Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Subdivision
64 Williams River Close, Clarencetown

Prepared for
Glen O'Connor

Project 223386.00
October 2023

Douglas Partners
Geotechnics / Environment / Groundwater

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

	Signature	Date
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Douglas Partners acknowledges Australia's First Peoples as the Traditional Owners of the Land and Sea on which we operate. We pay our respects to Elders past and present and to all Aboriginal and Torres Strait Islander peoples across the many communities in which we live, visit and work. We recognise and respect their ongoing cultural and spiritual connection to Country.

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Geotechnics / Environment / Groundwater

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Report on Geotechnical Investigation
Proposed Subdivision
64 Williams River Close, Clarencetown

1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed subdivision at 64 Williams River Close, Clarencetown. The investigation was commissioned in a signed service order dated 22 August 2023 by the owner of the site, and was undertaken in accordance with Douglas Partners' proposal 223386.00 dated 13 August 2023.

The proposed development includes the creation of a three lot subdivision.

The purpose of this investigation was to provide comment on:

- Subsurface soil and groundwater conditions at test locations;
- Site classification to AS2870 (2011);
- Identification of site and soil constraints to effluent application; and
- Comment on the sizing and location of a new disposal system for the proposed development.

The effluent disposal assessment was carried out in accordance with DLG (1998) guidelines, DPE (2023) and, AS 1547 (2012).

This assessment included a desktop review of available information followed by a site walkover, subsurface investigation, laboratory testing of retrieved samples and engineering analysis. The details of the field work are presented in this report, together with comments and recommendations on the items listed above.

2. Proposed Development

It is understood that the proposed development includes subdivision of the existing lot into three new allotments, each of greater than 4000 m^2 in area (refer Figure 1).

Figure 1: Proposed Subdivision layout

3. Site Description and Description

The site located at 64 Williams River Drive, Clarencetown with further details outlined in Table 1 which presents site identification details.

Table 1: Site Identification

Item	Details
Allotment Identification	Lot 4 DP 791047
Street Address	64 Williams River Drive
Locality	Clarencetown, NSW
Site Area	6.2 hectares (approximately)
Local Government Area	Dungog Shire Council

The majority of the site is predominately cleared land which is covered with a variable cover of grass. The western part of the site is relatively flat and is located on a broad ridgeline. The eastern part of the site (roughly half) is generally low lying ground and has a large ephemeral water body crossing in a generally north-south alignment (parallel to the Williams River).

Existing development at the site includes the following:

- An existing dwelling in the central, western part of the site;
- Another structure located to the south-west of the abovementioned dwelling;
- Access road entering the site from the south-western corner;
- A number of trees, including along the access road.

Figure 2: View looking towards existing dwelling on site

Figure 3: View looking north-east with low lying are to right

Figure 4: Rocky ground near change in grade, looking south-west

4. Review of Mapping

Reference to the NSW Seamless geological mapping (refer Figure 5)), the site is underlain by several geological units, as follows:

- Western Area - Quaternary Allluvium (terrace deposits), characterised by silt, clay, sand and gravel;
- Eastern Area - Quaternary Allluvium (floodplain deposits), characterised by silt, sand and clay.

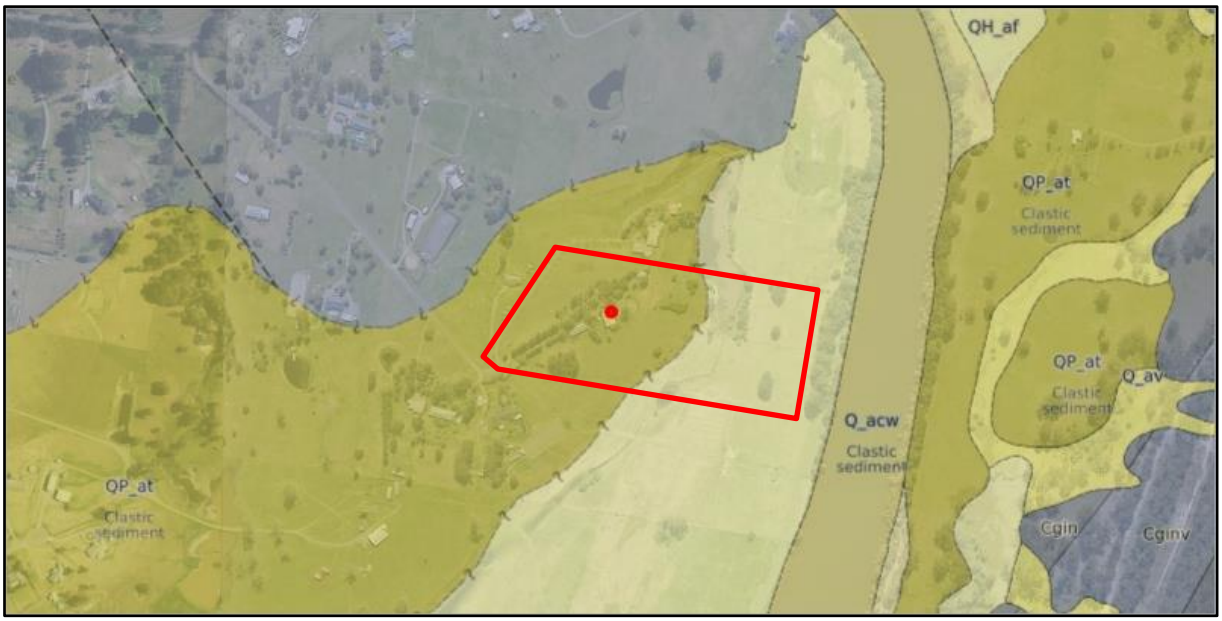

Figure 5: NSW Seamless Geology map with approximate site location (red polygon approximate site boundary)

Reference to the acid sulfate soil mapping (refer Figure 6) indicates that the lower, eastern portion of the site is mapped as having a high probability of acid sulfate soils. Assessment for the presence of acid sulfate soils was beyond the scope of the present investigation.

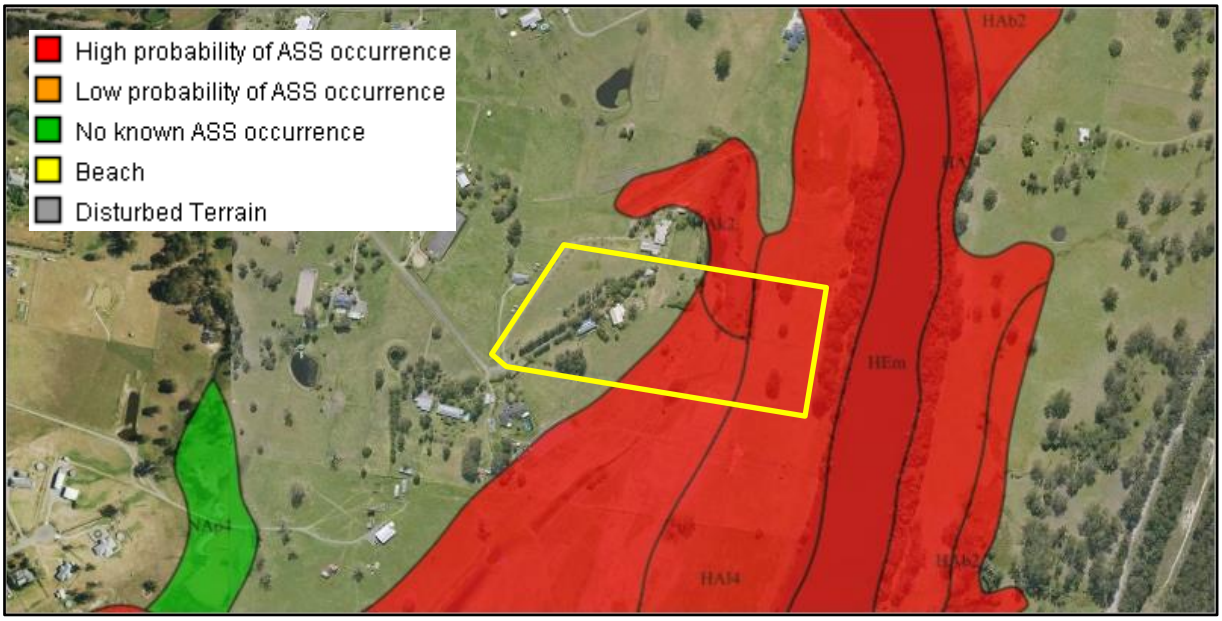

Figure 6: Acid sulfate soil mapping with approximate site location (yellow polygon approximate site boundary)

No registered groundwater bores were identified within 1 km of the site.

5. Field Work

5.1 Field Work Methods

The field work for the investigation was undertaken on 5 September 2023 and included a walkover inspection by an engineering geologist followed by the drilling of seven bores (designated Bores 1 to 6 and 4A).

The bores were drilled using a utility mounted push sampling rig which thrusts a 50 mm internal diameter tube into the ground to retrieve a near continuous sample. The bores were drilled to depths ranging from 0.39 m to 2.5 m depth.

The subsurface conditions encountered in the bores was logged by an engineering geologist who collected sample for identification purposes and laboratory testing.

5.2 Field Work Results

The results of the field work are given in the borehole logs sheets in Appendix B. These should be read in conjunction with the explanatory notes, in Appendix A, which define the descriptive terms and classification methods. In summary, the subsurface conditions in the bores included the following

Depth (m below ground level)		Description
From	To	
0.0	0.1 / 1.0	ALLUVIAL CLAY – sandy clay, generally stiff (all bores except Bore 4). It is noted that deeper alluvial soils were encountered in Bore 2 to 1 m depth.
0.0 / 1.0	0.39 / 1.1	RESIDUAL CLAY – generally sandy clay, but with some silty clay, initially firm to stiff or stronger, becoming very stiff to hard with depth
0.40 / 1.1	Limit of investigation (1.6 m)	SANDSTONE – generally inferred from equipment refusal and hence strength not assessed. Refusal on inferred sandstone bedrock occurred in all bores except Bore 2.

Groundwater seepages were not observed during the drilling of the bores. It should be noted that groundwater levels can be affected by factors such as soil permeability and recent weather conditions and will therefore vary with time.

6. Laboratory Testing

To assess the relevant parameters of the natural soil at the site for effluent disposal assessment, two soil samples were submitted for laboratory testing. Detailed results of the laboratory testing are presented in Appendix D and summarised in Table 2 and Table 3.

