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Austasia Leefield Pty Ltd
C/- Suite 26, 450 Elizabeth Street
SURRY HILLS NSW 2010

Attention: Mr Phil Mackey

Email: phil@bressangroup.net

Dear Sirs

On-site Effluent Disposal Assessment
Proposed Abalone Farm
180 Clarke Street, Pindimar

1. Introduction

This report presents the results of an effluent disposal assessment undertaken for a proposed abalone farm at 180 Clarke Street, Pindimar, New South Wales. The work was undertaken at the request of Ms Shay Gill of City Plan Services on behalf of Mr Phil Mackey of Austasia Leefield Pty Ltd.

The purpose of the investigation was to provide information on the suitability of the site to accept domestic effluent from staff facilities to be constructed as part of the proposed abalone farm development on the site.

The following details regarding the proposed development were provided:

- The proposed development comprises an abalone farm, including sheds, constructed dams and pipelines;
- On-site facilities for up to 15 full-time staff will include shower, toilet, wash basin and kitchenette facilities;
- The effluent disposal area should ideally be located within the proposed development footprint to minimise vegetation clearing.

The effluent disposal assessment was carried out with reference to "NSW Government Guidelines for On-Site Sewage Management for Single Households", January 1998 (Ref 1) and Australian Standard AS 1547:2012, "On site Domestic Wastewater Management" (Ref 2). The report was also prepared with reference to the guidance provided on the Great Lakes Council website.

The assessment included a site visit by an environmental engineer, subsurface investigation, laboratory testing followed by engineering analysis. Details of the field and laboratory work are given in this report, together with relevant engineering comment on the issues outlined above.

2. Site Description

2.1 Site Features

The site within Lot 2, DP 1014683, 180 Clarke Street, Pindimar and is defined by the development footprint of the proposed abalone farm. The site is shown Drawing 1 attached.

A site inspection was conducted by an environmental engineer from Douglas Partners on 12 August 2014. For the purposes of the assessment the site area was divided into a northern section and a central-southern section due to observed surface features and site slopes.

Northern Section

At the time of the investigation the northern section of the site was vegetated with mature trees and an undergrowth of smaller trees/shrubs. The ground surface within the northern section generally fell to the south-east with slopes of approximately 10% to 15%. A localised ridge (Ridge 1, refer to Drawing 1 attached) was observed in the north-eastern portion of the site oriented in an east-west direction. An existing track was present on this ridge with the ground surface falling to the north and south either side of the track at slopes ranging from 10% to 15%. Rock outcropping was observed in the northern portion of the site as shown in Figures 1 and 2 below.

Figure 1: Rock outcrop in the north-eastern portion of the site, looking north-east

Figure 2: Rock outcrop in the northern portion of the site (approx. 5 m south of Bore 2)

Central-Southern Section

At the time of the investigation the central-southern section of the site was vegetated with mature trees with an undergrowth of smaller trees/shrubs and ferns. The central-southern section was generally flat (slopes of less than 5%) with the exception of an area to the north-west of Bore 5 which fell to the south-east with slopes of up to 20%.

Figure 3: Slope falling to the south east in the vicinity of Bore 5 (looking north-west)

Figure 4: Flat area in the southern portion of the site, looking east from Bore 4

2.2 Regional Geology

An extract from the NSW 1:250 000 Geological survey indicates the site and areas to the south are mapped as being underlain by Quaternary alluvium generally comprising gravel, sand silt and clay. Areas in close proximity to the site to the west and north are underlain by Carboniferous aged Nerong Volcanics which generally comprise ignimbrite and sandstone. Conditions observe on site, particularly in the northern portion of the site, were more typical of the Nerong Volcanics (i.e. shallow rock).

2.3 Hydrogeology

A review of the Department of Water on-line information indicated the nearest registered groundwater bore to the site was located approximately 1.2 km east of the site. The work summary report for the bore GW078603 indicated the following:

- The bore is licensed for domestic purposes;
- The bore depth is 10.3 m.

The closest water course is Pig Station Creek which is located between approximately 40 m to 130 m to the east of the site as shown on Drawing 1, attached.

3. Field Work

3.1 Methods

The field work for the assessment was undertaken on 12 August 2014 and comprised the drilling of five boreholes (Bores 1 to 5) in possible areas of effluent disposal. The bores were drilled to depths ranging from 0.6 m to 1.8 m using a 90 mm diameter hand auger.

The bores were set out by an environmental engineer who also undertook a walk over inspection of the site. The engineer drilled the bores, logged the subsurface profile encountered and also collected representative samples for strata identification and testing purposes.

The approximate locations of the boreholes are shown on Drawing 1, attached.

3.2 Results

The results of the field work are given in the attached borehole logs. These should be read in conjunction with the explanatory notes, which define the descriptive terms and classification methods used.

A summary of the conditions encountered in the bores is presented below.

Depth (m) From	To	Material Description
0	0.6 / 1.5	Brown/dark brown **SILTY SAND / SANDY SILT** in all boreholes.
0.6	1.15 / 1.8	Light brown to brown **SAND** in Bores 4 and 5, some clayey sand layers.
1.5	1.7	Brown and orange **SILTY CLAY** encountered in Bore 3 only.
0.6 / 1.15	0.6 / 1.3	Light yellow and brown **SANDSTONE,** at termination in Bores 1 and 2 and from 1.15 to termination in Bore 5.

Groundwater was observed in Bore 4 at 0.9 m depth. It is noted that groundwater levels are variable and affected by climatic conditions and soil permeability.

In relation to effluent disposal at the site, the controlling soil for disposal of domestic effluent is the silty sand/sandy silt (Class 2 category soil – sandy loam) for surface irrigation and subsurface irrigation or evapotranspiration systems.

4. Laboratory Testing

To determine the relevant parameters of the natural soil at the site, two samples collected from the boreholes were submitted for laboratory testing. Detailed results of the laboratory testing are shown on the laboratory report sheets attached and summarised in Table 1.

