Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
On-site Effluent Disposal Assessment

Proposed Dwelling
1685 Opal Miners Way, Wilcannia

Prepared for
Willoway Farming Pty Ltd

Project 224043.00
August 2023

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

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

	Signature	Date
Author		31 August 2023
Reviewer		31 August 2023

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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Report on On-site Effluent Disposal Assessment
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1. Introduction

This report presents the results of an on-site effluent disposal assessment undertaken for a proposed dwelling at 1685 Opal Miners Way, Wilcannia. The investigation was commissioned in an email dated 18 July 2023 by James Holland of Willoway Farming Pty Ltd and was undertaken with reference to Douglas Partners Pty Ltd (DP) proposal 224043.00.P.001.Rev0 dated 18 July 2023.

It is understood that the proposed development of the site includes a single storey, 4-bedroom transportable house.

The purpose of this investigation was to provide comment on:

- Identify site and soil constraints to effluent disposal; and
- The suitable sizing and indicative location of an effluent disposal system to suite the proposed development.

The effluent disposal assessment was carried out in accordance with NSW Environment & Health Protection Guidelines (NSW, 1998) and AS 1547 (2012).

The assessment included a site visit by an experienced geotechnical officer, sub-surface investigation followed by laboratory testing and engineering analysis. Details of the field work and laboratory testing are presented in this report, together with relevant engineering comments on the matters outlined above.

This assessment was for a new septic system for the proposed residence and did not include an assessment of any existing septic systems at the site. The presence and location of any existing septic system was not indicated to DP whilst onsite and assessment of the existing system was not required as part of this assessment.

This assessment was undertaken in conjunction with a Site Classification Assessment, the results of which are reported separately (DP Report 224043.00.R.001.Rev0 dated 30 August 2023).

2. Site Description and Desktop Review

Table 1 presents a description of the site together with the results of a desktop review of available information.

Table 1: Site Description and Desktop Review

Site Location	The site is identified as the area of the proposed development and effluent application area which is located within the southern half of Lot 7 DP757434, 1685 Opal Miners Way, Wilcannia. Specifically, the site is located approximately 50 m to 100 m to the south-west of the existing residence at the Mena Murtee Station, which is located to the east of Dry Lake Road and south of the intersection of Dry Lake Road and Opal Miners Way.
Site Description	At the time of the investigation the site generally comprised open pasture with unmown grass. The area of the proposed new effluent application area is understood to be located south-west of the proposed residence (refer Drawing 1 and Figures 1 and 2).
Surface levels	Reference to available topographic data (TessaDEM, 2023) indicates that surface levels range from approximately 89 m to 92 m across the investigation area. Surface gradients across the investigation area were generally less than 5%.
Geology	Reference to regional geological mapping (GSNSW, 2019) indicates that the site is underlain by the Woorinen Formation which is described as "*fossil dunefields of openly spaced, east-west linear dunes, red-brown to light brown humic, clayey to silty, fine to medium grained sand with red clay and silty clay at depth*".
Soil Landscape	Reference to the on-line soil landscape (DPIE, 2021) indicates that the site forms part of the Copago land system which is characterised by linear, parallel, east-west trending dunes on quaternary sandplain, small drainage lines and sinks and few larger swamps. Site soils are expected to contain sands, red sandy earths, calcareous red earths and solonized brown soils.
Acid Sulfate Soil Mapping	Reference to the on-line Acid Sulfate Soil Risk Map (DPIE, 2021) indicated that the site is not mapped as comprising acid sulfate soils.
Groundwater Bore Search	Reference to the publicly available groundwater monitoring bores (WaterNSW, 2021; WaterNSW, 2021) indicates that there is one groundwater monitoring bore (GW022670) within the property. GW022670 is mapped as being located approximately 200 m north-west of the proposed development and records indicated the well is used for stock purposes. The lithology recorded on the groundwater monitoring bore log indicated intermixed gravel, sand and clay with some sandstone layers to approximately 140 m depth. The location of the borehole was not confirmed during the field work, however, the approximate location is shown on Drawing 1 in Appendix C.

Table 1: Site Description and Desktop Review (continued)

Climate

No site-specific temperature, evaporation or rainfall data are available for the site. Reference to The Bureau of Meteorology indicated that the nearest weather stations recording rainfall is located at Wilcannia Aerodrome AWS. Rainfall data from the Wilcannia Aerodrome AWS weather station has been adopted for this report, as detailed below.

Rainfall Data (5th Decile) — Wilcannia Aerodrome AWS

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
26.7	28.5	30.7	20.6	19.7	28.4	18	15.2	20.6	30.3	25.3	18.8

The nearest weather station recording evaporation data is located at Broken Hill (Stephens Creek Reservoir). The evaporation data from the Broken Hill weather station has been adopted for this report, as detailed below.

