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Project 85180.00
5 January 2016
TJW:dmcl

Attention: Mr George Paniker

Email: trustee@sydneymarthoma.org.au

Report on On-Site Effluent Disposal Assessment
Proposed Church
1650 The Horsley Drive, Horsley Park

1. Introduction

This report presents the results of an on-site effluent disposal assessment undertaken for a proposed church at 1650 The Horsley Drive, Horsley Park. The work was undertaken at the request of the Bethel Mar Thoma Church, under instruction from their architects NBRS and Partners Pty Ltd (NBRS).

The proposed church will include ancillary offices, a gym, a kitchen, toilet and shower facilities and a car parking area. It is anticipated that up to about 500 persons may use the facilities per week, mostly on weekends.

The purpose of the investigation was to provide information on the following:

- Subsurface conditions at test locations within the proposed effluent disposal area;
- Suitability of the proposed area for on-site effluent disposal;
- Estimates of minimum areas required for effluent disposal; and
- Recommended disposal options.

The effluent disposal assessment was carried out with reference to the "*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 assessment comprised a site walkover inspection by a senior engineering geologist, subsurface investigation then laboratory testing, followed by engineering analysis. Details of the field work, laboratory testing and analysis are provided in this report, together with relevant engineering comment on the matters outlined above.

For the purposes of the assessment NBRS provided a survey plan of the site showing the existing and planned development (Drawing 14013-DA001-E, dated 10 September 2015).

2. Site Description and Desktop Study

The site is identified as Lot 90A in DP 17288 and is located at 1650 The Horsley Drive, Horsley Park, New South Wales. The site is bound to the north by The Horsley Drive, by a petrol station to the north-east and rural land to the south- east, south and west (refer to Drawing 1).

The site is approximately rectangular and about 305 m long by 98 m wide (approximately 2.95 ha).

At the time of inspection the site was mostly covered by grass with three buildings including a residence located in the north east of the site (refer to Figures 1 and 2). A copse of mature trees and a farm dam were noted near the central area of the western boundary. Water was noted within the dam at the time of the investigation. It is understood that the dam is to be back-filled as part of the development of the site.

Figure 1: View of site from The Horsley Drive, looking south.

Figure 2: View from the rear of the site, looking north.

The client's preferred location for the application area is the existing farm dam and the area directly to the north of the dam.

Reference to a survey plan of the site provided by the project architect indicated that site levels generally fall from approximately RL 88 m AHD at the eastern boundary to approximately RL 80 m AHD at the western boundary, with an average surface gradient of approximately 4° to 5°.

A search of registered groundwater bore licences on the Department of Primary Industries Office of Water website in December 2015 indicates that there are no registered groundwater bore within 500 m of the site.

Reference to the 1:250,000 scale New South Wales Geological Survey map indicates that the site is underlain by sandstone, siltstone and shale of the Wianamatta Group. The weathering products of these rock types include clay and silty clay soils which were identified in bores drilled during the field work.

Reference to the 1:100,000 Penrith Soil Landscape Sheet indicates that the site lies within the Luddenham soil landscape group, which typically comprise shallow dark podzolic soils in the lower slopes. This type of soil is described as having a high erosion hazard with localised impermeable highly plastic subsoil.

3. Field Work

3.1 Methods

The field work for the assessment was undertaken on 10 November 2015 and comprised the drilling of two boreholes (Bores 1 and 2) to depths of 1.65 m and 1.70 m, respectively. The bores were drilled using a utility mounted push tube rig fitted with 60 mm diameter sampling tubes.

A walk over inspection of the site was undertaken by a senior engineering geologist from DP who also positioned the bores following discussions with the client. Borehole drilling was undertaken by a geotechnical officer who also logged the subsurface profile encountered and collected representative samples for strata identification and laboratory testing purposes

The approximate location of the test bores are shown on Drawing 1, attached. Reduced levels to Australian Height Datum (AHD) at each bore location have been estimated from the survey plan supplied by the client's architect.

3.2 Results

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

Subsurface conditions encountered in the bores generally comprised the following:

TOPSOIL	Sandy silty clay topsoil to 0.35 m depth; underlain by
RESIDUAL SOIL	Stiff to very stiff clay (generally hard below 1.0 m depth) to 1.35 m and 1.0 m depth, respectively, overlying very stiff to hard silty clay to the limit of the investigation at 1.65 m depth in Bore 1 and 1.6 m depth in Bore 2; underlain by
SHALE	Shale within Bore 2 only, to the limit of the borehole at 1.7 m.

No free groundwater was observed in the bores whilst they remained open. It should be noted that groundwater levels are variable and can be affected by such factors as soil permeability and recent weather conditions.

Surface water within the farm dam on site was estimated to be at approximately RL 79.5 m AHD. Construction details on the dam lining or methods of maintaining water levels within the dam are unknown at the time of investigation and therefore no comment on groundwater can be inferred from surface water levels within the dam.

In relation to the on-site effluent disposal the controlling soils is considered to be the natural brown clay which has been classified as a 'Class 6' category soil – very poorly drained, in accordance with AS1547 – 2012 (Ref 2).

4. Laboratory Testing

To determine the relevant parameters of the natural soil at the site, a representative soil sample was submitted for laboratory testing. Detailed results of the laboratory testing are attached, and summarised in Table 1 below.

Table 1 – Laboratory Test Results

Bore	Depth (m)	Description	Textural Class	Soil pH ($CaCl_2$)	ECe[1] (dS/m)	PSC[2] (kg/ha)	CEC[3] (cmol+/kg)	Sodicity[4] (ESP)
1	0.5	CLAY	Heavy Clay	4.3[5]	1.02	8760	12	5.4

Notes: 1 EC_e is the converted EC (1:5 – soil: water) as presented in Ref 3
2 PSC - Phosphorus Sorption Capacity based on PRI over soil depth (max 1m or depth to bedrock)
3 CEC – Cation Exchange Capacity
4 Exchangeable sodium percentage
5 Based on a conversion from ph (H_2O) to pH ($CaCl_2$) of -0.8pH units.

