m E 6273397 m N MGA94 50
SURFACE RL: 24.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 0.65 m

LOGGED: DK DATE: 11-12-20
CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
HA	L		0.0	24.00				SM	Silty SAND fine to medium grained, brown, about 15-20% silt, with rootlets	D	L	About 200 mm of topsoil	SEAT
				0.30									
			0.5	23.70					red brown, with gneiss gravel		MD - D		
	R			23.35					END OF HAND AUGER @ 0.65 m REFUSAL GROUNDWATER NOT ENCOUNTERED			Inferred refusal on Gneiss	Hammer Bounce
			1.0										
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										

DCP TEST (AS1289.6.3.2) Blows per 100 mm: 0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

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REPORT OF HAND AUGERED BOREHOLE: HA03

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 316007 m E 6273291 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 0.30 m

LOGGED: TC DATE: 10-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
HA	L		0.0					SM	Silty Gravelly SAND fine to coarse grained, brown, about 30% fine to medium gravel, about 15% silt	D	MD - D	inferred extremely weathered gneiss	0 5 10 15 20 25
	R		0.5						END OF HAND AUGER @ 0.30 m REFUSAL GROUNDWATER NOT ENCOUNTERED			Inferred refusal on Gneiss	
			1.0										
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										

Sketch & Other Observations

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GAP gINT FN. F03h RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:26 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA04

SHEET: 1 OF 1

CLIENT:	Smiths 2014 Pty Ltd	COORDS: 315947 m E 6273232 m N MGA94 50	
PROJECT:	Smiths Beach Development	SURFACE RL: DATUM: AHD	
LOCATION:	Yallingup	INCLINATION: -90°	LOGGED: DK DATE: 11-12-20
JOB NO:	20435097	HOLE DEPTH: 2.60 m	CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
HA	L		0.0					SP / SM	SAND / Silty SAND fine to medium grained, brown	D	L	about 300 mm of topsoil	SEAT
			0.5								MD - D		
			1.0	1.00					pale brown				
				1.20				SP	SAND fine to medium grained, pale grey brown, with clay/silt		VD		
	M		1.5	1.40	DS 1.40-1.80 m Rec = 400/400 mm			CH	Sandy CLAY high plasticity, orange brown and grey, about 60% fine to coarse sand		St		
	H		2.0							w ~ PL	VSt		
			2.5									Refusal in hard CLAY	
	R								END OF HAND AUGER @ 2.60 m REFUSAL GROUNDWATER NOT ENCOUNTERED				
			3.0										
			3.5										

0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

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REPORT OF HAND AUGERED BOREHOLE: HA05

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315912 m E 6273317 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 1.30 m

LOGGED: TC DATE: 10-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0					SM	Silty SAND fine to coarse grained, dark brown, about 20% silt	D	L	Likely refusal on cobble/boulder	SEAT
				0.40					red brown		MD		
			0.5								D		
	R		1.0						END OF HAND AUGER @ 1.30 m REFUSAL GROUNDWATER NOT ENCOUNTERED				
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										

0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

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REPORT OF HAND AUGERED BOREHOLE: HA06

SHEET: 1 OF 1

CLIENT:	Smiths 2014 Pty Ltd	COORDS: 315909 m E 6273413 m N MGA94 50	
PROJECT:	Smiths Beach Development	SURFACE RL: 16.0 m DATUM: AHD	
LOCATION:	Yallingup	INCLINATION: -90°	LOGGED: DK DATE: 10-12-20
JOB NO:	20435097	HOLE DEPTH: 3.00 m	CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm	
HA	L		0.0	16.00				SP	SAND fine to medium grained, brown, with silt	D	L	about 300 mm of topsoil	SEAT	
			0.5	0.60 15.40					red brown		MD			
			1.0											
			1.5								D			
			2.0											
	M		2.5											
			3.0	13.00					END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED					
			3.5											

0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:27 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA07

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315876 m E 6273480 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 2.00 m

LOGGED: TC DATE: 10-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0					SM	Silty SAND fine to medium grained, dark brown, about 15 to 20% silt	D	MD		SEAT
			0.5	0.60				SP	SAND fine to medium grained, brown, with silt/clay	M	D		
	M		1.0	1.30				SM	Silty SAND fine to coarse grained, brown orange, about 20% silt, trace gravel				
	H		1.5		DS 1.80-2.00 m Rec = 200/200 mm						VD		
	R		2.0						END OF HAND AUGER @ 2.00 m REFUSAL GROUNDWATER NOT ENCOUNTERED				
			2.5										
			3.0										
			3.5										

0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

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REPORT OF HAND AUGERED BOREHOLE: HA08

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315833 m E 6273396 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 3.00 m

LOGGED: DK DATE: 10-12-20
CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0					SP	SAND fine to medium grained, brown, with silt	D	L	About 250 mm of topsoil	SEAT
			0.5										
				0.80					red brown				
			1.0										
			1.5								MD		
			2.0										
			2.5										
			3.0						END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED				
			3.5										

0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:27 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA09

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315817 m E 6273322 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 3.00 m

LOGGED: DK DATE: 11-12-20
CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0					SP	SAND fine to medium grained, orange brown	D	L	About 300 mm of topsoil	SEAT
			0.5										
			1.0								MD		
			1.5										
			2.0										
			2.5								D		
			3.0						END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED				
			3.5										

0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:27 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA10

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315852 m E 6273231 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 1.30 m

LOGGED: DK DATE: 11-12-20
CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
HA	L		0.0					SP / SM	SAND / Silty SAND fine to medium grained, brown	D	L	About 250 mm of topsoil	SEAT
			0.5								MD - D		
				0.80									
	M							CH	Sandy CLAY orange brown and grey, fine to coarse sand, about 40% fines	w < PL	H	Extremely weathered rock	
	H		1.0										
	R								END OF HAND AUGER @ 1.30 m REFUSAL GROUNDWATER NOT ENCOUNTERED			Refusal on hard clay	
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										

DCP TEST (AS1289.6.3.2) Blows per 100 mm: 0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:27 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA11

SHEET: 1 OF 1

CLIENT:	Smiths 2014 Pty Ltd	COORDS: 315785 m E 6273235 m N MGA94 50	
PROJECT:	Smiths Beach Development	SURFACE RL: DATUM: AHD	
LOCATION:	Yallingup	INCLINATION: -90°	LOGGED: DK DATE: 11-12-20
JOB NO:	20435097	HOLE DEPTH: 1.50 m	CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
HA	L		0.0					SP / SM	SAND / Silty SAND fine to medium grained, brown, with fine to coarse gneiss gravel	D	L	About 200 mm of topsoil	SEAT
			0.5	0.60							MD		
	M			0.80				SP	Gravelly SAND fine to coarse grained, orange brown, fine to coarse gneiss gravel, with silt		VD		
	H		1.0					SC / CI	Clayey SAND / Sandy CLAY fine to coarse grained, pale grey and orange brown, about 25 to 60% medium plasticity fines in zones		VD - H		
			1.5						END OF HAND AUGER @ 1.50 m REFUSAL GROUNDWATER NOT ENCOUNTERED			Refusal on hard clay	
			2.0										
			2.5										
			3.0										
			3.5										

DCP TEST (AS1289.6.3.2) Blows per 100 mm: 0 5 10 15 20 25

Sketch & Other Observations

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GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:27 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA12

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315738 m E 6273338 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 3.00 m

LOGGED: TC DATE: 11-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0					SP	SAND fine to medium grained, brown	D			SEAT
			0.5	0.80					brown orange becoming pale brown orange with depth		MD		
			1.0										
			1.5		DS 1.50-1.70 m Rec = 200/200 mm					M			
			2.0								D		
			2.5										
			3.0						END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED				
			3.5										

0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:27 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA13

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315764 m E 6273379 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 3.00 m

LOGGED: DK DATE: 10-12-20
CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0					SP	SAND fine to medium grained, orange brown	D	L - MD	SEAT	0 5 10 15 20 25
			0.5										
			1.0										
			1.5								MD		
			2.0										
	M		2.5								D		
			3.0						END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED				
			3.5										

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:27 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA14

SHEET: 1 OF 1

CLIENT:	Smiths 2014 Pty Ltd	COORDS: 315792 m E 6273477 m N MGA94 50	
PROJECT:	Smiths Beach Development	SURFACE RL: 10.0 m DATUM: AHD	
LOCATION:	Yallingup	INCLINATION: -90°	LOGGED: TC DATE: 10-12-20
JOB NO:	20435097	HOLE DEPTH: 3.00 m	CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0	10.00				SP	SAND fine to medium grained, dark brown, trace fines	D	L - MD		SEAT
			0.5								D		
			1.0	*1.10* 8.90					pale brown				
			1.5							M	VD		
			2.0										
			2.5	*2.50* 7.50					with silt				
			3.0	7.00					END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED				
			3.5										

PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm: 0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:27 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA15

SHEET: 1 OF 1

CLIENT:	Smiths 2014 Pty Ltd	COORDS: 315694 m E 6273420 m N MGA94 50			
PROJECT:	Smiths Beach Development	SURFACE RL: 20.0 m DATUM: AHD			
LOCATION:	Yallingup	INCLINATION: -90°	LOGGED: DK	DATE: 10-12-20	
JOB NO:	20435097	HOLE DEPTH: 3.00 m	CHECKED: TC	DATE: 29-1-21	

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0	20.00				SP	SAND fine to medium grained, orange brown	D	L	SEAT	0 5 10 15 20 25
			0.5										
			1.0								MD		
			1.5										
			2.0								D		
	M		2.5										
			3.0	17.00					END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED				
			3.5										

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:27 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA16

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315694 m E 6273355 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 3.00 m

LOGGED: DK DATE: 11-12-20
CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0					SP	SAND fine to medium grained, orange brown	D	L - MD	About 200 mm of topsoil	SEAT 0 5 10 15 20 25
	M		3.0						END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED		D		

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:27 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA17

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315596 m E 6273379 m N MGA94 50
SURFACE RL: 34.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 3.00 m

LOGGED: DK DATE: 10-12-20
CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0	34.00				SP	SAND fine to medium grained, orange brown	D	L	About 150 mm of topsoil	SEAT
			0.5										
			1.0								MD		
	M		1.5										
			2.0								D		
			2.5										
			3.0	31.00					END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED				
			3.5										

0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:27 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA18

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315568 m E 6273453 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 3.00 m

LOGGED: DK DATE: 10-12-20
CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0					SP	SAND fine to medium grained, orange brown	D	MD	About 100 mm of topsoil	SEAT
			0.5										
			1.0										
			1.5								D		
			2.0										
			2.5										
			3.0						END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED				
			3.5										

0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:28 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA19

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315526 m E 6273391 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 3.00 m

LOGGED: DK DATE: 11-12-20
CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0					SP	SAND fine to medium grained, brown	D			SEAT
				0.40					fine to coarse grained, pale brown orange		MD		
			0.5										
			1.0										
			1.5							M			
					DS 1.80-2.00 m Rec = 200/200 mm						D		
			2.0										
			2.5										
			3.0						END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED				
			3.5										

PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm: 0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:28 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA20

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315430 m E 6273397 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 1.90 m

LOGGED: TC DATE: 11-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0					SM	Silty SAND fine to medium grained, dark brown, about 15% silt	D	L		SEAT
				0.40					pale brown orange	M	MD - D		
			0.5										
			1.0										
			1.5								D		
	R		2.0						END OF HAND AUGER @ 1.90 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED			Refusal on weathered rock	
			2.5										
			3.0										
			3.5										

PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:28 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA21

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315440 m E 6273464 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 1.10 m

LOGGED: TC DATE: 11-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0					SM	Silty SAND fine to medium grained, dark brown, about 15% silt		L		SEAT
				0.40									
			0.5						pale brown orange	D			
					DS 0.80-1.00 m Rec = 200/200 mm						MD		
	R		1.0						END OF HAND AUGER @ 1.10 m REFUSAL GROUNDWATER NOT ENCOUNTERED			Refusal on Gneiss	Hammer Bounce
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										

0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:28 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA22

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315529 m E 6273515 m N MGA94 50
SURFACE RL: 26.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 1.00 m

LOGGED: TC DATE: 11-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0	26.50				SM	Silty SAND fine to medium grained, brown, about 15% silt	D	MD	SEAT	0 5 10 15 20 25
				0.30									
				26.20					pale brown orange		D		
			0.5	*0.80*									
				25.70					fine to coarse grained, pale grey, extremely weathered gneiss		VD		
			1.0	25.50					END OF HAND AUGER @ 1.00 m REFUSAL GROUNDWATER NOT ENCOUNTERED			Refusal on inferred Gneiss	
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:28 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA23

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315460 m E 6273520 m N MGA94 50
SURFACE RL: 29.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 0.90 m

LOGGED: TC DATE: 11-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
			0.0	29.00				SM	Silty SAND fine to medium grained, dark grey, about 15% silt		L	Some rock outcrops in the vicinity	SEAT
HA	M			*0.30* 28.70					pale brown grey	D	MD - D		
			0.5	*0.70*									
	H			28.30					fine to coarse grained, pale grey, extremely weathered rock		VD		
			1.0	28.10					END OF HAND AUGER @ 0.90 m REFUSAL GROUNDWATER NOT ENCOUNTERED			Inferred refusal on gneiss	
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										

0 5 10 15 20 25

Sketch & Other Observations

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REPORT OF HAND AUGERED BOREHOLE: HA24

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315517 m E 6273591 m N MGA94 50
SURFACE RL: 20.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 0.40 m

LOGGED: TC DATE: 11-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0	20.00	DS 0.10-0.30 m Rec = 200/200 mm			SM	Silty SAND fine to medium grained, dark brown, about 15% silt	D	L - MD		0 5 10 15 20 25
			0.5	19.60					END OF HAND AUGER @ 0.40 m REFUSAL GROUNDWATER NOT ENCOUNTERED			Inferred refusal on Gneiss	SEAT
			1.0										
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:28 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA25

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315536 m E 6273661 m N MGA94 50
SURFACE RL: 10.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 0.20 m

LOGGED: DK DATE: 10-12-20
CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
HA	M		0.0	10.50				SM	Silty SAND fine to coarse grained, brown, about 15-20% silt	D	L - MD	About 50 mm of topsoil	SHAT Hammer Bounce
			0.5	10.30					END OF HAND AUGER @ 0.20 m REFUSAL GROUNDWATER NOT ENCOUNTERED			Refusal on inferred Gneiss	
			1.0										
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:28 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA26

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315505 m E 6273696 m N MGA94 50
SURFACE RL: 10.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 0.80 m

LOGGED: TC DATE: 10-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
HA	M		0.0	10.00				SM	Silty SAND fine to medium grained, dark brown, about 15% silt, with fine to medium gravel	D	MD - D		SEAT
				0.40									
	H		0.5	9.60				Cl	Sandy CLAY medium plasticity, brown orange red, about 40% fine to coarse sand	w < PL	H	Refusal on hard clay	
	R			9.20					END OF HAND AUGER @ 0.80 m REFUSAL GROUNDWATER NOT ENCOUNTERED				
			1.0										
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										

0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:28 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA27

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315594 m E 6273629 m N MGA94 50
SURFACE RL: 10.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 0.70 m

LOGGED: TC DATE: 10-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
HA	M		0.0	10.50				SM	Silty SAND fine to medium grained, dark brown, about 15% silt, with fine to medium gravel	D	MD - D		SEAT
				0.40									
	H		0.5	10.10				Cl	Sandy CLAY medium plasticity, brown orange red, about 40% fine to coarse sand, trace gravel	w < PL	VSt - H		
	R			9.80					END OF HAND AUGER @ 0.70 m REFUSAL GROUNDWATER NOT ENCOUNTERED			Refusal on hard clay	
			1.0										
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										

DCP TEST (AS1289.6.3.2) Blows per 100 mm: 0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:28 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA28

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315595 m E 6273557 m N MGA94 50
SURFACE RL: 19.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 1.00 m

LOGGED: TC DATE: 10-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
HA	M		0.0	19.00				GP	Sandy GRAVEL fine to coarse grained, lateritised gneiss, brown, fine to medium sand, with silt	D	MD		SEAT
			0.5	0.50 18.50	DS 0.60-1.00 m Rec = 400/400 mm			Cl / CH	Sandy CLAY medium to high plasticity, orange brown, red brown and pale grey, about 50% fine to coarse sand, trace gravel	M	VSt		
	H									D	H	Refusal on hard clay	
	R		1.0	18.00					END OF HAND AUGER @ 1.00 m REFUSAL GROUNDWATER NOT ENCOUNTERED				
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										

DCP TEST (AS1289.6.3.2) Blows per 100 mm: 0 5 10 15 20 25

Sketch & Other Observations

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REPORT OF HAND AUGERED BOREHOLE: HA29

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315661 m E 6273609 m N MGA94 50
SURFACE RL: 8.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 1.90 m

LOGGED: TC DATE: 10-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0	8.00				SP	SAND fine to medium grained, dark brown, with silt	D	L		SEAT
				0.40									
			0.5	7.60					orange brown				
			1.0		DS 1.00-1.20 m Rec = 200/200 mm						MD		
				1.40									
			1.5	6.60					pale grey brown, with clay	M	D		
				1.80									
	H							SC	Clayey SAND fine to coarse grained, orange brown, about 15% to 20% low plasticity clay		VD		
				6.10					END OF HAND AUGER @ 1.90 m REFUSAL GROUNDWATER NOT ENCOUNTERED				
			2.0										
			2.5										
			3.0										
			3.5										

0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:28 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA30

SHEET: 1 OF 1

CLIENT:	Smiths 2014 Pty Ltd	COORDS: 315727 m E 6273575 m N MGA94 50	
PROJECT:	Smiths Beach Development	SURFACE RL: 6.5 m DATUM: AHD	
LOCATION:	Yallingup	INCLINATION: -90°	LOGGED: TC DATE: 10-12-20
JOB NO:	20435097	HOLE DEPTH: 2.20 m	CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
	L		0.0	6.50				SP	SAND fine to medium grained, black and grey, with fines, minor organic content	M	L - MD		SEAT
			0.5								D		
			1.0										
				1.20 5.30				SP	SAND fine to medium grained, pale yellow				
	M		1.5	*1.50* 5.00				SC	Clayey SAND fine to coarse grained, yellow grey, about 15% to 20% low plasticty clay		VD		
	H		2.0	*2.00* 4.50	DS 2.00-2.20 m Rec = 200/200 mm				pale brown orange yellow, about 25% medium plasticity clay				
				4.30					END OF HAND AUGER @ 2.20 m REFUSAL GROUNDWATER NOT ENCOUNTERED				
			2.5										
			3.0										
			3.5										

Sketch & Other Observations

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GAP gINT FN. F03h RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:28 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA31

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315738 m E 6273539 m N MGA94 50
SURFACE RL: 8.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 3.00 m

LOGGED: TC DATE: 10-12-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0	8.00				SP	SAND & TOPSOIL fine to medium grained, black and grey, with fines	M	L	SEAT	0 5 10 15 20 25
				0.30 7.70				SP	SAND fine to medium grained, brown grey		MD		
			0.5										
			1.0								D		
			1.5										
			2.0	*2.20* 5.80				SC	Clayey SAND fine to medium grained, orange yellow, about 15% low plasticity clay		VD		
	M		2.5	*2.50* 5.50				SP	SAND fine to medium grained, pale grey	M - W		Water table close	
			3.0	5.00					END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED				
			3.5										

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:29 10.02.00.04 Datgel Tools

REPORT OF HAND AUGERED BOREHOLE: HA32

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315252 m E 6273212 m N MGA94 50
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 3.00 m

LOGGED: DK DATE: 11-12-20
CHECKED: TC DATE: 29-1-21

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0					SP	SAND fine to medium grained, dark brown, with silt, minor organic content		L		SEAT
			0.5										
			1.0	1.00					orange brown		D		
	M		1.5							D			
			2.0								VD		
			2.5										
			3.0						END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED				
			3.5										

0 5 10 15 20 25

Sketch & Other Observations

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GAP gINT FN. F03h
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED WITH SKETCH 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 13:29 10.02.00.04 Datgel Tools

APPENDIX C

Borehole Report

GOLDER
MEMBER OF WSP

METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT REPORTS

SYMBOLS


FILL


GRAVEL (GW, GP, GM or GC)


SAND (SW, SP, SM or SC)


SILT (ML or MH)


CLAY (CL, CI or CH)


ORGANIC SOILS (OL, OH or Pt)


COBBLES or BOULDERS

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay.

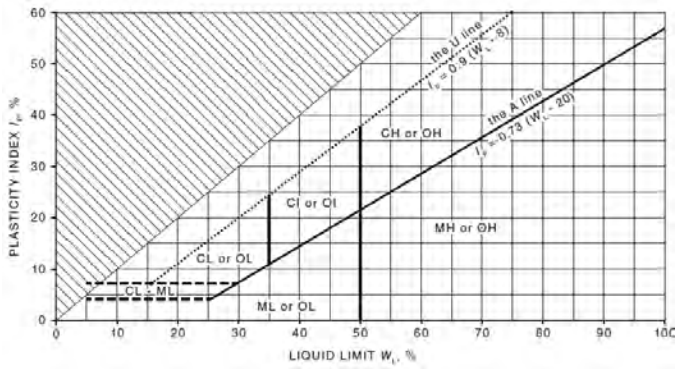
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil and Rock is classified and described in Reports of Boreholes and Test Pits using the preferred method given in AS1726-2017. The material properties are assessed in the field by visual/tactile methods.

Particle Size

Soil Group	Sub Division	Particle Size
BOULDERS		> 200 mm
COBBLES		63 to 200 mm
GRAVEL	Coarse	19 to 63 mm
	Medium	6.7 to 19 mm
	Fine	2.36 to 6.7 mm
SAND	Coarse	0.6 to 2.36 mm
	Medium	0.21 to 0.6 mm
	Fine	0.075 to 0.21 mm
SILT		0.002 to 0.075 mm
CLAY		< 0.002 mm

Plasticity Properties



MOISTURE CONDITION

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays and silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in dry condition and may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sand and gravels tend to cohere.

Moisture condition for fine grained soils is described relative to the plastic limit or liquid limit as specified in AS1726-2017.

CONSISTENCY AND DENSITY

Fine Grained Soils

Symbol	Term	Undrained Shear Strength
VS	Very Soft	0 to 12 kPa
S	Soft	12 to 25 kPa
F	Firm	25 to 50 kPa
St	Stiff	50 to 100 kPa
VSt	Very Stiff	100 to 200 kPa
H	Hard	Above 200 kPa
Fr	Friable	-

Coarse Grained Soils

Symbol	Term	Density Index (%)	SPN "N" *
VL	Very Loose	Less than 15	0 to 4
L	Loose	15 to 35	4 to 10
MD	Medium Dense	35 to 65	10 to 30
D	Dense	65 to 85	30 to 50
VD	Very Dense	Above 85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.

* SPT correlations are not stated in AS1726-2017, and may be subject to corrections for overburden pressure and equipment type.

CEMENTATION

Weakly Cemented	The soil may be easily disaggregated by hand in air or water.
Moderately Cemented	Effort is required to disaggregate the soil by hand in air or water.

EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT REPORTS

DRILLING/EXCAVATION METHOD

ADH	Hollow auger drilling	EX	Excavator	PQ3	Diamond core - 83 mm
ADT	Auger drilling with tc-bit	HA	Hand auger	PT	Push tube sampling
ADV	Auger drilling with v-bit	HAND	Excavated by hand	RAB	Rotary air blast
AIRCORE	Aircore	HMLC	methods Diamond core - 63	RC	Reverse circulation
AT	Air track	HQ3	mm Diamond core - 61 mm	RT	Rock roller
BH	Backhoe bucket Cable	JET	Jetting	SONIC	Sonic drilling
CT	tool rig	MZ	Mazier tube sampling	SPT	Standard penetration
DTC	Diatube coring Existing	NDD	Non-destructive digging	U	testing Undisturbed tube
EE	excavation Extruded	NMLC	Diamond core - 52 mm	WB	sampling Washbore drilling
EPT	push tube	NQ3	Diamond core - 45 mm		

PENETRATION/EXCAVATION RESISTANCE

L	**Low resistance.** Rapid penetration possible with little effort from the equipment used.
M	**Medium resistance.** Excavation/possible at an acceptable rate with moderate effort from the equipment used.
H	**High resistance** to penetration/excavation. Further penetration is possible at a slow rate and requires significant effort from the equipment.
R	**Refusal or Practical Refusal.** No further progress possible without the risk of damage or unacceptable wear to the digging implement or machine.

These assessments are subjective and are dependent on many factors including the equipment power, weight, condition of excavation or drilling tools, and the experience of the operator.

WATER

▽	Water level at date shown	◁	Partial water loss
▷	Water inflow	◀	Complete water loss

GROUNDWATER NOT OBSERVED	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.
GROUNDWATER NOT ENCOUNTERED	The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following 150mm seating
30/80 mm	Where practical refusal occurs, the blows and penetration for that interval are reported
RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB	Hammer double bouncing on anvil
DS	Disturbed sample
BDS	Bulk disturbed sample
G	Gas Sample
W	Water Sample
FP	Field permeability test over section noted
FV	Field vane shear test expressed as uncorrected shear strength (sv = peak value, sr = residual
PID	value) Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket penetrometer test expressed as instrument reading in kPa
U63	Thin walled tube sample - number indicates nominal sample diameter in millimetres
WPT	Water pressure test
DCP	Dynamic cone penetration test
CPT	Cone penetration test
CPTu	Cone penetration test with pore pressure (u) measurement

RANKING OF VISUALLY OBSERVABLE CONTAMINATION AND ODOUR (for specific soil contamination assessment projects)

R = 0	No visible evidence of contamination	R = A	No non-natural odours identified
R = 1	Slight evidence of visible	R = B	Slight non-natural odours identified
R = 2	contamination Visible contamination	R = C	Moderate non-natural odours identified
R = 3	Significant visible contamination	R = D	Strong non-natural odours identified

ROCK CORE RECOVERY

TCR = Total Core Recovery (%)	RQD = Rock Quality Designation (%)	SCR = Solid Core Recovery (%)	F = Fracture Frequency
$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100$	$= \frac{\sum \text{Axial lengths of core} > 100\text{ mm}}{\text{Length of core run}} \times 100$	$= \frac{\sum \text{Length of cyclindrical core recovered}}{\text{Length of core run}} \times 100$	$= \frac{\text{No. of defects}}{\text{Length of zone (m)}}$

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TERMS FOR ROCK MATERIAL STRENGTH & WEATHERING AND ABBREVIATIONS FOR DEFECT DESCRIPTIONS

STRENGTH

Symbol	Term	UCS (MPa)	Field Guide
VL	Very Low	0.6 to 2	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm can be broken by finger pressure.
L	Low	2 to 6	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	6 to 20	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High	20 to 60	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.
VH	Very High	60 to 200	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>200	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Material with strength less than 'Very Low' shall be described using soil characteristics. The presence of an original rock structure, fabric or texture should be noted, if relevant.

ROCK MATERIAL WEATHERING

Symbol		Term	Field Guide
RS		Residual Soil	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.
XW		Extremely Weathered	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.
	HW	Highly Weathered	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 recognizable. 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.
	MW	Moderately Weathered	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 recognizable, but shows little or no change of strength from fresh rock.
SW		Slightly Weathered	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
FR		Fresh	Rock shows no sign of decomposition of individual minerals or colour changes.

ABBREVIATIONS FOR DEFECT TYPES AND DESCRIPTIONS

Defect Type	
P	Parting
X	Foliation
L	Cleavage
C	Contact
J	Joint
SSu	Sheared Surface
SS	Sheared Seam
SZ	Sheared Zone
CS	Crushed Seam
IS	Infilled Seam
EWS	Extremely Weathered Seam
V	Vein

Coating or Infilling	
Cn	Clean
Sn	Stain
Ve	Veneer
Ct	Coating
In	Infill

Planarity	
Pl	Planar
Cv	Curved
Un	Undulating
St	Stepped
Ir	Irregular

Roughness	
VRo	Very Rough
Ro	Rough
Sm	Smooth
Po	Polished
Sl	Slickensided

Vertical Boreholes – The dip (inclination from horizontal) of the defect is given.

Inclined Boreholes – The inclination is measured as the acute angle between the core axis and the vertical direction.

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REPORT OF BOREHOLE: BH1

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315665 m E 6273623 m N MGA94 50
SURFACE RL: 6.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 6.50 m

DRILL RIG: GDR650
CONTRACTOR: OzDrill
LOGGED: TC DATE: 15-1-21
CHECKED: DK DATE: 29-1-21

Drilling						Field Material Description					Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	$Is_{(50)}$ MPa D- diametral A- axial	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
AS				0	6.00		SAND & GRAVEL					
					0.50							
HQ3		30	0 (0)		5.50		GNEISS medium to coarse grained, brown, grey, pale red, fractured, inferred boulder	MW				
					0.70							
				1	5.30		CORELOSS inferred sand/clay material					
					1.50							
		100	20 (55)		4.50		GNEISS medium to coarse grained, massive, brown, grey, pale red and black, fractured with Clayey SAND infill	SW			1.62 m: J, Pl, Ro, In 1.69 m: J, Pl, Ro, In 1.83 m: J, Pl, Ro, In 2.00-2.25 m: FZ	
		100	55 (70)	2							2.37 m: J, Pl, Ro, In 2.46 m: J, Pl, Ro, In 2.60 m: J, Pl, Ro, In	
										A 1.7		
		100	70 (100)	3							3.22 m: J, Pl, Ro, In 3.30 m: J, Pl, Ro, In 3.38 m: J, Pl, Ro, In 3.58 m: J, Pl, Ro, In	
					4.00						3.85 m: J, Pl, Ro, In 3.90-4.00 m: FZ	
		100	15 (30)	4	2.90 4.15		Sandy CLAY/ Clayey SAND	XW				
					1.85		GNEISS medium to coarse grained, massive, mottled pale blue, dark blue and grey	FR		D 9.8	4.36 m: J, Pl, Ro, Cn	
		100	80 (95)	5							4.71 m: J, Pl, Ro, Cn 4.88 m: J, Pl, Ro, Cn	
		100	100 (100)								5.11 m: J, Pl, Ro, Cn 5.21 m: J, Pl, Ro, Cn 5.50 m: J, Pl, Ro, Cn	
		100	100 (100)	6							5.80 m: J, Pl, Ro, Cn	
					6.50							
					-0.50		END OF BOREHOLE @ 6.50 m TARGET DEPTH GROUNDWATER NOT OBSERVED					
				7								
				8								
				9								
				10								

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RL3

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REPORT OF CORE PHOTOGRAPHS: BH1

SHEET: 1 OF 1

CLIENT:	Smiths 2014 Pty Ltd	COORDS:	315665 m E 6273623 m N MGA94 50	DRILL RIG:	GDR650	
PROJECT:	Smiths Beach Development	SURFACE RL:	6.0 m DATUM: AHD	CONTRACTOR:	OzDrill	
LOCATION:	Yallingup	INCLINATION:	-90°	LOGGED:	TC	DATE: 15-1-21
JOB NO:	20435097	HOLE DEPTH:	6.50 m	CHECKED:	DK	DATE: 29-1-21

PointID : BH1 Depth Range: 0.00 - 5.00 m

PointID : BH1 Depth Range: 5.00 - 6.50 m

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REPORT OF BOREHOLE: BH2

SHEET: 1 OF 1

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315702 m E 6273613 m N MGA94 50
SURFACE RL: 6.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 7.50 m

DRILL RIG: GDR650
CONTRACTOR: OzDrill
LOGGED: TC DATE: 15-1-21
CHECKED: DK DATE: 29-1-21

Drilling						Field Material Description					Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	$Is_{(50)}$ MPa D- diametral A- axial	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
AS				0	6.00		SAND & GRAVEL					
					0.50							
HQ3		100	15 (20)	1	5.50		GNEISS medium to coarse grained, mottled brown, grey pale red, fractured with sand/clay infill, inferred boulder	XW - MW			0.50-1.20 m: FZ	
					1.20							
		100	0 (0)	2	4.80		CLAYEY SAND fine to coarse grained, red brown, orange, grey, weakly to moderately cemented with iron cementing					
					2.25							
		100	100 (100)		3.75		GNEISS medium to coarse grained, massive, red brown, orange, grey	XW - MW				
					2.90							
		100	100 (100)	3	3.10		medium to coarse grained, red brown, dark grey, slightly fractured	SW		D 1.9	3.28 m: J, Pl, Ro, Cn	
		100	100 (100)	4								
		100	60 (100)	5						A 0.7	4.42 m: J, Un, Ro, In 4.67 m: J, Un, Ro, In 4.74 m: J, Un, Ro, In 4.83 m: J, Un, Ro, In 5.00 m: J, Pl, Ro, Cn 5.11 m: J, Pl, Ro, Cn 5.21 m: J, Un, Ro, In	
		100	100 (100)									
		85	40 (55)	6							5.66 m: J, Pl, Ro, Cn 5.81 m: J, Pl, Ro, Cn	
				7	7.30							
					-1.30 7.50		CORELOSS inferred highly fractured, extremely weathered zone					
					-1.50		END OF BOREHOLE @ 7.50 m TARGET DEPTH GROUNDWATER NOT OBSERVED					
				8								
				9								
				10								

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REPORT OF CORE PHOTOGRAPHS: BH2

			SHEET: 1 OF 1		
CLIENT:	Smiths 2014 Pty Ltd	COORDS: 315702 m E 6273613 m N MGA94 50	DRILL RIG: GDR650		
PROJECT:	Smiths Beach Development	SURFACE RL: 6.0 m DATUM: AHD	CONTRACTOR: OzDrill		
LOCATION:	Yallingup	INCLINATION: -90°	LOGGED: TC	DATE:	15-1-21
JOB NO:	20435097	HOLE DEPTH: 7.50 m	CHECKED: DK	DATE:	29-1-21

PointID : BH2 Depth Range: 0.00 - 5.00 m

PointID : BH2 Depth Range: 5.00 - 7.50 m

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REPORT OF BOREHOLE: BH3

SHEET: 1 OF 3

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315725 m E 6273608 m N MGA94 50
SURFACE RL: 5.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 12.00 m

DRILL RIG: GDR650
CONTRACTOR: OzDrill
LOGGED: TC DATE: 14-1-21
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			0	5.50				SP	SAND fine to medium grained, pale grey			
					C 0.50-1.50 m Rec = 0/1000 mm							
			1									
				1.40 4.10						D	MD	
HQ3					C 1.50-3.00 m Rec = 800/1500 mm			SM	Silty SAND fine to medium grained, dark grey black			
			2									
									For Continuation Refer to Sheet 2			
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

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REPORT OF BOREHOLE: BH3

SHEET: 2 OF 3

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315725 m E 6273608 m N MGA94 50
SURFACE RL: 5.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 12.00 m

DRILL RIG: GDR650
CONTRACTOR: OzDrill
LOGGED: TC DATE: 14-1-21
CHECKED: DK DATE: 29-1-21

Drilling						Field Material Description					Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	$Is_{(50)}$ MPa D- diametral A- axial	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0								
				1								
				2								
					2.80		Continuation of Sheet 1					
HQ3				3	2.70		GNEISS	MW				
					3.00		medium to coarse grained, mottled brown, pale red, dark grey, highly fractured, inferred boulder					
					2.50		CLAYEY SAND					
		100	0 (0)				fine to coarse grained, red brown and grey, weakly to moderately cemented with iron cementation					
		100	45 (45)	4	4.15							
					1.35		GNEISS	DW				
							medium to coarse grained, massive, mottled red brown and grey					
		80	65 (80)	5	5.20					A 0.3	4.70-4.90 m: FZ	
					0.30		CORELOSS					
					5.50		inferred weaker zone, extremely weathered					
					0.00		GNEISS	MW				
							medium to coarse grained, massive, mottled red brown and grey					
		100	100 (100)	6						A 0.5	6.25 m: J, Pl, Ro, Cn	
											6.80 m: J, Pl, Ro, Cn	
		55	25 (25)	7	7.15						7.00-7.15 m: FZ	
					-1.65		CORELOSS					
					7.50		inferred weaker zone, extremely weathered					
					-2.00		GNEISS	MW			7.65 m: J, Pl, Ro, Cn	
		100	40 (30)	8			medium to coarse grained, massive, mottled red brown and grey				7.90 m: J, Pl, Ro, Cn 8.00-8.50 m: FZ	
		100	45 (65)							D 1.1		
				9				SW			9.15 m: J, Pl, Ro, Cn	
		100	60 (70)								9.40 m: J, Pl, Ro, Cn	
											9.65 m: J, Pl, Ro, Cn 9.75 m: J, Pl, Ro, Cn	
				10								

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REPORT OF BOREHOLE: BH3

SHEET: 3 OF 3

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315725 m E 6273608 m N MGA94 50
SURFACE RL: 5.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 12.00 m

DRILL RIG: GDR650
CONTRACTOR: OzDrill
LOGGED: TC DATE: 14-1-21
CHECKED: DK DATE: 29-1-21

Drilling						Field Material Description					Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	$Is_{(50)}$ MPa D- diametral A- axial	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	45 (80)	10			GNEISS medium to coarse grained, massive, mottled red brown and grey	SW		A 0.7	10.00-10.20 m: FZ 10.62 m: J, Pl, Ro, Cn 10.73 m: J, Pl, Ro, Cn 11.10 m: J, Pl, Ro, Cn 11.23 m: J, Pl, Ro, Cn 11.47 m: J, Pl, Ro, Cn 11.70 m: J, Pl, Ro, Cn	
		100	95 (95)	11								
				12	12.00 -6.50		END OF BOREHOLE @ 12.00 m TARGET DEPTH GROUNDWATER NOT OBSERVED					
				13								
				14								
				15								
				16								
				17								
				18								
				19								
				20								

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GAP gINT FN. F02a
RL3

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REPORT OF CORE PHOTOGRAPHS: BH3

SHEET: 1 OF 1

CLIENT:	Smiths 2014 Pty Ltd	COORDS:	315725 m E 6273608 m N MGA94 50	DRILL RIG:	GDR650	
PROJECT:	Smiths Beach Development	SURFACE RL:	5.5 m DATUM: AHD	CONTRACTOR:	OzDrill	
LOCATION:	Yallingup	INCLINATION:	-90°	LOGGED:	TC	DATE: 14-1-21
JOB NO:	20435097	HOLE DEPTH:	12.00 m	CHECKED:	DK	DATE: 29-1-21

PointID : BH3 Depth Range: 2.00 - 7.00 m

PointID : BH3 Depth Range: 7.00 - 12.00 m

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REPORT OF BOREHOLE: BH4

SHEET: 1 OF 2

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315765 m E 6273585 m N MGA94 50
SURFACE RL: 6.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 16.50 m

DRILL RIG: GDR650
CONTRACTOR: OzDrill
LOGGED: TC DATE: 13-1-21
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			0	6.00					SAND & GRAVEL			
				0.50								
HA				5.50				SP	SAND fine to medium grained, pale grey		MD	
			1									
			2									
				3.00								
			3	3.00	Rec = 400/450 mm SPT 3.00-3.45 m 5, 4, 8 N=12			SC	Clayey SAND fine to coarse grained, pale brown, about 20-25% medium plasticity clay	D		
			4									
			5									
HQ3			6		Rec = 300/410 mm SPT 6.00-6.41 m 13, 18, 20/110mm N>38						VD	
			7									
				7.50								
				-1.50				SC / CI	Sandy CLAY medium plasticity, brown, grey, pale blue and pale red, fine to coarse sand, variable cementation, iron cemented	w < PL	VSt	
			8									
			9									
			10									

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REPORT OF BOREHOLE: BH4

SHEET: 2 OF 2

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315765 m E 6273585 m N MGA94 50
SURFACE RL: 6.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 16.50 m

DRILL RIG: GDR650
CONTRACTOR: OzDrill
LOGGED: TC DATE: 13-1-21
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ3			10					SC / CI	Sandy CLAY medium plasticity, brown, grey, pale blue and pale red, fine to coarse sand, variable cementation, iron cemented	w < PL	VSt	
			11									
			12									
			13									
			14									
			15									
			16									
				-10.50					END OF BOREHOLE @ 16.50 m TARGET DEPTH GROUNDWATER NOT OBSERVED			
			17									
			18									
			19									
			20									