Evaporation Data (daily average) — Broken Hill (Stephens Creek Reservoir)

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
12.7	11.1	8.7	5.9	3.4	2.4	2.6	3.9	5.8	7.9	9.6	11.6

Figure 1: View north-east from the approximate location of Bore 4

Figure 2: View south from the approximate location of Bore 4

3. Field Work

3.1 Methods

The field work for the investigation was undertaken on 19 July 2023 and included a walkover inspection by a senior geotechnical officer followed by the drilling of four bores (designated Bores 1 to 4). Bores 1 and 2 were drilled within the area of the proposed residence as part of DP (2023), whereas Bores 3 and 4 were drilled to the south-west of the proposed residence in the likely location for future effluent application. Bores 3 and 4 were drilled to 1.5 m depth using a truck-mounted drilling rig equipped with 100 mm diameter solid flight augers.

3.2 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. A summary of the sub-surface conditions encountered in Bores 3 and 4 are presented in Table .

Table 2: Summary of Sub-surface Profile (Bores 3 and 4)

Soil Texture (AS 1547:2012)	Depth (m below ground level)		Description
	From	To	
Clay Loam	0.0	0.05	TOPSOIL – generally red brown silty clay, with fine grained sand, low to medium plasticity, M<PL.
Light to medium Clay	0.05	Limit of investigation (1.5)	Silty CLAY – red brown with fine grained sand, trace fine sized gravel, low to medium plasticity, M<PL

Groundwater was not observed within the bores whilst they remained open. It should be noted that groundwater levels are variable and can be affected by such factors as soil permeability and recent weather conditions.

4. 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 3.

Table 3: 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
3	0.5	Silty CLAY	Light Medium Clay	8.1	0.8	5,460	22.1	2.0	4
4	1.0	Silty CLAY	Light Medium Clay	8.1	0.8	12,138	24.7	3.0	4

Notes to Table 3:

1 EC_e is the converted EC (1:5 – soil: water) as presented in Lillicrap, A, & McGhie, S. (2002).
2 PSC - Phosphorus Sorption Capacity based on PSC over a soil depth of 1m and a density of 1300kg/m^3
3 CEC – Cation Exchange Capacity
4 Exchangeable sodium percentage

For the purpose of this assessment, the PSC of 5,460 kg/ha from the sample in Bore 3 has been adopted.

The results of the laboratory testing indicate that the soil tested is generally suitable to effluent disposal. Further assessment of the soil characteristics is provided in below.

5. Comments

5.1 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 3 and Table 4. Recommended site improvement measures for moderate and major limitations are also shown in Table 3 and Table 4.

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	None	Flood levels unknown
	Minor	Vents, openings, and electrical components above 1 in 100 year flood contour	None	
Exposure	Minor	High sun and wind exposure	None	None required
Slope%	Minor	Surface Irrigation 0-6	None	None required
	Minor	Subsurface Irrigation 0-10		
	Minor	Absorption 0-10		
Landform	Minor	Hill crests, convex side slopes and plains	None	None required
Run-on and upslope seepage	Minor	None – low	None	None required
Erosion potential	Minor	No signs of erosion potential present	None	None required
Site drainage	Minor	No signs of surface dampness	None	None required
Fill	Minor	No fill	None	None required
Buffer distance	Minor	All buffer distances achievable	None	Refer to Section 5.9 (recommended buffer distanced)
Land area	Minor	Area is available	None	None required
Rocks and rock outcrops (%)	Minor	<10	None	None required
Geology/ Regolith	Minor		None	None required

Table 5: Soil Assessment Summary

Soil Features		Site Limitation		Restrictive Feature	Recommended Site Improvements
Depth to bedrock/hardpan		Minor	Irrigation >1.0	Excessive runoff	None Required
		Minor	Absorption >1.5	Resurfacing hazard	
Depth to high episodic or seasonal watertable (m)		Minor	Irrigation >1.0	None	None Required
		Minor	Absorption >1.5	None	
Soil Permeability category	Surface and subsurface irrigation	Moderate	2a and 5	Excessive run-off, waterlogging and percolation	Prepare soil by deep ripping, shallow cultivation and applying gypsum. Maintain surface vegetation
	Absorption system	Major	1, 2, 5 and 6		
Coarse fragments (%)		Minor	0 - 20	None	None Required
Bulk density (g/cm3)	Sandy Loam	Minor	<1.8	Restricts plant growth	Prepare soil by deep ripping, application of organic matter, shallow cultivation and applying gypsum.
	Loam and Clay Loam	Major	>1.6		
	Clay	Minor	<1.4		
pH CaCl		Minor	>6	None	None Required
Electrical Conductivity - ECe (dS/m)		Minor	<4	None	None Required
Sodicity (exchangeable sodium percentage)		Minor	0-5	None	None Required
Cation exchange capacity (cmol+/kg)		Minor	>15	None	None Required
Phosphorus sorption (kg P/ha)		Moderate	2000 - 6000	Unable to immobilise any excess Phosphorus	None Required
Modified Emerson Aggregate Test (dispersiveness)		Minor	Class 3 or above	None	None Required

