

Report on:

**SITE AND SOIL EVALUATION
PROPOSED WAREHOUSE DEVELOPMENT
29 STIRLING CRESCENT
HIGH WYCOMBE WA**

WAG240437-01 001 R Rev1 SSE

Submitted to:

Planning Solutions
Level 1, 251 St Georges Terrace
PERTH WA

2 September 2024

CONTENTS

1. INTRODUCTION	2
2. DEFINITIONS	2
3. GOVERNING STANDARDS, REGULATIONS AND POLICIES	2
4. SITE DESCRIPTION	3
5. PROPOSED DEVELOPMENT	3
6. PRELIMINARY HYDRAULIC LOADING	3
7. GEOTECHNICAL INFORMATION PROVIDED	4
8. SITE CONDITIONS	4
8.1. Geology	4
8.2. Ground Model	5
8.3. Groundwater and Surface Water	5
9. SITE ASSESSMENT	5
9.1. General	5
9.2. Horizontal Setbacks	6
9.3. Land Application Areas	6
9.3.1. Government Sewerage Policy (GSP, 2019)	6
9.3.2. Water Balance	6
9.3.3. Summary	6
10. SOIL ASSESSMENT	7
11. SITE SUITABILITY AND RECOMMENDATIONS	7
12. CLOSURE	8
Table 1: Summary of Site	3
Table 2: Summary of Proposed Development	3
Table 3: Summary of Preliminary Hydraulic Loading	3
Table 4: Summary of Geology Mapping	4
Table 5: Summary of Groundwater and Surface Water Levels	5
Table 6: Required Horizontal Setback Distances (AS1547)	6
Table 7: GSP LAA Calculation	6
Attached Table 1: Site Assessment	9
Attached Table 2: Soil Assessment	11
Appendix A: Proposed Development Plan Provided	
Appendix B: Brown Geotechnical Report	
Appendix C: Water Balance	
Understanding your Report	

1. INTRODUCTION

This revised report presents the outcomes of Galt Geotechnics' (Galt's) Site and Soil Evaluation (SSE) for the proposed warehouse development, at 29 Stirling Crescent, High Wycombe WA ("the site", refer In Line Image 1). This revision includes the proposed LAA provided by the client and update to dripper disposal.

This report is to be read in conjunction with the appended "Requirements and Limitations" found at the back of this report.

2. DEFINITIONS

Site and Soil Evaluation (SSE): an assessment of all relevant constraints and the risks to public health and the environment in accordance with AS1547-2012 "On-site domestic wastewater management". This SSE is a general assessment SSE, with the purpose being to undertake a site suitability assessment for onsite wastewater management and to recommend the type of onsite wastewater system for the proposed development.

A specific assessment is required to support an "application to install" an onsite wastewater system. This is for when a particular type of system/model is proposed, and a detailed design, including management recommendations and operation requirements. This document is not a specific assessment.

Land Application Area (LAA): The unencumbered plan area to which treated sewage from an on-site sewage system is distributed for further in-soil treatment and absorption or evaporation. This area is restricted to the distribution of treated sewage and may not be developed for other purposes.

Land Application System (LAS): The system used to apply effluent from a wastewater treatment unit into or onto the soil for further in-soil treatment and absorption or evaporation.

Effluent: The liquid discharged from a wastewater treatment unit.

Primary Treatment: The separation of suspended material from sewage in septic tanks, primary settling chambers or other structures before discharge to either a LAS or secondary treatment process.

Secondary Treatment: Microbiological digestions and physical settling and filtering processes and decomposition of sewage constituents following primary treatment.

Sewage: Any kind of sewage, faecal matter or urine, and any waste composed wholly or in part of liquid.

Infiltrative Area: Is the area within an LAA that has treated effluent directly discharged onto, and does not include setback areas. I.e., the base of drip irrigation, evapotranspiration beds etc.

3. GOVERNING STANDARDS, REGULATIONS AND POLICIES

SSEs are governed by various National and State Standards, Regulations and Policies, including:

- AS/NZS 1547:2012, On-site domestic wastewater management.
- Western Australia Government Sewerage Policy (2019)
- Western Australia Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations (1974)
- Western Australia State Planning Policy 2.9, Water Resources (2005)

Other regulatory requirements may become relevant depending on the outcomes of any SSE.

SSEs can be rejected on the basis of not meeting the regulatory requirements of the above. This report is intended to address all these various requirements.

4. SITE DESCRIPTION

Table 1: Summary of Site

Item	Comment
Site Extent	About 8,600 m ²
Site Area	Refer In Line Image 1.
Current Site Surface Levels ¹	About RL 24 m AHD around existing residence and estimated to be RL 21 m AHD within lake.
Vegetation	Typically grass with mature trees mostly around residence and site perimeter.
Current Land Use	Residence
Site Drainage	Stormwater appears to be disposed of on site, either by soakwells or into the manmade lake in southern part of site. Regional groundwater and some surface water appears to be controlled via swales draining to the north west towards the Helena River.
Site History ²	Prior to 1953: Judged to be partially cleared Pastoral land. Low lying Palusplain present in southern part of site. 1961 to 1965: agricultural development in northern part of site. 1983 to 1985: Agricultural works discontinued. 1985 to 1989: Construction of existing residence and lake in southern part of site. 1989 to present: Site relatively unchanged.

- NOTES:**
1. Site levels based on feature survey provided.
 2. Site history based on aerial imagery (Landgate).

5. PROPOSED DEVELOPMENT

Table 2: Summary of Proposed Development

Item	Comment
Proposed Development	Warehouse developments and associated hardstand areas (refer Appendix A).
Proposed Finished Level	About RL 23.9 m AHD for most of site.
Cut/Fill	Excavation of surficial clay and replacement (with sand fill) in northern and western part of site, extending to depths of up to 1.6 m. Bulk fill of about 0.9 m to 1.5 m over most of the site with deeper filling required within the existing lake to form finished site levels.
Assumed Stormwater Disposal	On site via soakwells and cellular structures with some above ground storage as per Porter Engineering stormwater management plan.
Assumed Sewage Disposal	Via drip irrigation in areas shown in Appendix A.

6. PRELIMINARY HYDRAULIC LOADING

We have been provided with the following wastewater flow rates which we understand were derived using Health Regulations 29. We have assumed that no industrial liquid waste is to be disposed of on site.

Table 3: Summary of Preliminary Hydraulic Loading

Source	Personnel	Rate (L/ person/day)	Total Volume (L/day)
Full Time Staff, Members - Office and Warehouse (non showering)	30	30	900
Full Time staff - showering	5	70	350
Visitors	0	10	0
TOTAL	-	-	1,250

7. GEOTECHNICAL INFORMATION PROVIDED

We have been provided with a geotechnical investigation report prepared by Brown Geotechnical dated 22 July 2024 (Referenced 24040) which has been relied upon. The investigation work summarised in the report includes:

- Excavation of 3 test pits (TH18 to TH20), extending to depths of 1.5 m to 2.5 m; and
- Cone Penetration tests probes at 4 locations (CPT1 to CPT4), extending to depths of 2.3 m to 4.2;

Test locations are shown on In Line Image 1.

The report also states that surficial sands have an unsaturated hydraulic conductivity of about 40 m/day.

Inline Image 1 – Test Location Plan from Brown Geotechnical Report. Nominal area where surficial clay / clayey fill was encountered indicated in red.



8. SITE CONDITIONS

8.1. Geology

Table 4: Summary of Geology Mapping

Map Sheet	Map Scale	Mapped Soils	Site Findings
Perth	1:50,000	NORTHERN PART OF SITE: thin layer of Bassendean Sand overlying typically clay / clayey soils of the Guildford Formation. SOUTHERN PART OF SITE: Peaty clay swamp deposits.	Clayey sand / sandy clay fill up to about 1.6 m thick (in northern and western parts of the site only), over natural sand, over of COFFEE ROCK. Some soft soils anticipated within lake.

NOTE: Thin surficial topsoil layers generally present over the site.

8.2. Ground Model

The subsurface conditions encountered by Brown Geotechnical (refer Section 7) can be summarised as comprising:

- **Surficial TOPSOIL**; overlying
- **In TH19, TH20 and CPT2 to CPT4 ONLY - FILL: Sandy CLAY / Clayey SAND (SC)**, extending to depths of up to about 1.6 m; overlying
- **SAND (SP)**, extending to depths of up to 4.2 m; overlying
- **COFFEE ROCK** inferred from CPT refusal at CPT1 at 3 m depth and CPT4 at 2.3 m depth.

Notes:

- We understand the insitu clayey sand / sandy clay fill is to be removed from site and replaced with free draining sand; and
- **Soft soils are anticipated at the base of the existing lake.** We understand that these soils are to be removed and the lake backfilled with free draining sand. Dewatering is proposed to enable these works.