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GAP gINT FN. F01a
RL3

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REPORT OF CORE PHOTOGRAPHS: BH4

SHEET: 1 OF 1

CLIENT:	Smiths 2014 Pty Ltd	COORDS: 315765 m E 6273585 m N MGA94 50	DRILL RIG: GDR650		
PROJECT:	Smiths Beach Development	SURFACE RL: 6.0 m DATUM: AHD	CONTRACTOR: OzDrill		
LOCATION:	Yallingup	INCLINATION: -90°	LOGGED: TC	DATE:	13-1-21
JOB NO:	20435097	HOLE DEPTH: 16.50 m	CHECKED: DK	DATE:	29-1-21

PointID : BH4 Depth Range: 8.00 - 13.00 m

PointID : BH4 Depth Range: 13.00 - 16.50 m

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GOLDER
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REPORT OF BOREHOLE: BH5

SHEET: 1 OF 3

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315750 m E 6273601 m N MGA94 50
SURFACE RL: 6.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 10.50 m

DRILL RIG: GDR650
CONTRACTOR: OzDrill
LOGGED: TC DATE: 16-1-20
CHECKED: DK DATE: 29-1-21

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			0	6.50					SAND & GRAVEL			
				0.50								
HA				6.00				SP	SAND fine to medium grained, pale grey			
			1									
HQ3			2							D	MD	
SPT			3		Rec = 300/450 mm SPT 3.00-3.45 m 8, 13, 12 N=25							
HQ3									For Continuation Refer to Sheet 2			
			4									
			5									
			6									
			7									
			8									
			9									
			10									

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GAP 10.0.6 LIB.GLB Log GAP NON-CORED FULL PAGE 2043097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 14:57 10.02.00.04 Datgel Tools

REPORT OF BOREHOLE: BH5

GOLDER
MEMBER OF WSP

SHEET: 2 OF 3

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315750 m E 6273601 m N MGA94 50
SURFACE RL: 6.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 10.50 m

DRILL RIG: GDR650
CONTRACTOR: OzDrill
LOGGED: TC DATE: 16-1-20
CHECKED: DK DATE: 29-1-21

Drilling						Field Material Description					Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	$Is_{(50)}$ MPa D- diametral A- axial	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0								
				1								
				2								
				3	3.50		Continuation of Sheet 1					
					3.60							
		30	15 (20)	4	3.75 2.75		GNEISS medium to coarse grained, red brown, grey, inferred boulder	MW				
					4.35		CORELOSS inferred weak zone					
					4.50		GNEISS red brown, inferred boulder	MW				
		100	0 (0)	5	2.00		CLAYEY SAND/ SANDY CLAY brown, red, orange and grey, moderately cemented with iron cementation in parts					
		100	0 (0)									
		100	0 (0)	6	6.00 0.50		moderately to well cemented, variably cemented			D 0.2		
		100	35 (35)	7	6.80 -0.30 7.25		CLAY mottled grey, blue and black, stiff to very stiff					
					-0.75		GNEISS medium to coarse grained, massive, mottled red brown, grey, pale red	SW		A 0.4		
		100	100 (100)	8				FR		D 4.8		
		100	100 (100)								8.49 m: J, Pl, Ro, Cn 8.70 m: J, Pl, Ro, Cn 8.83 m: J, Pl, Ro, Cn	
		100	100 (100)	9							9.25 m: J, Pl, Ro, Cn	
				10								

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GAP gINT FN. F02a
RL3

GAP 10.0.6 LIB.GLB Log GAP CORED BOREHOLE 2 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 14:57 10.02.00.04 Datgel Tools

GOLDER
MEMBER OF WSP

REPORT OF BOREHOLE: BH5

SHEET: 3 OF 3

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315750 m E 6273601 m N MGA94 50
SURFACE RL: 6.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 10.50 m

DRILL RIG: GDR650
CONTRACTOR: OzDrill
LOGGED: TC DATE: 16-1-20
CHECKED: DK DATE: 29-1-21

Drilling						Field Material Description					Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	$Is_{(50)}$ MPa D- diametral A- axial	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
		100	100 (100)	10	*10.50*		GNEISS medium to coarse grained, massive, mottled red brown, grey, pale red	FR			10.00 m: J, Pl, Ro, Cn	
					-4.00		END OF BOREHOLE @ 10.50 m TARGET DEPTH GROUNDWATER NOT OBSERVED					
				11								
				12								
				13								
				14								
				15								
				16								
				17								
				18								
				19								
				20								

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GAP 10.0.6 LIB.GLB Log GAP CORED BOREHOLE 2 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 14:57 10.02.00.04 Datgel Tools

REPORT OF CORE PHOTOGRAPHS: BH5

SHEET: 1 OF 1

CLIENT:	Smiths 2014 Pty Ltd	COORDS: 315750 m E 6273601 m N MGA94 50	DRILL RIG: GDR650		
PROJECT:	Smiths Beach Development	SURFACE RL: 6.5 m DATUM: AHD	CONTRACTOR: OzDrill		
LOCATION:	Yallingup	INCLINATION: -90°	LOGGED: TC	DATE:	16-1-20
JOB NO:	20435097	HOLE DEPTH: 10.50 m	CHECKED: DK	DATE:	29-1-21

PointID : BH5 Depth Range: 3.00 - 8.00 m

PointID : BH5 Depth Range: 8.00 - 10.50 m

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GAP 10.0.6 LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 14:57 10.02.00.04 Datgel Tools

GOLDER
MEMBER OF WSP

REPORT OF BOREHOLE: BH6

SHEET: 1 OF 2

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315761 m E 6273634 m N MGA94 50
SURFACE RL: 2.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 6.00 m

DRILL RIG: Jarco
CONTRACTOR: OzDrill
LOGGED: TC DATE: 10-3-21
CHECKED: DK DATE: 15-3-21

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	2.00				SP	SAND fine to medium grained, pale grey white, quatz and calcareous sand	D	L - MD	
				1.00								
			1	1.00					GNEISS fine to coarse grained, inferred boulder, mottled blue, grey and dark grey, slightly weathered, high strength			
				1.25								
				0.75					CORE LOSS			
				1.50								
HQ3				0.50				SC / CI	Clayey SAND /Sandy CLAY grey, brown, orange, red, fine to coarse grained sand, medium plasticity clay, variably cemented, moderately iron cemented in parts	M	VD - H	
			2	*2.40*								
				-0.40				CI	CLAY medium plasticity, grey, red brown	w ~ PL	VSt	
			3									
			4									
									For Continuation Refer to Sheet 2			
			5									
			6									
			7									
			8									
			9									
			10									

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GAP 10.0.6 LIB.GLB Log GAP NON-CORED FULL PAGE 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 14:59 10.02.00.04 Datgel Tools

GOLDER
MEMBER OF WSP

REPORT OF BOREHOLE: BH6

SHEET: 2 OF 2

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315761 m E 6273634 m N MGA94 50
SURFACE RL: 2.0 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 6.00 m

DRILL RIG: Jarco
CONTRACTOR: OzDrill
LOGGED: TC DATE: 10-3-21
CHECKED: DK DATE: 15-3-21

Drilling						Field Material Description					Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa (VL 0.6, L 2.0, M 6.0, H 20, VH 60, EH 200)	LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0								
				1								
				2								
				3								
				4								
					4.50		Continuation of Sheet 1					
HQ3		100	80 (100)	5	-2.50		GNEISS fine to coarse grained, massive, grey, brown, red	DW		PLI(D)=0.34 PLI(A)=0.89		
								SW				
				6	6.00					PLI(A)=3.30		
					-4.00		END OF BOREHOLE @ 6.00 m TARGET DEPTH GROUNDWATER NOT OBSERVED					
				7								
				8								
				9								
				10								

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GAP gINT FN. F02a
RL3

GAP 10.0.6 LIB.GLB Log GAP CORED BOREHOLE 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 14:59 10.02.00.04 Datgel Tools

REPORT OF CORE PHOTOGRAPHS: BH6

SHEET: 1 OF 1

CLIENT:	Smiths 2014 Pty Ltd	COORDS: 315761 m E 6273634 m N MGA94 50	DRILL RIG: Jarco		
PROJECT:	Smiths Beach Development	SURFACE RL: 2.0 m DATUM: AHD	CONTRACTOR: OzDrill		
LOCATION:	Yallingup	INCLINATION: -90°	LOGGED: TC	DATE:	10-3-21
JOB NO:	20435097	HOLE DEPTH: 6.00 m	CHECKED: DK	DATE:	15-3-21

PointID : BH6 Depth Range: 1.00 - 6.00 m

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GAP 10.0.6 LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 14:59 10.02.00.04 Datgel Tools

REPORT OF BOREHOLE: BH7

GOLDER
MEMBER OF WSP

SHEET: 1 OF 2

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315727 m E 6273627 m N MGA94 50
SURFACE RL: 2.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 6.00 m

DRILL RIG: Jarco
CONTRACTOR: OzDrill
LOGGED: TC DATE: 11-3-21
CHECKED: DK DATE: 15-3-21

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ3			0	2.50				SP	SAND fine to medium grained, pale grey white, quartz and calcareous sand	M	L - MD	
			1		Rec = 450/450 mm SPT 1.00-1.45 m 4, 13, 28 N=41						D	
									For Continuation Refer to Sheet 2			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

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GAP gINT FN. F01a
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED FULL PAGE 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 15:00 10.02.00.04 Datgel Tools

GOLDER
MEMBER OF WSP

REPORT OF BOREHOLE: BH7

SHEET: 2 OF 2

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315727 m E 6273627 m N MGA94 50
SURFACE RL: 2.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 6.00 m

DRILL RIG: Jarco
CONTRACTOR: OzDrill
LOGGED: TC DATE: 11-3-21
CHECKED: DK DATE: 15-3-21

Drilling						Field Material Description					Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa (VL 0.6, L 2.0, M 6.0, H 20, VH 60, EH 200)	LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0								
				1								
					1.50		Continuation of Sheet 1					
HQ3		85	35 (55)	2	1.65 0.85 1.90 0.60		GNEISS fine to coarse grained, dark blue, dark grey, possible boulder CORE LOSS GNEISS fine to coarse grained, massive, brown, red, dark grey, fractured with clay/sand infill	SW - FR DW		PLI(D)=0.87		
		100	55 (85)	3	3.50 -1.00		blue, green, grey, red-brown, slightly fractured	SW		PLI(D)=3.40		
		100	100 (100)	4						PLI(D)=2.10		
				5								
				6	6.00 -3.50		END OF BOREHOLE @ 6.00 m TARGET DEPTH GROUNDWATER NOT OBSERVED					
				7								
				8								
				9								
				10								

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GAP 10.0.6 LIB.GLB Log GAP CORED BOREHOLE 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 15:00 10.02.00.04 Datgel Tools

GOLDER
MEMBER OF WSP

REPORT OF CORE PHOTOGRAPHS: BH7

SHEET: 1 OF 1

CLIENT:	Smiths 2014 Pty Ltd	COORDS: 315727 m E 6273627 m N MGA94 50	DRILL RIG: Jarco		
PROJECT:	Smiths Beach Development	SURFACE RL: 2.5 m DATUM: AHD	CONTRACTOR: OzDrill		
LOCATION:	Yallingup	INCLINATION: -90°	LOGGED: TC	DATE:	11-3-21
JOB NO:	20435097	HOLE DEPTH: 6.00 m	CHECKED: DK	DATE:	15-3-21

PointID : BH7 Depth Range: 1.00 - 6.00 m

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GAP 10.0.6 LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 15:00 10.02.00.04 Datgel Tools

GOLDER
MEMBER OF WSP

REPORT OF BOREHOLE: BH8

SHEET: 1 OF 3

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315740 m E 6273614 m N MGA94 50
SURFACE RL: 6.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 10.50 m

DRILL RIG: Jarco
CONTRACTOR: OzDrill
LOGGED: TC DATE: 12-3-21
CHECKED: DK DATE: 15-3-21

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA			0	6.50				SP	SAND fine to medium grained, pale grey			
			1									
			2									
HQ3			3							M	MD	
			4									
			5									
			6						For Continuation Refer to Sheet 2			
			7									
			8									
			9									
			10									

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GAP gINT FN. F01a
RL3

GAP 10.0.6 LIB.GLB Log GAP NON-CORED FULL PAGE 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 15:00 10.02.00.04 Datgel Tools

GOLDER
MEMBER OF WSP

REPORT OF BOREHOLE: BH8

SHEET: 2 OF 3

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315740 m E 6273614 m N MGA94 50
SURFACE RL: 6.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 10.50 m

DRILL RIG: Jarco
CONTRACTOR: OzDrill
LOGGED: TC DATE: 12-3-21
CHECKED: DK DATE: 15-3-21

Drilling						Field Material Description					Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa (VL 0.6, L 2.0, M 6.0, H 20, VH 60, EH 200)	LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0								
				1								
				2								
				3								
				4								
				5								
					5.75		Continuation of Sheet 1					
HQ3				6	0.75		GNEISS fine to coarse grained, red brown, cemented clayey sand	XW		PLI(D)=0.07		
		100	0 (0)	7						PLI(D)=0.14		
		100	55 (55)	8	8.20 -1.70		GNEISS fine to coarse grained, massive, red brown and grey, slightly fractured	DW		PLI(D)=0.55		
		100	95 (100)	9						PLI(D)=0.18		
				10						PLI(A)=0.21		

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GAP gINT FN. F02a
RL3

GAP 10.0.6 LIB.GLB Log GAP CORED BOREHOLE 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 15:00 10.02.00.04 Datgel Tools

GOLDER
MEMBER OF WSP

REPORT OF BOREHOLE: BH8

SHEET: 3 OF 3

CLIENT: Smiths 2014 Pty Ltd
PROJECT: Smiths Beach Development
LOCATION: Yallingup
JOB NO: 20435097

COORDS: 315740 m E 6273614 m N MGA94 50
SURFACE RL: 6.5 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 10.50 m

DRILL RIG: Jarco
CONTRACTOR: OzDrill
LOGGED: TC DATE: 12-3-21
CHECKED: DK DATE: 15-3-21

Drilling						Field Material Description					Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa (VL 0.6, L 2.0, M 6.0, H 20, VH 60, EH 200)	LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	95 (100)	10	10.50 -4.00		GNEISS fine to coarse grained, massive, red brown and grey, slightly fractured	DW		PLI(D)=0.64		
							END OF BOREHOLE @ 10.50 m TARGET DEPTH GROUNDWATER NOT OBSERVED					
				11								
				12								
				13								
				14								
				15								
				16								
				17								
				18								
				19								
				20								

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GAP gINT FN. F02a
RL3

GAP 10.0.6 LIB.GLB Log GAP CORED BOREHOLE 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 15:00 10.02.00.04 Datgel Tools

REPORT OF CORE PHOTOGRAPHS: BH8

SHEET: 1 OF 1

CLIENT:	Smiths 2014 Pty Ltd	COORDS: 315740 m E 6273614 m N MGA94 50	DRILL RIG: Jarco		
PROJECT:	Smiths Beach Development	SURFACE RL: 6.5 m DATUM: AHD	CONTRACTOR: OzDrill		
LOCATION:	Yallingup	INCLINATION: -90°	LOGGED: TC	DATE:	12-3-21
JOB NO:	20435097	HOLE DEPTH: 10.50 m	CHECKED: DK	DATE:	15-3-21

PointID : BH8 Depth Range: 5.00 - 10.00 m

PointID : BH8 Depth Range: 10.00 - 10.50 m

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GAP 10.0.6 LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE 20435097 SMITHS BEACH.GPJ <<DrawingFile>> 18-10-2021 15:00 10.02.00.04 Datgel Tools

APPENDIX D

Pavement Dipping Report

Pavement Dipping Location	**PD01**	**northbound lane, closest to Canal Rocks Rd**	**Approx. Coordinates:** 316075 E 6273013 N	**Datum:** MGA zone 50J	
			Logged: DG **Date:** 22/12/2020	**Checked:** DMS **Date:** 03-02-21	
Pavement Thickness incl. Surfacing (mm)	>520		**Samples**		
End of Hole (mm)	520				
Surfacing	**ASPHALT** 14 mm DGA				
Thickness (mm)	40				
Comments	cored with water				
Basecourse	**Sandy GRAVEL (GP)** fine to coarse grained, sub-rounded to sub-angular, pale brown to brown, approximately 30-40% fine to coarse grained sand, trace non plastic fines		1 x DS		
Thickness (mm)	120				
Comments	dry				
Sub-base	**Gravelly SAND (SP)** fine to medium grained crushed limestone, pale yellow, fine to medium gravel (inferred fill)		1 x DS		
Thickness (mm)	>360				
Comments	dry, attempted hand augering to deeper depths but the material kept collapsing				
Subgrade					
Comments	Not encountered				
Pavement Conditions and General Comments	Asphalt surfacing looks relatively new. Shape of pavement is good, no significant defects observed.				

Pavement Dipping Location	PD02	southbound lane	Approx. Coordinates: 316075 E 6273130 N	Datum: MGA zone 50J
			Logged: DG Date: 22/12/2020	Checked: DMS Date: 03-02-21

Pavement Thickness incl. Surfacing (mm)	190	**Samples**
End of Hole (mm)	410	
Surfacing	**ASPHALT** 14 mm DGA with inferred 10 mm seal	
Thickness (mm)	40	
Comments	cored with water	
Basecourse	**Sandy GRAVEL (GP)** fine to coarse grained, sub-rounded to sub-angular, brown, approximately 30-40% fine to coarse grained sand, trace non-plastic fines	1 x DS
Thickness (mm)	150	
Comments	dry	
Subgrade	**Gravelly SAND (SP)** fine to coarse, pale brown, approximately 30% fine to medium gravel, trace fines	1 x BDS
Comments	dry	

Pavement Conditions and General Comments	Asphalt surfacing looks relatively new. Shape of pavement is good, no significant defects observed.

Perth Sands Penetrometer: *conducted at 410 mm depth*

Testing Increment (mm)	0-150	150-300	300-450	450-600			
Blow Count / 150 mm	8	7	7	7			

Pavement Dipping Location	PD03	southbound lane	Approx. Coordinates: 316074 E 6273292 N	Datum: MGA zone 50J
			Logged: DG Date: 22/12/2020	Checked: DMS Date: 03-02-21

Pavement Thickness incl. Surfacing (mm)	300	**Samples**
End of Hole (mm)	490	
Surfacing	**ASPHALT** 14 mm DGA with inferred 10 mm seal	
Thickness (mm)	30	
Comments	cored with water	
Basecourse	**Sandy GRAVEL/Gravelly SAND (GP-SP)** fine to medium grained, sub-rounded to sub-angular gravel, brown, fine to coarse grained sand, trace fines	
Thickness (mm)	270	
Comments	dry	
Subgrade	**Clayey Gravelly SAND (SP-SC)** fine to coarse, brown-orange, with fine to medium, sub-rounded gravel, low plasticity fines (inferred fill)	1 x DS
Comments	dry, similar material to basecourse - difficult to distinguish layer	

Pavement Conditions and General Comments	Asphalt surfacing looks relatively new. Shape of pavement is good, no significant defects observed.

Dynamic Cone Penetrometer: conducted at 490 mm depth

Testing Increment (mm)	0-100						
Blow Count / 100 mm	Refusal						

Pavement Dipping Location	**PD04**	**northbound lane**		**Approx. Coordinates:** 316065 E 6273444 N	**Datum:** MGA zone 50J
				Logged: DG **Date:** 22/12/2020	**Checked:** DMS **Date:** 03-02-21
Pavement Thickness incl. Surfacing (mm)	260		**Samples**		
End of Hole (mm)	870				
Surfacing	**ASPHALT** 14 mm DGA				
Thickness (mm)	30				
Comments	cored with water				
Basecourse	**Sandy GRAVEL/Gravelly SAND (GP/SP)** fine to medium grained, sub-rounded to sub-angular gravel, brown, fine to coarse grained sand, trace fines		1 x DS		
Thickness (mm)	230				
Comments	dry				
Subgrade	**SAND (SP)** fine to coarse, pale brown, with fine to medium, sub-rounded gravel, trace fines different subgrade material from approx. 500 mm depth - Clayey SAND (SC), fine to coarse, low plasticity clay		1 x DS		
Comments	dry to moist				
Pavement Conditions and General Comments	Asphalt surfacing looks relatively new. Shape of pavement is good, no significant defects observed.				

Pavement Dipping Location	PD05	northbound lane	Approx. Coordinates: 316063 E 6273536 N	Datum: MGA zone 50J
			Logged: DG Date: 22/12/2020	Checked: DMS Date: 03-02-21

		Samples
Pavement Thickness incl. Surfacing (mm)	290	
End of Hole (mm)	1000	
Surfacing	**ASPHALT** 10 mm red laterite DGA with inferred 5 mm seal	
Thickness (mm)	30	
Comments	cored with water	
Basecourse	**Sandy GRAVEL (GP)** fine to medium grained, sub-rounded to sub-angular gravel, brown, fine to coarse grained sand, trace fines	
Thickness (mm)	190	
Comments	dry to moist	
Sub-base	**Sandy GRAVEL (GP)** fine to medium grained, sub-rounded to sub-angular gravel, grey-brown, fine to coarse grained sand, trace fines	
Thickness (mm)	70	
Comments	dry to moist	
Subgrade	**Silty SAND(SM)** fine to medium, dark brown, inferred low to medium plasticity silt, trace fine to medium sub-rounded gravel. at 800 mm depth material transitions to red brown, inferred medium plasticity silt/clayey fines	
Comments	moist	

Pavement Conditions and General Comments	Asphalt surfacing looks relatively new. Shape of pavement is good, minor flushing on the wheel paths further north, closer to the bend.

Dynamic Cone Penetrometer: conducted at 450 mm depth

Testing Increment (mm)	0-100	100-200	200-300	300-400	400-500	500-600	
Blow Count / 100 mm	3	3	2	2	2	2	

Pavement Dipping Location	PD06	southbound lane	Approx. Coordinates: 315906 E 6273603 N	Datum: MGA zone 50J
			Logged: DG Date: 22/12/2020	Checked: DMS Date: 03-02-21

Pavement Thickness incl. Surfacing (mm)	290	**Samples**
End of Hole (mm)	750	
Surfacing	**ASPHALT** 10 mm red laterite DGA with inferred 5 mm seal	
Thickness (mm)	30	
Comments	cored with water	
Basecourse	**Clayey Sandy GRAVEL (GP-GC)** fine to coarse grained, sub-rounded to sub-angular, brown, approximately 30% fine to coarse grained sand, low plasticity fines	1 x DS
Thickness (mm)	260	
Comments	dry	
Subgrade	**SAND (SP)** fine to medium, brown to pale brown, trace non plastic fines	1 x BDS
Comments	dry	

Pavement Conditions and General Comments	Asphalt surfacing looks relatively new. Shape of pavement is good, no significant defects observed. Minor flushing on the wheel paths closer to the bend - inferred due to turning stresses.

Perth Sands Penetrometer: conducted at 750 mm depth

Testing Increment (mm)	0-150	150-300					
Blow Count / 150 mm	10	14					

APPENDIX E

Falling Weight Deflectometer Test Report

STATS Australia
Specialist Testing And Technical Services

Perth Add:
Unit 1/24 Baile Road, Canning Vale, WA 6155
Karratha Add:
1938 Pyramid Road, Karratha, WA 6714
Singapore Add:
71 Toh Guan Road East, #02-01/02/06 Techcentre, SG 608598
www.statswa.com.au

Client :	Golder Associates			**Job No:**	102162
Project Name:	FWD testing - Yallingup			**File Name:**	**Beach Rd North**
Road Name:	Smiths Beach Road - Starting form Canal Rock Road			**Survey Date:**	18/12/2020
Section / Lane:	Northbound L1			**Tested By:**	TM
Surface Tested:	Asphalt			**Testing Interval:**	25 m
Prepared By:	CK	**Checked By:**	**TM**		

DYNATEST FWD (E- 044) TEST RESULTS TO WA:326.2

Normalised to (kPa): **566**

Chainage (km)	Pavement Temp'tr deg ^{0}C	Lane	FWD Stress (kPa)	Geophone Location (mm) and Deflections (micron)									Deflection (mm)	Curvature (mm)
				0	200	300	400	500	600	750	900	1500		
0.000	55.0	L1	548	389	228	157	100	91	61	53	39	15	0.401	0.166
0.025	55.0	L1	552	341	223	157	118	94	77	64	42	21	0.350	0.121
0.050	55.0	L1	548	377	244	180	139	117	101	83	57	32	0.389	0.137
0.076	55.0	L1	547	388	239	164	118	89	66	52	35	16	0.402	0.154
0.100	55.0	L1	550	238	123	84	61	48	47	34	22	11	0.245	0.119
0.125	55.0	L1	544	244	132	86	61	48	36	29	13	9	0.253	0.116
0.150	55.0	L1	541	220	121	86	65	50	41	29	19	11	0.231	0.104
0.175	55.0	L1	537	311	192	114	73	51	39	28	15	6	0.328	0.126
0.200	55.0	L1	534	338	202	137	97	72	63	47	36	16	0.358	0.145
0.226	55.0	L1	542	485	320	228	165	137	105	81	59	28	0.506	0.172
0.251	55.0	L1	539	455	290	196	137	104	86	60	35	18	0.478	0.174
0.275	55.0	L1	545	353	201	126	78	55	42	32	26	15	0.367	0.158
0.301	55.0	L1	541	346	199	124	78	56	42	33	25	14	0.361	0.153
0.326	55.0	L1	545	280	178	115	91	65	49	44	30	19	0.291	0.106
0.350	55.0	L1	540	488	261	161	100	77	58	48	36	16	0.511	0.238
0.375	55.0	L1	542	257	137	84	58	46	38	31	24	12	0.269	0.126
0.400	55.0	L1	537	329	214	146	102	78	59	41	29	11	0.347	0.122

STATS Australia
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Singapore Add:
71 Toh Guan Road East, #02-01/02/06 Techcentre, SG 608598
www.statswa.com.au

Client :	Golder Associates			**Job No:**	102162
Project Name:	FWD testing - Yallingup			**File Name:**	**Beach Rd North**
Road Name:	Smiths Beach Road - Starting form Canal Rock Road			**Survey Date:**	18/12/2020
Section / Lane:	Northbound L1			**Tested By:**	TM
Surface Tested:	Asphalt			**Testing Interval:**	25 m
Prepared By:	CK	**Checked By:**	**TM**		

DYNATEST FWD (E- 044) TEST RESULTS TO WA:326.2

Normalised to (kPa): **566**

Chainage (km)	Pavement Temp'tr deg ^{0}C	Lane	FWD Stress (kPa)	Geophone Location (mm) and Deflections (micron)									Deflection (mm)	Curvature (mm)
				0	200	300	400	500	600	750	900	1500		
0.425	56.0	L1	531	444	327	252	197	149	116	88	54	22	0.473	0.124
0.453	56.0	L1	537	244	168	127	96	83	59	44	27	19	0.257	0.079
0.475	56.0	L1	533	395	223	137	87	64	49	37	23	13	0.419	0.182
0.500	56.0	L1	532	283	147	77	46	40	36	25	17	6	0.302	0.145
0.527	56.0	L1	526	385	244	155	106	83	55	40	22	6	0.415	0.152
0.550	56.0	L1	527	527	347	229	150	105	80	58	34	15	0.566	0.193
0.576	56.0	L1	525	407	206	128	77	60	44	35	18	9	0.439	0.217
0.600	57.5	L1	524	885	563	373	241	162	107	70	38	21	0.956	0.348
0.625	57.5	L1	526	739	535	387	279	209	154	96	60	23	0.795	0.220
0.650	57.5	L1	527	922	648	459	334	253	186	126	80	24	0.991	0.295
0.677	57.5	L1	531	655	409	280	199	145	106	69	40	17	0.698	0.262
0.701	57.5	L1	537	270	156	111	88	70	62	45	30	15	0.284	0.119
0.726	57.5	L1	538	227	120	75	58	52	44	39	27	19	0.239	0.113
0.752	57.5	L1	535	366	182	107	76	65	57	49	40	25	0.387	0.195
0.755	57.5	L1	517	407	245	147	96	64	46	40	34	19	0.446	0.178
0.775	57.5	L1	539	331	195	114	74	63	49	42	30	21	0.347	0.142
0.800	57.5	L1	541	274	173	115	85	70	61	51	41	26	0.286	0.105

STATS Australia
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www.statswa.com.au

Client :	Golder Associates			**Job No:**	102162
Project Name:	FWD testing - Yallingup			**File Name:**	**Beach Rd North**
Road Name:	Smiths Beach Road - Starting form Canal Rock Road			**Survey Date:**	18/12/2020
Section / Lane:	Northbound L1			**Tested By:**	TM
Surface Tested:	Asphalt			**Testing Interval:**	25 m
Prepared By:	CK	**Checked By:**	**TM**		

DYNATEST FWD (E- 044) TEST RESULTS TO WA:326.2

Normalised to (kPa): **566**

Chainage (km)	Pavement Temp'tr deg ^{0}C	Lane	FWD Stress (kPa)	Geophone Location (mm) and Deflections (micron)									Deflection (mm)	Curvature (mm)
				0	200	300	400	500	600	750	900	1500		
0.825	57.5	L1	537	529	298	172	105	69	48	34	30	18	0.557	0.243
0.851	57.5	L1	539	398	214	131	87	65	52	42	32	17	0.417	0.193
0.875	56.5	L1	563	337	195	128	94	71	57	46	36	17	0.339	0.143
0.901	56.5	L1	559	510	274	174	130	90	67	50	41	17	0.516	0.239
0.924	55.2	L1	562	432	234	147	91	66	56	37	27	14	0.435	0.200
0.950	55.2	L1	553	383	228	144	109	76	61	50	33	16	0.392	0.159
0.976	55.2	L1	552	394	218	137	89	67	52	38	27	16	0.404	0.180
0.993	55.2	L1	556	285	183	129	90	69	52	39	29	15	0.290	0.103
Redoxide Asphalt Surface														
Mean			540	402	244	161	112	85	66	50	34	17	0.422	**0.166**
SDEV			11	158	114	83	60	44	31	21	13	6	0.17	0.06
COVR, %			2	39	47	51	53	51	48	42	39	34	40.7	33.9
97.5 Percentile													**0.952**	
95 Percentile													**0.790**	

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www.statswa.com.au

Client :	Golder Associates			**Job No:**	102162
Project Name:	FWD testing - Yallingup			**File Name:**	**Beach Rd South**
Road Name:	Smiths Beach Road - Starting from the Carpark			**Survey Date:**	18/12/2020
Section / Lane:	Southbound - R1			**Tested By:**	TM
Surface Tested:	Asphalt			**Testing Interval:**	25 m
Prepared By:	CK	**Checked By:**	**TM**		

DYNATEST FWD (E- 044) TEST RESULTS TO WA:326.2

Normalised to (kPa): **566**

Chainage (km)	Pavement Temp'tr deg ^{0}C	Lane	FWD Stress (kPa)	Geophone Location (mm) and Deflections (micron)									Deflection (mm)	Curvature (mm)
				0	200	300	400	500	600	750	900	1500		
0.990	55.2	R1	547	299	182	123	90	69	58	47	39	22	0.309	0.121
0.965	55.2	R1	546	283	170	112	82	62	51	39	30	15	0.293	0.117
0.940	55.2	R1	550	216	142	96	69	53	44	35	27	14	0.222	0.076
0.921	55.2	R1	555	168	121	87	67	54	45	37	27	14	0.171	0.047
0.890	54.5	R1	548	210	139	97	74	58	50	40	30	19	0.217	0.074
0.865	54.5	R1	547	219	123	81	65	45	43	33	28	15	0.226	0.099
0.840	54.5	R1	551	149	109	68	58	45	40	30	23	14	0.153	0.041
0.816	54.5	R1	547	250	160	104	74	59	50	38	29	15	0.259	0.093
0.790	54.5	R1	545	306	161	105	75	62	50	41	34	19	0.318	0.151
0.765	54.5	R1	543	311	182	120	87	70	60	48	42	28	0.324	0.134
0.740	54.5	R1	539	318	177	116	79	61	48	38	31	15	0.334	0.148
0.715	54.5	R1	538	230	114	82	64	54	44	38	33	21	0.242	0.122
0.690	55.9	R1	538	101	82	57	45	39	35	28	23	11	0.106	0.020
0.665	55.9	R1	538	298	195	133	98	71	52	37	26	10	0.314	0.109
0.640	55.9	R1	525	1024	649	427	270	175	109	61	37	17	1.104	0.405
0.615	55.9	R1	521	1226	846	587	405	282	189	104	57	16	1.332	0.413
0.590	58.0	R1	524	816	505	355	252	163	118	78	42	17	0.881	0.335

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Client :	Golder Associates			**Job No:**	102162
Project Name:	FWD testing - Yallingup			**File Name:**	**Beach Rd South**
Road Name:	Smiths Beach Road - Starting from the Carpark			**Survey Date:**	18/12/2020
Section / Lane:	Southbound - R1			**Tested By:**	TM
Surface Tested:	Asphalt			**Testing Interval:**	25 m
Prepared By:	CK	**Checked By:**	**TM**		

DYNATEST FWD (E- 044) TEST RESULTS TO WA:326.2

Normalised to (kPa): **566**

Chainage (km)	Pavement Temp'tr deg ^{0}C	Lane	FWD Stress (kPa)	Geophone Location (mm) and Deflections (micron)									Deflection (mm)	Curvature (mm)
				0	200	300	400	500	600	750	900	1500		
0.564	58.0	R1	522	605	345	229	139	99	76	52	33	16	0.656	0.283
0.540	58.0	R1	525	438	191	103	67	47	34	24	18	7	0.473	0.267
0.515	58.0	R1	526	250	126	78	46	38	32	19	9	4	0.269	0.133
0.490	58.0	R1	518	502	319	221	153	114	84	54	30	8	0.548	0.199
0.465	58.0	R1	521	689	411	279	194	129	82	40	22	11	0.748	0.302
0.440	56.5	R1	526	377	208	139	97	70	52	38	21	7	0.405	0.181
0.415	56.5	R1	531	220	122	86	68	48	41	32	24	10	0.234	0.104
0.390	56.5	R1	527	547	337	224	166	100	76	54	31	10	0.588	0.225
0.365	56.5	R1	532	303	146	80	61	41	38	28	16	12	0.322	0.167
0.340	56.5	R1	532	235	133	97	68	52	44	33	23	10	0.250	0.109
0.315	56.5	R1	533	279	165	109	74	54	44	33	26	10	0.297	0.121
0.295	56.5	R1	537	310	173	109	73	54	43	36	27	12	0.326	0.144
0.265	56.5	R1	538	306	173	110	74	54	43	35	27	12	0.322	0.141
0.240	56.5	R1	532	440	226	120	76	49	46	33	25	12	0.468	0.229
0.215	56.5	R1	536	403	245	177	133	101	80	58	46	19	0.426	0.167
0.195	56.5	R1	528	495	309	213	157	123	101	85	59	27	0.531	0.200
0.165	56.5	R1	526	352	198	132	95	75	56	47	26	10	0.379	0.165

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Client :	Golder Associates			**Job No:**	102162
Project Name:	FWD testing - Yallingup			**File Name:**	**Beach Rd South**
Road Name:	Smiths Beach Road - Starting from the Carpark			**Survey Date:**	18/12/2020
Section / Lane:	Southbound - R1			**Tested By:**	TM
Surface Tested:	Asphalt			**Testing Interval:**	25 m
Prepared By:	CK	**Checked By:**	**TM**		

DYNATEST FWD (E- 044) TEST RESULTS TO WA:326.2

Normalised to (kPa): **566**

Chainage (km)	Pavement Temp'tr deg ^{0}C	Lane	FWD Stress (kPa)	Geophone Location (mm) and Deflections (micron)									Deflection (mm)	Curvature (mm)
				0	200	300	400	500	600	750	900	1500		
0.140	56.5	R1	528	300	139	83	57	47	38	23	13	8	0.321	0.172
0.115	56.5	R1	533	194	102	63	50	39	36	25	20	8	0.206	0.098
0.090	56.5	R1	537	192	90	45	42	27	26	18	15	8	0.202	0.108
0.065	56.5	R1	535	169	89	62	49	39	36	27	19	9	0.179	0.085
0.040	56.5	R1	533	358	212	146	111	87	72	56	42	18	0.380	0.155
0.015	56.5	R1	531	283	164	129	106	89	80	69	53	27	0.301	0.127
Redoxide Asphalt Surface														
Mean			535	367	217	145	103	75	59	42	29	14	0.391	**0.160**
SDEV			9	231	154	107	72	47	30	18	11	6	0.25	0.09
COVR, %			2	63	71	74	70	63	52	43	38	41	64.6	56.1
97.5 Percentile													**1.110**	
95 Percentile													**0.892**	

APPENDIX F

Laboratory Test Certificates

Soils testing - Particle size distribution & consistency limits test report

Standard method (by sieving)

AS1289.3.6.1, 2.1.1, 3.1.2, 3.2.1, 3.3.1 & 3.4.1

GOLDER

Test request #:	**TRP20-0279**	**Lab sample ID:**	**LPER202012150**
Client:	Smiths 2014 Pty Ltd		
Client address:	Level 3/338 Barker Road, Subiaco WA 6008		
Project ID:	**20435097**	**Lab report ref.:**	LPER_21061399
Project name:	Smith's Beach Redevelopment	**Exploratory Hole**	**HA04**
Project reference:		**Loc. ref.:**	Yallingup

Golder Associates Pty Ltd

PERTH GEOTECHNICAL LABORATORY

84 Guthrie Street,
Osborne Park,
Western Australia 6017

Sample depth (m): 1.40 - 1.80

Client sample ref:

Specimen description: (CH) Sandy CLAY, high plasticity, grey & brown, fine to coarse grained

Sampling: Tested as received

Easting (m)	Northing (m)	Level (m)

PARTICLE SIZE DISTRIBUTION AS 1289.3.6.1

Sieve Size	Passing	LB S	UB S
125 mm	100%		
75 mm	100%		
63 mm	100%		
53 mm	100%		
37.5 mm	100%		
26.5 mm	100%		
19 mm	100%		
13.2 mm	100%		
9.5 mm	100%		
6.7 mm	100%		
4.75 mm	100%		
2.36 mm	99%		
1.18 mm	90%		
600 µm	68%		
425 µm	60%		
300 µm	52%		
150 µm	42%		
75 µm	37%		

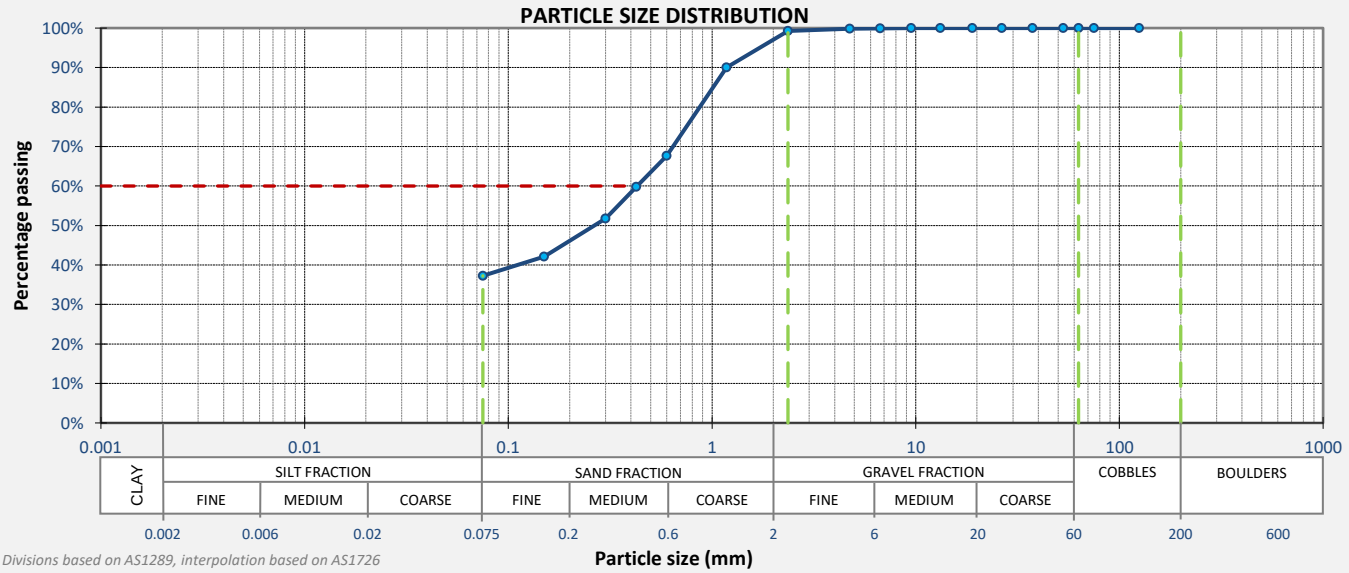
Method:	AS 1289.2.1.1	AS 1289.3.1.2	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1	
	Moisture content	**1 point Liquid limit**	**Plastic limit**	**Plasticity index**	**Linear shrinkage**	**Curling/ Crumbling/ Cracking**
Result:	19.1% As Rcvd.	75%	17%	58%	12.0%	Curling
LB S:						-
UB S:						-
Att. preparation method:	Dry sieved			**LSM length (mm):**		125
Specimen history/notes:	Preparation of specimen and testing performed on sample supplied to the laboratory					