Table 2: 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)	Emerson Stability Class
1	0.1 – 0.3	Sandy CLAY	Medium Clay	4.4	0.1	8784	10.1	11.6	3a
3	0.15 – 0.4	Sandy CLAY	Medium Clay	6.45	0.05	9536	14.2	1.05	5

Notes to Table:

1 EC_e is the converted EC (1:5 – soil: water) as presented in Lillicrap, A and McGhie, S (2002).
2 PSC - Phosphorus Sorption Capacity based on PSC over a soil depth of 1m and a density of 1400kg/m^3.
3 CEC – Cation Exchange Capacity.
4 Exchangeable sodium percentage.

The results of the laboratory testing indicate that the soil pH ($CaCl_2$) and CEC, along with the presence of possible shallow bedrock constitute limitations to effluent disposal. Further assessment of the soil characteristics is provided in below in Section 7.1.

Table 3: Results of Laboratory Testing - Shrink Swell

Bore	Depth (m)	Description	FMC (%)	Shrink (%)	Swell (%)	Iss (% per Δ pF)	PP before soaking (kPa)	PP after soaking (kPa)
BH2	0.4 - 0.8	Silty Clay	24.9	6.4	2.1	4.2	>600	260
BH1	0.2 - 0.58	Silty Clay	22.7	4.6	0.7	2.7	430	220

Notes to Table:
FMC - Field Moisture Content
Iss - Shrink-swell index
PP - Pocket Penetrometer reading

7. Comments – Effluent Disposal Assessment

7.1 Site and Soil Assessment

Site and soil characteristics observed during the inspection are assigned either a minor, moderate or major limitation depending on the restrictions to the disposal area in accordance with NSW Environment & Health Protection Guidelines (1998) and are detailed in Table 4 and Table 5. Recommended site improvement measures for moderate and major limitations are also shown in Table 4 and Table 5.

Table 4: Site Assessment Summary

Site Feature	Site Limitation		Restrictive Feature	Recommended Site Improvements
Flood potential	Minor	Rare, above 1 in 20-year flood contour	Transport of wastewater off-site	Flood levels may affect the eastern part of the site. Application areas should be above flood impacted area
	Minor	Vents, openings, and electrical components above 1 in 100-year flood contour	Transport of wastewater off-site. System failure and electrocution hazard	
Exposure	Minor	High sun and wind exposure	Poor evapotranspiration	None required
Slope%	Moderate	Surface irrigation (6 – 12%)	Run-off, erosion	None required
	Minor	Sub-surface irrigation (0– 10%)		
	Minor	Absorption system (0 – 10%)		
Landform	Minor	Hill crests, convex side slopes and plains	Groundwater pollution hazard. Resurfacing hazard	None required
Run-on and upslope seepage	Minor	None – Low	Transport of wastewater off-site	None required
Erosion potential	Minor	No signs of erosion potential present	Soil degradation and transport, system failure	None required
Site drainage	Minor	No signs of surface dampness	Groundwater pollution hazard. Resurfacing hazard	None required
Fill	Minor	No fill	Subsidence. Variable permeability	None required
Buffer distance	Minor	All buffer distances achievable	Health and pollution risks	None required
Land area	Minor	Area is available	Health and pollution risks	None required
Rocks and rock outcrops (% of land surface containing boulders)	Minor	<10% (in areas of likely effluent disposal)	Limits system performance	Should be positioned in areas with slope of less than 10%
Geology/ Regolith	Minor	-	Groundwater pollution hazard	None required

Table 5: Soil Assessment Summary

Soil Feature	Site Limitation		Restrictive Feature	Recommended Site Improvements
Depth to bedrock/hardpan (m)	Minor to	Irrigation >1.0	Restricts plant growth (trees), excessive runoff and waterlogging	Absorption systems not recommended. Application areas should be located in positions with at least 0.6 m depth of soil over bedrock or loamy soils imported to application areas to ensure at least 0.6 m of soil
	Moderate	Irrigation 0.5 – 1.0		
	Minor to	Absorption >1.5	Groundwater pollution hazard. Resurfacing hazard	
	Major	Absorption 0.5 - 1.0		
Depth to high episodic or seasonal water table (m)	Minor	Irrigation >1.0	Groundwater pollution hazard. Resurfacing hazard	None required
	Minor	Absorption >1.5	Groundwater pollution hazard	
Soil Permeability category	Minor	Irrigation 2b, 3 and 4	Excessive run-off, waterlogging and percolation	Trench absorption systems may not be appropriate
	Minor	Absorption 3 and 4		
Coarse fragments (%)	Moderate	10 – 20	May restrict plant growth, affect trench installation	Some exposed rock observed. Disposal areas should be positioned away from such areas.
Bulk density (g/cm^3) Clay	Minor	Unknown	Restricts plant growth, indicator of permeability	None required
pH CaCl (%)	Moderate	4.5 – 6.0	Reduces optimum plant growth	Adjust pH with the addition of agricultural lime
Electrical Conductivity - ECe (dS/m)	Minor	<4	Excessive salt may restrict plant growth	None required
Sodicity (exchangeable sodium %)	Minor to	0 – 5	Potential for structural degradation	Should be improved with addition of gypsum Careful selection of plantings
	Moderate	5 - 10		
Cation exchange capacity (cmol+/kg)	Moderate	5 – 15	Unable to hold plant nutrients	Tyne gypsum and lime into the soil within the application area
Phosphorus sorption (kg P/ha)	Minor	>6000	Unable to immobilise any excess Phosphorus	None required
Modified Emerson Aggregate Test (dispersiveness)	Minor	Class 3 or above	Potential for structural degradation	None required

7.2 Hydraulic Loading for Design

The number of bedrooms within the future residential dwelling are not known at this stage. For this assessment, a hydraulic loading of 900 L/day based on the following assumptions:

- The proposed residence will have a reticulated water supply;
- The proposed residence will have four bedrooms;
- An occupancy rate of 1.5 persons per bedroom; and
- Combined waste stream volume of 150 L/person/day.

The wastewater flow design allowance has been based on values presented in Table H1 (Appendix H) of AS 1547 (2012).

7.3 Effluent Treatment System

Based on the presence of clay soils, it is recommended that the effluent from the proposed development is treated using an aerated wastewater treatment system (AWTS) or similar which produces secondary quality effluent with phosphate reduction to 10 mg/L and nitrogen reduction to 25 mg/L prior to application to the land. 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.

7.4 Effluent Application Options

Based on assessment of the site (Tables 4 and 5) surface irrigation or sub-surface disposal are considered suitable for the site.

7.5 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 Clarencetown and Evaporation data from Williamtown RAAF weather and climate stations;
- Procedures outlined in NSW Environment and Health Protection Guidelines (1998) and AS 1547 (2012);
- A design irrigation rate (DIR) of 2 mm/day for an irrigation area;
- Run-off coefficient of 20%;
- Denitrification factor of 20%; and

- Variable crop factors throughout the year ranging from 0.7 to 0.8 as outlined in NSW Environment and Health Protection Guidelines (1998).

Using the parameters and assumptions outlined above, the recommended minimum application areas were calculated using an in-house computer program. Detailed results of the calculations are attached in Appendix E and summarised in Table 6.

Table 6: Minimum Application Area Required for Irrigation

Effluent Treatment	Effluent Application	Waste stream (L/day)	DLR / DIR (mm/day)	Nutrient Balance		Hydraulic Balance Area (m^2)
				Nitrogen Balance Area (m^2)	Phosphorous Balance Area (m^2)	
Secondary Treatment	Surface or Sub-surface Irrigation	900	2	500	477	**490**

Notes to Table:

Bold = results indicate the minimum are required.

Irrigation systems are typically designed based on the largest of the areas required to satisfy the nitrogen, phosphorus, or hydraulic balance areas. Therefore, based on the above calculations, the sub-surface irrigation or surface irrigation area should be designed to satisfy the nitrogen balance area of 500 m^2.

7.6 Council Development Assessment Framework

Reference to the Dungog Shire Council technical manual indicates that the site is likely to be “low to medium” risk. Reference to the Development Assessment Framework (DAF) indicates that owing to the size of the site, a cumulative impact assessment will not be required.

7.7 Construction

Based on assessment of the site and the hydraulic balance areas provided in Table 6, a sub-surface irrigation or surface irrigation area of 30 m by 19 m may be applicable.

If multiple areas are proposed, a distribution box should be fitted to evenly distribute the effluent between the recommended areas.

As detailed in Tables 5 and 6 the following is recommended:

- Confirmation that at least 0.6 m of soil is present within the proposed disposal areas. If shallow rock is present, the areas should be raised with loamy soil to ensure a minimum of 0.6 m of cover is present over the bedrock;

- Deep ripping, shallow cultivation, application of gypsum to topsoil and maintaining surface vegetation;
- Blending lime into the topsoil placed over the application area to improve the pH of the application area;
- Construction of a bund upslope of the application area to divert surface water around the disposal areas.
- For subsurface irrigation
    - 20 mm to 50 mm diameter drip lines should be installed parallel to site contours at approximately 600 mm to 1000 mm spacings;
    - Install lines at 100 mm to 150 mm depth in topsoil; and
    - Lines can be installed by trenching, ripping and ploughing of the surface or placed on the surface prior to backfilling (where topsoil will be added).
- For surface irrigation
    - 20 mm to 50 mm diameter drip lines should be installed parallel to site contours at approximately 600 mm to 1000 mm spacings;
    - A minimum 150 mm cover of mulch or other approved material should be placed above the drip lines; and
    - The drip lines should be held in place with resistant mesh netting and pinned securely.

It should be noted that surface irrigation is understood to generally be the least preferred option by Local Government Authorities.

Indicative application areas for irrigation are shown in Drawing 2, in Appendix C. The suggested layout of a sub-surface irrigation area and surface irrigation area is provided in Drawings 3 and 4 respectively. The final location and layout should be confirmed between the installer and client.

The application area should be constructed in accordance with recommended buffer distances detailed in Section 7.9.

Further recommendations pertaining to each of the effluent disposal options are provided in the following sections.

7.8 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 brochures titled *Vegetation Suitable for Land Application Areas* and *Your Land Application Area* from NSW Environment and Health Protection Guidelines (1998) provides recommendations on maintenance procedures and are provided in Appendix F.

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 at three yearly intervals or as specified by local regulations or the manufacturer;
- Regular maintenance of surface vegetation to encourage water and nutrient uptake;
- Trim trees or shrubs so that sunlight can reach the effluent disposal area;
- Check drains and trenches around your effluent disposal area to ensure stormwater is diverted away from the application area;
- Regular inspection to ensure that the disposal area is functioning as intended;
- Regular cleaning of the filtration system to prevent clogging of lines;
- Regular maintenance of the AWTS and disinfection system; and
- Prevent vehicles or machinery with high ground bearing pressure that may damage the effluent disposal system from entering the application area.

