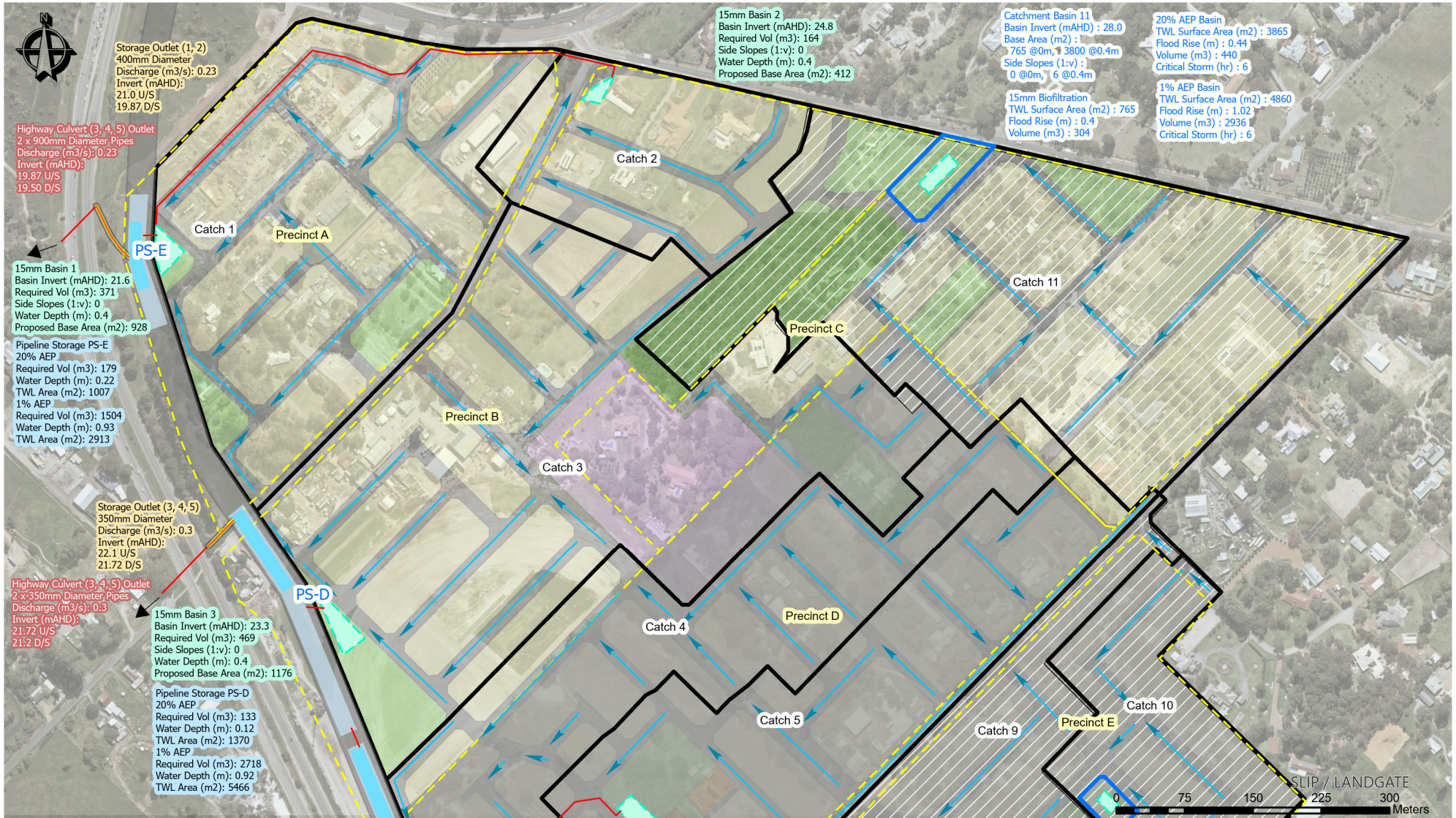
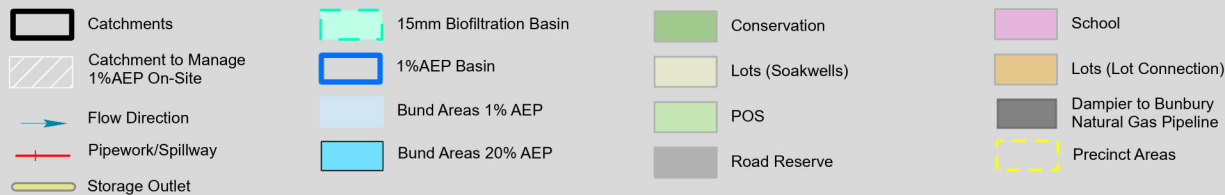
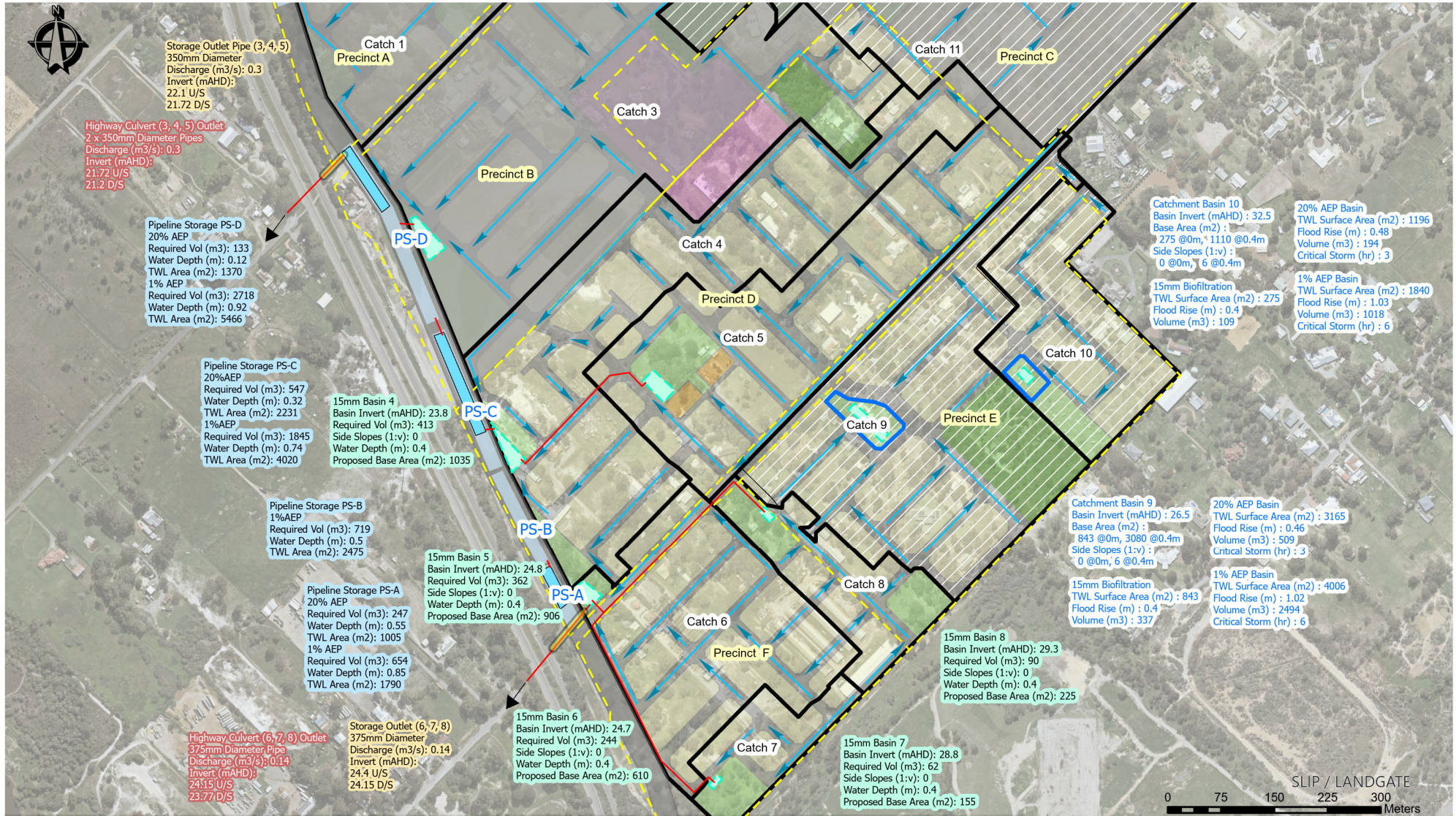




hydo
Wattle Grove South Local Water Management Strategy
Stormwater Management Plan: Precinct A, B & C
Figure 14a





Site
 Precinct Areas
 Groundwater Monitoring Bores
 Surface Water Monitoring Sites

Key Assessment Sites to be monitored for all precincts:

Groundwater Sites
 Surface Water Sites

0 125 250 375 500 Meters

hydo
 Wattle Grove South Local Water Management Strategy
Post Development Monitoring Program

Figure 15

APPENDIX A

LWMS Checklist

Better Urban Water Management Checklist

Local Water Management Strategy Item	Deliverable	✓	Comments
Executive summary			
Summary of the development design strategy, outlining how the design objectives are poposed to be met	Table 1: design elements and requirements for BMP's and critical control points	☑	Executive Summary and Strategy Table
Introduction			
Total water cycle management - principles and objectives Planning background Previous studies		☑	Chapter 1
Proposed development			
Structure plan, zoning and land use Key landscape features Previous land use	Site context plan Local structure plan Site conditions plan	☑	Chapter 2, Figures 1, 2 & 3
Landscape - proposed POS areas, POS credits, water source, bore(s), lake details (if applicable), irrigation areas	Landscape plan	☑	Appendix L. Stormwater Areas and Volumes to inform POS credits identified (Figure 14, Chapter 6). Water Availability identified (Section 5.2, Appendix K)
Design criteria			
Agreed design objective and source of objective		☑	Chapter 3
Pre-development environment			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		☑	Chapter 4
Site conditions- existing topography/ contours, aerial photo underlay, major physical features	Site condition plan	☑	Section 4.1, Figure 3
Geotechnical - topography, soils including acid sulfate soils and infiltration capacity, test pit locations	Geotechnical plan	☑	Section 4.2, Figure 4, Appendix B and C, Table 3
Environmental- areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental plan plus supporting data where appropriate	☑	Section 4.3, Figure 5
Surface water- topography, 100 year floodways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface water plan	☑	Section 4.4, Figures 6 & 7, Appendix I, Table 4
Groundwater - topography, pre development groundwater levels and water quality, test bore locations	Groundwater plan plus details of groundwater monitoring and testing	☑	Section 4.5, Figures 8, 9, 10, 11 & 12 Appendices from E to J Tables 6, 7 8 & 9
Water use sustainability initiatives			
Water efficiency measures- private and public open spaces including method of enforcement		☑	Section 5.1
Water supply (fit- for-purpose strategy), agreed actions and implementation. If non-potable supply, support with water balance		☑	Section 5.2, Appendix K
Wastewater management		☑	Section 5.3
Stormwater management strategy			
Flood protection - peak flow rates, volumes and top water levels at control points, 100 year flow paths and 100 year detentions storage areas	100yr event plan Long section of critical points	☑	Chapter 6, Table 11, Figures 13, 14a & 14b
Manage serviceability - storage and retention required for the critical 5 year ARI storm events Minor roads should be passable in the 5 year ARI event	5yr event plan	☑	Chapter 6, Table 11, Figures 13, 14a & 14b
Protect ecology - detention areas for the 1 yr 1 hr ARI event, areas for water quality treatment and types of (including indicative locations for) agreed structural and non-structural best management practices and treatment trains. Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages	1 yr event plan Typical cross sections	☑	Chapter 6, Table 11, Figures 13, 14a & 14b

Local Water Management Strategy Item	Deliverable	✓	Comments
Groundwater management strategy			
Post development groundwater levels, fill requirements (including existing and likely final surface levels), outlet controls, and subsoil areas/exclusion zones	Groundwater/subsoil Plan	☒	Section 7.1
Actions to adress acid sulphate soils or contamination		☒	Section 7.2
The next stage - subdivision and urban water management plans			
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required prior to detailed design		☒	Chapter 8
Monitoring			
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		☒	Chapter 9, Table 12, Figure 15
Implementation			
Developer commitments		☒	Chapter 10, Table 13
Roles, responsibilities, funding for implementation		☒	Chapter 10, Table 13
Review		☒	Chapter 10, Table 13

APPENDIX B

Geotechnical Report (Douglas Partners, 2020&2022)



Douglas Partners
Geotechnics | Environment | Groundwater

Report on
Preliminary Geotechnical Investigation

Proposed Wattle Grove Development
Precinct 1, Victoria Road, Wattle Grove

Prepared for
Hesperia Projects Pty Ltd

Project 96730.01
November 2020

Integrated Practical Solutions



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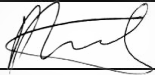
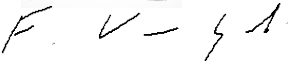
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		17 November 2020
Reviewer		17 November 2020



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Table of Contents

	Page
1. Introduction	1
2. Site Description	2
3. Field Work Methods	2
4. Field Work Results	3
4.1 Ground Conditions	3
4.2 Groundwater	5
4.3 Permeability	5
5. Laboratory Testing	5
6. Proposed Development.....	6
7. Comments.....	6
7.1 Site Suitability.....	6
7.2 Site Classification.....	7
7.3 Excavation Conditions.....	8
7.4 Site Preparation	9
7.4.1 Site Stripping	9
7.4.2 Proof Compaction.....	9
7.4.3 Re-use of Materials	10
7.4.4 Compaction	10
7.5 Pavement Design Parameters	11
7.6 Site Drainage and Reactive Materials	11
7.7 Acid Sulfate Soils	12
7.7.1 General Comments	12
7.7.2 Location 6.....	12
8. References.....	13
9. Limitations.....	13
 Appendix A: About This Report	
Appendix B: Drawing	
Appendix C: Field Work Results	
Appendix D: Laboratory Test Results	
Appendix E: CSRIO Note on Foundation Maintenance and Footing Performance	

Report on Preliminary Geotechnical Investigation

Proposed Wattle Grove Development

Precinct 1, Victoria Road, Wattle Grove

1. Introduction

This report presents the results of a preliminary geotechnical investigation undertaken for a proposed residential development located at Precinct 1, Victoria Road, Wattle Grove. The investigation was commissioned on 26 October 2020 by Judd Dyer of Hesperia Projects Pty Ltd and was undertaken in accordance with Douglas Partners' proposal forwarded by email dated 19 October 2020.

It is understood that the proposed Wattle Grove Development site includes a commercial precinct, medium density residential land-use, a primary school and public open space. The proposed entire Wattle Grove development covers an area of approximately 110 ha, however for the purposes of this preliminary investigation, access was provided to a selection of properties in the south-eastern part of the development area along Victoria Road and designated as Precinct 1.

The aim of the investigation was to assess the subsurface soil and groundwater conditions at selected accessible locations within the site, in order to provide some preliminary geotechnical comments on:

- The possible presence of fill materials, unsuitable foundation materials, rock or coffee rock and the distribution of clayey soils, if encountered.
- The thickness of sand and inputs to a ground model to assist with preliminary earthworks design assumptions.
- The site suitability and improvements that may be required to support the proposed development, and if significant variation in the ground conditions are anticipated.
- Key geotechnical risks and opportunities to the development, including the presence of unsuitable soils for development, and the depth of sand which could possibly be mined for re-use.
- The site classification in accordance with the requirements of AS 2870-2011, and the likely earthworks requirements in terms of sand fill thicknesses to improve the classification to achieve 'Class S' and 'Class A'.
- General site preparation requirements including comments on excavatability and earthworks to suitably prepare the ground for the proposed development.
- The suitability of the in situ material, from a geotechnical perspective, for re-use as structural fill, including the topsoil, sand, clay and uncontrolled fill.
- Parameters for pavement design, including a suitable California bearing ratio value based on field observations.
- The depth to groundwater and/or perched water.
- Permeability of the encountered soils at the site, to allow comments on stormwater disposal suitability, and general drainage conditions across the site.

The investigation included the excavation of 15 test pits, four infiltration tests and laboratory testing of selected samples. The details of the field work are presented in this report, together with comments and recommendations on the items listed above.

2. Site Description

The site of this preliminary geotechnical investigation comprises various accessible lots within Precinct 1 of the Wattle Grove Development area, situated along Victoria Road in Wattle Grove and covers an approximate area of 24 ha (refer to Drawing 1, Appendix B).

At the time of the investigation, the site generally comprised semi-rural residential lots with the exception of a disused poultry farm located towards the southern end of the site. Houses, sheds and other small structures occurred across the site along with several fenced paddocks. Abandoned machinery, hard wastes, and paved and gravel access tracks were observed within the lots at various locations. Vegetation generally consisted of short length grass and shrubs, with medium to tall sized trees.

Visual evidence of areas of fill, anticipated to be of an uncontrolled nature, and including variously granular, cohesive and organic soils, possibly with deleterious inclusions were noted in several areas of the site, along with some stockpiles and other mounds of soils.

The site surface levels generally fall to the west, with surface levels of approximately RL 36.5 m AHD in the east of the site falling to RL 22.7 m AHD in the west.

The Armadale 1:50,000 scale geological mapping which covers the site indicates the general area is underlain by (in a generally west to east direction):

- Bassendean Sand – white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to subrounded, of eolian origin.
- Thin Bassendean Sand over cohesive materials of the Guildford Formation – white to pale grey sand at surface, over alluvial deposits of sandy clay to clayey sand of the Guildford Formation.
- Sand (Yoganup Formation) - yellow, fine grained sand with minor silt and clay, subangular and medium to coarse grained quartz, of colluvial origin.

The Perth Groundwater Atlas (2004) indicates groundwater levels at the site were between RL 12.5 m AHD to RL 15.5 m AHD in May 2003 (i.e. over 10 m below the lowest level on the site).

Published acid sulfate soil risk mapping indicates the site is located within an area of moderate to low risk of acid sulfate soils occurring within 3.0 m of natural soil surface.

3. Field Work Methods

Field work for the investigation was carried out on 28 and 30 October 2020 and comprised:

- The excavation of 15 test pits (Locations 1 to 15).

- Perth sand penetrometer (PSP) testing adjacent to each test pit location.
- Four in situ infiltration tests (at Locations 3, 4, 9 and 11).

The test pits were excavated to a maximum depth of 2.9 m using a 5 tonne excavator attached with a 650 mm toothed bucket. Each test pit was logged in general accordance with AS 1726–2017 by an experienced Douglas Partners geotechnical engineer.

Perth sand penetrometer (PSP) tests were carried out adjacent to the test pits in accordance with AS 1289.6.3.3 to assess the in situ density of the shallow soils.

The infiltration tests were performed using the falling head method at depths of between 0.5 m and 1.0 m adjacent to test pit locations 3, 4, 9 and 11.

Test locations were determined using a handheld GPS and are marked on Drawing 1, Appendix B. Approximate surface elevations were obtained using publicly available LiDAR.

4. Field Work Results

4.1 Ground Conditions

Detailed logs of the ground conditions and results of the field testing are presented in Appendix C. Notes defining descriptive terms and classification methods are provided in Appendix A.

The ground conditions encountered within the test pits generally comprise:

- **Topsoil** – grey-brown, sandy topsoil with silt and roots, between 0.1 m to 0.15 m in thickness. The topsoil is fill at locations 1, 6 to 10 and 12 to 15. Overlying:
- **Bassendean Sand (light grey sand):**
 - o **SAND SP** – generally medium dense to dense, light grey sand, with trace silt encountered underlying the topsoil or surficial fill to depths of between 0.8 m and test pit termination depths of 2.5 m at test locations 3, 5, 7, 8 and 9. The depth to the base of the sand is provided in Table 1, below.
- **Yoganup Formation (yellow-brown sand with various fines content):**

The sand from the Yoganup Formation is yellow-brown and includes a fines content that increases with depth. When described based on its composition in accordance with AS 1726-2017, the sand is logged as ‘Sand trace silt and clay’ (up to 5% fines content) near surface, gradually transitioning with depth to ‘Sand with clay’ (5% to 12% fines content) and then ‘Clayey Sand’ (greater than 12% fines content):

 - o **SAND SP-SM** – generally medium dense to dense, light brown and yellow-brown sand, with low plasticity to non-plastic fines content of between approximately 5% to 12%, underlying topsoil or surficial fill at test locations 1, 2, 4, 5 and 10 to 15, and present below the Bassendean sand at location 3 from 0.8 m depth. Loose sand was encountered at location 1 to at least 1.0 m depth. Fines content typically increases with depth.
 - o **SAND/Clayey SAND SP-SC/SC** – yellow-brown sand with clay/clayey sand (approximately 12% and greater content of low plasticity fines) was encountered from depths of between 0.1 m

and 1.6 m extending to depths of between 0.6 m and termination depths of up to 2.5 m at locations 2 to 5, 10 to 12, 14 and 15.

- o **Clayey SAND SC** – yellow-brown low plasticity clayey sand was encountered from depths of between 0.6 m and 1.5 m extending to termination depths of up to 2.5 m at locations 1, 2, 4, 14 and 15.

The exceptions to the above profile are:

- **Fill** – various fill materials generally consisting of sand, silty sand, clayey sand and sandy clay/silt were encountered to depths of between 0.2 m and to test pit termination depth of 2.9 m at locations 1, 6 to 10 and 12 to 14. The fill variously included deleterious inclusions such as wood, brick, glass, concrete and plastic at locations 6, 8 and 13.
- **Coffee Rock** – brown, cemented silty sand excavated as gravelly sand, with silt and cobbles. Encountered from 1.1 m to 1.8 m and 1.8 m to 2.4 m at test locations 5 and 8, respectively.

Table 1: Summary of Depth of Sand

Test Location	Ground Surface Level ^[1] (m AHD)	Depth to Base of Sand (m)	Level of Base of Sand ^[2] (m AHD)	Description (Geological Unit)
1	32.4	1.2	31.2	Yellow-brown, with silt, SP-SM (Yoganup Formation)
3	30.1	0.8	29.3	Light grey, trace silt, SP (Bassendean Sand)
4	30.9	0.4	30.5	Light brown, with silt, SP-SM (Yoganup Formation)
5	25.7	1.1	24.6	Light grey, trace silt, SP (Bassendean Sand)
7	23.8	>2.5	<21.3	Light grey, trace silt, SP (Bassendean Sand)
8	25.7	>2.5	<23.2	Light grey, trace silt, SP (Bassendean Sand)
9	24.1	>2.5	<21.6	Light grey, trace silt, SP (Bassendean Sand)
11	31.2	0.2	31.0	Yellow-brown, with silt, SP-SM (Yoganup Formation)
12	32.1	0.3	31.8	Yellow-brown, with silt, SP-SM (Yoganup Formation)
13	30.3	>2.5	<27.8	Yellow-brown, with silt, SP-SM (Yoganup Formation)
15	34.4	0.4	34.0	Yellow-brown, with silt, SP-SM (Yoganup Formation)

Notes for Table 1:

[1]: Surface level obtained from publicly available LiDAR.

[2]: Level of Base of Sand = Surface Level – Depth to Base of Sand.

4.2 Groundwater

Groundwater was not observed in the test pits excavated on 28 October 2020, to a depth of up to 2.9 m. All test pits were immediately backfilled following sampling and logging, which precluded longer-term monitoring of groundwater levels.

Groundwater was measured at depths of between 13.5 m and 16.0 m on 5 November 2020, within two monitoring wells installed in the southern part of the site.

It should be noted that groundwater levels are affected by climatic conditions and land usage and will therefore vary with time.

4.3 Permeability

Four in situ infiltration tests using the falling head method were carried out at depths of between 0.5 m and 1.0 m at locations 3, 4, 9 and 11. Soil permeability values were estimated using a calculation derived from a method based on Hvorslev (1951). The results of the in situ testing are summarised in Table 2.

Table 2: Summary of Permeability Analysis

Test Location	Depth (m)	Estimated Permeability (m/day)	In situ Ground Conditions at Testing Depth
3	0.55	25	Sand, light grey trace silt, dense (Bassendean Sand)
4	1.0	6	Sand, yellow-brown with clay/Clayey Sand (fines content increasing with depth), medium dense (Yoganup Formation)
9	1.0	34	Sand, light grey, trace silt, dense (Bassendean Sand)
11	1.0	7	Sand, with clay (fines content increasing with depth), dense (Yoganup Formation)

Soil permeability is further discussed in Section 7.6.

5. Laboratory Testing

A geotechnical laboratory testing programme was carried out on selected soil samples by a NATA registered laboratory and included the determination of:

- the particle size distribution of seven samples; and
- the Atterberg limits and linear shrinkage of two samples.

Detailed test reports are given in Appendix D and the results are summarised in Table 3 (next page).

Table 3: Results of Laboratory Testing for Soil Identification and Site Classification

Test Location	Depth (m)	Fines (%)	Sand (%)	Gravel (%)	LL (%)	PL (%)	PI (%)	LS (%)	Material
3	0.6	4	96	0	-	-	-	-	Sand, light grey, trace silt (Bassendean Sand)
4	1.0	12	88	0	-	-	-	-	Sand, yellow-brown, with clay (Yoganup Formation)
6	0.8	23	63	14	-	-	-	-	Silty Sand, trace gravel (Fill)
11	1.1	9	91	0	-	-	-	-	Sand, yellow-brown, with clay (Yoganup Formation)
12	1.2	15	85	0	NO	NP	NP	0.5	Clayey Sand/Silty Sand, yellow-brown (Yoganup Formation)
14	0.4	14	86	0	-	-	-	-	Clayey Sand, yellow-brown (Yoganup Formation)
14	1.2	26	74	0	20	13	7	2.0	Clayey Sand, yellow-brown (Yoganup Formation)

Notes for Table 3:

- % fines is the amount of particles smaller than 75 µm.
- % sand is the amount of particles between 75 µm and 2.36 mm.
- % gravel is the amount of particles larger than 2.36 mm.
- LL: liquid limit.
- PL: plastic limit
- '-' means 'Not Tested'
- NP: Non-Plastic
- LS: linear shrinkage
- PI: plasticity Index
- NO: Not Obtainable

6. Proposed Development

It is understood that the proposed development of the site includes a commercial precinct, medium density residential land-use, a primary school and public open space.

7. Comments

7.1 Site Suitability

The investigation indicates that the site is generally underlain by sandy materials overlying sand with clay or clayey sand, as described in Section 4.1 above. Such ground conditions are generally considered suitable for the proposed land development. Possible geotechnical constraints imposed by the ground conditions include:

- The presence of loose sand as encountered at test location 1, and may also be present elsewhere within the site;

- Uncontrolled fill, as encountered at locations 1, 6 to 10 and 12 to 14, and anticipated to be elsewhere within the site based on observations made during the site walk-over. The fill is deeper than 2.9 m at test location 6; and
- Soils from the Yoganup Formation unit with relatively low permeability, in particular following densification during earthworks, with implications on stormwater disposal and other drainage applications.

The constraints regarding loose soils and uncontrolled fill can be managed with relative ease during typical earthworks site preparation procedures, as outlined further below. The presence of low permeability soils are likely to require civil design solutions, either with regard to the bulk earthworks design strategy, or the implementation of suitable drainage measures.