Definitions:
LB S = Lower bound specification
LSM = Linear shrinkage mould
UB S = Upper bound specification
N/A = Not applicable
ND = Not determined; SIB = Slip in bowl
NO = Not obtainable; NP = Non plastic

GRADING SUMMARY

Fines	Sand*	Gravel*	Cobbles*
(<75 µm)	**(>75 µm - <2.36 mm)**	**(>2.36 mm - <63 mm)**	**(>63mm - <200 mm)**
37.3%	**62.0%**	**0.7%**	**0.0%**

**Proportions based on guidance in AS1726-2017 Section 6.1.4.2*



Divisions based on AS1289, interpolation based on AS1726

Testing by: PK **Dates:** 21/12/20 - 14/01/21 **Results reviewed by:** SLenihan **Date reported:** 18/01/2021

Cert. ref.: 20435097_HA04_TRP20-0279_PSD_2012150_Rep21061399

Approved signatory:

NATA

NATA accreditation number: 1961 - Site:1598 - Perth

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Sean Lenihan - Laboratory Technician

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Soils testing - Determination of the California Bearing Ratio of a soil

Standard laboratory method for a remoulded specimen (Soaked)

AS 1289.6.1.1-2014

GOLDER

Test request #:	**TRP21-0007**	**Lab sample ID:**	LPER202101180	**Golder Associates Pty Ltd**	
Client:	Smiths 2014 Pty Ltd			**PERTH GEOTECHNICAL LABORATORY**	
Client address:	Level 3/338 Barker Road, Subiaco WA 6008			84 Guthrie Street, Osborne Park, Western Australia 6017	
Project ID:	**20435097**	**Lab report ref.:**	LPER_21061778		
Lab project name:	**Smith's Beach Redevelopment**	**Exploratory Hole**	**HA05**	**Sample depth (m):**	0.50 - 0.70
				Client sample ref.:	
Project reference:	**Smith's Beach -**	**Loc. ref.:**	-		
Specimen description: (Based on visual and tactile assessment)	(SM) Silty SAND, fine to coarse grained, red brown, non-plastic fines			**Sampled by:**	
				Sampled type:	**D**

SPECIMEN PREPARATION - SUMMARY OF COMPACTION AND MOISTURE CONTENT TEST RESULTS

Initial moisture content:	**4.8% As rcvd.**
Compaction method:	AS1289.5.2.1-2017 Modified
Maximum dry density (t/m^3):	**1.98**
Optimum moisture content:	**10.5%**
Oversize material (>19mm):	-
Compaction moisture content:	**10.6%**

Note on compaction:

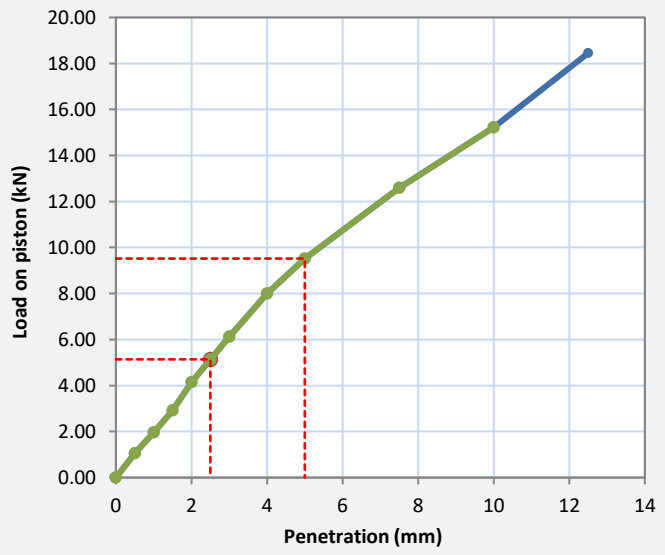
No oversize material was retained on the 19mm sieve

Notes on test:

Notes on compaction test

SUMMARY OF CALIFORNIA BEARING RATIO TEST RESULT

Penetration (mm):		0.0	0.5	1.0	1.5	2.0	**2.5**	3.0	4.0	**5.0**	7.5	10.0	12.5	**Correction:**	
Load (kN)	**Original**	0.00	1.06	1.96	2.93	4.15	5.14	6.12	8.01	9.52	12.59	15.22	18.45		
	Corrected	0.00	1.06	1.96	2.93	4.15	5.14	6.12	8.01	9.52	12.59	15.22			



Dry density t/m^3	before soaking:	**1.88**
	after soaking	**1.88**
Density ratio	before soaking	**95.0%**
	after soaking	**95.0%**
Moisture ratio at compaction:		**100.5%**
Duration of soaking (days):		**4**
Surcharge applied (kg):		**7.0**
Moisture content top 30mm:		**13.3%**
Moisture content remainder:		**11.6%**
Swell after soaking:		**NIL**
Bearing ratio at 2.5mm penetration:		**40.0%**
Bearing ratio at 5.0mm penetration:		**50.0%**

Penetration (mm) **5.0** **CBR Value** **50%**

Definitions:

ND = Not determined

Specimen prepared by: sl **Tested by:** sl **On:** 26/01/21

Results reviewed by: SLenihan **Date reported:** **27/01/21**

Cert. ref.: 20435097_HA05_TRP21-0007_CBRS_2101180_Rep-21061778 **Approved signatory:**

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Soils testing - Determination of the dry density moisture relationship
Modified compaction method
AS 1289.5.2.1-2017

GOLDER

Test request ID:	**TRP21-0007**	**Lab sample ID:**	LPER202101180	**Golder Associates Pty Ltd**	
Client:	Smiths 2014 Pty Ltd			PERTH GEOTECHNICAL LABORATORY	
Client address:	Level 3/338 Barker Road, Subiaco WA 6008			84 Guthrie Street, Osborne Park, Western Australia 6017	
Project ID:	**20435097**	**Lab report ref.:**	LPER_21061777		
Project name:	Smith's Beach Redevelopment	**Exploratory Hole**	**HA05**	**Sample depth (m):**	0.50 - 0.70
				Client sample ref:	
Location:	Yallingup	**Project reference:**	Smith's Beach -		
Specimen description: (Based on visual and tactile assessment)	(SM) Silty SAND, fine to coarse grained, red brown, non-plastic fines			**Sampling co-ordinates** Easting (m) / Northing (m)	**Reduced Level**
Curing compliance:	Liquid Limit			**Moisture content:**	*AS 1289 2.1.1-2005*
Material type	Measured:	Assumed:	Adopted:		
Granular	**Curing times are compliant**	**Cure:**	**2 Hrs**	**Portion test performed on:**	-19 mm

TEST REPORT - COMPACTION RESULTS

	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Dry density (t/m^3):	1.98	1.90	1.96	1.87		
Moisture content:	10.4%	12.9%	8.7%	6.6%		

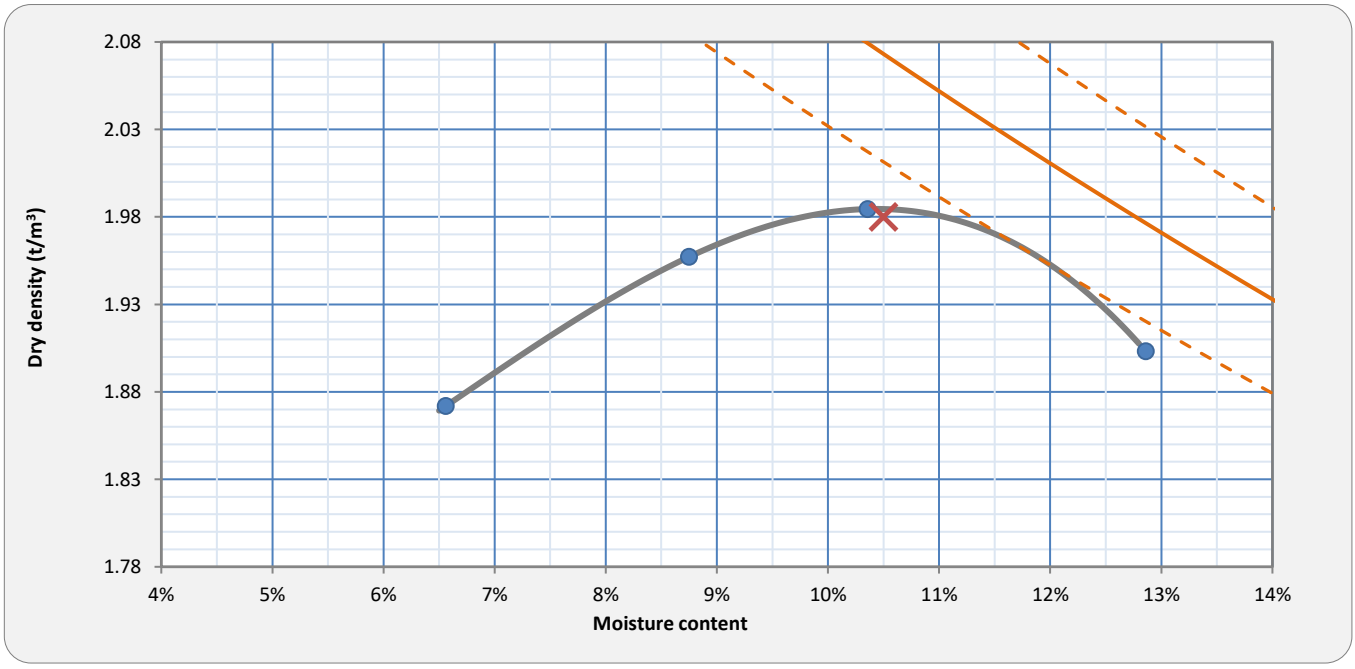
Oversize material - (by dry mass)

No oversize correction required

+19 mm:

+37.5 mm:

No oversize material present



Notes:

	Result	**Adjusted for oversize**
Modified maximum dry density (t/m^3):	1.98	
Modified optimum moisture content:	10.5%	

Specimens prepared by:	gm	**Tests performed by:**	gm	**Date tested:**	20/01/2021
Definition: ND = Not Determined		**Results reviewed by:**	SWai	**Date reported:**	27/01/2021

Cert. ref.:	**20435097_HA05_TRP21-0007_ModComp_s2101180_Rep21061777**	**Approved signatory:**
NATA	**NATA accreditation number: 1961 - Site:1598 - Perth** Accredited for compliance with ISO/IEC 17025 - Testing	Sean Lenihan
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Soils testing - Particle size distribution & consistency limits test report

Standard method (by sieving)

AS1289.3.6.1, 2.1.1, 3.1.2, 3.2.1, 3.3.1 & 3.4.1

GOLDER

Test request #:	**TRP21-0007**	**Lab sample ID:**	**LPER202101180**
Client:	Smiths 2014 Pty Ltd		
Client address:	Level 3/338 Barker Road, Subiaco WA 6008		
Project ID:	**20435097**	**Lab report ref.:**	LPER_21061776

Golder Associates Pty Ltd

PERTH GEOTECHNICAL LABORATORY

84 Guthrie Street,
Osborne Park,
Western Australia 6017

Project name:	Smith's Beach Redevelopment	**Exploratory Hole** HA05	**Sample depth (m):** 0.50 - 0.70 **Client sample ref:**
Project reference:	**Smith's Beach -**	**Loc. ref.:**	Yallingup

Specimen description:	(SM) Silty SAND, fine to coarse grained, red brown, non-plastic fines	**Sampling:**	**Tested as received**	
		Easting (m)	**Northing (m)**	**Level (m)**

PARTICLE SIZE DISTRIBUTION AS 1289.3.6.1

Sieve Size	Passing	LB S	UB S
125 mm	100%		
75 mm	100%		
63 mm	100%		
53 mm	100%		
37.5 mm	100%		
26.5 mm	100%		
19 mm	100%		
13.2 mm	100%		
9.5 mm	100%		
6.7 mm	100%		
4.75 mm	100%		
2.36 mm	100%		
1.18 mm	100%		
600 µm	87%		
425 µm	75%		
300 µm	54%		
150 µm	26%		
75 µm	20%		

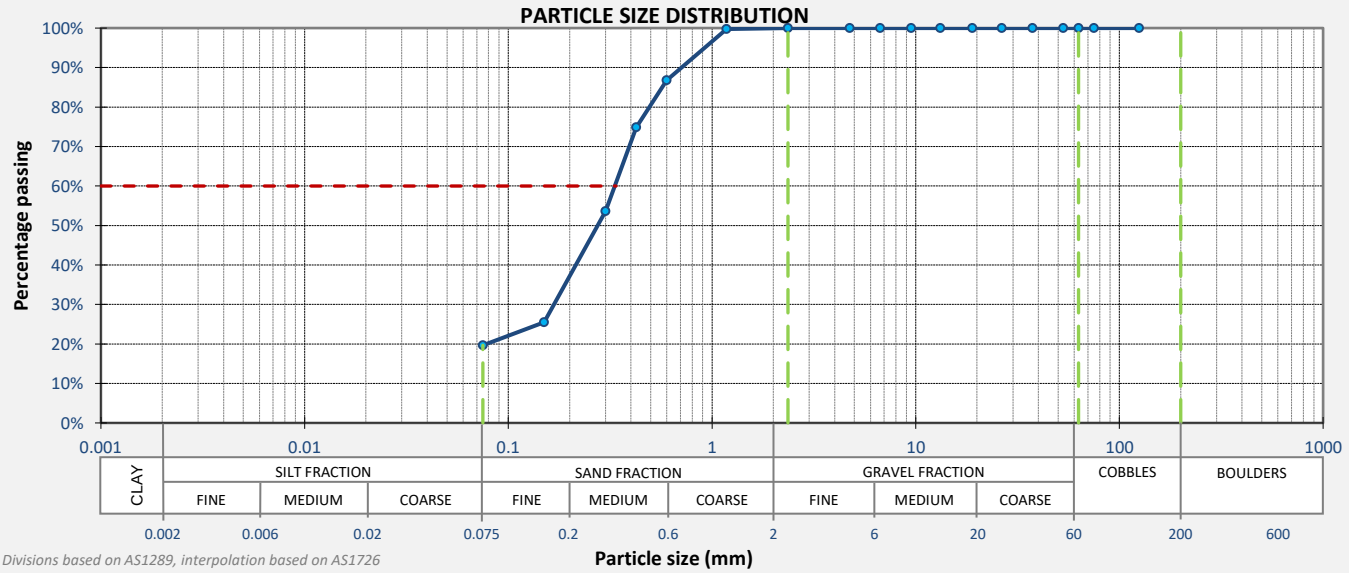
Method:	AS 1289.2.1.1	AS 1289.3.1.2	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1	
	Moisture content	**1 point Liquid limit**	**Plastic limit**	**Plasticity index**	**Linear shrinkage**	**Curling/ Crumbling/ Cracking**
Result:	4.8% As Rcvd.	SIB	NP	ND		
LB S:						-
UB S:						-
Att. preparation method:		Dry sieved		**LSM length (mm):**		
Specimen history/notes:	Preparation of specimen and testing performed on sample supplied to the laboratory					

Definitions: LB S = Lower bound specification; UB S = Upper bound specification; LSM = Linear shrinkage mould; N/A = Not applicable; ND = Not determined; SIB = Slip in bowl; NO = Not obtainable; NP = Non plastic

GRADING SUMMARY

Fines (<75 µm)	Sand* (>75 µm - <2.36 mm)	Gravel* (>2.36 mm - <63 mm)	Cobbles* (>63mm - <200 mm)
19.7%	**80.3%**	**0.0%**	**0.0%**

**Proportions based on guidance in AS1726-2017 Section 6.1.4.2*



Divisions based on AS1289, interpolation based on AS1726

Testing by:	SL	**Dates:**	21/01/21 - 27/01/21	**Results reviewed by:**	SWai

Date reported: 27/01/2021

Cert. ref.:	**20435097_HA05_TRP21-0007_PSD_2101180_Rep21061776**
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Approved signatory:

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Soils testing - Particle size distribution & consistency limits test report

Standard method (by sieving)

AS1289.3.6.1, 2.1.1, 3.1.2, 3.2.1, 3.3.1 & 3.4.1

GOLDER

Test request #:	**TRP20-0279**	**Lab sample ID:**	**LPER202012151**
Client:	Smiths 2014 Pty Ltd		
Client address:	Level 3/338 Barker Road, Subiaco WA 6008		
Project ID:	**20435097**	**Lab report ref.:**	LPER_21061400
Project name:	Smith's Beach Redevelopment	**Exploratory Hole**	**HA07**
Project reference:		**Loc. ref.:**	Yallingup

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PERTH GEOTECHNICAL LABORATORY

84 Guthrie Street,
Osborne Park,
Western Australia 6017

Sample depth (m): 1.80 - 2.00

Client sample ref:

Specimen description: (SM) Silty SAND, trace of gravel, fine to coarse grained, brown, non-plastic fines,

Sampling: Tested as received

Easting (m)	Northing (m)	Level (m)

PARTICLE SIZE DISTRIBUTION AS 1289.3.6.1

Sieve Size	Passing	LB S	UB S
125 mm	100%		
75 mm	100%		
63 mm	100%		
53 mm	100%		
37.5 mm	100%		
26.5 mm	100%		
19 mm	100%		
13.2 mm	100%		
9.5 mm	99%		
6.7 mm	99%		
4.75 mm	98%		
2.36 mm	96%		
1.18 mm	90%		
600 µm	80%		
425 µm	68%		
300 µm	44%		
150 µm	20%		
75 µm	16%		

Method:	AS 1289.2.1.1	AS 1289.3.1.2	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1	
	Moisture content	**1 point Liquid limit**	**Plastic limit**	**Plasticity index**	**Linear shrinkage**	**Curling/ Crumbling/ Cracking**
Result:	6.9% As Rcvd.	SIB	NP	ND		
LB S:						-
UB S:						-
Att. preparation method:	Dry sieved			**LSM length (mm):**		
Specimen history/notes:	Preparation of specimen and testing performed on sample supplied to the laboratory					

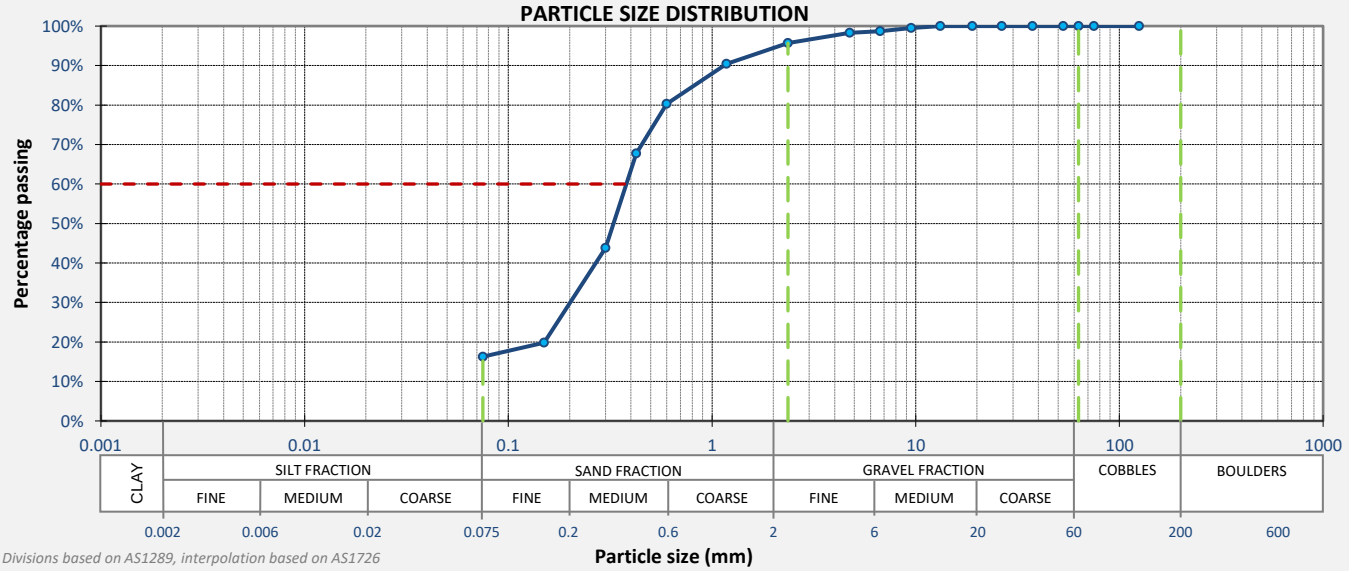
Definitions:
LB S = Lower bound specification
LSM = Linear shrinkage mould
UB S = Upper bound specification
N/A = Not applicable
ND = Not determined; SIB = Slip in bowl
NO = Not obtainable; NP = Non plastic

GRADING SUMMARY

Fines	Sand*	Gravel*	Cobbles*
(<75 µm)	(>75 µm - <2.36 mm)	(>2.36 mm - <63 mm)	(>63mm - <200 mm)
16.3%	79.4%	4.3%	0.0%

**Proportions based on guidance in AS1726-2017 Section 6.1.4.2*

PARTICLE SIZE DISTRIBUTION



Divisions based on AS1289, interpolation based on AS1726

Testing by: pk **Dates:** 23/12/20 - 14/01/21 **Results reviewed by:** SWai **Date reported:** 18/01/2021

Cert. ref.: 20435097_HA07_TRP20-0279_PSD_2012151_Rep21061400

Approved signatory:

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Soils testing - Particle size distribution & consistency limits test report

Standard method (by sieving)

AS1289.3.6.1, 2.1.1, 3.1.2, 3.2.1, 3.3.1 & 3.4.1

GOLDER

Test request #:	**TRP20-0279**	**Lab sample ID:**	**LPER202012155**
Client:	Smiths 2014 Pty Ltd		
Client address:	Level 3/338 Barker Road, Subiaco WA 6008		
Project ID:	**20435097**	**Lab report ref.:**	LPER_21061401

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PERTH GEOTECHNICAL LABORATORY

84 Guthrie Street,
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Western Australia 6017

Project name:	Smith's Beach Redevelopment	**Exploratory Hole** HA19	**Sample depth (m):** 1.80 - 2.00 **Client sample ref:**
Project reference:		**Loc. ref.:**	Yallingup

Specimen description: (SP) SAND, trace of silt, fine to coarse grained, brown, non-plastic fines

Sampling: Tested as received

Easting (m)	Northing (m)	Level (m)

PARTICLE SIZE DISTRIBUTION AS 1289.3.6.1

Sieve Size	Passing	LB S	UB S
125 mm	100%		
75 mm	100%		
63 mm	100%		
53 mm	100%		
37.5 mm	100%		
26.5 mm	100%		
19 mm	100%		
13.2 mm	100%		
9.5 mm	100%		
6.7 mm	100%		
4.75 mm	100%		
2.36 mm	100%		
1.18 mm	100%		
600 µm	97%		
425 µm	80%		
300 µm	35%		
150 µm	7%		
75 µm	5%		

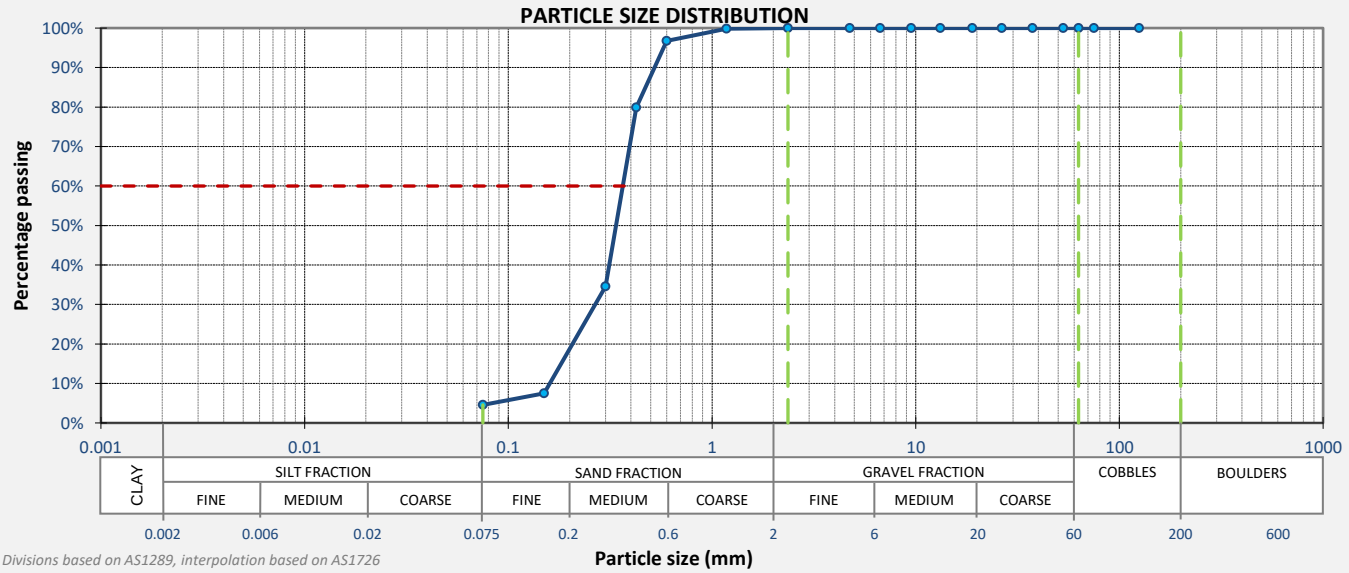
Method:	AS 1289.2.1.1	AS 1289.3.1.2	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1	
	Moisture content	**1 point Liquid limit**	**Plastic limit**	**Plasticity index**	**Linear shrinkage**	**Curling/ Crumbling/ Cracking**
Result:	2.6% As Rcvd.	SIB	NP	ND		
LB S:						-
UB S:						-
Att. preparation method:		Dry sieved		**LSM length (mm):**		
Specimen history/notes:	Preparation of specimen and testing performed on sample supplied to the laboratory					

Definitions: LB S = Lower bound specification; UB S = Upper bound specification; LSM = Linear shrinkage mould; N/A = Not applicable; ND = Not determined; SIB = Slip in bowl; NO = Not obtainable; NP = Non plastic

GRADING SUMMARY

Fines	Sand*	Gravel*	Cobbles*
(<75 µm)	(>75 µm - <2.36 mm)	(>2.36 mm - <63 mm)	(>63mm - <200 mm)
4.6%	95.4%	0.0%	0.0%

**Proportions based on guidance in AS1726-2017 Section 6.1.4.2*



Divisions based on AS1289, interpolation based on AS1726

Testing by:	PK	**Dates:**	18/12/20 - 14/01/21	**Results reviewed by:**	SWai

Date reported: 18/01/2021

Cert. ref.:	20435097_HA19_TRP20-0279_PSD_2012155_Rep21061401
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Soils testing - Particle size distribution & consistency limits test report

Standard method (by sieving)

AS1289.3.6.1, 2.1.1, 3.1.2, 3.2.1, 3.3.1 & 3.4.1

GOLDER

Test request #:	**TRP20-0279**	**Lab sample ID:**	**LPER202012152**
Client:	Smiths 2014 Pty Ltd		
Client address:	Level 3/338 Barker Road, Subiaco WA 6008		
Project ID:	**20435097**	**Lab report ref.:**	LPER_21061402
Project name:	Smith's Beach Redevelopment	**Exploratory Hole**	**HA21**
Project reference:		**Loc. ref.:**	Yallingup

Golder Associates Pty Ltd

PERTH GEOTECHNICAL LABORATORY

84 Guthrie Street,
Osborne Park,
Western Australia 6017

Sample depth (m): 0.80 - 1.00

Client sample ref:

Specimen description: (SM) Silty SAND, fine to coarse grained, brown, non-plastic fines

Sampling: Tested as received

Easting (m): | **Northing (m):** | **Level (m):**

PARTICLE SIZE DISTRIBUTION AS 1289.3.6.1

Sieve Size	Passing	LB S	UB S
125 mm	100%		
75 mm	100%		
63 mm	100%		
53 mm	100%		
37.5 mm	100%		
26.5 mm	100%		
19 mm	100%		
13.2 mm	100%		
9.5 mm	100%		
6.7 mm	100%		
4.75 mm	100%		
2.36 mm	99%		
1.18 mm	92%		
600 µm	75%		
425 µm	69%		
300 µm	53%		
150 µm	23%		
75 µm	15%		

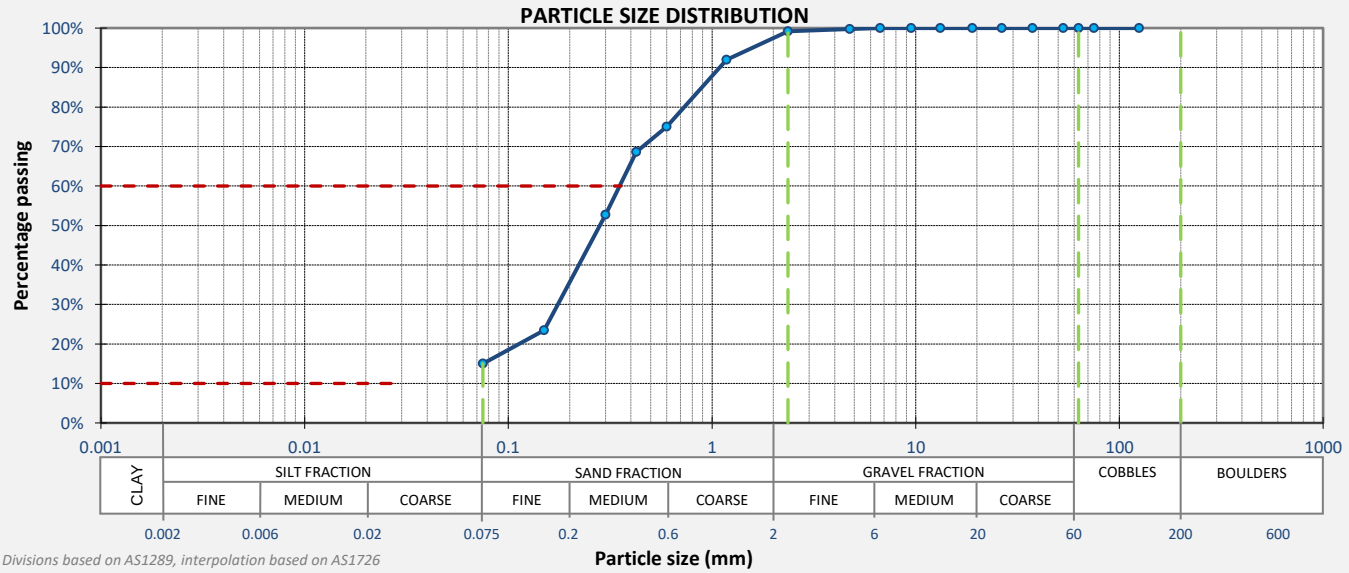
Method:	AS 1289.2.1.1	AS 1289.3.1.2	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1	
	Moisture content	**1 point Liquid limit**	**Plastic limit**	**Plasticity index**	**Linear shrinkage**	**Curling/ Crumbling/ Cracking**
Result:	4.4% As Rcvd.	SIB	NP	ND		
LB S:						-
UB S:						-
Att. preparation method:	Dry sieved			**LSM length (mm):**		
Specimen history/notes:	Preparation of specimen and testing performed on sample supplied to the laboratory					

Definitions:
LB S = Lower bound specification
LSM = Linear shrinkage mould
UB S = Upper bound specification
N/A = Not applicable
ND = Not determined; SIB = Slip in bowl
NO = Not obtainable; NP = Non plastic

GRADING SUMMARY

Fines	Sand*	Gravel*	Cobbles*
(<75 µm)	(>75 µm - <2.36 mm)	(>2.36 mm - <63 mm)	(>63mm - <200 mm)
15.0%	84.2%	0.8%	0.0%

**Proportions based on guidance in AS1726-2017 Section 6.1.4.2*



Divisions based on AS1289, interpolation based on AS1726

Testing by: PK **Dates:** 18/12/20 - 14/01/21 **Results reviewed by:** SWai **Date reported:** 18/01/2021

Cert. ref.: 20435097_HA21_TRP20-0279_PSD_2012152_Rep21061402

Approved signatory:

NATA

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Soils testing - Particle size distribution & consistency limits test report

Standard method (by sieving)

AS1289.3.6.1, 2.1.1, 3.1.2, 3.2.1, 3.3.1 & 3.4.1

GOLDER

Test request #:	**TRP20-0279**	**Lab sample ID:**	**LPER202012153**
Client:	Smiths 2014 Pty Ltd		
Client address:	Level 3/338 Barker Road, Subiaco WA 6008		
Project ID:	**20435097**	**Lab report ref.:**	LPER_21061403
Project name:	Smith's Beach Redevelopment	**Exploratory Hole**	**HA28**
Project reference:		**Loc. ref.:**	Yallingup

Golder Associates Pty Ltd

PERTH GEOTECHNICAL LABORATORY

84 Guthrie Street,
Osborne Park,
Western Australia 6017

Sample depth (m): 0.60 - 1.00

Client sample ref:

Specimen description: (CI) Sandy CLAY, trace of gravel, medium plasticity, brown, fine to coarse grained

Sampling: Tested as received

Easting (m): | **Northing (m):** | **Level (m):**

PARTICLE SIZE DISTRIBUTION AS 1289.3.6.1

Sieve Size	Passing	LB S	UB S
125 mm	100%		
75 mm	100%		
63 mm	100%		
53 mm	100%		
37.5 mm	100%		
26.5 mm	100%		
19 mm	100%		
13.2 mm	97%		
9.5 mm	96%		
6.7 mm	95%		
4.75 mm	95%		
2.36 mm	94%		
1.18 mm	85%		
600 µm	69%		
425 µm	62%		
300 µm	55%		
150 µm	47%		
75 µm	42%		

Method:	AS 1289.2.1.1	AS 1289.3.1.2	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1	
	Moisture content	**1 point Liquid limit**	**Plastic limit**	**Plasticity index**	**Linear shrinkage**	**Curling/ Crumbling/ Cracking**
Result:	25.4% As Rcvd.	50%	21%	29%	9.5%	None
LB S:						-
UB S:						-

Att. preparation method: Dry sieved | **LSM length (mm):** 125

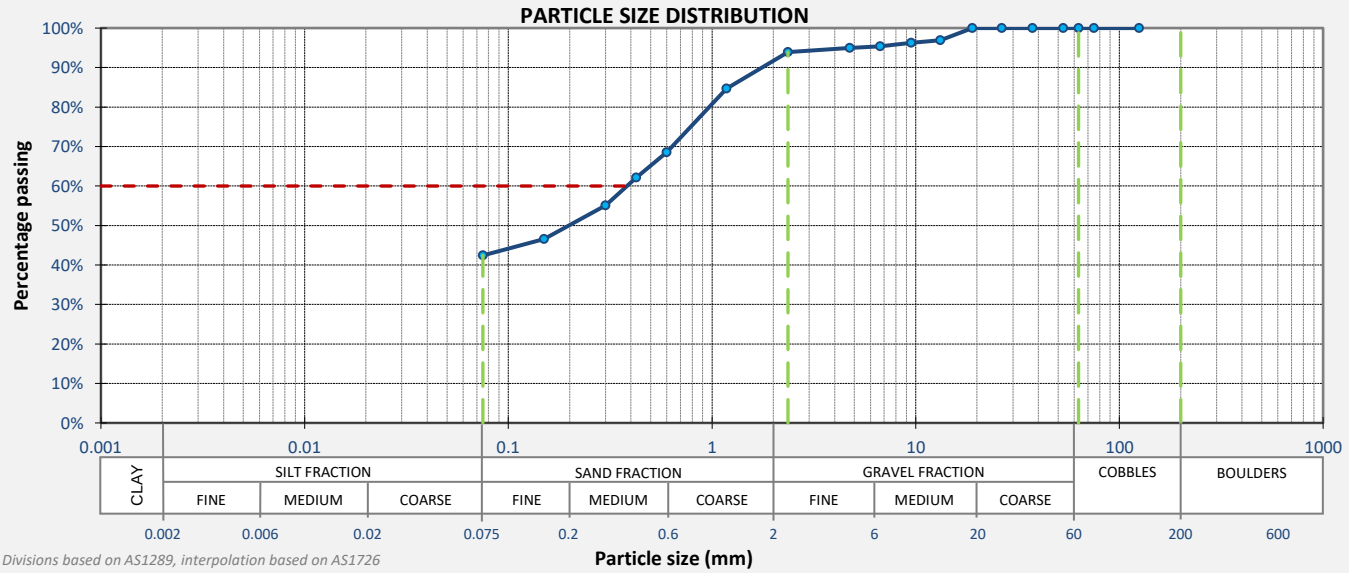
Specimen history/notes: Preparation of specimen and testing performed on sample supplied to the laboratory

Definitions:
LB S = Lower bound specification
LSM = Linear shrinkage mould
UB S = Upper bound specification
N/A = Not applicable
ND = Not determined; SIB = Slip in bowl
NO = Not obtainable; NP = Non plastic

GRADING SUMMARY

Fines	Sand*	Gravel*	Cobbles*
(<75 µm)	**(>75 µm - <2.36 mm)**	**(>2.36 mm - <63 mm)**	**(>63mm - <200 mm)**
42.4%	**51.5%**	**6.1%**	**0.0%**

**Proportions based on guidance in AS1726-2017 Section 6.1.4.2*



Divisions based on AS1289, interpolation based on AS1726

Testing by: PK **Dates:** 12/01/21 - 14/01/21 **Results reviewed by:** SLenihan **Date reported:** 18/01/2021

Cert. ref.: 20435097_HA28_TRP20-0279_PSD_2012153_Rep21061403

Approved signatory:

NATA

NATA accreditation number: 1961 - Site:1598 - Perth

Accredited for compliance with ISO/IEC 17025 - Testing

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Sean Lenihan

Sean Lenihan - Laboratory Technician

For issue

Phone: +61 (0)8 9441 0700 **Fax:** +61 (0)8 9441 0701 **E-mail:** perthlab@golder.com.au **Web:** www.golder.com.au

Soils testing - Particle size distribution & consistency limits test report

Standard method (by sieving)

AS1289.3.6.1, 2.1.1, 3.1.2, 3.2.1, 3.3.1 & 3.4.1

GOLDER

Test request #:	**TRP20-0279**	**Lab sample ID:**	**LPER202012154**
Client:	Smiths 2014 Pty Ltd		
Client address:	Level 3/338 Barker Road, Subiaco WA 6008		
Project ID:	**20435097**	**Lab report ref.:**	LPER_21061404
Project name:	Smith's Beach Redevelopment	**Exploratory Hole**	**HA30**
Project reference:		**Loc. ref.:**	Yallingup

Golder Associates Pty Ltd

PERTH GEOTECHNICAL LABORATORY

84 Guthrie Street,
Osborne Park,
Western Australia 6017

Sample depth (m): 2.00 - 2.20

Client sample ref:

Specimen description: (SC) Clayey SAND, fine to coarse grained, grey & brown, low plasticity

Sampling: Tested as received

Easting (m)	Northing (m)	Level (m)