8.3. Groundwater and Surface Water

Table 5: Summary of Groundwater and Surface Water Levels

Item	Date	Depth Range (m) ¹	Elevation Range (m AHD)	Comment
Perth Groundwater Atlas ²	2004	9.4	14.5	End of summer level in 2004 only
	2019	4.4 to 5.9	18 to 19.5	Range of water levels in 2019 only
Brown Geotechnical Site Observations	June 2024	2.5 to 2.2	21.4 to 21.7	Encountered in CPT01 to CPT03
	July 2024	3.7	20.5	Encountered in TH19
Feature Survey	February 2024	3.0	21.2	Level in manmade lake at site measured in survey by Scanlan Surveys.
DBCA Mapping	-	-	-	Site mapped as sumpland.
Design water level at proposed LAA	-	-	22.0	Groundwater levels can be impacted by stormwater disposal. Design groundwater levels must also be assessed by project civil designer. This is unlikely to be an issue unless LAA is in close proximity to stormwater disposal elements.

NOTES: 1. Depth below proposed site level of RL 23.9 m AHD.

2. Perth Groundwater Atlas observations based on levels in nearby boreholes.

9. SITE ASSESSMENT

9.1. General

The results of our site assessment are presented in Attached Table 1.

9.2. Horizontal Setbacks

Table 6: Required Horizontal Setback Distances (AS1547)

Feature	Sub-Type	Horizontal Setback Distances (m)
Treatment tanks to buildings, property boundaries, driveways, paths and other tanks	-	1.2
Trenches, beds and soak wells to boundary, building, tanks and other land application systems	-	1.8
Trenches, beds and soak wells to trafficable areas	-	1.2
Any land application system to wells, streams, private bores or underground source of water intended for human consumption	-	30.0
Trenches, beds and soak wells to subsoil drains or open drainage channels	-	6.0
Spray irrigation	Boundaries, buildings, driveways etc.	1.8
	Subsoil and open drains	6.0
	Swimming pools	3.0
	Treatment tanks	1.2
Subsurface Drippers	Boundaries, buildings, driveways etc.	0.5
	Subsoil and open drains	3.0
	Swimming pools	2.0
	Garden bore	10.0
On-site waste system to water resources (river, stream etc.)	-	100.0

9.3. Land Application Areas

9.3.1. Government Sewerage Policy (GSP, 2019)

The minimum LAA size in accordance with the GSP (2019) has been calculated and is shown below. The LAA may need to be resized if the hydraulic loading changes.

Table 7: GSP LAA Calculation

Soil Category (AS1547)	Conversion Factor (Table 2 of GSP)	Hydraulic Loading (L/day, Section 6)	Minimum LAA (m ²)
1	0.2	1,250	250

NOTE: Conversion factor based on secondary treated effluent.

9.3.2. Water Balance

Water balance calculations are presented in Appendix C. We note that the irrigation rate used in the water balance calculation accounts for the high permeability of the insitu soil in relation to disposal of rainfall. This is based on the mingled infiltration of stormwater and wastewater. We have nonetheless based the sewage loading for sizing of the dripper system on the maximum indicated in AS1547-2012.

The proposed drip irrigation configuration must have an infiltrative area not less than the minimum required to meet the infiltrative area requirements (in accordance with the WA Health Regulations Method). Drip irrigation must be installed to meet the horizontal setback requirements outlined in Section 9.2. The LAA shown in appendix A appears to meet required setbacks to the infiltrative area.

9.3.3. Summary

The minimum drip irrigation infiltrative area for the proposed loading is 250 m², within a minimum 250 m² total LAA. This may need to be resized if the hydraulic loading changes.

A detailed plan will be required with the application to install that shows the dripper configuration and that the required setbacks are met.

10. SOIL ASSESSMENT

Details of our soil assessment are presented in Attached Table 2.

11. SITE SUITABILITY AND RECOMMENDATIONS

Based on our assessment, the site is suitable for disposal of wastewater. Wastewater must have secondary treatment (i.e. an ATU). The WA Health Regulations method indicates a minimum LAA of 250 m² is required for wastewater disposal, with the LAA appropriately set back from drains, driveways, site boundaries, buildings etc... This will need to be resized if the hydraulic loading changes.

LAA Location and Setbacks

The location of the proposed LAA is shown in Appendix A. The proposed LAA appears to satisfy the setback requirements, including meeting the appropriate distances from site boundaries, buildings, trafficable areas, drainage basins and driveways etc...

Disposal Method

We recommend the use of drip irrigation for wastewater disposal.

Separation to Groundwater and LAA Surface Level

The disposal area must be minimum 1.5 m above maximum groundwater levels. Based on the information available (refer Table 5), this would require a ground level of not lower than RL 23.5 m AHD in drip irrigation areas. Stormwater runoff must be diverted away from the disposal area to ensure groundwater levels are controlled in the vicinity of the LAA.

Although we have nominated a design groundwater level of RL 22 m AHD, groundwater levels can be impacted by stormwater disposal. Design groundwater levels must also be assessed by project civil designer. There is unlikely to be an impact unless the LAA is in close proximity to stormwater disposal elements.

Treatment Units

The wastewater may be treated using an ATU (secondary treatment), also known as aerated wastewater treatment systems (AWTS). ATU's use the processes of aeration followed by clarification to achieve biological treatment of wastewater.

ATU's (or any other proposed system) must be certified to AS1546.3 (2008) and require approval by the Chief Health Officer. A list of approved ATU's is presented in Table 2 on the [Department of Health website](#). The selected ATU must meet the hydraulic loading for the site and must treat sewage to achieve the following nutrient targets:

- Phosphorous: <1 mg/L
- Nitrogen: <10 mg/L

Soil Improvement

Improvement of the disposal areas must be done to achieve a phosphorous retention index (PRI) of at least 20, and monitored 3-yearly, in accordance with Department of Health requirements. This can be done with a product like 'gypsum', or by importing a high-PRI sand from off site. Improvement must be carried out to a minimum depth of 200 mm below the base of all infiltration zones and at least 0.5 m in plan outside the irrigation area.

12. CLOSURE

GALT GEOTECHNICS

A handwritten signature in black ink, appearing to read "O. Woodland".

Owen Woodland CPEng
Geotechnical Engineer

A handwritten signature in black ink, appearing to read "T. Mardesic".

Tyrone Mardesic CPEng
Geotechnical Engineer

[https://galtgeo.sharepoint.com/sites/wag240437/shared documents/01 ps sse/03 correspondence/wag240437-01 001 r rev1 sse.docx](https://galtgeo.sharepoint.com/sites/wag240437/shared%20documents/01%20ps%20sse/03%20correspondence/wag240437-01%20001%20r%20rev1%20sse.docx)

Attached Table 1: Site Assessment

Consideration	Assessment / Discussion	Reference	Level of Constraint	Mitigation Measures
Geology	NORTHERN PART OF SITE: thin layer of Bassendean Sand overlying typically clay / clayey soils of the Guildford Formation. SOUTHERN PART OF SITE: Peaty clay swamp deposits.	Perth Sheet of the 1:50,000 Environmental Geology Series Map	Nil	Peat soils not encountered at site.
Climate	To satisfy zero storage requirements, minimum LAA's to be sized as required for hydraulic loading.	Appendix C, Water Balance Calculation	Low	LAA to be greater than area required to meet zero storage requirement.
Exposure	Site will be cleared and broadly levelled - minimal/no tree cover or significant site aspect.	-	Low	-
Vegetation	Assume light grass at surface, no significant vegetation	-	Moderate	LAA designed to accommodate water balance and have nutrient stripping capabilities.
Landform and Drainage	Stormwater appears to be disposed of on site, either by soakwells or into the manmade lake in southern part of site. Regional groundwater and some surface water appears to be controlled via swales draining to the north west towards the Helena River.	-	Low to Moderate	Civil design to minimise rainfall run-on and run-off (using bunds/curbs etc.).
Slope	The site has a gentle slope generally to south.	-	Low	Slope is <5% grade.
Fill (Imported)	Site to be filled to about RL 24.2 m AHD. Imported fill must be high permeability sand soil (Soil Category 1).	-	Low	Imported fill must high permeability sand soil (Soil Category 1).
PDWSAs	The site is not mapped as being within a public drinking water source area.	Department of water (DoW) mapping service	-	-
SSAs	The site is mapped as a Sewage Sensitive Area (within the estuary catchment of the Swan River Plain, and within 1 km of a significant wetland)	Department of lands and heritage (DPLH) mapping service.	Moderate	ATU's must be used for effluent treatment (Secondary treatment is required). 1.5 m vertical clearance from base of disposal area to maximum known water level is required.