The results of the laboratory testing indicate that the pH ($CaCl_2$), CEC and sodicity constitute a limitation to effluent disposal. Further assessment of the soil characteristics is provided in Table 3.

5. Comments

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, on the following pages. Recommended site improvement measures for moderate and major limitations are also shown in Tables 2 and 3.

Table 2 – Site Assessment Summary (bold type indicates pertinent features)

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. Application area to be above 1 in 20 year flood contour. Vents, openings and electrical components to be above 1 in 100 year flood contour
	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	For irrigation systems reduce DIR by 20% or terrace application area to ensure less than 10% slope
	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	Upslope bund advisable
Erosion potential	All land application systems	***No signs of erosion potential present***		Signs of erosion, eg rills, mass movement and slope failure present	Soil degradation and transport, system failure	None Required
Site drainage	All land application systems	***No signs of surface dampness***			Groundwater pollution hazard. Resurfacing hazard	None Required
Fill	All systems	No fill	***Fill present***		Subsidence. Variable permeability	None Required
Buffer distance	All land application systems	***All buffer distances achievable***	Possible encroachment	Encroachment on Buffer Distances	Health and pollution risks	None Required
Land area	All systems	***Area is available***	Area is limited	Area is not available	Health and pollution risks	None Required
Rocks and rock outcrops (% of land surface containing boulders)	All land application systems	***<10%***	10-20%	>20%	Limits system performance	None Required
Geology/ Regolith	All land application systems			Major geological discontinuities, fractured or highly porous regolith	Groundwater pollution hazard	None Required

Table 3 – Soil Assessment Summary (bold type indicates pertinent features)

Soil Features	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
	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	None Required
	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	Prepare receiving soil by deep ripping, shallow cultivation and applying gypsum. Traditional Absorptions systems 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 Required
* 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	Should be improved with the addition of lime
Electrical Conductivity - ECe (dS/m)	All land application systems	***<4***	4 - 8	>8	Excessive 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	Should be improved with the addition of gypsum
	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 with the addition of lime and organic matter
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 immobilise any excess Phosphorus	None Required
Modified Emerson Aggregate Test (dispersiveness)	All land application systems	***Class 3 or above***	Class 2	Class 1	Potential for structural degradation	None Required

5.2 Effluent Treatment System Considerations

Owing to the large number of people that may be utilising the church on a weekly basis, the effluent generation and peak loading pattern will be different than for normal residential circumstances. AS1547:2012 (Ref 2) relates to domestic wastewater management with effluent flows of up to 14,000 L / week from a population of equivalent of up to 10 persons. Given that the projected usage of the church involves non-residing people, the estimated total weekly volume of wastewater flow (as discussed in Section 5.4) is within this range and therefore, in absence of guidelines relating specifically to such circumstances, AS1547:2012 (Ref 2) has been utilised.

Given the likelihood of non-uniform generation of effluent through the weekly cycle, and the possibility of special (uncommon) events, the system selected for treatment and disposal of effluent should have the following characteristics:

- An effluent treatment system comprising an aerated wastewater treatment systems (AWTS) producing secondary quality effluent with phosphate reduction to 10 mg/L and nitrogen reduction to 25mg/L prior to application to the land;
- Capacity to accommodate periods of high usage (e.g. uncommon functions or special events when the number of people on-site is increased);
- Contingency for periods of treatment or disposal failure. This may involve being able to take the treated effluent off-site by means of pump out in such circumstances or suitably sized on-site storage; and
- A suitably sized wet weather storage system for periods of extended wet weather when the ground becomes saturated.

Given that the peak loading (taking up the majority of the weekly loading) would be on a single day, as outlined in Section 5.4, the treatment tank should be large enough to hold the weekly volume of effluent and dispose of the effluent at the design irrigation/loading rates provided in Section 5.5. An up-front flow balance tank may be required to ensure that the treated effluent is distributed at the design daily rates to the application area.

The nutrient balance calculations have been undertaken for systems which produce secondary quality effluent. The system selected for use should be approved by the NSW Health Department.

The report has been based on the assumption that the effluent streams (blackwater and greywater) will be combined.

5.3 Effluent Disposal System

Given the subsurface profile, secondary treated effluent (via an AWTS) discharging to either subsurface drip irrigation or Evapotranspiration absorption (ETA) trenches or beds is considered suitable at this site.

The use of traditional absorption trenches or beds is not considered appropriate given the presence of heavy clay soils.

5.4 Hydraulic Loading for Design

Table H4 in AS1547 – 2012 (Ref 2) provides domestic wastewater flow allowances for commercial premises. It should be noted, however, that this table is for commercial premises in New Zealand only and no allowances are provided for commercial premises in Australia. Australia and New Zealand experience significantly different climatic conditions and water usage reduction requirements and hence this table should only be used as a guide. Australia generally experiences a drier climate than New Zealand and greater restrictions on water usage. Therefore the values provided in Table H4 of AS1547 are considered to be conservative for usage in Australia.

Assuming that the church would have a reticulated (town) water supply, then a wastewater design flow of 15 L/day/person (for meetings at community halls) may be considered appropriate.

It is understood that the church will have the capacity to hold up to 400 persons in a single event. Whilst only one main event is likely to occur during the week, smaller meetings of up to 10 – 20 persons may also be scheduled. Given this information, it is anticipated that up to about 500 persons would visit the church on a regular weekly basis and a combined (greywater and blackwater) waste stream volume of 7500 L per week has been adopted for design purposes.

In the event that further information indicates that an alternative volume is more appropriate then review of the recommendations made in this report should be undertaken.

5.5 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 Horsley Park Equestrian Centre and evaporation data from Prospect Reservoir;
- Procedures outlined in Environment and Health Protection Guidelines (Ref 1) and AS 1547 - 2012 (Ref 2);
- Design irrigation rate (DIR) for a subsurface drip irrigation system of 2 mm/day from Table M1 (Ref 2); and
- Design loading rate (DLR) for ETA trenches or beds of 5 mm/day from Table L1 (Ref 2);

Using the parameters and assumptions outlined above, the recommended minimum disposal area required for the existing development was calculated using an in-house computer program. The area required is shown below in Tables 4 and 5.