Table 1: Results of Effluent Suite Testing

Bore	Sample Depth	Soil Description	Textural class	Soil pH (in CaCl)	ECe[1, 2] (dS/m)	PSC [3] (kg/ha)	CEC (cmol/kg)	Sodicity (ESP)
1	0.0-0.2	Silty sand	Sandy loam	4.5	1.12	24296	7.6	2.1
4	0.2-0.3	Sandy silt	Sandy loam	4.2	0.7	36900	4.1	2.7

Notes to Table 1:

EC - Electrical Conductivity

CEC – Cation Exchange Capacity

ESP – Exchangeable Sodium Percentage

1 - As defined in Reference 1

2 - EC_e is converted EC (1:5 – soil:water) as presented in Reference 3

3 - Phosphorus Retention Index calculated assuming a soil depth up to 1 m, however nutrient balance calculations take into account reduced soil depth profile where present. PSC is also limited in calculations to 12000kg/ha

Discussion of soil limitations for effluent disposal is provided in Table 3.

5. Discussion

5.1 Site and Soil Assessment

Site and soil characteristics observed during the field work are assigned either a minor, moderate or major limitation depending on the restrictions to the disposal area in accordance with Environment & Health Protection Guidelines (Ref 1) and are detailed in Tables 2 and 3. The limitations relevant to this site are shown in bold italics. Recommended site improvement measures for moderate and major limitations are also shown.

Table 2: Site Assessment Summary

Site Feature	Relevant System(s)	Minor Limitation	Moderate Limitation	Major Limitation	Restrictive Feature	Recommended Site Improvements
Flood potential	All land application systems	Rare, above 1 in 20 year flood contour		Frequent, below 1 in 20 year flood contour	Transport of wastewater off-site	Flood levels unknown
	All treatment systems	Vents, openings, and electrical components above 1 in 100 year flood contour		Vents, openings, and electrical components below 1 in 100 year flood contour	Transport of wastewater off-site. System failure and electrocution hazard	
Exposure	All land application systems	***High sun and wind exposure***		Low sun and wind exposure	Poor evapotranspiration	None required
Slope%	Surface irrigation	0-6	6 - 12	***>12***	Run-off, erosion	Terracing may be required if irrigation systems adopted
	Sub-surface irrigation	0-10	***10 - 20***	>20		
	Absorption system	0-10	***10 - 20***	>20		
Landform	All systems	***Hill crests, convex side slopes and plains***	Concave side slopes and footslopes	Drainage plains and incised channels	Groundwater pollution hazard. Resurfacing hazard	None required
Run-on and upslope seepage	All land application systems	None – low	***Moderate***	High – diversion not practical	Transport of wastewater off-site	Bunding may be required
Erosion potential	All land application systems	***No signs of erosion potential present***		Signs of erosion, eg rills, mass movement and slope failure present	Soil degredation and transport, system failure	None required
Site drainage	All land application systems	No signs of surface dampness		***Visible signs of surface dampness, such as moisture-tolerant vegetation (sedges and ferns), and seepages, soaks and springs***	Groundwater pollution hazard. Resurfacing hazard	Additional measures may be required
Fill	All systems	***No fill***	Fill present		Subsidence. Variable permeability	None required
Buffer distance	All land application systems	All buffer distances achievable		***Encroachment on Buffer Distances to intermittent watercourse***	Health and pollution risks	Additional protection measures will be required
Land area	All systems	Area is available	***Area is limited***	Area is not available	Health and pollution risks	Alternative system to cater for limited area
Rocks and rock outcrops (% of land surface containing boulders)	All land application systems	<10%	***10-20%***	>20%	Limits system performance	Design to consider presence of rock
Geology/ Regolith	All land application systems			Major geological discontinuities, fractured or highly porous regolith	Groundwater pollution hazard	None required

Table 3: Soil Assessment Summary

Soil Feature	Relevant System(s)	Minor Limitation	Moderate Limitation	Major Limitation	Restrictive Feature	Recommended Site Improvements
Depth to bedrock/hardpan	Surface and subsurface irrigation	>1.0	***0.5 - 1.0***	<0.5	Restricts plant growth (trees), excessive runoff and waterlogging	None required for irrigation, absorption system not recommended
	Absorption system	>1.5	1.0 - 1.5	***<1.0***	Groundwater pollution hazard. Resurfacing hazard	
Depth to high episodic or seasonal watertable (m)	Surface and subsurface irrigation	>1.0	***0.5 - 1.0***	<0.5	Groundwater pollution hazard. Resurfacing hazard	Consider surface/near-surface irrigation or mound system
	Absorption system	>1.5	1.0 - 1.5	***<1.0***	Potential for groundwater pollution	
Soil Permeability category	Surface and subsurface irrigation	***2b, 3 and 4***	2a and 5	1 and 6	Excessive run-off, waterlogging and percolation	None required for irrigation, absorption system not recommended
	Absorption system	3 and 4		***1, 2, 5 and 6***		
Coarse fragments (%)	All land application systems	0 - 20	20- 40	>40	May restrict plant growth, affect trench installation	None required
Bulk density (g/cm3)	All land application systems				Restricts plan growth, indicator of permeability	None tested
* Sandy Loam		<1.8		>1.8		
* Loam and Clay Loam		<1.6		>1.6		
*Clay		<1.4		>1.4		
pH CaCl	All land application systems	>6	***4.5 - 6.0***	***<4.5***	Reduces optimum plant growth	Adjust pH of soil in application area - lime addition
Electrical Conductivity - Ece (dS/m)	All land application systems	***<4***	4 - 8	>8	Excesive salt may restrict plant growth	None required
Sodicity (exchangeable sodium percentage)	Surface and subsurface irrigation (0 - 0.4 m)	***0 - 5***	5 - 10	>10	Potential for structural degradation	none required
	Absorption system (0 - 1.2 m)					
Cation exchange capacity (cmol+/kg) (0 - 40 cm)	Surface and subsurface irrigation	>15	5 - 15	***<5***	Unable to hold plant nutrients	Should be improved by addition of loamy topsoil and gypsum
Phosphorus sorption (kg P/ha) (0-1 m for irrigation) (1 m below intended base of trench)	All systems	***>6000***	2000 - 6000	<2000	Unable to immobilse any excess Phosphorus	None required
Modified Emerson Aggregate Test (dispersiveness)	All land application systems	***Class 3 or above***	Class 2	Class 1	Potential for structual degradation	None required