Attached Table 1: Site Assessment CONTINUED (Page 2 of 2)

Consideration	Assessment / Discussion	Reference	Level of Constraint	Mitigation Measures
Groundwater Level	AAMGL of about RL 22 m AHD inferred for LAA from Information provided, (refer Table 5). Groundwater levels can be impacted by stormwater disposal. Design groundwater levels must also be assessed by project civil designer.	Table 5	Moderate	The ground level in drip irrigation areas must be at least 1.5 m above maximum groundwater levels. This could require a ground level of not lower than RL 23.5 m AHD in irrigation areas. Stormwater runoff must be diverted away from the disposal area to ensure groundwater levels are controlled in the vicinity of the LAA (subject to civil design).
Groundwater Separation	Because the site is in an SSA, a minimum separation of 1.5 m is required from the base of the disposal area to the maximum known groundwater level.	Government Sewerage Policy (2019)	Moderate	See comments above
Rainfall Run-on/Seepage	There is a gentle slope down towards the south. Some rainfall run-on and run-off may occur	-	Moderate	Incident rainfall must be diverted away from LAA's using curbs or diversion bunds. Similarly, any run-off must be prevented by either having a level LAA, or by using retention bunds.
Surface Water/Water Resources	Surface water could occur in the table drains along Stirling crescent along the southern site boundary.	-	Moderate	The required minimum setbacks to water resources must be met for the proposed LAA configuration. Site is over 100 m from nearby open water bodies or public drainage swales.
Flood Potential	The site is not in a floodplain area	DWER floodplain mapping	Low	-
Setbacks	All setbacks to be met.	Section 9.2, Appendix A	Moderate	LAA appears to meet setback requirements (refer Appendix A).
LAA	Within the LAA, minimum 250 m ² is required to meet the minimum infiltrative area for drip irrigation, based on assumed hydraulic loading. The minimum total LAA area by the GSP 2019 method is 250 m ² and should not be dual use. This will need to be resized as required for the hydraulic loading if a different hydraulic loading applies.	Section 9.3.3, Appendix A	Moderate	LAA appears to be appropriately sized and meet the minimum required infiltrative area and setbacks (refer Appendix A). Design Loading Rate to be confirmed.

Attached Table 2: Soil Assessment

Consideration	Assessment / Discussion				Reference	Level of Constraint	Mitigation Measures
Subsurface Soil Conditions	At proposed LAA, we understand soil conditions will comprise SAND (Category 1). This will involve removal of surficial clay / clayey fill (where the LAA is in the north west part of site (refer In Line Image 1).				Section 8	Low	-
Acid Sulfate Soils	Site soils are mapped as "High to moderate" risk of ASS due to peat soils being mapped in the area. No Peat encountered at site. No indicators of ASS are noted, and the LAA will be above groundwater.				Department of Environmental Regulation (DER) mapping	Low to Moderate	Organic soils could be present in the base of lake at site. It is proposed to remove these soils and backfill the lake with free draining sand. Any organic acid generating soils removed from the lake would require treatment and disposal off site.
Soil Category	Insitu SAND Soil Category 1 based on provided geotechnical report.				AS1547-2012	Low to Moderate	LAA is being placed in southwest of the site away from clayey fill area (refer In Line Image 1).
Design Loading Rates	5 mm/day (for treated effluent)				Table L1, AS1547-2012	-	Secondary treated effluent
Laboratory Testing	Level of Constraint				-		
	Result	Low	Medium	High			
Coarse Fragments ¹	<10	<10%	10-40%	>40%	-	Low	Erosion risk is relatively low for sand and can be controlled using vegetation etc... as per civil design requirements.
Phosphorous Retention Index (PRI) ²	<5 (Presumptive)	>20	5-20	<5		Low to Moderate	Bassendean sand as found on the site is known to have a low PRI. Therefore, the upper 0.2 m of soil below the disposal area must comprise either imported high PRI (PRI>20) sand, or the in situ sand amended with gypsum to improve nutrient stripping capability.
pH ¹	NA	6-8	4.5-6	<4.5,>8		-	Erosion risk is relatively low for sand and can be controlled using vegetation etc... as per civil design requirements.
Exchangeable Sodium Percentage ¹	NA	<10	10-20	<20		-	
Electric Conductivity (dS/m) ¹	NA	<0.3	0.3 – 2.0	>2.0		-	
Emerson Class ¹	NA	> 4	4	1 - 3		-	

- Notes**
1. Level of constraint based on our interpretation of AS1547 description of "non-dispersive soils".
 2. Phosphorus retention index requirements are based on our interpretation of The Department of Primary Industries and Regional Development Standards for Land Resource Mapping (2005), as this is not specified in AS1547.

Appendices

Appendix A: Proposed Development Plan Provided

Appendix B: Brown Geotechnical Report



[Brown Geotechnical](#)

[Consulting Engineers – Land Development](#)
[Geotechnical/Acid Sulphate Soil/Groundwater Monitoring](#)

Our reference: 24040

22 July 2024

David Jones & Anita Jones
29 Stirling Crescent
High Wycombe WA 6057
C/- Planning Solutions
Attention: Joshua Carmody

Geotechnical Investigation – 29 Stirling Crescent, High Wycombe.

Dear Joshua

Introduction

Brown Geotechnical visited the above site on 2nd July 2024 to carry out a geotechnical investigation for a proposed commercial development including warehouses, offices and truck parking.

In addition to the three test holes previously carried out by Brown Geotechnical as part of the preliminary investigation for the area Structure Plan, four additional test holes were extended to a depth of 4m using an electric friction cone penetrometer (CPT) rig to allow for confirmation of soil depth and type across the site.

At the time of the investigation the site was occupied by an existing single storey residence and out-buildings. A large, approximately 1.5m deep, pond occupied the southern corner of the lot, and occasional medium to large tree were scattered across the property.

Brief

The report will address:

- Subsurface conditions,
- The existing soil classification in accordance with (AS2870-2011),
- Any earthworks required to obtain a classification suitable for development,
- Suitability of in-situ soil for use as engineering fill in the development,
- Soil bearing capacity and settlements,
- Retaining wall parameters,
- CBR for car park pavement design,
- Earthquake sub-soil class (AS1170.4-2007),
- Groundwater levels,
- Site permeability and drainage issues.

Laboratory Test Results

Table 1 – Geotechnical Test Results

Sample Location	Depth (m)	Fines (%)	Sand (%)	Gravel (%)	LL (%)	PL (%)
CPT4	0.5	43	57	0	39	17

Ground Conditions

The natural in-situ soil below the site is a medium grained, non-cohesive, well-draining sand. CPT 1 and 4 noted a very dense / cemented layer at approx. 2.5m to 3m. Experience in the area suggests this to be an iron cemented silty sand layer, locally known as coffee rock. It is usually approx. 0.5m thick. CPT2 and CPT3 pushed through the layer, though the zone still appears to be cemented.

The rear third of the site has a layer of clayey sand fill approx. 0.5m - 1m thick (see attached plan). The fill is compact and appears free from any deleterious materials but has some cohesive (plastic) fines, though only a small area was investigated. The area is raised 0.5m – 1.0m above the adjacent paddocks to the northwest. A sample taken at CPT4 has a moderate fines content, with low plasticity and low shrink swell potential.

The ground either side of the pond has a thin layer of fill to approx. 0.3m - 0.5m.

Site Classification

The site classification for the site will depend on whether the clayey sand fill is removed or retained.

If the clayey sand fill remains, specifically in the rear third of the site, it has been determined that the appropriate site classification for footing design in this area is Class 'S' in accordance with AS2870-2011 (refer Table 2) and following the earthworks and foundation considerations below.

If the clayey sand fill is removed, which is recommended, the site classification will be Class 'A'.

It is therefore considered that the land is suitable for development.

Table 2 - Definition of Site Classifications (Australian Standard AS2870-2011)

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement for moisture changes ($y_s < 20\text{mm}$).
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes (y_s 20–40mm).
H1	Highly reactive clay site, which can experience moderate to high ground movement from moisture changes (y_s 40–60mm)
H2	Highly reactive clay site, which can experience high ground movement from moisture changes (y_s 60–75mm)
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes ($y_s > 75\text{mm}$)

y_s : Characteristic Surface Movement

Earthworks

All earthworks should be undertaken in accordance with AS3798-1996 "Guidelines on earthworks for commercial and residential developments".

Topsoil / Fill

Topsoil is not suitable for foundation support and should be removed. There are some trees across the site. Unless they are to be retained, they should be removed with the entire root bulb material. The excavations should then be backfilled with material exhibiting the same geotechnical properties as the surrounding soils, then compacted as stated below.

All uncontrolled materials associated with the demolition of the existing structures, including footings, etc, should be removed from site.

Proof Rolling and Site Compaction

Prior to footing placement or placing any additional fill on site, the sand should be proof rolled to achieve at least 98% SMDD.

Should the clayey sand fill be retained, or re-worked, it should be compacted to a dry density ratio of at least 95% MMDD. Compaction should be checked using nuclear dry density tests.

Imported Fill Material

Any sand fill imported to obtain site formation levels, should be compacted in layers not more than 300mm thick to at least 98% SMDD. In-situ density tests should be carried out to calibrate the PSP to specific densities of the compacted material. Moisture conditioning (wetting) of the sand may be required to optimise compaction. Imported sand should ideally contain less than 5% non-plastic fines to retain good drainage characteristics and should be compacted at optimum moisture content.