Sand with a generally low fines content, both the light grey sand of the Bassendean Sand unit and some shallow yellow-brown sand from the Yoganup Formation, was encountered from site surface overlying more clayey materials at most of the test locations, with these depths provided in Table 1, Section 4.1. The sand at these locations is considered suitable for excavation and re-use as structural fill without impacting the AS 2870 site classification. In particular, light grey sand with trace silt (Bassendean Sand) was identified to depths of greater than 2.5 m depth within the most western part for the investigated site.

From a drainage perspective, it is anticipated that only the Bassendean Sand would meet typical civil specifications regarding sand permeability (ie permeability greater than 5 m/day) following compaction from site preparation, with the sand from the Yoganup Formation generally not meeting such specification.

From a geotechnical standpoint, the land is physically capable of development, provided that the comments outlined in the subsequent subsections of this report are taken into consideration in the development plans.

It is emphasised that the test pits undertaken as part of this preliminary geotechnical investigation represent a small portion of the total development area, and as such, other varied ground conditions not encountered or discussed in this report may exist. It is recommended that further detailed geotechnical investigation of the development site is undertaken during the detailed design phase of the development.

7.2 Site Classification

Site classification is determined in accordance with AS 2870-2011 and is based on the expected ground surface movement and the depth to which this movement extends. The depth of soil suction at this site is assessed to be 1.8 m (HU, COCKS, VERHEYDE, 2019).

The shallow ground conditions encountered across the site are relatively variable. Ground conditions generally consist of sand overlying sand with clay or clayey sand materials, although clayey sand also occurs near ground surface in some parts of the site. Based on a visual and tactile assessment together with limited laboratory testing, the clayey sand forms a slightly reactive layer. Various uncontrolled fill materials were also encountered across the site.

Test locations with uncontrolled fill should be classified as 'Class P' in accordance with AS 2870-2011. Test locations with clayey materials within 1.8 m of surface are currently classified as 'Class S' which generally applies to the majority of the site in its current condition. Test locations with at least 1.8 m of non-reactive soil from surface (test locations 7, 8, 9 and 13), can be classified as 'Class A' following suitable site preparation as outlined in Section 7.4. The current site classification at test locations where clayey materials were encountered and the thickness of non-reactive fill required to improve the site classification, is shown in Table 4, below.

Table 4: Site Classification at Test Locations with Encountered Clayey Sand Materials

Test Location	Depth to Clayey Materials (m)	Current Site Classification ^[1]	Minimum Thickness of non-reactive fill required to improve site classification to 'Class A' ^[1] (m)
1	1.2	S	0.6
2	0.1	S	1.7
3	0.8	S	1.0
4	0.4	S	1.4
5	1.6	S	0.2
10	0.3	S	1.5
11	0.25	S	1.55
12	0.3	S	1.5
14	0.2	S	1.6
15	0.4	S	1.4

Notes for Table 4: [1] Thickness of sand required above existing surface level.

It is emphasised that the classifications provided above will need re-assessment if bulk earthworks for the proposed development include cutting the site.

7.3 Excavation Conditions

Based on the ground conditions described in Section 4.1, excavations associated with bulk earthworks, service trenches and foundations are anticipated to be undertaken through medium dense to dense sand (either fill or natural) and clayey sand following site preparation as described in Section 7.4. Coffee rock was encountered at test locations 5 and 8 however at these locations it was excavated with relative ease using a 5 tonne excavator. Stronger coffee rock could possibly occur elsewhere at the site.

It should be noted that some difficulty in excavating the fill encountered at test location 6 was encountered using a 5 tonne excavator, although more powerful excavators are anticipated to be

suitable. The fill thickness at this location was greater than 2.9 m (maximum reach of excavator used during the investigation).

In general, excavations should be readily achieved using typical earthmoving equipment (ie excavators, loaders, and scrapers). Consideration can be given to using larger excavators (greater than 20 tonne) with toothed buckets to excavate the fill encountered at test location 6, and through cemented materials such as coffee rock.

7.4 Site Preparation

Inspections of earthworks should be undertaken by an experienced geotechnical engineer, in general accordance with the guidelines set out for Level 2 inspections within AS 3798-2008, as a minimum requirement.

7.4.1 Site Stripping

All deleterious material, including vegetation, topsoil and uncontrolled fill (encountered at locations 1, 6 to 10 and 12 to 14), should be stripped from within development areas and either removed from site or stockpiled for possible treatment and re-use, if applicable (see Section 7.4.3). Uncontrolled fill should be removed to its full depth, and it is noted that at location 6, the fill extended deeper than 2.9 m.

Tree roots should also be removed, with the site grubbed to at least 0.5 m depth below surface level. Existing pavements, structures including their footings, associated buried services, soakwells and other infrastructure should be completely removed. Any excavations occurring from stripping and grubbing activities should be backfilled with material similar to the adjacent subgrade and suitably compacted.

7.4.2 Proof Compaction

Following site stripping and removal of all unsuitable materials, it is recommended that the exposed subgrade soils across the site should be compacted using a heavy (minimum of 14 tonne) smooth drum roller. All proposed building envelope and pavement areas should be compacted to target a minimum blow count of 8 blows per 300 mm penetration when tested with a PSP to a depth of not less than 1 m below the existing surface level, to ensure suitable densification of the identified loose sand across the site.

Any areas that show signs of excessive deformation during compaction should be continually compacted until deformation ceases. Alternatively, the poor-quality material could be excavated and replaced with suitable structural filling compacted to achieve not less than 8 blows per 300 mm rod penetration when tested using a PSP. Care should be taken not to operate heavy vibrating plant immediately adjacent to existing buildings and services.

Confirmation of site stripping and suitable compaction should be verified by a geotechnical engineer, prior to placement of any fill materials.

7.4.3 Re-use of Materials

The naturally occurring light grey sand (Bassendean Sand) is considered suitable for re-use as structural fill for urban development, and should form a well-drained material. The material should be free from organic matter and particles greater than 150 mm in size.

The naturally occurring yellow-brown sand (Yoganup Formation) is also considered suitable for re-use as structural fill. However the fines content of this sand, which generally increases with depth, is anticipated to preclude its re-use in applications requiring good drainage conditions. Following placement and compaction, the yellow-brown sand is expected to have a permeability below typical earthworks specifications of 5 m/day.

Sandy topsoil was recorded over a thickness of 100 mm and 150 mm within the test pits undertaken at the site. A general procedure for the re-use of sandy topsoil which is considered suitable for this site is:

- Stripping and stockpiling the topsoil, followed by removal of the bulk of the large organic particles by passing the topsoil through a screen with an aperture size of say 25 mm; and
- Blending the screened topsoil with clean sand. A preliminary blending ratio of approximately 2:1 (clean sand : topsoil/organic sand) is suggested at this stage, but this blending ratio should be refined following assessment of the material resulting from the screening operations.

The suitability of the screened material should also be regularly assessed by a geotechnical engineer (including the determination of organic content and particle size gradings) for approval prior to use as fill, which may also result in optimisation of the blending ratio.

Blended fill materials typically have a reduced permeability in comparison with clean sand, and therefore verification of the permeability of the blended material is suggested, prior to use. Any material considered unsuitable for use as fill by the geotechnical engineer should be removed from the site or used in non-structural areas.

Various uncontrolled fill materials were observed within the site including sand, silty sand, clayey sand and sandy clay/silt. Following excavation of uncontrolled fill materials during site stripping, it is recommended that the materials are assessed by a geotechnical engineer to assess their suitability of re-use. It is anticipated that most soil materials can be re-used somewhere within the site following suitable preparation, to limit off-site disposal costs. Prior to re-use, uncontrolled fill materials may require raking or screening to remove deleterious or large particles, and blending with other soils, subject to assessment and verification by a geotechnical engineer on a case by case basis.

7.4.4 Compaction

Materials approved by a geotechnical engineer for use as structural fill should be placed in layers within 2% of the optimum moisture content. Each layer should be compacted to achieve a dry density ratio of not less than 95% relative to modified compaction. The type of roller (smooth drum or pad foot) and the use of vibratory modes should be at the discretion of the earthwork's contractor based on the encountered subgrade, the depth to groundwater, and the size and type of compaction plant.

Compaction control in sand could be carried out using a Perth sand penetrometer (PSP) test in accordance with test method AS 1289.6.3.3. Sand should be compacted to achieve a minimum blow

count of 8 blows per 300 mm rod penetration to a depth of not less than 1 m below foundation level. This compaction level has not been directly correlated to a dry density of 95% relative to modified compaction. Lower blow counts than the above level may be acceptable provided that a correlation between Perth sand penetrometer (PSP) test and dry density ratio has been established by a NATA accredited laboratory and following review by a geotechnical engineer.

It is recommended that the compaction control of clayey materials is carried out using a nuclear surface moisture-density gauge, in accordance with AS 1289.5.8.1.

It is recommended that verification of the compaction works be undertaken by an experienced geotechnical engineer.

During construction, some loosening of the surface sands in foundation excavations is expected. Therefore, the top 300 mm in the base of any excavation should be re-compacted using a vibratory plate compactor prior to construction of any footings.

7.5 Pavement Design Parameters

Based on field observations and Douglas Partners' experience, it is suggested that a preliminary subgrade California bearing ratio (CBR) of 12% be considered for the design of flexible pavements on the natural sand encountered at the site, where a minimum of 0.5 m of sand exists below subgrade level. To achieve this CBR value, the sand subgrade should be compacted to achieve a dry density ratio of not less than 95% relative to modified compaction, as determined by AS 1289.5.2.1.

A presumptive design CBR value of 6% is suggested if clayey sand forms the subgrade of proposed pavement. Detailed laboratory testing could indicate the suitability to adopt of greater CBR design value for the encountered clayey sand.

It is recommended that subgrade be inspected by a suitably experienced geotechnical engineer prior to placement of the pavement layers to identify unsuitable subgrade materials, if any.

7.6 Site Drainage and Reactive Materials

The shallow soil conditions beneath the site generally comprise sand, trace silt to with silt, overlying sand with clay and clayey sand. Based on the infiltration testing undertaken, the estimated permeability rates for the sandy soils in their in situ (prior to any earthworks) conditions are:

- Bassendean Sand (Light grey, trace silt): 20 m/day;
- Yoganup Sand (Yellow-brown, with silt and increasing fines content): 5 m/day to 7 m/day.

These permeability values are anticipated to decrease following densification of the soils during earthworks. Based on our experience in similar ground conditions, following compaction the Yoganup sand is anticipated to have a generally low permeability, and is unlikely to form a suitably drained material for on-site stormwater disposal, unless specific additional drainage provisions are adopted.

The clayey sand should be considered impermeable for site drainage following earthworks.

In areas with shallow clearance to impermeable layers, water may pond as it infiltrates through the sand, collecting on the underlying sand with clay or clayey sand. Localised low-points in the underlying sand with clay and clayey sand surface may trap water, resulting in waterlogged conditions near surface. It is also expected that the infiltration capacity of the site soils will reduce due to compaction works during earthworks on-site. If soakwells are selected for stormwater disposal, the provision of measures such as overflow outlets should be considered. Some ponding of water at surface may occur during heavy or prolonged rainfall events, following densification of the sand during site works.

The clayey sand underlying the site is slightly reactive and therefore has some propensity to swell and shrink with moisture variation resulting in surface movement. It is recommended that attention be given to minimise moisture content changes within these clayey materials through the adoption of appropriate measures, such as ensuring that:

- The site is well drained, both during construction and throughout the life of structures on the site.
- Plumbing systems be maintained and repaired to avoid leaks beneath and around structures.
- No large trees be planted adjacent to structures.
- Irregular or excessive watering around the structures be avoided.

Further advice on footing maintenance on reactive sites is provided in the CSIRO note '*Building Technology File 18: Foundation Maintenance and Footing Performance – A Homeowner's Guide, 2012*', included in Appendix E.

7.7 Acid Sulfate Soils

7.7.1 General Comments

Published acid sulfate soil risk mapping indicates the site is located within an area of moderate to low risk of acid sulfate soils occurring within 3.0 m of natural soil surface. With reference to Department of Water and Environmental Regulation (DWER) endorsed guidelines, investigation of acid sulfate soil as part of a future subdivision of the site is recommended in areas of moderate to low risk for the following:

- Excavation of greater than 100 m³ from below the natural water table; and/or
- Where dewatering (temporary or permanent) is proposed to be undertaken.

7.7.2 Location 6

A sample of the dark grey silty sand fill was collected at location 6 and submitted to a NATA accredited laboratory for analysis of the Chromium suite of testing to assess presence of acid sulfate soils. The calculated net acidity in the analysed sample was reported as 0.044 %S, which exceeds the DWER endorsed criteria for management. Consequently, on the basis of the single laboratory result, the dark grey silty sand fill encountered at location 6, would be considered as acid sulfate soil. Given the testing was limited to one sample, it is recommended that further sampling be undertaken of this material with due consideration to proposed earthworks to ascertain requirement further management (if required).

8. References

- Armadale 1:50,000 Geological Mapping . (n.d.).
- AS 1289.6.3.3. (1997). *Methods for testing soils for engineering purposes - Soil strength and consolidation tests - Determination of the penetration resistance of a soil - Perth sand penetrometer test*. Reconfirmed 2013: Standards Australia.
- AS 1726. (2017). *Geotechnical Site Investigations*. Standards Australia.
- AS 2870. (2011). *Residential Slabs and Footings*. Standards Australia.
- AS 3798. (2007). *Guidelines on Earthworks for Commercial and Residential Developments*. Standards Australia.
- CSIRO. (2012). *Building Technology File 18: Foundation Maintenance and Footing Performance – A Homeowner's Guide*. BTF-18: CSIRO Publishing, Commonwealth Scientific and Industrial Research Organisation.
- Hu Y., Cocks G., Verheyde F. (2019). RE-assessment of TMI based climate zones in metropolitan Perth, WA. *Proceedings of 13th ANZ Conference on Geomechanics – Acosta-Martínez & Lehane (Eds.), Australian Geomechanics Society, Sydney, Australia*, ISBN 978-0-9946261-0-3, pp. 1053-1058.
- Department of Environment (December 2004). *Perth Groundwater Atlas, Second Edition*.

9. Limitations

Douglas Partners (DP) has prepared this report for the Proposed Wattle Grove Development in accordance with DP's proposal dated 19 October 2020 and acceptance received from Hesperia Projects Pty Ltd dated 26 October 2020. The work was carried out under a Professional Services Agreement. This report is provided for the exclusive use of for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

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

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

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

The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners



Introduction

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

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

Copyright

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

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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



Sampling

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

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

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

Test Pits

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

Large Diameter Augers

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

Continuous Spiral Flight Augers

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

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

Non-core Rotary Drilling

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

Continuous Core Drilling

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

Standard Penetration Tests

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

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

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:
4,6,7
N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:
15, 30/40 mm

Sampling Methods

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

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



Description and Classification Methods

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

Soil Types

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

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

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

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

Definitions of grading terms used are:

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

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

In fine grained soils (>35% fines)

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

In coarse grained soils (>65% coarse)

- with clays or silts

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

In coarse grained soils (>65% coarse)

- with coarser fraction

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

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

Soil Descriptions

Cohesive Soils

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

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

Cohesionless Soils

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

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

Soil Origin

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

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

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

Moisture Condition – Coarse Grained Soils

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

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
Soil tends to stick together.
Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

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

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

Symbols & Abbreviations

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Introduction

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

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U ₅₀	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

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

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

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

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

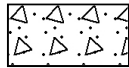
General



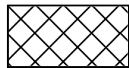
Asphalt



Road base



Concrete



Filling

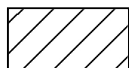
Soils



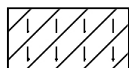
Topsoil



Peat



Clay



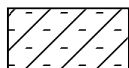
Silty clay



Sandy clay



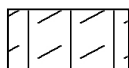
Gravelly clay



Shaly clay



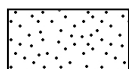
Silt



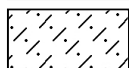
Clayey silt



Sandy silt



Sand



Clayey sand



Silty sand



Gravel



Sandy gravel



Cobbles, boulders



Talus

Sedimentary Rocks



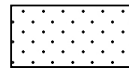
Boulder conglomerate



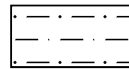
Conglomerate



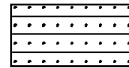
Conglomeratic sandstone



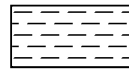
Sandstone



Siltstone



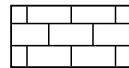
Laminite



Mudstone, claystone, shale

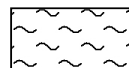


Coal

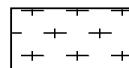


Limestone

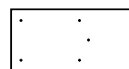
Metamorphic Rocks



Slate, phyllite, schist

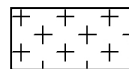


Gneiss

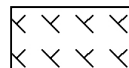


Quartzite

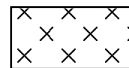
Igneous Rocks



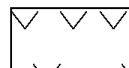
Granite



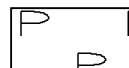
Dolerite, basalt, andesite



Dacite, epidote



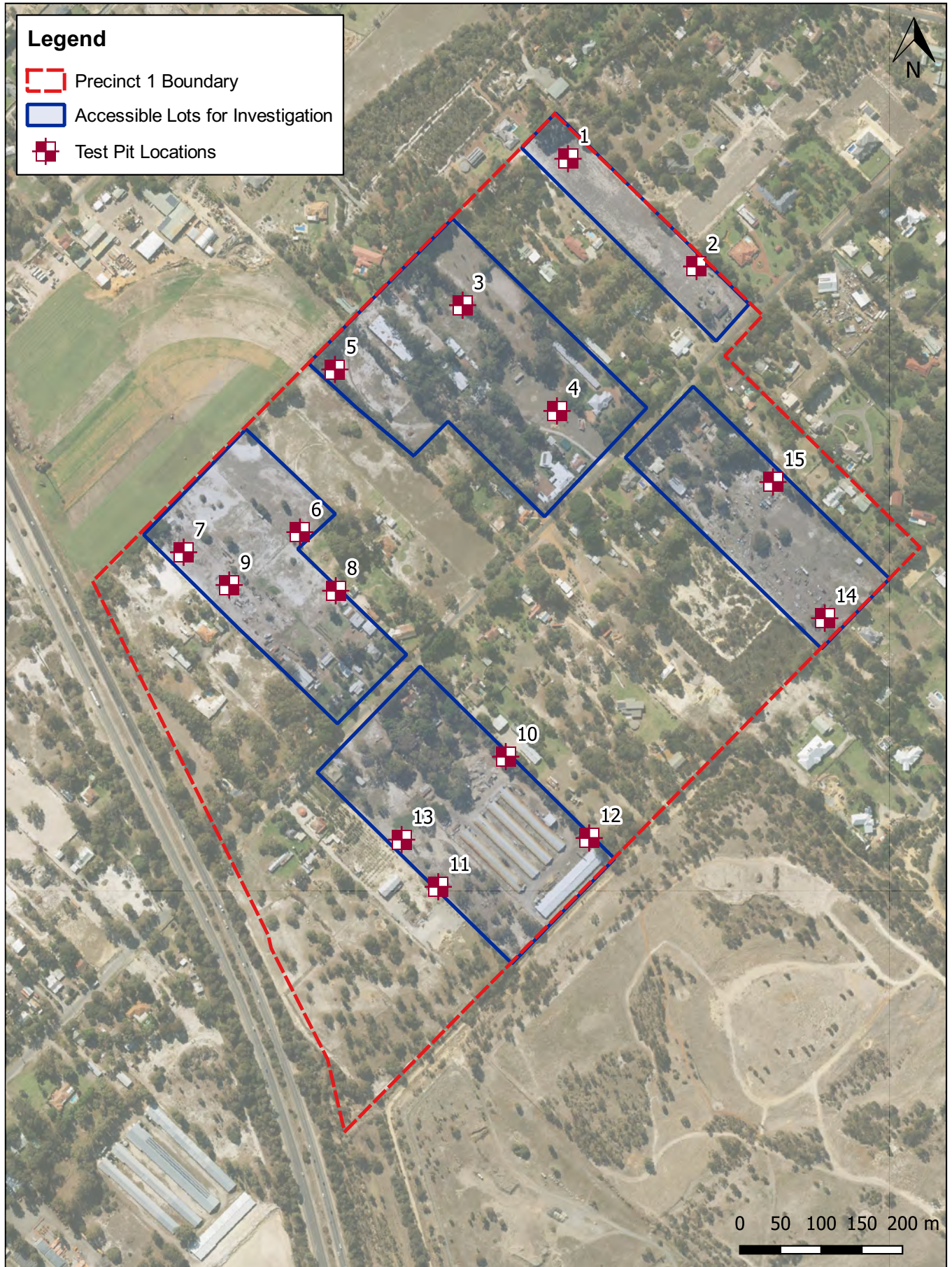
Tuff, breccia



Porphyry

Appendix B

Drawing



 Douglas Partners Geotechnics Environment Groundwater	Test Location Plan		PROJECT: 96730.01
	Preliminary Geotechnical Investigation		Drawing No: 1
	Precinct 1, Victoria Road, Wattle Grove		REV: 1
	CLIENT: Hesperia Projects Pty Ltd		DATE: 14/11/2020

Appendix C

Field Work Results

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 32.4 m AHD*
EASTING: 406131
NORTHING: 6457764

PIT No: 1
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
32.4	0.1	FILL/Sandy TOPSOIL SP-SM: fine to medium grained, grey-brown, with silt, with roots, moist. FILL/SAND SP-SM: fine to medium grained, light brown, with silt, moist. SAND SP-SM: fine to medium grained, yellow-brown, with silt, moist, medium dense. - becoming loose from 0.7 m depth.		E	0.0							
	0.2				0.1							
				E	0.3							
					0.4							
31.2	1.2	Clayey SAND SC: fine to medium grained, yellow-brown, low plasticity clay, moist.										
30.0	2.5	Pit discontinued at 2.5m (Target depth)										



RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 35.6 m AHD*
EASTING: 406289
NORTHING: 6457631

PIT No: 2
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
	0.1	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, with roots, moist.		E	0.0				
	0.1				0.1				
		SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, dense.		E	0.4				
		- becoming medium dense from 0.5 m depth.			0.5				
	0.8	Clayey SAND SC: fine to medium grained, yellow-brown, low plasticity clay, moist, medium dense.							
	1								
	2			D	2.3				
	2.5	Pit discontinued at 2.5m (Target depth)							
	3								




RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	SP	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 30.1 m AHD*
EASTING: 406002
NORTHING: 6457584

PIT No: 3
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
30	0.1	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, with roots, moist.		E	0.0							
					0.1							
		SAND SP: fine to medium grained, light grey, trace silt, moist, dense. Tree roots observed to 0.2 m depth.		B	0.3							
				E	0.4							
				D	0.5							
		- becoming yellow-brown, with silt from 0.6 m depth.			0.6							
0.8		SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, medium dense.										
1												
2												
2.5		Pit discontinued at 2.5m (Target depth)										
3												




RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 30.9 m AHD*
EASTING: 406118
NORTHING: 6457454

PIT No: 4
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
	0.1	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, with roots, moist.		E	0.0				
					0.1				
	0.4	SAND SP-SM: fine to medium grained, light brown, with silt, moist, dense.		D	0.3				
				E	0.4				
		SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, medium dense. Clay content increasing with depth.							
	1			D	1.0				
	1.5	Clayey SAND SC: fine to medium grained, yellow-brown, low plasticity clay, moist.							
	2								
	2.5	Pit discontinued at 2.5m (Target depth)							
	3								



RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 25.7 m AHD*
EASTING: 405845
NORTHING: 6457505

PIT No: 5
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
	0.15	TOPSOIL/Silty SAND SM: fine to medium grained, dark grey-brown, low plasticity silt, with roots, moist.		E	0.0				
				E	0.1				
		SAND SP: fine to medium grained, light grey, trace silt, moist, dense.		E	0.4				
				E	0.5				
	1.1	COFFEE ROCK: brown, excavated as gravelly sand, with silt, with cobbles. - tree root observed at 1.2 m depth.		D	1.3				
	1.6	SAND/Clayey SAND SP-SC/SC: fine to medium grained, light brown, with clay/clayey, low plasticity fines, moist.		D	2.2				
	2.5	Pit discontinued at 2.5m (Target depth)							



RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A Auger sample	G Gas sample	PID Photo ionisation detector (ppm)	
B Bulk sample	P Piston sample	PL(A) Point load axial test Is(50) (MPa)	
BLK Block sample	U _t Tube sample (x mm dia.)	PL(D) Point load diametral test Is(50) (MPa)	
C Core drilling	W Water sample	pp Pocket penetrometer (kPa)	
D Disturbed sample	W Water seep	S Standard penetration test	
E Environmental sample	W Water level	V Shear vane (kPa)	

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 24.9 m AHD*
EASTING: 405802
NORTHING: 6457305

PIT No: 6
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.1	FILL/Sandy TOPSOIL: fine to medium grained, grey-brown, with silt, with roots, moist.		E	0.0							
	0.3	FILL/SAND SP-SM: fine to medium grained, light grey-brown and light brown, with silt, with gravel, moist, dense.			0.1							
		FILL/Silty SAND SM: fine to medium grained, dark grey mottled orange-brown, low plasticity silt, trace gravel, pockets of orange-brown sandy clay, trace of burnt wood, fragments of brick and glass. Hard digging with excavator using flat edged bucket.		D	0.8							
				E	1.0							
					1.1							
	1.3	FILL/Clayey SAND SC: fine to medium grained, grey, low plasticity clay, with gravel, moist.										
	2.6	FILL/Sandy CLAY Cl: medium plasticity, brown, fine to medium grained sand, moist.										
	2.9	Pit discontinued at 2.9m (Limit of excavator reach)										



RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 23.8 m AHD*
EASTING: 405658
NORTHING: 6457280

PIT No: 7
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
	0.05	FILL/Sandy SILT TOPSOIL ML: low plasticity, grey-brown, fine to medium grained sand, with roots, moist.		E	0.0				
				D	0.1				
	0.3			E	0.2				
		FILL/SILT ML: low plasticity, grey-brown, with sand, moist.			0.3				
		SAND SP: fine to medium grained, light grey, trace silt, moist, dense. Becoming grey-brown to dark grey-brown with depth.			0.6				
				E	0.7				
	1								
	2								
	2.5	Pit discontinued at 2.5m (Target depth)							
	3								



RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

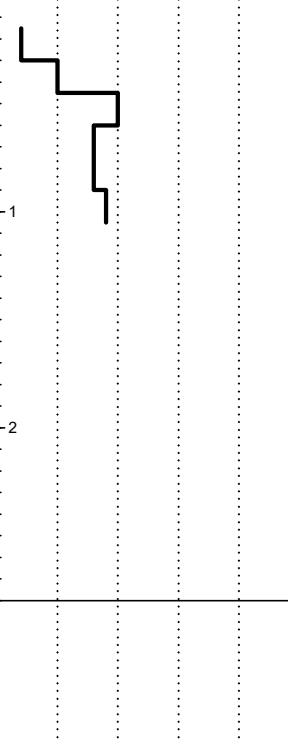
SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 25.7 m AHD*
EASTING: 405846
NORTHING: 6457233

PIT No: 8
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
	0.1	FILL/Sandy TOPSOIL: fine to medium grained, grey-brown, with silt, trace gravel, with roots, moist.		D	0.4				
		FILL/SAND SP-SM: fine to medium grained, grey-brown, with silt, trace gravel, moist, medium dense to dense. A brick found in fill.							
	0.6	SAND SP: fine to medium grained, light grey, trace silt, moist, dense.							
	1.8	COFFEE ROCK: brown, excavated as gravelly sand, with silt, with cobbles.							
	2.4	SAND SP-SM: fine to medium grained, light brown, with silt, moist.							
	2.8	Pit discontinued at 2.8m (Target depth)							



RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 24.1 m AHD*
EASTING: 405715
NORTHING: 6457240

PIT No: 9
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
24	0.1	FILL/Sandy SILT TOPSOIL ML: low plasticity, grey-brown, fine to medium grained sand, with roots, moist. FILL/SAND SP-SM: fine to medium grained, grey-brown, with silt, moist. SAND SP: fine to medium grained, light grey, trace silt, moist, dense.		E	0.0				
	0.1			E	0.1				
	0.2				0.2				
				E	0.5				
					0.6				
1				D	1.1				
2									
2.5		Pit discontinued at 2.5m (Target depth)							
3									



RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 31.9 m AHD*
EASTING: 406055
NORTHING: 6457029

PIT No: 10
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.1	FILL/Sandy TOPSOIL: fine to medium grained, grey-brown, with silt, trace gravel, with roots, moist.										
	0.3	FILL/SAND SP-SM: fine to medium grained, grey-brown, with silt, trace gravel, moist, medium dense.										
		SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, medium dense. Clay content increasing with depth.										
31	1											
30	2	- tree roots observed to 1.8 m depth.										
29	2.5	Pit discontinued at 2.5m (Target depth)										
28	3											




RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 31.2 m AHD*
EASTING: 405972
NORTHING: 6456869

PIT No: 11
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

[illegible]

RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa).



TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 32.1 m AHD*
EASTING: 406158
NORTHING: 6456928

PIT No: 12
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
32.1	0.05	FILL/SAND SP-SM: fine to medium grained, yellow-brown, trace gravel, moist.		E	0.0							
	0.2			E	0.05							
	0.3	FILL/Sandy GRAVEL GP-GM: fine to medium sized gravel of crushed asphalt, dark grey-black, fine to medium grained sand, with silt, moist.		E	0.2							
		SAND SP-SM: fine to medium grained, light brown, with silt, moist, dense.		E	0.3							
		SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, medium dense. Clay content increasing with depth.		E	0.5							
	1				0.6							
				D	1.2							
	2											
	2.5	Pit discontinued at 2.5m (Target depth)										
	3											



RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

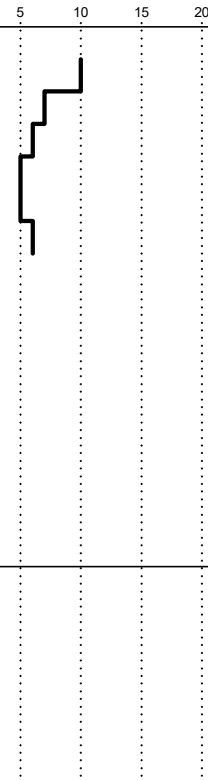
SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 30.3 m AHD*
EASTING: 405927
NORTHING: 6456927

PIT No: 13
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
30.3	0.1	FILL/Sandy TOPSOIL: fine to medium grained, grey-brown, with silt, with gravel, with roots, moist.		D	0.5				
29.0	1.3	FILL/SAND SP-SM: fine to medium grained, grey-brown and brown, with silt, with gravel and cobbles, moist, dense. Concrete, plastic and bricks observed.							
28.0		SAND SP-SM: fine to medium grained, yellow-brown, with silt, moist, dense.		D	1.9				
27.0	2.5	Pit discontinued at 2.5m (Target depth)							



RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

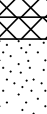
SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	SP	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 35.5 m AHD*
EASTING: 406447
NORTHING: 6457199

PIT No: 14
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.1	FILL/Sandy TOPSOIL: fine to medium grained, grey-brown, with silt, with roots, moist.		E	0.0							
	0.2			E	0.1							
		FILL/SAND SP-SM: fine to medium grained, yellow-brown and grey-brown, with silt, moist.		E	0.2							
				B	0.3							
	0.6	SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, dense.			0.4							
		Clayey SAND SC: fine to medium grained, yellow-brown, low plasticity clay, trace gravel, moist, medium dense. Clay content increasing with depth.		D	1.2							
	2.5	Pit discontinued at 2.5m (Target depth)										



RIG: Hitachi 5 tonne excavator with a 650 mm wide flat edged bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from publicly available LiDAR.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

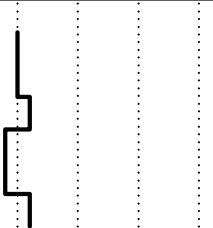
SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: Hesperia Projects Pty Ltd
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Precinct 1 Victoria Rd, Wattle Grove

SURFACE LEVEL: 34.4 m AHD*
EASTING: 406383
NORTHING: 6457366

PIT No: 15
PROJECT No: 96730.01
DATE: 28/10/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)					
				Type	Depth	Sample	Results & Comments		5	10	15	20		
34	0.1	FILL/Sandy TOPSOIL: fine to medium grained, grey-brown, with silt, with roots, with gravel, moist. Gravel is demolition rubble including brick and concrete.		E	0.0									
	E			0.1										
	E			0.2										
	34	0.4	SAND SP-SM: fine to medium grained, light brown, with silt, moist, dense.		E									0.4
		E			0.5									
1	0.7	SAND/Clayey SAND SP-SC/SC: fine to medium grained, yellow-brown, with clay/clayey, low plasticity fines, moist, dense. Clayey SAND SC: fine to medium grained, yellow-brown, low plasticity clay, trace gravel, moist, medium dense. Clay content increasing with depth.												
33														
2														
32														
3	2.5	Pit discontinued at 2.5m (Target depth)												
31														





Appendix D

Laboratory Test Results



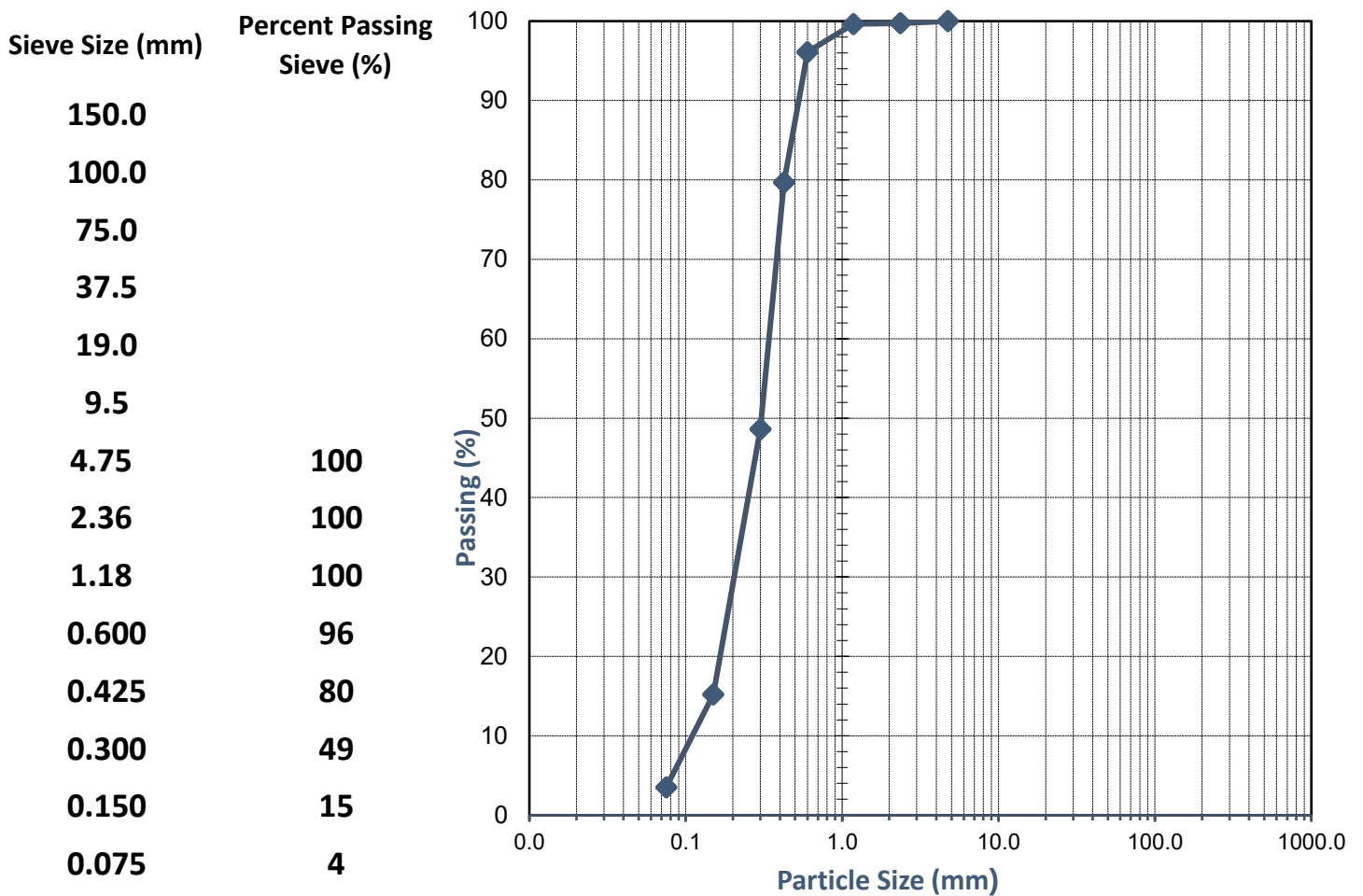
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	Ticket No.	S1949
Client Address:	-	Report No.	WG20/9963_1_PSD
Project:	Preliminary Geotechnical Investigation	Sample No.	WG20/9963
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	Date Sampled:	28-10-2020
Sample Identification:	TP3, 0.6m	Date Tested:	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020



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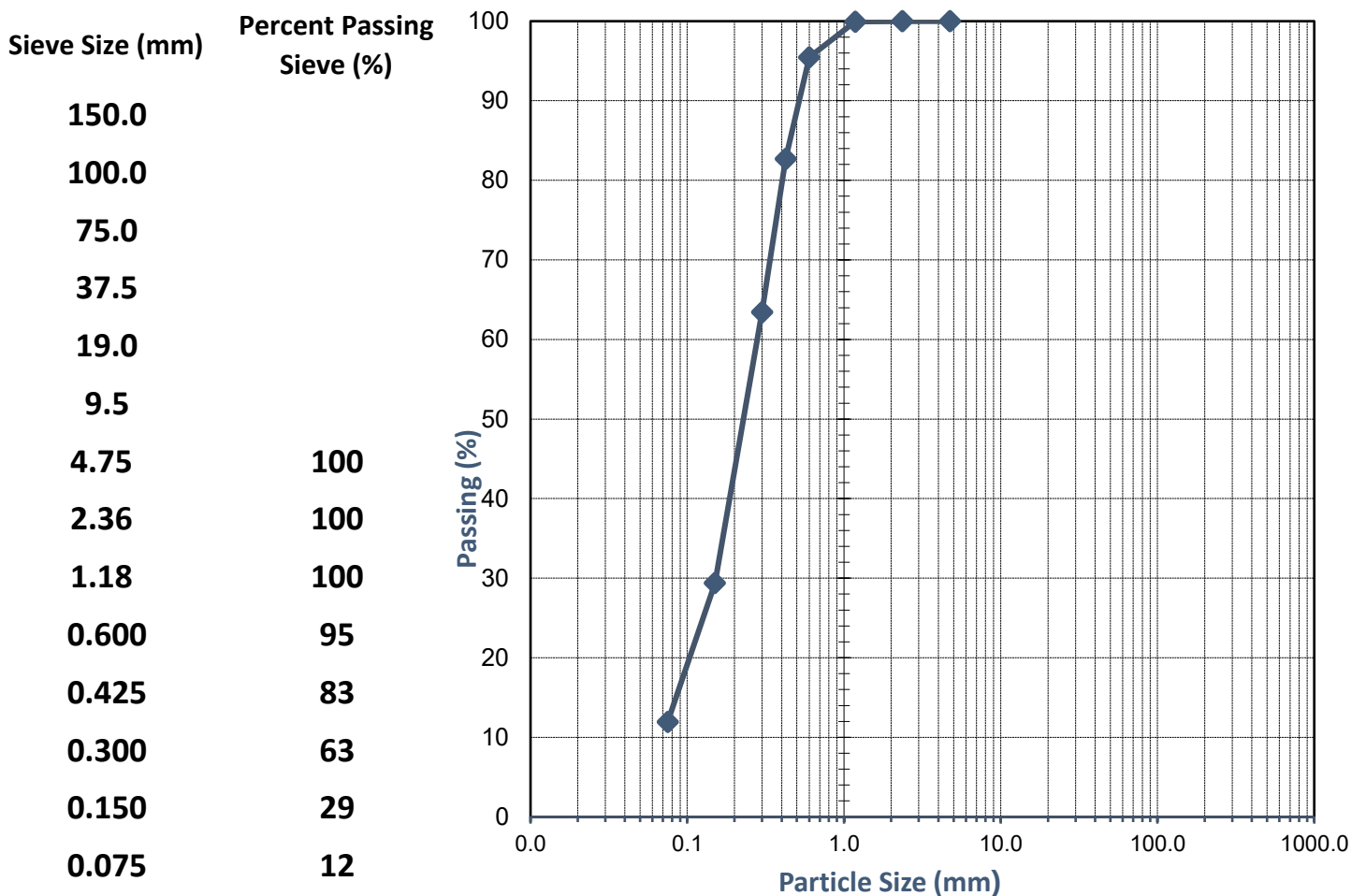
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	Ticket No.	S1949
Client Address:	-	Report No.	WG20/9964_1_PSD
Project:	Preliminary Geotechnical Investigation	Sample No.	WG20/9964
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	Date Sampled:	28-10-2020
Sample Identification:	TP4, 1.0m	Date Tested:	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020



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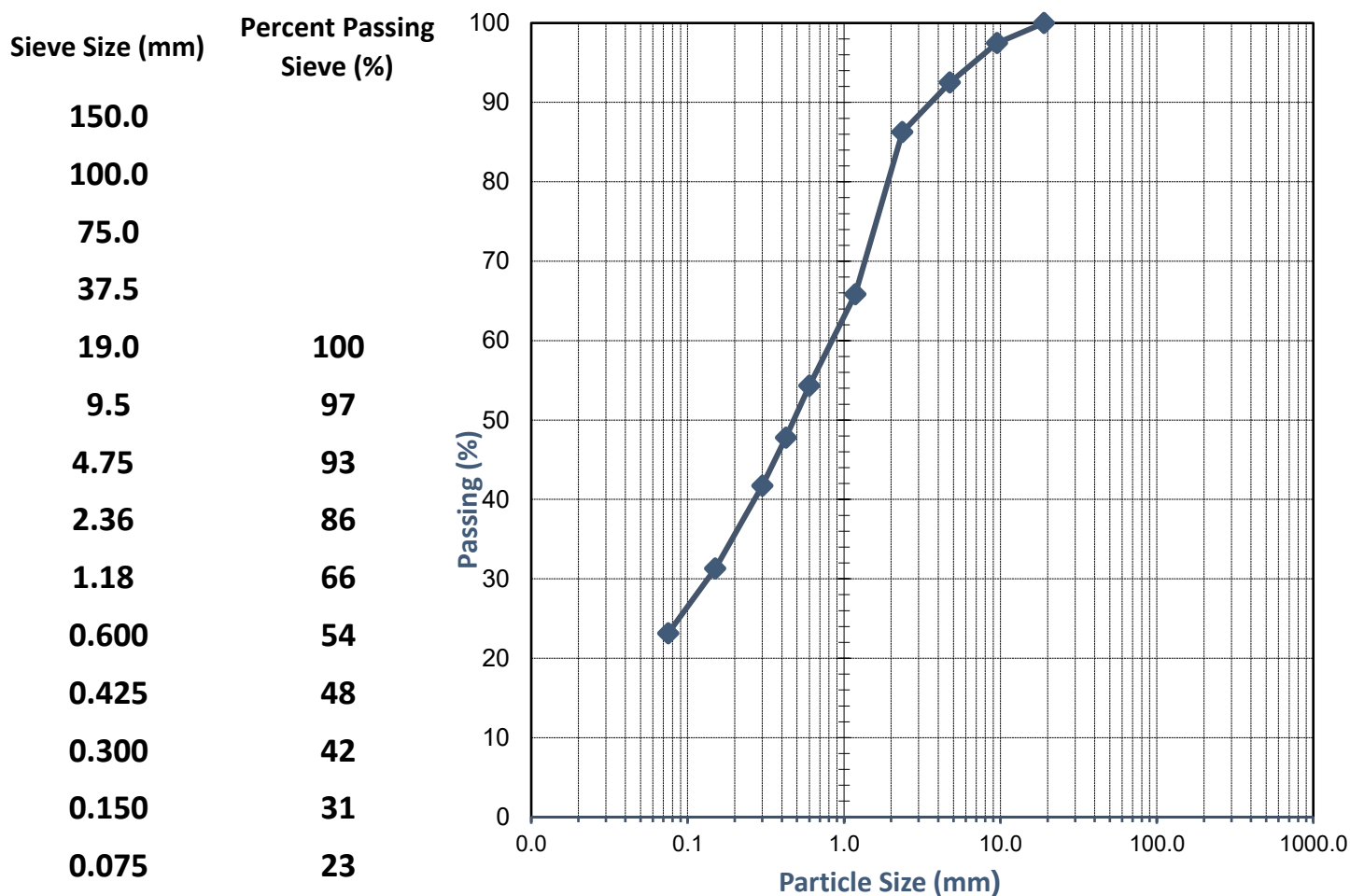
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	Ticket No.	S1949
Client Address:	-	Report No.	WG20/9965_1_PSD
Project:	Preliminary Geotechnical Investigation	Sample No.	WG20/9965
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	Date Sampled:	28-10-2020
Sample Identification:	TP6, 0.8m	Date Tested:	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020



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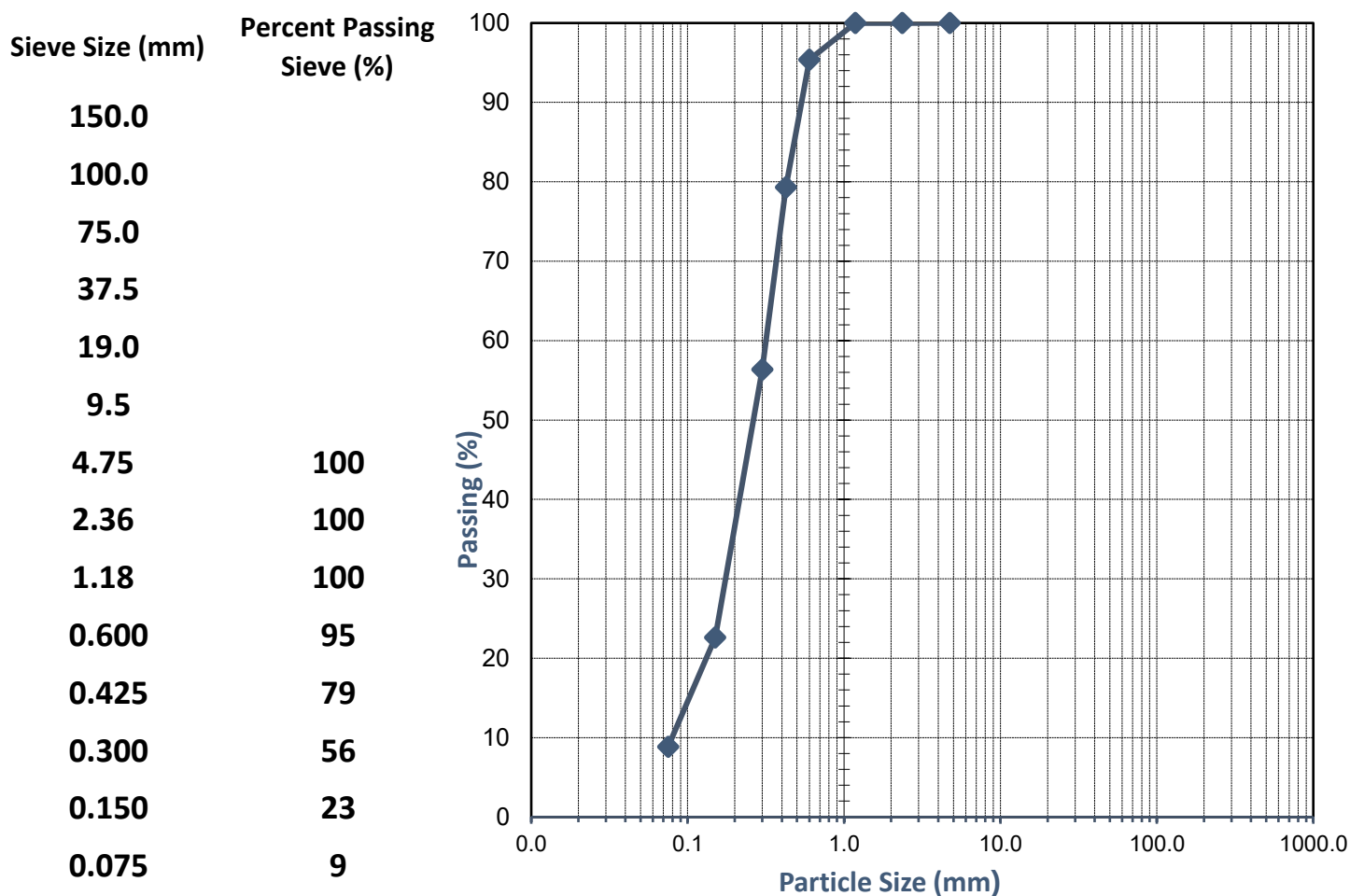
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	Ticket No.	S1949
Client Address:	-	Report No.	WG20/9966_1_PSD
Project:	Preliminary Geotechnical Investigation	Sample No.	WG20/9966
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	Date Sampled:	28-10-2020
Sample Identification:	TP11, 1.1m	Date Tested:	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020



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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Hesperia Projects Pty Ltd	Ticket No.	S1949
Client Address:	-	Report No.	WG20/9967_1_PI
Project:	Preliminary Geotechnical Investigation	Sample No.	WG20/9967
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	Date Sampled:	28-10-2020
Sample Identification:	TP12, 1.2m	Date Tested:	4-11-2020

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:

Sampled by Client, Tested as Received

History of Sample:

Oven Dried <50°C

Method of Preparation:

Dry Sieved

AS 1289.3.1.1	Liquid Limit (%)	Not Obtainable
AS 1289.3.2.1	Plastic Limit (%)	Non-Plastic
AS 1289.3.3.1	Plasticity Index (%)	Non-Plastic
AS 1289.3.4.1	Linear Shrinkage (%)	0.5
AS 1289.3.4.1	Length of Mould (mm)	250
AS 1289.3.4.1	Condition of Dry Specimen:	-

Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020



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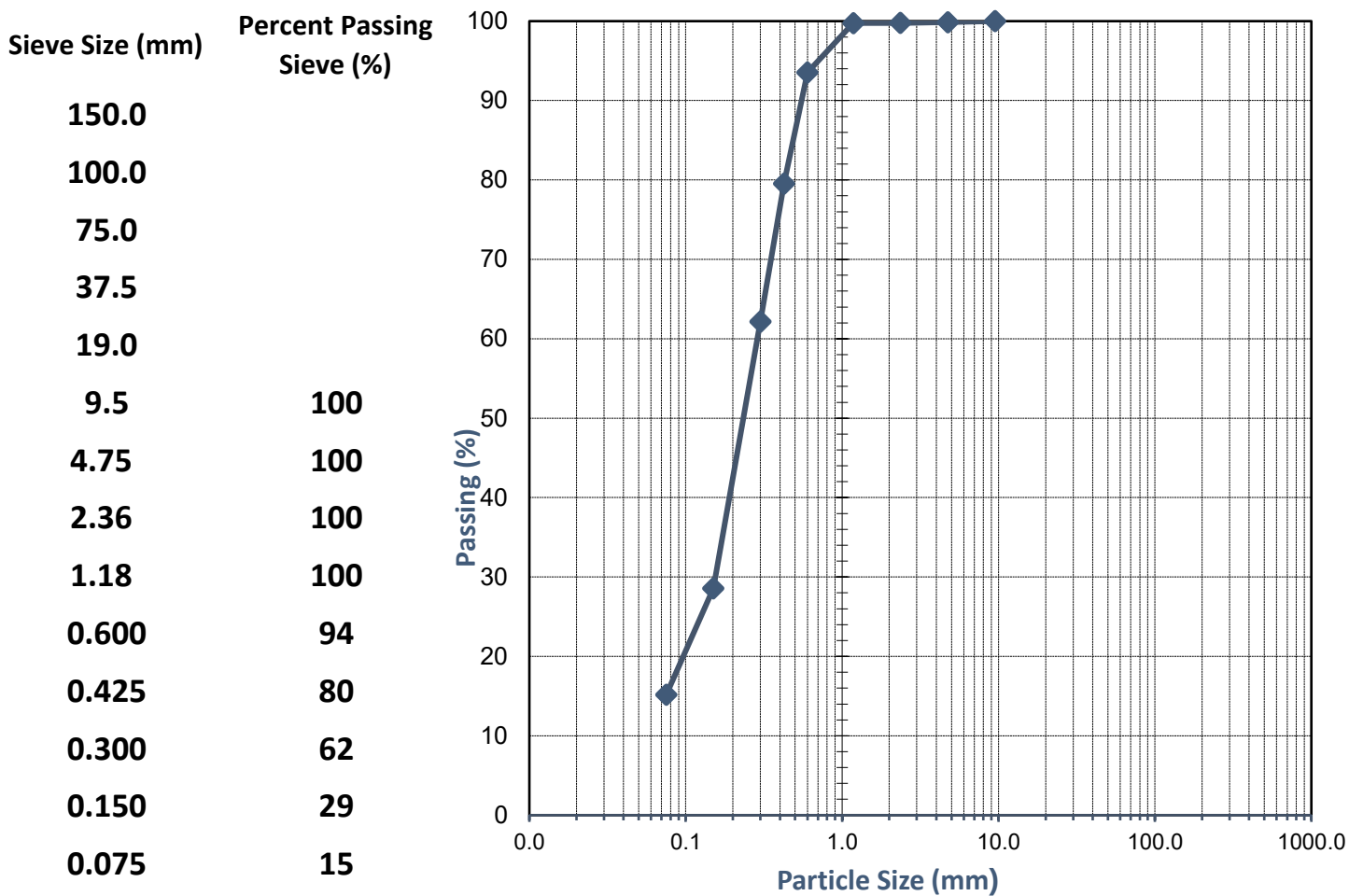
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	Ticket No.	S1949
Client Address:	-	Report No.	WG20/9967_1_PSD
Project:	Preliminary Geotechnical Investigation	Sample No.	WG20/9967
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	Date Sampled:	28-10-2020
Sample Identification:	TP12, 1.2m	Date Tested:	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020



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SOIL | AGGREGATE | CONCRETE | CRUSHING