5.2 Buffer Distances and Location of Disposal Areas

Table 4 outlines the range of setback distances recommend by AS 1547:2012 (Ref 2) and the recommended setback distances for the site following an evaluation of the site and soil constraints, as outlined in Table R2 of AS 1547:2012. Reference has also been made to the recommended buffer distances provided in the Environment & Health Guidelines (Ref 1).

Table 4: Recommended Buffer Distances for On-Site Systems

Recommended Buffer Distances from AS 1547:2012	Adopted Minimum Buffer Distances Following Evaluation of Site and Soil Constraints	Comments
1.5 to 50 m to property boundaries	3 m to upslope boundary; and 25 m to downslope boundary	Slope in disposal areas, likely buffer to eastern lot boundary
2.0 to >6 m to buildings/houses	3 m to upslope buildings/houses; and ≥10 m to downslope buildings/houses	Potential sensitive use (abalone) in buildings
15 to 100 m to surface water (e.g. dams, rivers, streams, lakes etc. permanent or intermittent)	Nearest permanent creek approx. 40 m downslope	Recommend soil bund downgradient of disposal area
15 to 50 m to domestic groundwater well	50 m to registered groundwater bores	
3 to 15 m to recreational areas (e.g. children play areas, pools etc.)	Not applicable	
4 to 15 m to in-ground water tanks	10 m to in-ground water tanks (any future tanks)	Recommend in-ground tanks to be installed upgradient of disposal area
3 m or 45° angle from toe of retaining walls, embankments, escarpments and cuttings	N/A	Retaining walls for pump house and growout shed likely to be away from disposal area

In addition to the above, the following recommendations are made with regards to location of effluent disposal systems:

- A buffer of 25 m has been applied between proposed disposal areas and settlement ponds 1 and 2. We understand that the settlement ponds accept water from the abalone farm process and does not hold water prior to use in the farming process. In addition, the settlement ponds are cross contour or up contour from the proposed disposal area location hence there is considered to be a low probability of migration of treated effluent to the ponds;
- A buffer of 25 m has been applied between proposed disposal areas and the upslope open drains leading to the settlement ponds;
- Proposed disposal areas have been positioned downgradient of the open drain and settlement ponds in the central and southern portion of the site.

The effluent application areas shown on Drawing 1 have been located to maintain the adopted buffer distances and are based on irrigation areas outlined in Section 5.4 and 5.6 with the provision of at least 150 mm of good quality topsoil over the distribution pipelines.

5.3 Effluent Treatment System Options

Given the presence of sandy loam at the site it is recommended that the proposed effluent treatment system consists of, at a minimum, an aerated wastewater treatment system (AWTS) producing secondary quality effluent with phosphate reduction to 10 mg/L and nitrogen reduction to 25mg/L. Effluent that has been treated in an AWTS has a lower biochemical oxygen demand (BOD), lower suspended solid level and much lower faecal coliform level than effluent that has been treated in a septic tank only.

It is understood that the proposed development includes construction of surface water bodies and land-based cultivation of abalone. Due to the potentially sensitive landuses, it is further recommended that an advanced secondary treatment system producing secondary quality effluent with phosphate reduction to ≤5 mg/L and nitrogen reduction to ≤10 mg/L is considered.

The system selected for use should be approved by the NSW Health Department.

The greywater and blackwater waste streams can be treated and disposed of together or separately. Environment and Health Protection Guidelines (Ref. 1) indicates that greywater must be treated (using an AWTS or a greywater treatment device) if it is to be disposed of via subsurface or surface irrigation. The following sections of this report, however, have been based on the assumption that the effluent streams will be combined.

5.4 Effluent Disposal System Options

Appendix K of AS 1547:2012 (Ref 2) provides guidance on selection of suitable systems for site which are subject to significant constraints. Based on this guidance and previous experience with similar sites, the following options may be suitable for the disposal of effluent at the site:

Irrigation

Surface drip in areas ≤10% slope, where a minimum of 0.6 m depth of soil is available below dripper lines may be suitable.

The above disposal method should be discharging into at least 150 mm of good quality loamy topsoil as required in Table M1 of AS 1547:2012. It is recommended that the application lines are installed in 100 to 150 mm of good quality topsoil. This may require importation of suitable material to increase the thickness of topsoil within the application areas.

Wisconsin Soil Mound

A Wisconsin Mound system may be suitable for disposal of secondary treated effluent at this site.

5.5 Hydraulic Loading for Design

The hydraulic loading calculation is based on the following assumptions:

- The proposed development will have a non-reticulated water supply (tank water);
- Up to 15 full-time staff will be using the facilities each day (i.e. toilet, basin, shower, kitchenette);
- Combined waste stream volume of 1800 L/day from the development based on 120 L/day/person, or 1425 L/day combined waste stream volume using three star water reduction features (e.g. shower head, low flushing toilet, tap fixtures).

5.6 Sizing of Disposal Area

The area required for effluent disposal is determined by considering the hydraulic conductivity of the soil receiving the effluent and the ability of the soil to accept the nutrient loading associated with the effluent. These calculations are referred to as the hydraulic balance and nutrient balance respectively.