Following excavation for foundations, the bases of pad and strip footings should also be compacted to achieve at least 98% SMDD.

Earthwork Inspections

A geotechnical consultant should be engaged to inspect the site following the removal of topsoil, trees, buildings and other unsuitable materials, and to confirm the compaction of the subsurface following proof rolling. Inspections and auditing of the earthworks should be carried out by the geotechnical consultant to enable confirmation of the final site classification.

Pond Backfill

It is understood, following discussions with the owner, that the pond is man-made and does not contain a clay liner. It is assumed the water within the pond is natural groundwater at the natural groundwater level.

Prior to backfilling, the pond should be dewatered, and any fines and sludge removed. The excavations should then be backfilled with material exhibiting the same geotechnical properties as the surrounding soils, then compacted as stated above. Only following the backfill and compaction should the dewatering be stopped.

Note: On no account should sand fill be placed into standing water in an attempt to backfill the pond. Saturated soils cannot be compacted and may result in excessive settlement below the future development.

Suitability of Existing Soils for use in the Development

The in-situ sands on site have low fines, are medium grained, cohesionless and free draining. They will be suitable for use as engineering fill in the development.

The clayey sand fill may be retained, however will likely form an impermeable layer restricting drainage. Further inspection and testing of the fill should be carried out as it is uncovered during the development.

Note: If the clayey sand fill is retained below proposed building envelopes, care should be taken avoid placing pad and strip footing across area of differing soil types to avoid differential settlement.

Bearing Capacity

It is understood that approximately 1m of clean sand fill will be imported on to the site during the bulk earthworks. For the estimate bearing capacity purposes, we considered the fill to have been proof rolled to a dense condition.

The following allowable bearing pressures have been based on a dense sand and a Young's modulus, $E = 40 \text{ MPa}$. Potential settlements should be taken into account for design bearing pressures.

Table 3 - Strip Footing Allowable Bearing Pressure and Estimated Settlement

Footing Depth (m)	Footing Width (m)	Allowable Bearing Pressure (kPa)	Estimated Settlement (mm)
0.5	0.5	125	<5
	1.0	150	5-10
	1.5	200	10-15

Table 4 - Pad Footing Allowable Bearing Pressure and Estimated Settlement

Footing Depth (m)	Footing Dimension (m)	Allowable Bearing Pressure (kPa)	Estimated Settlement (mm)
0.5	0.5 x 0.5	150	<5
	1.0 x 1.0	200	5-10
	1.5 x 1.5	250	10-15

The bearing pressures presented in Table 3 and 4 are also based on the following:

- Loading is isolated, vertical, non-eccentric, on level ground, and not influenced by any nearby cuttings or embankments,
- Factor of Safety of 2.5,
- It is recommended that the total settlement be limited to 15mm,
- Differential Settlement to be no greater than nominally half the total.

California Bearing Ratio

An average CBR correlation value of 18% for dense sand (in-situ) is considered adequate for access road and car park pavement design based on the CPT data.

For imported Perth sand fill, typical CBR values can vary from 12 to 20. Testing of additional imported fill should be carried out to determine more accurate values.

Earthquake Sub-Soil Class

The site Sub-Soil Class is considered as a Class C_e .

Retaining Wall Parameters

Assuming compaction / proof rolling of the soils has been carried out as stated above, the following retaining wall parameters have been based on a medium dense sand soil with $\phi=30^\circ$.

$$\gamma=18 \text{ kN/m}^3$$

$$K_o=0.50$$

$$K_a=0.29$$

$$K_p=4.$$

The parameters detailed above assume design of the retaining structure and compaction of the foundations are in accordance with AS 4678-2002, and that backfill material is composed of clean cohesionless sand.

Groundwater

Groundwater was encountered at approx. 1.5m bgl in the CPT probes. The preliminary investigation noted groundwater at 2.3m in TH19, below a 1m layer of fill. This equates to approximately the same level noted in CPT1 where there is no fill present.

The Perth groundwater map indicates the groundwater level to be approx. 19mAHD, or approx. 4m below ground level. The DoW notes these values can vary locally by up to 3m.

The layer of cemented sand / coffee rock seen in the CPT probes at approx. 2.5m could influence the local groundwater level, being an aquiclude to vertical drainage or causing perching of groundwater in sands above the layer.

For more accurate groundwater information, groundwater monitoring bores should be considered.

Permeability and Site Drainage

Drainage within the clayey sand fill will be poor. It is recommended that the material be removed if soakwells are required in the future development.

The drainage characteristics of the sand on site are good. The near surface soil permeability is 5×10^{-4} m/s. Soakwells will be suitable for stormwater runoff within the sand.

Permeability and drainage conditions may be reduced during earthworks due to compaction of in-situ and imported sands. Over compaction during earthworks can seriously reduce soil permeability and drainage potential. It is recommended that further permeability testing be carried out following the completion of earthworks.

Regards

Ken Brown

Senior Geotechnical Engineer
BROWN GEOTECHNICAL

Attachments: 1. Site and Test Location Plan
2. CPT Plots and Test Hole Logs
3. Laboratory Test Certificates
3. Conditions Relating to this Report

Brown Geotechnical

PO Box 278, Como, Western Australia 6952 Phone 0431 122 320 Email admin@browngeotechnical.com.au

Site and Test Location Plan



ELECTRIC FRICTION-CONE PENETROMETER

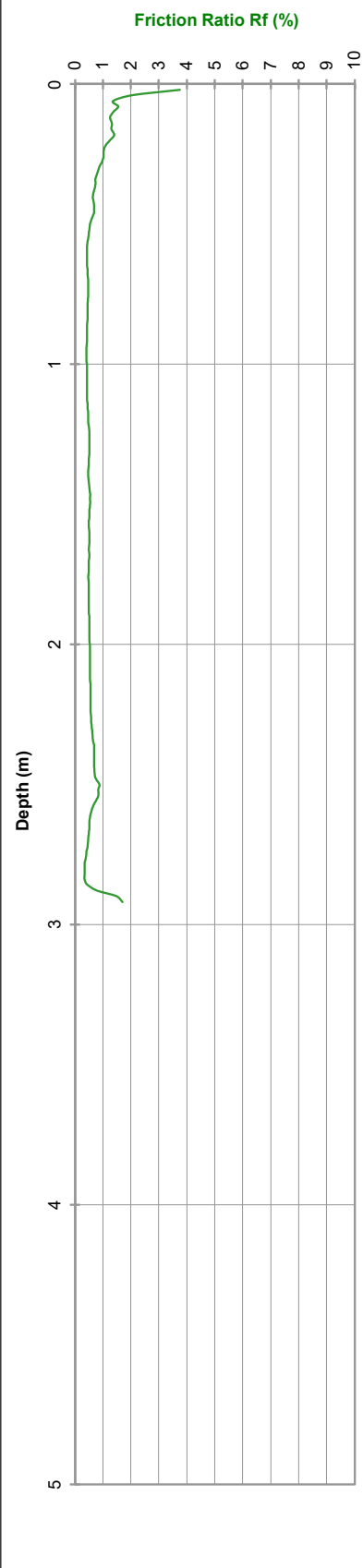
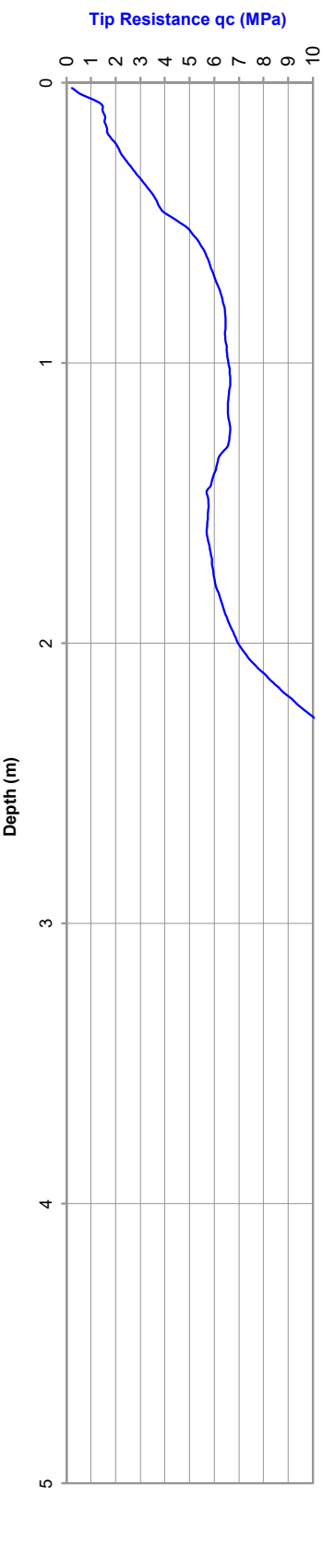
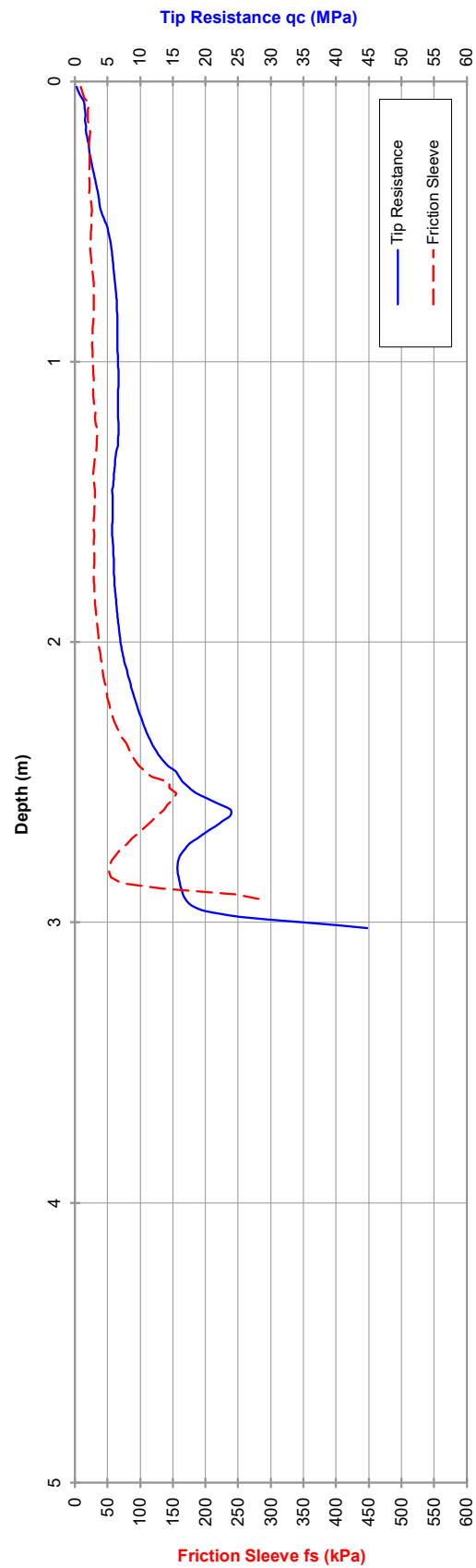
CLIENT: Brown Geotechnical
PROJECT: 29 Stirling Crescent
LOCATION: High Wycombe