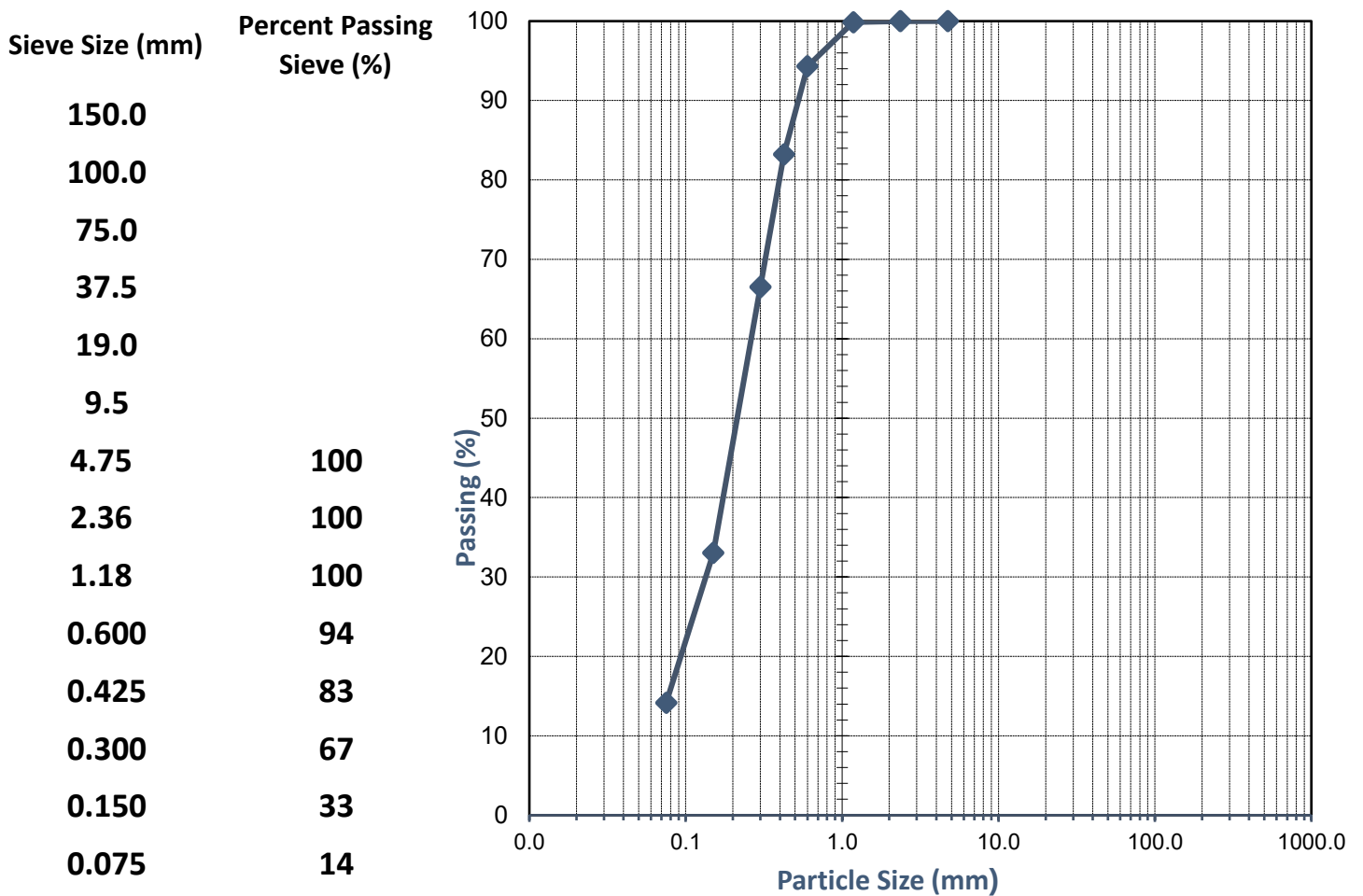
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	Ticket No.	S1949
Client Address:	-	Report No.	WG20/9968_1_PSD
Project:	Preliminary Geotechnical Investigation	Sample No.	WG20/9968
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	Date Sampled:	28-10-2020
Sample Identification:	TP14, 0.4m	Date Tested:	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020



Accreditation No. 20599

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Hesperia Projects Pty Ltd	Ticket No.	S1949
Client Address:	-	Report No.	WG20/9969_1_PI
Project:	Preliminary Geotechnical Investigation	Sample No.	WG20/9969
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	Date Sampled:	28-10-2020
Sample Identification:	TP14, 1.2m	Date Tested:	4-11-2020

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:

Sampled by Client, Tested as Received

History of Sample:

Oven Dried <50°C

Method of Preparation:

Dry Sieved

AS 1289.3.1.1	Liquid Limit (%)	20
AS 1289.3.2.1	Plastic Limit (%)	13
AS 1289.3.3.1	Plasticity Index (%)	7
AS 1289.3.4.1	Linear Shrinkage (%)	2.0
AS 1289.3.4.1	Length of Mould (mm)	250
AS 1289.3.4.1	Condition of Dry Specimen:	-

Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020



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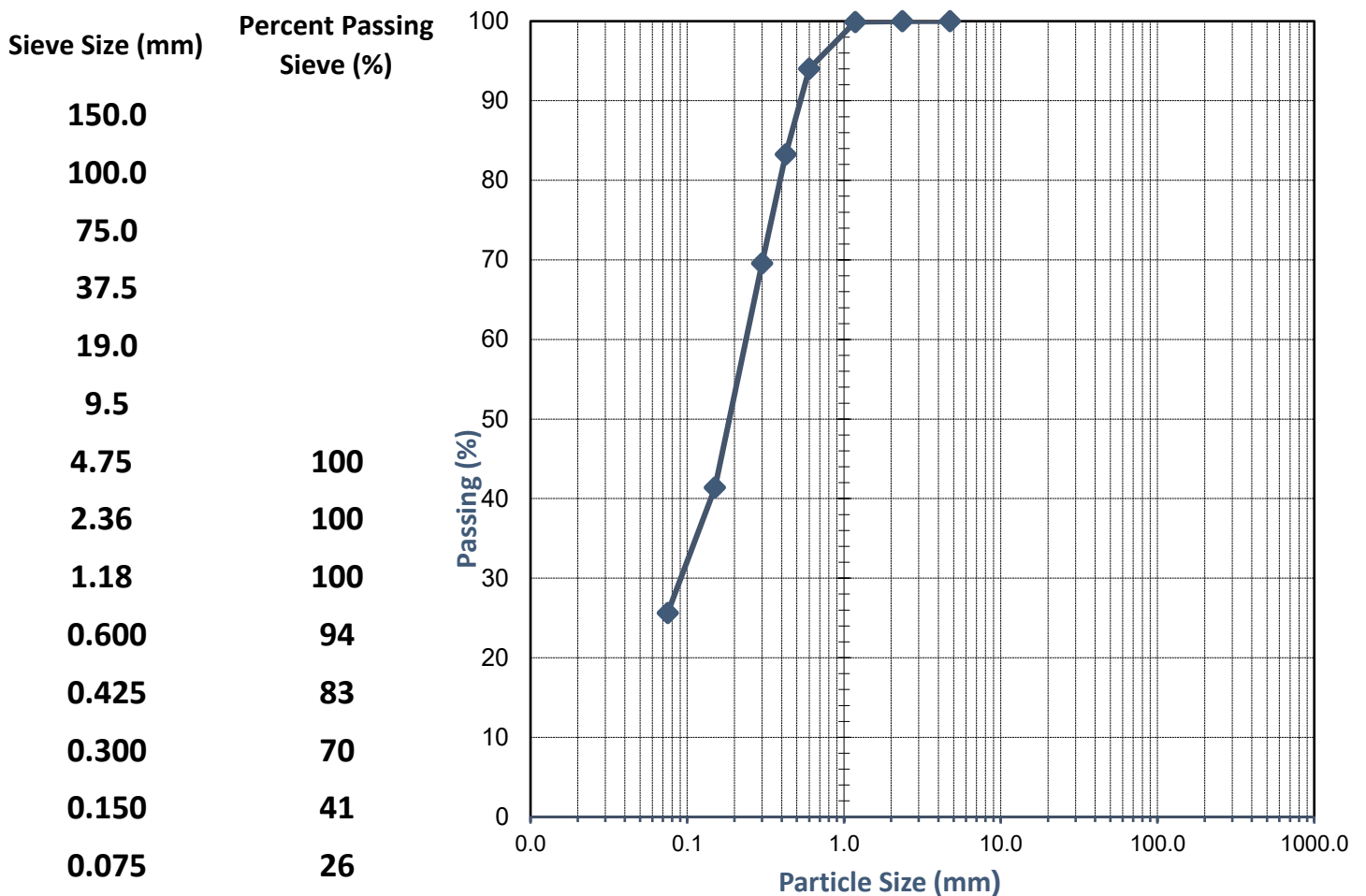
TEST REPORT - AS 1289.3.6.1

Client:	Hesperia Projects Pty Ltd	Ticket No.	S1949
Client Address:	-	Report No.	WG20/9969_1_PSD
Project:	Preliminary Geotechnical Investigation	Sample No.	WG20/9969
Location:	Precinct 1 Victoria Rd, Wattle Grove, WA	Date Sampled:	28-10-2020
Sample Identification:	TP14, 1.2m	Date Tested:	3/11-4/11/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 05-November-2020



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CERTIFICATE OF ANALYSIS 252921

Client Details

Client	Douglas Partners Perth
Attention	Rob Shapland
Address	36 O'Malley St, Osborne Park, WA, 6017

Sample Details

Your Reference	<u>96730.01 - Wattle Grove Geo</u>
Number of Samples	1 Soil
Date samples received	09/11/2020
Date completed instructions received	09/11/2020

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	16/11/2020
Date of Issue	12/11/2020

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

Stacey Hawkins, Acid Soils Supervisor

Authorised By



Michael Kubiak, Laboratory Manager

sPOCAS field test		
Our Reference		252921-1
Your Reference	UNITS	TP6
Depth		0.8m
Date Sampled		28/10/2020
Type of sample		Soil
Date prepared	-	09/11/2020
Date analysed	-	10/11/2020
pH _f (field pH test)*	pH Units	5.8
pHFOX (field peroxide test)*	pH Units	2.0
Reaction Rate*	-	Medium

Chromium Suite		
Our Reference		252921-1
Your Reference	UNITS	TP6
Depth		0.8m
Date Sampled		28/10/2020
Type of sample		Soil
Date analysed	-	12/11/2020
pH _{KCl}	pH units	5.8
TAA	moles H ⁺ /t	24
S _{KCl}	%w/w S	NT
Chromium Reducible Sulfur	%w/w	0.006
ANC _{BT}	% CaCO ₃	NT
S _{HCl}	%w/w S	NT
s-TAA	%w/w S	0.038
a-Chromium Reducible Sulfur	moles H ⁺ /t	<5
a-ANC _{BT}	moles H ⁺ /t	NT
s-ANC _{BT}	%w/w S	NT
Fineness Factor		1.50
S _{NAS}	%w/w S	NT
a-S _{NAS}	moles H ⁺ /t	NT
s-SNAS	%w/w S	NT
s-Net Acidity	%w/w S	0.044
a-Net Acidity	moles H ⁺ /t	28
Liming rate	kg CaCO ₃ /t	2.1
s-Net Acidity without ANCE	% w/w S	0.044
a-Net Acidity without ANCE	moles H ⁺ /t	28
Liming rate without ANCE	kg CaCO ₃ /t	2.1

Method ID	Methodology Summary
INORG-063	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.
INORG-064	Suspension Peroxide Oxidation Combined Acidity and Sulphate (SPOCAS) using ASSMAC guidelines.
INORG-068	Chromium Reducible Sulfur - Hydrogen Sulfide is quantified by iodometric titration after distillation to determine potential acidity. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

Client Reference: 96730.01 - Wattle Grove Geo

QUALITY CONTROL: sPOCAS field test						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			09/11/2020	1	09/11/2020	09/11/2020		[NT]	[NT]
Date analysed	-			10/11/2020	1	10/11/2020	10/11/2020		[NT]	[NT]
pH _F (field pH test)*	pH Units		INORG-063	[NT]	1	5.8	5.8	0	[NT]	[NT]
pHFOX (field peroxide test)*	pH Units		INORG-063	[NT]	1	2.0	1.9	5	[NT]	[NT]

Client Reference: 96730.01 - Wattle Grove Geo

QUALITY CONTROL: Chromium Suite				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date analysed	-			12/11/2020	1	12/11/2020	12/11/2020		12/11/2020	[NT]
pH _{KCl}	pH units		INORG-064	[NT]	1	5.8	5.7	2	97	[NT]
TAA	moles H ⁺ /t	5	INORG-064	[NT]	1	24	23	4	104	[NT]
S _{KCl}	%w/w S	0.005	INORG-064	[NT]	1	NT	NT		[NT]	[NT]
Chromium Reducible Sulfur	%w/w	0.005	INORG-068	[NT]	1	0.006	0.006	0	97	[NT]
ANC _{BT}	% CaCO ₃	0.01	INORG-068	[NT]	1	NT	NT		[NT]	[NT]
S _{HCl}	%w/w S	0.005	INORG-068	[NT]	1	NT	NT		[NT]	[NT]
s-TAA	%w/w S	0.01	INORG-068	[NT]	1	0.038	0.036	5	[NT]	[NT]
a-Chromium Reducible Sulfur	moles H ⁺ /t	5	INORG-068	[NT]	1	<5	<5	0	[NT]	[NT]
a-ANC _{BT}	moles H ⁺ /t	5	INORG-068	[NT]	1	NT	NT		[NT]	[NT]
s-ANC _{BT}	%w/w S	0.01	INORG-068	[NT]	1	NT	NT		[NT]	[NT]
Fineness Factor			INORG-064	[NT]	1	1.50	1.50	0	[NT]	[NT]
S _{NAS}	%w/w S	0.005	INORG-068	[NT]	1	NT	NT		[NT]	[NT]
a-S _{NAS}	moles H ⁺ /t	5	INORG-064	[NT]	1	NT	NT		[NT]	[NT]
s-SNAS	%w/w S	0.01	INORG-064	[NT]	1	NT	NT		[NT]	[NT]
s-Net Acidity	%w/w S	0.005	INORG-064	[NT]	1	0.044	0.042	5	[NT]	[NT]
a-Net Acidity	moles H ⁺ /t	5	INORG-064	[NT]	1	28	26	7	[NT]	[NT]
Liming rate	kg CaCO ₃ /t	0.75	INORG-068	[NT]	1	2.1	2.0	5	[NT]	[NT]
s-Net Acidity without ANCE	% w/w S	0.005	INORG-064	[NT]	1	0.044	0.042	5	[NT]	[NT]
a-Net Acidity without ANCE	moles H ⁺ /t	5	INORG-064	[NT]	1	28	26	7	[NT]	[NT]
Liming rate without ANCE	kg CaCO ₃ /t	0.75	INORG-064	[NT]	1	2.1	2.0	5	[NT]	[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.

Appendix E

CSRIO Note on Foundation Maintenance and Footing Performance

Foundation Maintenance and Footing Performance: A Homeowner's Guide



PUBLISHING
BTF 18-2011
replaces
Information
Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870-2011, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume, particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.

In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes

Notes

1. Where controlled fill has been used, the site may be classified A to E according to the type of fill used.
2. Filled sites. Class P is used for sites which include soft fills, such as clay or silt or loose sands; landslide; mine subsidence; collapsing soils; soil subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.
3. Where deep-seated moisture changes exist on sites at depths of 3 m or greater, further classification is needed for Classes M to E (M-D, H1-D, H2-D and E-D).

Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpend).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

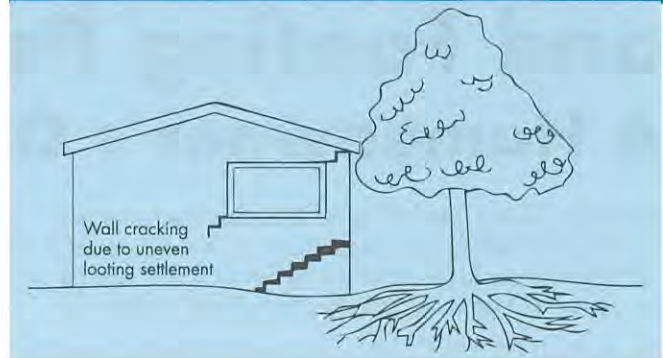
Seasonal swelling/shrinkage in clay

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring. As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the

Trees can cause shrinkage and damage



external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures

Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation causes a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures

Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem. Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.

- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870-2011.

AS 2870-2011 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing

Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage

In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

Protection of the building perimeter

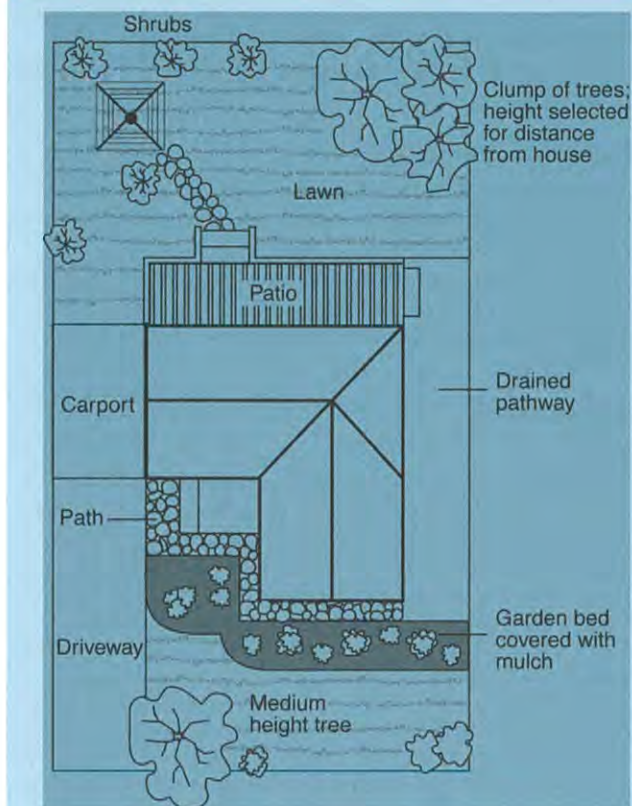
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving should

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly.	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired.	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted.	15–25 mm but also depends on number of cracks	4

Gardens for a reactive site



extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

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Douglas Partners

Geotechnics | Environment | Groundwater

Report on
Preliminary Geotechnical Investigation

Proposed Residential Development
Victoria Road, Wattle Grove, WA

Prepared for
The Trustee for the Wattle Grove Trust

Project 96730.04
December 2022

Integrated Practical Solutions



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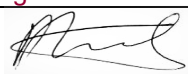
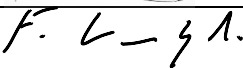
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Table of Contents

	Page
1. Introduction.....	1
2. Site Description	2
3. Field Work Methods	2
4. Field Work Results	3
4.1 Ground Conditions	3
4.2 Groundwater	3
4.3 Results of Infiltration Testing	4
5. Laboratory Testing	4
6. Proposed Development.....	5
7. Comments	5
7.1 Site Suitability	5
7.2 Site Classification.....	6
7.3 Excavation Conditions	6
7.4 Site Preparation	6
7.4.1 Site Stripping.....	6
7.4.2 Proof Compaction	7
7.4.3 Re-use of Materials	7
7.4.4 Compaction	8
7.5 Pavement Design Parameters	8
7.6 Site Drainage and Reactive Materials	9
8. References	9
9. Limitations	10
 Appendix A: About This Report	
Appendix B: Drawing 1	
Results of Field Work	
Appendix C: Laboratory Test Certificates	

Report on Preliminary Geotechnical Investigation

Proposed Residential Development

Victoria Road, Wattle Grove, WA

1. Introduction

This report presents the results of a preliminary geotechnical investigation undertaken for a proposed residential development across various lots on Victoria Road, Wattle Grove, WA. The investigation was commissioned in an email dated 27 October 2022 by Hesperia Projects on behalf of The Trustee for the Wattle Grove Trust and was undertaken in accordance with Douglas Partners' proposal P96730.04.P.001.Rev1 dated 25 October 2022.

It is understood that the parcel of land to the east of Tonkin Highway will be redeveloped to include a commercial precinct, medium density residential land-use, a primary school site and public open space. At this stage, access has been provided to selected properties within the overall development area, to allow a preliminary geotechnical assessment of the ground conditions.

The aim of this preliminary geotechnical investigation was to assess the subsurface soil and groundwater conditions across the site in order to provide preliminary comments on:

- the possible presence of fill materials, unsuitable foundation materials, rock or coffee rock and the distribution of clayey soils, if encountered;
- the site suitability and improvements that may be required to support the proposed development, and if significant variation in the ground conditions are anticipated;
- the site classification in accordance with the requirements of AS 2870-2011, and the likely earthworks requirements in terms of sand fill thicknesses to improve the classification to achieve 'Class S' and 'Class A';
- general site preparation requirements including comments on excavatability and earthworks to suitably prepare the ground for the proposed development;
- the suitability of the in situ material, from a geotechnical perspective, for re-use as structural fill;
- parameters for pavement design, including a suitable California bearing ratio value based on field observations;
- the depth to groundwater at the time of the investigation, if encountered;
- the permeability of the encountered soils at the site, to allow comments on stormwater disposal suitability, and general drainage conditions across the site.

The investigation included the excavation of twelve test pits and laboratory testing of selected samples. This investigation is subsequent to an earlier investigation across various other lots in the same proposed development area, with the results reported in Douglas Partners report 96730.01.R.001.Rev0, dated November 2020.

2. Site Description

The investigation was undertaken across various lots along Victoria Road in Wattle Grove, as indicated on Drawing 1.

The site typically consists of semi-rural residential allotments, and includes houses, sheds and other small structures, areas of hardstand and paddocks. Vegetation generally consisted of short length grass and shrubs, with medium to tall sized trees.

The 1:50 000 scale Armadale Environmental Geology map indicates that the shallow ground conditions across the site predominantly comprise soils of the Yoganup Formation, with some areas comprising Bassendean Sand, locally overlying clayey materials of the Guildford Formation at a shallow depth.

The site is undulating, with a high point at RL 33 m AHD at the eastern side, sloping down to RL 25 m AHD at the western side and RL 29 m AHD at the southern side of the site.

The Perth Ground water Atlas (2004) indicates that the regional groundwater level beneath the site in May 2003 (i.e. near seasonal low levels for that year) was between RL 13 m AHD and RL 15 m AHD, approximately 10 m to 16 m below the existing surface level. However, our experience indicates that shallower groundwater perched on the Guildford Formation is possible.

3. Field Work Methods

The field work for the current phase of the investigation was carried out on 1 November 2022 and comprised:

- the excavation of 12 test pits; and
- in-situ infiltration testing at three locations.

The test pits (test locations 101 to 112) were excavated using an 8 tonne backhoe with 450 mm wide toothed bucket, to depths of up to 2.5 m. The ground conditions were logged in accordance with AS 1726-2011 by a geotechnical engineer, and samples collected from selected locations for laboratory analysis. Perth sand penetrometer testing was carried out adjacent to each test pit location in accordance with AS 1289.6.3.3, to assess the in-situ density of the soils.

Test locations were determined using a differential GPS and site features and are marked on Drawing 1 in Appendix B. Surface elevations at the test locations were also obtained using a differential GPS, with a reported accuracy of 0.1 m, and are provided on the test pit logs in Appendix B.

4. Field Work Results

4.1 Ground Conditions

Logs of the ground conditions are presented in Appendix B, and should be read in conjunction with the notes defining descriptive terms and classification methods provided in Appendix A.

The ground conditions at the tested locations generally comprised either topsoil or uncontrolled fill overlying Bassendean Sand and Yoganup Sand, with cemented sand (coffee rock) encountered at several locations. Silty and clayey soils of the Yoganup Formation were encountered at four locations underlying the sand. A summary of the ground conditions encountered at the test locations is given below:

- **Uncontrolled FILL:**
 - o **FILL (SAND SP)** – grey-brown, fine to medium grained, with silt, 0.25 m thick, encountered at location 103.
 - o **FILL (Gravelly SAND SP-SM)** – brown and grey-brown, 0.1 m thick, encountered at location 106.
- **TOPSOIL (SAND SP, SP-SM)** – 100 mm to 150 mm thick, dark grey-brown and grey-brown, sand trace/with silt, roots and rootlets.
- **SAND SP** – pale grey and locally pale yellow-brown at depth, fine to medium grained, generally trace silt, generally loose to medium dense, at all test locations underlying the topsoil or fill to depths of between 0.5 m and test pit termination depths of up to 2.5 m.
- **Cemented SAND SP-SM (Coffee Rock)** – generally weakly to moderately cemented, dark brown, occurring as a layer of variable thickness at several locations within the sand layer (SP). Typically between approximately 0.2 m and 0.4 m in thickness.
- **SAND SP-SM** – yellow-brown, fine to medium grained, with silt, underlying the sand (SP) or cemented sand, at several locations.
- **Silty SAND SM / Silty Sandy GRAVEL GM / Sandy GRAVEL GP** – orange-brown and yellow-brown, fine to medium grained, fine to coarse sized, generally loose to medium dense, weakly cemented, underlying the sand (SP-SM) from a depth of between 0.6 m and 1.9 m at test locations 109 to 112.
- **Clayey Sandy GRAVEL GC** – fine to coarse sized, yellow-brown mottled grey, underlying the sandy gravel material from a depth of 1.8 m, at location 110.

4.2 Groundwater

No free groundwater was observed at the test locations 101 to 112 undertaken on 1 November 2022 to depths of up to 2.5 m. The test pits were immediately backfilled following sampling, which precluded longer-term monitoring of groundwater levels.

It should be noted that groundwater levels are affected by climatic conditions and land usage and will therefore vary with time.

4.3 Results of Infiltration Testing

In situ infiltration tests was undertaken at test locations 103, 108 and 111 using a falling head method, with a soil permeability value estimated from the results using a method based on a calculation by Hvorslev (1951). The results are summarised in Table 1 below.

Table 1: Summary of In Situ Infiltration Test Results

Test Location	Depth (m)	Measured Permeability		In situ Conditions of Tested Material
		(m/s)	(m/day)	
103	1.0	6.1×10^{-4}	>20	SAND SP, trace silt, medium dense, pale grey
108	1.0	8.2×10^{-5}	7.1	SAND SP-SM, with silt, loose to medium dense, yellow-brown
111	1.3	2.7×10^{-5}	2.4	Silty SAND SM, loose to medium dense, orange-brown

5. Laboratory Testing

A geotechnical laboratory testing programme was carried out on selected soil samples by a NATA registered laboratory, and comprised the determination of:

- the particle size distributions of 8 samples; and
- the Atterberg limits and linear shrinkage of two samples.

The test certificates are presented in Appendix C, with the results summarised in Table 2, next page.

Table 2: Results of Laboratory Testing for Soil Identification

Test Location	Depth (m)	Fines (%)	Sand (%)	Gravel (%)	LL (%)	PL (%)	PI (%)	LS (%)	Material
106	1.0	3	97	0	-	-	-	-	SAND SP, trace silt, grey
107	2.3	8	92	0	-	-	-	-	SAND SP-SM, with silt, pale yellow
108	1.5	9	91	0	-	-	-	-	SAND SP-SM, with silt, yellow-brown
110	1.0	3	33	64	-	-	-	-	Sandy GRAVEL GP, trace silt
110	2.0-2.5	23	35	42	37	16	21	8.5	Clayey Sandy GRAVEL GC, medium plasticity
111	1.3	17	83	0	-	-	-	-	Silty SAND SM, orange-brown
111	2.5	23	77	0	-	-	-	-	Silty SAND SM, orange-brown
112	1.5	17	83	0	NO	NP	NP	0	Silty SAND SM, orange-brown

Notes: Fines are particles smaller than 75 µm.
 Sand is particles larger than 75 µm and smaller than 2.36 mm.
 Gravel is particles larger than 2.36 mm and smaller than 63 mm.
 PL: plastic limit LL: liquid limit PI: plasticity Index LS: linear shrinkage
 NO: Not Obtainable NP: Non-Plastic
 '-' not tested.