Table 4 – Application Areas for a Subsurface Drip Irrigation System[(1)]

Effluent Treatment	Waste Stream	Nitrogen Balance Area (m²)	Phosphorus Balance Area (m²)	Hydraulic Balance Area (m²)
Secondary treatment	7500 L/week (1075 L/day)	747	571	**761[(1)]**

Notes: Bold values indicate minimum area required.
(1) Based on application area having slopes no greater than 10%.

Based on the above calculations subsurface drip irrigation lines for disposal of secondary treated effluent should be designed to satisfy the hydraulic balance area.

The approximate minimum area required for disposal of secondary treated effluent discharging to a subsurface drip irrigation system is shown in Drawing 2.

Table 5 – Application Areas for ETA Trenches or Beds

Effluent Treatment	Waste Stream	Nitrogen Balance Area (m²)	Phosphorus Balance Area (m²)	Hydraulic Balance Area (m²)
Secondary treatment	7500 L/week (1075 L/day)	**747**	571	223

Notes: Bold values indicate minimum area required

Based on the above calculations ETA trenches and beds for disposal of secondary treated effluent should be designed to satisfy the nitrogen balance area.

The approximate minimum area required for disposal of secondary treated effluent discharging to ETA trenches is shown in Drawing 3. The application area is based on 0.6 m wide trenches spaced at 1 m intervals (refer Figure L7 in Ref 2).

ETA trenches and beds should be constructed in accordance with Figures L6 and L7 of Reference 2. Trenches should be constructed parallel to the site surface gradient.

5.6 Reserve Area Requirements

Typically a reserve effluent disposal area equal to 100% of the design 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 that the "100% requirement is normally applied to septic tank units followed by a conventional trench land application system". Given that the treatment systems proposed (i.e. AWTS or AWTS with nutrient removal) the reserve area could be significantly decreased or even removed, subject to Council approval.

5.7 Buffer Distances and Location of Disposal Areas

Effluent disposal areas within the site should comply with appropriate buffer distances based on a site specific evaluation of the site and soil constraints. Table 6 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 6 – Recommended Buffer Distances for On-Site Systems

Recommended Buffer Distances from AS 1547:2012	Recommended Minimum Buffer Distances Following Evaluation of Site and Soil Constraints – Secondary Treated Effluent
1.5 - 50 m to property boundaries	6 m to upslope boundary; and 12 m to downslope boundary
2.0 - >6 m to buildings/houses	3 m to upslope buildings/houses/car parking; and 6 m to downslope buildings/houses/car parking
15 - 100 m to surface water (e.g. dams, rivers, streams, lakes etc. permanent or intermittent)	50 m to downslope surface water
15 - 50 m to domestic groundwater well	50 m to groundwater wells
3 - 15 m to recreational areas (e.g. children play areas, pools etc.)	3 m to upslope recreational areas
4 - 15 m to in-ground water tanks	4 m upslope and 15 m downslope to in-ground water tanks
3 m or 45° angle from toe of retaining walls, embankments, escarpments and cuttings	3 m from toe of raised embankments/retaining walls

All recommended buffer distances provided in Table 6, above, are achievable provided that the assumptions made previously are correct. The approximate areas required for effluent application, are shown in Drawings 2 and 3.

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 church should develop and implement an effluent disposal management plan which clearly sets out stormwater control arrangements such as upslope bunding, maximum loading rates for treated effluent, manufacturer's maintenance requirements and failure event and wet weather protocols.

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).

6. Conclusion

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 domestic effluent provided that the limitations raised in Section 5.1 are addressed and recommended site and soil improvements contained within this report are implemented. Primarily this includes;

- Addition of gypsum and lime to improve to pH, sodicity and CEC of the application area;
- Cultivation of the receiving soils;
- Construction of a clay bund upslope of the effluent disposal area to reduce surface runoff entering the application area; and
- Minor terracing of the application area for ETA trenches and ensuring site slopes are less than 10% for ETA beds or drip irrigation.

Based on the constraints outlined above, and the buffer distances recommended in Table 6, it is suggested that sufficient room is available for the proposed on-site effluent disposal. Disposal of the secondary treated effluent from the proposed development could be carried out via either a subsurface irrigation system or ETA trenches or beds.

7. References

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

8. Limitations

Douglas Partners (DP) has prepared this report for a proposed church at 1650 The Horsley Drive, Horsley Park in accordance with DP's proposal SYD15-1397, dated 19 October 2015 and acceptance received from Bethel Mar Thoma Church, Sydney on 29 October 2015. The work was carried out under DP's Conditions of Engagement. The report is provided for the exclusive use of the Bethel Mar Thoma Church for this project only and for the purpose(s) described in the report. It should not be used for other projects or by a third party. 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 only at the specific sampling 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 anthropogenic 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 limited by undetected variations in ground conditions between sampling 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 notes 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 given 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 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

David McLintock
Associate/Senior Engineering Geologist

Reviewed by

Michael Gawn
Principle

Attachments: About this Report
Drawing 1 – Test Location Plan
Drawing 2 – Secondary Treated Effluent Discharging to Subsurface Drip Irrigation
Drawing 3 – Secondary Treated Effluent Discharging to ETA Trenches
Drawing 4 – Typical Bunding Arrangement
Field Work Results and Accompanying Notes
Laboratory Test Results
Appendix 7 (Ref. 1): *Vegetation Suitable for Land Application Areas*
Appendix 8 (Ref. 1): *Your Land Application Area*

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.