The areas required have been calculated based on the following design parameters:

- Rainfall data from Nelson Bay and evaporation data from Williamtown;
- Procedures outlined in Environment and Health Protection Guidelines (Ref. 1) and AS 1547 - 2012 (Ref. 2);
- Design irrigation rate (DIR) of 5 mm/day from Table M1 (Ref 2);
- Mound DLR of 24 mm/day for Table N1 (Ref 2);
- Loading on aggregate rate within mound of 40 mm/day.

Surface Irrigation

The recommended minimum disposal required for a surface irrigation system with standard water use is presented in Table 5. The minimum disposal required with three-star water reduction features is presented in Table 6.

Table 5: Irrigation System – Standard Water Use

Effluent Treatment	Wastestream (Combined)	Nitrogen Balance Area (m²)	Phosphorus Balance Area (m²)	Hydraulic Balance Area (m²)
Secondary	1800 L/day	**1250**	772	1152
Advanced secondary	1800 L/day	500	386	**1152**

Notes to Table 5:

Bold values indicate minimum area required

Table 6: Irrigation System – Water Reduction Features

Effluent Treatment	Wastestream (Combined)	Nitrogen Balance Area (m²)	Phosphorus Balance Area (m²)	Hydraulic Balance Area (m²)
Secondary	1425 L/day	**990**	611	912
Advanced secondary	1425 L/day	396	305	**912**

Notes to Table 6:

Bold values indicate minimum area required

Wisconsin Soil Mound

An estimate of the area required for a Wisconsin Mound has been determined by DP, however, this should be confirmed by the system provider. It is noted that a mound system is based on satisfying the water balance only as described in AS 1597 (Ref 2).

In a mound system, the basal area, defined as the area beneath and downslope of the distribution bed, is determined using the DLR for the controlling soil. For the current site conditions and following secondary treatment, the required basal area is 290 m^2 based on mound batter slopes of 1V:3H. Based on N2.2 (Ref 2) the distribution bed should be 45 m^2 (A = 2 m, B = 22.5 m).

Additional area is likely to be required for the construction of the mound and advice should be sought by an appropriately licensed plumber/contractor with experience in constructing mound systems.

It should be noted that mound systems are designed to satisfy the hydraulic balance only. They do not satisfy the nutrient balance requirements of the NSW Health Guidelines and therefore will be subject to council approval. It is noted, however, that pre-treatment of the effluent within an AWTS to advanced secondary quality will reduce the risk of exportation of nutrients from the mound.

5.7 Reserve Area Requirements

Typically, a reserve effluent disposal area is nominated during the assessment to allow for resting of the effluent disposal area and/or future expansion. AS 1547 - 2012 (Ref 2) states the requirement for a reserve area is typically associated with effluent generated from septic tanks and the need for a reserve area may be “reduced or even eliminated if an improved wastewater treatment” is utilised

(Section C5.5.3.4 of AS 1547 - 2012 (Ref 2)). Provided that an AWTS is used to treat the effluent from the proposed future development a reserve area may not be required, subject to Council approval.

5.8 Construction and Maintenance

Maintenance of the effluent disposal area is essential and should be conducted regularly, in accordance with the advice and recommendations of the supplier / manufacturer. The attached brochure titled *Your Land Application Area* (Appendix 8 of Ref 1) produced by the Department of Local Government provides recommendations on maintenance procedures.

The performance of the effluent disposal system is dependent on proper maintenance which should incorporate the following:

- The removal of sludge from the treatment tanks or sullage treatment tanks at three yearly intervals or as specified by local regulations or the manufacturer;
- Regular maintenance of surface vegetation to encourage water and nitrogen uptake;
- Maintenance of surface drains to prevent the ponding of water in the vicinity of the disposal area.

The disposal area should be constructed in accordance with the recommendations contained within this report and the methods detailed in AS 1547 - 2012 (Ref 2).

The disposal area should be cleared of mature trees observed within the area at the time of the assessment.

5.9 Location of Disposal Areas

The attached Drawing 1 shows the location of a suitable disposal area based on the buffer distances presented in Section 5.2 plus the requirement for the disposal areas to be within the proposed development footprint. Insufficient area is available in the northern section of the site.

The location of the disposal area has also been chosen to minimise contact with the proposed underground pipe between the primary and secondary settlement tanks in the central-southern portion of the site.

6. Conclusions

In accordance with Environment and Health Protection Guidelines (Ref 1) and AS 1547 – 2012 (Ref 2), the site is considered suitable for the disposal of effluent from the proposed development provided that the limitations raised in this report are addressed and recommended site and soil improvements contained are implemented. Primarily this includes the following:

- The use of an AWTS providing secondary treatment for the effluent, and potentially considering advanced secondary treatment due to the sensitive site use and nearby water bodies;
- If a mound system is considered, construction of the mound as per the dimensions provided in Section 5.6, along with construction by an experienced and licensed contractor;
- Alternatively, the use of surface drip irrigation within an area of up to 1250 m^2;
- If irrigation is proposed, blending lime and gypsum into the site soils to improve the pH and CEC within the application area together with the importation of loamy topsoil to improve CEC;
- Ensure at least 150 mm of topsoil in the irrigation area;
- Construction of the effluent disposal area in the south-eastern portion of the site as indicated on Drawing 1 attached;
- Construction of catch bunds/drains upgradient of disposal areas to minimise run-on and cross-contamination of open drains.

It is also recommended that further water reduction features such as water efficient fixtures are considered to minimise effluent loads.

7. References

1. NSW Government, 'Environment & Health Protection Guidelines: On-site Sewage Management for Single Households', January 1998.
2. Standards Australia, 'AS 1547-2012: On-site domestic-wastewater management'.
3. Local Government Salinity Initiative, 'Site Investigations for Urban Salinity'.

8. Limitations

Douglas Partners (DP) has prepared this report for this project at 180 Clarke Street, Pindimar in accordance with DP's proposal dated 15 July 2014 and acceptance received from Austasia Leefield Pty Ltd dated 15 July 2014. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Austasia Leefield Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of 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.
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 contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the (geotechnical / environmental / groundwater) components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Please contact either of the undersigned for clarification of the above as necessary.