7.9 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) states that the "100% requirement is normally applied to septic tank units followed by a conventional trench land application system".

Based on the site assessment, it is considered that a 100% reserve application area would be available within the site.

7.10 Buffer Distances

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 7, below, outlines the range of setback distances recommend by AS 1547 (2012) 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).

Table 7: 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 Quality Effluent
1.5 – 50 m to property boundaries	3 m from upslope and side boundaries and 5 m from downslope boundary
2.0 – >6 m to buildings/houses	3 m to upslope and side dwellings/buildings and 6 m from downslope dwellings/buildings 2 m to driveways
15 – 100 m to surface water (e.g., dams, rivers, streams, lakes etc. permanent or intermittent)	40 m downslope of the site
15 – 50 m to domestic groundwater wells	50 m
3 – 15 m to recreational areas (e.g., children play areas, pools etc.)	3 m to upslope recreational areas/pools and 6 m to downslope recreational areas/pools
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 upslope or 45° angle from toe of retaining walls and 3 m from crest of disused quarry

7.11 Conclusion

In accordance with NSW Environment and Health Protection Guidelines (1998) and AS 1547 (2012), the site soils are considered suitable for the disposal of secondary treated domestic effluent to an irrigation area, provided that the limitations raised in this report are addressed and the recommendations in Sections 7.7 and 7.8 are followed.

8. Comments – Preliminary Site Classification

8.1 Preliminary Site Classification

Site classification of foundation soil reactivity indicates the propensity of the ground surface to move with 'normal' seasonal moisture variation. The magnitude of moisture related seasonal ground movements should be considered in design of structures. The site classification is based on procedures presented in AS 2870:2011 Residential Slabs and Footings, the typical soil profiles revealed at the test locations and the results of laboratory testing.

A depth of design suction soil change (H_s) of 3.0 m is considered appropriate for the site. A crack depth factor of 0.5 was used for the assessment.

Due to the presence of trees and existing structures in parts of the site, a classification of Class P would apply. Trees can lead to appreciable changes in local soil suction stresses and consequential clay shrink-swell soil movements. Similarly, the presence of existing structures can lead to abnormal soil moisture profile. The consequence of the Class P classification is the requirement for footing systems to be engineer-designed.

However, based on the soil profiles encountered in the bores and the results of laboratory testing, characteristic surface movements in the range of about 50 mm to 70 mm are estimated for the site (i.e. characteristic surface movements commensurate with a Class H2 site) under normal seasonal moisture fluctuations, without the influence of trees.

Appendix H and its commentary of AS 2870-2011, "A Guide to Design of Footings for Trees", provides guidance and a method to estimate potential surface movements due to tree induced suction change for existing and possible new trees (e.g. extreme drying effects). However, it does not provide a method to determine maximum potential surface movements due to tree induced suction change (e.g. extreme swell effects) in the event the trees are removed immediately prior to construction. Appendix H of AS 2870 indicates that, for tree removal or dying trees, ultimate bending moment strength (M_u) for centre and edge heave should not be less than 1.5 times cracking moment capacity (M_{cr}) for footing design methods. Additional information on the design of footings based on differential mound movement is also provided in AS 2870. It is recommended that if trees are to be removed, they should be removed well ahead of building construction (preferably more than 12 months) to allow some rehydration of the clay.

Based on the methods presented in AS2870-2011, additional surface movements greater than normal seasonal effects due to the influence of trees (y_t), is estimated to be about 5 mm to 15 mm.

These surface movements should be taken into account when calculating the differential mound movement (y_m) as defined in AS2870-2011.

It should be noted that this classification is dependent on proper site maintenance, which should be carried out in accordance with the attached CSIRO (2021), "Foundation Maintenance and Footing Performance: A Homeowners Guide" in Appendix A and with AS 2870:2011.

The site classification should be revised if cutting or filling is undertaken in proposed building areas, as required by AS 2870, 2011. Clay soil, if used as fill in the building area, could have an adverse effect on shrink-swell movements, leading to a more severe site classification and increased characteristic free surface movement, y_{s2}.. The planting of trees in proximity to the structure could also affect site classification and therefore should be avoided.

Masonry walls should be articulated in accordance with the Cement Concrete & Aggregates Australia guideline (CCAA, 2008) to reduce the effects of differential movement.

8.2 Footings

Shallow footings up to 0.4 m wide could be founded in the stiff or stronger silty clay material at a depth of at least 0.4 m and be proportioned for a maximum allowable bearing pressure of 100 kPa.

Settlement of about 10 mm to 15 mm is expected for shallow footings proportioned as above, which is independent of, and could be additive to reactive soil surface movements.

Alternative, bored piles would be suitable for the support of structural load. Piles should be founded in very stiff or stronger material at 1 m depth or greater below existing ground level and be proportioned for a maximum allowable bearing pressure of 350 kPa could be used for design. Shaft friction should be ignored.

Footings should be founded within material of similar stiffness (i.e. not partly on clay soils and partly on rock).

It is recommended that the correct founding stratum be confirmed by geotechnical inspection at the time of construction.

9. Recommended Additional Investigation

Following the subdivision of the site, and prior to construction of the proposed dwellings and effluent application areas, it is recommended that additional subsurface investigation is undertaken to inform detailed design.

10. References

AS 1547. (2012). *On-site domestic wastewater management.* Standards Australia.

AS2870. (2011). *Australian Standard AS2870-2011 "Residential Slabs and Footings".* Standards Australia.

CCAA. (2008). *TN61, Articulated Walling.* Technical Note 61, 3rd Edition: Cement Concrete & Aggregates Australia.

CSIRO. (2021). *Foundation Maintenance and Footing Performance.* CSIRO Building Technology Resources.

DLG. (1998). *On-site Sewage Management for Single Households. NSW Environment & Health Protection Guidelines.* NSW Deparment of Local Government.

DPE. (2023). *Onsite Wastewater Management. NSW Environment & Health Protection Guidelines (Draft).* NSW Office of Local Government, Department of Planning and Environment.

Lillicrap, A and McGhie, S. (2002). *Site investigation for urban salinity.* Sydney: Department of Land and Water Conservation.

11. Limitations

Douglas Partners (DP) has prepared this report for this project at 64 Williams River Close, Clarencetown in accordance with DP's proposal dated 15 June 2023 and acceptance received from Glen O'Connor dated 22 August 2023. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Glen O'Connor for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

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

Douglas Partners Pty Ltd

Appendix A

About This Report
Terminology, Symbols and Abbreviations
Soil Descriptions
Sampling, Testing and Excavation Methodology

About this Report

November 2020

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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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.

continued next page

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.

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Terminology, Symbols and Abbreviations

November 2020

Introduction to Terminology, Symbols and Abbreviations

Douglas Partners' reports, investigation logs, and other correspondence may use terminology which has quantitative or qualitative connotations. To remove ambiguity or uncertainty surrounding the use of such terms, the following sets of notes pages may be attached Douglas Partners' reports, depending on the work performed and conditions encountered:

- Soil Descriptions;
- Rock Descriptions; and
- Sampling, insitu testing, and drilling methodologies

In addition to these pages, the following notes generally apply to most documents.

Abbreviation Codes

Site conditions may also be presented in a number of different formats, such as investigation logs, field mapping, or as a written summary. In some of these formats textual or symbolic terminology may be presented using textual abbreviation codes or graphic symbols, and, where commonly used, these are listed alongside the terminology definition. For ease of identification in these note pages, textual codes are presented in these notes in the following style `XW`. Code usage conforms with the following guidelines:

- Textual codes are case insensitive, although herein they are generally presented in upper case; and
- Textual codes are contextual (i.e. the same or similar combinations of characters may be used in different contexts with different meanings (for example `PL` is used for plastic limit in the context of soil moisture condition, as well as in `PL(A)` for point load test result in the testing results column).

Data Integrity Codes

Subsurface investigation data recorded by Douglas Partners is generally managed in a highly structured database environment, where records "span" between a top and bottom depth interval. Depth interval "gaps" between records are considered to introduce ambiguity, and, where appropriate, our practice guidelines may require contiguous data sets. Recording meaningful data is not always appropriate (for example assigning a "strength" to a concrete pavement) and the following codes may be used to maintain contiguity in such circumstances.

Term	Description	Abbreviation Code
Core loss	No core recovery	`KL`
Unknown	Information was not available to allow classification of the property. For example, when auguring in loose, saturated sand auger cuttings may not be returned.	`UK`
No data	Information required to allow classification of the property was not available. For example if drilling is commenced from the base of a hole predrilled by others	`ND`
Not Applicable	Derivation of the properties not appropriate or beyond the scope of the investigation. For example providing a description of the strength of a concrete pavement	`NA`

Graphic Symbols

Douglas Partners' logs contain a "graphic" column which provides a pictorial representation of the basic composition of the material. The symbols used are directly representing the material name stated in the adjacent "Description of Strata" column, and as such no specific graphic symbology legend has been provided in these notes.

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Soil Descriptions

September 2023

Introduction

All materials which are not considered to be "in-situ rock" are described in general accordance with the soil description model of AS 1726-2017 Part 6.1.3, and can be broken down into the following description structure:

The "classification" comprises a two character "group symbol" providing a general summary of dominant soil characteristics. The "name" summarises the particle sizes within the soil which most influence its behaviour. The detailed description presents more information about composition, condition, structure, and origin of the soil.

Classification, naming and description of soils require the relative proportion of particles of different sizes within the whole soil mixture to be considered.

Particle size designation and Behaviour Model

Solid particles within a soil are differentiated on the basis of size.

The engineering behaviour properties of a soil can subsequently be modelled to be either "fine grained" (also known as "cohesive" behaviour) or "coarse grained" ("non cohesive" behaviour), depending on the relative proportion of fine or coarse fractions in the soil mixture.

Particle Size Designation	Particle Size (mm)	Behaviour Model	
		Behaviour	Approximate Dry Mass
Boulder	>200	Excluded from particle behaviour model as "oversize"	
Cobble	63 - 200		
Gravel[1]	2.36 - 63	Coarse	>65%
Sand[1]	0.075 - 2.36		
Silt	0.002 - 0.075	Fine	>35%
Clay	<0.002		

[1] – refer grain size subdivision descriptions below

The behaviour model boundaries defined above are not precise, and the material behaviour should be assumed from the name given to the material (which considers the particle fraction which dominates the behaviour, refer "component proportions" below), rather than strict observance of the proportions of particle sizes. For example, if a material is named a "Sandy CLAY", this is indicative that the material exhibits fine grained behaviour, even if the dry mass of coarse grained material may exceed 65%.