PARTICLE SIZE DISTRIBUTION AS 1289.3.6.1

Sieve Size	Passing	LB S	UB S
125 mm	100%		
75 mm	100%		
63 mm	100%		
53 mm	100%		
37.5 mm	100%		
26.5 mm	100%		
19 mm	100%		
13.2 mm	100%		
9.5 mm	100%		
6.7 mm	100%		
4.75 mm	100%		
2.36 mm	100%		
1.18 mm	99%		
600 µm	91%		
425 µm	66%		
300 µm	34%		
150 µm	20%		
75 µm	17%		

Method:	AS 1289.2.1.1	AS 1289.3.1.2	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1	
	Moisture content	**1 point Liquid limit**	**Plastic limit**	**Plasticity index**	**Linear shrinkage**	**Curling/ Crumbling/ Cracking**
Result:	12.5% As Rcvd.	27%	12%	15%	3.0%	None
LB S:						-
UB S:						-

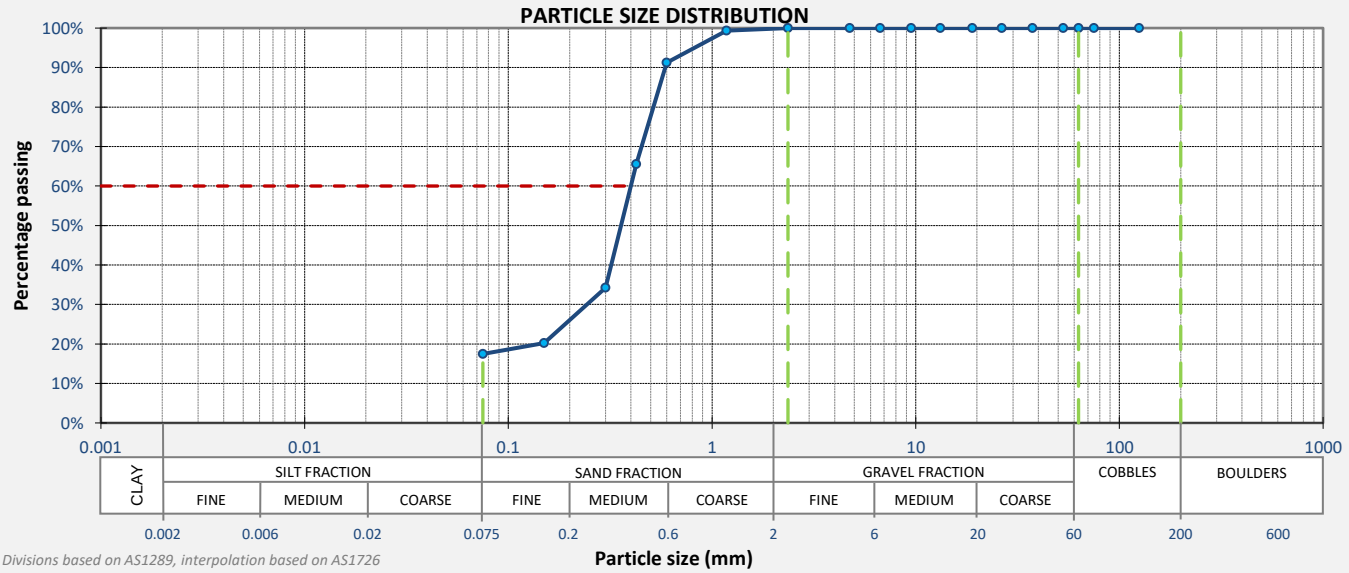
Att. preparation method:	Dry sieved	**LSM length (mm):**	125
Specimen history/notes:	Preparation of specimen and testing performed on sample supplied to the laboratory		

Definitions:
LB S = Lower bound specification
LSM = Linear shrinkage mould
UB S = Upper bound specification
N/A = Not applicable
ND = Not determined; SIB = Slip in bowl
NO = Not obtainable; NP = Non plastic

GRADING SUMMARY

Fines	Sand*	Gravel*	Cobbles*
(<75 µm)	**(>75 µm - <2.36 mm)**	**(>2.36 mm - <63 mm)**	**(>63mm - <200 mm)**
17.5%	**82.5%**	**0.0%**	**0.0%**

**Proportions based on guidance in AS1726-2017 Section 6.1.4.2*



Divisions based on AS1289, interpolation based on AS1726

Testing by: PK **Dates:** 21/12/20 - 14/01/21 **Results reviewed by:** SLenihan **Date reported:** 18/01/2021

Cert. ref.: 20435097_HA30_TRP20-0279_PSD_2012154_Rep21061404

Approved signatory:

NATA

NATA accreditation number: 1961 - Site:1598 - Perth

Accredited for compliance with ISO/IEC 17025 - Testing

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Rocks testing - Determination of point load strength index

Including tests on; Axial (**A**), Diametral (**D**) or irregular Lump (**L**) specimens

AS 4133.4.1-2007

TEST REPORT - SUMMARY OF ANALYSIS

GOLDER

Test request ID:	TRP21-0007	**Lab sample IDs:**	2101181 - 2101182	**Lab report ref.:**	LPER_21061770
Client:	Smiths 2014 Pty Ltd			**Project reference:**	Smith's Beach -
Client address:	Level 3/338 Barker Road, Subiaco WA 6008			**Location:**	Yallingup
Project ID:	20435097	**Project name:**	Smith's Beach Redevelopment		

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Osborne Park,
Western Australia 6017

Exploratory hole reference	Sample depth (m)	Specimen reference	Sub-specimen:	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
BH1	2.75		Test type:	A									
			**Compliant test:	Yes									
Lab sample ID	LPER202101181		Failure mode	M									
Sampling By		Date:	Failure load [kN]	4.9									
		Method: -	Defect orientation	90°									
Moisture content			Is [MPa]	1.6									
Moisture content type:			$Is_{(50)}$ [MPa]	1.7									
Density (t/m³)	As received	Dry	Lithological description	GNEISS									
	ND	ND											

Location test conducted:	Laboratory												
Mean values: *Calculation excludes specimens which are not compliant with the tolerances specified in the test method*													
Axial	**Diametral**	**Irregular**											
4.9													
-	-	-											
1.6													
1.7													
History:	Test performed on samples submitted to the laboratory.												
Client ref.:													

Exploratory hole reference	Sample depth (m)	Specimen reference	Sub-specimen:	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
BH1	4.50		Test type:	D									
			**Compliant test:	Yes									
Lab sample ID	LPER202101182		Failure mode	M									
Sampling By		Date:	Failure load [kN]	24									
		Method: -	Defect orientation	180°									
Moisture content			Is [MPa]	9.8									
Moisture content type:			$Is_{(50)}$ [MPa]	9.8									
Density (t/m³)	As received	Dry	Lithological description	GNEISS									
	ND	ND											

Location test conducted:	Laboratory												
Mean values: *Calculation excludes specimens which are not compliant with the tolerances specified in the test method*													
Axial	**Diametral**	**Irregular**											
	24												
-	-	-											
	9.8												
	9.8												
History:	Test performed on samples submitted to the laboratory.												
Client ref.:													

Definitions:

Test types: A = Axial, **D** = Diametral, **L** = Lump / Irregular

n/a = Not applicable, **ND** = Not determined

Failure modes: B = Along bedding plane, **M** = Through rock matrix, **J** = Along joint, **W** = Along a plane of weakness, **DF** = Didn't Fail

** A non compliant test = platen gap at failure being outside of the tolerance of the method

Cert. ref.:	20435097_TRP21-0007_PtLd_2101181 - 2101182_Rep-21061770	**Specimens prepared by:**	SL
NATA	**NATA accreditation number: 1961 - Site:1598 - Perth** Accredited for compliance with ISO/IEC 17025 - Testing	**Tests performed by:**	SL 27/01/21
		Results reviewed by:	SLenihan
	THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL	**Date reported:**	**27/01/2021**

Approved signatory:

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Rocks testing - Determination of point load strength index

Including tests on; Axial (**A**), Diametral (**D**) or irregular Lump (**L**) specimens

AS 4133.4.1-2007

TEST REPORT - SUMMARY OF ANALYSIS

GOLDER

Test request ID:	TRP21-0007	**Lab sample IDs:**	2101183 - 2101184	**Lab report ref.:**	LPER_21061771
Client:	Smiths 2014 Pty Ltd			**Project reference:**	Smith's Beach -
Client address:	Level 3/338 Barker Road, Subiaco WA 6008			**Location:**	Yallingup
Project ID:	20435097	**Project name:**	Smith's Beach Redevelopment		

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Osborne Park,
Western Australia 6017

Exploratory hole reference	Sample depth (m)	Specimen reference	Sub-specimen:	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
BH2	3.40		Test type:	D									
			**Compliant test:	Yes									
Lab sample ID	LPER202101183		Failure mode	M									
Sampling By		Date:	Failure load [kN]	5.4									
		Method: -	Defect orientation	180°									
Moisture content			Is [MPa]	1.9									
Moisture content type:			$Is_{(50)}$ [MPa]	1.9									
Density (t/m³)	As received	Dry	Lithological description										
	ND	ND											

Location test conducted:	Laboratory
Mean values: *Calculation excludes specimens which are not compliant with the tolerances specified in the test method*	

Axial	Diametral	Irregular
	5.4	
-	-	-
	1.9	
	1.9	

History: Test performed on samples submitted to the laboratory.

Client ref.:

Exploratory hole reference	Sample depth (m)	Specimen reference	Sub-specimen:	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
BH2	4.60		Test type:	A									
			**Compliant test:	Yes									
Lab sample ID	LPER202101184		Failure mode	M									
Sampling By		Date:	Failure load [kN]	1.9									
		Method: -	Defect orientation	90°									
Moisture content			Is [MPa]	0.62									
Moisture content type:			$Is_{(50)}$ [MPa]	0.65									
Density (t/m³)	As received	Dry	Lithological description	GNEISS									
	ND	ND											

Location test conducted:	Laboratory
Mean values: *Calculation excludes specimens which are not compliant with the tolerances specified in the test method*	

Axial	Diametral	Irregular
1.9		
-	-	-
0.62		
0.65		

History: Test performed on samples submitted to the laboratory.

Client ref.:

Definitions:

Test types: A = Axial, **D** = Diametral, **L** = Lump / Irregular

n/a = Not applicable, **ND** = Not determined

Failure modes: B = Along bedding plane, **M** = Through rock matrix, **J** = Along joint, **W** = Along a plane of weakness, **DF** = Didn't Fail

** A non compliant test = platen gap at failure being outside of the tolerance of the method

Cert. ref.:	20435097_TRP21-0007_PtLd_2101183 - 2101184_Rep-21061771	**Specimens prepared by:**	SL
NATA	**NATA accreditation number: 1961 - Site:1598 - Perth** Accredited for compliance with ISO/IEC 17025 - Testing	**Tests performed by:**	SL 27/01/21
		Results reviewed by:	SLenihan
	THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL	**Date reported:**	**27/01/2021**

Approved signatory:

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Rocks testing - Determination of point load strength index

Including tests on; Axial (**A**), Diametral (**D**) or irregular Lump (**L**) specimens

AS 4133.4.1-2007

TEST REPORT - SUMMARY OF ANALYSIS

GOLDER

Test request ID:	TRP21-0007	**Lab sample IDs:**	2101185 - 2101186	**Lab report ref.:**	LPER_21061772
Client:	Smiths 2014 Pty Ltd			**Project reference:**	Smith's Beach -
Client address:	Level 3/338 Barker Road, Subiaco WA 6008			**Location:**	Yallingup
Project ID:	20435097	**Project name:**	Smith's Beach Redevelopment		

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Osborne Park,
Western Australia 6017

Exploratory hole reference	Sample depth (m)	Specimen reference	Sub-specimen:	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
BH3	4.60		Test type:	A									
			**Compliant test:	Yes									
Lab sample ID	LPER202101185		Failure mode	M									
Sampling By	Date:		Failure load [kN]	0.78									
	Method:	-	Defect orientation	90°									
Moisture content			Is [MPa]	0.24									
Moisture content type:			$Is_{(50)}$ [MPa]	0.25									
Density (t/m³)	As received	Dry	Lithological description	GNEISS									
	ND	ND											

Location test conducted: Laboratory

Mean values: *Calculation excludes specimens which are not compliant with the tolerances specified in the test method*

Axial	Diametral	Irregular
0.78		
-	-	-
0.24		
0.25		

History: Test performed on samples submitted to the laboratory.

Client ref.:

Exploratory hole reference	Sample depth (m)	Specimen reference	Sub-specimen:	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
BH3	6.15		Test type:	A									
			**Compliant test:	Yes									
Lab sample ID	LPER202101186		Failure mode	M									
Sampling By	Date:		Failure load [kN]	1.4									
	Method:	-	Defect orientation	90°									
Moisture content			Is [MPa]	0.45									
Moisture content type:			$Is_{(50)}$ [MPa]	0.47									
Density (t/m³)	As received	Dry	Lithological description	GNEISS									
	ND	ND											

Location test conducted: Laboratory

Mean values: *Calculation excludes specimens which are not compliant with the tolerances specified in the test method*

Axial	Diametral	Irregular
1.4		
-	-	-
0.45		
0.47		

History: Test performed on samples submitted to the laboratory.

Client ref.:

Definitions:

Test types: A = Axial, **D** = Diametral, **L** = Lump / Irregular

n/a = Not applicable, **ND** = Not determined

Failure modes: B = Along bedding plane, **M** = Through rock matrix, **J** = Along joint, **W** = Along a plane of weakness, **DF** = Didn't Fail

** A non compliant test = platen gap at failure being outside of the tolerance of the method

Cert. ref.:	20435097_TRP21-0007_PtLd_2101185 - 2101186_Rep-21061772	**Specimens prepared by:**	SL
NATA	**NATA accreditation number: 1961 - Site:1598 - Perth** Accredited for compliance with ISO/IEC 17025 - Testing	**Tests performed by:**	SL 27/01/21
		Results reviewed by:	SLenihan
	THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL	**Date reported:**	**27/01/2021**

Approved signatory:

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Rocks testing - Determination of point load strength index

Including tests on; Axial (**A**), Diametral (**D**) or irregular Lump (**L**) specimens

AS 4133.4.1-2007

TEST REPORT - SUMMARY OF ANALYSIS

Golder Associates Pty Ltd

PERTH GEOTECHNICAL LABORATORY

84 Guthrie Street,
Osborne Park,
Western Australia 6017

Test request ID:	**TRP21-0007**	**Lab sample IDs:**	2101187 - 2101188	**Lab report ref.:**	LPER_21061773
Client:	Smiths 2014 Pty Ltd			**Project reference:**	Smith's Beach -
Client address:	Level 3/338 Barker Road, Subiaco WA 6008			**Location:**	Yallingup
Project ID:	**20435097**	**Project name:**	**Smith's Beach Redevelopment**		

Exploratory hole reference	Sample depth (m)	Specimen reference	Sub-specimen:	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
BH3	**8.60**		**Test type:**	**D**									
			****Compliant test:**	**Yes**									
Lab sample ID	**LPER202101187**		**Failure mode**	M									
Sampling **By**		**Date:**	**Failure load [kN]**	3									
		Method: -	**Defect orientation**	45°									
Moisture content			**Is [MPa]**	1.1									
Moisture content type:			**$Is_{(50)}$ [MPa]**	1.1									
Density (t/m³)	**As received**	**Dry**	**Lithological description**	GNEISS									
	ND	**ND**											

Location test conducted: Laboratory

Mean values: *Calculation excludes specimens which are not compliant with the tolerances specified in the test method*

Axial	Diametral	Irregular
	3	
-	-	-
	1.1	
	1.1	

History: Test performed on samples submitted to the laboratory.

Client ref.:

Exploratory hole reference	Sample depth (m)	Specimen reference	Sub-specimen:	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
BH3	**10.40**		**Test type:**	**A**									
			****Compliant test:**	**Yes**									
Lab sample ID	**LPER202101188**		**Failure mode**	M									
Sampling **By**		**Date:**	**Failure load [kN]**	2									
		Method: -	**Defect orientation**	90°									
Moisture content			**Is [MPa]**	0.64									
Moisture content type:			**$Is_{(50)}$ [MPa]**	0.67									
Density (t/m³)	**As received**	**Dry**	**Lithological description**	GNEISS									
	ND	**ND**											

Location test conducted: Laboratory

Mean values: *Calculation excludes specimens which are not compliant with the tolerances specified in the test method*

Axial	Diametral	Irregular
2		
-	-	-
0.64		
0.67		

History: Test performed on samples submitted to the laboratory. Soaked for at least 24 hours.

Client ref.:

Definitions:

Test types: A = Axial, **D** = Diametral, **L** = Lump / Irregular

n/a = Not applicable, **ND** = Not determined

Failure modes: B = Along bedding plane, **M** = Through rock matrix, **J** = Along joint, **W** = Along a plane of weakness, **DF** = Didn't Fail

****** A non compliant test = platen gap at failure being outside of the tolerance of the method

Cert. ref.:	**20435097_TRP21-0007_PtLd_2101187 - 2101188_Rep-21061773**	**Specimens prepared by:**	SL
	NATA accreditation number: 1961 - Site:1598 - Perth	**Tests performed by:**	SL 27/01/21
	Accredited for compliance with ISO/IEC 17025 - Testing	**Results reviewed by:**	SLenihan
	THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL	**Date reported:**	**27/01/2021**

Approved signatory:

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Rocks testing - Determination of point load strength index

Including tests on; Axial (**A**), Diametral (**D**) or irregular Lump (**L**) specimens

AS 4133.4.1-2007

TEST REPORT - SUMMARY OF ANALYSIS

GOLDER

Test request ID:	TRP21-0007	**Lab sample IDs:**	2101189 - 21011810	**Lab report ref.:**	LPER_21061774
Client:	Smiths 2014 Pty Ltd			**Project reference:**	Smith's Beach -
Client address:	Level 3/338 Barker Road, Subiaco WA 6008			**Location:**	Yallingup
Project ID:	20435097	**Project name:**	Smith's Beach Redevelopment		

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PERTH GEOTECHNICAL LABORATORY
84 Guthrie Street,
Osborne Park,
Western Australia 6017

Exploratory hole reference	Sample depth (m)	Specimen reference	Sub-specimen:	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
BH5	6.40		Test type:	D									
			**Compliant test:	Yes									
Lab sample ID	LPER202101189		Failure mode	M									
Sampling By		Date:	Failure load [kN]	0.59									
		Method: -	Defect orientation	180°									
Moisture content			Is [MPa]	0.2									
Moisture content type:			$Is_{(50)}$ [MPa]	0.2									
Density (t/m³)	As received	Dry	Lithological description	GNEISS									
	ND	ND											

Location test conducted:	Laboratory
Mean values: *Calculation excludes specimens which are not compliant with the tolerances specified in the test method*	

Axial	Diametral	Irregular
	0.59	
-	-	-
	0.2	
	0.2	

History: Test performed on samples submitted to the laboratory.

Client ref.:

Exploratory hole reference	Sample depth (m)	Specimen reference	Sub-specimen:	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
BH5	7.65		Test type:	A									
			**Compliant test:	Yes									
Lab sample ID	LPER2021011810		Failure mode	M									
Sampling By		Date:	Failure load [kN]	1.3									
		Method: -	Defect orientation	90°									
Moisture content			Is [MPa]	0.4									
Moisture content type:			$Is_{(50)}$ [MPa]	0.42									
Density (t/m³)	As received	Dry	Lithological description	GNEISS									
	ND	ND											

Location test conducted:	Laboratory
Mean values: *Calculation excludes specimens which are not compliant with the tolerances specified in the test method*	

Axial	Diametral	Irregular
1.3		
-	-	-
0.4		
0.42		

History: Test performed on samples submitted to the laboratory.

Client ref.:

Definitions:

Test types: A = Axial, **D** = Diametral, **L** = Lump / Irregular

n/a = Not applicable, **ND** = Not determined

Failure modes: B = Along bedding plane, **M** = Through rock matrix, **J** = Along joint, **W** = Along a plane of weakness, **DF** = Didn't Fail

** A non compliant test = platen gap at failure being outside of the tolerance of the method

Cert. ref.:	20435097_TRP21-0007_PtLd_2101189 - 21011810_Rep-21061774	**Specimens prepared by:**	SL
NATA	**NATA accreditation number: 1961 - Site:1598 - Perth** Accredited for compliance with ISO/IEC 17025 - Testing	**Tests performed by:**	SL 27/01/21
		Results reviewed by:	SLenihan
	THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL	**Date reported:**	**27/01/2021**

Approved signatory:

Sean Lenihan

Sean Lenihan - Laboratory Technician

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Rocks testing - Determination of point load strength index

Including tests on; Axial (**A**), Diametral (**D**) or irregular Lump (**L**) specimens

AS 4133.4.1-2007

TEST REPORT - SUMMARY OF ANALYSIS

GOLDER

Golder Associates Pty Ltd

PERTH GEOTECHNICAL LABORATORY

84 Guthrie Street,
Osborne Park,
Western Australia 6017

Test request ID:	TRP21-0007	**Lab sample ID:**	21011811	**Lab report ref.:**	LPER_21061775
Client:	Smiths 2014 Pty Ltd			**Project reference:**	Smith's Beach -
Client address:	Level 3/338 Barker Road, Subiaco WA 6008			**Location:**	Yallingup
Project ID:	20435097	**Project name:**	Smith's Beach Redevelopment		

Exploratory hole reference	Sample depth (m)	Specimen reference	Sub-specimen:	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
BH5	8.15		Test type:	D									
			**Compliant test:	Yes									
Lab sample ID	LPER2021011811		Failure mode	M									
Sampling By		Date:	Failure load [kN]	12									
		Method: -	Defect orientation	180°									
Moisture content			Is [MPa]	4.8									
Moisture content type:			$Is_{(50)}$ [MPa]	4.8									
Density (t/m³)	As received	Dry	Lithological description	GNEISS									
	ND	ND											

Location test conducted: Laboratory

Mean values: *Calculation excludes specimens which are not compliant with the tolerances specified in the test method*

	Axial	Diametral	Irregular
		12	
	-	-	-
		4.8	
		4.8	

History: Test performed on samples submitted to the laboratory.

Client ref.:

Exploratory hole reference	Sample depth (m)	Specimen reference	Sub-specimen:	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
			Test type:										
			**Compliant test:										
Lab sample ID			Failure mode										
Sampling By		Date:	Failure load [kN]										
		Method: -	Defect orientation										
Moisture content			Is [MPa]										
Moisture content type:			$Is_{(50)}$ [MPa]										
Density (t/m³)	As received	Dry	Lithological description										

Location test conducted:

Mean values: *Calculation excludes specimens which are not compliant with the tolerances specified in the test method*

	Axial	Diametral	Irregular
	-	-	-

History:

Client ref.:

Definitions:

Test types: A = Axial, **D** = Diametral, **L** = Lump / Irregular

n/a = Not applicable, **ND** = Not determined

Failure modes: B = Along bedding plane, **M** = Through rock matrix, **J** = Along joint, **W** = Along a plane of weakness, **DF** = Didn't Fail

** A non compliant test = platen gap at failure being outside of the tolerance of the method

Cert. ref.:	20435097_TRP21-0007_PtLd_21011811_Rep-21061775	**Specimen prepared by:**	SL
	NATA accreditation number: 1961 - Site:1598 - Perth	**Test performed by:**	SL 27/01/21
	Accredited for compliance with ISO/IEC 17025 - Testing	**Result reviewed by:**	SLenihan
	THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL	**Date reported:**	**27/01/2021**

Approved signatory:

Sean Lenihan

Sean Lenihan - Laboratory Technician

Phone: +61 (0)8 9441 0700 **Fax:** +61 (0)8 9441 0701 **E-mail:** perthlab@golder.com.au **Web:** www.golder.com.au

Qualcon Laboratories Pty. Ltd.

N.A.T.A. Accreditation Number: 10731
Unit 2/2 Lorries Court, MALAGA. W.A. 6090.
as trustee for Qualcon Unit Trust (ABN: 34 736 601 547 ACN: 068 691 369)

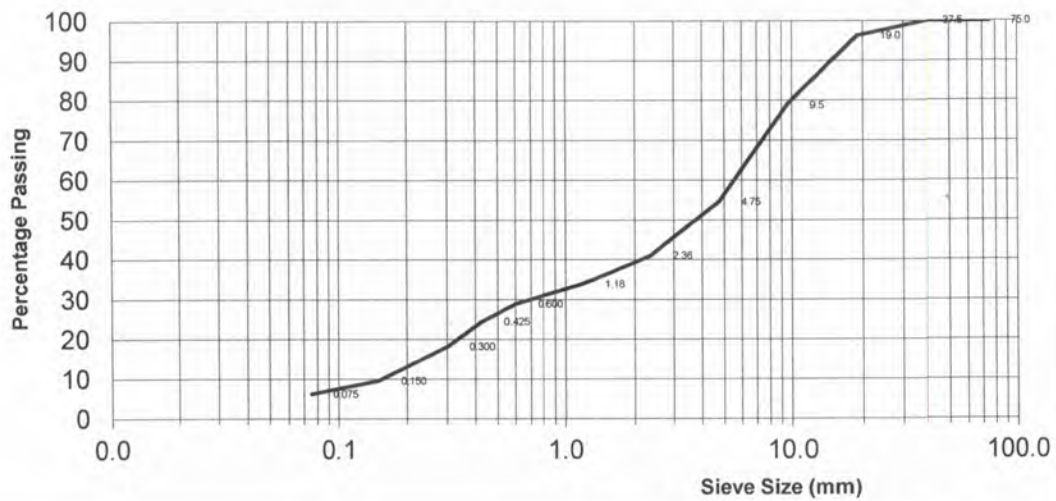
Phone: (08) 9249 9895
Fax: (08) 9248 1822
Email: qualcon@iinet.net.au

PARTICLE SIZE DISTRIBUTION REPORT

Client	Golder Associates Pty Ltd	**Report Number**	QL3698-21
Location	Smiths Beach Road, Yallingup (PD1 - 0.04m to 0.16m)	**Date of Report**	13-Jan-21
Sampled By	C Prince	**Test Number**	7381
Sample Date	22-Dec-20 (Ex Pavement)	**Sample Description**	Sandy Gravel - Base
Test Method	AS1289.3.6.1, AS1289.1.2.1 - 6.4(b)	**Moisture Content (%)**	5.6

Sieve Size (mm)	Percentage Passing
75.0	100
37.5	100
19.0	96
9.5	79
4.75	55
2.36	41
1.18	34
0.600	29
0.425	24
0.300	18
0.150	10
0.075	6

GRADING CURVE



Authorised Signatory : G J Donatti

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AS1289.3.6.1.REP.JAN2021
Approved by : G Donatti

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CASAGRANDE REPORT

Report Number	QL3698-21	**Date of Report**	13-Jan-21
Client	Golder Associates Pty Ltd		
Location	Smiths Beach Road, Yallingup (PD1 - 0.04m to 0.16m)		
Test Methods	AS1289.3.1.2, AS1289.3.2.1, AS1289.3.3.1. AS1289.3.4.1		
Material Description	Sandy Gravel - Base (Ex Pavement)		

Test Number		7381			
Material Status		Air Dried			
Preparation Method		Dry Sieved			
Liquid Limit (w_L)	(%)	NO			
Plastic Limit (w_P)	(%)	ND			
Plasticity Index (I_P)	(%)	NP			
Linear Shrinkage (LS)	(%)	NO			
Cracking		-			
Crumbling		-			
Curling		-			

Notes on Test:

Liquid Limt = (NO)	**Not Obtainable, material slips in cup, test is not applicable.**
Plastic Limit = (ND)	**Not Determined, material can not be rolled.**
Plasticity Index = (NP)	**Non Plastic, when neither the liquid limit or Plastic Limit can be determined.**
Linear Shrinkage = (NO)	**Not Obtainable, material slips in cup, test is not applicable.**

Authorised Signatory G.J.Donatti

AS1289.3.1.2, AS1289.3.2.1, AS1289.3.3.1. AS1289.3.4.1.REP.JAN2021
Approved By: G. Donatti

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PARTICLE SIZE DISTRIBUTION REPORT

Client	Golder Associates Pty Ltd	**Report Number**	QL3699-21
Location	Smiths Beach Road, Yallingup (PD3 - 0.30m to 0.49m)	**Date of Report**	13-Jan-21
Sampled By	C Prince	**Test Number**	7382
Sample Date	22-Dec-20 (Ex Pavement)	**Sample Description**	Clayey Gravelly Sand
Test Method	AS1289.3.6.1, AS1289.1.2.1 - 6.4(b)	**Moisture Content (%)**	3.3 (Subgrade)

Sieve Size (mm)	Percentage Passing
75.0	100
37.5	100
19.0	100
9.5	93
4.75	82
2.36	72
1.18	65
0.600	55
0.425	49
0.300	42
0.150	28
0.075	20

GRADING CURVE

Authorised Signatory: G J Donatti

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CASAGRANDE REPORT

Report Number	QL3699-21	**Date of Report**	13-Jan-21
Client	Golder Associates Pty Ltd		
Location	Smiths Beach Road, Yallingup (PD3 - 0.30m to 0.49m)		
Test Methods	AS1289.3.1.2, AS1289.3.2.1, AS1289.3.3.1. AS1289.3.4.1		
Material Description	Clayey Gravelly Sand - Subgrade (Ex Pavement)		

Test Number		7382			
Material Status		Air Dried			
Preparation Method		Dry Sieved			
Liquid Limit (w_L)	(%)	20			
Plastic Limit (w_P)	(%)	16			
Plasticity Index (I_P)	(%)	4			
Linear Shrinkage (LS)	(%)	1.0			
Cracking		Yes			
Crumbling		-			
Curling		-			

Authorised Signatory G.J.Donatti

AS1289.3.1.2, AS1289.3.2.1, AS1289.3.3.1. AS1289.3.4.1.REP.JAN2021
Approved By: G. Donatti

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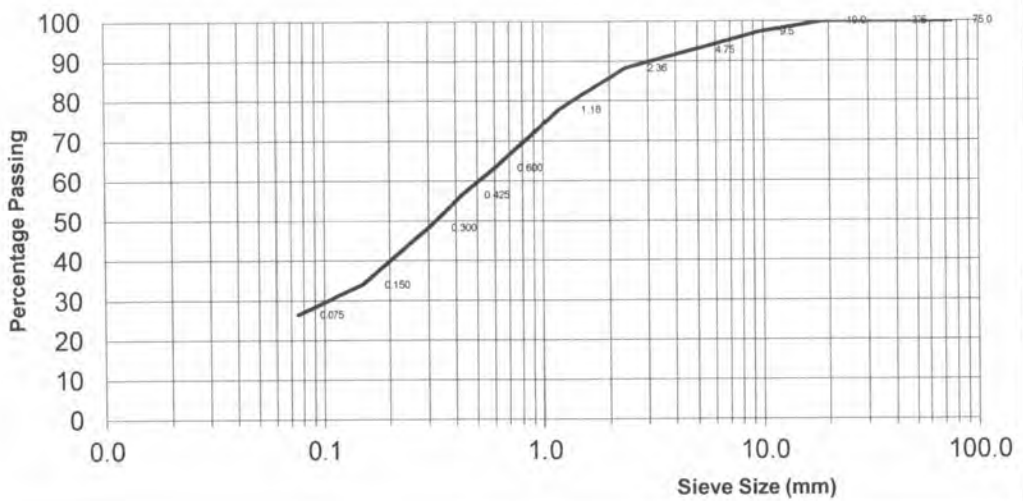
PARTICLE SIZE DISTRIBUTION REPORT

Client	Golder Associates Pty Ltd	**Report Number**	QL3700-21
Location	Smiths Beach Road, Yallingup (PD4 - 0.49m to 0.99m)	**Date of Report**	13-Jan-21
Sampled By	C Prince	**Test Number**	7383
Sample Date	22-Dec-20 (Ex Pavement)	**Sample Description**	Gravelly Clayey Sand
Test Method	AS1289.3.6.1, AS1289.1.2.1 - 6.4(b)	**Moisture Content (%)**	11.9 (Below Subgrade)

Sieve Size (mm)	Percentage Passing
75.0	100
37.5	100
19.0	100
9.5	97
4.75	93
2.36	88
1.18	78
0.600	63
0.425	57
0.300	48
0.150	34
0.075	26

GRADING CURVE



Authorised Signatory : G J Donatti

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AS1289.3.6.1 R.P.JAN2021
Approved by :G Donatti

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CASAGRANDE REPORT

Report Number	QL3700-21	**Date of Report**	13-Jan-21
Client	Golder Associates Pty Ltd		
Location	Smiths Beach Road, Yallingup (PD4 - 0.49m to 0.99m)		
Test Methods	AS1289.3.1.2, AS1289.3.2.1, AS1289.3.3.1. AS1289.3.4.1		
Material Description	Gravelly Clayey Sand - Below Subgrade (Ex Pavement)		

Test Number		7383			
Material Status		Air Dried			
Preparation Method		Dry Sieved			
Liquid Limit (w_L)	(%)	30			
Plastic Limit (w_P)	(%)	18			
Plasticity Index (I_P)	(%)	12			
Linear Shrinkage (LS)	(%)	5.0			
Cracking		Yes			
Crumbling		-			
Curling		-			

Authorised Signatory G.J.Donatti

AS1289.3.1.2, AS1289.3.2.1, AS1289.3.3.1. AS1289.3.4.1.REP.JAN2021
Approved By: G. Donatti

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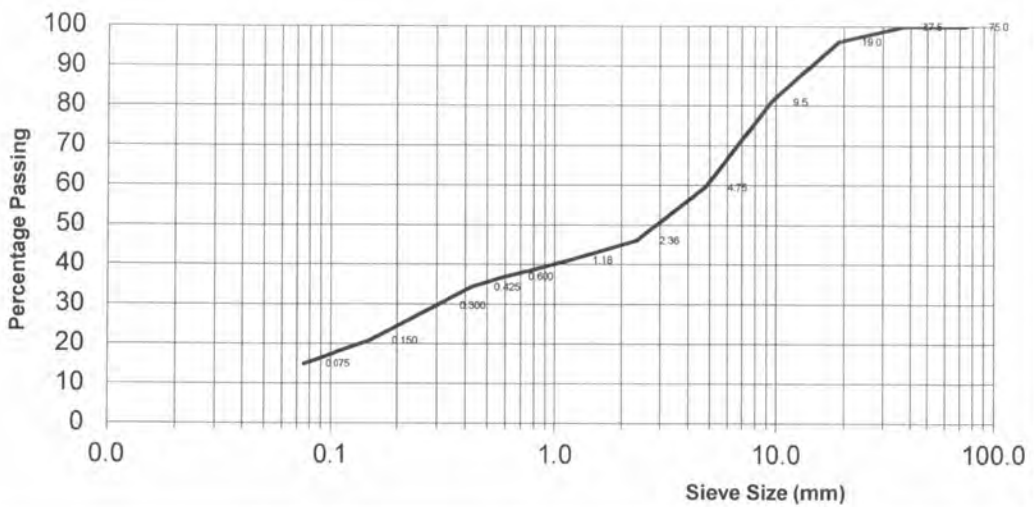
PARTICLE SIZE DISTRIBUTION REPORT

Client	Golder Associates Pty Ltd	**Report Number**	QL3701-21
Location	Smiths Beach Road, Yallingup (PD6 - 0.03m to 0.29m)	**Date of Report**	13-Jan-21
Sampled By	C Prince	**Test Number**	7384
Sample Date	22-Dec-20 (Ex Pavement)	**Sample Description**	Clayey Sandy Gravel - Base
Test Method	AS1289.3.6.1, AS1289.1.2.1 - 6.4(b)	**Moisture Content (%)**	8.0

Sieve Size (mm)	Percentage Passing
75.0	100
37.5	100
19.0	96
9.5	81
4.75	60
2.36	46
1.18	41
0.600	37
0.425	34
0.300	30
0.150	21
0.075	15

GRADING CURVE



Authorised Signatory :

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AS1289.3.6.1 REP JAN2021

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CASAGRANDE REPORT

Report Number	QL3701-21	**Date of Report**	13-Jan-21
Client	Golder Associates Pty Ltd		
Location	Smiths Beach Road, Yallingup (PD6 - 0.03m to 0.29m)		
Test Methods	AS1289.3.1.2, AS1289.3.2.1, AS1289.3.3.1. AS1289.3.4.1		
Material Description	Clayey Sandy Gravel - Base (Ex Pavement)		

Test Number		7384			
Material Status		Air Dried			
Preparation Method		Dry Sieved			
Liquid Limit (w_L)	(%)	21			
Plastic Limit (w_P)	(%)	16			
Plasticity Index (I_P)	(%)	5			
Linear Shrinkage (*LS*)	(%)	2.5			
Cracking		Yes			
Crumbling		-			
Curling		-			

Authorised Signatory G.J.Donatti

AS1289.3.1.2, AS1289.3.2.1, AS1289.3.3.1. AS1289.3.4.1.REP.JAN2021
Approved By: G. Donatti

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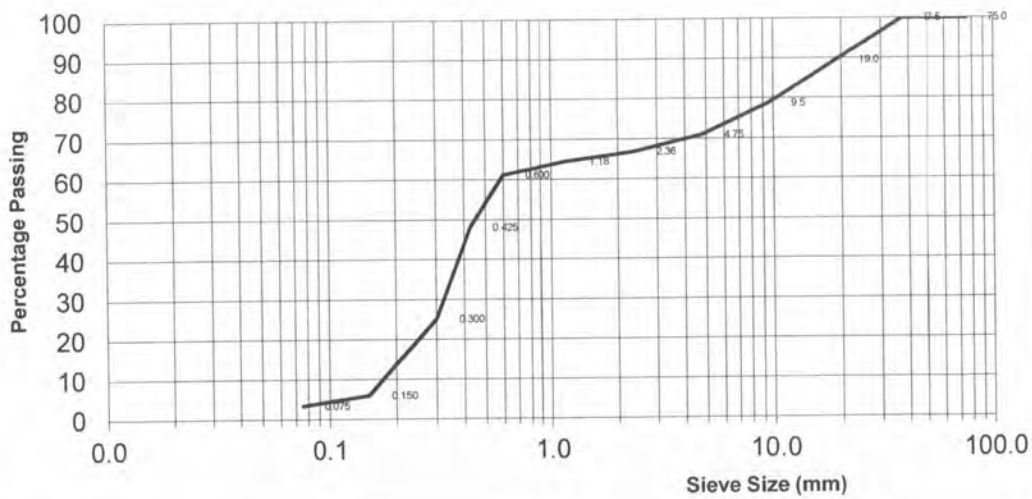
PARTICLE SIZE DISTRIBUTION REPORT

Client	Golder Associates Pty Ltd	**Report Number**	QL3702-21
Location	Smiths Beach Road, Yallingup (PD2 - 0.20m to 0.40m)	**Date of Report**	13-Jan-21
Sampled By	C Prince	**Test Number**	7376
Sample Date	22-Dec-20 (Ex Verge)	**Sample Description**	Gravelly Sand
Test Method	AS1289.3.6.1, AS1289.1.2.1 - 6.5.1	**Moisture Content (%)**	6.9

Sieve Size (mm)	Percentage Passing
75.0	100
37.5	100
19.0	90
9.5	79
4.75	71
2.36	67
1.18	65
0.600	61
0.425	48
0.300	25
0.150	6
0.075	3

GRADING CURVE



Authorised Signatory
G J Donatti

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AS1289.3.6.1.REP.JAN2021
Approved by: G Donatti

Qualcon Laboratories Pty. Ltd.