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

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

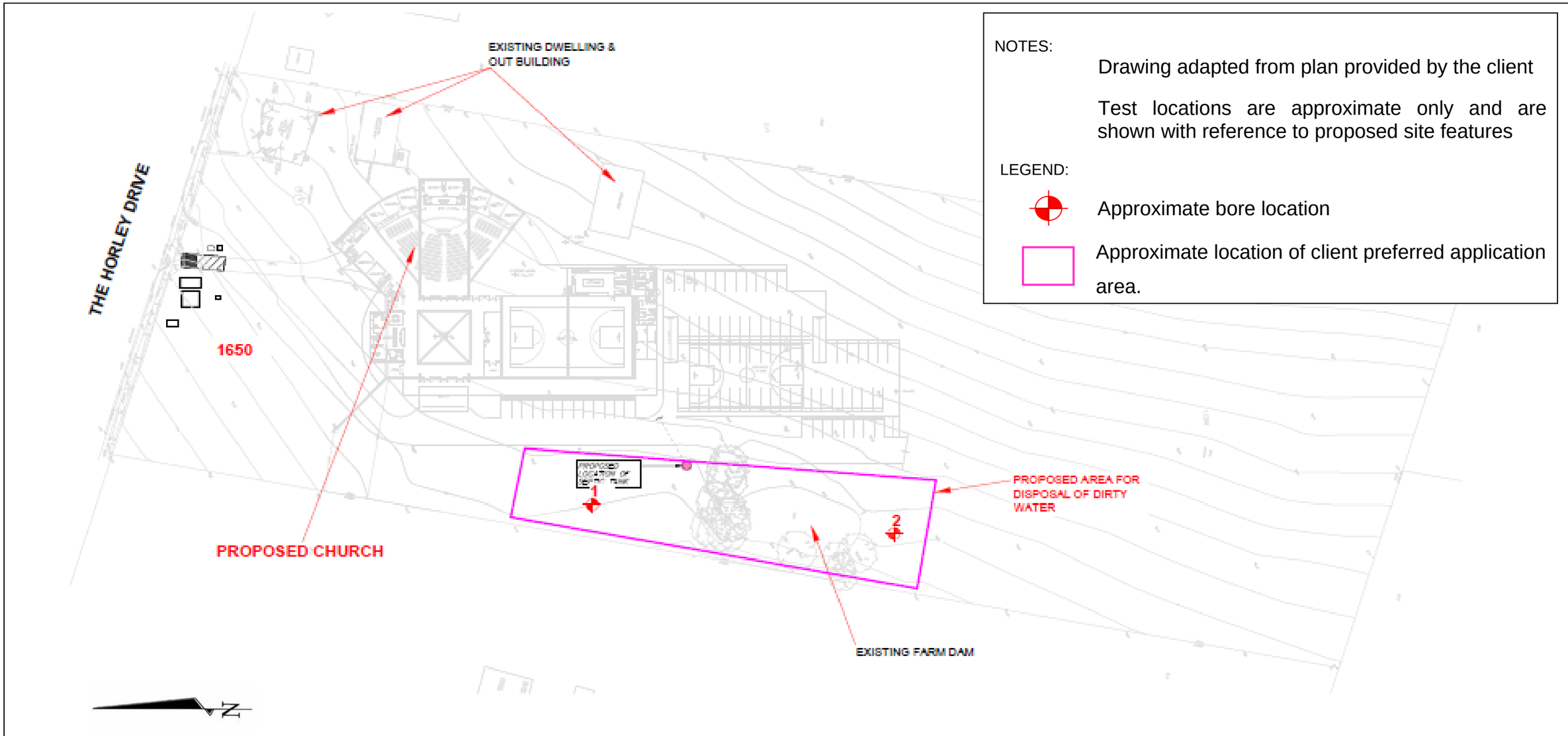
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later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

Information for Contractual Purposes

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

Site Inspection

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



NOTES:

Drawing adapted from plan provided by the client

Test locations are approximate only and are shown with reference to proposed site features

LEGEND:

Approximate bore location

Approximate location of client preferred application area.

NOTE:

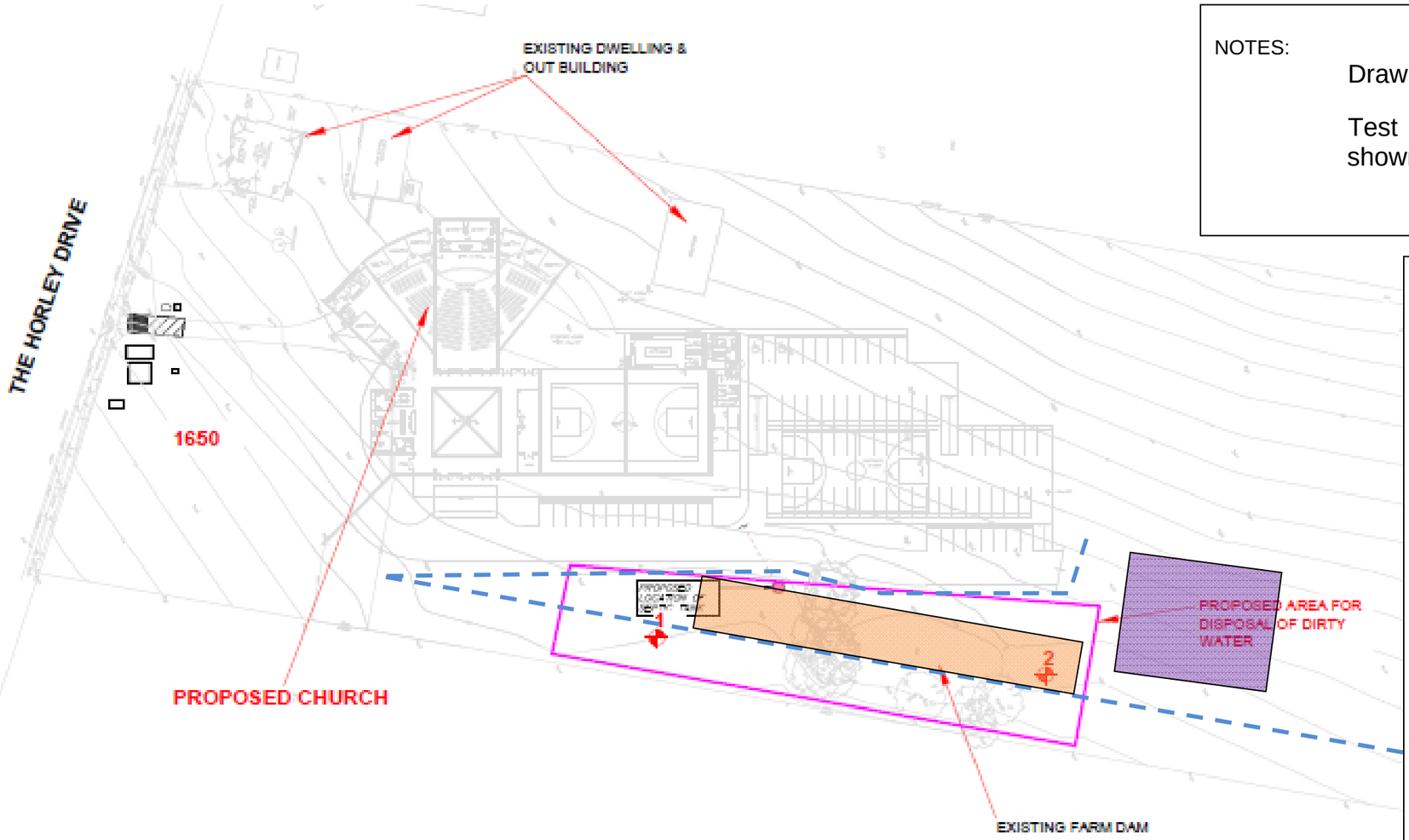
1: Base drawing from Jones Nicholson Consulting Engineers (Dwg 141261 DA3 2, dated Aug 2015)