Component proportions

The relative proportion of the dry mass of each particle size fraction is assessed to be a "primary", "secondary", or "minor" component of the soil mixture, depending on its influence over the soil behaviour.

Component Proportion Designation	Definition[1]	Relative Proportion	
		In Fine Grained Soil	In Coarse Grained Soil
Primary	The component (particle size designation, refer above) which dominates the engineering behaviour of the soil	The clay/silt component with the greater proportion	The sand/gravel component with the greater proportion
Secondary	Any component which is not the primary, but is significant to the engineering properties of the soil	Any component with greater than 30% proportion	Any granular component with greater than 30%; or Any fine component with greater than 12%
Minor[2]	Present in the soil, but not significant to its engineering properties	All other components	All other components

[1] As defined in AS1726-2017 6.1.4.4

[2] In the detailed material description, minor components are split into two further sub-categories. Refer "identification of minor components" below.

Composite Materials

In certain situations, a lithology description may describe more than one material, for example, collectively describing a layer of interbedded sand and clay. In such a scenario, the two materials would be described independently, with the names preceded or followed by a statement describing the arrangement by which the materials co-exist. For example, "INTERBEDDED Silty CLAY AND SAND".

Classification

The soil classification comprises a two character group symbol. The first character identifies the primary component. The second character identifies either the grading or presence of fines in a coarse grained soil, or the plasticity in a fine grained soil. Refer AS1726-2017 6.1.6 for further clarification.

Soil Name

For most soils, the name is derived with the primary component included as the noun (in upper case), preceded by any secondary components stated in an adjective form. In this way, the soil name also describes the general composition and indicates the dominant behaviour of the material.

Component[1]	Prominence in Soil Name
Primary	Noun (eg "CLAY")
Secondary	Adjective modifier (eg "Sandy")
Minor	No influence

[1] – for determination of component proportions, refer component proportions on previous page

For materials which cannot be disaggregated, or which are not comprised of rock or mineral fragments, the names "ORGANIC MATTER" or "ARTIFICIAL MATERIAL" may be used, in accordance with AS1726-2017 Table 14.

Commercial or colloquial names are not used for the soil name where a component derived name is possible (for example "Gravelly SAND" rather than "CRACKER DUST").

Materials of "fill" or "topsoil" origin are generally assigned a name derived from the primary/secondary component (where appropriate). In log descriptions this is preceded by uppercase "FILL" or "TOPSOIL". Origin uncertainty is indicated in the description by the characters `(?)`, with the degree of uncertainty described (using the terms "probably" or "possibly" in the origin column, or at the end of the description).

Identification of minor components

Minor components are identified in the soil description immediately following the soil name. The minor component fraction is usually preceded with a term indicating the relative proportion of the component.

Minor Component Proportion Term	Relative Proportion	
	In Fine Grained Soil	In Coarse Grained Soil
With	All fractions: 15-30%	Clay/silt: 5-12% sand/gravel: 15-30%
Trace	All fractions: 0-15%	Clay/silt: 0-5% sand/gravel: 0-15%

The terms "with" and "trace" generally apply only to gravel or fine particle fractions. Where cobbles/boulders are encountered in minor proportions (generally less than about 12%) the term "occasional" may be used. This term describes the sporadic distribution of the material within the confines of the investigation excavation only, and there may be considerable variation in proportion over a wider area which is difficult to factually characterise due to the relative size of the particles and the investigation methods.

Soil Composition

Plasticity

Descriptive Term	Laboratory liquid limit range	
	Silt	Clay
Non-plastic materials	Not applicable	Not applicable
Low plasticity	≤50	≤35
Medium plasticity	Not applicable	>35 and ≤50
High plasticity	>50	>50

Note, Plasticity descriptions generally describe the plasticity behaviour of the whole of the fine grained soil, not individual fine grained fractions.

Grain Size

Type		Particle size (mm)
Gravel	Coarse	19 - 63
	Medium	6.7 - 19
	Fine	2.36 – 6.7
Sand	Coarse	0.6 - 2.36
	Medium	0.21 - 0.6
	Fine	0.075 - 0.21

Grading

Grading Term	Particle size (mm)
Well	A good representation of all particle sizes
Poorly	An excess or deficiency of particular sizes within the specified range
Uniformly	Essentially of one size
Gap	A deficiency of a particular size or size range within the total range

Note, AS1726-2017 provides terminology for additional attributes not listed here.

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Soil Condition

Moisture

The moisture condition of soils is assessed relative to the plastic limit for fine grained soils, while for coarse grained soils it is assessed based on the appearance and feel of the material. The moisture condition of a material is considered to be independent of stratigraphy (although commonly these are related), and this data is presented in its own column on logs.

Applicability	Term	Tactile Assessment	Abbreviation code
Fine	Dry of plastic limit	Hard and friable or powdery	w<PL
	Near plastic limit	Can be moulded	w=PL
	Wet of plastic limit	Water residue remains on hands when handling	w>PL
	Near liquid limit	"oozes" when agitated	w=LL
	Wet of liquid limit	"oozes"	w>LL
Coarse	Dry	Non-cohesive and free running	D
	Moist	Feels cool, darkened in colour, particles may stick together	M
	Wet	Feels cool, darkened in colour, particles may stick together, free water forms when handling	W

The abbreviation code NDF, meaning "not-assessable due to drilling fluid use" may also be used.

Note, observations relating to free ground water or drilling fluids are provided independent of soil moisture condition.

Consistency/Density/Compaction/Cementation/Extremely Weathered Material

These concepts give an indication of how the material may respond to applied forces (when considered in conjunction with other attributes of the soil). This behaviour can vary independent of the composition of the material, and on logs these are described in an independent column and are generally mutually exclusive (i.e it is inappropriate to describe both consistency and compaction at the same time). The method by which the behaviour is described depends on the behaviour model and other characteristics of the soil as follows:

- In fine grained soils, the "consistency" describes the ease with which the soil can be remoulded, and is generally correlated against the materials undrained shear strength;
- In granular materials, the relative density describes how tightly packed the particles are, and is generally correlated against the density index;
- In anthropogenically modified materials, the compaction of the material is described qualitatively;
- In cemented soils (both natural and anthropogenic), the cemented "strength" is described qualitatively, relative to the difficulty with which the material is disaggregated; and
- In soils of extremely weathered material origin, the engineering behaviour may be governed by relic rock features, and expected behaviour needs to be assessed based the overall material description.

Quantitative engineering performance of these materials may be determined by laboratory testing or estimated by correlated field tests (for example penetration or shear vane testing). In some cases, performance may be assessed by tactile or other subjective methods, in which case investigation logs will show the estimated value enclosed in round brackets, for example (VS).

Consistency (fine grained soils)

Consistency Term	Tactile Assessment	Undrained Shear Strength (kPa)	Abbreviation Code
Very soft	Extrudes between fingers when squeezed	<12	VS
Soft	Mouldable with light finger pressure	>12 - ≤25	S
Firm	Mouldable with strong finger pressure	>25 - ≤50	F
Stiff	Cannot be moulded by fingers	>50 - ≤100	St
Very stiff	Indented by thumbnail	>100 - ≤200	VSt
Hard	Indented by thumbnail with difficulty	>200	H
Friable	Easily crumbled or broken into small pieces by hand	-	Fr

Relative Density (coarse grained soils)

Relative Density Term	Density Index	Abbreviation Code
Very loose	<15	VL
Loose	>15 - ≤35	L
Medium dense	>35 - ≤65	MD
Dense	>65 - ≤85	D
Very dense	>85	VD

Note, tactile assessment of relative density is difficult, and generally requires penetration testing, hence a tactile assessment guide is not provided.

Compaction (anthropogenically modified soil)

Compaction Term	Abbreviation Code
Well compacted	WC
Poorly compacted	PC
Moderately compacted	MC
Variably compacted	VC

Cementation (natural and anthropogenic)

Cementation Term	Abbreviation Code
Moderately cemented	MOD
Weakly cemented	WEK

Extremely Weathered Material

AS1726-2017 considers weathered material to be soil if the unconfined compressive strength is less than 0.6 MPa (i.e. less than very low strength rock). These materials may be identified as "extremely weathered material" in reports and by the abbreviation code XWM on log sheets. This identification is not correlated to any specific qualitative or quantitative behaviour, and the engineering properties of this material must therefore be assessed according to engineering principles with reference to any relic rock structure, fabric, or texture described in the description.

Soil Origin

Term	Description	Abbreviation Code
Residual	Derived from in-situ weathering of the underlying rock	RS
Extremely weathered material	Formed from in-situ weathering of geological formations. Has strength of less than 'very low' as per as1726 but retains the structure or fabric of the parent rock.	XWM
Alluvial	Deposited by streams and rivers	ALV
Estuarine	Deposited in coastal estuaries	EST
Marine	Deposited in a marine environment	MAR
Lacustrine	Deposited in freshwater lakes	LAC
Aeolian	Carried and deposited by wind	AEO
Colluvial	Soil and rock debris transported down slopes by gravity	COL
Slopewash	Thin layers of soil and rock debris gradually and slowly deposited by gravity and possibly water	SW
Topsoil	Mantle of surface soil, often with high levels of organic material	TOP
Fill	Any material which has been moved by man	FILL
Littoral	Deposited on the lake or seashore	LIT
Unidentifiable	Not able to be identified	UID

Cobbles and Boulders

The presence of particles considered to be "oversize" may be described using one of the following strategies:

- Oversize encountered in a minor proportion (when considered relative to the wider area) are noted in the soil description; or
- Where a significant proportion of oversize is encountered, the cobbles/boulders are described independent of the soil description, in a similar manner to composite soils (described above) but qualified with "MIXTURE OF".

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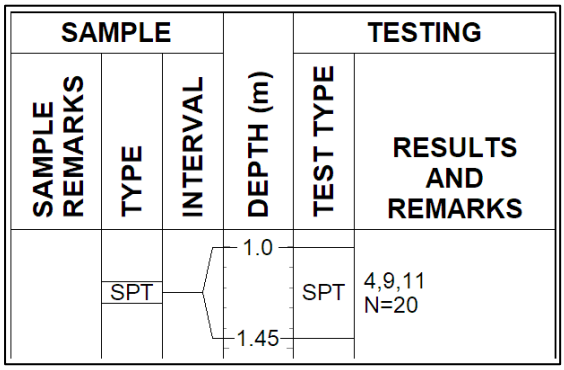
Sampling, Testing and Excavation Methodology

Terminology
Symbols
Abbreviations

September 2023

Sampling and Testing

A record of samples retained, and field testing performed is usually shown on a Douglas Partners' log with samples appearing to the left of a depth scale, and selected field and laboratory testing (including results, where relevant) appearing to the right of the scale, as illustrated below:



Sampling

The type or intended purpose for which a sample was taken is indicated by the following abbreviation codes.