Yours faithfully
Douglas Partners Pty Ltd

Reviewed by

Patrick Heads
Associate

Michael Gawn
Senior Associate

Attachments:

About this Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations
Appendix 7 (Ref. 1): Vegetation Suitable for Land Application Areas
Appendix 8 (Ref. 1): Your Application Area
Borehole Logs (Bores 1 to 5)
Laboratory Test Results
Drawing 1 – Test Location Plan

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

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

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.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. 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	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

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

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

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	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

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;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

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

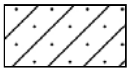
Soils


Topsoil

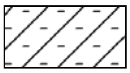

Peat


Clay

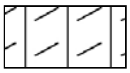

Silty clay

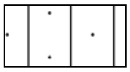

Sandy clay

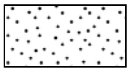

Gravelly clay

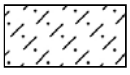

Shaly clay

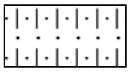

Silt


Clayey silt


Sandy silt

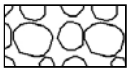

Sand

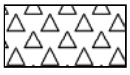

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

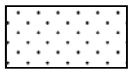

Talus

Sedimentary Rocks

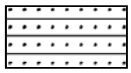

Boulder conglomerate

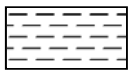

Conglomerate


Conglomeratic sandstone

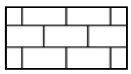

Sandstone


Siltstone


Laminite

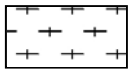

Mudstone, claystone, shale

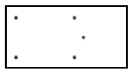

Coal


Limestone

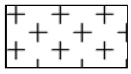
Metamorphic Rocks

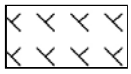

Slate, phyllite, schist

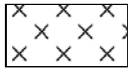

Gneiss

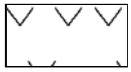

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

APPENDIX 7

VEGETATION SUITABLE FOR LAND APPLICATION AREAS

Botanical Name	Approximate Height	Common Name or Variety
Grasses		
Carex spp.		
Lomandra longifolia		
Microlaena stipoides		
Oplismenus imbecillis		
Pennisetum alopecuroides	40 - 80 cm	Available as lawn turf
Poa lab		
Stipa spp.		
Ground cover/climbers		
Hibbertia scandens		Snake vine
Hibbertia stellaris		
Isotoma fluviatalis	Prostrate	
Kennedia rubicunda	Climber	Dusky coral pea
Scaevola albida		
Scaevola ramosissima		
Veronica plebeia		
Viola hederacea		Native violet
Sedges/grasses/small plants		
Anigozanthus flavidus	2m	Kangaroo Paw
Baumea acuta		
Baumea articulata	Sedge	
Baumea juncea	Sedge	
Baumea nuda	Sedge	
Baumea rubiginosa	Sedge	
Baumea teretifolia	Sedge	
Blandfordia grandiflora	30-90cm	Christmas Bell
Blandfordia nobilis	30-90cm	Christmas Bell
Brachyscome diversifolia	Clump	Native Daisy
Carex appressa	Sedge	
Cotula coronopifolia	10-20cm	Waterbutton
Crinum pedunculatum	<2m	Swamp Lily
Cyperus polystachyos	Sedge	
Dianella caerulea	Low plant	Blue Flax Lily
Epacris microphylla	50cm -1m	
Ferns		
Gahnia spp.	Tall Grass	
Juncus spp.	0.5 m Rush	
Lobelia trigonocaulis	5-10cm	
Lomandra spp.	Grass	
Patersonia fragilis		Native Iris
Patersonia glabrata		Native Iris
Patersonia occidentalis		Native Iris
Ranunculus graniticola	5cm	
Restio australis	Reed	
Restio tetraphyllus	1m	
Sowerbaea juncea	Sedge	Rush Lily
Tetratheca juncea	<30cm	
Xyris operculata	<1m	Tall Yellow Eye

Botanical Name	Approximate Height	Common Name or Variety
Shrubs		
Agonis flexuosa nana		
Baekea linifolia	1 - 2.5 m	
Baekea utilis	1-2.5 m	
Baekea virgata	< 4 m	
Banksia aemula	1 - 7 m	
Banksia robur	0.5 - 2 m	
Bauera ruboides	0.5 - 1.5 m	
Callistemon	2 - 3 m	Burgundy
Callistemon	2 - 4 m	Eureka
Callistemon	3 - 4 m	Harkness
Callistemon	3 - 4.5 m	Kings Park Special
Callistemon	2 - 3 m	Mauve Mist
Callistemon	1 - 2.5 m	Red Clusters
Callistemon	2 - 3 m	Reeves Pink
Callistemon citrinus	50 - 80 cm	Austraflora Firebrand
Callistemon citrinus	2 - 4 m	Splendens
Callistemon citrinus	60cm – 1m	White Ice
Callistemon linearis	1 - 3 m	
Callistemon macropunctatus	2 - 4 m	
Callistemon pachyphyllus	2 - 3 m	
Callistemon pallidus	1.5 - 4 m	
Callistemon paludosus	3 - 7 m	
Callistemon pinifolius	1 - 3 m	
Callistemon rigidus	1.5 - 2.5 m	
Callistemon salignus	3 – 10m	
Callistemon shiresii	4 - 8 m	
Callistemon sieberi	1.5 - 2 m	
Callistemon sieberi	50 - 80 cm	Austraflora Little Cobber
Callistemon subulatus	1 - 2 m	
Callistemon viminalis	1 - 2 m	Captain Cook
Callistemon viminalis	5 - 10 m	Dawson River
Callistemon viminalis	3 - 5 m	Hannah Ray
Callistemon viminalis	50 cm - 1 m	Little John
Callistemon viminalis	1.5 - 2 m	Rose Opal
Callistemon viminalis	2 - 3 m	Western Glory
Goodenia ovata	1 - 1.5 m	
Hibiscus diversifolius	1 - 2 m	Swamp hibiscus
Kunzea capitata	1 - 2 m	
Leptospermum flavescens	< 2 m	Tea-tree
Leptospermum juniperinum	1 m	Tea-tree
Leptospermum lanigerum	1 - 2 m	Woolly tea-tree
Leptospermum squarrosum	< 2 m	Tea-tree
Melaleuca alternifolia	4 - 7 m	
Melaleuca decussata	1 - 2 m	Cross-leaved honey myrtle
Melaleuca lanceolata	4 - 6 m	
Melaleuca squamea	1 - 2 m	
Melaleuca thymifolia		