2: Test locations are approximate only and are shown with reference to existing feature.

0 10 20 30 40 50 75 100m

1:1000 @ A3

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT:	Bethel Mar Thoma Church	TITLE:	**Test Location Plan**	PROJECT No: 85180.00
	OFFICE: Sydney	DRAWN BY: TJW		**On-site Effluent Disposal Assessment**	DRAWING No: 1
	SCALE: Scale bar attached	DATE: January 2016		**1650 The Horsley Drive, HORSLEY PARK**	REVISION: 0



NOTES:

Drawing adapted from plan provided by the client

Test locations are approximate only and are shown with reference to proposed site features

LEGEND:

- Approximate bore location
- Approximate location of client preferred application area.
- Approximate site buffer distances to site boundary and areas of car parking
- Approximate minimum size of application area required for disposal of secondary treated effluent to a subsurface drip irrigation system. Area shown is approximately 10 m by 77 m .
- Approximate size of 100 % reserve application area.

NOTE:

1: Base drawing from Jones Nicholson Consulting Engineers (Dwg 141261 DA3 2, dated Aug 2015)

2: Test locations are approximate only and are shown with reference to existing features.

0 10 20 30 40 50 75 100m

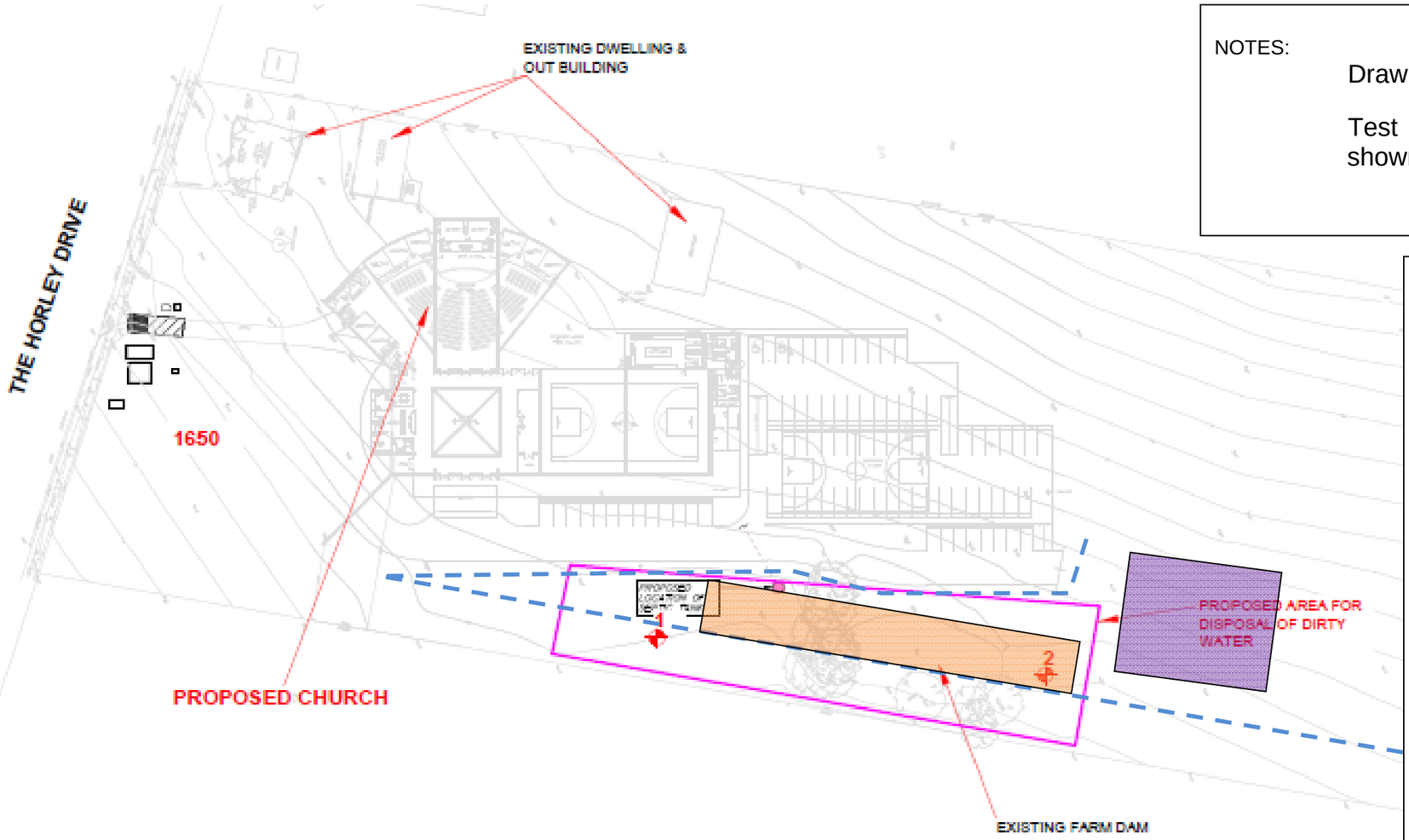
1:1000 @ A3

LEGEND

Borehole location

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Bethel Mar Thoma Church		TITLE:	**Secondary Treated Effluent Discharging to Subsurface Drip Irrigation**	PROJECT No: 85180.00
OFFICE:	Sydney	DRAWN BY: TJW		**On-site Effluent Disposal Assessment**	DRAWING No: 2
SCALE:	Scale bar attached	DATE: January 2016		**1650 The Horsley Drive, HORSLEY PARK**	REVISION: 0



NOTES:

Drawing adapted from plan provided by the client

Test locations are approximate only and are shown with reference to proposed site features

LEGEND:

- Approximate bore location
- Approximate location of client preferred application area.
- Approximate site buffer distances to site boundary and areas of car parking
- Approximate minimum size of application area required for disposal of secondary treated effluent to ETA trenches. Area shown is approximately 10 m by 75 m .
- Approximate size of 100 % reserve application area.

LEGEND

Borehole location

NOTE:

1: Base drawing from Jones Nicholson Consulting Engineers (Dwg 141261 DA3 2, dated Aug 2015)