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CASAGRANDE REPORT

Report Number	QL3702-21	**Date of Report**	13-Jan-21
Client	Golder Associates Pty Ltd		
Location	Smiths Beach Road, Yallingup (PD2 - 0.20m to 0.40m)		
Test Methods	AS1289.3.1.2, AS1289.3.2.1, AS1289.3.3.1. AS1289.3.4.1		
Material Description	Gravelly Sand (Ex Verge)		

Test Number		7376			
Material Status		Air Dried			
Preparation Method		Dry Sieved			
Liquid Limit (w_L)	(%)	NO			
Plastic Limit (w_P)	(%)	ND			
Plasticity Index (I_P)	(%)	NP			
Linear Shrinkage (LS)	(%)	NO			
Cracking		-			
Crumbling		-			
Curling		-			

Notes on Test:

Liquid Limt = (NO)	**Not Obtainable, material slips in cup, test is not applicable.**
Plastic Limit = (ND)	**Not Determined, material can not be rolled.**
Plasticity Index = (NP)	**Non Plastic, when neither the liquid limit or Plastic Limit can be determined.**
Linear Shrinkage = (NO)	**Not Obtainable, material slips in cup, test is not applicable.**

Authorised Signatory G.J.Donatti

AS1289.3.1.2, AS1289.3.2.1, AS1289.3.3.1. AS1289.3.4.1.REP.JAN2021
Approved By: G. Donatti

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CALIFORNIAN BEARING RATIO OF REMOULDED SPECIMEN REPORT

Report Number	QL3702-21	**Date of Report**	13-Jan-21
Client	Golder Associates Pty Ltd		
Location	Smiths Beach Road, Yallingup (PD2 - 0.20m to 0.40m)		
Test Methods	AS1289.6.1.1, AS1289.5.2.1, AS1289.2.1.1		
Sampling Method	AS1289.1.2.1 - 6.5.1	**Date Sampled**	22-Dec-20
Date Tested	11-Jan-21	**Test Number**	7376
Material Description	Gravelly Sand (Ex Verge)		

LABORATORY COMPACTION DETAILS	
Maximum Dry Density (t/m^3)	1.93
Optimum Moisture Content (%)	11.0

TEST CONDITIONS OF SPECIMEN	
Condition of Specimen	Soaked
Soaking Period	4 Days
Surcharge Mass (kg)	6.75
Dry Density Ratio of Specimen (%)	95
Compactive Effort Used in Remoulding Specimen (mass of rammer (kg)/drop of rammer (mm)/no. of layers/blows per layer	4.9/450/5/10

TEST RESULTS	
Dry Density (t/m^3)	
Specimen after Compaction	1.84
Specimen after Soaking	1.84
Dry Density Ratio (%)	
Specimen after Compaction	95
Specimen after Soaking	96
Moisture Content (%)	
Specimen at Compaction	10
Specimen after Soaking	12
Top 30mm Layer of Specimen after Penetration	14
Entire Depth of Specimen after Penetration	15
Moisture Ratio (%)	
Specimen at Compaction	95
Specimen after Soaking	115
Top 30mm Layer of Specimen after Penetration	132
Entire Depth of Specimen after Penetration	142
Specimen Swell (%)	0.0
CALIFORNIAN BEARING RATIO (%)	**13**
PENETRATION (mm)	**5.0**

Note 1 MDD/OMC figures were obtained from Qualcon Laboratories Pty Ltd Report No. QL3702-21, Page 5 of 5.

Note 2 Percentage of material retained on 19.0mm sieve size was 10.

Note 3 : The sample was cured for a minumum of 2 Hours.

Note 4 : The liquid limit as determined by Actual (Not Obtainable - Non Plastic).

Authorised Signatory : G. J. Donatti

AS1289.6.1.1.REP.JAN2021

Approved by : G Donatti

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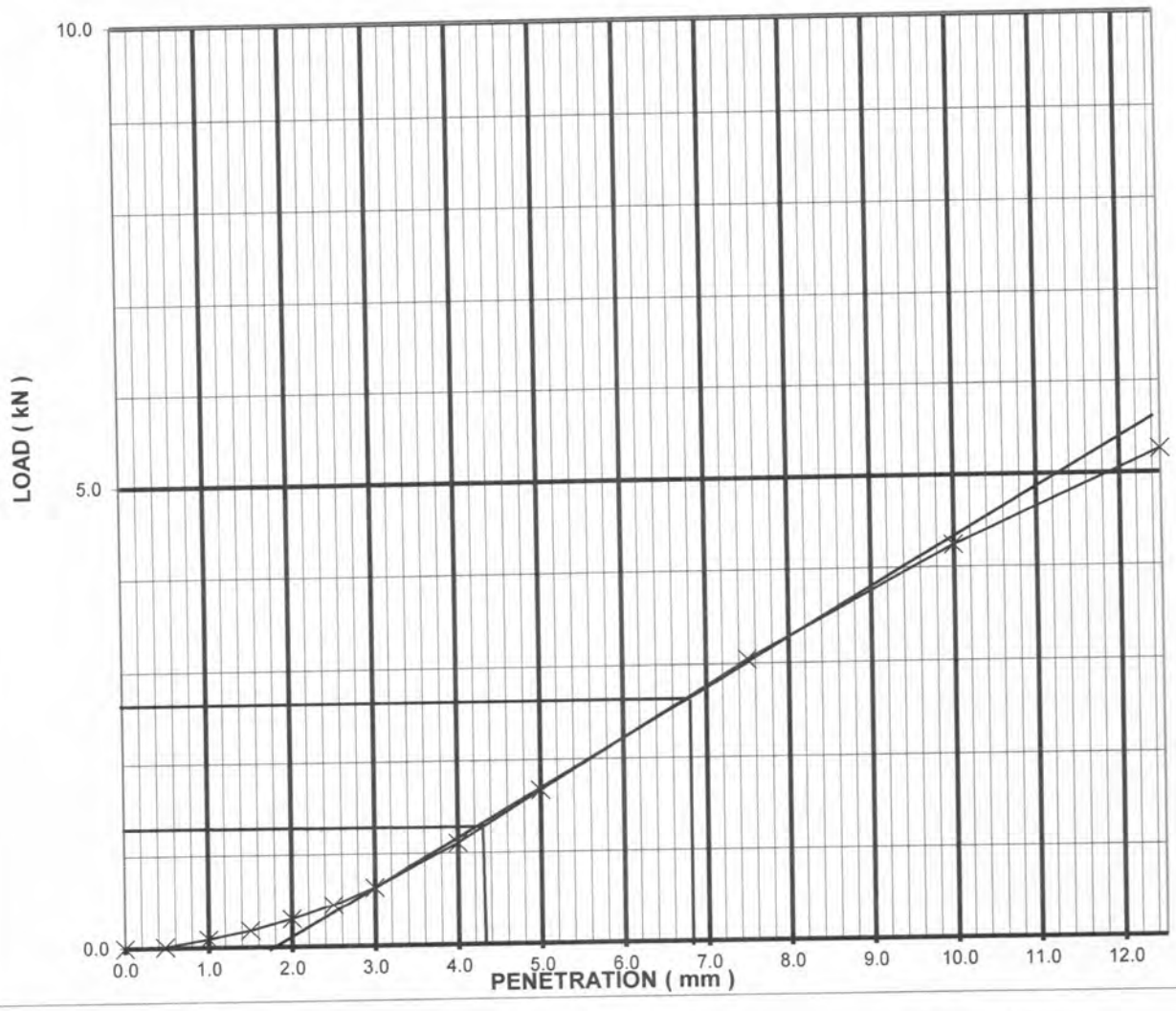
Qualcon Laboratories Pty Ltd

LABORATORY C.B.R. PLOT SHEET

Client	Golder Associates Pty Ltd	Report No :	QL3702-21
Location	Smiths Beach Road, Yallingup (PD2 - 0.20m to 0.40m)	Test No :	7376
Material Description	Gravelly Sand (Ex Verge - 22-Dec-20)		

Date Tested: 11-Jan-21 By: C Prince Checked By: G Donatti Date: 13-Jan-21



C.B.R Calculations

S. LOAD AT CORRECTED 2.5mm PENETRATION = 1.300 kN

T. C.B.R. = 2.5 S = 9.85 %

U. LOAD AT CORRECTED 5.0mm PENETRATION = 2.650 kN

V. C.B.R. = 5.0 U = 13.38 %

REPORTED C.B.R = 13 @ 5.0 mm PENETRATION.

CBR REPORTING

<5	0.5
5 - 20	1
20 - 50	5
>50	10

AS1289.6.1.1.PLOT.REP.JAN2021
Approved by :: G Donatti

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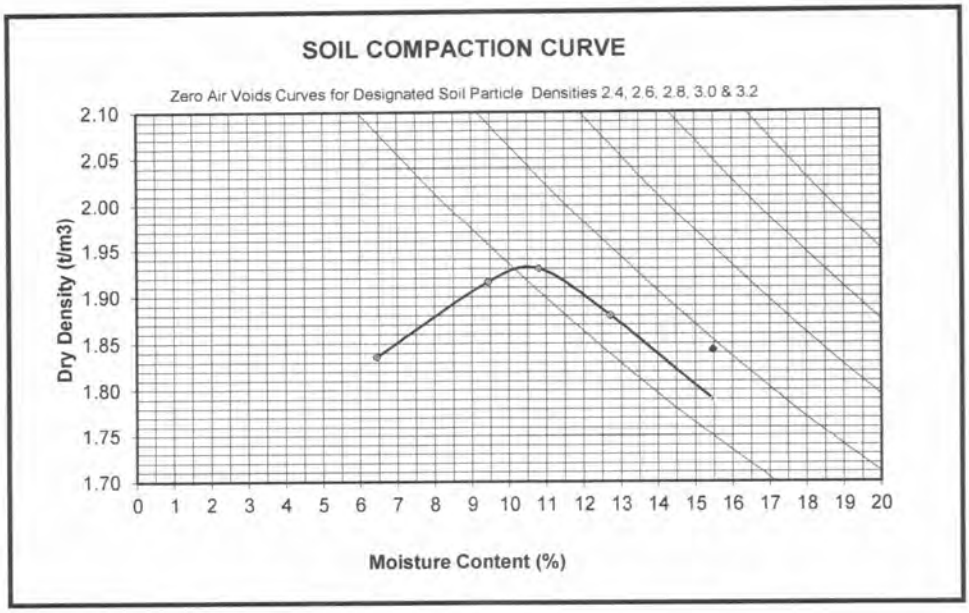
SOIL COMPACTION REPORT

Report Number	QL3702-21	**Date of Report**	13-Jan-21
Client	Golders & Associates Pty Ltd	**Test Number**	7376
Location	Smiths Beach Road, Yallingup (PD2 - 0.20m to 0.40m)		
Test Methods	AS1289.1.1, AS1289.2.1.1, AS1289.5.2.1, AS1289.1.2.1.6.4(b)		
Material Type	Gravelly Sand (Ex Verge - 22-Dec-20)		
Compaction Type	Modified (Small Mould)	**Minimum Curing Time**	2hrs
Liquid Limit Method	AS1289.3.1.2		
Liquid Limit Value	Sands and granular material		

Maximum Dry Density (t/m^3)	**1.93**
Optimum Moisture Content(%)	**11.0**
Percent Retained on 19.0mm sieve	**10**
Percent Retained on 37.5mm sieve	**0**



Notes:

Authorised Signatory: G. J. Donatti

AS1289.5.2.1, .5.1.1.REP.JAN2020

Approved By: G. Donatti

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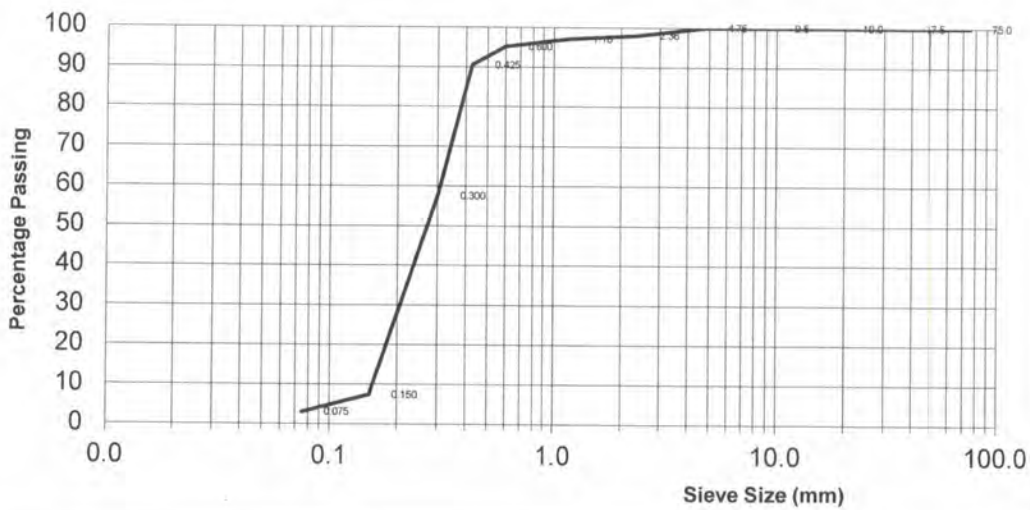
PARTICLE SIZE DISTRIBUTION REPORT

Client	Golder Associates Pty Ltd	**Report Number**	QL3703-21
Location	Smiths Beach Road, Yallingup (PD6 - 0.10m to 0.30m)	**Date of Report**	13-Jan-21
Sampled By	C Prince	**Test Number**	7377
Sample Date	22-Dec-20 (Ex Verge)	**Sample Description**	Sand
Test Method	AS1289.3.6.1, AS1289.1.2.1 - 6.5.1	**Moisture Content (%)**	2.5

Sieve Size (mm)	Percentage Passing
75.0	100
37.5	100
19.0	100
9.5	100
4.75	100
2.36	98
1.18	97
0.600	95
0.425	91
0.300	58
0.150	7
0.075	3

GRADING CURVE



Authorised Signatory: G J Donatti

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AS1289.3.6.1.REP JAN2021
Approved by : G Donatti

Qualcon Laboratories Pty. Ltd.

N.A.T.A. Accreditation Number: 10731

as trustee for Qualcon Unit Trust
ABN: 34 736 601 547 ACN: 068 691 369

Unit 2/2 Lorries Court,
MALAGA. W.A. 6090.
Phone: (08) 9249 9895
Fax: (08) 9248 1822
Email: qualcon@iinet.net.au

CASAGRANDE REPORT

Report Number	QL3707-21	**Date of Report**	13-Jan-21
Client	Golder Associates Pty Ltd		
Location	Smiths Beach Road, Yallingup (PD6 - 0.10m to 0.30m)		
Test Methods	AS1289.3.1.2, AS1289.3.2.1, AS1289.3.3.1. AS1289.3.4.1		
Material Description	Sand (Ex Verge)		

Test Number		7377			
Material Status		Air Dried			
Preparation Method		Dry Sieved			
Liquid Limit (w_L)	(%)	NO			
Plastic Limit (w_P)	(%)	ND			
Plasticity Index (I_P)	(%)	NP			
Linear Shrinkage (LS)	(%)	NO			
Cracking		-			
Crumbling		-			
Curling		-			

Notes on Test:

Liquid Limt = (NO)	**Not Obtainable, material slips in cup, test is not applicable.**
Plastic Limit = (ND)	**Not Determined, material can not be rolled.**
Plasticity Index = (NP)	**Non Plastic, when neither the liquid limit or Plastic Limit can be determined.**
Linear Shrinkage = (NO)	**Not Obtainable, material slips in cup, test is not applicable.**

Authorised Signatory G.J.Donatti

AS1289.3.1.2, AS1289.3.2.1, AS1289.3.3.1. AS1289.3.4.1.REP.JAN2021
Approved By: G. Donatti

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CALIFORNIAN BEARING RATIO OF REMOULDED SPECIMEN REPORT

Report Number	QL3703-21	**Date of Report**	13-Jan-21
Client	Golder Associates Pty Ltd		
Location	Smiths Beach Road, Yallingup (PD6 - 0.10m to 0.30m)		
Test Methods	AS1289.6.1.1, AS1289.5.2.1, AS1289.2.1.1		
Sampling Method	AS1289.1.2.1 - 6.5.1	**Date Sampled**	22-Dec-20
Date Tested	11-Jan-21	**Test Number**	7377
Material Description	Sand (Ex Verge)		

LABORATORY COMPACTION DETAILS

Maximum Dry Density (t/m^3)	1.64
Optimum Moisture Content (%)	16.5

TEST CONDITIONS OF SPECIMEN

Condition of Specimen	Soaked
Soaking Period	4 Days
Surcharge Mass (kg)	6.75
Dry Density Ratio of Specimen (%)	95
Compactive Effort Used in Remoulding Specimen (mass of rammer (kg)/drop of rammer (mm)/no. of layers/blows per layer	4.9/450/5/11

TEST RESULTS

Dry Density (t/m^3)	
Specimen after Compaction	1.56
Specimen after Soaking	1.57
Dry Density Ratio (%)	
Specimen after Compaction	95
Specimen after Soaking	95
Moisture Content (%)	
Specimen at Compaction	16
Specimen after Soaking	21
Top 30mm Layer of Specimen after Penetration	23
Entire Depth of Specimen after Penetration	23
Moisture Ratio (%)	
Specimen at Compaction	99
Specimen after Soaking	129
Top 30mm Layer of Specimen after Penetration	143
Entire Depth of Specimen after Penetration	140
Specimen Swell (%)	0.0
CALIFORNIAN BEARING RATIO (%)	**17**
PENETRATION (mm)	**2.5**

Note 1 MDD/OMC figures were obtained from Qualcon Laboratories Pty Ltd Report No. QL3703-21, Page 4 of 4.

Note 2 Percentage of material retained on 19.0mm sieve size was 0.

Note 3 : The sample was cured for a minumum of 2 Hours.

Note 4 : The liquid limit as determined by Actual (Not Obtainable - Non Plastic).

Authorised Signatory : 

G. J. Donatti

AS1289.6.1.1.REP.JAN2021

Approved by : G Donatti

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Qualcon Laboratories Pty. Ltd.

N.A.T.A. Accreditation Number: 10731

as trustee for Qualcon Unit Trust
ABN: 34 736 601 547 ACN: 068 691 369

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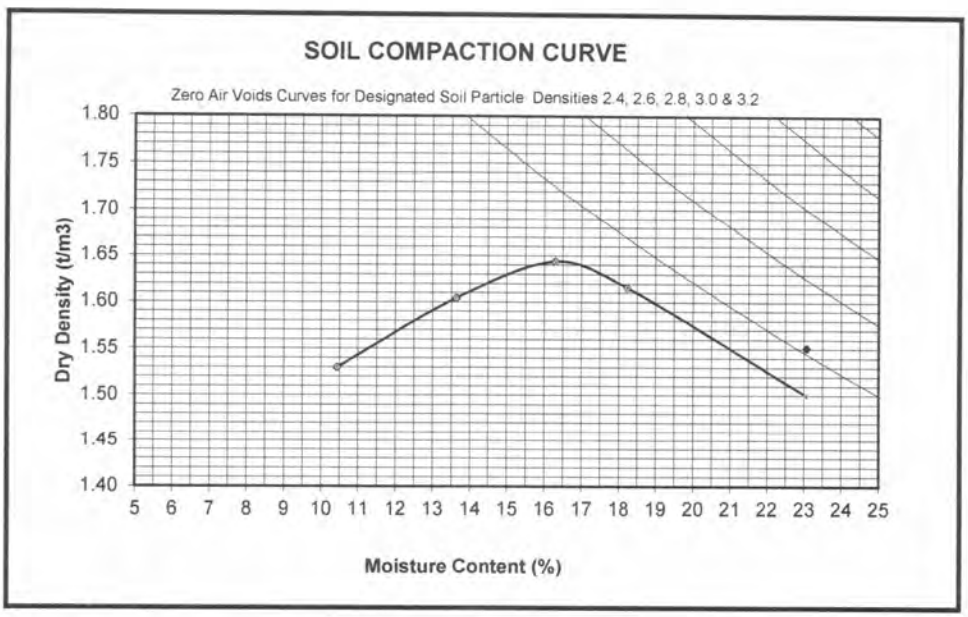
Phone: (08) 9249 9895
Fax: (08) 9248 1822
Email: qualcon@iinet.net.au

SOIL COMPACTION REPORT

Report Number	QL3703-21	**Date of Report**	13-Jan-21
Client	Golders & Associates Pty Ltd	**Test Number**	7377
Location	Smiths Beach Road, Yallingup (PD6 - 0.10m to 0.30m)		
Test Methods	AS1289.1.1, AS1289.2.1.1, AS1289.5.2.1, AS1289.1.2.1.6.4(b)		
Material Type	Sand (Ex Verge - 22-Dec-20)		
Compaction Type	Modified (Small Mould)	**Minimum Curing Time**	2hrs
Liquid Limit Method	AS1289.3.1.2		
Liquid Limit Value	Sands and granular material		

Maximum Dry Density (t/m^3)	**1.64**
Optimum Moisture Content(%)	**16.5**
Percent Retained on 19.0mm sieve	**0**
Percent Retained on 37.5mm sieve	**0**



Notes:

Authorised Signatory: G. J. Donatti

AS1289.5.2.1, .5.1.1.REP.JAN2020

Approved By: G. Donatti

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APPENDIX G

Pavement Visual Assessment

Photograph	Location/Description of Defect
	Minor potholes on the outer wheel path and outside of the inner wheel path of the northbound lane (approx. 210 m north of the intersection with Canal Rocks Road)
	Observed minor to moderate ravelling in both lanes, pinhole defects suggest that aggregate have been plucked out by the traffic movement. As the asphalt looks relatively new (inferred age around 2 years), the early ravelling may have been caused by temperature of the mix/temperature during construction.

Photograph	Location/Description of Defect
	Minor ravelling along the longitudinal joint, could be due to construction practices. Pinholes observed across both lanes.
	Longitudinal and transverse cracking between the two lanes

Photograph	Location/Description of Defect
	Minor to moderate ravelling on both lanes
	Small localised potholes along the edge of pavement (associated with edge break)

Photograph	Location/Description of Defect
	Observed minor ravelling outside the wheel path and along the joint on the northbound lane.
	Longitudinal crack along the edge of pavement at localised areas

Photograph	Location/Description of Defect
	Pavement shape along the investigated extent of road is good, no crocodile cracking or rutting observed.
	Ravelling on the inner wheel path of the northbound lane

Photograph	Location/Description of Defect
	Localised longitudinal cracking – southbound lane
	Transverse and longitudinal cracking between the lanes. Minor ravelling observed.

Photograph	Location/Description of Defect
	Minor flushing observed on the wheel paths, predominantly on the southbound lane along the bend of the road. Increased turning stresses may have contributed to the observed flushing around the bend.
	As above

Photograph	Location/Description of Defect
	Some minor cracking along the joints and pumping of fines. Minor ravelling within the turning pocket.
	Close up of pavement – small pin holes were generally observed on the pavement surface, as well as minor ravelling at localised spots, between wheel paths. Pavement may have been constructed during wet or cold weather.

Photograph	Location/Description of Defect
	Intersection stub of Canal Rocks Road and Smiths Beach Road – the asphalt surfacing joins to a spray sealed through lane and the joint sealing is relatively poor. Spray sealed shoulder on the left turn heading north widens the intersection stub, some minor stripping observed on the sealed surface.

Photograph	Location/Description of Defect
	Edge break and drop off along the edge of the northbound lane (spray seal) and pumping of fines along the joint. Some ravelling was also observed on the wheel path of the turning lane (asphalt surfacing).

APPENDIX H

Design Traffic Calculation

Site	Location on Smiths Beach Rd	Direction	AADT (1-dir)	Year	Growth Rate	Design AADT (1-dir)	Lane Factor	Heavy Vehicle Composition											R			Design Traffic (ESAs)		
								C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	%HV	5	15	40	5	15	40
Linear growth rate assumed																								
ATC1	West of Canal Rocks Apartment	EB	233	2021	1.0%	233	100	5.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	5.1	16.1	48.9	6.16E+03	1.94E+04	5.90E+04
		WB	217	2021	1.0%	217	100	1.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	5.1	16.1	48.9	2.46E+03	7.76E+03	2.36E+04
ATC2	East of Canal Rocks Apartment	EB	477	2021	1.0%	477	100	4.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	5.1	16.1	48.9	1.34E+04	4.23E+04	1.28E+05
		WB	483	2021	1.0%	483	100	2.1	1.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	5.1	16.1	48.9	2.29E+04	7.23E+04	2.20E+05
ATC3	West of Smiths Beach Resort	EB	506	2021	1.0%	506	100	3.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	5.1	16.1	48.9	9.42E+03	2.97E+04	9.03E+04
		WB	508	2021	1.0%	508	100	3.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	5.1	16.1	48.9	9.46E+03	2.98E+04	9.06E+04
ATC4	East of Smiths Beach Resort	EB	703	2021	1.0%	703	100	3.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	5.1	16.1	48.9	1.34E+04	4.23E+04	1.28E+05
		WB	707	2021	1.0%	707	100	4.9	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	5.1	16.1	48.9	2.20E+04	6.93E+04	2.11E+05
ATC6	South of Off-Street Carpark	NB	993	2021	1.0%	993	100	4.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	5.1	16.1	48.9	2.23E+04	7.04E+04	2.14E+05
		SB	978	2021	1.0%	978	100	2.6	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	5.1	16.1	48.9	3.86E+04	1.22E+05	3.70E+05

Year (assumed)	2021

ESAs per Heavy Vehicle (Rural Main and Secondary)										
C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
0.23	1.09	3.24	0.96	0.6	2.9	3.13	5.64	7.26	7.87

APPENDIX I

Pavement Design

GRANULAR PAVEMENT THICKNESS DESIGN (ERN 9, April 2009)

PROJECT TITLE Smiths Beach Development

DESIGNED BY DG
DATE 29-01-21
PROJECT DETAIL Empirical Pavement Design

SUBGRADE CBR

Input CBR (%)		
Mean CBR (%)		k value
Standard Deviation		
Design CBR (%)	12	

DESIGN TRAFFIC

1. Initial number of vehicles (AADT) daily in one direction	n	0
2. Percentage of heavy vehicles	c (%)	0
3. Annual heavy traffic growth rate r1 for the first Q years, and traffic growth rate r2 for the remainder of the design life P years	r_1	0
	Q	0
	r_2	0
4. Percentage of vehicles using design lane	d (%)	0
5. Equivalent number of standard axles per heavy vehicle	F	0
6. Pavement design life	P (year)	0
7. Cumulative Growth Factor	R	0.00
8. Design Traffic	ESA	3.70E+05
9. Design Traffic at roundabouts or small radius curves	ESA	1.11E+06

GRANULAR PAVEMENT THICKNESS	Calculated	Rounded to
1. Minimum Thickness of All Granular Material (mm)	205	**205**
2. Minimum Thickness of Basecourse Material (mm)	118	**120**

CIRCLY Pro - Version 6.0 (20 February 2019)

Job Title: 20435097 Smiths Beach Development

Damage Factor Calculation

Assumed number of damage pulses per movement:
Combined pulse for gear (i.e. ignore NROWS)

Traffic Spectrum Details:

Load No.	Load ID	Movements
1	ESA750-Full	1.22E+05

Details of Load Groups:

Load No.	Load ID	Load Category	Load Type	Radius	Pressure/ Ref. stress	Exponent
1	ESA750-Full	ESA750-Full	Vertical Force	92.1	0.75	0.00

Load Locations:

Location No.	Load ID	Gear No.	X	Y	Scaling Factor	Theta
1	ESA750-Full	1	-165.0	0.0	1.00E+00	0.00
2	ESA750-Full	1	165.0	0.0	1.00E+00	0.00
3	ESA750-Full	1	1635.0	0.0	1.00E+00	0.00
4	ESA750-Full	1	1965.0	0.0	1.00E+00	0.00

Layout of result points on horizontal plane:
Xmin: 0 Xmax: 165 Xdel: 165
Y: 0

Details of Layered System:

ID: trial1 Title: trial

Layer No.	Lower i/face	Material ID	Isotropy	Modulus (or Ev)	P.Ratio (or vvh)	F	Eh	vh
1	rough	115003B-02	Iso.	2.31E+03	0.40			
2	rough	Gran_500	Aniso.	5.00E+02	0.35	3.70E+02	2.50E+02	0.35
3	rough	Sub_CBR12	Aniso.	1.20E+02	0.35	8.89E+01	6.00E+01	0.35

Performance Relationships:

Layer No.	Location	Material ID	Component	Perform. Constant	Perform. Exponent	Traffic Multiplier
1	bottom	115003B-02	ETH	0.004759	5.000	1.130
3	top	Sub_CBR12	EZZ	0.009300	7.000	1.530

Reliability Factors:
Project Reliability: Austroads 95%

Layer No.	Reliability Factor	Material Type
1	1.00	Asphalt
3	1.00	Subgrade (Austroads 2004)

Details of Layers to be sublayered:
Layer no. 2: Austroads (2004) sublayering

Results:

Layer No.	Thickness	Material ID	Load ID		Critical Strain	CDF
1	30.00	115003B-02	ESA750-Full		-4.45E-04	9.82E-01
2	139.00	Gran_500		n/a		n/a
3	0.00	Sub_CBR12	ESA750-Full		1.60E-03	8.29E-01

CIRCLY Pro - Version 6.0 (20 February 2019)

Job Title: 20435097 Smiths Beach Development

Damage Factor Calculation

Assumed number of damage pulses per movement:
Combined pulse for gear (i.e. ignore NROWS)

Traffic Spectrum Details:

Load No.	Load ID	Movements
1	ESA750-Full	1.22E+05

Details of Load Groups:

Load No.	Load ID	Load Category	Load Type	Radius	Pressure/ Ref. stress	Exponent
1	ESA750-Full	ESA750-Full	Vertical Force	92.1	0.75	0.00

Load Locations:

Location No.	Load ID	Gear No.	X	Y	Scaling Factor	Theta
1	ESA750-Full	1	-165.0	0.0	1.00E+00	0.00
2	ESA750-Full	1	165.0	0.0	1.00E+00	0.00
3	ESA750-Full	1	1635.0	0.0	1.00E+00	0.00
4	ESA750-Full	1	1965.0	0.0	1.00E+00	0.00

Layout of result points on horizontal plane:
Xmin: 0 Xmax: 165 Xdel: 165
Y: 0

Details of Layered System:

ID: trial1 Title: trial

Layer No.	Lower i/face	Material ID	Isotropy	Modulus (or Ev)	P.Ratio (or vvh)	F	Eh	vh
1	rough	115003B-02	Iso.	2.31E+03	0.40			
2	rough	Gran_500	Aniso.	5.00E+02	0.35	3.70E+02	2.50E+02	0.35
3	rough	Sub_CBR12	Aniso.	1.20E+02	0.35	8.89E+01	6.00E+01	0.35

Performance Relationships:

Layer No.	Location	Material ID	Component	Perform. Constant	Perform. Exponent	Traffic Multiplier
1	bottom	115003B-02	ETH	0.004759	5.000	1.130
3	top	Sub_CBR12	EZZ	0.009300	7.000	1.530

Reliability Factors:
Project Reliability: Austroads 95%

Layer No.	Reliability Factor	Material Type
1	1.00	Asphalt
3	1.00	Subgrade (Austroads 2004)

Details of Layers to be sublayered:
Layer no. 2: Austroads (2004) sublayering

Results:

Layer No.	Thickness	Material ID	Load ID	Critical Strain	CDF
1	40.00	115003B-02	ESA750-Full	-4.47E-04	1.00E+00
2	165.00	Gran_500	n/a	n/a	n/a
3	0.00	Sub_CBR12	ESA750-Full	1.17E-03	9.20E-02

APPENDIX J

Pavement Work Tip – Treatment of Cracks

pavement work tips

Treatment of Cracks in Flexible Pavements

pavement work tips — no. 8 May 1998

INTRODUCTION

Pavement cracking may occur as the result of a wide variety of causes, but regardless of the cause, the outcome is a path for the entry of moisture. Unless treated, this will result in the accelerated deterioration of the pavement. Treatment will stop or slow down the rate of deterioration and improve the effectiveness of subsequent surfacing treatments.

This Work Tip provides advice on the treatment of cracks in flexible pavements surfaced with asphalt, sprayed seals or slurry surfacing. Treatment can be applied:

- directly to individual cracks
- as a complete surfacing of the affected area
- as a combination of the two.

The severity and extent of the cracks, as well as the underlying causes, will influence choice and effectiveness of the treatment.

TREATING INDIVIDUAL CRACKS

General

Filling of individual cracks is often regarded as being tedious and time consuming. However, when done correctly, it often provides the most effective treatment in terms of waterproofing and extending the life of the pavement.

Crack Filling

This involves cleaning the cracks and filling with an appropriate crack sealant, and is suitable for all cracks from about 2 - 10mm wide.

Overbanding

This involves cleaning the surface around the cracks and applying a "band-aid" of sealant over the top of the crack. A band of material about 50 to 100mm wide, 2 to 3mm thick, is applied over the crack using a special applicator. Suitable for cracks from about 5-15mm wide.

If it is intended to overlay the area with dense graded asphalt, overbanding may also be applied in the form of a proprietary, pre-formed strip of binder, highly modified and/or reinforced, about 250 to 300mm wide. A tack coat is sprayed and the strip placed centrally over the crack and rolled, just prior to placing the asphalt. Suitable for cracks from about 5-15 mm width.

Overbanding would be used in preference to filling cracks if crack movement is relatively large and/or cracks to be treated are deep or difficult to clean out.

Routing and Filling

This involves routing the crack and filling with a thick "plug" of joint sealant material. Width to depth ratio should be about 1:2 to minimise tension at the interface at the walls of the crack, and optimise its performance. This is most suitable for use with cracks that are reasonably straight e.g. joints in aged asphalt, or concrete pavements.

Suitable for medium to large cracks. Maximum recommended routing width is about 15mm.

This method may be used to treat cracks in the existing surface or with a dense graded asphalt overlay the routing and filling can be applied in the new asphalt directly over the cracks. It is essential that the location of cracks can be accurately marked prior to placing the overlay. This has been found to be a most cost effective treatment when asphalting over cracked concrete pavements.

Key Summary

This issue of 'pavement work tips' provides advice on treating cracks in flexible pavements to stop or slow down deterioration and improve future surfacing treatments

CRACK AND JOINT SEALANTS

General

The material must be able to fill and/or seal the cracks to prevent water entering the pavement at the surface. A typical problem is the thermal contraction and expansion of the pavements with seasonal and/or diurnal temperature variations. This movement can exceed the resilience of normal bitumen when used as a crack sealant, allowing the cracks to reopen. Polymer modified bitumen is often used to address this problem because it has improved cohesive (internal) strength, and is usually more elastic, at normal road surface temperatures.

The practitioner must assess whether the enhanced properties are required, and if modified sealant provides an economic solution.

The following, generally in order of performance and cost, provides a brief description of the materials commonly used:

- Bitumen emulsion can be poured into the cracks, or sprayed or spread onto the surface

continued on reverse

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with a broom or squeegee, and covered with grit or clean sand. Generally most suitable for small cracks, less than 2mm, with little movement.

- Bitumen emulsion modified with natural rubber, or polymers, provides improved performance over standard emulsions. Suitable for small to medium cracks, 2 - 5mm, with little movement.
- Hot poured modified bitumen, usually with a high polymer content, is generally used as a sealant in overbanding, and routing and filling treatments. These treatments are suitable for medium to large cracks, about 5 - 15mm with larger movement.

PROCEDURES FOR CRACK FILLING

- Cracks must be cleaned out, generally to a depth of about twice the width. Any greater depth may affect the ability of the sealant to remain bonded to the sides if the crack width increases due to any movement in the pavement.
- Compressed air is the most common method of cleaning out cracks, but this may be supplemented by wire brushes etc.
- The cracks should be filled level, or just below the surface, to prevent pick-up and minimise potential bleeding in subsequent reseals.
- If possible, treat cracks when, environmentally, they are at their widest, such as at the end of a long dry spell.
- When applying grit or sand, take care not to fill the full depth of the crack as this will reduce the effectiveness and life of the sealant.
- Bonding of the sealant to the sides of the crack may be a problem when using hot pour sealant. When this occurs, the crack may need to be dried out using a blower, or a primer applied to the sides.

TREATING THE ENTIRE SURFACE

General

It is generally more cost effective to treat the entire surface by applying a sprayed seal if cracking is extensive and treating cracks individually would be labour intensive and time consuming.

Sprayed Seals

These may be either single or two coat seals, with normal binder. Suitable for untreated small cracks, less than 2mm, with very small movement, or over all sizes of treated cracks.

Stress Alleviating Membrane (SAM)

These are sprayed seals using a polymer modified binder to provide a thicker and more elastic film of binder, thereby giving improved waterproofing properties. Suitable for small to medium cracks, about 2-5mm.

Strain Alleviating Membrane Interlayer (SAMI)

These are similar to SAM's, but generally with a more highly modified binder at higher rates of application, used over a cracked pavement prior to placing an asphalt overlay. Suitable for small to medium cracks, about 2-5mm.

Reinforced Seals

These are sprayed seals reinforced with glass fibres, or geotextile fabric, to provide an extremely strong and waterproof membrane.

In areas where the cracking or loading is extreme, the performance may be further improved by using a two coat seal, with modified binder.

Suitable for medium to large cracks, about 5-15mm, but has been successfully used in treating larger cracks.

Choice of Polymer Modified Binder (PMB)

The widths of the cracks and amount/cause of any movement influence the choice of a suitable polymer modified binder. The movement is usually defined in terms of being due to environmental causes or traffic (load) induced. If movement exceeds about 0.5 to 1mm, it is doubtful that a PMB alone will provide a long term solution and it should be used in conjunction with a geotextile. APRG Report No 19 provides guidance as to the selection of a suitable grade of PMB to use.

SAFETY ASPECTS

Where cracks are evident as crocodile crazing/cracking, and the pattern is closely spaced, overbanding may cause problems due to water ponding, which may cause loss of skid resistance and a rough ride.

For more information on any of the construction practices discussed in "pavement work tips", please contact either your local AUSTROADS Pavement Research Group representative or AAPA — tel (03) 9853 3595; fax (03) 9853 3484; e-mail: info@aapa.asn.au

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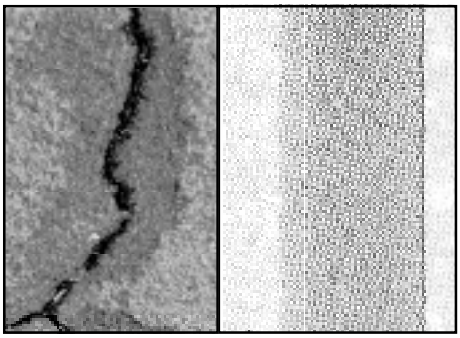
This edition was prepared by Ian Cossens and Walter Holtrop, in consultation with members of the National Bituminous Surfacings Research Group (NaBSuRG).

Crack filling with insulated hand lance



Overbanding before (left) and after (right)

Filling and sanding cracks after routing

APPENDIX K

Important Information

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The scope of Golder's Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

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Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

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Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification

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APPENDIX C
Geophysical Report

GBGMAPS

Advanced Subsurface Investigations

Report

Smiths Beach Geophysical Investigation, Yallingup Western Australia.

Date: 19th March 2019
Report Ref: 70492

DOCUMENT HISTORY

DETAILS

Project number	70492
Document Title	Smiths Beach Geophysical Investigation, Yallingup WA
Site Address	Smiths Beach Road, Yallingup WA 6282
Report prepared for	Smiths 2014 Pty Ltd

STATUS AND REVIEW

Revision	Prepared by	Reviewed by	Date issued
0	Stephen Kelly	Andrew Spyrou	19th March 2019

DISTRIBUTION

Revision	Electronic	Paper	Issued to
0	1	0	Sam Gill, Smiths 2014 Pty Ltd

COMPANY DETAILS

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CONTENTS

1. INTRODUCTION

At the request of Smiths 2014 Pty Ltd, GBG MAPS Pty Ltd (GBGMAPS) carried out a geophysical subsurface investigation along a 200 metre section of coastal foreshore and dune system at Smiths Beach, Yallingup WA in March 2019. The investigation was carried out as part of the foreshore management plan, in particular to determine the elevation of underlying rock for coastal modelling.

During the investigation, 7 geophysical transects were acquired including 2 Multi-channel Analysis of Surface Waves (MASW) and 5 Seismic Refraction transects within the site boundaries. The acquired data was processed and inverted in order to obtain seismic velocity sections which have been demarcated into geological sections showing the interpreted level to the top of limestone rock and overlying sand strata.

2. INVESTIGATION SITE

The geophysical investigation was carried out along a 200 metre section of beach foreshore and coastal dune system on Smiths Beach. An overview of the investigation site is shown in Figure 1 below. A site map showing the acquired geophysical transects is provided in drawing 70492-01 in Appendix B of this Report.

Figure 1: The extent of the geophysical investigation at Smiths Beach (blue polygon). Image supplied by Smiths 2014 Pty Ltd.

3. SUBSURFACE TEST METHODS

During the investigation two subsurface test methods were used so as to provide the required subsurface information within the anticipated geological conditions.