Sample Type	Code
Auger sample	A
Bulk sample	B
Core sample	C
Disturbed sample	D
Sample from SPT test	SPT
Environmental sample	ES
Gas sample	G
Undisturbed tube sample	U[1]
Water sample	W
Piston sample	P
Core sample for unconfined compressive strength testing	UCS
Material Sample	MT

[1] – numeric suffixes indicate tube diameter/width in mm

The above codes only indicate that a sample was retained, and not that testing was scheduled or performed.

Field and Laboratory Testing

A record that field and laboratory testing was performed is indicated by the following abbreviation codes.

Test Type	Code
Pocket penetrometer (kPa)	PP
Photo ionisation detector (ppm)	PID
Standard Penetration Test x/y =*x* blows for *y* mm penetration HB = hammer bouncing HW = fell under weight of hammer	SPT
Shear vane (kPa)	V
Unconfined compressive strength, (MPa)	UCS

Field and laboratory testing (continued)

Test Type	Code
Point load test, (MPa), axial (A), diametric (D), irregular (I)	PLT(_)
Dynamic cone penetrometer, followed by blow count penetration increment in mm (cone tip, generally in accordance with AS1289.6.3.2)	DCP/150
Perth sand penetrometer, followed by blow count penetration increment in mm (flat tip, generally in accordance with AS1289.6.3.3)	PSP/150

Groundwater Observations

▷	seepage/inflow
▽	standing or observed water level
NFGWO	no free groundwater observed
OBS	observations obscured by drilling fluids

Drilling or Excavation Methods/Tools

The drilling/excavation methods used to perform the investigation may be shown either in a dedicated column down the left-hand edge of the log, or stated in the log footer. In some circumstances abbreviation codes may be used.

Method	Abbreviation Code
Toothed bucket	TB[1]
Mud/blade bucket	MB[1]
Ripping tyne/ripper	R
Rock breaker/hydraulic hammer	RB
Hand auger	HA[1]
NMLC series coring	NMLC
HMLC series coring	HMLC
NQ coring	NQ3
HQ coring	HQ3
PQ coring	PQ3
Push tube	PT[1]
Rock roller	RR[1]
Solid flight auger. Suffixes: /T = tungsten carbide tip, /V = v-shaped tip	AD[1]
Sonic drilling	SON[1]
Vibrocore	VC[1]
Wash bore (unspecified bit type)	WB[1]
Existing exposure	X
Hand tools (unspecified)	HAND
Predrilled	PD
Diatube	DT[1]
Hollow flight auger	HSA[1]
Vacuum excavation	VE

[1] – numeric suffixes indicate tool diameter/width in mm

Appendix B

Borehole Logs (Bores 1 to 6 and 4A)

BOREHOLE LOG

CLIENT: Glen O'Connor
PROJECT: Proposed Subdivision
LOCATION: 64 Williams River Close, Clarencetown, NSW

SURFACE LEVEL: 9.4 AHD
COORDINATE: E:385075.5, N:6391780.5
DATUM/GRID: MGA2020 56
DIP/AZIMUTH: /---°

LOCATION ID: 1
PROJECT No: 223386.00
DATE: 05/09/23
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE			TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
No free groundwater observed	0.10	Sandy CLAY (CL-CI), trace gravel: brown grey; low to medium plasticity; fine to coarse sand; fine to medium, sub-angular gravel.		ALV	St	w<PL		D		0.10	PP	100kPa
		Sandy CLAY (CI), trace gravel: grey; medium plasticity; fine to medium sand; fine to medium, sub-angular gravel.		ALV	VSt	w=PL to w<PL		D		0.20	PP	230kPa
										0.30	PP	330-350kPa
								U50			PP	340-440kPa
										0.50	PP	400-500kPa
					H	w<PL		D		0.58		
	0.80	Borehole discontinued at 0.80m depth. Refusal on possible sandstone.								0.70		
	1									1		

DCP 9/10

5 10 15 30

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Push Tube
METHOD: 50mm Push tube to 0.8m
REMARKS: Sandstone fragments in bottom of tube.

OPERATOR: Douglas Partners (Runge)
CASING: Nil

LOGGED: Runge

Refer to explanatory notes for symbol and abbreviation definitions

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Glen O'Connor
PROJECT: Proposed Subdivision
LOCATION: 64 Williams River Close, Clarencetown, NSW

SURFACE LEVEL: 7.6 AHD
COORDINATE: E:385127.5, N:6391812.5
DATUM/GRID: MGA2020 56
DIP/AZIMUTH: /---°

LOCATION ID: 2
PROJECT No: 223386.00
DATE: 05/09/23
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
No free groundwater observed		0.18	Sandy CLAY (CL-CI), trace gravel: brown; low to medium plasticity; fine to medium sand; fine to medium, sub-angular gravel.		ALV	St	w<PL		D		0.15		
			Silty CLAY (CH), with sand: grey mottled orange; high plasticity; fine to medium sand.		ALV	St to VSt	w=PL		D		0.20		
									U50		0.40	PP	>600kPa
											0.50	DCP9/0	
									D		0.80		
		1.00	Sandy CLAY (CI): grey; medium plasticity; fine to medium sand.			H			D		1.00		
			1.30m: grey mottled orange				w<PL to w=PL		U50		1.20		
					RS						1.30	PP	450-550kPa
						VSt to H					1.75		
		2							D		1.80		
						VSt					2		
		2.40	Sandy CLAY (CI): orange; medium plasticity; fine to medium sand.		RS possibly XWM		w<PL		D		2.10		
		2.50	Borehole discontinued at 2.50m depth. .								2.40		
											2.50		

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Push Tube
METHOD: 50mm Push tube to 2.5m
REMARKS:

OPERATOR: Douglas Partners (Runge)
CASING: Nil

LOGGED: Runge

BOREHOLE LOG

CLIENT: Glen O'Connor
PROJECT: Proposed Subdivision
LOCATION: 64 Williams River Close, Clarencetown, NSW

SURFACE LEVEL: 12.8 AHD
COORDINATE: E:385150.5, N:6391674.5
DATUM/GRID: MGA2020 56
DIP/AZIMUTH: /---°

LOCATION ID: 3
PROJECT No: 223386.00
DATE: 05/09/23
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
No free groundwater observed		Sandy CLAY (CI), trace gravel: brown grey; low to medium plasticity; fine to medium sand; fine to medium, sub-angular gravel.		ALV possibly RS	St	w<PL		D		0.15	PP	130kPa
	0.50	Sandy CLAY (CI), trace gravel: dark grey mottled orange; medium plasticity; fine to medium sand; fine to coarse, sub-angular gravel.		RS				D		0.40	PP	100kPa
	0.92	Borehole discontinued at 0.92m depth. Refusal on possible sandstone.								0.70	PP	100-130kPa
	1									1		

DCP9/0

5 10 15

30

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Push Tube
METHOD: 50mm Push tube to 0.92m
REMARKS:

OPERATOR: Douglas Partners (Runge)
CASING: Nil

LOGGED: Runge

Refer to explanatory notes for symbol and abbreviation definitions

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Glen O'Connor
PROJECT: Proposed Subdivision
LOCATION: 64 Williams River Close, Clarencetown, NSW

SURFACE LEVEL: 10.4 AHD
COORDINATE: E:385210.5, N:6391771.5
DATUM/GRID: MGA2020 56
DIP/AZIMUTH: /---°

LOCATION ID: 4
PROJECT No: 223386.00
DATE: 05/09/23
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
No free groundwater observed		0.20	Sandy CLAY (CL-CI), with gravel: dark brown; low to medium plasticity; fine to medium sand; medium to coarse, sub-angular to sub-rounded gravel.		RS possibly FILL	VSt	w<PL		D		0.20	PP	240kPa 5 10 15
		0.39	Sandy CLAY (CI), trace gravel: grey mottled orange; medium plasticity; medium to coarse sand; fine to medium, sub-angular gravel.		RS		w>PL to w<PL		D		0.39	PP DCP(s)	200-300kPa
		0.40	SANDSTONE: low strength, highly weathered, fine grained, orange, possible cobble						D				30
		1	Borehole discontinued at 0.40m depth. Refusal an possible sandstone or sandstone cobble.								1		

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Push Tube
METHOD: 50mm Push tube to 0.4m
REMARKS: Bricks and rock rubble on surface 1-2m away.

OPERATOR: Douglas Partners (Runge)
CASING: Nil

LOGGED: Runge

Refer to explanatory notes for symbol and abbreviation definitions

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Glen O'Connor
PROJECT: Proposed Subdivision
LOCATION: 64 Williams River Close, Clarencetown, NSW

SURFACE LEVEL: 10.6 AHD
COORDINATE: E:385205.0, N:6391771.1
DATUM/GRID: MGA2020 56
DIP/AZIMUTH: /---°

LOCATION ID: 4A
PROJECT No: 223386.00
DATE: 05/09/23
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE			TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
No free groundwater observed	0.00	Sandy CLAY (CL-CI): brown; low to medium plasticity; fine to medium sand.		ALV possibly RS	F to St	w<PL		D		0.00	PP	50-100kPa
	0.20	Sandy CLAY (CI), trace gravel: dark grey; medium plasticity; fine to coarse sand; fine to medium, sub-angular gravel.		RS		w=PL		D		0.20	PP	90-100kPa
	0.45	Gravelly CLAY (CI), with sand: grey mottled orange; medium plasticity; fine to medium, sub-angular gravel; fine to medium sand.		RS				D		0.40	DCP 5/10	
	0.50				ND	ND		D		0.45		
	0.55	SANDSTONE: low strength, highly weathered, fine grained, orange grey								0.50		
		Borehole discontinued at 0.55m depth. Refusal on possible sandstone.								0.55		
	1									1		

5 10 15

30

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Push Tube
METHOD: 50mm Push tube to 0.55m
REMARKS:

OPERATOR: Douglas Partners (Runge)
CASING: Nil

LOGGED: Runge

BOREHOLE LOG

CLIENT: Glen O'Connor
PROJECT: Proposed Subdivision
LOCATION: 64 Williams River Close, Clarencetown, NSW