2: Test locations are approximate only and are shown with reference to existing features.

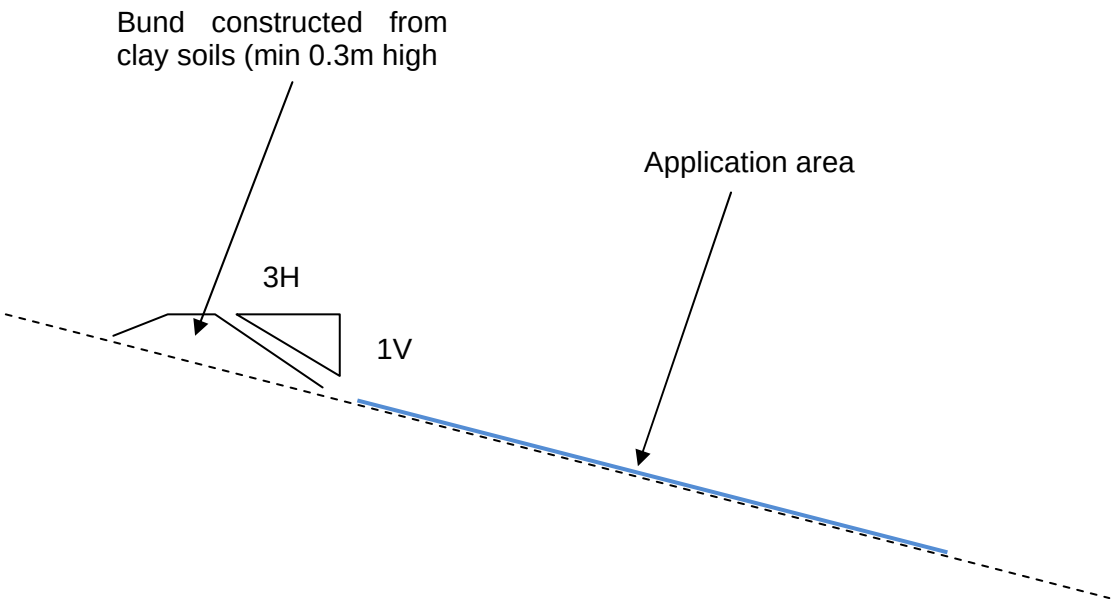
0 10 20 30 40 50 75 100m

1:1000 @ A3

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Bethel Mar Thoma Church		TITLE:	**Secondary Treated Effluent Discharging to ETA Trenches**	PROJECT No: 85180.00
OFFICE:	Sydney	DRAWN BY: TJW		**On-site Effluent Disposal Assessment**	DRAWING No: 3
SCALE:	Scale bar attached	DATE: January 2016		**1650 The Horsley Drive, HORSLEY PARK**	REVISION: 0

Typical Bunding Arrangement



Douglas Partners Geotechnics / Environment / Groundwater	**Typical Bunding Arrangement** **On-site Effluent Disposal Assessment** **1650 The Horsley Drive, HORSLEY PARK**	PROJECT: 85180.00 DWG No: 4 REV: 0
	CLIENT: Bethel Mar Thoma Church	DATE: January 2016

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

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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

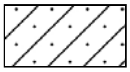
Soils


Topsoil

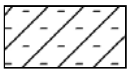

Peat


Clay

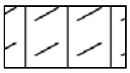

Silty clay

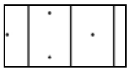

Sandy clay

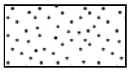

Gravelly clay

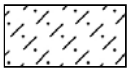

Shaly clay

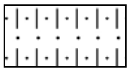

Silt


Clayey silt


Sandy silt

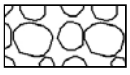

Sand

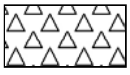

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

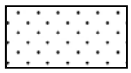

Talus

Sedimentary Rocks

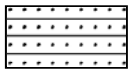

Boulder conglomerate

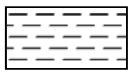

Conglomerate


Conglomeratic sandstone

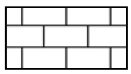

Sandstone


Siltstone


Laminite

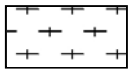

Mudstone, claystone, shale

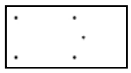

Coal


Limestone

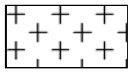
Metamorphic Rocks

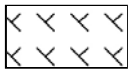

Slate, phyllite, schist

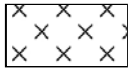

Gneiss

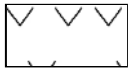

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Bethel Mar Thoma Church Sydney
PROJECT: Proposed On-Site Effluent Disposal
LOCATION: 1650 The Horsley Drive, Horsley Park