6. Proposed Development

It is understood that the proposed development of the site includes a commercial precinct, medium density residential land-use, a primary school and public open space.

7. Comments

7.1 Site Suitability

The results of the investigation indicate that shallow ground conditions across the site generally comprise topsoil and loose to medium dense sand (either fill or natural) overlying cemented sand (coffee rock) and clayey materials. Relatively shallow uncontrolled fill was encountered at isolated locations.

From a geotechnical standpoint, the land is considered to be physically capable of development provided that site preparation is undertaken as outlined in the following sections of this report.

7.2 Site Classification

Site classification is determined in accordance with AS 2870-2011 and is based on the expected ground surface movement and the depth to which this soil movement extends. The depth of soil suction change at this site is assessed to be 1.8 m.

The shallow ground conditions encountered across the site are variable from a site classification standpoint. Ground conditions generally consist of sand overlying silty sand and clayey sandy gravel materials. Based on a visual and tactile assessment together with limited laboratory testing, the clayey sandy gravel forms a slightly reactive layer. Various uncontrolled fill materials were also encountered across the site.

Following suitable site preparation as described in Section 7.4, the site would be classified as:

- 'Class A' where there is at least 1.8 m of sand present overlying any clayey materials.
- 'Class S' where there is at least 1.2 m of sand present overlying any clayey materials.

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

7.3 Excavation Conditions

Based on the ground conditions described in Section 4.1, excavations associated with bulk earthworks, service trenches and foundations are anticipated to be undertaken through medium dense to dense sand, silty sand and clayey sandy gravel. Coffee rock was encountered at several test locations however at these locations it was excavated with relative ease using an 8 tonne backhoe. Stronger coffee rock could possibly occur elsewhere at the site.

In general, excavations should be readily achieved using typical earthmoving equipment (ie excavators, loaders, and scrapers). Consideration can be given to using larger excavators (greater than 20 tonne) with toothed buckets to excavate through cemented materials such as coffee rock.

7.4 Site Preparation

Inspections of earthworks should be undertaken by an experienced geotechnical engineer, in general accordance with the guidelines set out for Level 2 inspections within AS 3798-2007, as a minimum requirement.

7.4.1 Site Stripping

All deleterious material, including vegetation, topsoil and uncontrolled fill (such as encountered at locations 103 and 106), should be stripped from within development areas and either removed from site or stockpiled for possible treatment and re-use, if applicable (see Section 7.4.3). Uncontrolled fill should be excavated to its full depth, and either removed from site or assessed by a geotechnical engineer for its possible suitability for re-use applications.

Tree roots should also be removed, with the site grubbed to at least 0.5 m depth below surface level. Existing pavements, structures including their footings, associated buried services, soakwells and other infrastructure should be completely removed. Any excavations occurring from stripping and grubbing activities should be backfilled with material similar to the adjacent subgrade and suitably compacted.

7.4.2 Proof Compaction

Following site stripping and removal of all unsuitable materials, it is recommended that the exposed subgrade soils across the site should be compacted using a heavy (minimum of 14 tonne) smooth drum roller. All proposed building envelope and pavement areas should be compacted to target a minimum blow count of 8 blows per 300 mm penetration when tested with a PSP to a depth of not less than 1 m below the existing surface level, to ensure suitable densification of the identified loose sand across the site.

Any areas that show signs of excessive deformation during compaction should be continually compacted until deformation ceases. Alternatively, the poor-quality material could be excavated and replaced with suitable structural filling compacted to achieve not less than 8 blows per 300 mm rod penetration when tested using a PSP. Care should be taken not to operate heavy vibrating plant immediately adjacent to existing buildings and services.

Confirmation of site stripping and suitable compaction should be verified by a geotechnical engineer, prior to placement of any fill materials.

7.4.3 Re-use of Materials

The naturally occurring light grey sand (Bassendean Sand) is considered suitable for re-use as structural fill for urban development, and should form a well-drained material. The material should be free from organic matter and particles greater than 150 mm in size.

The naturally occurring yellow-brown sand (Yoganup Sand) is also considered suitable for re-use as structural fill. However the fines content of this sand, which generally increases with depth, is anticipated to preclude its re-use in applications requiring good drainage conditions. Following placement and compaction, the yellow-brown sand is expected to have a permeability below typical local earthworks specifications of 5 m/day.

Sandy topsoil was recorded over a thickness of 100 mm and 150 mm within the test pits undertaken at the site. A general procedure for the re-use of sandy topsoil which is considered suitable for this site is:

- Stripping and stockpiling the topsoil, followed by removal of the bulk of the large organic particles by passing the topsoil through a screen with an aperture size of say 25 mm; and
- Blending the screened topsoil with clean sand. A preliminary blending ratio of approximately 2:1 (clean sand : topsoil/organic sand) is suggested at this stage, but this blending ratio should be refined following assessment of the material resulting from the screening operations.

The suitability of the screened material should also be regularly assessed by a geotechnical engineer (including the determination of organic content and particle size gradings) for approval prior to use as fill, which may also result in optimisation of the blending ratio.

Blended fill materials typically have a reduced permeability in comparison with clean sand, and therefore verification of the permeability of the blended material is suggested, prior to use. Any material considered unsuitable for use as fill by the geotechnical engineer should be removed from the site or used in non-structural areas.

Following excavation of uncontrolled fill materials during site stripping, it is recommended that the materials are assessed by a geotechnical engineer to assess their suitability of re-use. It is anticipated that most soil materials can be re-used somewhere within the site following suitable preparation, to limit off-site disposal costs. Prior to re-use, uncontrolled fill materials may require raking or screening to remove deleterious or large particles, and blending with other soils, subject to assessment and verification by a geotechnical engineer on a case by case basis.

7.4.4 Compaction

Materials approved by a geotechnical engineer for use as structural fill should be placed in layers within 2% of the optimum moisture content. Each layer should be compacted to achieve a dry density ratio of not less than 95% relative to modified compaction. The type of roller (smooth drum or pad foot) and the use of vibratory modes should be at the discretion of the earthwork's contractor based on the encountered subgrade, the depth to groundwater, and the size and type of compaction plant.

Compaction control in sand could be carried out using a Perth sand penetrometer (PSP) test in accordance with test method AS 1289.6.3.3, after the relationship between PSP blow counts and soil dry density ratio has been established by a NATA accredited laboratory and following review by a geotechnical engineer.

It is recommended that the compaction control of clayey materials is carried out using a nuclear surface moisture-density gauge, in accordance with AS 1289.5.8.1, noting however that clayey materials were encountered more than 1.8 m below existing ground level and might impact earthworks only if significant cutting of the site or relatively deep excavations are proposed.

It is recommended that verification of the compaction works be undertaken by an experienced geotechnical engineer.

During construction, some loosening of the surface sands in foundation excavations is expected. Therefore, the top 300 mm in the base of any excavation should be re-compacted using a vibratory plate compactor prior to construction of any footings.

7.5 Pavement Design Parameters

Based on field observations and Douglas Partners' experience, it is suggested that a preliminary subgrade California bearing ratio (CBR) of 12% be considered for the design of flexible pavements on the natural grey Sand (noted 'SP' in the logs in Appendix B) where a minimum of 0.5 m of sand exists below subgrade level. A presumptive design CBR value of 8% is recommended if the orange-brown and yellow-brown Silty Sand (SP-SM) of the Yoganup Formation is within 0.5 m of the proposed pavement subgrade level, unless results of further laboratory testing indicate the suitability to adopt of greater design CBR value. These design CBR values assumed that the sand subgrade is compacted to achieve a dry density ratio of not less than 95% relative to modified compaction, as determined by AS 1289.5.2.1.

It is recommended that subgrade be inspected by a suitably experienced geotechnical engineer prior to placement of the pavement layers to identify unsuitable subgrade materials, if any.

7.6 Site Drainage and Reactive Materials

The shallow soil conditions beneath the site generally comprise sand, trace silt to with silt, overlying sand with clay and clayey sand. Based on the infiltration testing undertaken, the estimated permeability rates for the sandy soils in their in situ (prior to any earthworks) conditions are:

- Bassendean Sand (light grey, trace silt): 20 m/day;
- Yoganup Sand (yellow-brown, with silt and increasing fines content with depth): 2 m/day to 7 m/day.

These permeability values are anticipated to decrease following densification of the soils during earthworks. Based on our experience in similar ground conditions, following compaction the Yoganup sand is anticipated to have a generally low permeability, and is unlikely to form a suitably draining material for on-site stormwater disposal, unless specific additional drainage provisions are adopted.

The clayey sandy gravel and silty sand should be considered impermeable for site drainage following earthworks.

In areas with shallow clearance to low permeability layers, water may pond as it infiltrates through the sand, collecting on the underlying silty sand SM (and to a lesser extent the sand with silt SP-SM). Localised low-points in the underlying silty sand surface may trap water, resulting in waterlogged conditions near surface. It is also expected that the infiltration capacity of the site soils will reduce due to compaction works during earthworks on-site. If soakwells are selected for stormwater disposal, the provision of measures such as overflow outlets should be considered. Some ponding of water at surface may occur during heavy or prolonged rainfall events, following densification of the sand during site works.

The clayey sandy gravel underlying the site is slightly reactive and therefore has some propensity to swell and shrink with moisture variation resulting in surface movement. It is recommended that attention be given to minimise moisture content changes within these clayey materials through the adoption of appropriate measures, such as ensuring that:

- The site is well drained, both during construction and throughout the life of structures on the site.
- Plumbing systems be maintained and repaired to avoid leaks beneath and around structures.
- No large trees be planted adjacent to structures.
- Irregular or excessive watering around the structures be avoided.

8. References

AS 1289.6.3.3. (1997). *Methods for testing soils for engineering purposes - Soil strength and consolidation tests - Determination of the penetration resistance of a soil - Perth sand penetrometer test*. Reconfirmed 2013: Standards Australia.

AS 1726. (2017). *Geotechnical Site Investigations*. Standards Australia.

AS 2870. (2011). *Residential Slabs and Footings*. Standards Australia.

AS 3798. (2007). *Guidelines on Earthworks for Commercial and Residential Developments*. Standards Australia.

Department of Environment. (2004). *Perth Groundwater Atlas, Second Edition, Dec 2004*.

Hvorslev, M. J. (1951). *Time lag and soil permeability in groundwater observations*. US Army Corps of Engineers Waterways Experiment Observation Station, Bulletin 36, Vicksburg, Mississippi.

9. Limitations

Douglas Partners (DP) has prepared this preliminary geotechnical report for the proposed Wattle Grove development at various lots on Victoria Road in Wattle Grove, WA in accordance with DP's proposal P96730.04 dated 25 October 2022 and acceptance received from Hesperia Projects on behalf of The Trustee for the Wattle Grove Trust dated 27 October 2022. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of The Trustee for the Wattle Grove Trust for the proposed Wattle Grove development at various lots on Victoria Road in Wattle Grove only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

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

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

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

The scope of work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of fill of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such fill may contain contaminants and hazardous building materials.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners



Introduction

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

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

Copyright

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

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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



Sampling

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

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

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

Test Pits

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

Large Diameter Augers

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

Continuous Spiral Flight Augers

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

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

Non-core Rotary Drilling

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

Continuous Core Drilling

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

Standard Penetration Tests

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

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

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:
4,6,7
N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:
15, 30/40 mm

Sampling Methods

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

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



Description and Classification Methods

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

Soil Types

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

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

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

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

Definitions of grading terms used are:

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

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

In fine grained soils (>35% fines)

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

In coarse grained soils (>65% coarse)

- with clays or silts

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

In coarse grained soils (>65% coarse)

- with coarser fraction

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

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

Soil Descriptions

Cohesive Soils

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

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

Cohesionless Soils

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

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

Soil Origin

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

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

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

Moisture Condition – Coarse Grained Soils

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

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
Soil tends to stick together.
Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

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

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

Symbols & Abbreviations

Douglas Partners



Introduction

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

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U ₅₀	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

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

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

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

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

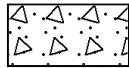
General



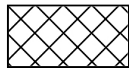
Asphalt



Road base



Concrete



Filling

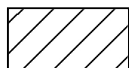
Soils



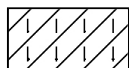
Topsoil



Peat



Clay



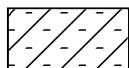
Silty clay



Sandy clay



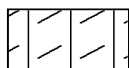
Gravelly clay



Shaly clay



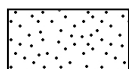
Silt



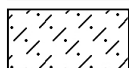
Clayey silt



Sandy silt



Sand



Clayey sand



Silty sand



Gravel



Sandy gravel



Cobbles, boulders



Talus

Sedimentary Rocks



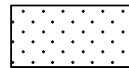
Boulder conglomerate



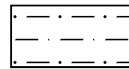
Conglomerate



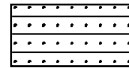
Conglomeratic sandstone



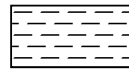
Sandstone



Siltstone



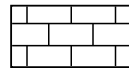
Laminite



Mudstone, claystone, shale

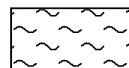


Coal

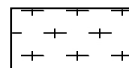


Limestone

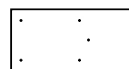
Metamorphic Rocks



Slate, phyllite, schist

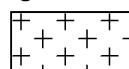


Gneiss

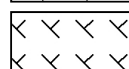


Quartzite

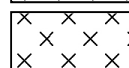
Igneous Rocks



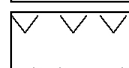
Granite



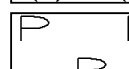
Dolerite, basalt, andesite



Dacite, epidote



Tuff, breccia



Porphyry

Appendix B

Drawing 1
Results of Field Work



 Douglas Partners Geotechnics Environment Groundwater	Test Pit Locations	PROJECT: 96730.04
	Preliminary Geotechnical Investigation	Drawing No: 1
	Victoria Road, Wattle Grove, WA	REV: 0
	CLIENT: The Trustee for the Wattle Grove Trust	DATE: 29/11/2022

TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 25.0 m AHD*
EASTING: 405877
NORTHING: 6457393

PIT No: 101
PROJECT No: 96730.04
DATE: 1/11/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
25.0	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, moist, topsoil. SAND SP: fine to medium grained, pale grey, trace silt, moist, medium dense. Bassendean Sand.										
24.0	1.2	Cemented Silty SAND SM: fine to medium grained, dark brown, moist, moderately to well cemented. Coffee rock.										
23.0	1.6	SAND SP: fine to medium grained, pale brown, trace silt, moist. Bassendean Sand. - becoming pale grey from 1.8 m depth.										
22.0	2.5	Pit discontinued at 2.5m (Target depth)		D	2.5							



RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 25.5 m AHD*
EASTING: 405993
NORTHING: 6457298

PIT No: 102
PROJECT No: 96730.04
DATE: 1/11/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, moist, topsoil. SAND SP: fine to medium grained, pale grey, trace silt, moist, medium dense. Bassendean Sand.										
	1.1	Cemented Silty SAND SM: fine to medium grained, brown and dark brown, moist, weakly to moderately cemented. Coffee rock.										
	1.5	SAND SP: fine to medium grained, pale grey, trace silt, moist. Bassendean Sand.										
	2.5	Pit discontinued at 2.5m (Target depth)										



RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 23.5 m AHD*
EASTING: 405655
NORTHING: 6457234

PIT No: 103
PROJECT No: 96730.04
DATE: 1/11/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.25	FILL/TOPSOIL: SAND SP: fine to medium grained, grey-brown, trace silt, moist, medium dense, fill.		D	1.0							
		SAND SP: fine to medium grained, pale grey, trace silt, moist, medium dense. Bassendean Sand.										
	2.5	Pit discontinued at 2.5m (Target depth)										



RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 24.5 m AHD*
EASTING: 405776
NORTHING: 6457181

PIT No: 104
PROJECT No: 96730.04
DATE: 1/11/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
24	0.15	FILL/SAND SP: fine to medium grained, grey-brown and brown, trace silt, moist, fill. Plastic wrap observed in fill. SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.3 m depth.										
1												
23												
2	2.0	Cemented Silty SAND SM: fine to medium grained, dark brown, moist, moderately to well cemented. Coffee rock.										
	2.2	Pit discontinued at 2.2m (Slow digging)										
22												




RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 24.4 m AHD*
EASTING: 405726
NORTHING: 6457045

PIT No: 105
PROJECT No: 96730.04
DATE: 1/11/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
24	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, moist, topsoil. SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.3 m depth.		D	0.05							
23												
22	2.1	Cemented Silty SAND SM: fine to medium grained, dark brown and brown, moist, moderately to well cemented. Coffee rock.										
21	2.5	Pit discontinued at 2.5m (Target depth)										



RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 23.8 m AHD*
EASTING: 405681
NORTHING: 6457119

PIT No: 106
PROJECT No: 96730.04
DATE: 1/11/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.1	FILL/Gravelly SAND SP-SM: fine to medium grained, brown and grey-brown, fine to medium sized, with silt, moist, fill. SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.3 m depth.										
	1			D	1.0							
	2											
	2.5	Pit discontinued at 2.5m (Target depth)										



RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 25.7 m AHD*
EASTING: 405766
NORTHING: 6456928

PIT No: 107
PROJECT No: 96730.04
DATE: 1/11/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.1	TOPSOIL/SAND SP: fine to medium grained, dark grey-brown, trace silt, moist, topsoil. SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.4 m depth.										
	1.6	Cemented Silty SAND SM: fine to medium grained, brown, moist, weakly to moderately cemented. Coffee rock.										
	1.85	SAND SP-SM: fine to medium grained, pale yellow, with silt, moist, weakly cemented. Bassendean Sand.										
	2.3			D	2.3							
	2.5	Pit discontinued at 2.5m (Target depth)										



RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 29.5 m AHD*
EASTING: 405863
NORTHING: 6456798

PIT No: 108
PROJECT No: 96730.04
DATE: 1/11/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, moist, topsoil.										
		SAND SP: fine to medium grained, pale grey, trace silt, moist, medium dense. Bassendean Sand.										
	0.75	SAND SP-SM: fine to medium grained, yellow-brown, with silt, moist, loose to medium dense, weakly cemented. Yoganup Formation.		D	1.0							
				D	1.5							
	2.5	Pit discontinued at 2.5m (Target depth)										



RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 29.6 m AHD*
EASTING: 405985
NORTHING: 6456730

PIT No: 109
PROJECT No: 96730.04
DATE: 1/11/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.15	TOPSOIL/SAND SP: fine to medium grained, dark grey-brown, trace silt, moist, topsoil.										
		SAND SP: fine to medium grained, pale grey, trace silt, moist, loose to medium dense. Bassendean Sand.										
	1	- becoming pale yellow-brown from 0.9 m depth.										
	1.2	SAND SP-SM: fine to medium grained, yellow-brown, with silt, moist, loose to medium dense, weakly cemented. Yoganup Formation.										
		- trace pockets of Silty SAND SM from 1.7 m depth.										
	1.9	Silty Sandy GRAVEL GM: fine to coarse sized, yellow-brown and orange-brown, fine to medium grained, moist, loose to medium dense. Guildford Formation.										
	2.3			D	2.3							
	2.5	Pit discontinued at 2.5m (Target depth)										



RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 27.9 m AHD*
EASTING: 405924
NORTHING: 6456686

PIT No: 110
PROJECT No: 96730.04
DATE: 1/11/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.15	TOPSOIL/SAND SP-MS: fine to medium grained, dark grey-brown, with silt, moist, topsoil.										
	0.6	SAND SP: fine to medium grained, pale grey, trace silt, moist. Bassendean Sand.										
27	1	Sandy GRAVEL GP: fine to coarse sized, brown and grey-brown, fine to medium grained, moist, medium dense to dense. Guildford Formation.		D	1.0							
26	2	Clayey Sandy GRAVEL GC: fine to coarse sized, yellow-brown mottled grey, medium plasticity, fine to medium grained, moist. Guildford Formation.		B	2.0							
25	2.5	Pit discontinued at 2.5m (Target depth)			2.5							



RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 33.8 m AHD*
EASTING: 406337
NORTHING: 6457084

PIT No: 111
PROJECT No: 96730.04
DATE: 1/11/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, moist, topsoil.										
	0.5	SAND SP: fine to medium grained, grey-brown, trace silt, moist, medium dense. Yoganup Formation. - becoming pale yellow-brown from 0.2 m depth.										
	1.1	SAND SP-SM: fine to medium grained, yellow-brown, with silt, moist, loose to medium dense. Yoganup Formation.										
	1.3	Silty SAND SM: fine to medium grained, orange-brown, moist, loose to medium dense. Yoganup Formation.		D	1.3							
	2.5	- trace gravel from 2.2 m depth.										
	2.5	Pit discontinued at 2.5m (Target depth)		D	2.5							



RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

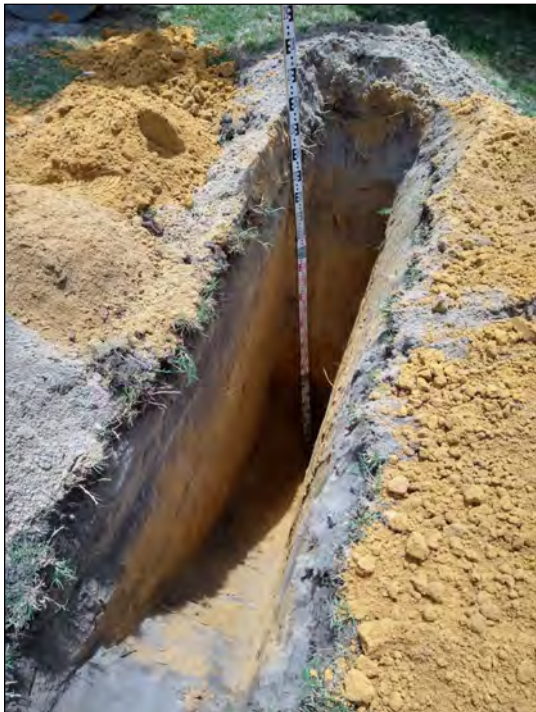
TEST PIT LOG

CLIENT: The Trustee for the Wattle Grove Trust
PROJECT: Proposed Wattle Grove Development
LOCATION: Victoria Road, Wattle Grove, WA

SURFACE LEVEL: 30.4 m AHD*
EASTING: 406158
NORTHING: 6457231

PIT No: 112
PROJECT No: 96730.04
DATE: 1/11/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, moist, topsoil.										
	0.5	SAND SP: fine to medium grained, grey-brown, trace silt, moist, medium dense. Yoganup Formation.										
	1.4	SAND SP-SM: fine to medium grained, yellow-brown, with silt, moist, medium dense, weakly cemented. Yoganup Formation.										
	1.4	Silty SAND SM: fine to medium grained, orange-brown, moist, medium dense. Yoganup Formation.		D	1.5							
	2.5	Pit discontinued at 2.5m (Target depth)										



RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 H

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level measured using a differential GPS with a reported accuracy of 0.1 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

Appendix C

Laboratory Test Results



SOIL | AGGREGATE | CONCRETE | CRUSHING

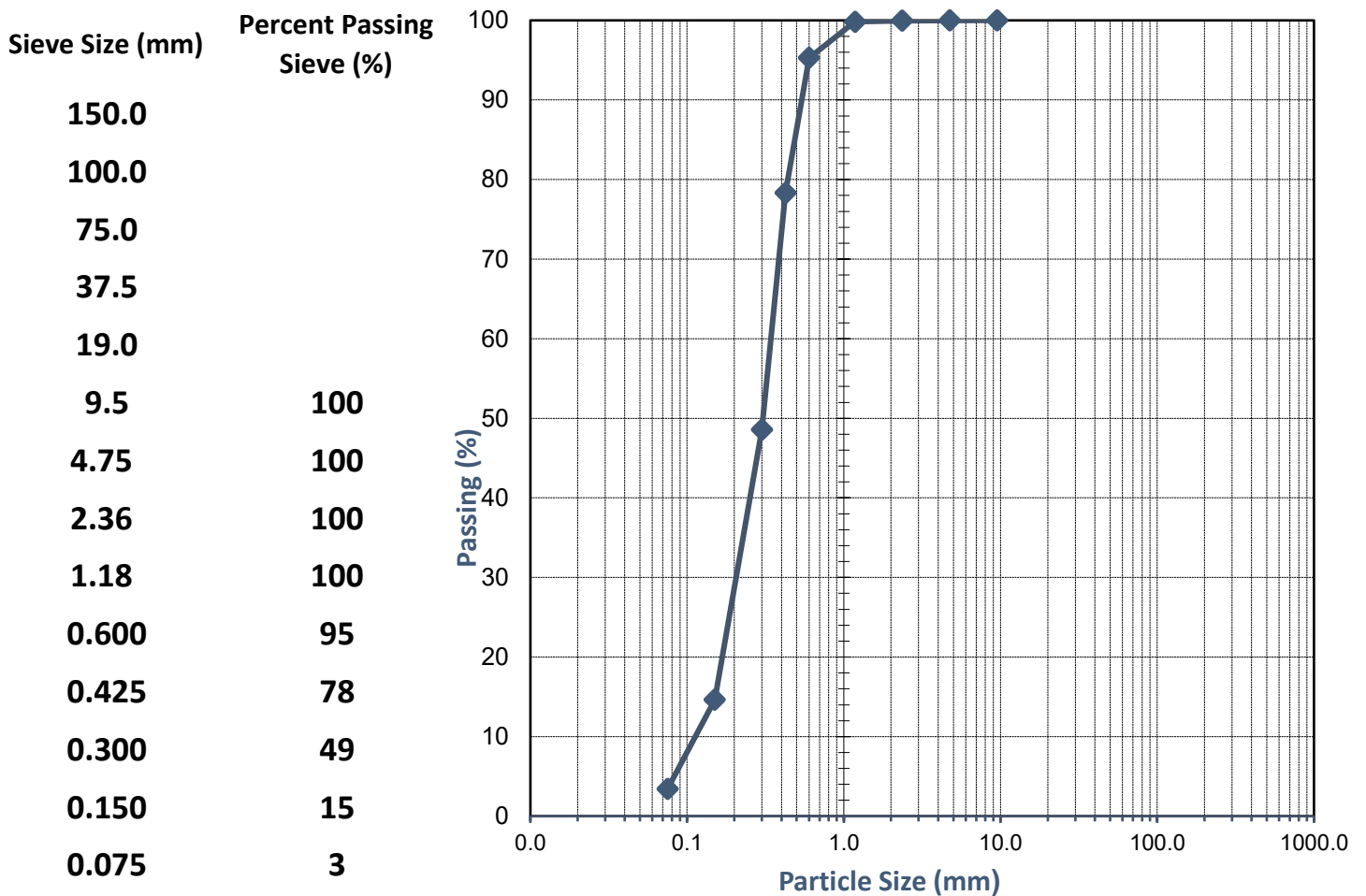
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	Ticket No.	S8061
Client Address:	-	Report No.	WG22.17764_1_PSD
Project:	Proposed Wattle Grove Development	Sample No.	WG22.17764
Location:	Victoria Road, Wattle Grove, WA	Date Sampled:	1/11/2022
Sample Identification:	TP 106, 1.0m	Date Tested:	23/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 23/November/2022