5.2 Hydraulic Loading for Design

The hydraulic loading calculation as 720 L/day based on the following assumptions:

- The proposed residence will have a non-reticulated water supply;
- The proposed residence will have four bedrooms;
- An occupancy rate of 1.5 persons per bedroom / study / hobby room; and
- Combined waste stream volume of 120 L/person/day.

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

5.3 Effluent Treatment System

It is understood that effluent (greywater and blackwater waste streams) from the dwelling will be discharged to a new septic tank which will treat the effluent to a primary standard. NSW (1998) provides typical nutrient concentrations for primary treated effluent of 50-60 mg/L for nitrogen and 10-15 mg/L for phosphorus. For the purpose of this assessment a nitrogen concentration of 50 mg/L and a phosphorus concentration of 15 mg/L have been adopted.

5.4 Effluent Application Options

NSW Environment & Health Protection Guidelines (1998) indicates that primary treated effluent is suitable only for subsurface disposal such as traditional absorption beds/trenches, evapotranspiration (ETA) beds/trenches and low pressure effluent distribution (LPED) irrigation. The use of a pressurized system with a pumping well would be required for a LPED irrigation area.

The following sections of this report have been based on the primary effluent being discharged via gravity to a traditional absorption area or ETA beds.

5.5 Sizing of Disposal Area

The area required for effluent disposal to a traditional absorption area or ETA beds is determined by considering the hydraulic conductivity of the soil receiving the effluent. This calculation is referred to as the hydraulic balance.

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

- Rainfall data from Wilcannia Aerodrome and evaporation data from Broken Hill weather and climate station;
- Procedures outlined in NSW Environment and Health Protection Guidelines (NSW, 1998) and AS 1547 (2012);
- A design loading rate (DLR) of 8 mm/day; and
- Run-off coefficient of 25% for ETA beds.

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	Hydraulic Balance Area (m^2)
Primary Treated Effluent	Evapotranspiration (ETA) Beds	720 L/day	81
	Traditional Absorption		90

It should be noted that traditional absorption and ETA systems are designed to satisfy the hydraulic balance only. They do not satisfy the nutrient balance requirements of the NSW (1998) and therefore will be subject to council approval.

5.6 Construction

The actual length of an ETA bed or traditional absorption area can vary according to the width. Typical dimensions as tabled in AS 1547 (2012) are provided in Table 7.

Table 7: Typical Dimensions of Absorptions Area (after Table L2 of AS 1547:2012)

	Typical Dimensions (mm)	Maximum (mm)	Minimum (mm)
Width	1000 – 4000	4000	1000
Depth of Aggregate	300 – 600	600	300
Depth of Topsoil	100 – 150	150	100
Spacing between adjacent beds (sidewall to sidewall)	-	N/A	1000

Based on assessment of the site and the hydraulic balance areas provided in Table 6, the following minimum dimensions are suggested:

- ETA – Two beds of 10.25 m long by 4 m wide; and
- Absorption – Two beds of 15 m long by 3 m wide

A distribution box should be fitted to evenly distribute the effluent between the recommended beds/areas.

Where constructed, the upslope mound of ETA beds should be angled to prevent ponding of surface water on the upslope side.

As detailed in Table 4, the base of the bed should be ripped and tyned along with the application of gypsum to improve infiltration.

The application area should be constructed in accordance with recommended buffer distances detailed in Section 5.9.

5.7 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 (NSW, 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;
- 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; and
- Prevent vehicles or machinery with high ground bearing pressure that may damage the effluent disposal system from entering the application area.

5.8 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”.