Botanical Name	Approx Height	Common Name or Variety
Trees		
Acacia elongata	> 2 m	
Acacia floribunda	2 - 4 m	Gossamer wattle
Agonis flexuosa	5 - 6 m	Willow myrtle
Allocasuarina diminuta	1.5 m	
Allocasuarina paludosa	0.5 - 2 m	
Angophora floribunda	Large tree	
Angophora subvelutina	Large tree	
Callicoma serratifolia	< 4m	
Casuarina cunninghamiana	10 - 30 m	River she-oak
Casuarina glauca	6 - 12 m	Swamp oak
Elaeocarpus reticulatis	Large tree	Blueberry ash
Eucalyptus amplifolia	Large tree	
Eucalyptus botryoides (coastal areas)	10 - 30 m	
Eucalyptus camaldulensis (west of ranges)	15 - 20 m	River red gum
Eucalyptus deanei	Large tree	Blue Mountains blue gum
Eucalyptus elata	Large tree	River Peppermint
Eucalyptus grandis	10 - 20 m	Flooded gum
Eucalyptus longifolia	20 m	Woollybutt
Eucalyptus pilularis	30 - 40 m	Blackbutt
Eucalyptus punctata	< 35 m	Greygum
Eucalyptus robusta	20 - 30 m	Swamp mahogany
Eucalyptus saligna (coastal)	30 - 50 m	Sydney blue gum
Eucalyptus tereticornis	30 - 40 m	Forest red gum
Eucalyptus viminalis (ranges)	20 - 40 m	Ribbon gum
Acmena smithii	10 - 20 m	Lilli pilli
Flindersia australis	< 40 m	Native teak
Hymenosporum flavuum	3 - 6 m	Native frangipani
Melaleuca armillaris	3 - 4 m	Bracelet honey myrtle
Melaleuca decora	4 - 7 m	
Melaleuca ericifolia	6 m	
Melaleuca halmaturorum	4 - 6 m	
Melaleuca hypericifolia	2 - 3 m	
Melaleuca linariifolia	4 - 8 m	Snow in summer
Melaleuca quinquenervia	5 - 7 m	Broad paperbark
Melaleuca squarrosa	6 m	
Melaleuca stypheloides	6 - 15 m	
Melia azedarach	15 - 20 m	
Pittosporum spp.		
Syzgium paniculatum	8 - 10 m	Bush cherry
Tristania laurina	5 - 15 m	Kanuka
Viminaria juncea	2 - 3 m	Golden spray

Source: Australian Plants Society

Maintaining your land application area

The effectiveness of the application area is governed by the activities of the owner.

DO

- ✓ Construct and maintain diversion drains around the top side of the application area to divert surface water.
- ✓ Ensure that your application area is kept level by filling any depressions with good quality top soil (not clay).
- ✓ Keep the grass regularly mowed and plant small trees around the perimeter to aid absorption and transpiration of the effluent.
- ✓ Ensure that any run off from the roof, driveway and other impermeable surfaces is directed away from the application area.
- ✓ Fence irrigation areas.
- ✓ Ensure appropriate warning signs are visible at all times in the vicinity of a spray irrigation area.
- ✓ Have your irrigation system checked by the service agent when they are carrying out service on the treatment system.

DON'T

- ✘ Don't erect any structures, construct paths, graze animals or drive over the land application area.
- ✘ Don't plant large trees that shade the land application area, as the area needs sunlight to aid in the evaporation and transpiration of the effluent.
- ✘ Don't plant trees or shrubs near or on house drains.
- ✘ Don't alter stormwater lines to discharge into or near the land application area.
- ✘ Don't flood the land application area through the use of hoses or sprinklers.
- ✘ Don't let children or pets play on land application areas.
- ✘ Don't water fruit and vegetables with the effluent.
- ✘ Don't extract untreated groundwater for potable use.

Warning signs

Regular visual checking of the system will ensure that problems are located and fixed early.

The visual signs of system failure include:

- surface ponding and run-off of treated wastewater
- soil quality deterioration
- poor vegetation growth
- unusual odours

Volume of water

Land application areas and systems for on-site application are designed and constructed in anticipation of the volume of waste to be discharged. Uncontrolled use of water may lead to poorly treated effluent being released from the system.

If the land application area is waterlogged and soggy the following are possible reasons:

- Λ Overloading the treatment system with wastewater.
- Λ The clogging of the trench with solids not trapped by the septic tank. The tank may require desludging.
- Λ The application area has been poorly designed.
- Λ Stormwater is running onto the area.

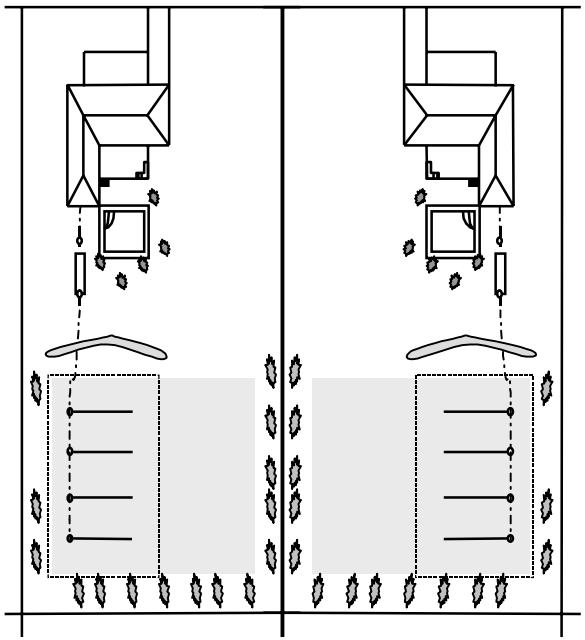
HELP PROTECT YOUR HEALTH AND THE ENVIRONMENT

Poorly maintained land application areas are a serious source of water pollution and may present health risks, cause odours and attract vermin and insects.