Job No.: 24024
RL (m):
Co-ords:

Probe I.D

CPT 01

02-Jul-24



ELECTRIC FRICTION-CONE PENETROMETER

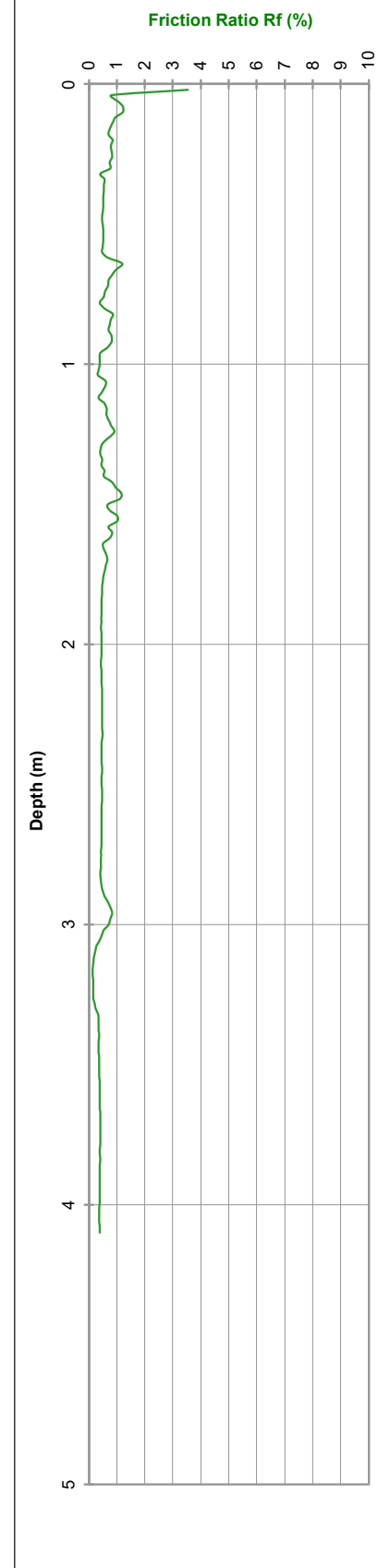
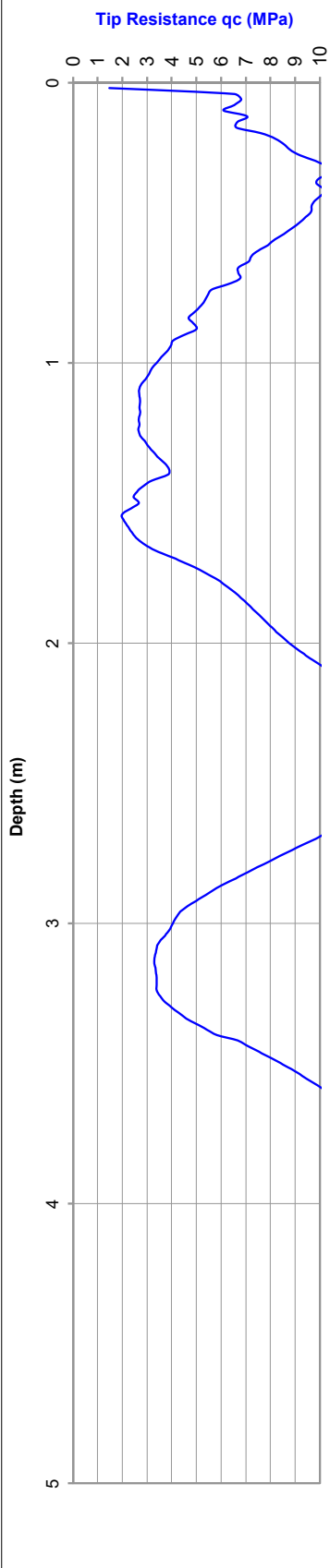
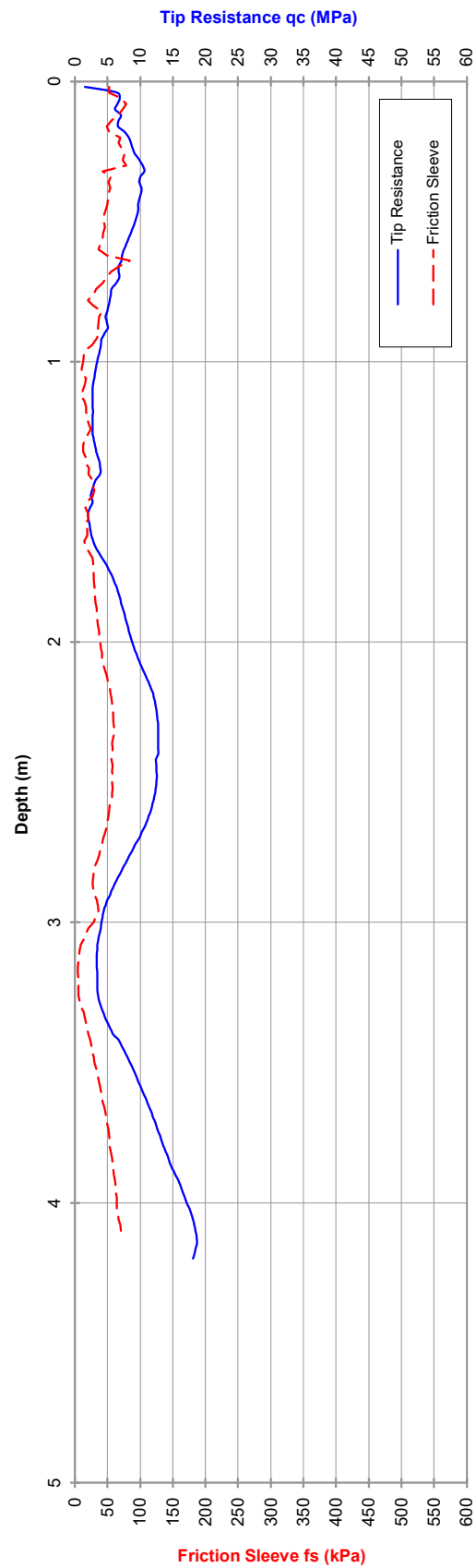
CLIENT: Brown Geotechnical
PROJECT: 29 Stirling Crescent
LOCATION: High Wycombe

Job No.: 24024
RL (m):
Co-ords:

Probe I.D

CPT 02

02-Jul-24



ELECTRIC FRICTION-CONE PENETROMETER

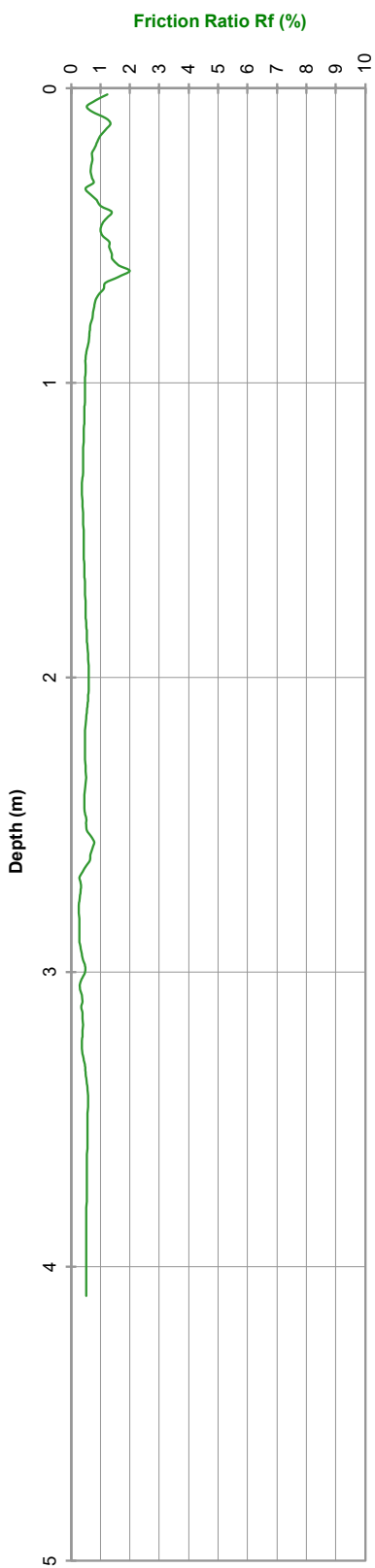
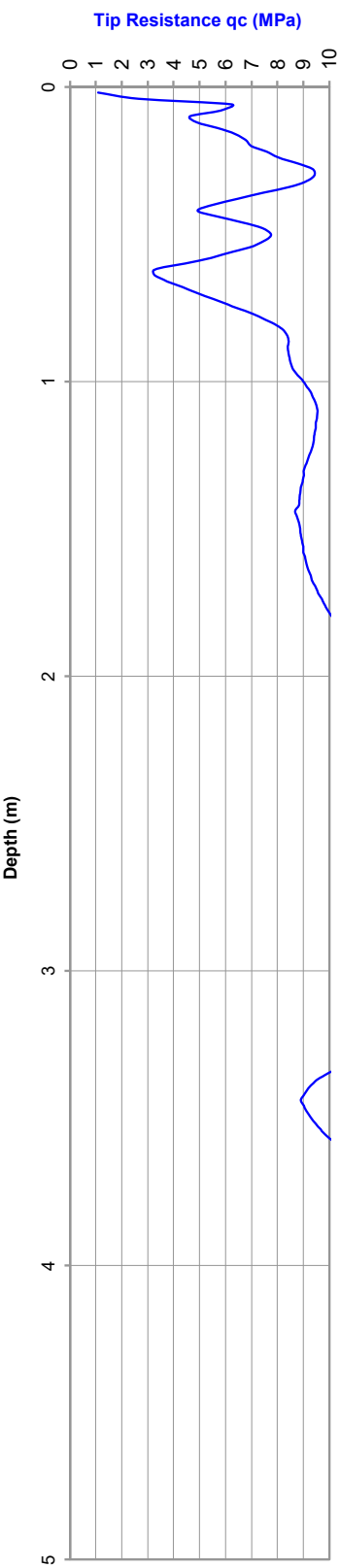
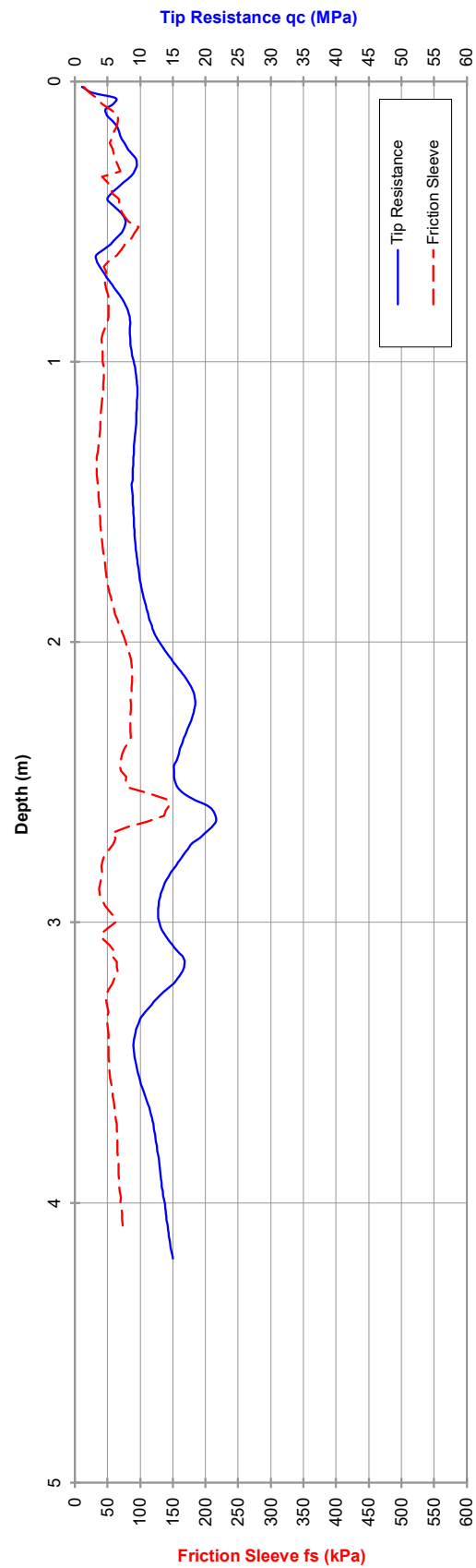
CLIENT: Brown Geotechnical
PROJECT: 29 Stirling Crescent
LOCATION: High Wycombe

Job No.: 24024
RL (m):
Co-ords:

Probe I.D

CPT 03

02-Jul-24



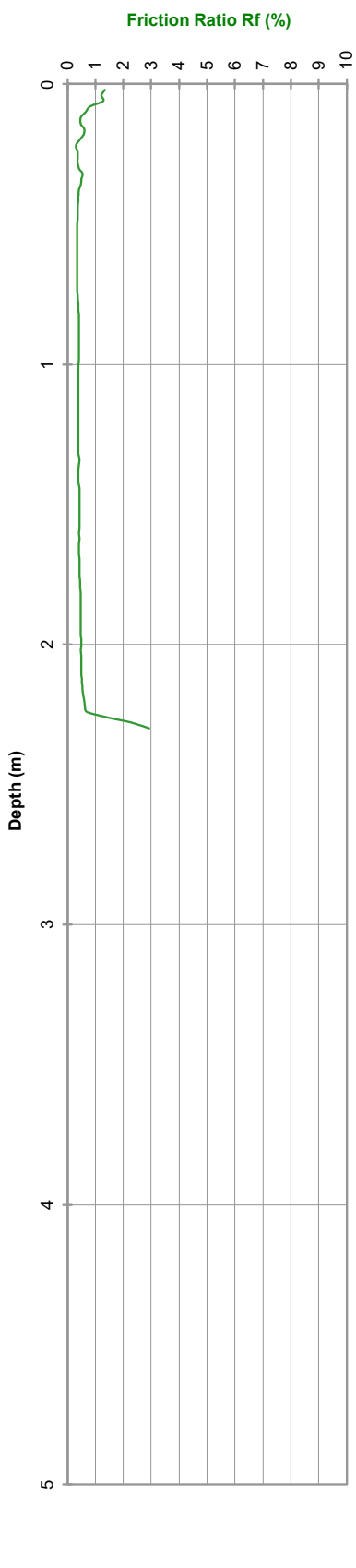
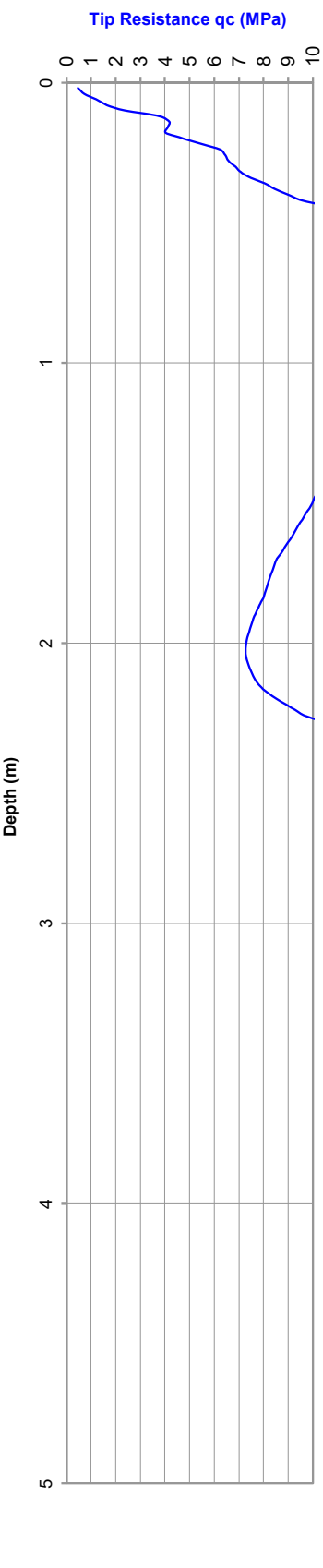
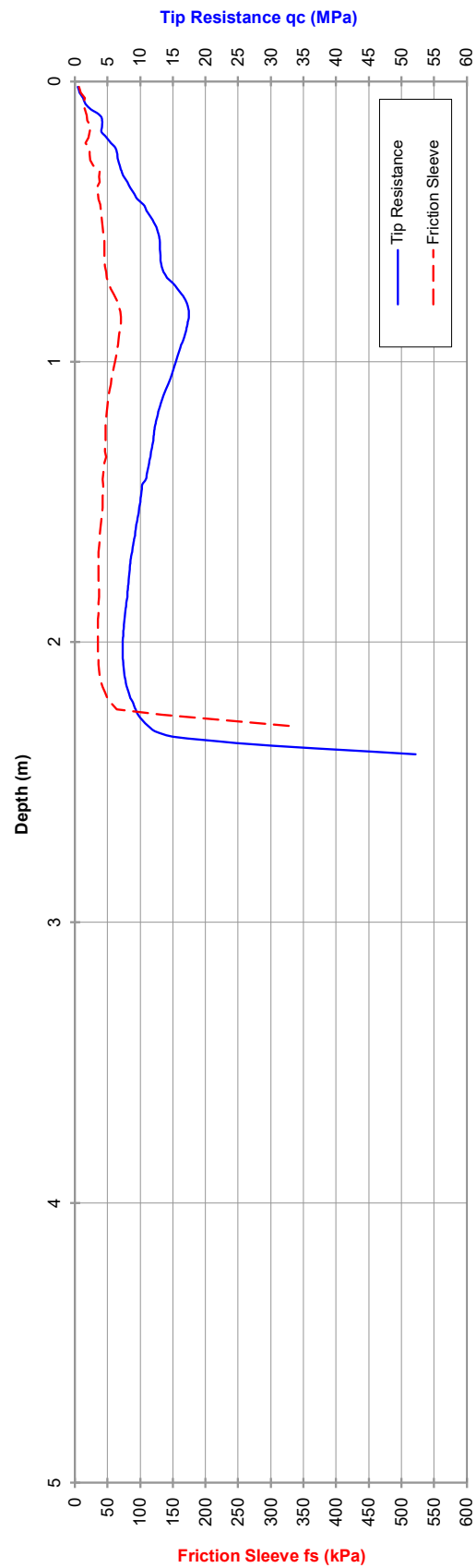
ELECTRIC FRICTION-CONE PENETROMETER

Probe I.D

CLIENT: Brown Geotechnical
PROJECT: 29 Stirling Crescent
LOCATION: High Wycombe

Job No.: 24024
RL (m):
Co-ords:

CPT 04
02-Jul-24



CLIENT

Marwon Pty Ltd

PROJECT NAME

Stirling Crescent/Hatch Court LSP

PROJECT NUMBER

14010

PROJECT LOCATION

High Wycombe

DATE STARTED

25/06/14

COMPLETED

25/06/14

R.L. SURFACE

23.1

DATUM

m AHD

DRILLING CONTRACTOR

SLOPE

90°

BEARING

EQUIPMENT

5 tonne excavator

HOLE LOCATION

31.993031S 116.00253E MGA

HOLE SIZE

0.5m x 1m

LOGGED BY

KB

CHECKED BY

KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		23.0				TOPSOIL: Fine to medium, grey, silty sand, with rootlets, moist		
					FILL	FILL: Dense, grey & brown, sandy gravel fill		
			0.5		SP	SAND: Medium dense, medium, grey, trace silt, moist		
		22.5						
			1.0					
		22.0						
			1.5					
		21.5						
			2.0					
		21.0						
			2.5			Collapse Borehole TH18 terminated at 2.3m		
		20.5						
			3.0					

CLIENT Marwon Pty Ltd PROJECT NAME Stirling Crescent/Hatch Court LSP
PROJECT NUMBER 14010 PROJECT LOCATION High Wycombe

DATE STARTED 25/06/14 COMPLETED 25/06/14 R.L. SURFACE 24.0 DATUM m AHD
DRILLING CONTRACTOR _____ SLOPE 90° BEARING ---
EQUIPMENT 5 tonne excavator HOLE LOCATION 31.92991S 116.00179E MGA
HOLE SIZE 0.5m x 1m LOGGED BY KB CHECKED BY KB

NOTES _____

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Fine to medium, grey, silty sand, with rootlets, moist		
						FILL: Dense, brown, clayey sand fill		
		23.5	0.5					
		23.0	1.0					
						SAND: Medium dense, medium, grey, trace silt, moist		
		22.5	1.5					
		22.0	2.0					
						wet below 2.3m		
		21.5	2.5					
						Borehole TH19 terminated at 2.5m		
		21.0	3.0					

NOTES _____

BOREHOLE / TEST PIT STIRLING HATCH.GPJ GINT AUSTRALIA.GDT 13/08/14



SOIL | AGGREGATE | CONCRETE | CRUSHING

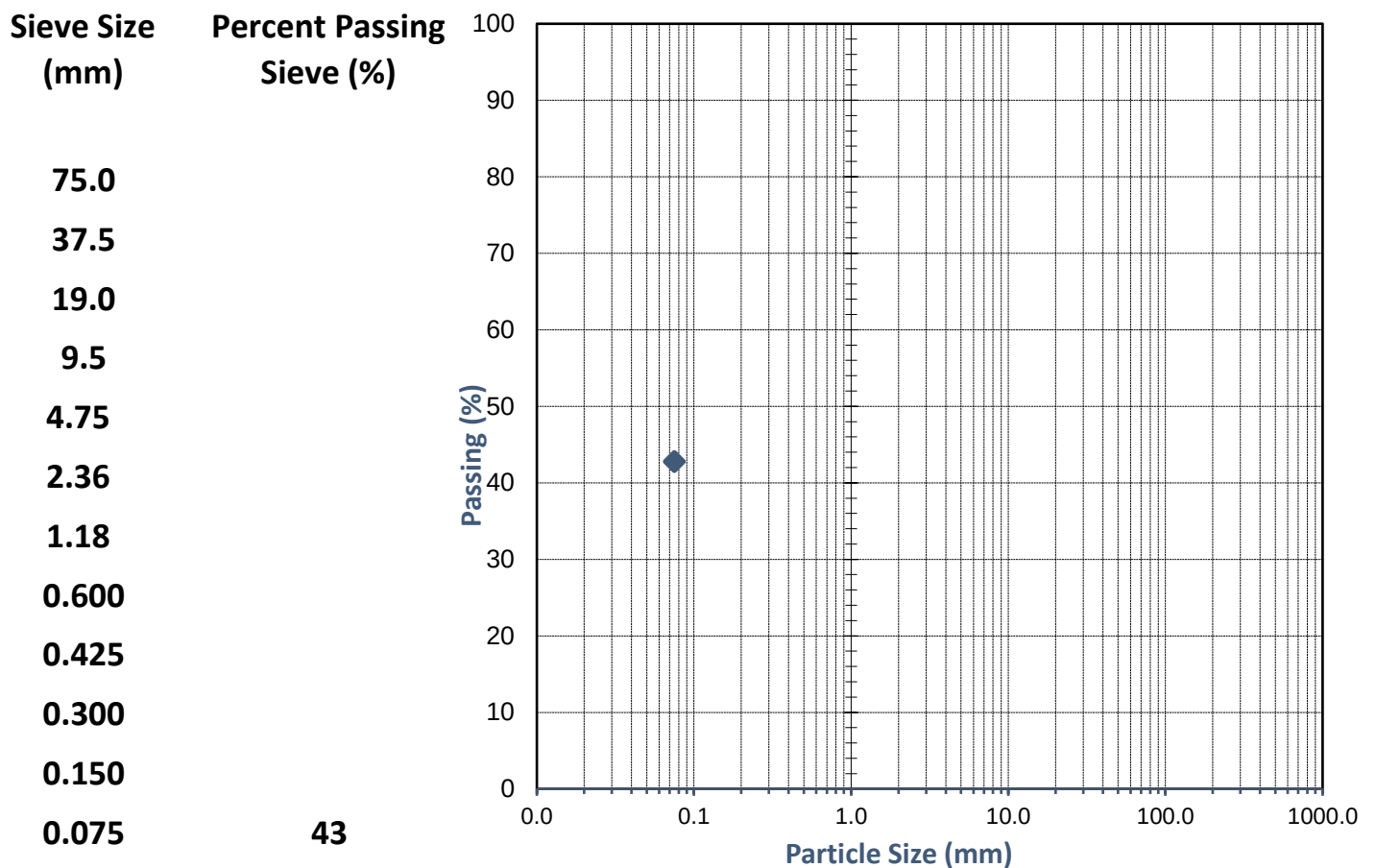
TEST REPORT - AS 1289.3.6.1 (% Fines)

Client:	Brown Geotechnical	Ticket No.	S13725
Client Address:	PO Box 278, Como WA 6952	Report No.	WG24.10365_1_%FINES
Project:	29 Stirling Crescent	Sample No.	WG24.10365
Location:	High Wycombe	Date Sampled:	2/07/2024
Sample Identification:	CPT4 - 0.5m	Date Tested:	04/07 - 05/07/2024

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments: Clients request for the % Fines of Material passing 0.075mm only.