SURFACE LEVEL: 12.4 AHD
COORDINATE: E:385107.5, N:6391699.5
DATUM/GRID: MGA2020 56
DIP/AZIMUTH: /---°

LOCATION ID: 5
PROJECT No: 223386.00
DATE: 05/09/23
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	SAMPLE TYPE	SAMPLE INTERVAL	DEPTH (m)	TESTING AND REMARKS: TEST TYPE	RESULTS AND REMARKS
No free groundwater observed		0.25	Sandy CLAY (CL-CI), with gravel: grey brown; low to medium plasticity; fine to medium sand; fine to coarse, sub-angular gravel.		ALV possibly RS	St	w<PL		D		0.25	PP	100kPa
			Sandy CLAY (CI), with gravel: grey mottled orange; medium plasticity; medium to coarse sand; fine to medium, sub-angular gravel.		RS	F to St			D		0.30	PP	90-190kPa
		0.65	Sandy CLAY (CI): pale grey mottled orange brown; medium plasticity; medium to coarse sand.		RS	VSt	w>PL		D		0.60	PP	320kPa
		1									0.70		
		1.10	1.05m-1.10m: sandstone fragments possible sandstone Borehole discontinued at 1.10m depth. Refusal on possible sandstone.								1.00	PP	340kPa

DCP9/0: 5, 10, 15, 30

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Push Tube
METHOD: 50mm Push tube to1.1m
REMARKS:

OPERATOR: Douglas Partners (Runge)
CASING: Nil

LOGGED: Runge

BOREHOLE LOG

CLIENT: Glen O'Connor
PROJECT: Proposed Subdivision
LOCATION: 64 Williams River Close, Clarencetown, NSW

SURFACE LEVEL: 12.9 AHD
COORDINATE: E:385043.5, N:6391738.5
DATUM/GRID: MGA2020 56
DIP/AZIMUTH: /---°

LOCATION ID: 6
PROJECT No: 223386.00
DATE: 05/09/23
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	SAMPLE TYPE	SAMPLE INTERVAL	DEPTH (m)	TESTING AND REMARKS: TEST TYPE	RESULTS AND REMARKS
No free groundwater observed		0.17	Sandy CLAY (CL), trace gravel: brown; low plasticity; fine to medium sand; fine to medium, sub-angular gravel.		ALV				D		0.15	PP	100kPa
			Sandy CLAY (CL): grey mottled orange; low plasticity; fine to medium sand.		RS	F to St	w<PL		D		0.20	PP	100-150kPa
		0.45	Sandy CLAY (CI), trace gravel: grey mottled orange brown; medium plasticity; fine to medium sand; fine to medium, sub-angular gravel.		RS	St			U50		0.40		
									D		0.63	PP	100-200kPa
		0.78							D		0.70		
		0.80	SANDSTONE: low strength, highly weathered, fine grained, orange grey			NA	NA				0.78		
			Borehole discontinued at 0.80m depth. Refusal on possible sandstone.								0.80		
		1									1		

DCP9/0: 5 | 10 | 15 | 30

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Push Tube
METHOD: 50mm Push tube to 0.8m
REMARKS:

OPERATOR: Douglas Partners (Runge)
CASING: Nil

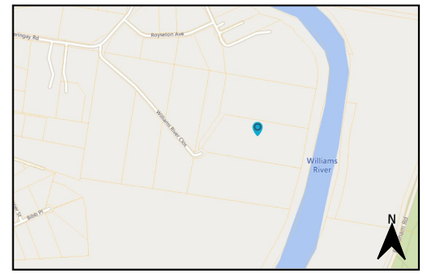
LOGGED: Runge

Refer to explanatory notes for symbol and abbreviation definitions

Douglas Partners
Geotechnics / Environment / Groundwater

Appendix C

Drawing 1 – Test Location Plan
Drawing 2 – Indicative Effluent Disposal Areas
Drawing 3 – Indicative Sub-surface Drip Irrigation Arrangement
Drawing 4 – Indicative Covered Surface Drip Irrigation Arrangement



Site Location

Legend

Cadastral Boundaries

Proposed Approximate Subdivision Boundaries

Bore Locations

NOTE:
1. Drawing adapted from MetroMap aerial imagery
2. Test locations are approximate only and were located using differential GPS typically accurate to ± 0.1 m depending on satellite coverage (handheld GPS, measured off site features)

0

Douglas Partners
Geotechnics / Environment / Groundwater

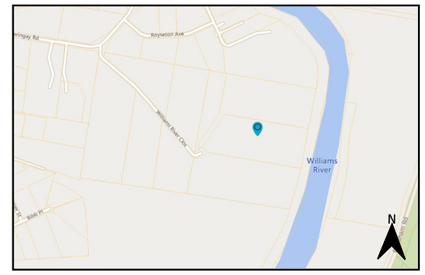
CLIENT: Glen O'Connor		
OFFICE: Newcastle	DRAWN BY: MPG	
SCALE: 1:2000 @A3	DATE: 11.October.2023	

TITLE: **Test Location Plan**
Geotechnical Investigation - Proposed Subdivision
64 Williams River Drive, Clarencetown, NSW

N

Project:	223386.00
DRAWING No:	1
REVISION:	0

DP.QGIS.A3LandscapeDrawingLayout.3.26.3 - P:\223386.00 - CLARENCETOWN, 64 Williams River Close\7.0 Drawings\7.2 Out\223386.00.D.qgz



Site Location

Legend

- Proposed Approximate Subdivision Boundaries
- Bore Locations
- Indicative Irrigation Area (500 m 2)
- 6 m buffer to proposed boundaries
- 6 m buffer to Pool
- 40 m Buffer to Low Lying Area

NOTE:
1. Drawing adapted from MetroMap aerial imagery
2. Test locations are approximate only and were located using differential GPS typically accurate to ± 0.1 m depending on satellite coverage (handheld GPS, measured off site features)

0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Glen O'Connor		
OFFICE: Newcastle	DRAWN BY: MPG	
SCALE: 1:2000 @A3	DATE: 13.October.2023	

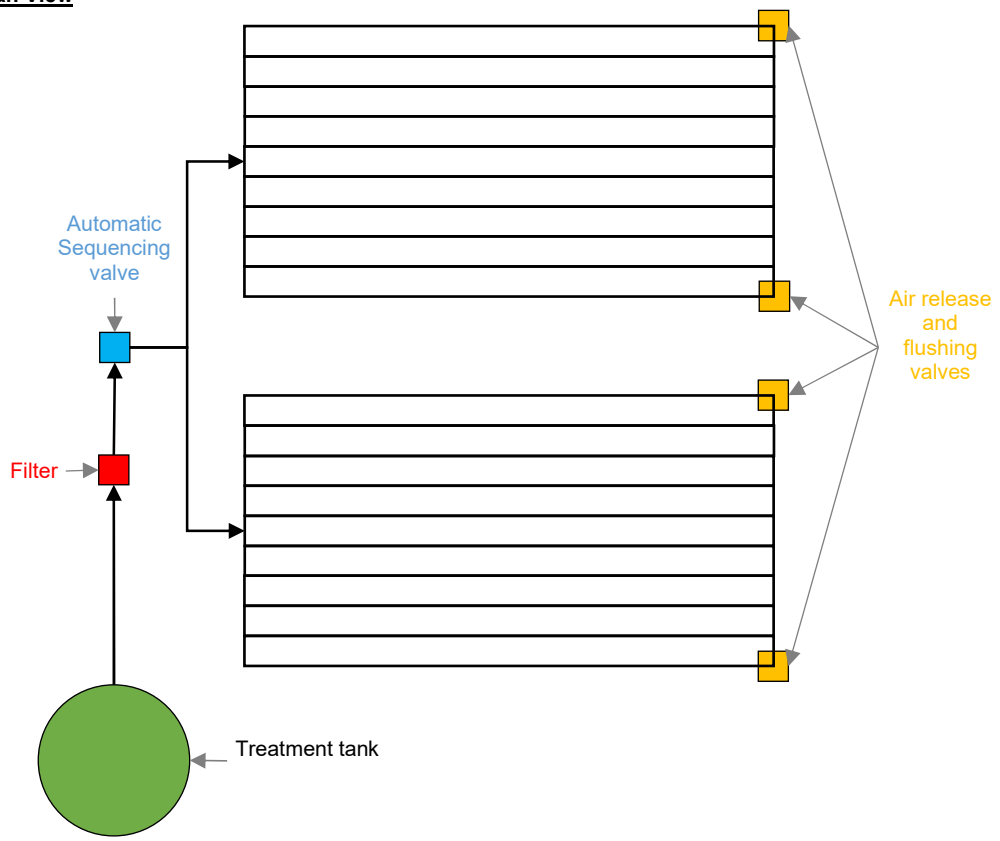
TITLE: **Test Location Plan**
Geotechnical Investigation - Proposed Subdivision
64 Williams River Drive, Clarencetown, NSW

N

Project:	223386.00
DRAWING No:	2
REVISION:	0

Indicative Subsurface Drip Irrigation Arrangement

Plan View



Cross Section

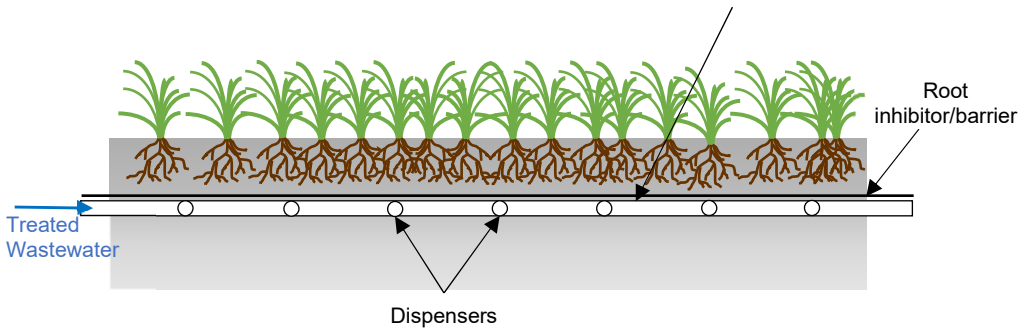
Lines can be installed by trenching, ripping and ploughing of the surface or placed on the surface prior to backfilling (where topsoil will be added)

Approximately 600 mm to 1000mm spacing between lines

Ø20-50 mm pressurised (pump) irrigation.