- **Multi-channel Analysis of Surface Waves (MASW)** was acquired along 2 transects including along the beach foreshore and Smiths Beach Road where surface conditions were suitable for MASW data acquisition. The MASW data was inverted to obtain seismic shear (S-) wave velocity sections

- **Seismic Refraction** – acquired along 5 transects where surface conditions including vegetation and undulating surface topography precluded the use of MASW. The seismic refraction data was inverted to obtain seismic compressional (P-) wave velocity sections

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

4. GEOPHYSICAL DATA ACQUISITION

The geophysical site work was carried out on 5-6 March 2019 by a two person crew from GBGMAPS consisting of a qualified geophysicist and field assistant.

Data was acquired using an Ambrogeo digital seismograph connected with seismic cables to geophones (vibration sensors). Seismic energy was generated using sledgehammer impacts onto a metal base plate. Acquisition parameters are provided in Tables 1 and 2 respectively.

Spatial positioning was achieved by Navcom differential GNSS receiver used to pick up the location of each refraction geophone location and MASW sounding position. Survey accuracy was better than 100mm for horizontal and vertical readings. All positions are given in GDA94 (MGA zone 50), whilst elevations are given in Australian Height Datum (AHD).

Table 1 – MASW acquisition parameters

Number of geophones	24
Geophone spacing	1 m
Geophone frequency	4.5 Hz
Array length	23 m
Record length	2 s
Sample interval	0.500 ms
Source offset	6 m
Source stacks	5
Sounding interval	6 m

Table 2 – Seismic refraction acquisition parameters

Number of geophones	24 or 48
Geophone spacing	2 or 3m
Geophone frequency	12 Hz
Array length	46 or 141 m
Record length	200 ms
Sample interval	0.064 ms
Max source offset	12 m
Source stacks	5

5. GEOPHYSICAL DATA PROCESSING

The acquired geophysical datasets were processed and analysed with current industry standard software by qualified geophysicists using GBGMAPS standard processing routines.

The MASW data was processed and inverted using SurfSeis V4 (Kansas Geological Survey, 2014) in order to generate seismic velocity sections showing the variation in modelled S-wave velocity laterally along the transects and with elevation.

The seismic refraction data was processed and inverted using Rayfract version 3.35 (Intelligent Resources Incorporated, 2016) in order to generate seismic velocity sections showing the variation in modelled P-wave velocity laterally along the transects and with elevation.

Seismic S-wave and P-wave velocities are governed by the elastic properties of the medium they propagate through including bulk modulus, shear modulus and density as shown in the equations below. As such calculated seismic velocities provide a useful guide to the subsurface material condition with increasing velocity an indication of increasing material hardness and stiffness.

Seismic P-wave velocity $$V_p = \sqrt{\frac{K+\frac{4}{3}G}{\rho}}$$

Seismic S-wave velocity $$V_s = \sqrt{\frac{G}{\rho}}$$

where;

K = Bulk modulus

G = Shear modulus

ρ = In-situ material density

6. RESULTS AND INTERPRETATION

6.1 PRESENTATION OF RESULTS

The results of the geophyiscal investigation to determine rock profile along the beach foreshore and dune system along Smiths Beach are provided in Appendix B of this report as follows:

- **70492-01**. Site map showing acquired geophysical transects
- **70492-02**. Transects M-01 and M-02, S-wave velocity and interpreted sections
- **70492-03**. Transects R-01 and R-02, P-wave velocity and interpreted sections
- **70492-04.** Transects R-03, R-04 and R-05, P-wave velocity and interpreted sections
- **70492-05.** Site map with modelled level (mAHD) to top of interpreted rock
- **70492-06.** Site map with modelled thickness (m) of sand overlying interpreted rock

6.2 GEOPHYSICAL AND INTERPRETED CROSS-SECTIONS

The results of the geophysical transects are presented as drawings 70492-02 to -04 in Appendix B. At the top of each drawing are the seismic velocity sections generated from the MASW and refraction data. The images show the variations in the seismic S-wave or P-wave velocity as a contour plot as per the colour scale with increasing velocity from blue, green, yellow, orange, red then brown.

Below the seismic velocity sections are geological sections giving the interpreted layering of the subsurface based on detectable seismic velocity contrasts. The calculated seismic velocity values have been classed into four categories representing different subsurface conditions:

1. **Very low seismic wave velocity**. Regions with very low seismic wave velocity are interpreted as sand of low compaction.

2. **Low seismic wave velocity.** Regions with low seismic wave velocity are interpreted as moderately compacted sand with possible lithified sand or calcarenite lenses.

3. **Moderate seismic wave velocity**. Regions with moderate seismic wave velocity are interpreted as extremely weathered to weathered limestone with low rock strength. It is likely that this class represents a highly variable weathered limestone and transitional zone to stronger, more competent limestone below.

4. **Moderate to high seismic wave velocity**. Regions with moderate to high seismic wave velocity are interpreted as limestone of low to moderate rock strength. It is postulated that this class represents competent or slightly weathered limestone.

6.3 MODELLED LEVEL TO TOP OF ROCK

The level to the interpreted top of rock profile and overlying sand thickness along the geophysical transects are presented in Drawings 70492-05 and -06 respectively. These has been generated by digitising the interface between the interpreted sand dune strata and the underlying rock profile as modelled from the geophysical transects.

The resulting x = Easting, y = Northing, and z = mAHD values for the top of rock have been shown as a classed post map giving the level to top of rock as eight classes from less than -1.0mAHD to greater than 5.0mAHD at 1m increments.

The modelled sand thickness was generated by subtracting the interpreted rock level from the surface elevation and plotted into eight classes from less than 1.0m to greater than 8.0m at 1.0m increments.

7. CONCLUSIONS

A geophysical investigation has been carried out by GBGMAPS along a 200m section of coastal foreshore and dune system at Smiths Beach in Yallingup, Western Australia.

The objective of the geophysical investigation was to provide information on the subsurface material at the site in particular to model the interface between the sand strata and underlying limestone rock. The results of the investigation are to be used as part of the Smiths Beach foreshore management plan.

As part of the investigation scope, Multi-channel Analysis of Surface Waves (MASW) and Seismic Refraction datasets were acquired along a series of transects. The acquired datasets were processed and analysed to provide colour cross sections showing variations in the seismic wave velocity of the subsurface material. The seismic velocity sections were demarcated into velocity ranges representing different subsurface conditions for the generation of interpreted geological sections showing the modelled depth to top of rock.

The methods used during the investigation are geophysical and as such the results are based on indirect measurements and the processing and interpretation of 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 the attached drawings provide you with the information required. If you require clarification on any points arising from this geophysical investigation, please do not hesitate to contact the undersigned on (08) 6436 1599.

For and on behalf of
GBGMAPS PTY LTD

ANDREW SPYROU

Senior Geophysicist

APPENDIX A: GEOPHYSICAL METHODS

MULTI-CHANNEL ANALYSIS OF SURFACE WAVES

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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

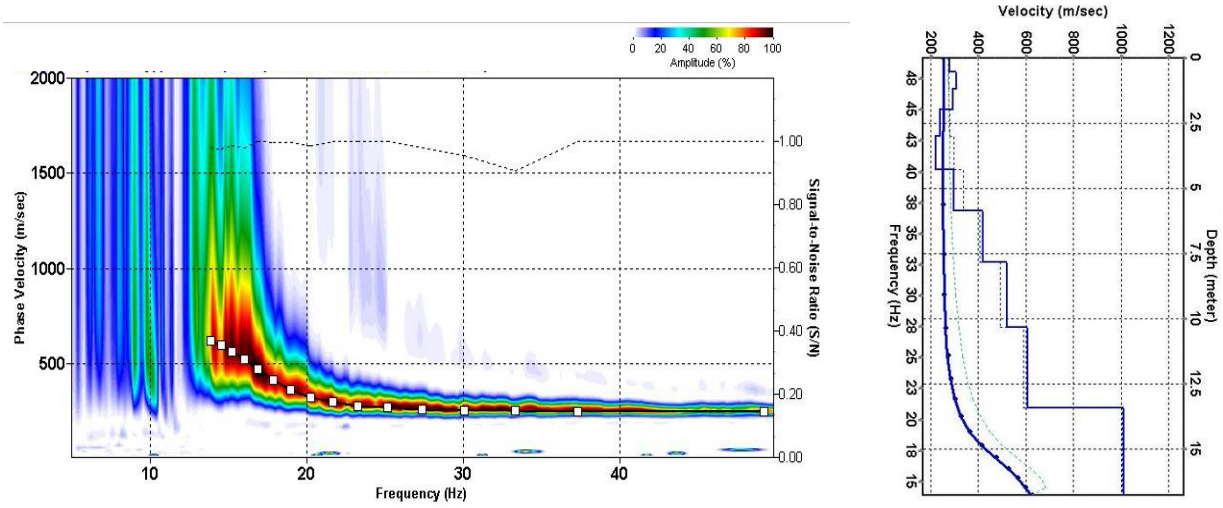
The Multi-channel Analysis of Surface Waves method (MASW) is a non-destructive seismic method which uses the elastic properties of subsurface materials to determine subsurface structure. By analysis of the dispersive properties of varying frequencies from a single seismic source, shear-wave velocity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

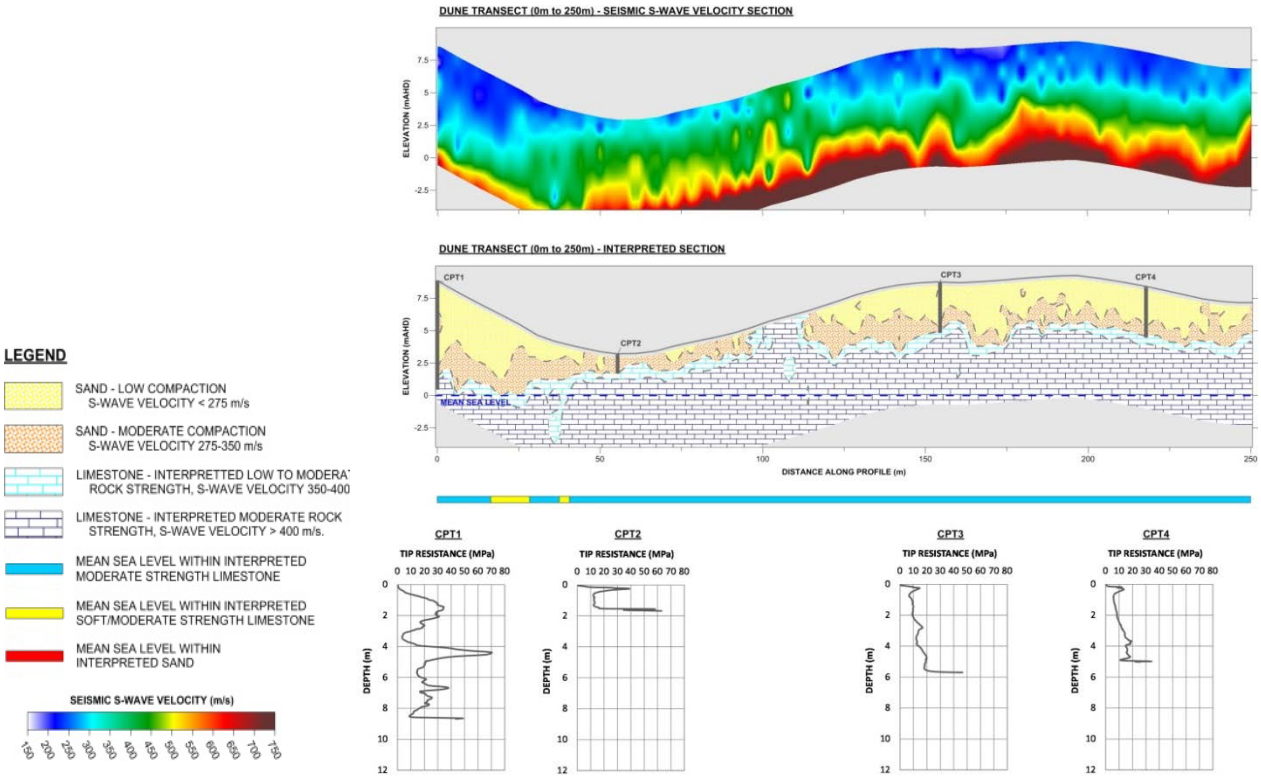
Seismic surface waves have dispersion properties that traditionally utilized body waves lack. Differing wavelengths/frequencies have different depth of penetration, and therefore propagates with different phase velocity, with an increase in wavelength being proportional to increased depth of penetration. 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.

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.

SEISMIC REFRACTION

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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.

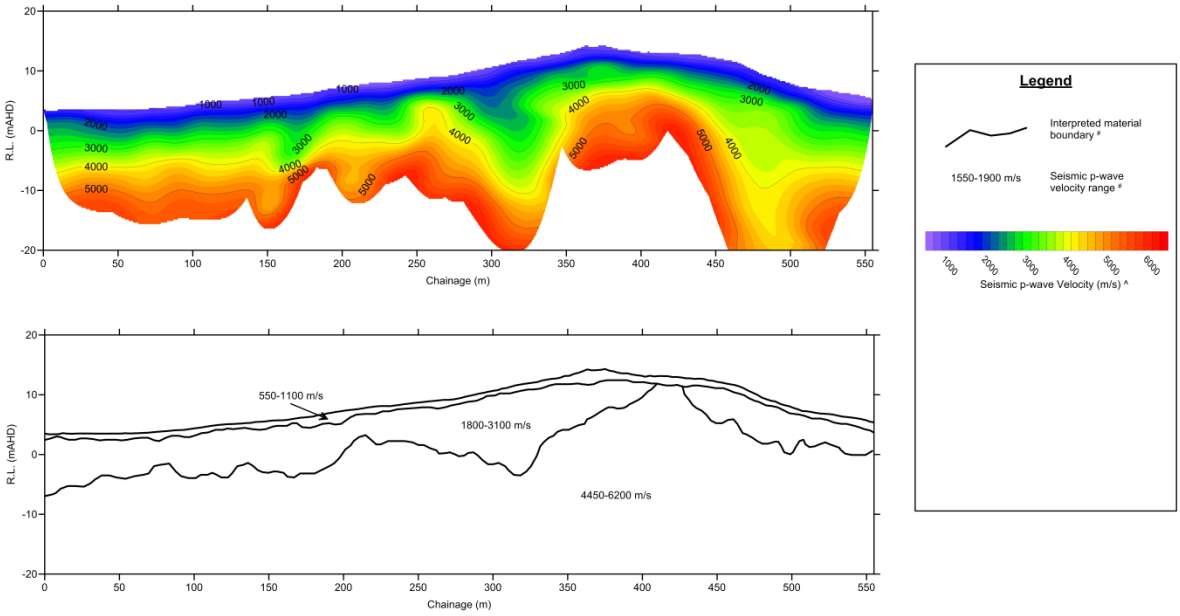
For near surface investigations seismic energy is generated on the surface using a sledge hammer. More powerful sources such as accelerated drop weight, down-hole airguns, or explosives are required for deeper investigations. The generated seismic waves propagate through the subsurface at a certain velocity. 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.

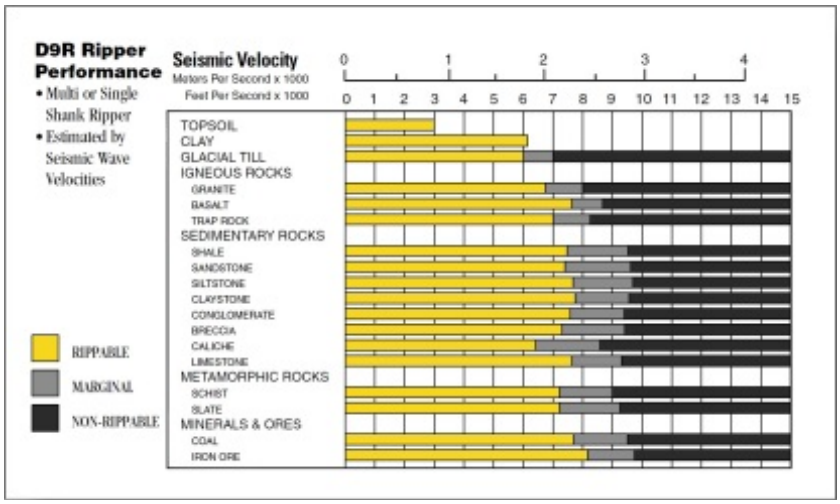
DATA ANALYSIS & PRESENTATION

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.

APPENDIX B: RESULTS DRAWINGS

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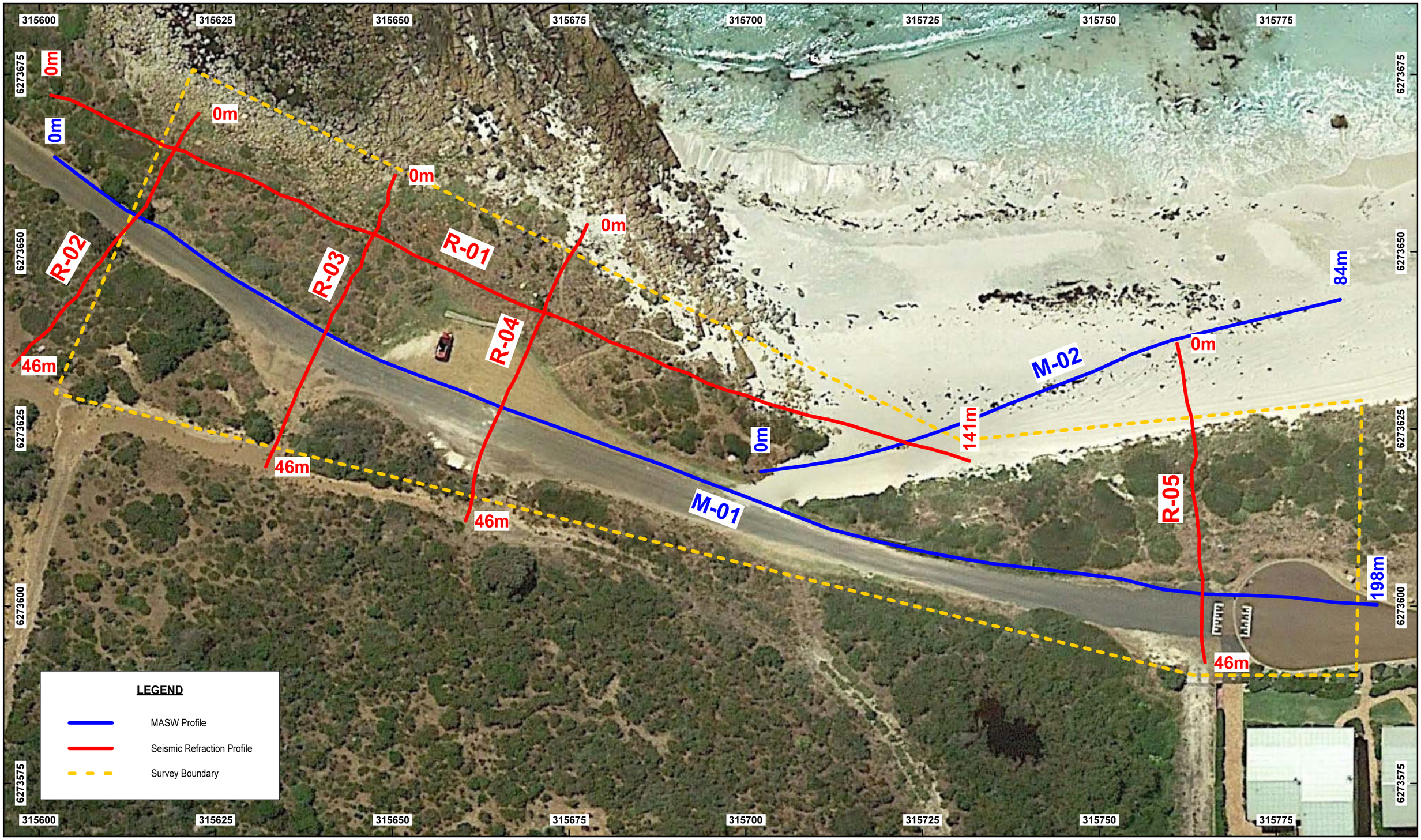
SMITHS BEACH, YALLINGUP WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION

ACQUIRED SEISMIC GEOPHYSICAL TRANSECTS



NOTES

Drawing to be used in conjunction with Report 70492
Map Projection: GDA 94, MGA Zone 50
Aerial image from Google Earth Pro.

0 5 10 15 20 25
Metres

N

CLIENT	SMITHS BEACH 2014 Pty Ltd	Date	28 February 2019	Paper Size	A3
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		Drawing	70492-01	Revision	0

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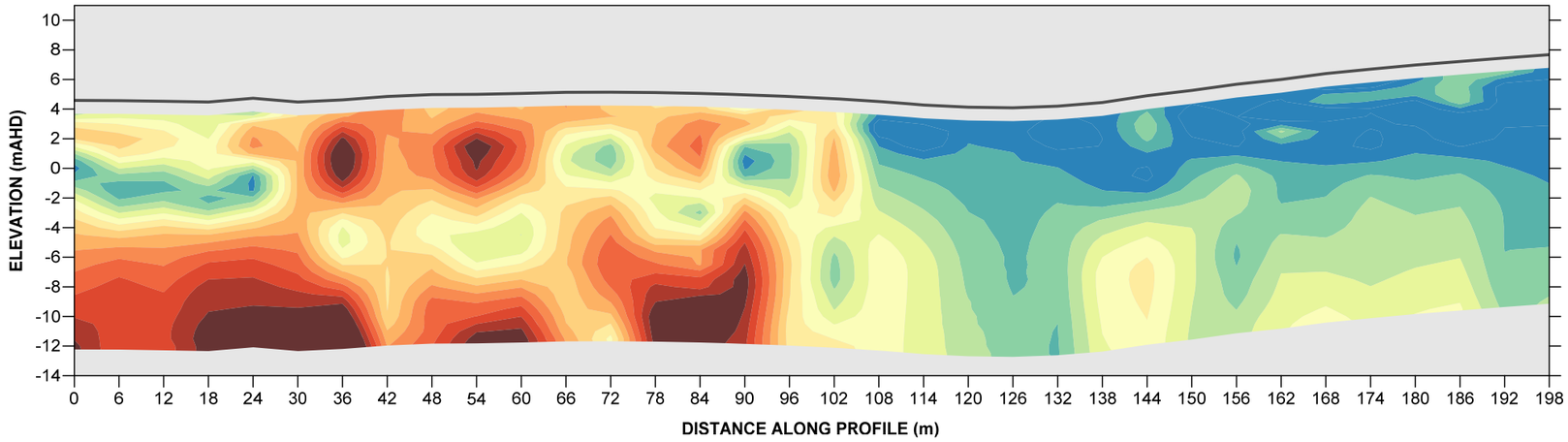
SMITHS BEACH, YALLINGUP WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION

SEISMIC GEOPHYSICAL AND INTERPRETED TRANSECTS

TRANSECT M-01 - SEISMIC S-WAVE VELOCITY SECTION



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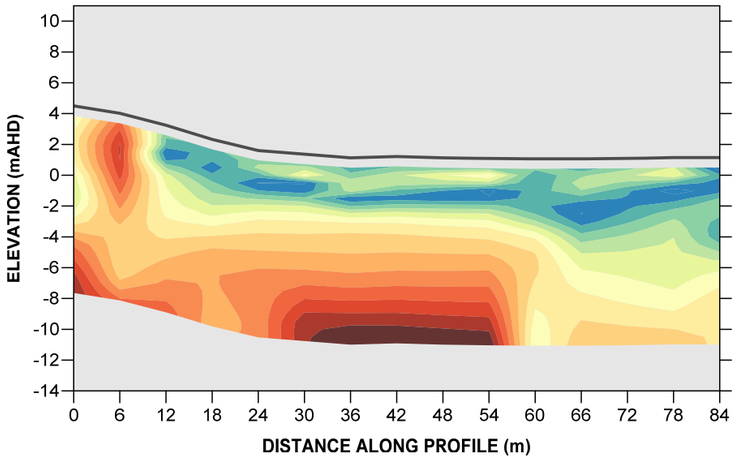
6273600.2 N

TRANSECT M-02 - SEISMIC S-WAVE VELOCITY SECTION



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315784.1 E
6273643.2 N

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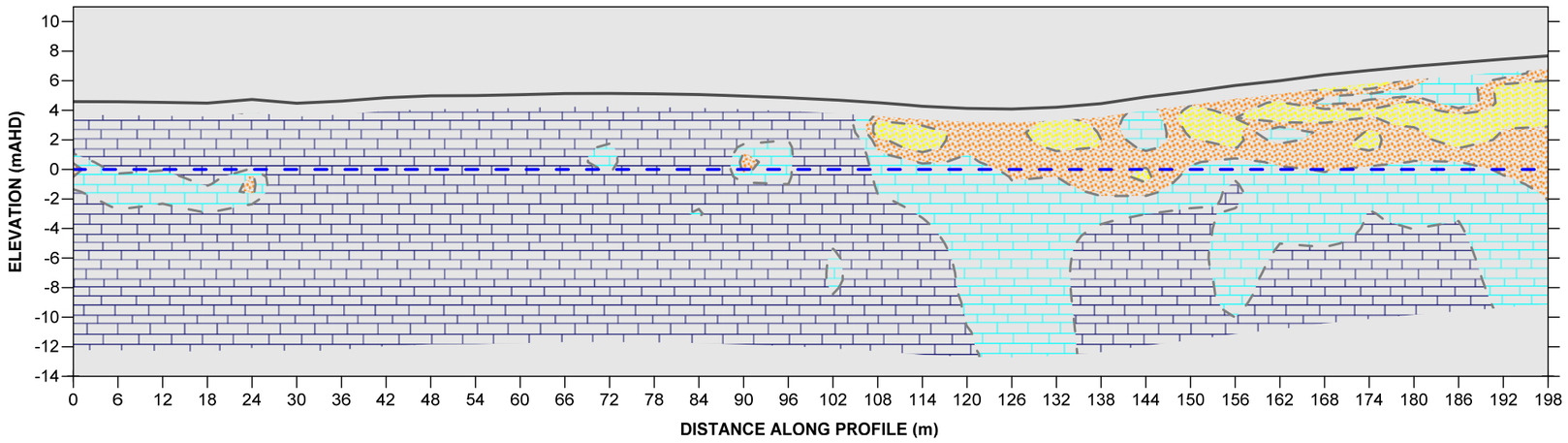

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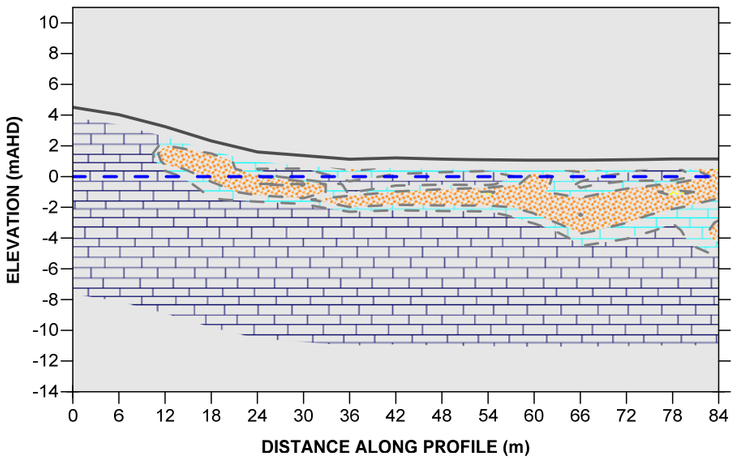
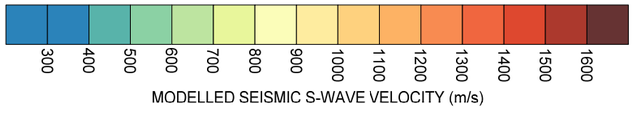


LEGEND

- SAND - LOW COMPACTION
  S-WAVE VELOCITY < 300 m/s
- SAND MODERATE COMPACTION WITH POSSIBLE LITHIFIED SAND/CALCARENITE LENSES
  S-WAVE VELOCITY 300-450 m/s
- MEAN SEA-LEVEL (0mAHD)
- LIMESTONE - EXTREMELY WEATHERED TO WEATHERED
  LOW ROCK STRENGTH, S-WAVE VELOCITY 450-600 m/s.
- LIMESTONE - WEATHERED TO COMPETENT
  LOW TO MODERATE ROCK STRENGTH. S-WAVE VELOCITY > 600 m/s.



NOTES

Map Projection GDA 94, MGA Zone 50.
Elevation in Australian Height Datum (mAHD)
Refer to Drawing 70492-01 for transect locations.
Drawing to be used in conjunction with Report 70492.

CLIENT	SMITHS BEACH 2014 Pty Ltd	Date	18 March 2019	Paper Size	A3
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		Drawing	70492-02	Revision	0

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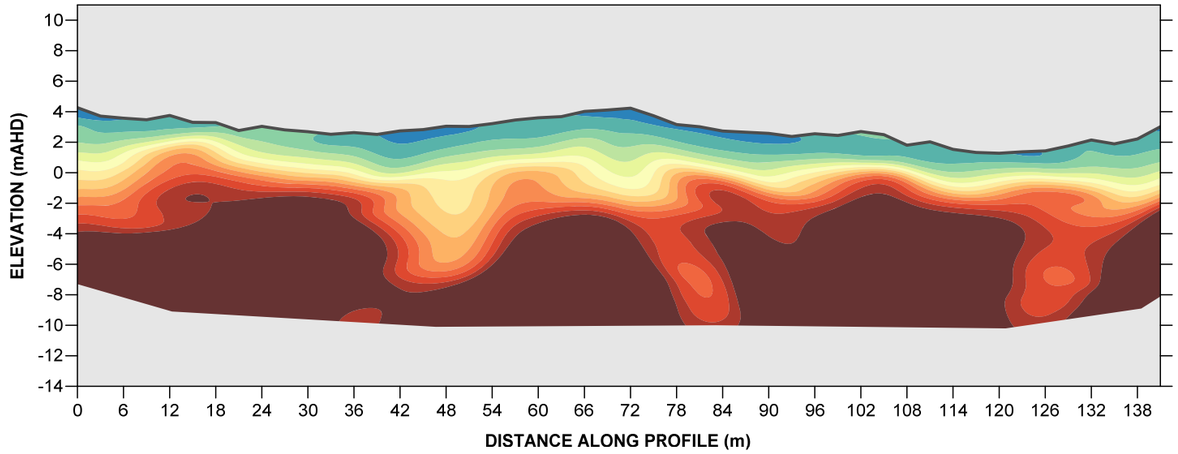
SMITHS BEACH, YALLINGUP WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION

SEISMIC GEOPHYSICAL AND INTERPRETED TRANSECTS

TRANSECT R-01 - SEISMIC P-WAVE VELOCITY SECTION



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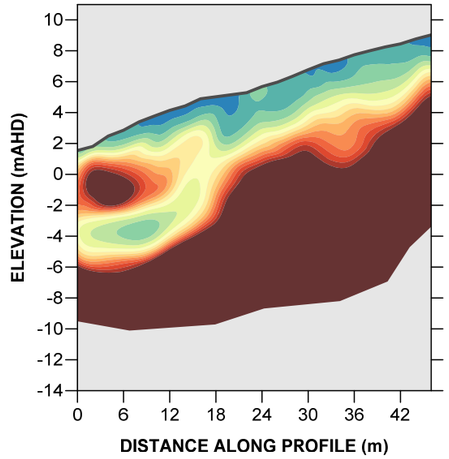

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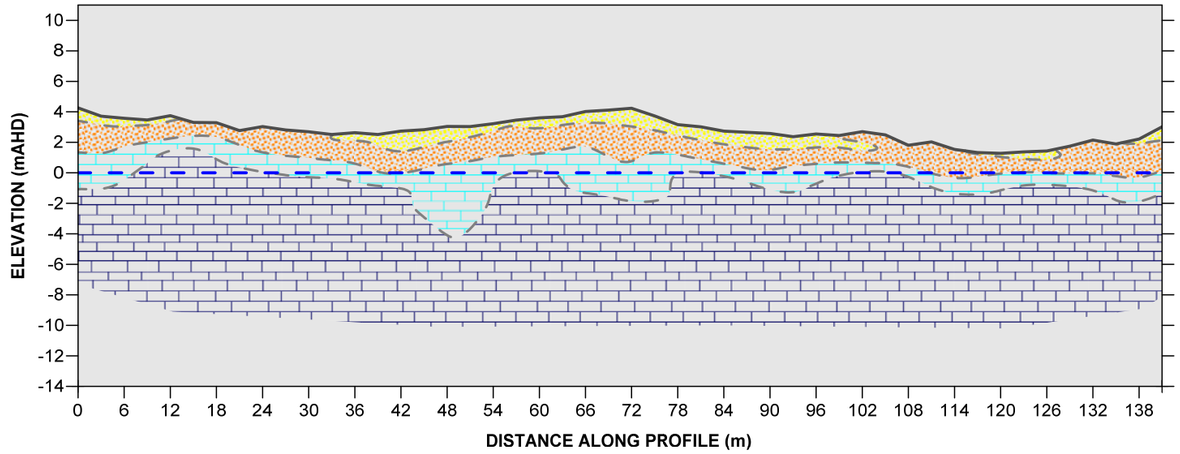

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315731.6 E
6273620.5 N

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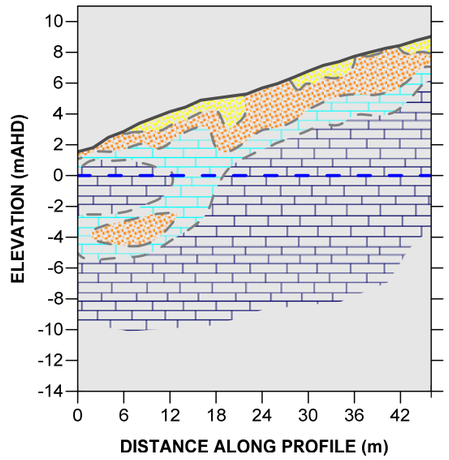
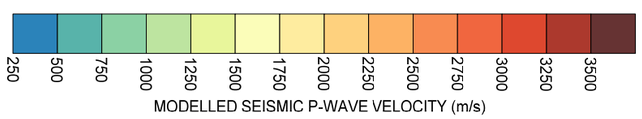


315622.6 E
6273669.5 N

315596.3 E
6273633.9 N

LEGEND

- SAND - LOW COMPACTION
  P-WAVE VELOCITY < 600 m/s
- SAND MODERATE COMPACTION WITH POSSIBLE LITHIFIED SAND/CALCARENITE LENSES
  P-WAVE VELOCITY 700-1250 m/s
- MEAN SEA-LEVEL (0mAHD)
- LIMESTONE - EXTREMELY WEATHERED TO WEATHERED
  LOW ROCK STRENGTH, P-WAVE VELOCITY 1250-2250 m/s.
- LIMESTONE - WEATHERED TO COMPETENT
  LOW TO MODERATE ROCK STRENGTH. P-WAVE VELOCITY > 2250 m/s.



NOTES
Map Projection GDA 94, MGA Zone 50.
Elevation in Australian Height Datum (mAHD)
Refer to Drawing 70492-01 for transect locations.
Drawing to be used in conjunction with Report 70492.

CLIENT	SMITHS BEACH 2014 Pty Ltd	Date	18 March 2019	Paper Size	A3
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		Drawing	70492-03	Revision	0

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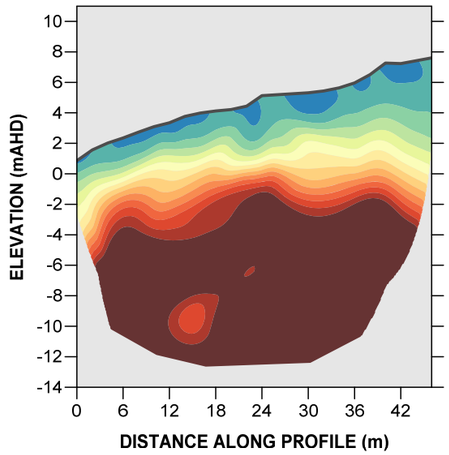
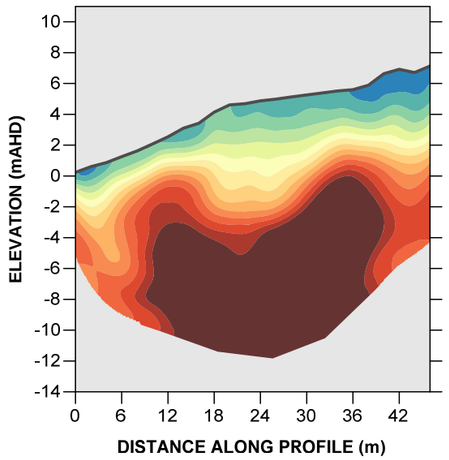
SMITHS BEACH, YALLINGUP WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION

SEISMIC GEOPHYSICAL AND INTERPRETED TRANSECTS

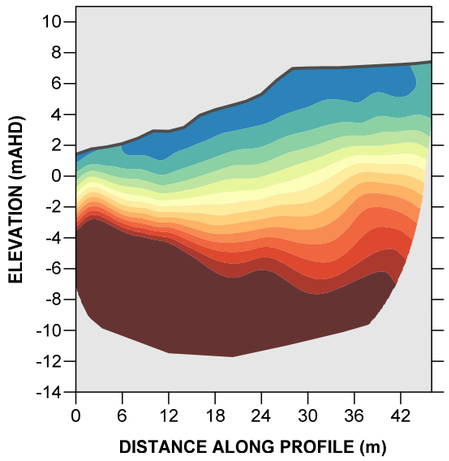
TRANSECT R-03 - SEISMIC P-WAVE VELOCITY SECTION



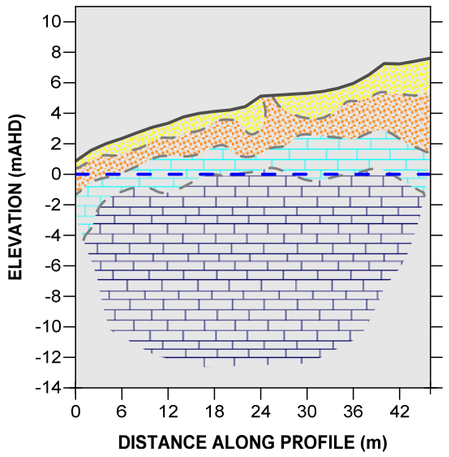
TRANSECT R-04 - SEISMIC P-WAVE VELOCITY SECTION



TRANSECT R-05 - SEISMIC P-WAVE VELOCITY SECTION



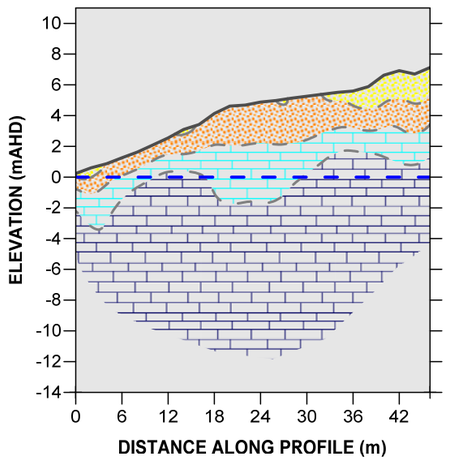
TRANSECT R-03 - GEOLOGICAL INTERPRETED SECTION



315650.4 E
6273660.8 N

315632.1 E
6273619.7 N

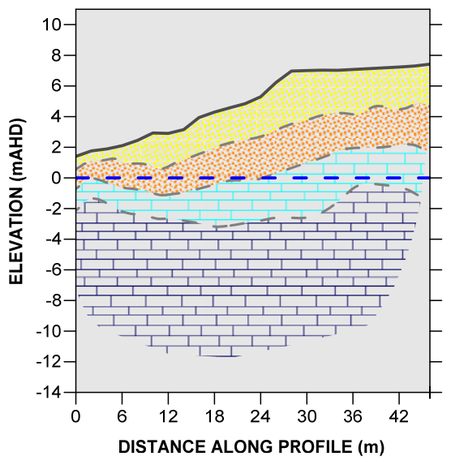
TRANSECT R-04 - GEOLOGICAL INTERPRETED SECTION



315677.5 E
6273653.8 N

315660.3 E
6273612.0 N

TRANSECT R-05 - GEOLOGICAL INTERPRETED SECTION

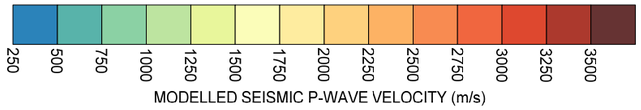


315761.0 E
6273637.0N

315765.0 E
6273592.1 N

LEGEND

- SAND - LOW COMPACTION
  P-WAVE VELOCITY < 600 m/s
- SAND MODERATE COMPACTION WITH POSSIBLE LITHIFIED SAND/CALCARENITE LENSES
  P-WAVE VELOCITY 700-1250 m/s
- MEAN SEA-LEVEL (0mAHD)
- LIMESTONE - EXTREMELY WEATHERED TO WEATHERED
  LOW ROCK STRENGTH, P-WAVE VELOCITY 1250-2250 m/s.
- LIMESTONE - WEATHERED TO COMPETENT
  LOW TO MODERATE ROCK STRENGTH. P-WAVE VELOCITY > 2250 m/s.