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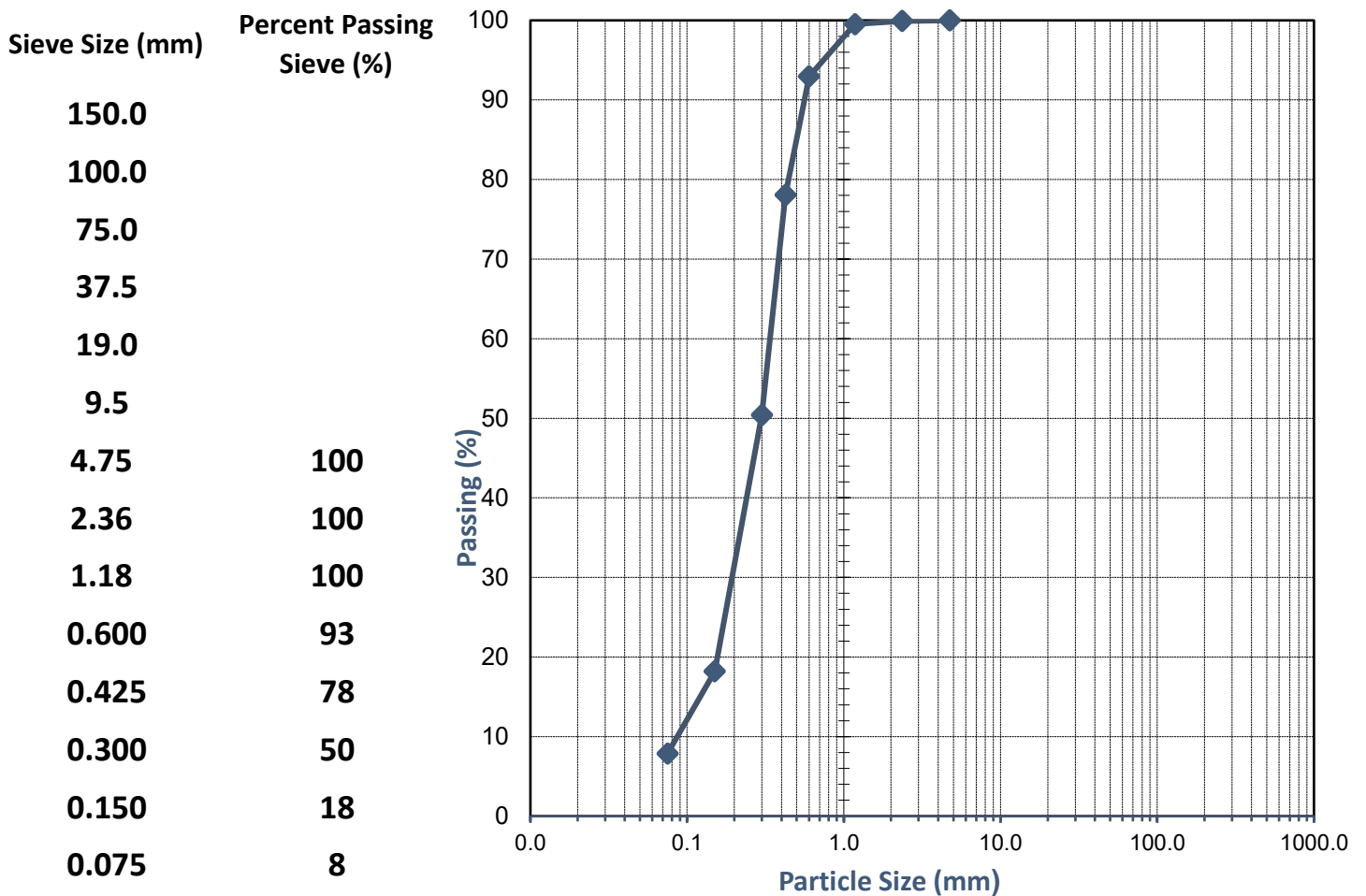
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	Ticket No.	S7965
Client Address:	-	Report No.	WG22.17228_1_PSD
Project:	Proposed Wattle Grove Development	Sample No.	WG22.17228
Location:	Victoria Road, Wattle Grove, WA	Date Sampled:	1/11/2022
Sample Identification:	TP107 2.3m	Date Tested:	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022



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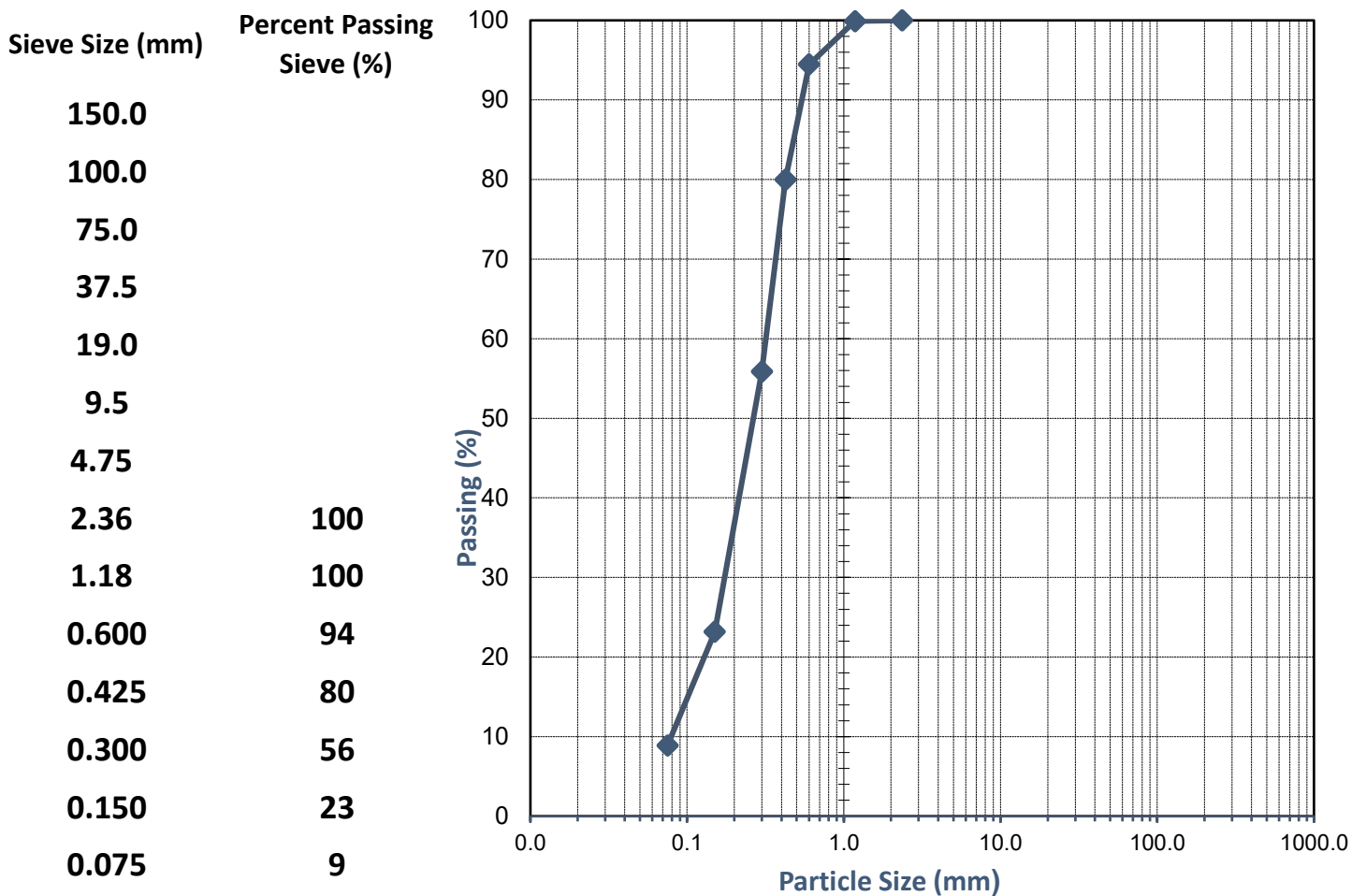
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	Ticket No.	S7965
Client Address:	-	Report No.	WG22.17229_1_PSD
Project:	Proposed Wattle Grove Development	Sample No.	WG22.17229
Location:	Victoria Road, Wattle Grove, WA	Date Sampled:	1/11/2022
Sample Identification:	TP108 1.5m	Date Tested:	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022



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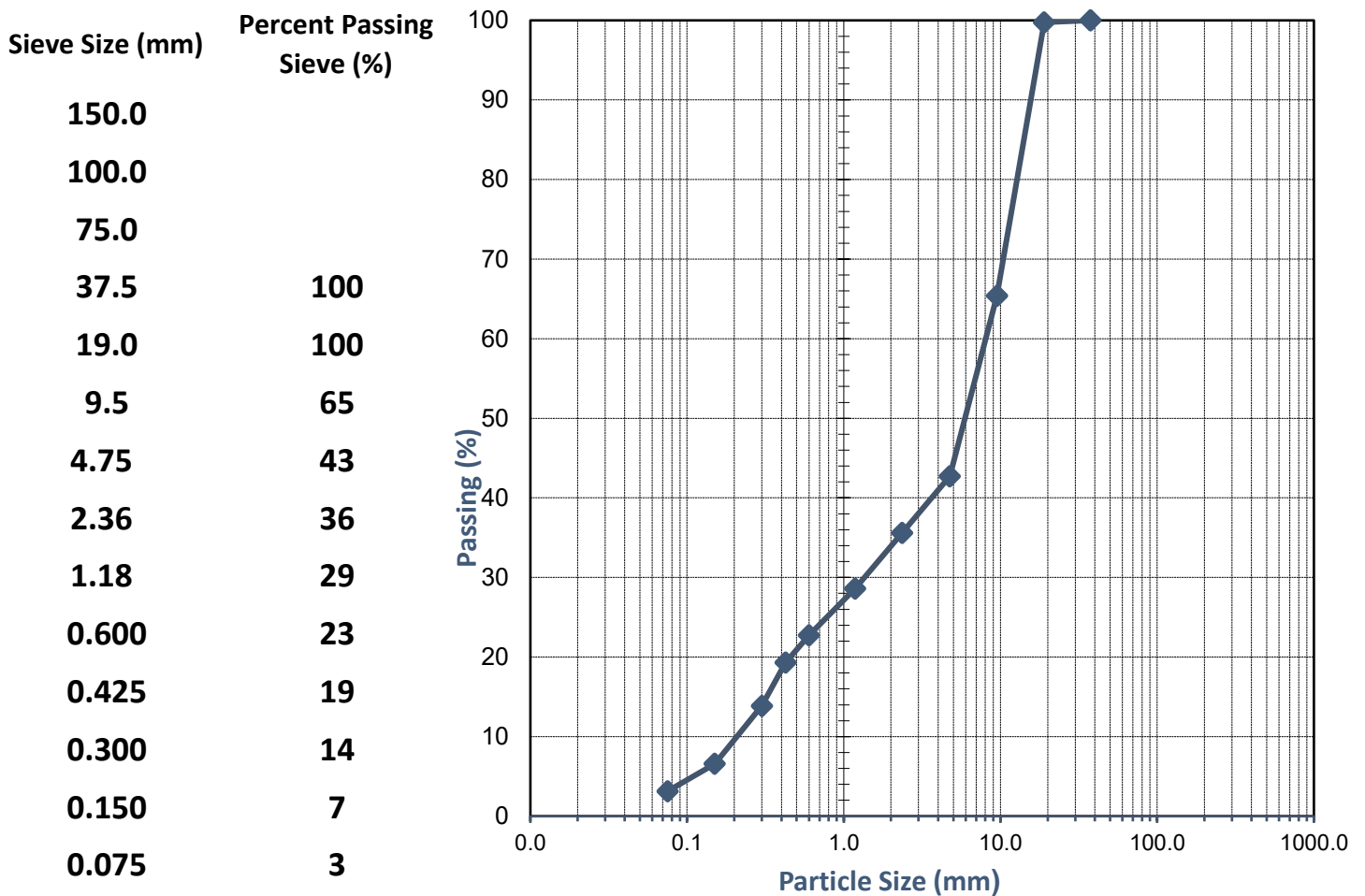
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	Ticket No.	S7965
Client Address:	-	Report No.	WG22.17230_1_PSD
Project:	Proposed Wattle Grove Development	Sample No.	WG22.17230
Location:	Victoria Road, Wattle Grove, WA	Date Sampled:	1/11/2022
Sample Identification:	TP110 1.0m	Date Tested:	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022



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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	The Trustee for the Wattle Grove Trust	Ticket No.	S7965
Client Address:	-	Report No.	WG22.17231_1_PI
Project:	Proposed Wattle Grove Development	Sample No.	WG22.17231
Location:	Victoria Road, Wattle Grove, WA	Date Sampled:	1/11/2022
Sample Identification:	TP110 2.0-2.5m	Date Tested:	11/11/2022

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:

Sampled by Client, Tested as Received

History of Sample:

Oven Dried <50°C

Method of Preparation:

Dry Sieved

AS 1289.3.1.1 Liquid Limit (%) 37

AS 1289.3.2.1 Plastic Limit (%) 16

AS 1289.3.3.1 Plasticity Index (%) 21

AS 1289.3.4.1 Linear Shrinkage (%) 8.5

AS 1289.3.4.1 Length of Mould (mm) 250

AS 1289.3.4.1 Condition of Dry Specimen: Cracked

Comments:

Approved Signatory:

Name: Madhav Basnet

Date: 14/November/2022



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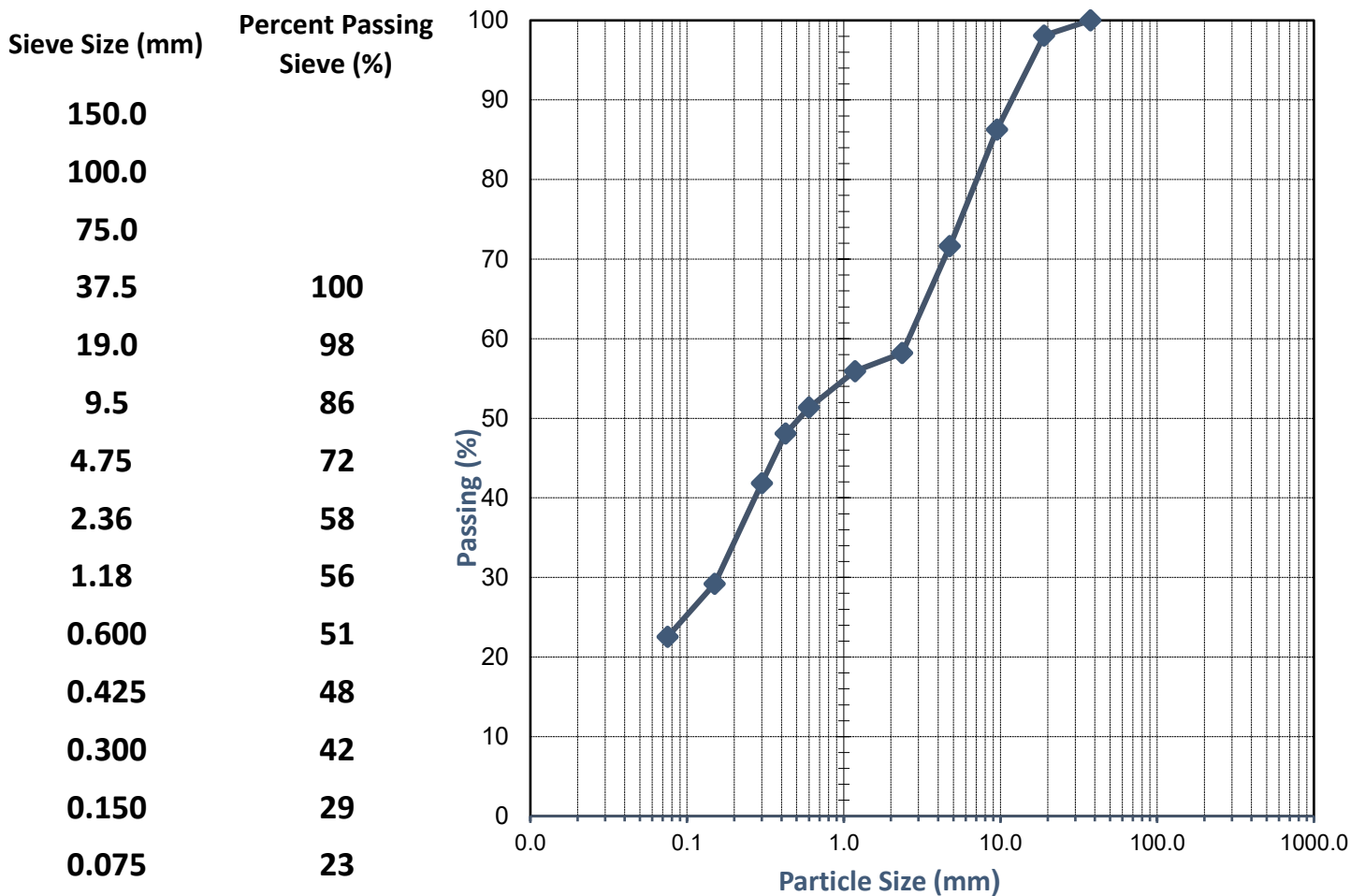
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	Ticket No.	S7965
Client Address:	-	Report No.	WG22.17231_1_PSD
Project:	Proposed Wattle Grove Development	Sample No.	WG22.17231
Location:	Victoria Road, Wattle Grove, WA	Date Sampled:	1/11/2022
Sample Identification:	TP110 2.0-2.5m	Date Tested:	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022



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SOIL | AGGREGATE | CONCRETE | CRUSHING

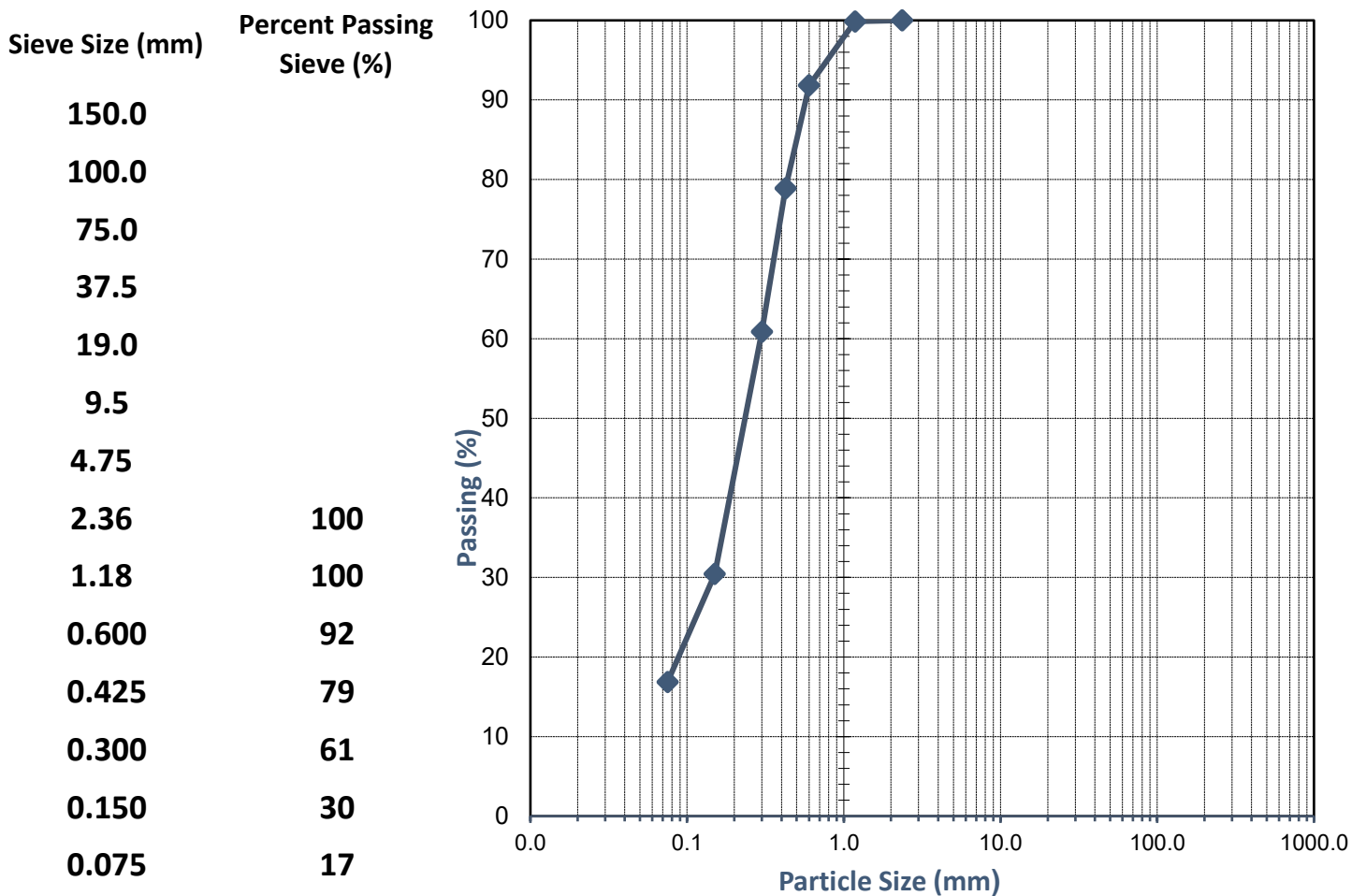
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	Ticket No.	S7965
Client Address:	-	Report No.	WG22.17232_1_PSD
Project:	Proposed Wattle Grove Development	Sample No.	WG22.17232
Location:	Victoria Road, Wattle Grove, WA	Date Sampled:	1/11/2022
Sample Identification:	TP111 1.3m	Date Tested:	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022



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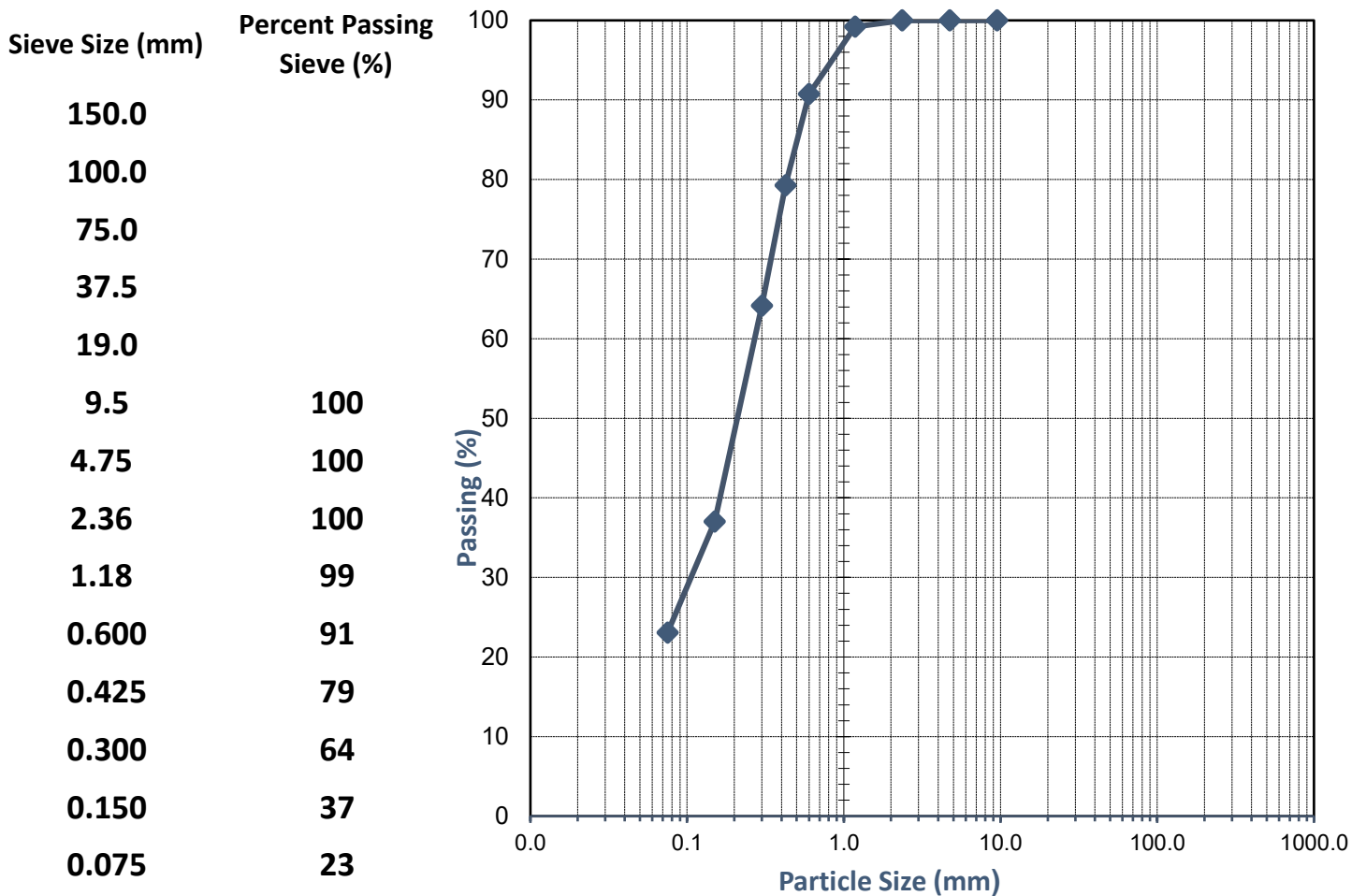
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	Ticket No.	S7965
Client Address:	-	Report No.	WG22.17233_1_PSD
Project:	Proposed Wattle Grove Development	Sample No.	WG22.17233
Location:	Victoria Road, Wattle Grove, WA	Date Sampled:	1/11/2022
Sample Identification:	TP111 2.5m	Date Tested:	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022



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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	The Trustee for the Wattle Grove Trust	Ticket No.	S7965
Client Address:	-	Report No.	WG22.17234_1_PI
Project:	Proposed Wattle Grove Development	Sample No.	WG22.17234
Location:	Victoria Road, Wattle Grove, WA	Date Sampled:	1/11/2022
Sample Identification:	TP112 1.5m	Date Tested:	11/11/2022

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:

Sampled by Client, Tested as Received

History of Sample:

Oven Dried <50°C

Method of Preparation:

Dry Sieved

AS 1289.3.1.1	Liquid Limit (%)	Not Obtainable
AS 1289.3.2.1	Plastic Limit (%)	Non-Plastic
AS 1289.3.3.1	Plasticity Index (%)	Non-Plastic
AS 1289.3.4.1	Linear Shrinkage (%)	0.0
AS 1289.3.4.1	Length of Mould (mm)	250
AS 1289.3.4.1	Condition of Dry Specimen:	-

Comments:

Approved Signatory:

Name: Madhav Basnet

Date: 14/November/2022



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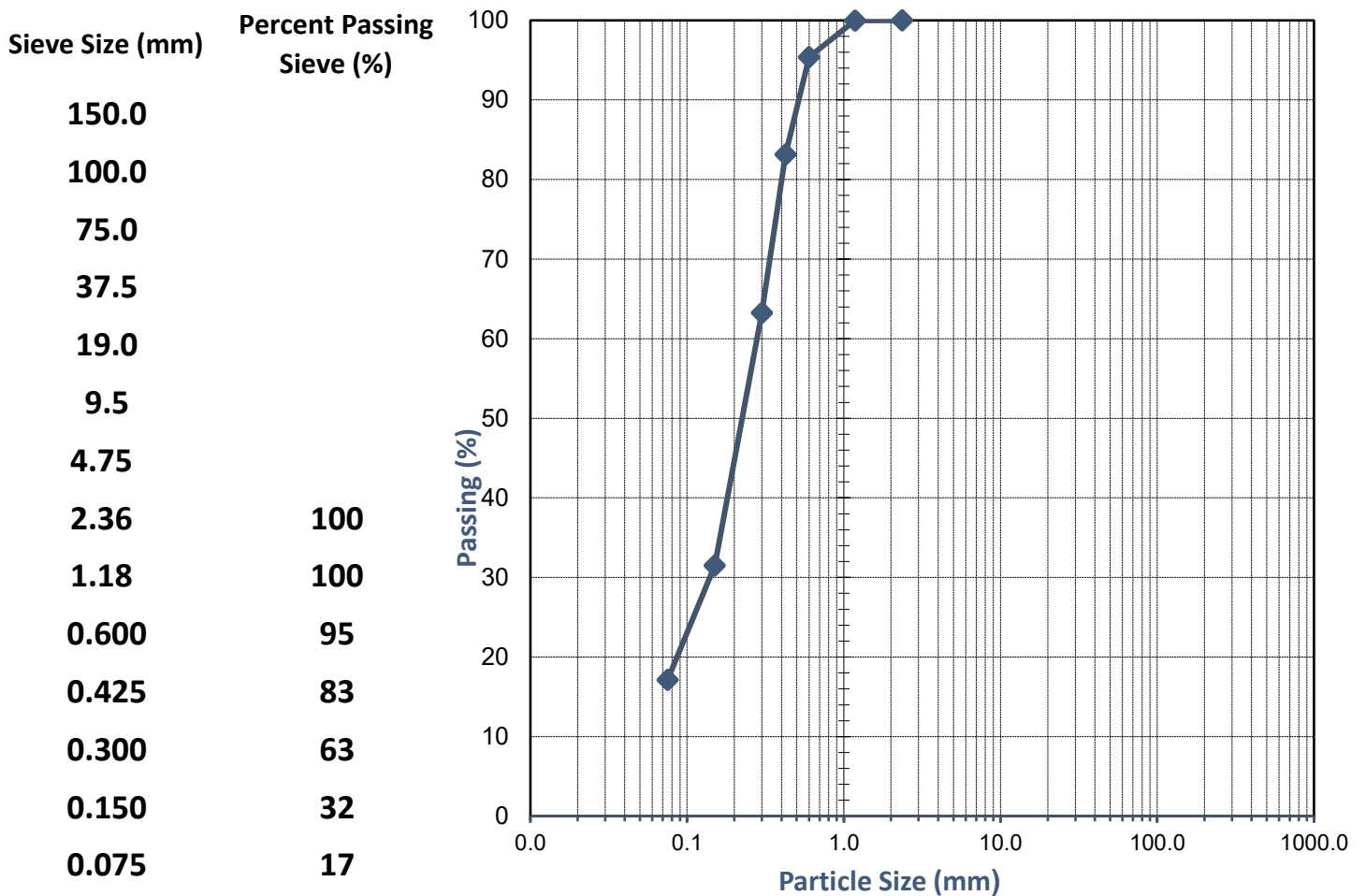
TEST REPORT - AS 1289.3.6.1

Client:	The Trustee for the Wattle Grove Trust	Ticket No.	S7965
Client Address:	-	Report No.	WG22.17234_1_PSD
Project:	Proposed Wattle Grove Development	Sample No.	WG22.17234
Location:	Victoria Road, Wattle Grove, WA	Date Sampled:	1/11/2022
Sample Identification:	TP112 1.5m	Date Tested:	10/11 - 11/11/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Natasha Bielawski

Date: 11/November/2022



Accreditation No. 20599

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APPENDIX C

Monitoring Bore Details & Logs

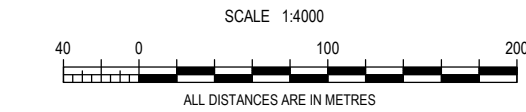
GDA94 (MGA50)										AHD71				Surface		SWL		Notes
Location	ID	Description	Development	Horizontal		Horizontal		Ellipsoidal Height (m)	Accuracy	n Value (m)	AHD (m) T.O.C.	Height Pipe A.G.L. (m)	Elevation (m)	T.O.C.				
				Accuracy	Accuracy	RWL (m)	RWL (m)											
														Easting (m) (m)	Northing (m) (m)	(m)	(m)	
Wattle Grove	WGG1	Piezometer	**	406115.254	0.020	6457799.939	0.020	1.224	0.020	-30.874	32.098	0.65	31.448	15.75	16.348	DGPS Control		
Wattle Grove	WGG2	Piezometer	**	405780.404	0.020	6457018.024	0.020	-4.808	0.020	-30.925	26.117	0.65	25.467	9.12	16.997	DGPS Control		
Wattle Grove	WGG3	Piezometer	**	405419.369	0.020	6457710.395	0.020	-8.007	0.020	-30.980	22.973	0.65	22.323	6.78	16.193	DGPS Control		
Wattle Grove	MBc	Piezometer	N/A	406182.479	0.020	6456899.787	0.020	2.488	0.060	-30.845	33.333	0.60	32.733	16.84	16.493	DGPS Control		
Wattle Grove	MBb	Piezometer	N/A	406066.860	0.020	6456783.321	0.020	1.026	0.020	-30.875	31.901	0.65	31.251	15.10	16.801	DGPS Control		
Wattle Grove	Mba	Piezometer	N/A	405245.280	0.020	6457957.717	0.020	-10.401	0.020	-31.011	20.610	0.58	20.030	1.86	18.750	DGPS Control		

*** Good Bore Development (Yield >=15L p/min.)
 ** Reasoanble Bore Development (Yield <15L p/min.)
 * Poor Bore Development (Low yield or ran dry)



All levels are related to SSM around the boreholes
(LES12,LES14A,LES15,LES16)
Horizontal Accuracy of ±30mm and Vertical Accuracy of ±3mm
Bore level observed on black mark on top of white casing
Aerial imagery extracted by Veris from Metromap on the day of survey

Point#	Easting	Northing	Casing RL	Ground RL	Code
BORE01	405735.85	6458037.07	25.728	25.11	BORE HOLE
BORE02	405735.28	6458036.18	25.659	25.11	BORE HOLE
BORE03	405351.33	6457885.04	23.497	22.85	BORE HOLE
BORE04	405352.15	6457884.35	23.437	22.90	BORE HOLE
BORE05	406304.11	6457567.00	35.144	34.54	BORE HOLE
BORE06	406304.16	6457565.91	35.129	34.55	BORE HOLE
BORE07	405789.50	6457474.08	25.344	24.64	BORE HOLE
BORE08	405781.41	6457018.25	26.012	25.21	BORE HOLE
BORE09	405590.09	6456775.37	24.515	24.00	BORE HOLE
BORE10	405328.62	6457512.04	21.811	21.19	BORE HOLE
BORE11	405329.46	6457512.65	21.775	21.20	BORE HOLE
BORE12	405052.99	6457750.12	19.372	18.81	BORE HOLE
Point#	Easting	Northing		RL	Code
BM1	405742.56	6458031.48		25.240	BENCH MARK
BM10	405059.11	6457741.72		19.061	BENCH MARK
BM3	405282.18	6457968.07		21.739	BENCH MARK
BM4	405360.16	6457891.54		23.432	BENCH MARK
BM5	406331.73	6457550.89		34.421	BENCH MARK
BM6	406034.47	6457246.28		27.184	BENCH MARK
BM7	405780.68	6456986.97		25.743	BENCH MARK
BM8	405581.97	6456783.17		23.704	BENCH MARK
BM9	405312.58	6457500.49		20.972	BENCH MARK
LES12	405420.649	6456628.288		23.622	SSM
LES14A	405799.243	6458119.909		25.582	SSM
LES15	405613.779	6457791.463		24.780	SSM
LES16	404773.293	6456929.885		13.289	SSM



NOTES

This plan has been prepared for the client and should not be used for any other purpose unless authorised by VERIS.

Prior to the commencement of any work, relevant authorities should be contacted for the location of underground services.

Due to overwriting some levels may be switched off for this plot only.

Levels are based on AHD.

This note is an integral part of this plan.

00	18/08/22	FIREST ISSUE	BL	AK	PR
Rev.	Date	Description	Surveyor	Drawn	Approved

veris

WESTERN AUSTRALIA
T 08 6241 3333

www.veris.com.au
veris.wa@veris.com.au

Client: Hesperia Property Pty Lt

Surveyed By: BL Survey Date: 17/08/2022

Drawn By: AK Drawn Date: 18/08/2022

Approved By: PR

Scale (A2): 1:4000

Hor Datum: MGA2020 Z50

Vert Datum: AHD_(Based_on_SSMs_LES12,LES14A,LES15,LES16)



GROUND WATER MONITORING WELL SURVEY
Brentwood and Victoria Roads
Wattle Grove

Job No Item No Plan No Rev
637149 - 000 - 001 - 00
Sheet 1 of 1



Point#	Easting	Northing	Casing RL	Ground RL	Code	NOTE
WG8	406958.96	6457833.84	41.766	41.08	BORE HOLE	TOP OF CASING
WG9	405650.68	6457337.92	23.862	23.23	BORE HOLE	TOP OF CASING
WG10A	405364.46	6458073.56	23.597	22.80	BORE HOLE	TOP OF CASING (EAST)
WG10B	405365.23	6458074.51	23.615	22.88	BORE HOLE	TOP OF CASING (WEST)
Point#	Easting	Northing		RL	Code	NOTE
BM6	406034.47	6457246.28		27.184	BENCH MARK	EXISTING,DSPK IN BIT
BM11	405643.64	6457331.19		23.176	BENCH MARK	NEW, DSPK IN BIT
BM12	405884.59	6457085.48		28.985	BENCH MARK	NEW, TACKS IN WPEG
BM13	406938.21	6457800.47		41.062	BENCH MARK	NEW,DSPK IN BIT
BM14	406904.69	6457775.32		40.778	BENCH MARK	NEW, DSPK IN BIT

Hyd2o Monitoring Sites

	Site	Name / Type	Projected Coordinate System	Easting m	Northing m	Owner	Date Drilled	Driller	Headworks	Nat Surf mAHD	Top of Case mAHD	End of Hole mAHD	Bore Depth m	Screen Interval	Aquifer	Bore Condition	Comment/Description/Location
1	WG1	Hyd2o Bore Wattle Grove 1	GDA94 - MGA50	406115	6457800	Hesperia	19/11/2020	Edrill	Steel Casing	31.45	32.10	13.95	17.50	14.5-17.5 m	Superficial	Good	Site Bore Victoria Rd North - Rear of Lot (Install : Nov 2020)
2	WG2	Hyd2o Bore Wattle Grove 2 (Deep)	GDA94 - MGA50	405780	6457018	Hesperia	19/11/2020	Edrill	Steel Casing	25.47	26.12	14.47	11.00	8.0-11.0 m	Superficial	Good	Site Bore Victoria Rd South - Front of Lot (Install : Nov 2020)
3	WG2S	Hyd2o Bore Wattle Grove 2 Shallow	GDA94 - MGA50	405781	6457018	Hesperia	21/07/2022	DPP	Steel Casing	25.21	26.01	22.21	3.00	1.0-3.0 m	Shallow/Perched	Good	Site Bore Victoria Rd South - Front of Lot (Install : July 2022)
4	WG3	Hyd2o Bore Wattle Grove 3	GDA94 - MGA50	405419	6457710	Hesperia	19/11/2020	Edrill	Steel Casing	22.32	22.97	14.32	8.00	5.0-8.0 m	Superficial	Good	Site Bore Brentwood Rd South - Front of Lot (Install : Nov 2020)
5	WG4S	Hyd2o Bore Wattle Grove 4 Shallow	GDA94 - MGA50	405735	6458036	Hesperia	20/07/2022	DPP	Steel Casing	25.11	25.66	21.11	4.00	1.0-4.0 m	Shallow/Perched	Good	Site Bore Brentwood Rd North - Front of Lot (Install : Jul 2022)
6	WG4D	Hyd2o Bore Wattle Grove 4 Deep	GDA94 - MGA50	405736	6458037	Hesperia	20/07/2022	DPP	Steel Casing	25.11	25.73	13.11	12.00	9.0-12.0 m	Superficial	Good	Site Bore Brentwood Rd North - Front of Lot (Install : Jul 2022)
7	WGS5	Hyd2o Bore Wattle Grove 5 Shallow	GDA94 - MGA50	406304	6457567	Hesperia	20/07/2022	DPP	Steel Casing	34.54	35.14	29.24	5.30	2.3-5.3 m	Shallow/Perched	Good	Site Bore Victoria Rd North - Front of Lot (Install : July 2022)
8	WGSd	Hyd2o Bore Wattle Grove 5 Deep	GDA94 - MGA50	406304	6457566	Hesperia	20/07/2022	DPP	Steel Casing	34.55	35.13	14.55	20.00	17.0-20.0 m	Superficial	Good	Site Bore Victoria Rd North - Front of Lot (Install : Jul 2022)
9	WG6	Hyd2o Bore Wattle Grove 6	GDA94 - MGA50	405790	6457474	Hesperia	21/07/2022	DPP	Steel Casing	24.64	25.34	13.64	11.00	8.0-11.0m	Superficial	Good	Site Bore Victoria Rd Turf Farm North - Rear of Lot (Install : Jul 2022)
10	WGS7S	Hyd2o Bore Wattle Grove 7 Shallow	GDA94 - MGA50	405351	6457885	Hesperia	20/07/2022	DPP	Steel Casing	22.85	23.50	19.85	3.00	1.0-3.0 m	Shallow/Perched	Good	Site Bore Boundary Rd South - Rear of Lot (Install : Jul 2022)
11	WGS7D	Hyd2o Bore Wattle Grove 7 Deep	GDA94 - MGA50	405352	6457884	Hesperia	20/07/2022	DPP	Steel Casing	22.90	23.44	11.90	11.00	8.0-11.0 m	Superficial	Good	Site Bore Boundary Rd South - Rear of Lot (Install : Jul 2022)
12	WG8	Hyd2o Bore Wattle Grove 8	GDA94 - MGA50	406959	6457834	Hesperia	10/10/2022	DPP	Steel Casing	41.08	41.77	14.08	27.00	24.0-27.0 m	Superficial	Good	Upstream Bore Emanuel Crt North - Verge (Install : Oct 2022)
13	WG9	Hyd2o Bore Wattle Grove 9	GDA94 - MGA50	405651	6457338	Hesperia	10/10/2022	DPP	Steel Casing	23.23	23.86	17.23	6.00	3.0-6.0 m	Superficial	Good	Site Bore Victoria Rd Turf Farm South - Rear of Lot (Install : Oct 2022)
14	WG10S	Hyd2o Bore Wattle Grove 10 Shallow	GDA94 - MGA50	405364	6458074	Hesperia	11/10/2022	DPP	Steel Casing	22.80	23.60	19.80	3.00	1.5-3.0 m	Shallow/Perched	Good	Site Bore Boundary Rd North - Verge (Install : Oct 2022)
15	WG10D	Hyd2o Bore Wattle Grove 10 Deep	GDA94 - MGA50	405365	6458075	Hesperia	11/10/2022	DPP	Steel Casing	22.88	23.62	13.88	9.00	6.0-9.0 m	Superficial	Good	Site Bore Boundary Rd North - Verge (Install : Oct 2022)
16	MBa	Unknown Origin Bore (likely BH013 further below)	GDA94 - MGA50	405245	6457958	Hesperia	-	-	Steel Casing	20.03	20.61	-	-	-	Shallow/Perched	Good	Downstream Bore Boundary Rd South - Verge (Install : Unknown)
17	MBb	Douglas Partners Bore 1	GDA94 - MGA50	406067	6456783	Hesperia	-	DPP	Steel Casing	31.25	31.90	-	-	-	Superficial	Good	Site Bore Chicken Shed South - Rear of Lot (Install : Oct 2020)
18	GW1	Urbagua Bore 1	GDA94 - MGA50	405363	6458071	City of Kalamunda	3/09/2019	Edrill	Steel Casing	22.99	23.49	14.99	8.00	5.0-8.0 m	Superficial	Good	Site Bore Boundary Rd North - Verge (Install : Sep 2019)
19	GW3	Endemic Bore 3	GDA94 - MGA50	403634	6456299	City of Gosnells	19/06/2009	Endemic	Steel Casing	8.97	9.65	7.33	1.60	-	Shallow/Perched	Poor	Downstream Bore Boundary Rd South - GBSWA (Install : Jun 2009)
20	GW5	Endemic Bore 5	GDA94 - MGA50	405055	6457747	City of Gosnells	19/06/2009	Endemic	Steel Casing	18.84	19.41	17.66	1.20	-	Shallow/Perched	Poor	Downstream Bore Boundary Rd North - GBSWA (Install : Jun 2009)
21	GW5D	Hyd2o Deep Bore next to Endemic 5	GDA94 - MGA50	405053	6457750	Hesperia	21/07/2022	DPP	Steel Casing	18.81	19.37	11.81	7.00	4.0-7.0 m	Superficial	Good	Downstream Bore Boundary Rd North - GBSWA (Install : Jul 2022)
22	GW8	Endemic Bore 8	GDA94 - MGA50	405590	6456777	City of Gosnells	19/06/2009	Endemic	Steel Casing	24.00	24.61	20.48	3.50	-	Shallow/Perched	Poor	Downstream Bore Victoria Rd North - Verge (Install : Jun 2009)
23	GW8D	Hyd2o Deep Bore next to Endemic 8	GDA94 - MGA50	405590	6456775	Hesperia	22/07/2022	DPP	Steel Casing	24.00	24.52	14.50	9.50	6.5-9.5 m	Superficial	Good	Downstream Bore Victoria Rd North - Verge (Install Jul 2022)
24	GW9S	Hyd2o Bore Wetlands 9 Shallow	GDA94 - MGA50	405329	6457512	Hesperia	22/07/2022	DPP	Steel Casing	21.19	21.81	18.19	3.00	1.0-3.0 m	Shallow/Perched	Good	Downstream Bore Brentwood Rd North - Verge (Install Jul 2022)
25	GW9D	Hyd2o Bore Wetlands 9 Deep	GDA94 - MGA50	405329	6457513	Hesperia	22/07/2022	DPP	Steel Casing	21.20	21.78	13.20	8.00	5.0-8.0 m	Superficial	Good	Downstream Bore Brentwood Rd North - Verge (Install Jul 2022)
26	GW12	Endemic Bore 12	GDA94 - MGA50	403440	6456803	City of Gosnells	19/06/2009	Endemic	Steel Casing	8.90	9.39	6.57	2.30	-	Shallow/Perched	Poor	Downstream Bore Brook Rd South - GBSWA (Install : Jun 2009)
27	SCC 05/08	DWER Bore 1	GDA94 - MGA50	405767	6461821	SCC	13/02/2008	WDR	Steel Casing	41.21	41.78	12.21	29.00	17.0-29.0 m	Superficial	Good	Long Term DWER Bore - Ilex Way Forrestfield (Install : Feb 2008)
28	SCC 06/08	DWER Bore 2	GDA94 - MGA50	401381	6457518	SCC	11/01/2008	-	Steel Casing	7.49	7.98	-4.51	12.00	3.0-12.0 m	Superficial	Good	Long Term DWER Bore - Crawford St, Cannington (Install : Jan 2008)
29	SCC 09/08	DWER Bore 3	GDA94 - MGA50	405600	6452440	SCC	14/01/2008	-	Steel Casing	12.62	13.21	0.87	11.80	2.75-11.75 m	Superficial	Good	Long Term DWER Bore - Banach St, Maddington (Install : Jan 2008)

Other Bores

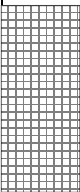
1	WA01	DBCA Brixton Wetland Bore 1	GDA94 - MGA50	403354	6456394	DBCA	7/11/2016	DBCA	-	7.10	7.55	-0.40	7.50	4.5 -7.0 m	Superficial	Good	Installed within Greater Brixton Street Wetlands
2	WA02	DBCA Brixton Wetland Bore 2	GDA94 - MGA50	403176	6456183	DBCA	7/11/2016	DBCA	-	6.30	6.77	-0.70	7.00	4.0 - 7.0 m	Superficial	Good	Installed within Greater Brixton Street Wetlands
3	WA03	DBCA Brixton Wetland Bore 3	GDA94 - MGA50	402998	6455992	DBCA	7/11/2016	DBCA	-	5.70	6.17	-2.50	8.20	2.2 - 8.2 m	Superficial	Good	Installed within Greater Brixton Street Wetlands
4	BH005	Arup Bore 5	GDA94 - PCG94	66937	257229	Main Roads	3/10/2019	Edge Drilling	Steel Casing	20.40	20.30	0.45	19.95	3.95 - 19.95 m	Superficial	Good	Installed within Tonkin Hwy Reserve
5	BH006	Arup Bore 6	GDA94 - PCG94	67005	257195	Main Roads	4/10/2019	Edge Drilling	Steel Casing	20.81	20.74	0.86	19.95	3.95 - 19.95 m	Superficial	Good	Installed within Tonkin Hwy Reserve
6	BH007	Arup Bore 7	GDA94 - PCG94	67026	257277	Main Roads	8/10/2019	Edge Drilling	Steel Casing	21.42	22.11	1.47	19.95	3.95 - 19.95 m	Superficial	Good	Installed within Tonkin Hwy Reserve
7	BH008	Arup Bore 8	GDA94 - PCG94	66898	257282	Main Roads	7/11/2019	Edge Drilling	Steel Casing	20.43	20.98	0.48	19.95	3.95 - 19.95 m	Superficial	Good	Installed within Tonkin Hwy Reserve
8	BH013	Arup Bore 13	GDA94 - PCG94	67010	256973	Main Roads	11/10/2019	Edge Drilling	Steel Casing	20.00	21.26	4.55	15.45	9.45 - 15.45 m	Superficial	Good	Installed within Tonkin Hwy Reserve
9	BH014	Arup Bore 14	GDA94 - PCG94	67137	257614	Main Roads	15/10/2019	Edge Drilling	Steel Casing	20.00	22.37	5.00	15.00	9.0 - 15.0 m	Superficial	Good	Installed within Tonkin Hwy Reserve
10	MW201-S	MKSEA - DP Bore 1 Shallow	GDA94 - MGA50	405483	6457148	Hesperia	12/10/2022	DPP	Steel Casing	23.14	23.86	16.14	7.00	5.5 - 7.0 m	Superficial	Good	Installed within private property with access via Victoria Rd (south of Tonkin)
11	MW202-D	MKSEA - DP Bore 2 Deep	GDA94 - MGA50	405320	6457004	Hesperia	13/10/2022	DPP	Steel Casing	20.37	21.02	9.87	10.50	8.5 - 10.5 m	Superficial	Good	Installed within private property with access via Victoria Rd (south of Tonkin)
12	MW202-S	MKSEA - DP Bore 2 Shallow	GDA94 - MGA50	405319	6457002	Hesperia	13/10/2022	DPP	Steel Casing	20.35	21.02	15.35	5.00	3.5 - 5.0 m	Shallow/Perched	Good	Installed within private property with access via Victoria Rd (south of Tonkin)
13	MW203-D	MKSEA - DP Bore 3 Deep	GDA94 - MGA50	405783	6456481	Hesperia	12/10/2022	DPP	Steel Casing	26.90	27.53	12.90	14.00	12.5 - 14.0 m	Superficial	Good	Installed within private property with access via Victoria Rd (south of Tonkin)
14	MW203-S	MKSEA - DP Bore 3 Shallow	GDA94 - MGA50	405765	6456480	Hesperia	12/10/2022	DPP	Steel Casing	26.95	27.57	21.95	5.00	3.5 - 5.0 m	Shallow/Perched	Good	Installed within private property with access via Victoria Rd (south of Tonkin)
15	MW204-S	MKSEA - DP Bore 4 Shallow	GDA94 - MGA50	405408	6456579	Hesperia	12/10/2022	DPP	Steel Casing	24.07	24.74	17.07	7.00	4.0 - 7.0 m	Shallow/Perched	Good	Installed within private property with access via Victoria Rd (south of Tonkin)
16	MW205-D	MKSEA - DP Bore 5 Deep	GDA94 - MGA50	405033	6456675	Hesperia	13/10/2022	DPP	Steel Casing	16.48	17.18	6.48	10.00	8.5 - 10.0 m	Superficial	Good	Installed within private property with access via Victoria Rd (south of Tonkin)
17	MW205-S	MKSEA - DP Bore 5 Shallow	GDA94 - MGA50	405034	6456674	Hesperia	14/10/2022	DPP	Steel Casing	16.47	17.22	12.47	4.00	2.5 - 4.0 m	Shallow/Perched	Good	Installed within private property with access via Victoria Rd (south of Tonkin)
18	MW206-S	MKSEA - DP Bore 6 Shallow	GDA94 - MGA50	405237	6456474	Hesperia	12/10/2022	DPP	Steel Casing	19.98	20.61	14.98	5.00	3.5 - 5.0 m	Shallow/Perched	Good	Installed within private property with access via Victoria Rd (south of Tonkin)
19	MW207-S	MKSEA - DP Bore 7 Shallow	GDA94 - MGA50	404905	6456053	Hesperia	13/10/2022	DPP	Steel Casing	12.96	13.66	8.96	4.00	2.5 - 4.0 m	Shallow/Perched	Good	Installed within private property with access via Victoria Rd (south of Tonkin)
20	MW208-D	MKSEA - DP Bore 8 Deep	GDA94 - MGA50	405158	6455878	Hesperia	13/10/2022	DPP	Steel Casing	15.15	15.81	6.15	9.00	8.0 - 9.0 m	Superficial	Good	Installed within private property with access via Victoria Rd (south of Tonkin)
21	MW208-S	MKSEA - DP Bore 8 Shallow	GDA94 - MGA50	405159	6455878	Hesperia	13/10/2022	DPP	Steel Casing	15.19	15.85	11.19	4.00	2.5 - 4.0 m	Shallow/Perched	Good	Installed within private property with access via Victoria Rd (south of Tonkin)

Date : 19-11-20
Client : Hesperia
Project : Wattle Grove South
Easting : 406115
Northing : 6457799
Datum : AHD
Drill type: Drill Rig RAB
Hole diameter: 2.5 Inch

Job Number : H20072
Start Hole : 7.30 am
End Hole : 10.30 am
Logged by : SO
Total Depth : 17.5 m
RL Top of Casing : 32.1 mAHD
RL Nat Surface : 31.45 mAHD

Bore Name

WG01

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics								
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment			
PVC (Class9)					Light Grey	Fine to Medium	Sand	None	Dry				
		2.0m	Light Brown	Fine									
		4.0m	Yellow Brown										
		6.0m	Yellow										
		8.0m	Light Brown										
		10.0m	White	Very Fine									
		12.0m											
		14.0m			Fine to Medium								
			16.0m	Light Grey	Medium to Large								
				Light Grey Brown									
				18.0m									
				</									