Refer to manufacturer for drip irrigation dispersal spacing

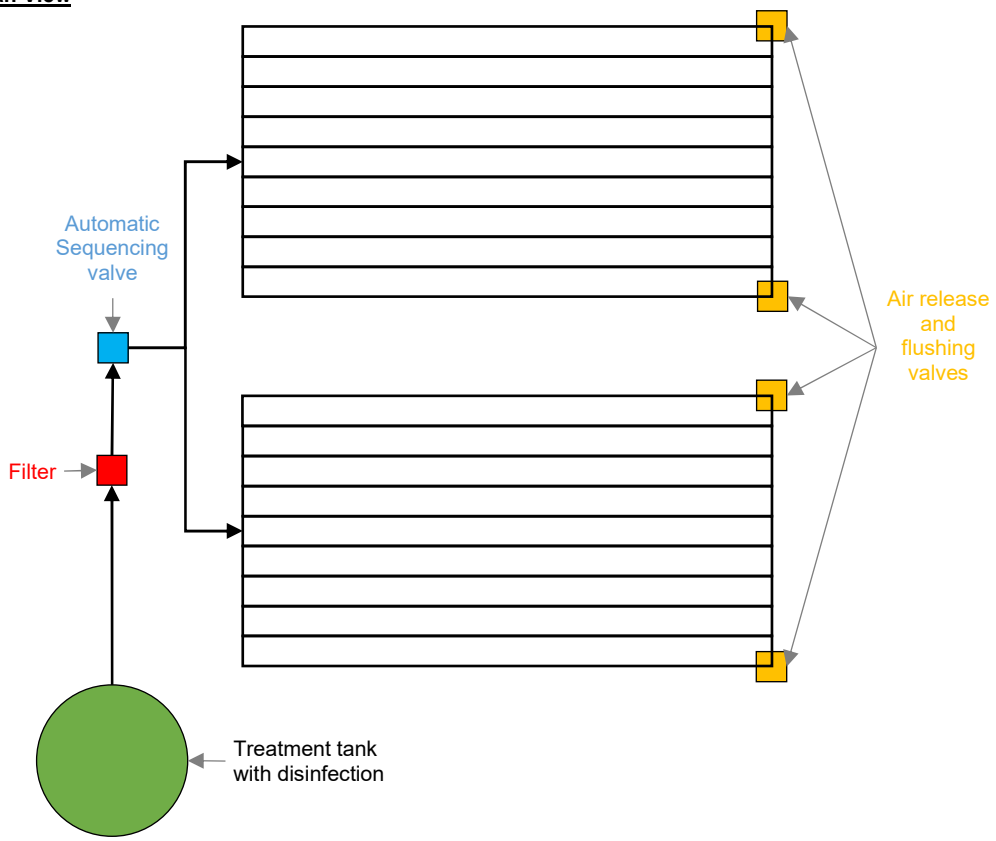
Install lines at 100-150 mm depth in topsoil



Douglas Partners Geotechnics / Environment / Groundwater	Proposed Residential Subdivision	Project: 223386.00
	64 Williams River Drive, Clarencetown NSW	DWG No: 3 Rev: 0
	Client: Mr Glen O'Connor	Date: Oct 2023

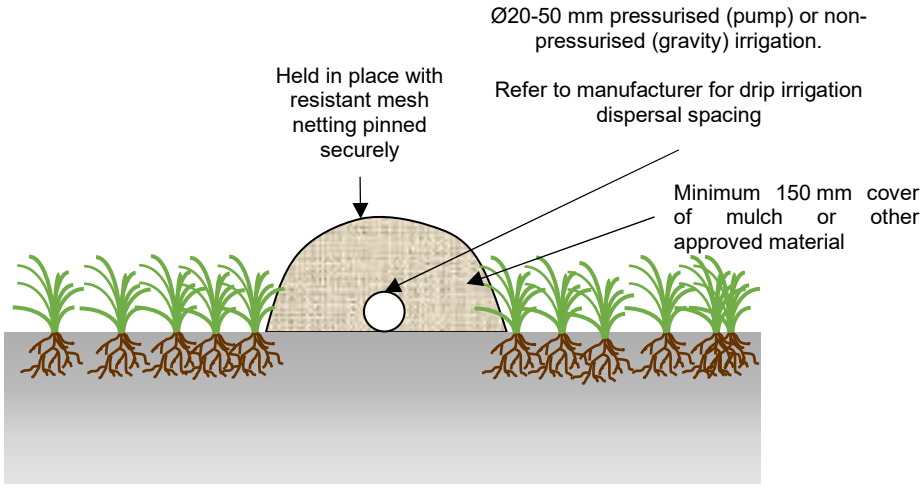
Indicative Covered Surface Drip Irrigation Arrangement

Plan View



Cross Section

Lines should be parallel to site contours and spaced at approximately 600 mm to 1000 mm.



Douglas Partners Geotechnics / Environment / Groundwater	Proposed Residential Subdivision	Project: 223386.00
	64 Williams River Drive, Clarencetown NSW	DWG No: 4 Rev: 0
	Client: Mr Glen O'Connor	Date: Oct 2023

Appendix E

Input and Output Data

Douglas Partners
Geotechnics · Environment · Groundwater

Project:	Clarencetown	Project Number:	223386
Client:	Glen O'Connor	Location:	64 Williams River Drive, Clarencetown

INPUTS

Development Details

Number of bedrooms: 4
Non-typical:
Wastewater Flow: 900 L/day

Wastestream: Combined

Water Supply: Reticulated

Application System:
- [x] Irrigation
- [ ] Evapotranspiration (ETA)
- [ ] Absorption Trench

Soil Parameters from Laboratory Testing

Description	Bore / Depth	EC	Soil Texture	pH(CaC_L)	PRI or PSC (mgP/kg)	Emerson Class	Density (kg/m^3)	CEC	ESP
sandy clay	1 / 0.1-0.3	9 uS/cm	Medium Clay	4.4	549	3a	1600	10.1	11.6
sandy clay	3 / 0.15 - 0.4	7 uS/cm	Medium Clay	6.45	596	5	1600	14.2	1.05
		mS/cm	Loam						

Controlling Soil Parameters

Sample: 1 / 0.1-0.3
PSC (kg/ha) = 8784
Limiting value of PSC: 12000

- [x] Bedrock < 1 m depth

0.6
Design Life in years: 50

Design Loading/Irrigation Rates (mm/day)

DLR (ETA) =
DIR (Irrigation) = 2
DLR (Trenches) =

DLR=Design Loading Rate DIR = Design Irrigation Rate

Site Factors

DIR reduction: Not Factored

- [ ] Include Terraced Area

Rainfall Run-off Coefficient: 0.8

Desired Effluent Quality

	N Conc	P Conc
[ ] Primary		
[x] Secondary	25	10
[x] Adv Secondary	25	5
%Phos Uptake	33	
Critical N Loading	36	
Critical P Loading	3	
Denitrification	20%	

Climate Data

Rainfall from: Clarencetown (2023)
Evaporation from: WILLIAMTOWN RAAF

Trial Areas

	$10m^2$	$1 m^2$
Trial Irrigation Area	490	
Trial ETA Area		

Irrigation Area

Effluent Treatment	Wastestream (Combined)	Nitrogen Balance Area (m^2)	Phosphorus Balance Area (m^2)	Hydraulic Balance Area (m^2)
Secondary	900 L/day	**500**	477	490
Advanced secondary	900 L/day	**500**	238	490

Douglas Partners
Geotechnics · Environment · Groundwater

Project:	Clarencetown	Project Number:	223386
Client:	Glen O'Connor	Location:	64 Williams River Drive, Clarencetown

Calculations

Rainfall Data (5th Decile) Clarencetown (2023)

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
83.8	87.9	107.1	76.7	69.8	73.2	51.6	42.2	47.3	53.2	65.4	82.6

Evaporation Data (monthly average) WILLIAMTOWN RAAF

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
213.9	186	155	114	84	77	81	112	141	174	189	223

Results of Laboratory Testing

Bore / Depth	Soil Description	Textural class	Soil pH (in CaCl)	Ece (dS/m)	PSC (kg/ha)	CEC (cmol/kg)	Sodicity (ESP)	Emerson Stability Class
1 / 0.1-0.3	sandy clay	Medium Clay	4.4	0.1	8784	10.1	11.6	3a
3 / 0.15 - 0.4	sandy clay	Medium Clay	6.45	0.05	9536	14.2	1.05	5
-	-	-	-	-	-	-	-	-

Hydraulic Balance - Irrigation for 4 Bedrooms with Reticulated water supply

Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Precipitation	mm/month	67	70	86	61	56	59	41	34	38	43	52	66	673
Effluent Irrigation	mm/month	57	51	57	55	57	55	57	57	55	57	55	57	670
Crop Factor	ratio	0.80	0.80	0.80	0.70	0.70	0.70	0.70	0.70	0.70	0.80	0.80	0.80	NA
Total Inputs	mm/month	124	122	143	116	113	114	98	91	93	99	107	123	1343
Evapotranspiration	mm/month	171	149	124	80	59	54	57	78	99	139	151	178	1339
Percolation	mm/month	62	56	62	60	62	60	62	62	60	62	60	62	730
Total Outputs	mm/month	233	205	186	140	121	114	119	140	159	201	211	240	2069
Storage	mm/month	-109	-83	-43	-23	-8	0	-20	-50	-66	-102	-104	-117	-
Cummulative Storage	mm	0	0	0	0	0	0	0	0	0	0	0	0	-

Nutrient Calculations for 4 Bedrooms with Reticulated water supply

Calculation for Nitrogen and BOD	Area =	concentration of nutrient (mg/L) x wastewater flow (L/day) x retained Nutrient after denitrification / critical loading rate for nutrient (mg/m2/day)
Calculation formula for Phosphorus	Area =	concentration of nutrient (mg/L) x wastewater flow (L/day) x 365 x design life in years / phosphorus adsorption capacity x %adsorbed + critical loading rate for nutrient x 365 x design life in years)(mg/m2/day)

Nitrogen Calculations

Area Secondary = ((25*900)*0.8)/36= 500

Area Adv Sec = ((25*900)*0.8)/36= 500

Phosphorus Calculations

Area Secondary = (10*900*365*50/(8784*33+3*365*50))= 477

Area Adv Sec = (5*900*365*50/(8784*33+3*365*50))= 238

Appendix D

Laboratory Test Results

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Newcastle Laboratory
15 Callistemon Close Warabrook Newcastle NSW 2310
Phone: (02) 4960 9600
Email: Peter.Gorseski@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