NOTES

Map Projection GDA 94, MGA Zone 50.
Elevation in Australian Height Datum (mAHD)
Refer to Drawing 70492-01 for transect locations.
Drawing to be used in conjunction with Report 70492.

CLIENT	SMITHS BEACH 2014 Pty Ltd	Date	18 March 2019	Paper Size	A3
GEOPHYSICAL INVESTIGATION FOR BEDROCK MAPPING, SMITHS BEACH YALLINGUP WESTERN AUSTRALIA		Scale	1:400 Ver, 1:800 Hor	Drawn	AHWS
		Drawing	70492-04	Revision	0

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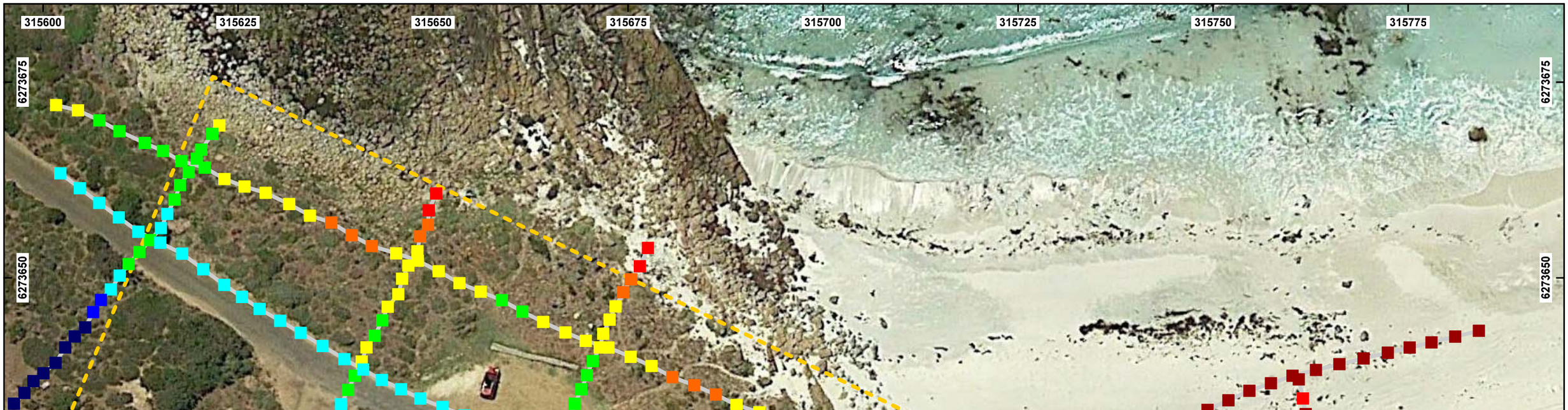
SMITHS BEACH, YALLINGUP WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION

MODELLED LEVEL TO TOP OF INTERPRETED ROCK



NOTES

Drawing to be used in conjunction with Report 70492
Map Projection: GDA 94, MGA Zone 50
Aerial image from Google Earth Pro.

0 5 10 15 20 25
Metres

N

CLIENT	SMITHS BEACH 2014 Pty Ltd	Date	18 March 2019	Paper Size	A3
GEOPHYSICAL INVESTIGATION FOR BEDROCK MAPPING, SMITHS BEACH YALLINGUP WESTERN AUSTRALIA		Scale	1:500	Drawn	AHWS
		Drawing	70492-05	Revision	0

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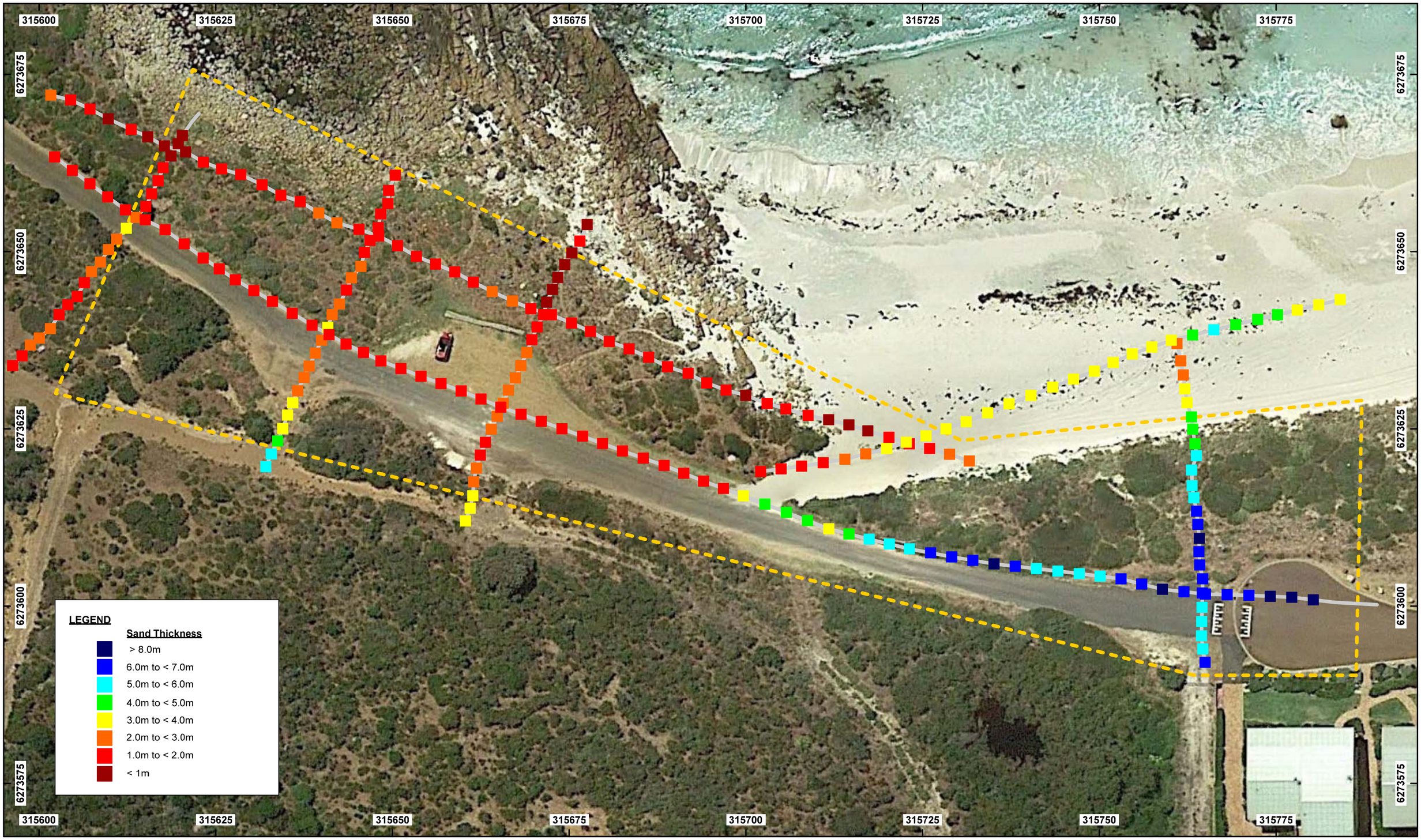
SMITHS BEACH, YALLINGUP WESTERN AUSTRALIA - GEOPHYSICAL INVESTIGATION

MODELLED SAND THICKNESS OVERLYING ROCK



NOTES

Drawing to be used in conjunction with Report 70492
Map Projection: GDA 94, MGA Zone 50
Aerial image from Google Earth Pro.

0 5 10 15 20 25
Metres

N

CLIENT SMITHS BEACH 2014 Pty Ltd

GEOPHYSICAL INVESTIGATION FOR BEDROCK MAPPING, SMITHS BEACH YALLINGUP WESTERN AUSTRALIA

Date	18 March 2019	Paper Size	A3
Scale	1:500	Drawn	AHWS
Drawing	70492-06	Revision	0

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Email: info@gbgmaps.com.au

APPENDIX D
Hyd2o Permeability Testing

Borehole Permeameter : Field Result Analysis

Project/Site	Smiths Beach Test Site HS1 (Main Basin)	
Soil Descrip	Dark brown-black fine grained	
Location	315719	mE
	6273585	mN

hyd2o HYDROLOGY

TEST 1

r	4.0	cm
H	20.0	cm
time step	10	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**3.3**	
10	**12.4**	9.1
20	**16.4**	4.0
30	**21.2**	4.8
40	**27.8**	6.6
50	**34.3**	6.5
60	**38.5**	4.2
70	**44.5**	6.0
80	**50.9**	6.4
90	**56.0**	5.1
100	**62.0**	6.0
110	**67.0**	5.0
120	**73.5**	6.5
		5.9
	q (cm^3/s)	5.1

TEST 2

r	4.0	cm
H	20.0	cm
time step	10	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**5.9**	
10	**15.5**	9.6
20	**20.5**	5.0
30	**26.7**	6.2
40	**33.5**	6.8
50	**40.3**	6.8
60	**47.5**	7.2
70	**54.0**	6.5
80	**57.5**	3.5
90	**64.7**	7.2
100	**75.5**	10.8
	Avg Diff (cm)	7.0
	q (cm^3/s)	6.1

TEST 3

r	4.0	cm
H	20.0	cm
time step	10	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**3.5**	
10	**12.1**	8.6
20	**18.0**	5.9
30	**26.9**	8.9
40	**33.2**	6.3
50	**38.7**	5.5
60	**47.0**	8.3
70	**52.7**	5.7
80	**59.3**	6.6
90	**66.0**	6.7
100	**73.4**	7.4
	Avg Diff (cm)	7.0
	q (cm^3/s)	6.2

METHOD 1 : Elrick and Reynolds (1992)

Ks (cm/s)	0.0033	Ks (cm/s)	0.0039	Ks (cm/s)	0.0040
Ks (m/day)	2.86	Ks (m/day)	3.40	Ks (m/day)	3.41
Average (m/day)	**3.2**				

METHOD 2 : Talsma and Hallam Method (for low Ks only <2.9)

q (cm3/min)	308.9		367.5	cm3/min	369.1	cm3/min
r (cm)	4		4.0	cm	4.0	cm
H (cm)	20.0		20.0	cm	20.0	cm
$0.5\sinh^{-1}(H/2r)$	0.82		0.82		0.82	
-sqrt((r/H)^2+0.25)	-0.54		-0.54		-0.54	
r/H	0.20		0.20		0.20	
Sum	0.49		0.49		0.49	
Sum*4.4*q	659.28		784.38		787.76	
$2*pi*H^2$	2513.27		2513.27		2513.27	
Ksat (cm/min)	0.3		0.3		0.3	
Ksat (m/day)	3.78		4.49		4.51	
Average (m/day)	**4.1**					

Borehole Permeameter : Field Result Analysis

Project/Site	Smiths Beach Site HS2 (Uphill West)	
Soil Descrip	Light brown sand fine to medium	
Location	315558	mE
	6273339	mN

TEST 1

r	4.0	cm
H	10.0	cm
time step	10	secs
H/r	2.50	
C	1.06	

Time (sec)	Level (cm)	Diff (cm)
0	**12.0**	
10	**63.0**	51.0
20		
	q (cm^3/s)	51.0
		44.9

TEST 2

r	4.0	cm
H	10.0	cm
time step	5	secs
H/r	2.50	
C	1.06	

Time (sec)	Level (cm)	Diff (cm)
0	**4.6**	
5	**31.0**	26.4
10	**54.0**	23.0
	Avg Diff (cm)	24.7
	q (cm^3/s)	43.5

TEST 3

r	4.0	cm
H	10.0	cm
time step	5	secs
H/r	2.50	
C	1.06	

Time (sec)	Level (cm)	Diff (cm)
0	**4.0**	
5	**28.2**	24.2
10	**65.0**	36.8
	Avg Diff (cm)	30.5
	q (cm^3/s)	53.7

METHOD 1 : Elrick and Reynolds (1992)

Ks (cm/s)	0.0700	Ks (cm/s)	0.0678	Ks (cm/s)	0.0837
Ks (m/day)	60.47	Ks (m/day)	58.57	Ks (m/day)	72.33

Average (m/day) **63.79**

METHOD 2 : Talsma and Hallam Method (recommended for low Ks only <2.9)

q (cm3/min)	2692.8		2608.3	cm3/min	3220.8	cm3/min
r (cm)	4		4.0	cm	4.0	cm
H (cm)	10.0		10.0	cm	10.0	cm
$0.5\sinh^{-1}(H/2r)$	0.52		0.52		0.52	
-sqrt((r/H)^2+0.25)	-0.64		-0.64		-0.64	
r/H	0.40		0.40		0.40	
Sum	0.28		0.28		0.28	
Sum*4.4*q	3358.81		3253.44		4017.40	
$2*pi*H^2$	628.32		628.32		628.32	
Ksat (cm/min)	5.3		5.2		6.4	
Ksat (m/day)	76.98		74.56		92.07	

Average (m/day) **81.20**

Borehole Permeameter : Field Result Analysis

Project/Site	Smiths Beach Site HS2 (Behind Beach Resort)	
Soil Descrip	Dark brown sand fine	
Location	315860	mE
	6273478	mN

TEST 1

r	4.0	cm
H	20.0	cm
time step	10	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**6.5**	
10	**17.2**	10.7
20	**24.1**	6.9
30	**31.5**	7.4
40	**40.7**	9.2
50	**48.0**	7.3
60	**55.5**	7.5
70	**64.9**	9.4
80	**71.7**	6.8
		8.2
	q (cm^3/s)	7.2

TEST 2

r	4.0	cm
H	20.0	cm
time step	10	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**5.5**	
10	**15.1**	9.6
20	**22.1**	7.0
30	**32.0**	9.9
40	**39.5**	7.5
50	**46.6**	7.1
60	**55.0**	8.4
70	**62.6**	7.6
80	**70.0**	7.4
	Avg Diff (cm)	8.1
	q (cm^3/s)	7.1

TEST 3

r	4.0	cm
H	20.0	cm
time step	10	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**8.5**	
10	**19.5**	11.0
20	**26.0**	6.5
30	**33.5**	7.5
40	**43.5**	10.0
50	**51.0**	7.5
60	**61.0**	10.0
70	**69.5**	8.5
	Avg Diff (cm)	8.7
	q (cm^3/s)	7.7

METHOD 1 : Elrick and Reynolds (1992)

Ks (cm/s)	0.0046	Ks (cm/s)	0.0046	Ks (cm/s)	0.0049
Ks (m/day)	3.98	Ks (m/day)	3.94	Ks (m/day)	4.25

Average (m/day) **4.06**

METHOD 2 : Talsma and Hallam Method (recommended for low Ks only <2.9)

q (cm3/min)	430.3		425.7	cm3/min	460.1	cm3/min
r (cm)	4		4.0	cm	4.0	cm
H (cm)	20.0		20.0	cm	20.0	cm
$0.5\sinh^{-1}(H/2r)$	0.82		0.82		0.82	
-sqrt((r/H)^2+0.25)	-0.54		-0.54		-0.54	
r/H	0.20		0.20		0.20	
Sum	0.49		0.49		0.49	
Sum*4.4*q	918.49		908.63		982.08	
$2*pi*H^2$	2513.27		2513.27		2513.27	
Ksat (cm/min)	0.4		0.4		0.4	
Ksat (m/day)	5.26		5.21		5.63	

Average (m/day) **5.37**

Borehole Permeameter : Field Result Analysis

Project/Site	Smiths Beach Site HS4 (Uphill East)	
Soil Descrip	Reddish brown fine slightly loamy	
Location	315899	mE
	6273295	mN

TEST 1

r	4.0	cm
H	20.0	cm
time step	20	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**5.0**	
20	**8.5**	3.5
40	**12.3**	3.8
60	**15.0**	2.7
80	**18.2**	3.2
100	**21.5**	3.3
120	**25.0**	3.5
140	**28.5**	3.5
160	**32.0**	3.5
180	**33.6**	1.6
200	**37.0**	3.4
220	**40.2**	3.2
240	**43.7**	3.5
260	**47.3**	3.6
280	**50.9**	3.6
300	**54.5**	3.6
320	**56.2**	1.7
340	**60.0**	3.8
360	**63.5**	3.5
380	**65.0**	1.5
400	**69.0**	4.0
420	**73.0**	4.0
440	**74.9**	1.9
		3.2
	q (cm^3/s)	1.4

TEST 2

r	4.0	cm
H	20.0	cm
time step	20	secs
H/r	5.00	
C	1.67	

Time (sec)	Level (cm)	Diff (cm)
0	**9.0**	
20	**14.7**	5.7
40	**17.5**	2.8
60	**20.2**	2.7
80	**23.0**	2.8
100	**25.7**	2.7
120	**28.8**	3.1
140	**31.5**	2.7
160	**34.0**	2.5
180	**36.3**	2.3
200	**42.0**	5.7
220	**44.3**	2.3
240	**47.3**	3.0
260	**50.5**	3.2
280	**53.4**	2.9
300	**56.2**	2.8
320	**56.2**	0.0
340	**58.6**	2.4
360	**61.5**	2.9
380	**64.5**	3.0
400	**67.3**	2.8
420	**70.0**	2.7
440	**72.2**	2.2
460	**75.0**	2.8
	Avg Diff (cm)	2.9
	q (cm^3/s)	1.3

METHOD 1 : Elrick and Reynolds (1992)

Ks (cm/s)	0.0009	Ks (cm/s)	0.0008
Ks (m/day)	0.78	Ks (m/day)	0.70
Average (m/day)	**0.7**		

METHOD 2 : Talsma and Hallam Method (for low Ks only <2.9)

q (cm3/min)	83.9		75.8	cm3/min
r (cm)	4		4.0	cm
H (cm)	20.0		20.0	cm
$0.5\sinh^{-1}(H/2r)$	0.82		0.82	
-sqrt((r/H)^2+0.25)	-0.54		-0.54	
r/H	0.20		0.20	
Sum	0.49		0.49	
Sum*4.4*q	179.04		161.70	
$2*pi*H^2$	2513.27		2513.27	
Ksat (cm/min)	0.1		0.1	
Ksat (m/day)	1.03		0.93	
Average (m/day)	**1.0**			

APPENDIX E
Pre Development Flow Estimation

RFFE About Limitations Publications Acknowledgments Changelog Logged in as

Regional Flood Frequency Estimation Model

Release Version of the Regional Flood Frequency Estimation Model for the 4th edition of Australian Rainfall and Runoff.

Australian Rainfall & Runoff

Input Data

Basic Advanced

Catchment Name

Smiths Beach

Catchment Outlet Latitude

-33.6614

Catchment Outlet Longitude

115.0124

Catchment Centroid Latitude

-33.66680

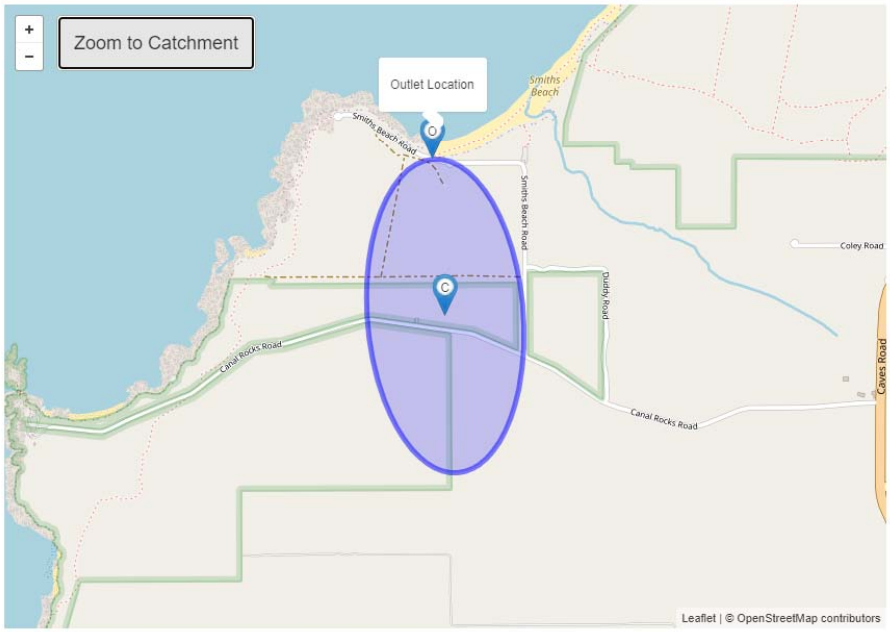
Catchment Centroid Longitude

115.01291

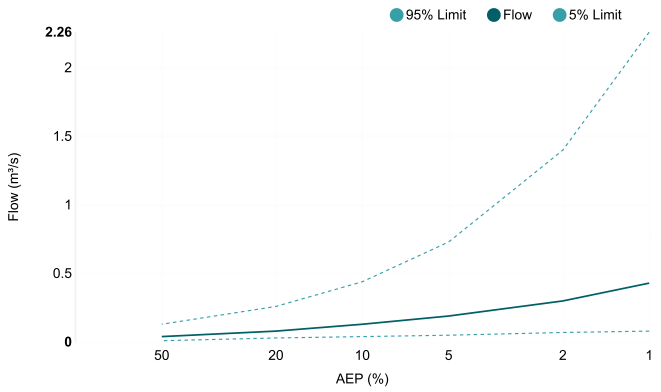
Catchment Area (km²)

0.557

Submit



Results | Regional Flood Frequency Estimation Model



AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
50	0.0400	0.0100	0.130
20	0.0800	0.0300	0.260
10	0.130	0.0400	0.440
5	0.190	0.0500	0.730
2	0.300	0.0700	1.40
1	0.430	0.0800	2.26

Input Data	
Date/Time	2021-06-04 18:08
Catchment Name	Smiths Beach
Latitude (Outlet)	-33.6614
Longitude (Outlet)	115.0124
Latitude (Centroid)	-33.6668
Longitude (Centroid)	115.01291
Catchment Area (km^2)	0.557
Distance to Nearest Gauged Catchment (km)	15.43
50% AEP 6 Hour Rainfall Intensity (mm/h)	6.743621
2% AEP 6 Hour Rainfall Intensity (mm/h)	14.250703
Rainfall Intensity Source (User/Auto)	Auto
Region	SW WA
Region Version	RFFE Model 2016 v1
Region Source (User/Auto)	Auto
Shape Factor	0.81
Interpolation Method	Natural Neighbour
Bias Correction Value	-0.883

Statistics

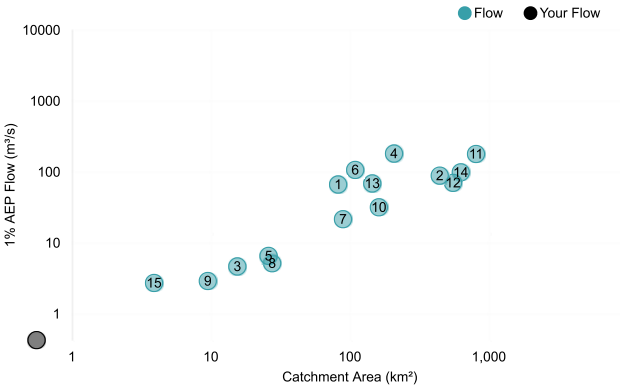
Variable	Value	Standard Dev
Mean	-3.246	0.658
Standard Dev	0.749	0.349
Skew	0.394	0.091

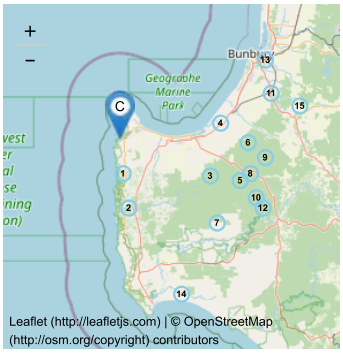
Note: These statistics come from the nearest gauged catchment. Details.

Correlation		
1.000		
-0.280	1.000	
-0.050	-0.070	1.000

Note: These statistics are common to each region. Details.

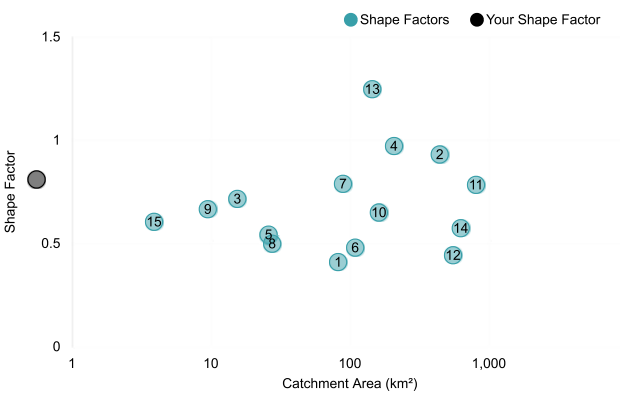
1% AEP Flow vs Catchment Area



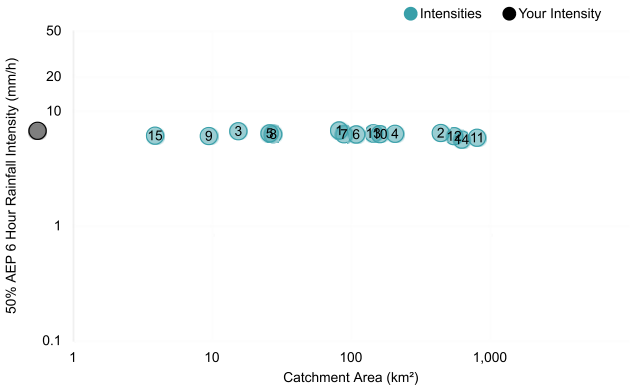


Shape Factor vs Catchment Area

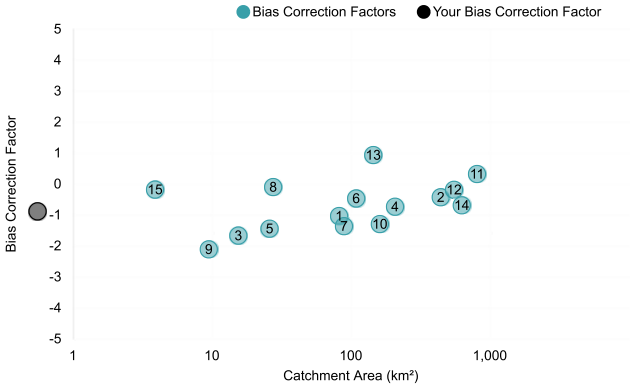
Note: This region does not use shape factors



Intensity vs Catchment Area



Bias Correction Factor vs Catchment Area



Download

TXT Nearby JSON

Method by Dr Ataur Rahman and Dr Khaled Haddad from Western Sydney University for the Australian Rainfall and Runoff Project. Full description of the project can be found at the project page (http://arr.ga.gov.au/revision-projects/project-list/projects/project-5) on the ARR website. Send any questions regarding the method or project here (mailto:admin@arr-software.org).

ENGINEERS AUSTRALIA (http://www.engineersaustralia.org.au)

WESTERN SYDNEY UNIVERSITY (http://www.uws.edu.au)

APPENDIX F
Laboratory Water Quality Testing

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 258675

Client Details

Client	Hyd2O
Attention	Sasha Martens
Address	Suite 6B, 103 Rokeby Rd, Subiaco, WA, 6008

Sample Details

Your Reference	**H19053 - H20045 Smith**
Number of Samples	1 Water
Date samples received	15/03/2021
Date completed instructions received	15/03/2021

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	22/03/2021
Date of Issue	22/03/2021

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

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

Results Approved By
Heram Halim, Operations Manager

Authorised By

Michael Kubiak, Laboratory Manager

Miscellaneous Inorganics			
Our Reference			258675-1
Your Reference	UNITS	PQL	SBL1
Date Sampled			14/03/2021
Type of sample			Surface Water
Date prepared	-		15/03/2021
Date analysed	-		15/03/2021
pH	pH Units		8.1
Electrical Conductivity (EC)	µS/cm	1	3,600
Total Suspended Solids	mg/L	5	5

Nutrients in Water			
Our Reference	UNITS	PQL	258675-1
Your Reference			SBL1
Date Sampled			14/03/2021
Type of sample			Surface Water
Date prepared	-		15/03/2021
Date analysed	-		15/03/2021
Total Nitrogen	mg/L	0.1	6.6
Ammonia as N	mg/L	0.005	0.093
Nitrate as N	mg/L	0.005	<0.005
Nitrite as N	mg/L	0.005	<0.005
Total Kjeldahl Nitrogen	mg/L	0.1	6.6
NOx as N	mg/L	0.005	<0.005
Total Phosphorus	mg/L	0.05	0.08
Phosphate as P	mg/L	0.005	<0.005

Metals in Water - Low Level			
Our Reference	UNITS	PQL	258675-1
Your Reference			SBL1
Date Sampled			14/03/2021
Type of sample			Surface Water
Date prepared	-		19/03/2021
Date analysed	-		19/03/2021
Arsenic-Dissolved	mg/L	0.001	0.002
Cadmium-Dissolved	mg/L	0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.017
Lead-Dissolved	mg/L	0.001	<0.001
Mercury-Dissolved	mg/L	0.00005	<0.00005
Nickel-Dissolved	mg/L	0.001	<0.001
Zinc-Dissolved	mg/L	0.001	0.011

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-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The solids are dried at 104±5°C
INORG-055	Nitrite - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrate - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
INORG-057	Ammonia by colourimetric analysis based on APHA latest edition 4500-NH3 F.
INORG-060	Phosphate- determined colourimetrically. Soils are analysed from a water extract.
INORG-062	TKN by calculation from Total Nitrogen and NOx using APHA methodology.
INORG-110	Total Nitrogen by high temperature catalytic combustion with chemiluminescence detection. Dissolved/Total Carbon and Dissolved/Total Organic and Inorganic Carbon by high temperature catalytic combustion with NDIR
METALS-020	Determination of various metals by ICP-AES.
METALS-021	Determination of Mercury by Cold Vapour AAS. For urine samples total Mercury is determined, however, mercury in urine is almost entirely in the inorganic form (CDC).
METALS-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			15/03/2021	1	15/03/2021	15/03/2021		15/03/2021	[NT]
Date analysed	-			15/03/2021	1	15/03/2021	15/03/2021		15/03/2021	[NT]
pH	pH Units		INORG-001	[NT]	1	8.1	[NT]		102	[NT]
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	1	3600	[NT]		103	[NT]
Total Suspended Solids	mg/L	5	INORG-019	<5	1	5	5	0	94	[NT]

QUALITY CONTROL: Nutrients in Water					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			15/03/2021	[NT]	[NT]	[NT]	[NT]	15/03/2021	[NT]
Date analysed	-			15/03/2021	[NT]	[NT]	[NT]	[NT]	15/03/2021	[NT]
Total Nitrogen	mg/L	0.1	INORG-110	<0.1	[NT]	[NT]	[NT]	[NT]	96	[NT]
Ammonia as N	mg/L	0.005	INORG-057	<0.005	[NT]	[NT]	[NT]	[NT]	105	[NT]
Nitrate as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	[NT]	[NT]	103	[NT]
Nitrite as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	[NT]	[NT]	110	[NT]
Total Kjeldahl Nitrogen	mg/L	0.1	INORG-062	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
NOx as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	[NT]	[NT]	103	[NT]
Total Phosphorus	mg/L	0.05	METALS-020	<0.05	[NT]	[NT]	[NT]	[NT]	88	[NT]
Phosphate as P	mg/L	0.005	INORG-060	<0.005	[NT]	[NT]	[NT]	[NT]	120	[NT]

QUALITY CONTROL: Metals in Water - Low Level						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			19/03/2021	[NT]	[NT]	[NT]	[NT]	19/03/2021	[NT]
Date analysed	-			19/03/2021	[NT]	[NT]	[NT]	[NT]	19/03/2021	[NT]
Arsenic-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	[NT]	[NT]	105	[NT]
Cadmium-Dissolved	mg/L	0.0001	METALS-022	<0.0001	[NT]	[NT]	[NT]	[NT]	103	[NT]
Chromium-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	[NT]	[NT]	102	[NT]
Copper-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	[NT]	[NT]	105	[NT]
Lead-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	[NT]	[NT]	105	[NT]
Mercury-Dissolved	mg/L	0.00005	METALS-021	<0.00005	[NT]	[NT]	[NT]	[NT]	104	[NT]
Nickel-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	[NT]	[NT]	106	[NT]
Zinc-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	[NT]	[NT]	105	[NT]

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

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.

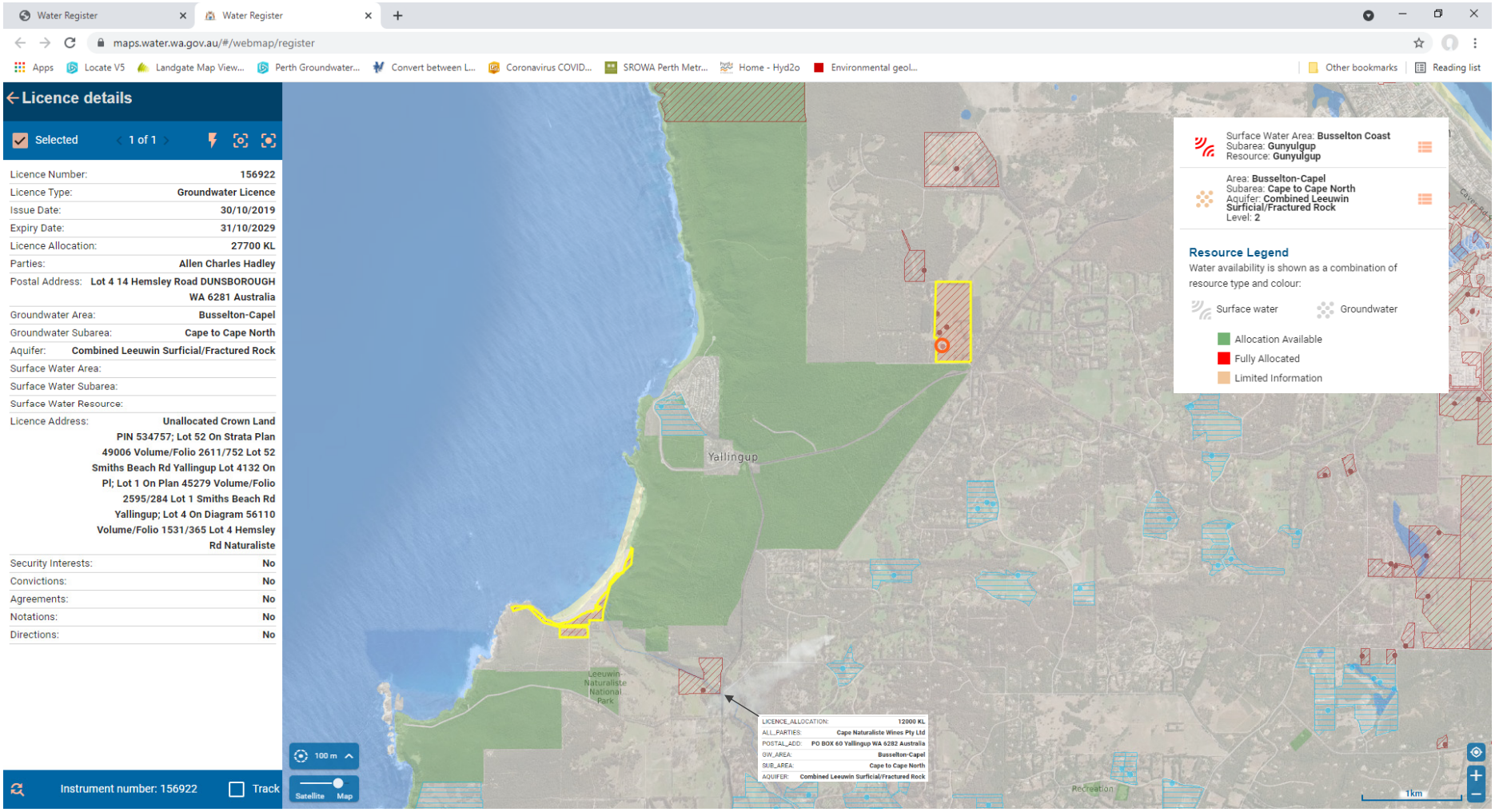
Measurement Uncertainty estimates are available for most tests upon request.

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.