Date : 19-11-20
Client : Hesperia
Project : Wattle Grove Due Diligence
Easting : 405780
Northing : 6457018
Datum : AHD
Drill type : Drill Rig RAB
Hole diameter : 2.5 Inch

Job Number : H20072
Start Hole : 10.30 am
End Hole : 12.00 pm
Logged by : SO
Total Depth : 11 m
RL Top of Casing : 26.12 mAHD
RL Nat Surface : 25.47 mAHD

Bore Name

WG02

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)				1.0m	Beige	Fine to Medium				
				2.0m	White Brown	Fine				
				3.0m	Light Grey					
				4.0m	White	Very Fine	Sand	None	Dry	Chunks of silcrete/calcrete material - crumbles
				5.0m						
				6.0m						
				7.0m					Moist	
				8.0m		Fine to Medium				
				9.0m	Beige				Wet	
				11.0m						

COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle
PARTICLE SIZE : Fine, Medium, Course
TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay
ORGANICS : High, Medium, Low
MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date 23-11-20
Stickup above NS (m) 0.65
Water Level bTOC (m) 9.18
Water Level bNS (m) 8.53

Date :	19-11-20
Client :	Hesperia
Project:	Wattle Grove South
Easting	405419
Northing	6457710
Datum:	AHD
Drill type:	Drill Rig RAB
Hole diameter:	2.5 Inch

Job Number :	H20072
Start Hole :	12.30 pm
End Hole :	2.00 pm
Logged by :	SO
Total Depth :	8 m
RL Top of Casing :	22.97 mAHD
RL Nat Surface :	22.32 mAHD

Bore Name

WG03

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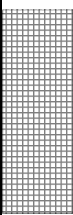
COLOUR :	Black, White, Biege
	Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
	Composition : Solid , Blemish, Mottle
PARTICLE SIZE :	Fine, Medium, Course
TEXTURE :	Sand, Loamy Sand, Clayey Sand
	Silt, Loam, Sandy Loam, Clayey Loam
	Clay, Sandy Clay
ORGANICS :	High, Medium, Low
MOISTURE :	Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	23-11-20
Stickup above NS (m)	0.65
Water Level bTOC (m)	6.82
Water Level bNS (m)	6.17

Date :	21-07-22	Job Number :	H21003	Bore Name
Client :	Hesperia	Start Hole :	12.30pm	
Project :	Wattle Grove DWMS	End Hole :	2.00pm	
Easting :	405781	Logged by :	SO	
Northing :	6457018	Total Depth :	5m	
Datum :	AHD	RL Top of Casing (mAHD) :	26.01	
Drill type :	Drill Rig Auger	RL Nat Surface (mAHD) :	25.21	
Hole diameter :	2.5 inch			

WG2S

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					Comment
					Colour	Particle Size	Texture	Organic Content	Moisture	
PVC (Class 9)			1.0m	Orange	Fine to Medium	Sand	Medium	Dry		
	2.0m		Low							
	3.0m									
	4.0m			Beige Yellow	Fine	Clay				
	5.0m			Yellow						
	6.0m									
	7.0m									
	8.0m									
	9.0m									
	10.0m									
	11.0m									
	12.0m									

COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	26-08-22
Stickup above NS (m)	0.8
Water Level bTOC (m)	3.51 DRY
Water Level bNS (m)	2.71 DRY

Date :	20-07-22	Job Number :	H21003	Bore Name
Client :	Hesperia	Start Hole :	10.30am	
Project :	Wattle Grove DWMS	End Hole :	12.30am	
Easting :	405736 D / 405735 S	Logged by :	SO	
Northing :	6458037 D / 6458036 S	Total Depth :	12m D / 4m S	
Datum :	AHD	RL Top of Casing (mAHD) :	25.73 D / 25.66 S	
Drill type :	Drill Rig Auger	RL Nat Surface (mAHD) :	25.11 D / 25.11 S	
Hole diameter :	2.5 inch			

WG4S/D

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					Comment
					Colour	Particle Size	Texture	Organic Content	Moisture	
PVC (Class 9)	S D	▽ ▽	S D	1.0m	Grey	Fine to Medium	Sand	Medium	Dry	
								Moist		
							Clayey Sand	Low	Saturated	
				2.0m	Brown					
				3.0m			Sandy Clay			
				4.0m						
				5.0m	Light Brown	Fine			Moist	
					Light Brown Grey					
				6.0m						
				7.0m	Light Brown					
				8.0m						
				9.0m						
10.0m	Beige	Fine to Medium	Sandy Clay		Saturated					
11.0m					Slurry					
12.0m					Yellow	Fine	Clay	Moist		

COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	26-08-22
Stickup above NS (m)	0.62 D / 0.55 S
Water Level bTOC (m)	9.82 D / 1.16 S
Water Level bNS (m)	9.20 D / 0.61 S

Date :	20-07-22	Job Number :	H21003	Bore Name
Client :	Hesperia	Start Hole :	1.30pm	
Project :	Wattle Grove DWMS	End Hole :	5.00 pm	
Easting :	406304 D / 406304 S	Logged by :	SO	
Northing :	6457566 D / 6457567 S	Total Depth :	21m D / 5.3m S	
Datum :	AHD	RL Top of Casing (mAHD) :	35.13 D / 35.14 S	
Drill type:	Drill Rig Auger	RL Nat Surface (mAHD) :	34.55 D / 34.54 S	
Hole diameter:	2.5 inch			

WG5S/D

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)	S		S	1.0m	Brown Yellow	Fine	Sand	Medium	Dry	
	2.0m			Yellow						
	3.0m			Light Brown						Crumbly sand
	4.0m									Frimer crumbles
	5.0m									Some ironstone
	6.0m									Probe refusal
	7.0m			Grey						Tough drilling
	8.0m									Ground down calcrete to fine sand
	9.0m									
	10.0m									
	11.0m			Beige						
	12.0m									
	13.0m									
	14.0m									
	15.0m									
	16.0m									
	17.0m			Beige Grey						
	18.0m									
	19.0m								Moist	
	20.0m								Saturated	
	21.0m			Slurry						
									</	

COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

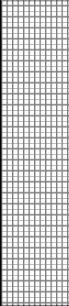
MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	26-08-22
Stickup above NS (m)	0.58 D / 0.60 S
Water Level bTOC (m)	18.78 D / DRY at 5.81 S
Water Level bNS (m)	18.20 D / DRY at 5.21 S

Date :	21-07-22	Job Number :	H21003	Bore Name
Client :	Hesperia	Start Hole :	8.00am	
Project :	Wattle Grove DWMS	End Hole :	10.00am	
Easting :	405790	Logged by :	SO	
Northing :	6457474	Total Depth :	12m	
Datum :	AHD	RL Top of Casing (mAHD) :	25.34	
Drill type:	Drill Rig Auger	RL Nat Surface (mAHD) :	24.64	
Hole diameter:	2.5 inch			

WG6

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)				1.0m	Beige	Fine to Medium	Sand	Medium	Dry	
					Brown	Fine				
				2.0m	Light Brown	Fine to Medium				
				3.0m						
					Beige					
				4.0m						
					Light Brown					
				5.0m						
					Beige	Clayey Sand	Low	Clay Globules		
				6.0m						
				7.0m						
				8.0m		Fine	Sandy Clay	Moist		
			Grey							
10.0m										
				11.0m	Orange	Clay	Saturated			
				12.0m						

COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	26-08-22
Stickup above NS (m)	0.7
Water Level bTOC (m)	6.94
Water Level bNS (m)	6.24

Date :	20-07-22	Job Number :	H21003	Bore Name
Client :	Hesperia	Start Hole :	8.00am	
Project :	Wattle Grove DWMS	End Hole :	10.00am	
Easting :	405352 D / 405351 S	Logged by :	SO	
Northing :	6457884 D / 6457885 S	Total Depth :	11m D / 3m S	
Datum :	AHD	RL Top of Casing (mAHD) :	23.44 D / 23.50 S	
Drill type:	Drill Rig Auger	RL Nat Surface (mAHD) :	22.90 D / 22.85 S	
Hole diameter:	2.5 inch			

WG7S/D

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					Comment
					Colour	Particle Size	Texture	Organic Content	Moisture	
PVC (Class 9)	S									

COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

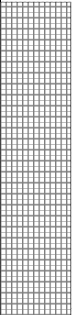
Date	26-08-22
Stickup above NS (m)	0.54 D / 0.65 S
Water Level bTOC (m)	5.67 D / DRY at 3.68 S
Water Level bNS (m)	5.13 D / DRY at 3.03 S

Date : 21-07-22
Client : Hesperia
Project : Wattle Grove DWMS
Easting : 405329
Northing : 6457750
Datum : AHD
Drill type: Drill Rig Auger
Hole diameter: 2.5 inch

Job Number : H21003
Start Hole : 2.30pm
End Hole : 4.00pm
Logged by : SO
Total Depth : 7m
RL Top of Casing 19.37
RL Nat Surface : 18.81

Bore Name

GW5D

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					Comment
					Colour	Particle Size	Texture	Organic Content	Moisture	
PVC (Class 9)				1.0m	Grey	Fine to Medium	Sand	Medium	Moist	
					Beige					
				2.0m	Light Brown	Fine to Large				Probe refusal @ 1.5m
				3.0m	Brown Grey		Sandy Clay		Moist	Some clay and rocky fragments present - expected hardpan layer
				4.0m				Low		
				5.0m	Grey	Fine to Medium			Saturated	
				6.0m						
				7.0m						
				8.0m						
				9.0m						
				10.0m						
				11.0m						
				12.0m						

COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle
PARTICLE SIZE : Fine, Medium, Course
TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay
ORGANICS : High, Medium, Low
MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date 26-08-22
Stickup above NS (m) 0.56
Water Level bTOC (m) 2.32
Water Level bNS (m) 1.76

Date : 22-07-22
Client : Hesperia
Project : Wattle Grove DWMS
Easting : 405590
Northing : 6456775
Datum : AHD
Drill type: Drill Rig Auger
Hole diameter: 2.5 inch

Job Number : H21003
Start Hole : 9.30am
End Hole : 11.00am
Logged by : SO
Total Depth : 9.5m
RL Top of Casing 24.52
RL Nat Surface : 24

Bore Name

GW8D

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics						
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment	
PVC (Class 9)				1.0m	Beige Grey	Fine to Medium	Sand	Medium	Dry		
					Beige						
					Brown Yellow						
				2.0m	Yellow	Fine		Low			
					Grey					Clayey Sand	Moist
				4.0m	Yellow Grey		Sandy Clay		Saturated		
				5.0m			Clay		Moist		
									6.0m	Dry	
				8.0m						Moist	
									9.0m	Saturated	
				Beige		Fine to Medium		Sand			
				10.0m							
				11.0m							
12.0m											

COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle
PARTICLE SIZE : Fine, Medium, Course
TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay
ORGANICS : High, Medium, Low
MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date 26-08-22
Stickup above NS (m) 0.52
Water Level bTOC (m) 6.78
Water Level bNS (m) 6.26

Date : 22-07-22
 Client : Hesperia
 Project : Wattle Grove DWMS
 Easting : 405329 D / 405329 S
 Northing : 6457513 D / 6457512 S
 Datum : AHD
 Drill type: Drill Rig Auger
 Hole diameter: 2.5 inch

Job Number : H21003
 Start Hole : 11.30am
 End Hole : 1.30pm
 Logged by : SO
 Total Depth : 8.0m
 RL Top of Casing 21.78 D / 21.81 S
 RL Nat Surface : 21.20 D / 21.19 S

Bore Name

GW9S/D

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)	S	▽	S	1.0m	Brown	Fine to Large	Sand	Medium	Dry	
	2.0m			Black Beige	Fine to Medium	Low		Saturated		
	3.0m			Beige						
	D		4.0m	Grey	Fine	Clay	Moist			
	5.0m		Clayey Sand			Saturated				
	6.0m									
	D		7.0m		Fine to Medium	Sand				
	8.0m									
			9.0m							
			10.0m							
			11.0m							
			12.0m							

COLOUR : Black, White, Biege
 Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
 Composition : Solid , Blemish, Mottle
 PARTICLE SIZE : Fine, Medium, Course
 TEXTURE : Sand, Loamy Sand, Clayey Sand
 Silt, Loam, Sandy Loam, Clayey Loam
 Clay, Sandy Clay
 ORGANICS : High, Medium, Low
 MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date 26-08-22
 Stickup above NS (m) 0.58 D / 0.62 S
 Water Level bTOC (m) 2.35 D / 2.11 S
 Water Level bNS (m) 1.77 D / 1.49 S

Date :	10-10-22	Job Number :	H21003	Bore Name
Client :	Hesperia	Start Hole :	8.00am	
Project :	Wattle Grove DWMS	End Hole :	12.00 pm	
Easting :	406954*	Logged by :	SO	
Northing :	6457829*	Total Depth :	30m	
Datum :	AHD	RL Top of Casing (mAHD) :		
Drill type:	Drill Rig Auger	RL Nat Surface (mAHD) :		
Hole diameter:	2.5 inch			

WG8

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics								
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment			
PVC (Class 9)				2.0m	Grey - Orange	Fine	Sand	Medium	Dry	small amount feldspar stone fragments			
				4.0m	Light Brown			more frequent feldspar stone fragments					
				6.0m	Yellow								
				8.0m	Light Brown			Tight digging began					
				10.0m	Bright Orange Brown								
				12.0m									
				14.0m									
				16.0m	Light Brown								
				18.0m	Dark Beige			white crumbly fragments					
				20.0m									
				22.0m	Beige								
				24.0m	Light Brown			Fine to Medium		Low	Moist	Loose digging began	
				26.0m									
				28.0m	Light Grey								
				30.0m	Light Brown	Fine							
				32.0m									
				34.0m									
				36.0m									
				38.0m									
				40.0m									

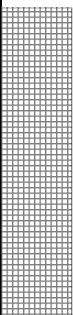
COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle
PARTICLE SIZE : Fine, Medium, Course
TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay
ORGANICS : High, Medium, Low
MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	10-10-22
Stickup above NS (m)	0.7
Water Level bTOC (m)	25.19
Water Level bNS (m)	24.49

Date :	10-10-22	Job Number :	H21003	Bore Name
Client :	Hesperia	Start Hole :	1.00pm	
Project :	Wattle Grove DWMS	End Hole :	3.00pm	
Easting :	405650*	Logged by :	SO	
Northing :	6457336*	Total Depth :	8m	
Datum :	AHD	RL Top of Casing (mAHD) :		
Drill type :	Drill Rig Auger	RL Nat Surface (mAHD) :		
Hole diameter :	2.5 inch			

WG9

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics								
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment			
PVC (Class 9)				1.0m	Grey	Fine to Medium	Sand	Medium	Dry				
				Beige	Fine								
				2.0m	Light Grey Brown	Fine to Medium							
				Brown									
				3.0m									
				4.0m									
				5.0m	Beige			Low		Saturated			
				6.0m									
				7.0m	White				large clay chunks				
				8.0m									
				9.0m									
				10.0m									
				11.0m									
				12.0m									
													



COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	10-10-22
Stickup above NS (m)	0.61
Water Level bTOC (m)	4.14
Water Level bNS (m)	3.53

Date :	11-10-22	Job Number :	H21003	Bore Name
Client :	Hesperia	Start Hole :	8.30am	
Project :	Wattle Grove DWMS	End Hole :	11.00am	
Easting :	405365	Logged by :	SO	
Northing :	6458073	Total Depth :	9m	
Datum :	AHD	RL Top of Casing (mAHD) :		
Drill type:	Drill Rig Auger	RL Nat Surface (mAHD) :		
Hole diameter:	2.5 inch			

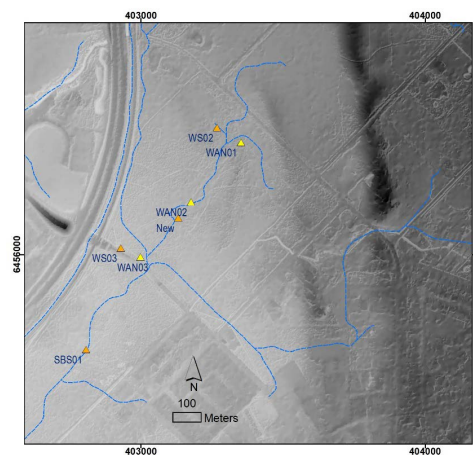
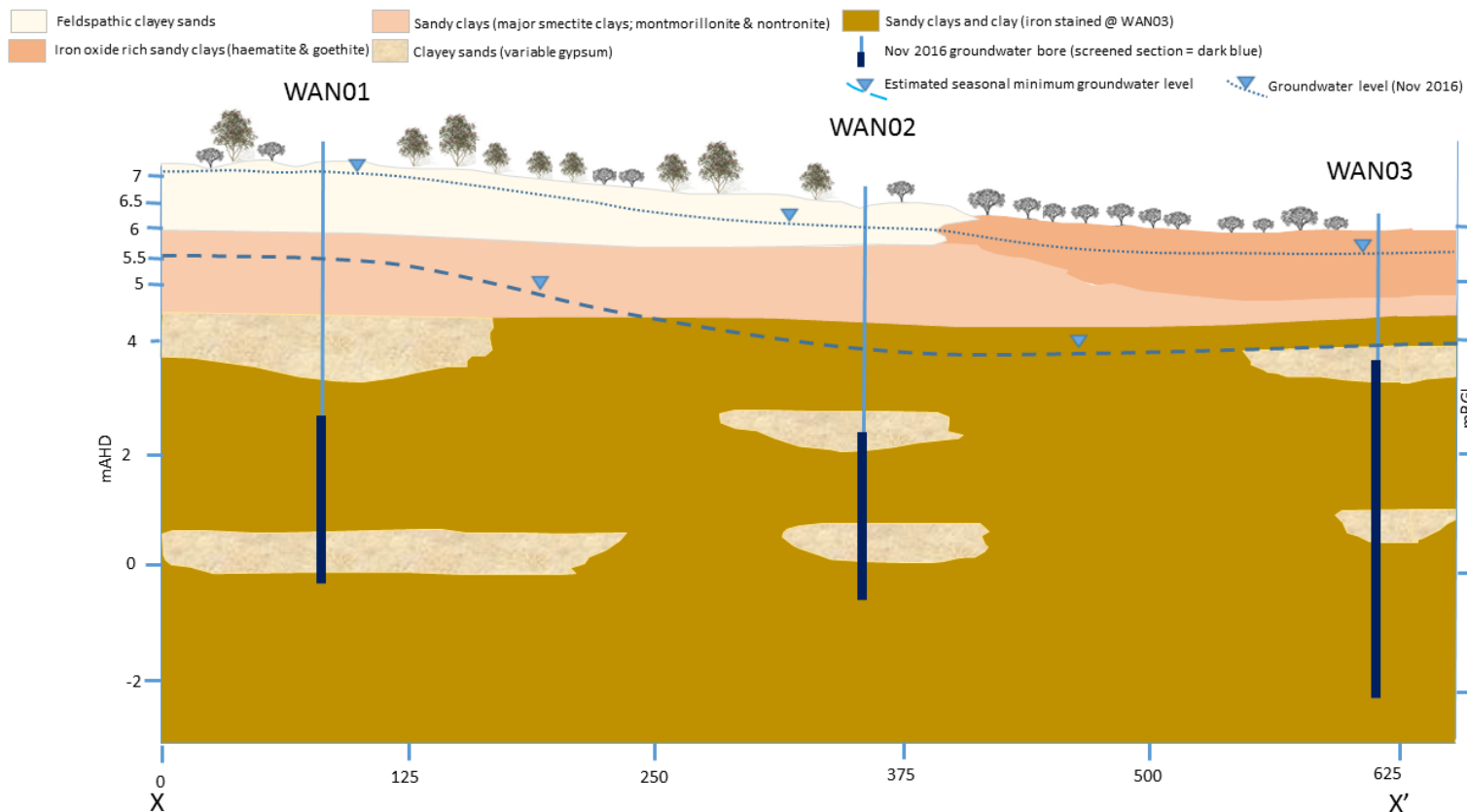
WG10

support	Bent. Seal	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)	S	▽		1.0m	Grey	Fine to Medium	Sand	Medium	Dry	
				2.0m	Beige - White			Low		Moist
	3.0m		Beige - White with Orange	Sandy Clay	Dry					
	4.0m		Brown	Clay	Clayey Sand			Saturated		
	D		5.0m	Grey Yellow		Fine	Moist			
			6.0m	Grey		Fine to Medium			Saturated	
	7.0m		Light Brown							
	8.0m		Grey							
	9.0m									
	10.0m									
	11.0m									
	12.0m									

COLOUR : Black, White, Biege
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid , Blemish, Mottle
PARTICLE SIZE : Fine, Medium, Course
TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay
ORGANICS : High, Medium, Low
MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date
Stickup above NS (m)
Water Level bTOC (m)
Water Level bNS (m)

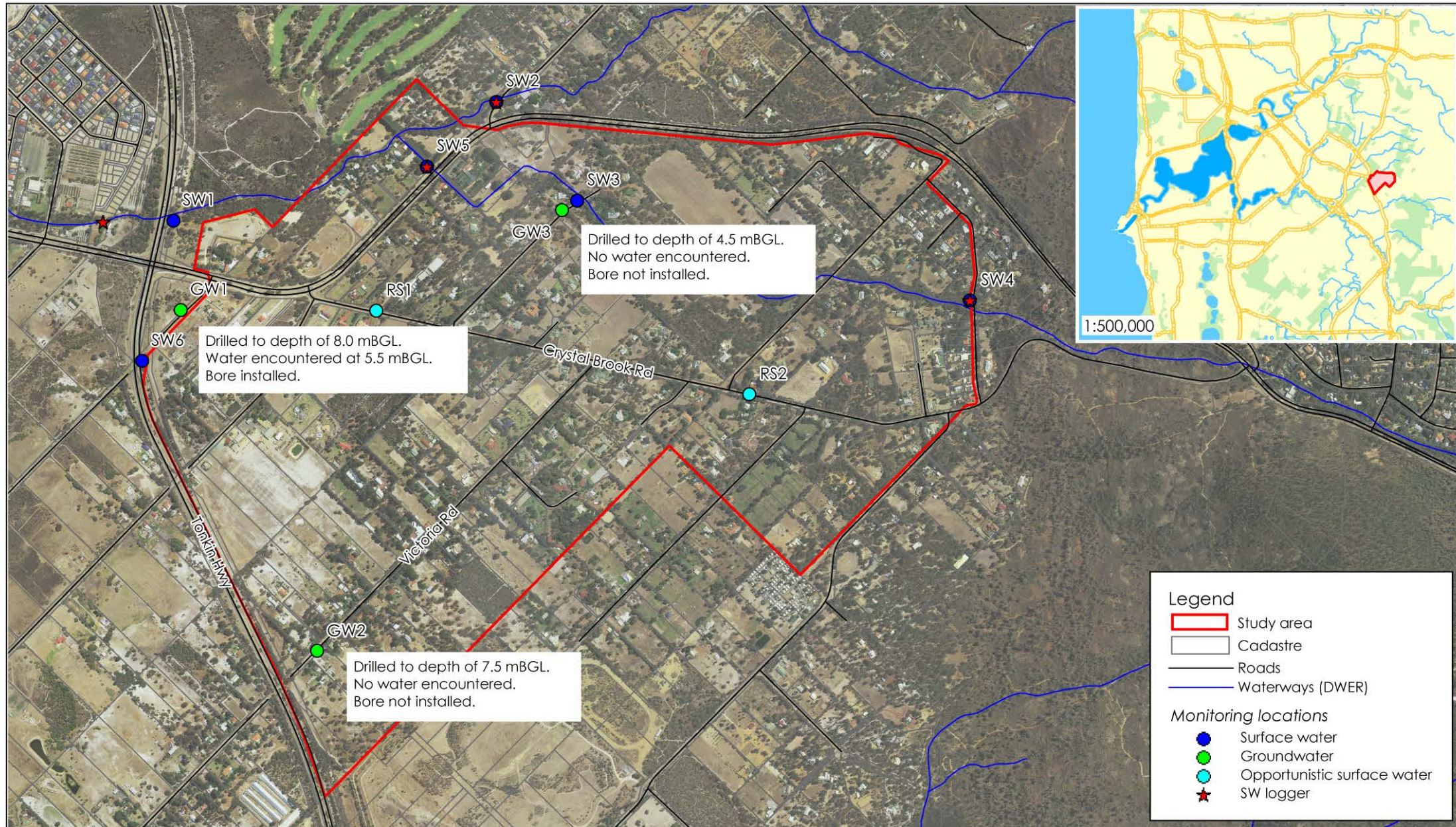


Drilling and construction summary

	WAN01	WAN02	WAN03
Drilling date	7/11/2016	7/11/2016	7/11/2016
Drilling start time (aprox)	8:30AM	12:00 noon	2:15PM
Depth hole (m)	7.5	7	8.2
Depth Bore (m)	7.5	7	8.2
Bore diameter (mm)	0.5	0.5	0.5
top of slotted section (m bgl)	4.5	4	2.2
bottom of slotted section m bgl)	7.5	7	8.2
bentonite seal from (m bgl)	1	1	1
bentonite seal to (m bgl)	1.5	1.5	1.5
gravel pack from (m bgl)	1.5	1.5	1.5
gravel pack to (m bgl)	7.5	7	8.2
Steel riser length	0.45	0.47	0.47
PVC stick up	0.32	0.25	0.33

City of Kalamunda - Wattle Grove South Monitoring

Figure 1 - Monitoring sites



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Data source: DWER, MRWA, DPLH, CoK, Created by: AT., Projection: MGA: zone 50.



0 500
metres
Scale 1:16,000 @ A4

urbaqua
land and water solutions

NOTE:

	Monitor Well Screen		Water encountered
	Gravel Pack		
	Bentonite Layer		
	Sand Fill		
	Cement Grout		



Figure 1: Samples collected at 0.5 m intervals during drilling



Figure 2: Drill rig on location



Figure 1: Samples collected at 0.5 m intervals during drilling



Figure 2: Drill rig on location



BOREHOLE LOG

Bore ID: GW3

CLIENT:	City of Kalamunda	DATE COMMENCED:	3/9/2019
PROJECT:	Wattle Grove Monitoring	DATE COMPLETED:	3/9/2019
LOCATION:	Johnson Place, Wattle Grove	LOGGED BY:	AT
CONTRACTOR:	eDrill	INSTALLATION METHOD:	Rotary drill
HORIZONTAL DATUM:	GDA94 Zone 50	R.L. SURFACE (m AHD):	~36
EASTING:	406,645.4	TOTAL DEPTH (m):	4.5
NORTHING:	6,458,437.8	DIAMETER (mm):	50

Depth BGL (m)	Sample Taken	Water	Lithology	Observations
			0 - 0.2 m: Sand, grey, medium grained, moderately sorted, damp	
			0.2 - 0.5 m: Loose gravelly-sand, coarse grained, poorly sorted, damp	
			0.5 - 1.5 m: Laterite, yellow/red, clayey-sand, damp	
1.0				
			1.5 - 4.5 m: Indurated clay, red/orange, dry	
2.0				
3.0				
4.0				
5.0				

NOTE:

	Monitor Well Screen	Water encountered
	Gravel Pack	
	Bentonite Layer	
	Sand Fill	
	Cement Grout	



Figure 1: Samples collected at 0.5 m intervals during drilling



Figure 2: Drill rig on location