SURFACE LEVEL: 79.7 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 85180
DATE: 10/11/2015
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
		TOPSOIL - brown, sandy silty clay with a trace of fine rootlets, M>WP		D	0.1				
	0.35	CLAY - stiff to very stiff, brown clay, M>WP		D	0.5				
79					0.6		pp = 250		
		From 0.8m: becoming very stiff and red-brown, M=WP			0.85		pp = 330		
	1			D	1.0				1
		From 1.1m: hard			1.2		pp = 400		
	1.35	SILTY CLAY - hard, light grey-brown, silty clay with a trace of siltstone inclusions (apparently weathered shale)		D	1.5				
78	1.65	Bore discontinued at 1.65m							

RIG: 4WD **DRILLER:** MVH **LOGGED:** MVH **CASING:** Uncased
TYPE OF BORING: Dynamic push tube
WATER OBSERVATIONS: No free groundwater observed
REMARKS: Level estimated from supplied survey plan

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: Bethel Mar Thoma Church Sydney
PROJECT: Proposed On-Site Effluent Disposal
LOCATION: 1650 The Horsley Drive, Horsley Park

SURFACE LEVEL: 80.3 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 85180
DATE: 10/11/2015
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
80		TOPSOIL - brown, sandy silty clay with a trace of fine rootlets, M>WP		D	0.1				
	0.35	CLAY - stiff to very stiff, brown clay, M>WP			0.4		pp = 120		
				D	0.5				
					0.6		pp = 80		
		- hard below 0.85m			0.9		pp = 450		
	1 1.0	SILTY CLAY - very stiff to hard, light grey-red mottled, silty clay, M=WP		D	1.1				1
79					1.3		pp = 250		
					1.4		pp >400		
				D	1.5				
	1.6	SHALE - extremely low strength, extremely weathered, brown shale							
	1.7	Bore discontinued at 1.7m		D	1.7				

RIG: 4WD **DRILLER:** MVH **LOGGED:** MVH **CASING:** Uncased
TYPE OF BORING: Dynamic push tube
WATER OBSERVATIONS: No free groundwater observed
REMARKS: Level estimated from supplied survey plan

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

12 Ashley Street, Chatswood, NSW 2067
tel: +61 2 9910 6200

email: sydney@envirolab.com.au
envirolab.com.au

Envirolab Services Pty Ltd - Sydney | ABN 37 112 535 645

CERTIFICATE OF ANALYSIS 137986

Client:

Douglas Partners Pty Ltd
96 Hermitage Rd
West Ryde
NSW 2114

Attention: David McLintock

Sample log in details:

Your Reference:	**85180.00, Horsley Park**		
No. of samples:	1 soil		
Date samples received / completed instructions received	25/11/15	/	25/11/15

Analysis Details:

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	3/12/15	/	4/12/15
Date of Preliminary Report:	02/12/2015		

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Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Jacinta Hurst
Laboratory Manager

Misc Inorg - Soil		
Our Reference:	UNITS	137986-1
Your Reference	----------	Bore 1
Depth	----------	0.5
Type of sample		soil
Date prepared	-	27/11/2015
Date analysed	-	27/11/2015
pH 1:5 soil:water	pH Units	5.1
Electrical Conductivity 1:5 soil:water	µS/cm	170
Phosphorus Sorption Capacity	kg/ha	8,760

CEC		
Our Reference:	UNITS	137986-1
Your Reference	----------	Bore 1
Depth	----------	0.5
Type of sample		soil
Date prepared	-	01/12/2015
Date analysed	-	01/12/2015
Exchangeable Ca	meq/100g	4.8
Exchangeable K	meq/100g	0.2
Exchangeable Mg	meq/100g	6.5
Exchangeable Na	meq/100g	0.65
Cation Exchange Capacity	meq/100g	12

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA latest edition 2510 and Rayment & Lyons.
Ext-062	Analysed by East West Enviroag
Metals-009	Determination of exchangeable cations and cation exchange capacity in soil based on Rayment and Lyons 2011.

QUALITY CONTROL Misc Inorg - Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			27/11/2015	[NT]	[NT]	LCS-1	27/11/2015
Date analysed	-			27/11/2015	[NT]	[NT]	LCS-1	27/11/2015
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	LCS-1	101%
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	LCS-1	101%
Phosphorus Sorption Capacity	kg/ha	2	Ext-062	[NT]	[NT]	[NT]	[NR]	[NR]
QUALITY CONTROL CEC	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			01/12/2015	137986-1	01/12/2015 || 01/12/2015	LCS-1	01/12/2015
Date analysed	-			01/12/2015	137986-1	01/12/2015 || 01/12/2015	LCS-1	01/12/2015
Exchangeable Ca	meq/100g	0.1	Metals-009	<0.1	137986-1	4.8 || 4.7 || RPD: 2	LCS-1	96%
Exchangeable K	meq/100g	0.1	Metals-009	<0.1	137986-1	0.2 || 0.2 || RPD: 0	LCS-1	97%
Exchangeable Mg	meq/100g	0.1	Metals-009	<0.1	137986-1	6.5 || 6.3 || RPD: 3	LCS-1	94%
Exchangeable Na	meq/100g	0.1	Metals-009	<0.1	137986-1	0.65 || 0.66 || RPD: 2	LCS-1	106%
Cation Exchange Capacity	meq/100g	1	Metals-009	<1.0	137986-1	12 || 12 || RPD: 0	[NR]	[NR]