Approved Signatory:

Name: Natasha Bielawski

Date: 05/July/2024



Accreditation No. 20599
Accredited for compliance
with ISO/IEC 17025 - Testing

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WESTERN GEOTECHNICAL

& Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.2, 3.2.1, 3.3.1 & 3.4.1

Client:	Brown Geotechnical	Ticket No.	S13725
Client Address:	PO Box 278, Como WA 6952	Report No.	WG24.10365_1_PI
Project:	29 Stirling Crescent	Sample No.	WG24.10365
Location:	High Wycombe	Date Sampled:	2/07/2024
Sample Identification:	CPT4 - 0.5m	Date Tested:	5/07/2024

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 1289.3.1.2	Liquid Limit (%)	39
AS 1289.3.2.1	Plastic Limit (%)	17
AS 1289.3.3.1	Plasticity Index (%)	22
AS 1289.3.4.1	Linear Shrinkage (%)	8.0
AS 1289.3.4.1	Length of Mould (mm)	250
AS 1289.3.4.1	Condition of Dry Specimen	-

Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 08/July/2024



Accreditation No. 20599

Accredited for compliance

with ISO/IEC 17025 - Testing

WORLD RECOGNISED
ACCREDITATION

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CONDITIONS RELATING TO THIS REPORT

1. This report has been prepared for the sole use of the client. It has been issued in accordance with the agreed terms and scope detailed in the proposal for the investigation. No responsibility or liability to any third party is accepted for any damages arising out of the use of this report.
2. This report has been prepared by suitably qualified and experienced personnel for the purposes stated herein. Every care is taken with the report as it relates to interpretation of sub-surface conditions, discussion of findings and recommendations given. No responsibility for the consequences of extrapolation by others is accepted by the company.
3. Findings and conclusions produced in the report are based on the investigation of the sub-surface through isolated locations. Conditions between investigated sites are based on extrapolation, interpretation and professional estimates. Unexpected variations in ground conditions often occur which cannot always be anticipated. The conclusions and recommendations in the report were considered accurate at the time of issue and based on certain assumptions at the time. Conditions and assumptions change with time and may affect the accuracy of the report.
4. Certain content within this report is based on information provided by the client and/or other parties and the accuracy of this information cannot be guaranteed.
5. These conditions must be read as part of the report and must be reproduced with all future copies.
6. The recommendations of this report should be considered a starting point. Recommendations should be continuously reviewed during the earthworks stage as sub-surface information and results from monitoring become available. It is strongly recommended that the Brown Geotechnical be retained to provide consultancy and/or inspections during the earthwork stages.

Appendix C: Water Balance

WA Site & Soil Evaluation

Irrigation area sizing

Please read the attached notes before using this spreadsheet																
Water Balance for Zero Storage																
Site Address:		29 Stirling Crescent, High Wycombe WA														
Date:		Monday, 26 August 2024				Assessor:		Tyrone Mardesic								
INPUT DATA																
Design Wastewater Flow	Q	1,250	L/day	Based on maximum potential occupancy and derived from the Supplement to Regulation 29 and Schedule 9 - Wastewater system loading rates												
Design Irrigation Rate	DIR	50.0	mm/day	Based on soil texture class/permeability and derived from Table M1 of AS/NZS 1547:2012												
Nominated Land Application Area	L	30	m ²	¹												
Crop Factor	C	0.8-1.0	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type ²												
Rainfall Runoff Factor	RF	1.0	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff												
Mean Monthly Rainfall Data				Midland												
Mean Monthly Pan Evaporation Data				Upper Swan												
				BoM Station and number												
				BoM Station and number or data from the Evaporation Data for Western Australia Report (https://researchlibrary.agric.wa.gov.au/cgi/viewcontent.cgi?article=1058&context=rmt)												
Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	10	13.1	16.9	40.3	100.1	159.1	162	122.1	74.1	46.7	22.3	10.7	777.4
Evaporation	E		mm/month	327	281	241	136	89	63	60	87	110	161	221	303	2079
Crop Factor	C		unitless	1.00	1.00	0.90	0.90	0.80	0.80	0.80	0.80	0.90	1.00	1.00	1.00	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	327	281	217	122	71	50	48	70	99	161	221	303	1970.5
Percolation	B	DIRxD	mm/month	1550.0	1400	1550.0	1500.0	1550.0	1500.0	1550.0	1550.0	1500.0	1550.0	1500.0	1550.0	18250.0
Outputs		ET+B	mm/month	1877.0	1681	1766.9	1622.4	1621.2	1550.4	1598.0	1619.6	1599.0	1711.0	1721.0	1853.0	20220.5
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	10	13.1	16.9	40.3	100.1	159.1	162	122.1	74.1	46.7	22.3	10.7	777.4
Applied Effluent	W	(QxD)/L	mm/month	1291.7	1166.7	1291.7	1250.0	1291.7	1250.0	1291.7	1291.7	1250.0	1291.7	1250.0	1291.7	15208.3
Inputs		RR+W	mm/month	1301.7	1179.8	1308.6	1290.3	1391.8	1409.1	1453.7	1413.8	1324.1	1338.4	1272.3	1302.4	15985.7
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-575.3	-501.2	-458.3	-332.1	-229.4	-141.3	-144.3	-205.8	-274.9	-372.6	-448.7	-550.6	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m ²	21	21	22	24	25	27	27	26	25	23	22	21	
MINIMUM AREA REQUIRED FOR ZERO STORAGE:				27 m ²												
CELLS																
		Please enter data in blue cells														
		Enter available Land Application Area														
		Data in yellow cells is calculated by the spreadsheet, DO NOT ALTER THESE CELLS														
NOTES																
¹ This value should be the largest of the following: land application area required based on the most limiting nutrient balance or minimum area required for zero storage																
² Values selected are suitable for grass in WA																

Understanding your Report

1. EXPECTATIONS OF THE REPORT

The following sections have been prepared to clarify what is and is not provided in your report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with the conditions on site.

Geotechnical engineering and environmental science are less exact than other engineering and scientific disciplines. We include this information to help you understand where our responsibilities begin and end. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of projects and we can help you to manage your risk.

2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following:

- the project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
- the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this report if any of the following conditions apply:

- the report was not written for you;
- the report was not written for the site specific to your development;
- the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the project team. Furthermore, we recommend that we be able to review work produced by other members of the project team that relies on information provided in our report.

3. DATA PROVIDED BY THIRD PARTIES

Where data is provided by third parties, it will be identified as such in our reports. We necessarily rely on the completeness and accuracy of data provided by third parties in order to draw conclusions presented in our reports. We are not responsible for omissions, incomplete or inaccurate data associated with third party data, including where we have been requested to provide advice in relation to field investigation data provided by third parties.

4. SOIL LOGS

Our reports often include logs of intrusive and non-intrusive investigation techniques prepared by Galt. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

5. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party because of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

6. CHANGE IN SUBSURFACE CONDITIONS

The recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including anthropogenic events (such as construction or contaminating activities on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

7. SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use professional judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from professional judgement and opinion.

The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

8. ENVIRONMENTAL AND GEOTECHNICAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not addressed in geotechnical reports. Similarly, geotechnical issues are not addressed in environmental reports. The investigation techniques used for geotechnical investigations can differ from those used for environmental investigations. It is the client's responsibility to satisfy themselves that geotechnical and environmental considerations have been taken into account for the site.

Geotechnical advice presented in a Galt Environmental report has been provided by Galt Geotechnics under a sub-contract agreement. Similarly, environmental advice presented in a Galt Geotechnics report has been provided by Galt Environmental under a sub-contract agreement.

Unless specifically noted otherwise, no parties shall draw any inferences about the applicability of the Western Australian state government landfill levy from the contents of this document.

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