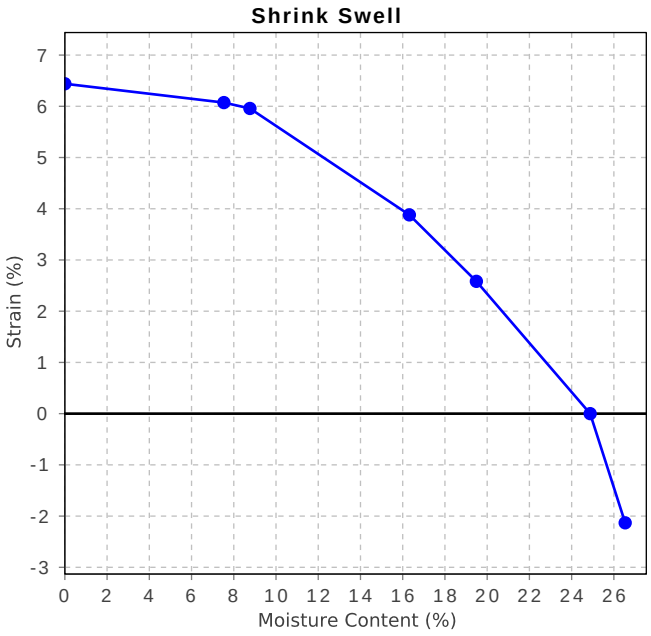
Approved Signatory: Peter Gorseski
Laboratory Manager
Laboratory Accreditation Number: 828

Report Number:	**223386.00-1**
Issue Number:	1
Date Issued:	20/09/2023
Client:	Glen O'Connor
	64 Williams River Close, Clarencetown NSW 2321
Project Number:	223386.00
Project Name:	Proposed Subdivision
Project Location:	64 Williams River Close, Clarencetown NSW
Work Request:	10608
Sample Number:	NC-10608A
Date Sampled:	05/09/2023
Dates Tested:	13/09/2023 - 19/09/2023
Sampling Method:	Sampled by Douglas Partners
	The results apply to the sample as received
Sample Location:	**BH2, Depth: 0.4 - 0.8m**
Material:	Silty Clay

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**4.2**
Visual Description	Silty Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**6.4**
Estimated % by volume of significant inert inclusions	0
Cracking	Uncracked
Crumbling	No
Moisture Content (%)	24.9

Swell Test	
Initial Pocket Penetrometer (kPa)	>600
Final Pocket Penetrometer (kPa)	260
Initial Moisture Content (%)	24.3
Final Moisture Content (%)	26.5
Swell (%)	**2.1**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Newcastle Laboratory
15 Callistemon Close Warabrook Newcastle NSW 2310
Phone: (02) 4960 9600
Email: Peter.Gorseski@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

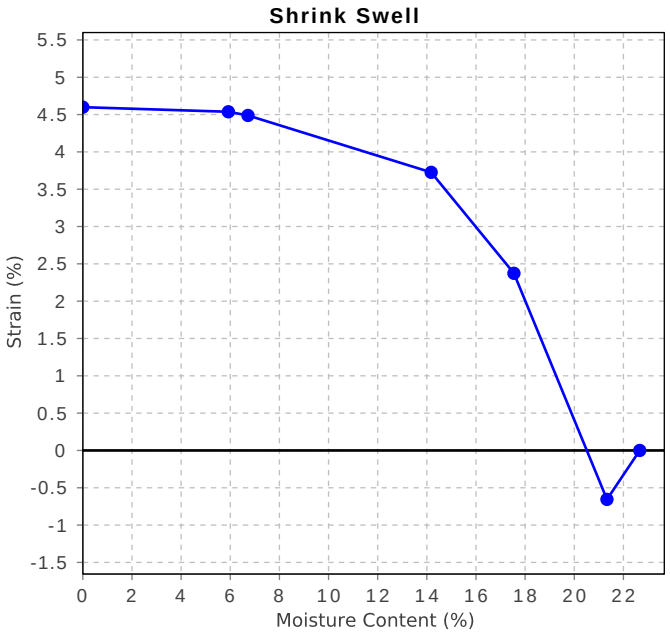
Approved Signatory: Peter Gorseski
Laboratory Manager
Laboratory Accreditation Number: 828

Report Number:	**223386.00-1**
Issue Number:	1
Date Issued:	20/09/2023
Client:	Glen O'Connor
	64 Williams River Close, Clarencetown NSW 2321
Project Number:	223386.00
Project Name:	Proposed Subdivision
Project Location:	64 Williams River Close, Clarencetown NSW
Work Request:	10608
Sample Number:	NC-10608B
Date Sampled:	05/09/2023
Dates Tested:	13/09/2023 - 19/09/2023
Sampling Method:	Sampled by Douglas Partners
	The results apply to the sample as received
Sample Location:	**BH1, Depth: 0.2 - 0.58m**
Material:	Silty Clay

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**2.7**
Visual Description	Silty Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**4.6**
Estimated % by volume of significant inert inclusions	0
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	22.7

Swell Test	
Initial Pocket Penetrometer (kPa)	430
Final Pocket Penetrometer (kPa)	220
Initial Moisture Content (%)	20.4
Final Moisture Content (%)	21.3
Swell (%)	**0.7**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



eastwest
geo ag enviro

82 Plain Street Tamworth NSW 2340
e admin@eastwestonline.com.au
t 02 6762 1733
f 02 6765 9109
abn 82 125 442 382

eastwestonline.com.au

ANALYSIS REPORT SOIL

PROJECT NO: EW231702		**Date of Issue:**	**22/09/2023**
Customer:	DOUGLAS PARTNERS PTY LTD	Report No:	1
Address:	Box 324 HUNTER REGION MAIL CENTRE NSW 2310	Date Received:	14/09/2023
		Matrix:	Soil
Attention:	Michael Gawn	Location:	Clarencetown
Phone:	02 4960 9600	Sampler ID:	Client
Fax:	02-49609601	Date of Sampling:	5/09/2023
Email:	michael.gawn@douglaspartners.com.	Sample Condition:	Acceptable

Comments:
3a = severe dispersion of the remould.

Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

Signed: Anne Michie

NATA Accredited Laboratory 15708 and 12360
Accredited for compliance with ISO/IEC 17025 - Testing

This analysis relates to the sample submitted and it is the client's responsibility to make certain the sample is representative of the matrix to be tested.

Samples will be discarded one month after the date of this report. Please advise if you wish to have your sample/s returned.

WORLD RECOGNISED ACCREDITATION

results you can rely on

ANALYSIS REPORT

PROJECT NO: EW231702 Location: Clarencetown

				CLIENT SAMPLE ID	BH1	BH3		
				DEPTH	0.1-0.3	0.15-0.4		
Test Parameter	**Method Description**	**Method Reference**	**Units**	**LOR**	**231702-1**	**231702-2**		
pH (1:5 in CaCl2)	Electrode	R&L 4B2	pH units	na	4.40	6.45		
Electrical Conductivity	Electrode	R&L 3A1	dS/m	0.01	0.09	0.07		
Phosphorus Buffer Index	UV-Vis	PMS-12	mg/kg	10	115	105		
Phosphorus (Colwell)	Bicarb/UV-Vis	R&L 9B1	mg/kg	5	<5.00	273		
Phosphorus Sorption Capacity	Calc	PMS-12	mg/kg	na	549	594		
Phosphorus Sorption Capacity	Calc	na	kg/ha	na	7690	8320		
Exchangeable Potassium	NH4Cl/ICP	R&L 15A1	mg/kg	10	216	76.6		
Exchangeable Calcium	NH4Cl/ICP	R&L 15A1	mg/kg	20	305	2522		
Exchangeable Magnesium	NH4Cl/ICP	R&L 15A1	mg/kg	10	709	143		
Exchangeable Sodium	NH4Cl/ICP	R&L 15A1	mg/kg	10	268	34.1		
Exchangeable Aluminium	KCl/ICP	R&L 15G1	mg/kg	2	82.7	<2.00		
Exchangeable Potassium	R&L 15A1	R&L 15A1	cmol/kg	na	0.55	0.20		
Exchangeable Calcium	R&L 15A1	R&L 15A1	cmol/kg	na	1.53	12.6		
Exchangeable Magnesium	R&L 15A1	R&L 15A1	cmol/kg	na	5.91	1.19		
Exchangeable Sodium	R&L 15A1	R&L 15A1	cmol/kg	na	1.17	0.15		
Exchangeable Aluminium	Calculation	R&L 15J1	cmol/kg	na	0.92	0.02		
ECEC	Calculation	PMS-15A1	cmol/kg	na	10.1	14.2		
Ca/Mg Ratio	Calculation	PMS-15A1	cmol/kg	na	0.26	10.6		
K/Mg Ratio	Calculation	PMS-15A1	cmol/kg	na	0.09	0.16		
Exchangeable Potassium %	Calculation	PMS-15A1	%	na	5.50	1.39		
Exchangeable Calcium %	Calculation	PMS-15A1	%	na	15.1	89.0		

ANALYSIS REPORT

PROJECT NO: EW231702 **Location: Clarencetown**

				CLIENT SAMPLE ID	BH1	BH3		
				DEPTH	0.1-0.3	0.15-0.4		
Test Parameter	**Method Description**	**Method Reference**	**Units**	**LOR**	**231702-1**	**231702-2**		
Exchangeable Magnesium %	Calculation	PMS-15A1	%	na	58.7	8.41		
Exchangeable Sodium %	Calculation	PMS-15A1	%	na	11.6	1.05		
Exchangeable Aluminium %	Calculation	PMS-15A1	%	na	9.12	0.16		
Emerson Aggregate Test	Class	PMS-21	Number	na	3a	5		

Soils are air dried at 40^{0}C and ground <2mm.

NB: LOR is the Lowest Obtainable Reading.

DOCUMENT END

Appendix F

Environment and Health Protection Guidelines (1998) Appendix 7: Vegetation Suitable for Land Application Areas
Environment and Health Protection Guidelines (1998) Appendix 8: Your Land Application Area

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).

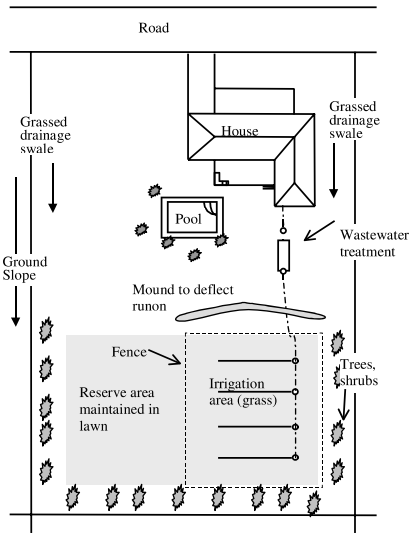
Soil absorption systems do not require highly treated effluent, and wastewater treated by a septic tank is reasonable as the solids content in the effluent has been reduced. Absorption systems release the effluent into the soil at a depth that cannot be reached by the roots of most small shrubs and grasses. 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.

Typical Site Layout (not to scale)



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:

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