By looking after your sewage management system you can do your part in helping to protect the environment and the health of you and your family.

For more information please contact:

Your Land Application Area



BOREHOLE LOG

CLIENT: Austasia Leefield Pty Ltd
PROJECT: Effluent Disposal Assessment
LOCATION: Clarke Street, Pindimar

SURFACE LEVEL: --
EASTING: 414256.8
NORTHING: 6383547.78
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 81560
DATE: 12/8/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SILTY SAND - Brown silty fine to medium grained sand with some to abundant organics, moist		A	0.0				
		From 0.1m, trace organics			0.2				
					0.3				
		From 0.4m, some cobbles		A					
	0.7	Bore discontinued at 0.7m, refusal (boulder or rock)			0.6				
	1								1
	2								2

RIG: Hand Tools **DRILLER:** Sebastian **LOGGED:** Sebastian **CASING:** Uncased
TYPE OF BORING: 90mm diameter hollow sand hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS: Auger free spinning at 0.7m

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_x	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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Austasia Leefield Pty Ltd
PROJECT: Effluent Disposal Assessment
LOCATION: Clarke Street, Pindimar

SURFACE LEVEL: --
EASTING: 414173.2
NORTHING: 6383545.92
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 81560
DATE: 12/8/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SILTY SAND - Light brown and orange-brown silty fine to medium grained sand with some to abundant sandstone gravel and cobbles, moist		A	0.0				
					0.2				
				A	0.3				
		Grading to extremely low strength, extremely weathered sandstone			0.5				
	0.6	Bore discontinued at 0.6m, refusal							
	1								1
	2								2

RIG: Hand Tools **DRILLER:** Sebastian **LOGGED:** Sebastian **CASING:** Uncased
TYPE OF BORING: 90mm diameter hollow sand hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS: Auger free spinning at 0.6m

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_x	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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Austasia Leefield Pty Ltd
PROJECT: Effluent Disposal Assessment
LOCATION: Clarke Street, Pindimar

SURFACE LEVEL: --
EASTING: 414235.53
NORTHING: 6383532.82
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 81560
DATE: 12/8/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SILTY SAND - Brown silty fine to medium grained sand with some rootlets and organics, moist		A	0.0				
	0.15				0.1				
		SILTY SAND / SANDY SILT - Brown and orange silty fine to medium grained sand / sandy silt with trace gravel, moist		A	0.2				
					0.4				
				A	0.6				
					0.8				
	1				1.0				1
				A					
		From 1.2m, trace clay			1.2				
				A	1.3				
					1.4				
	1.5	SILTY CLAY - Firm, brown and orange silty clay, M>Wp							
		Grading to extremely low strength sandstone		A	1.6				
	1.7	Bore discontinued at 1.7m, limit of investigation							
	2								2

RIG: Hand Tools **DRILLER:** Sebastian **LOGGED:** Sebastian **CASING:** Uncased
TYPE OF BORING: 90mm diameter hollow sand hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

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_x	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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Austasia Leefield Pty Ltd
PROJECT: Effluent Disposal Assessment
LOCATION: Clarke Street, Pindimar

SURFACE LEVEL: --
EASTING: 414131.69
NORTHING: 6383426.83
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 81560
DATE: 12/8/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		SANDY SILT - Dark brown, fine to medium grained sandy silt with abundant organics and rootlets and trace gravel, moist		A	0.0				
	0.15	SANDY SILT - Dark brown, fine to medium grained sandy silt, moist		A	0.1				
				A	0.2				
					0.3				
				A	0.5				
	0.6	SAND - Light brown, fine to medium grained sand, moist		A	0.7				
					0.8				
	0.9	CLAYEY SAND - Light brown and brown mottled orange clayey fine to medium grained sand, moist to wet		A	1.0			12-08-14	
1					1.1				1
				A	1.3				
					1.4				
	1.45	SAND - Light brown-yellow, fine to medium grained sand with trace clay, saturated		A	1.5				
		From 1.65m, colour change to light brown		A	1.6				
					1.7				
	1.8	Bore discontinued at 1.8m, limit of investigation							
2									2

RIG: Hand Tools **DRILLER:** Sebastian **LOGGED:** Sebastian **CASING:** Uncased
TYPE OF BORING: 90mm diameter hollow sand hand auger
WATER OBSERVATIONS: Free groundwater observed at 0.9m
REMARKS:

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_x	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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Austasia Leefield Pty Ltd
PROJECT: Effluent Disposal Assessment
LOCATION: Clarke Street, Pindimar

SURFACE LEVEL: --
EASTING: 414188.94
NORTHING: 6383473.91
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 81560
DATE: 12/8/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.0	SANDY SILT - Brown, fine to medium grained sandy silt with abundant rootlets and organics, trace gravel and cobbles, moist		A	0.0 0.01				
	0.15	SILTY SAND - Dark brown, silty fine to medium grained sand with trace gravel and cobbles, moist		A	0.3 0.5				
	0.6	SAND - Light brown, fine to medium grained sand with trace silt, moist		A	0.7 0.8				
	0.9	CLAYEY SAND - Light brown and brown clayey fine to medium grained sand, moist (trace wet)		A	1.0 1.1				
1	1.15	SANDSTONE - Extremely low strength, extremely weathered, light yellow, brown and light green / yellow, fine to medium grained sandstone with some clay, humid		A	1.2				1
	1.3	Bore discontinued at 1.3m, refusal							
2									2