DA APPENDIX O - Engineering Report (Stantec)

APPENDIX H
Water Register Extracts

DWER WATER REGISTER EXTRACTS



APPENDIX I
Post Development Runoff Rate Estimation

CURRV

Calculator for Urban Runoff Rates & Volumes

09-09-21

	Land Use Description	Area (ha)	Use in Calc	Imperv Initial Loss mm	Perv Initial Loss mm	Perv Continue Loss mm/hr	On Site Soak (mm)	Empty (days)	AR&R EIA/TIA System Connect Ratio	Roof %	Ext Imp %	Ext Perv %	Comment
1	A: Holiday Homes / Camping	7.97	Yes	1.5	28.0	4.1	15.0	0.25	40%	20	5	75	Inclusive of impervious and pervious areas
2	A: Holiday Homes / Camping: Shallow Rock & Clay Area	3.25	Yes	1.5	14.0	1.5	0.0	1.00	70%	20	5	75	Inclusive of impervious and pervious areas
3	A: Private Road / Carpark	3.89	Yes	1.5	28.0	4.1	0.0	1.00	95%	0	70	30	Total road reserve inclusive of pervious shoulders
4	A: Vegetation : Sand Area	7.23	Yes	1.5	28.0	4.1	0.0	1.00	30%	0	0	100	Based on calibrated pre development model
5	A: Vegetation : Shallow Rock & Clay Area	2.53	Yes	1.5	14.0	1.5	0.0	1.00	65%	0	0	100	Based on calibrated pre development model
6	B: Community Hub	0.66	Yes	1.5	28.0	4.1	0.0	1.00	60%	70	15	15	Inclusive of impervious and pervious areas
7	C: Hotel Complex	0.83	Yes	1.5	28.0	4.1	0.0	1.00	100%	90	10	0	Impervious portion (roof/paving) of site only
8	C: Vegetation : Shallow Rock & Clay Area	2.03	Yes	1.5	14.0	1.5	0.0	1.00	65%	0	0	100	Based on calibrated pre development model
9	D: Upstream Catchment : Road	0.97	Yes	1.5	28.0	4.1	0.0	1.00	95%	0	70	30	Based on calibrated pre development model
10	D: Upstream Catchment Vegetation	23.45	Yes	1.5	28.0	4.1	0.0	1.00	30%	0	0	100	Based on calibrated pre development model

EIA : Effective Impervious Area, TIA : Total Impervious Area

hyd2o HYDROLOGY

Project: H20045 Smiths Beach Yallingup

Rainfall IFD Data

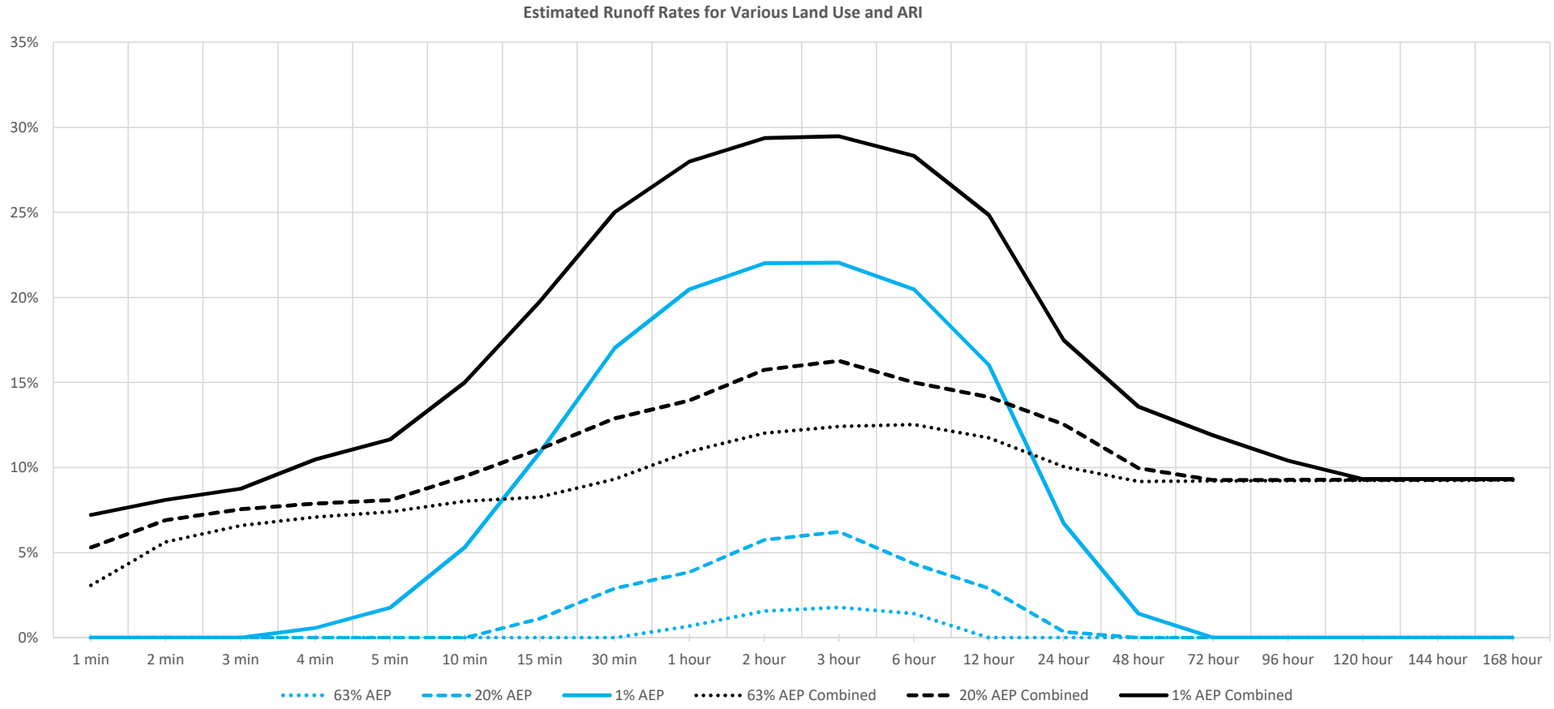
Annual Exceedence Probability

	Duration	63.2% 1.00	50% 1.44	20% 4.48	10% 10	5% 20	2% 50	1% 100
1	1 min	2.23	2.52	3.45	4.11	4.78	5.70	6.44
2	2 min	3.74	4.17	5.66	6.77	7.96	9.59	10.90
3	3 min	5.03	5.63	7.64	9.13	10.70	12.80	14.60
4	4 min	6.11	6.86	9.35	11.20	13.00	15.60	17.70
5	5 min	7.05	7.93	10.80	12.90	15.00	18.00	20.30
6	10 min	10.3	11.7	16.0	19.1	22.1	26.3	29.7
7	15 min	12.4	14.0	19.3	23.0	26.7	31.8	35.8
8	30 min	16.2	18.2	25.0	29.8	34.7	41.6	47.0
9	1 hour	20.4	22.8	31.0	37.0	43.2	52.0	59.1
10	2 hour	25.5	28.4	38.0	45.2	52.8	63.4	72.3
11	3 hour	29.2	32.3	42.9	50.9	59.2	71.0	80.7
12	6 hour	36.7	40.5	53.1	62.4	72.0	85.7	97.0
13	12 hour	45.7	50.3	65.5	76.3	87.2	103.0	116.0
14	24 hour	55.7	61.3	79.3	91.8	104.0	122.0	137.0
15	48 hour	66.6	73.1	93.6	108.0	122.0	143.0	159.0
16	72 hour	74.2	81.0	103.0	118.0	133.0	155.0	172.0
17	96 hour	81.0	88.2	111.0	127.0	142.0	164.0	180.0
18	120 hour	87.8	95.4	119.0	135.0	150.0	171.0	187.0
19	144 hour	95.0	103.0	127.0	143.0	158.0	178.0	192.0
20	168 hour	103.0	111.0	136.0	152.0	166.0	184.0	196.0

Land Use Graph Selector	1

(11 - combined total)

A: Holiday Homes / Camping



Estimated Runoff Rates

Annual Exceedence Probability

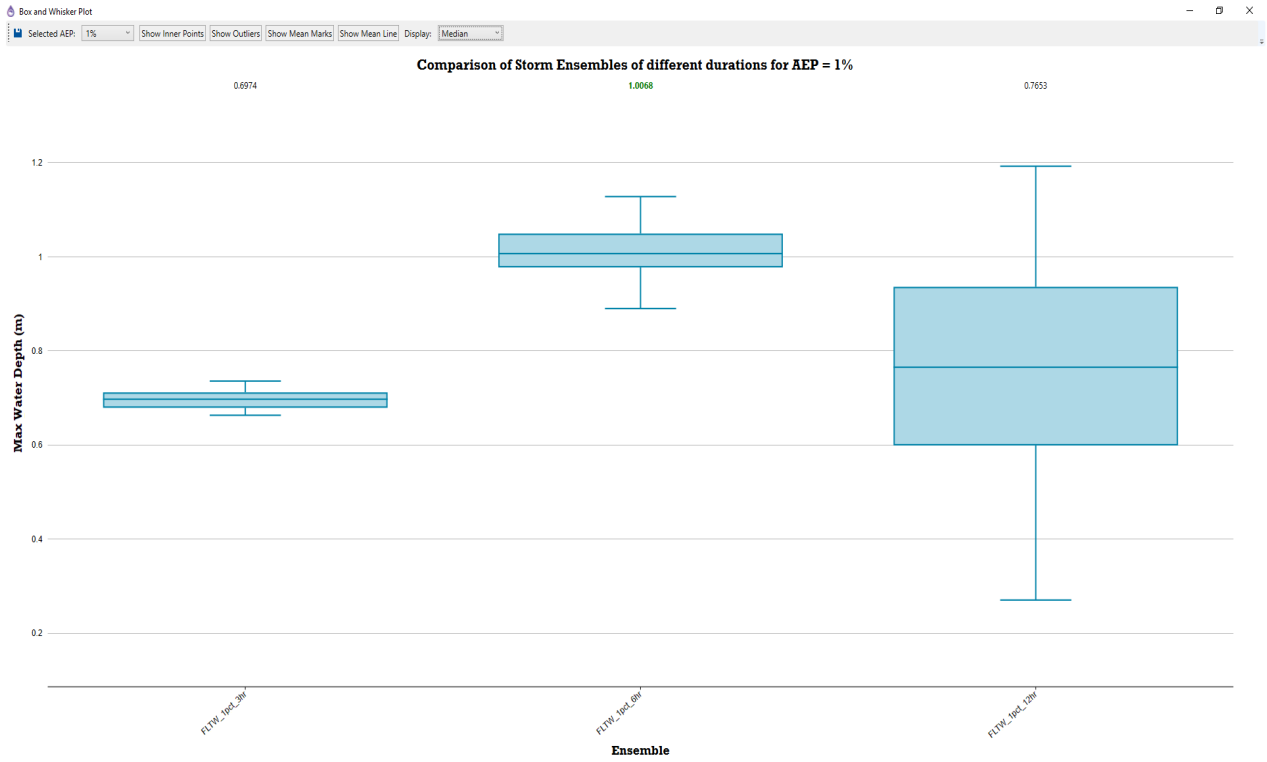
	63.2%	50%	20%	10%	5%	2%	1%
Maximum of All Events	1.00	1.44	4.48	10	20	50	100
A: Holiday Homes / Camping	2%	3%	6%	12%	16%	20%	22%
omes / Camping: Shallow Rock & Clay Area	36%	40%	47%	50%	53%	56%	58%
A: Private Road / Carpark	66%	66%	66%	70%	74%	77%	80%
A: Vegetation : Sand Area	0%	0%	2%	6%	10%	13%	15%
A: Vegetation : Shallow Rock & Clay Area	24%	28%	37%	41%	45%	48%	50%
B: Community Hub	50%	50%	50%	51%	53%	54%	55%
C: Hotel Complex	99%	99%	99%	99%	99%	99%	99%
C: Vegetation : Shallow Rock & Clay Area	24%	28%	37%	41%	45%	48%	50%
D: Upstream Catchment : Road	66%	66%	66%	70%	74%	77%	80%
D: Upstream Catchment Vegetation	0%	0%	2%	6%	10%	13%	15%
combined total	13%	13%	16%	21%	24%	27%	29%

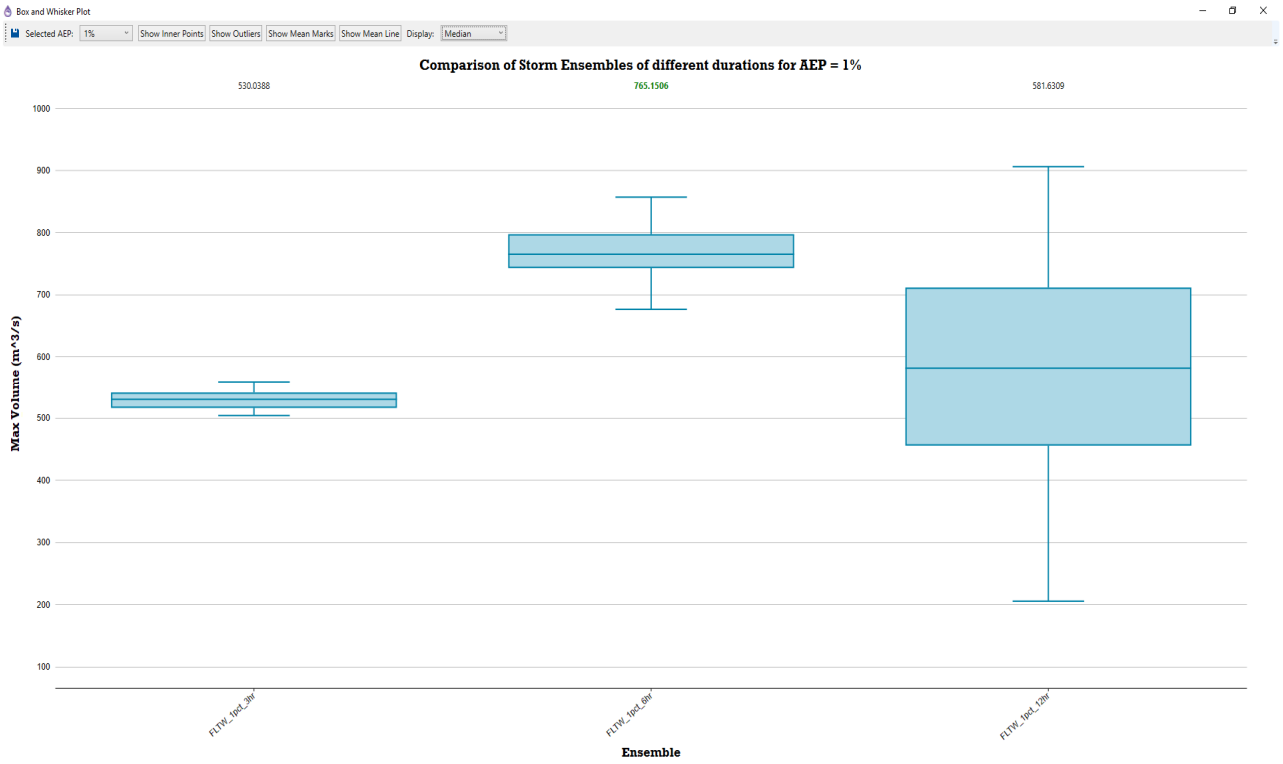
Event Selector	8	30 min					
A: Holiday Homes / Camping	0%	0%	3%	4%	9%	14%	17%
omes / Camping: Shallow Rock & Clay Area	21%	26%	38%	43%	47%	51%	53%
A: Private Road / Carpark	60%	61%	63%	63%	67%	72%	75%
A: Vegetation : Sand Area	0%	0%	0%	0%	4%	8%	11%
A: Vegetation : Shallow Rock & Clay Area	6%	12%	27%	33%	37%	42%	45%
B: Community Hub	46%	47%	48%	48%	50%	52%	53%
C: Hotel Complex	91%	92%	94%	95%	96%	96%	97%
C: Vegetation : Shallow Rock & Clay Area	6%	12%	27%	33%	37%	42%	45%
D: Upstream Catchment : Road	60%	61%	63%	63%	67%	72%	75%
D: Upstream Catchment Vegetation	0%	0%	0%	0%	4%	8%	11%

APPENDIX J
PONDS Modelling Outputs

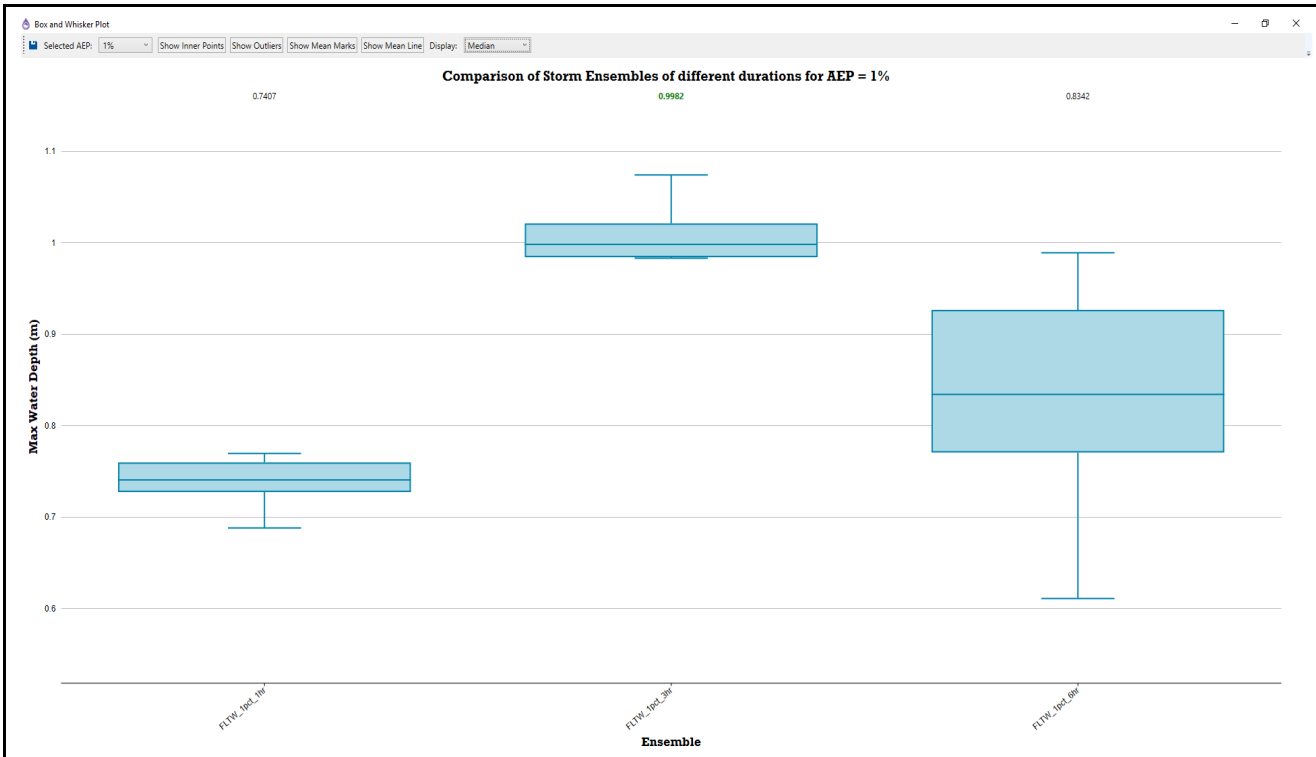
SUMMARY OF INDIVIDUAL MODELLED STORAGE AREAS & VOLUMES

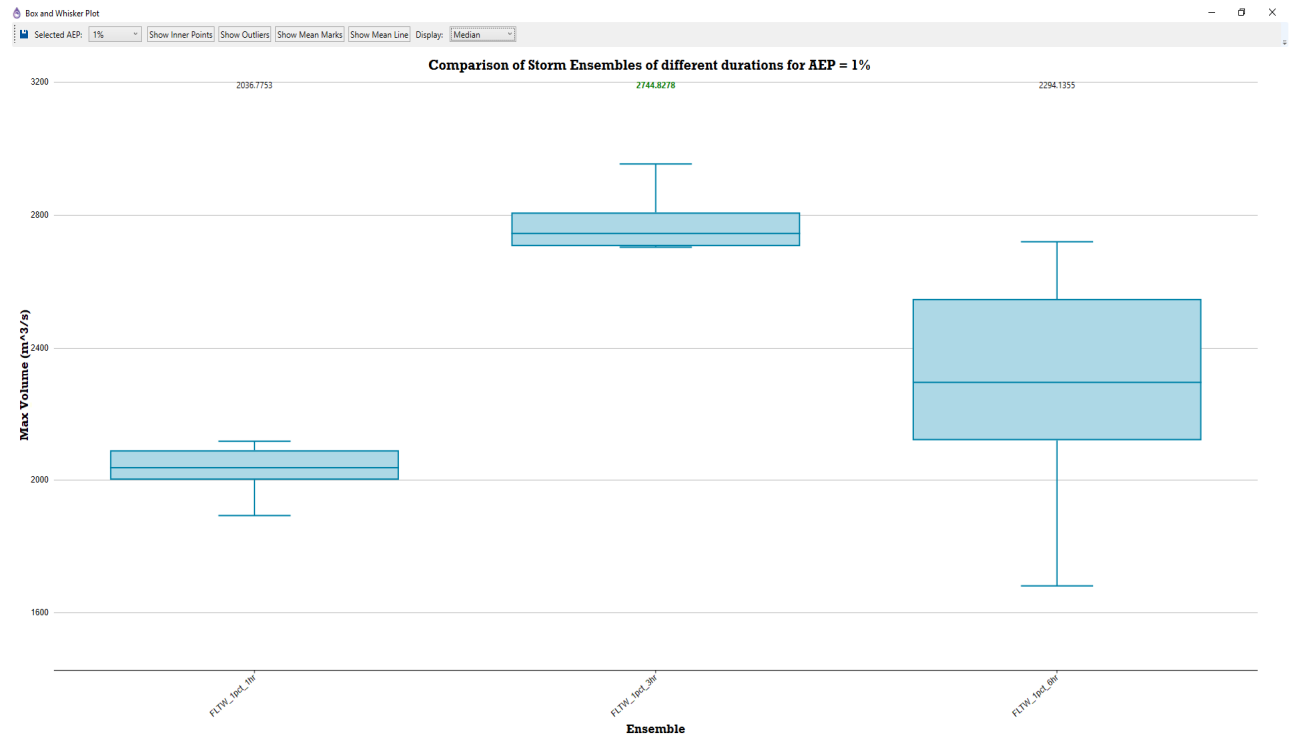
StorageID	Type	Base Area (m2)	TWL Area (m2)	Volume (m3)
BA1	Bioretention Area	20	56	11
BA2	Bioretention Area	15	42	9
BA3	Bioretention Area	15	42	9
BA4	Bioretention Area	16	45	10
BA5	Bioretention Area	16	45	10
BA6	Bioretention Area	16	45	10
BA7	Bioretention Area	28	78	16
BA8	Bioretention Area	300	480	117
BS1	Bioretetion Swale	35	121	27
BS2	Bioretetion Swale	169	583	132
BS3	Bioretetion Swale	154	531	120
BS4	Bioretetion Swale	42	145	33
BS5	Bioretetion Swale	79	273	62
BS6	Bioretetion Swale	52	179	41
BS7	Bioretetion Swale	130	449	101
BS8	Bioretetion Swale	275	949	214
BS9	Bioretetion Swale	50	173	39
5YrA	20% AEP Underground Storage	8	8	8
5YrB	20% AEP Underground Storage	7.5	7.5	7.5
5YrC	20% AEP Underground Storage	7.5	7.5	7.5
5YrD	20% AEP Underground Storage	9	9	9
5YrE	20% AEP Underground Storage	9	9	9
5YrF	20% AEP Underground Storage	9	9	9
100YrA	1% AEP Underground Storage	2750	2750	2750
100YrB	1% AEP Underground Storage	760	760	760
100YrC	1% AEP Underground Storage	280	280	280
TOTAL		**5252**	**8075**	**4798**





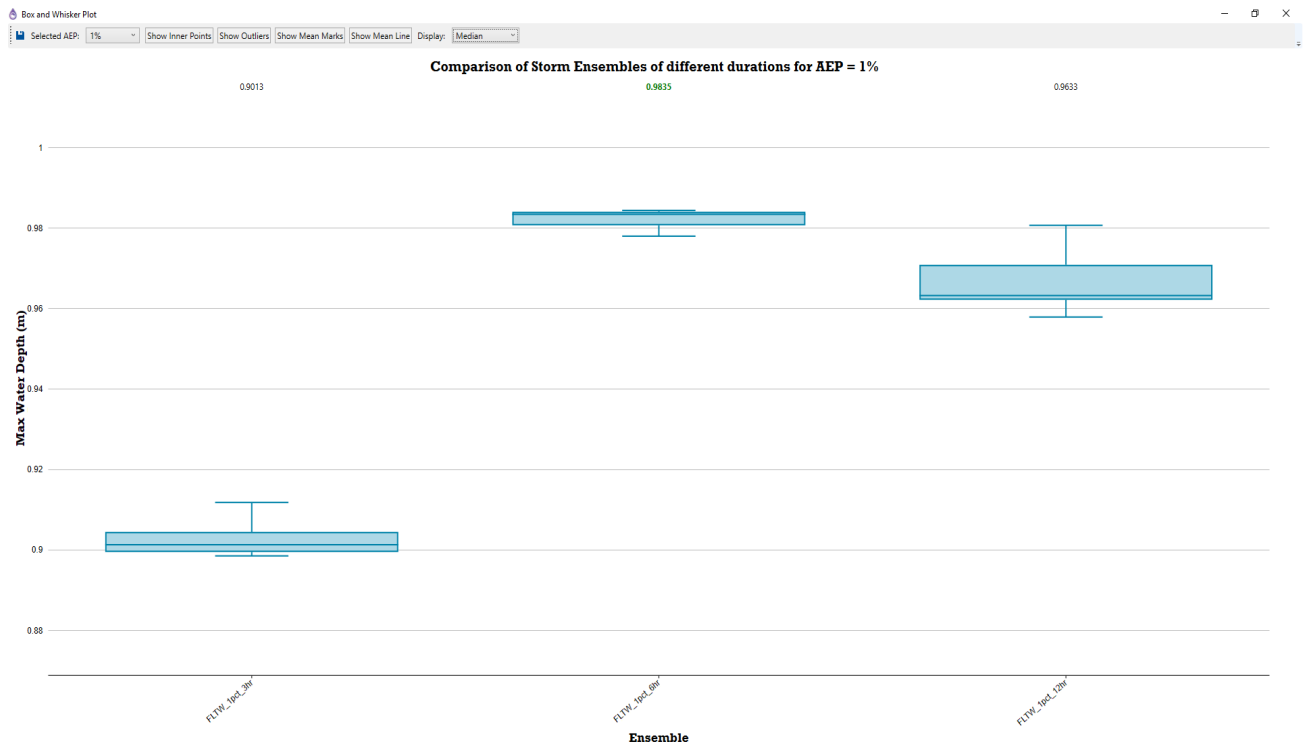
XP Storm modelling key parameters
1m storage depth
760 m3 max storage volume
5 m/d permeablity rate
Retained veg - 15% runoff , 0.35 mannings
private road - 80% runoff, 0.015 mannings

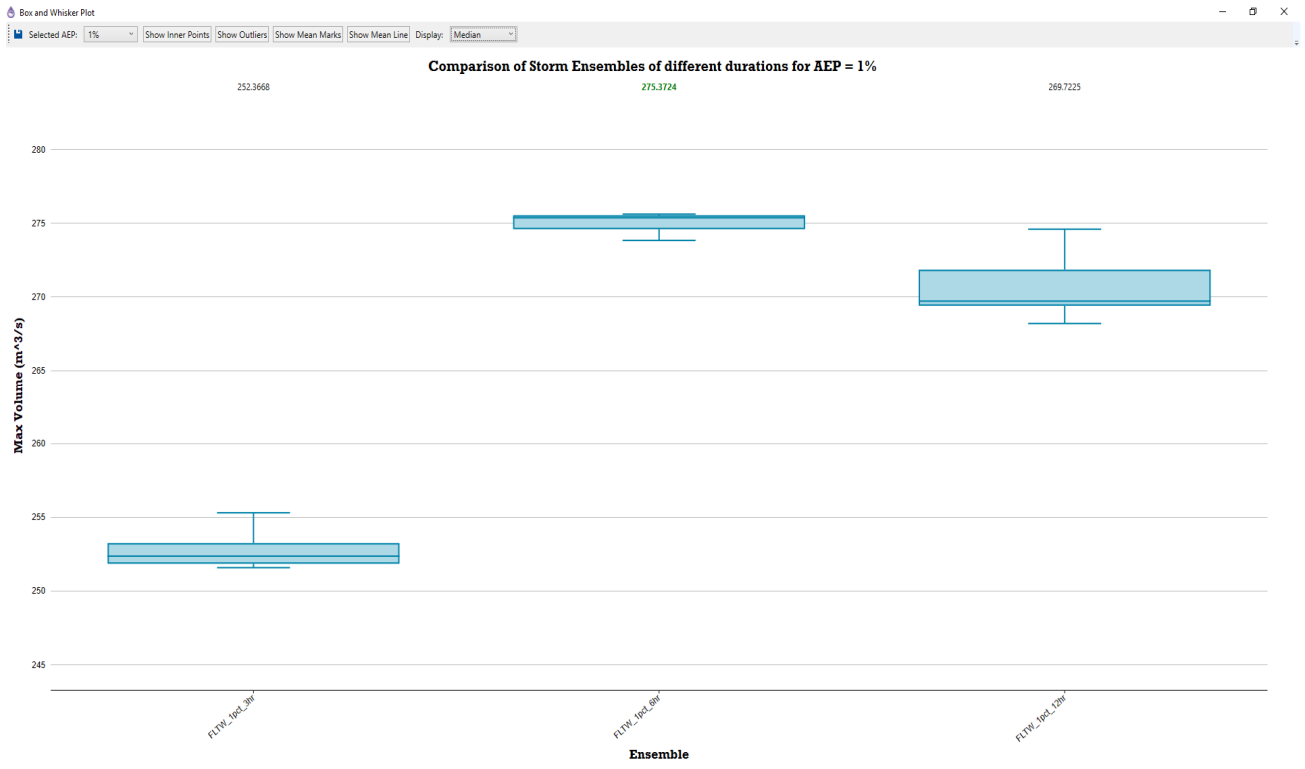




XP Storm modelling key parameters
1m storage depth
2750 m3 max storage volume
5 m/d permeablity rate
lots - 25% runoff, 0.25 mannings
lots over shallow rock and clay - 58% runoff, 0.15 mannings
private road - 80% runoff, 0.015 mannings
retained veg - 15% runoff, 0.35 mannings
retained veg over shallow rock and clay - runoff 50%, 0.25 mannings

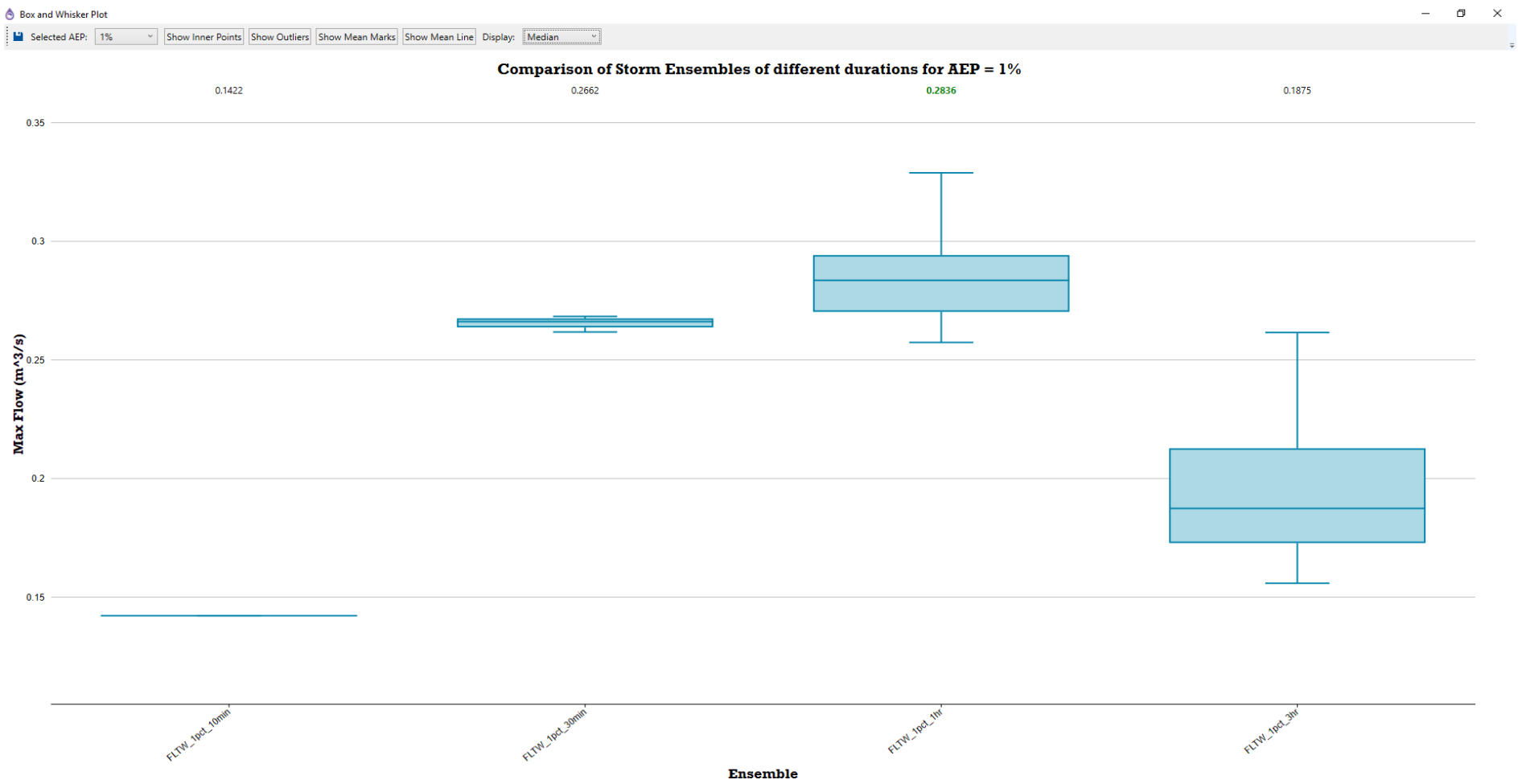
Date: 8/09/2021 Job No. H20045





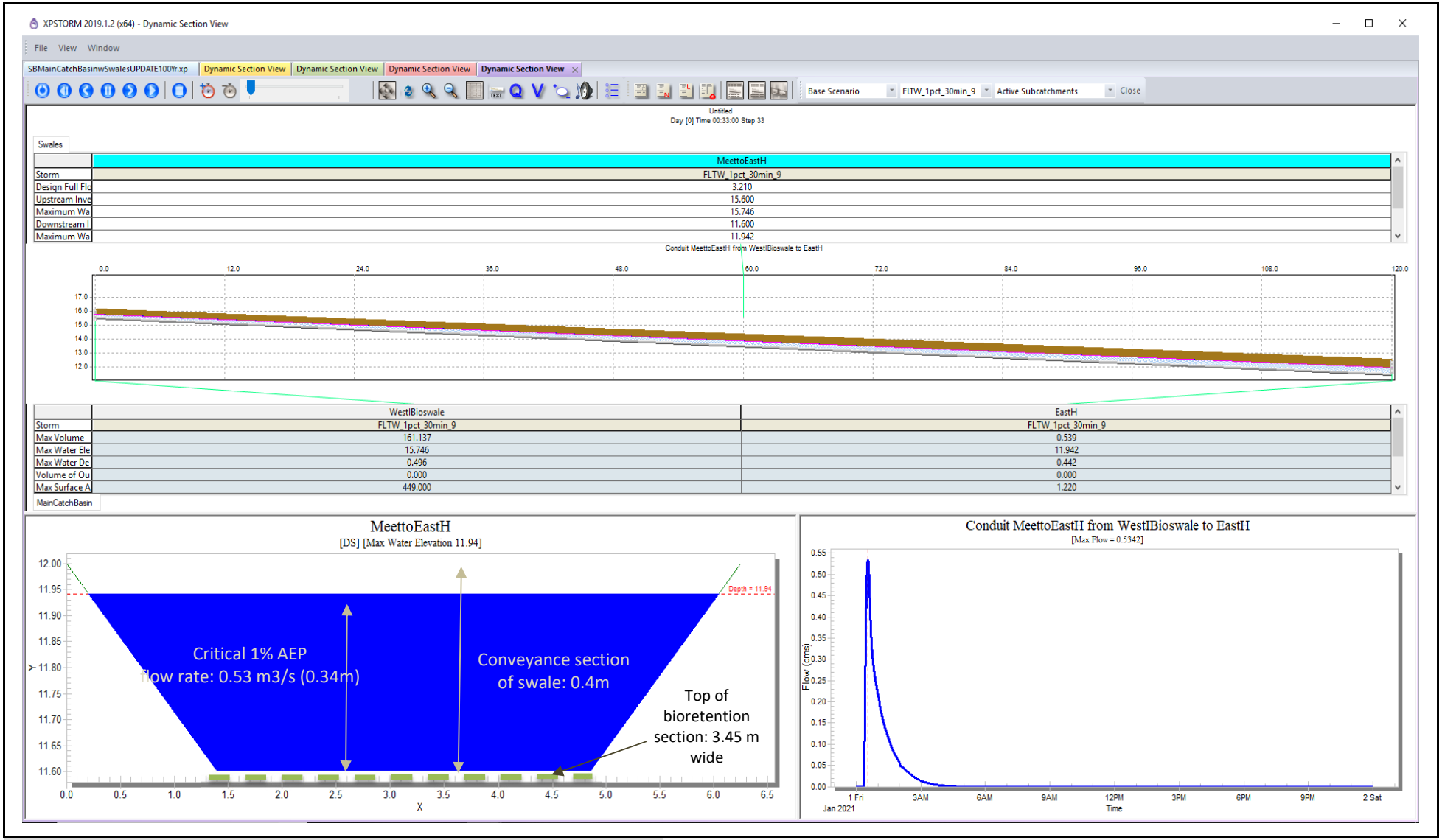
XP Storm modelling key parameters
1m storage depth
280 m3 max storage volume
1 m/d permeablity rate
55% runoff
0.016 mannings (composite)

Date : 16/6/2021 Job No: H20045



XP Storm modelling key parameters
65% runoff (composite shallow rock vegetation/hotel complex)
0.018 mannings (composite)

Date : 8/9/2021 Job No: H20045



hyd2o

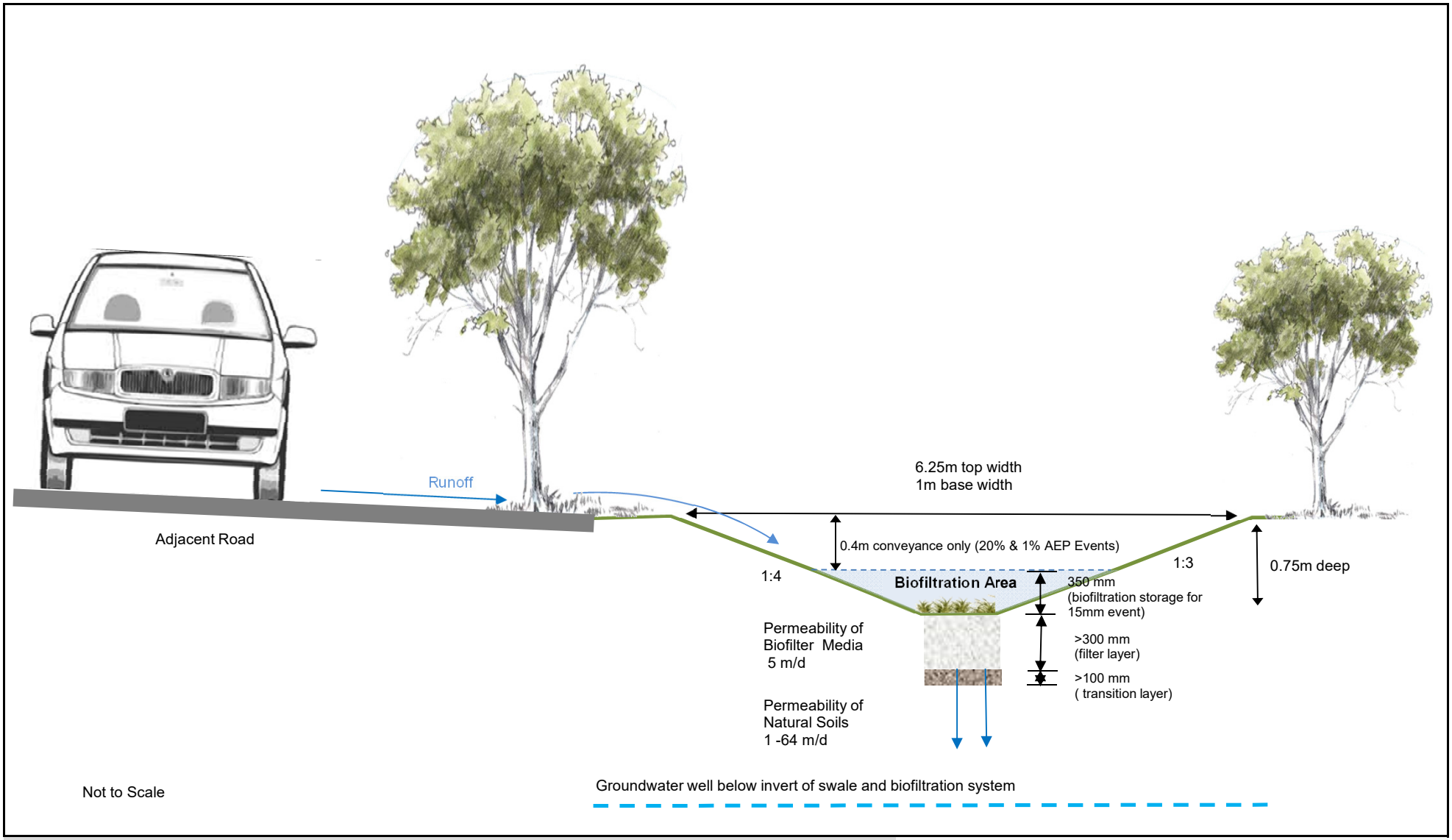
Smiths Beach Urban Water Management Plan

XP-Storm 1% AEP Event Road Swale Conveyance Section: Bioretention Swale 7

Appendix J

APPENDIX K
Indicative Storage Cross Sections

Date: 09/09/2021 Job No H20045



Swale cross section shown indicative for modelling purposes
Actual flood depth and width may vary based on location within network and contributing catchment
Biofilter media below swale may not be possible in shallow rock areas - these areas operate as conveyance systems only
Rock pitched weirs or crossover culverts to be used within swales to reduce velocities and detain flows

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Smiths Beach Urban Water Management Plan

Typical Two Way Road Reserve Swale Cross Section

Appendix K