Report Comments:

Phosphorus Sorption Capacity analysed by East West Enviro Ag, report number EW150965

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NR: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

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Determination of Emerson Class Number of Soil

Client :	Bethel Mar Thoma Church Sydney	**Project No. :**	85180
Project :	Horsley Park	**Report No. :**	1
Location :	1650 The Horsley Drive, Horsley Park	**Report Date :**	30/11/2015
		Page:	1 of 1

Sample No.	Depth (m)	Date of Test	Description	Water Type	Water Temp	Class No.
BH1	0.5	27/01/2015	Clay	Distilled	22	5

Test Methods: AS 1289 3.8.1

Sampling Methods: AS 1289.1.2.1, AS 1289.1.1

Remarks:

NATA Accredited Laboratory Number: 828

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025

Mark Matthews
Laboratory Manager

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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

LAND APPLICATION AREAS

The reuse of domestic wastewater on-site can be an economical and environmentally sound use of resources.

What are land application areas?

These are areas that allow treated domestic wastewater to be managed entirely on-site.

The area must be able to utilise the wastewater and treat any organic matter and wastes it may contain. The wastewater is rich in nutrients, and can provide excellent nourishment for flower gardens, lawns, certain shrubs and trees. The vegetation should be suitably tolerant of high water and nutrient loads.

How does a land application area work?

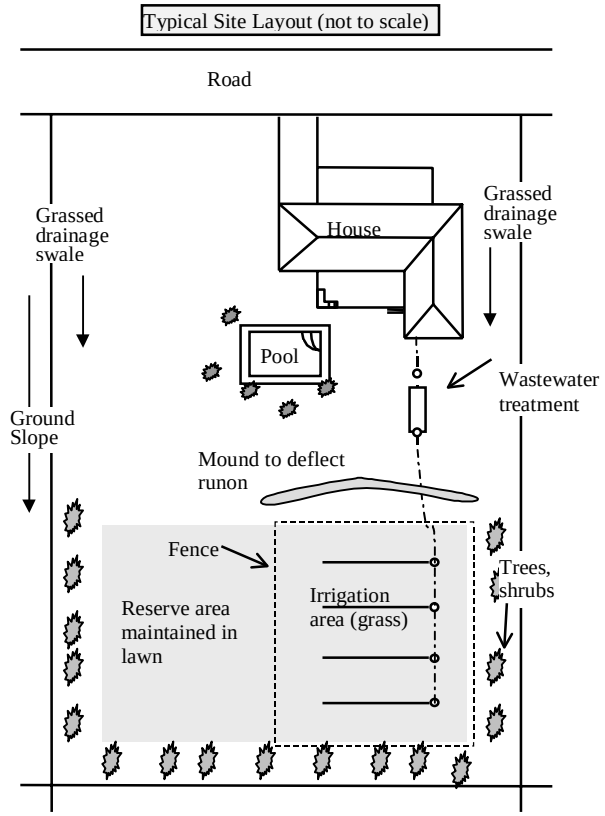
Treated wastewater applied to a land application area may be utilised or simply disposed, depending on the type of application system that is used. The application of the wastewater can be through a soil absorption system (based on disposal) or through an irrigation system (based on utilisation).

Soil absorption systems do not require highly treated effluent, and wastewater treated by a septic tank is reasonable as the solids content in the effluent has been reduced. Absorption systems release the effluent into the soil at a depth that cannot be reached by the roots of most small shrubs and grasses. They rely mainly on the processes of soil treatment and then transmission to the water table, with minimal evaporation and up-take by plants. **These systems are not recommended in sensitive areas as they may lead to contamination of surface water and groundwater.**

Irrigation systems may be classed as either subsurface or surface irrigation. If an irrigation system is to be used, wastewater needs to be pre-treated to at least the quality produced by an aerated wastewater treatment system (AWTS).

Subsurface irrigation requires highly treated effluent that is introduced into the soil close to the surface. The effluent is utilised mainly by plants and evaporation.

Surface irrigation requires highly treated effluent that has undergone aeration and disinfection treatments, so as to reduce the possibility of bacteria and virus contamination.



The effluent is then applied to the land area through a series of drip, trickle, or spray points which are designed to eliminate airborne drift and run-off into neighbouring properties.

There are some public health and environmental concerns about surface irrigation. There is the risk of contact with treated effluent and the potential for surface run-off. Given these problems, subsurface irrigation is arguably the safest, most efficient and effective method of effluent utilisation.

Regulations and recommendations

The design and installation of land application areas should only be carried out by suitably qualified or experienced people, and only after a site and soil evaluation is done by a soil scientist. Care should be taken to ensure correct buffer distances are left between the application area and bores, waterways, buildings, and neighbouring properties.

Heavy fines may be imposed under the Clean Waters Act if effluent is managed improperly.

At least two warning signs should be installed along the boundary of a land application area. The signs should comprise of 20mm high Series C lettering in black or white on a green background with the words:

RECLAIMED EFFLUENT
NOT FOR DRINKING
AVOID CONTACT

Depending on the requirements of your local council, wet weather storage and soil moisture sensors may need to be installed to ensure that effluent is only irrigated when the soil is not saturated.

Regular checks should be undertaken of any mechanical equipment to ensure that it is operating correctly. Local councils may require periodic analysis of soil or groundwater characteristics

Humans and animals should be excluded from land application areas during and immediately after the application of treated wastewater. The longer the period of exclusion from an area, the lower the risk to public health.

The householder is required to enter into a service contract with the installation company, its agent or the manufacturer of their sewage management system, this will ensure that the system operates efficiently.

Location of the application area

Treated wastewater has the potential to have negative impacts on public health and the environment. For this reason the application area must be located in accordance with the results of a site evaluation, and approved landscaping must be completed prior to occupation of the building. Sandy soil and clayey soils may present special problems.

The system must allow even distribution of treated wastewater over the land application area.

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