RIG: Hand Tools **DRILLER:** Sebastian **LOGGED:** Sebastian **CASING:** Uncased
TYPE OF BORING: 90mm diameter hollow sand hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

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_x	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)

Douglas Partners
Geotechnics / Environment / Groundwater

Effluent Subdivison Profile

SESL AUSTRALIA
Environment & Soil Sciences

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 31450 **Sample N°: 1** **Date Received: 15/8/14** **Report Status:** ○ Draft ◉ Final

Client Name:	**Douglas Partners (Newcastle)**	Project Name:	**Pindimar**
Client Contact:	**Patrick Heads**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	**116019**	Sample Name:	**1/0.0-0.2**
Address:	**PO Box 324**	Description:	**Soil**
	Hunter Region Mail Centre NSW 2310	Test Type:	**pHEC_S, ECEC_NH4Cl, pri, mEAT**

TEST	RESULT	COMMENTS
pH in water 1:5	5.6	
pH in $CaCl_2$ 1:5	4.5	
EC mS/cm 1:5	0.08	

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium	0.23		0.16	2.1	
Potassium	0.06		0.2	2.6	
Calcium	0.05		3.5	46	
Magnesium	0.1		3.4	44.7	
Aluminium			0.35	4.6	
		ECEC	7.6		
		Ca/Mg	1.7		

Phosphate Retention Index (%): 27.00 Low **PRI (mgP/kg):** 1349.8 **PRI (kg/ha):** 2632.12 to 150 mm

PHYSICAL CHARACTERISTICS **Comment**

Texture:	-	**Field Density (g/mL):**	
Colour:	-	**Emerson Stability Class:**	H20 Class 7
Size:	-	**High SAR/Low Iconic Strength:**	Class 7
Aggregate strength:	-	**Med SAR/High Iconic Strength:**	Class 7
Structural unit:	Did not test	**Particle Size Analysis (PSA)**	
Approx. Clay Content (%):	Did not test	> 2mm	Gravel
Potential infiltration rate:	Did Not Test	2 - 0.2 mm	Coarse Sand
Gravel Content:	Soil is	0.2 - 0.02 mm	Fine Sand
Additional comments:		0.02 - 0.002 mm	Silt
		< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia

No commentary requested.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: 9H1 of Rayment & Lyons. Wax Block Density: Method 30-4 Black (1983), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6. Texture/Structure/Colour - PM0003 (Texture- "Northcote" (1992), Structure- "Murphy" (1991), Colour- "Munsell" (2000))

Consultant: Kelly Lee

Authorised Signatory: Ryan Jacka

Date Report Generated
22/08/2014

Effluent Subdivison Profile

SESL AUSTRALIA
Environment & Soil Sciences

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 31450 **Sample N°: 2** **Date Received: 15/8/14** **Report Status:** ○ Draft ◉ Final

Client Name:	**Douglas Partners (Newcastle)**	Project Name:	**Pindimar**
Client Contact:	**Patrick Heads**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	**116019**	Sample Name:	**4/0.2-0.3**
Address:	**PO Box 324**	Description:	
	Hunter Region Mail Centre NSW 2310	Test Type:	**pHEC_S, ECEC_NH4Cl, pri, mEAT**

TEST	RESULT	COMMENTS
pH in water 1:5	5.5	
pH in $CaCl_2$ 1:5	4.2	
EC mS/cm 1:5	0.05	

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium	0.16		0.11	2.7	
Potassium	0.02		0.11	2.7	
Calcium	0		0.28	6.8	
Magnesium	0.06		1.6	39	
Aluminium			2	48.3	
		ECEC	4.1		
		Ca/Mg	.3		

Phosphate Retention Index (%): 36.50 Medium **PRI (mgP/kg):** 2050.7 **PRI (kg/ha):** 3998.8 to 150 mm

PHYSICAL CHARACTERISTICS **Comment**

Texture:	-	**Field Density (g/mL):**	
Colour:	-	**Emerson Stability Class:**	H20 Class 5
Size:	-	**High SAR/Low Iconic Strength:**	Class 5
Aggregate strength:	-	**Med SAR/High Iconic Strength:**	Class 6
Structural unit:	Did not test	**Particle Size Analysis (PSA)**	
Approx. Clay Content (%):	Did not test	> 2mm	Gravel
Potential infiltration rate:	Did Not Test	2 - 0.2 mm	Coarse Sand
Gravel Content:	Soil is	0.2 - 0.02 mm	Fine Sand
Additional comments:		0.02 - 0.002 mm	Silt
		< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia

No commentary requested.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: 9H1 of Rayment & Lyons. Wax Block Density: Method 30-4 Black (1983), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6. Texture/Structure/Colour - PM0003 (Texture- "Northcote" (1992), Structure- "Murphy" (1991), Colour- "Munsell" (2000))

Consultant: Kelly Lee

Authorised Signatory: Ryan Jacka

Date Report Generated
22/08/2014

RIDGE 1

1

2

3

440 m2

PIG STATION CREEK

SITE

PINDIMAR

SETTLEMENT POND 1

OPEN DRAIN

PIPELINE

5

1250 m2
approx.

SETTLEMENT POND 2

4

PIG STATION CREEK

0 50 100

metres

LEGEND

Approximate Borehole Location

Approximate Extent of Proposed Disposal Area

DRAFT

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Austasia Leefield Pty Ltd	TITLE: Test Location Plan On-Site Effluent Disposal Assessment, Proposed Abalone Farm 180 Clarke Street, Pindimar, NSW	PROJECT No: 81560
	OFFICE: Newcastle / DRAWN BY: PH		DRAWING No: 1
	SCALE: 1:1000 @ A3 / DATE: 29.8.2014	MGA	REVISION: 0