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

5.9 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 8, 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 8: 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 Primary Quality Effluent
1.5 - 50 m to property boundaries	6 m from upslope and side boundaries and 12 m from downslope boundary
2.0 - >6 m to buildings/houses	6 m to upslope and side dwellings/buildings and 3 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 to domestic groundwater wells
3 - 15 m to recreational areas (e.g., children play areas, pools etc.)	3 m to upslope recreational areas and 6 m to downslope recreational areas
4 - 15 m to in-ground water tanks	4 m upslope and 15 m downslope to in-ground water tanks
3 m or 45° angle from toe of retaining walls, embankments, escarpments, and cuttings	3 m upslope or 45° angle from toe of retaining walls

5.10 Conclusion

In accordance with NSW (1998) and AS 1547 (2012), the site soils are considered suitable for the disposal of primary treated domestic effluent to ETA beds or a traditional absorption area provided that the limitations raised in this report are addressed. Primarily this includes:

- Regular maintenance of the septic tank and application area;
- Ripping and tyning of the base of the ETA beds / absorption area to improve infiltration; and
- Tyning gypsum into the soil within the base of the beds.

6. References

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

DPIE, N. (2021). *eSpade*. Retrieved from State of NSW Department of Planning, Industry and Environment.: https://www.environment.nsw.gov.au/eSpade2WebApp

GSNSW. (2019). *NSW Seamless Geology.* Geological Survey NSW Web Map Service.

NSW. (1998). *Environment & Health Protection Guidelines, On-site Sewage Management for Single Households.* January 1998: NSW Government Departments.

TessaDEM. (2023). *Wilcannia topographic map*. Retrieved from topographic-map.com: https://en-au.topographic-map.com/map-zq4s/Wilcannia/?center=-31.41738%2C143.17057&zoom=15&base=2&popup=-31.41702%2C143.17251

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7. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at 1685 Opal Miners Way, Wilcannia with reference to DP's proposal 224042.00.P.001.Rev0 dated 18 July 2023 and acceptance received from James Holland dated 18 July 2023. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Willoway Farming Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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.

Copyright

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

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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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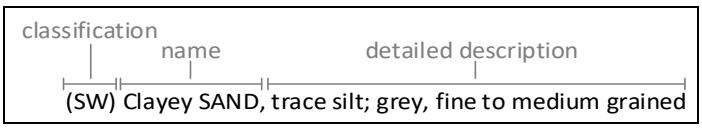
Introduction

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 it's behaviour. The detailed description presents more information about the soil's composition, condition, structure, and origin.

Classification, naming and description of soils requires 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 Fraction	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 soils 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 it's 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 symbol identifies the primary component. The second symbol 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 characterize 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 particle size with the 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	<PL
	Near plastic limit	Can be moulded	≈PL
	Wet of plastic limit	Water residue remains on hands when handling	>PL
	Near liquid limit	"oozes" when agitated	≈LL
	Wet of liquid limit	"oozes"	>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 Rock

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 rock 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	MCE
Weakly cemented	WKCE
Cemented	CE
Strongly bound	SB
Weakly bound	WB
Unbound	UB

Extremely Weathered Rock

AS1726-2017 considers weathered rock material to be soil if the unconfined compressive strength is less than 0.6 MPa (i.e. very low strength rock). These materials may be identified as “extremely weathered rock” in reports and by the abbreviation code XWR 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	RES
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	LCS
Aeolian	Carried and deposited by wind	AEO
Colluvial	Soil and rock debris transported down slopes by gravity	COL
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 sea shore	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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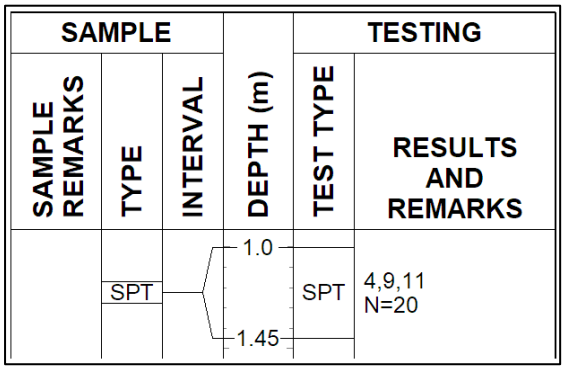
Sampling, Testing and Excavation Methodology

Terminology
Symbols
Abbreviations

November 2020

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
Acid sulfate sample	ASS
Bulk sample	B
Core sample	C
Disturbed sample	D
Sample from SPT test	SPT
Environmental sample	E
Gas sample	G
Jar sample	J
Undisturbed tube sample	U[1]
Water sample	W
Piston sample	P
Core sample for unconfined compressive strength testing	UCS

[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	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
Excavator/backhoe bucket	B[1]
Toothed bucket	TB[1]
Mud/blade bucket	MB[1]
Ripping tyne/ripper	RT
Rock breaker/hydraulic hammer	RB
Hand auger	HA[1]
NMLC series coring	NMLC
HMLC series coring	HMLC
NQ coring	NQ
HQ coring	HQ
PQ coring	PQ
Push tube	PT [1]
Rock roller	RR[1]
Solid flight auger. Suffixes: (TC) = tungsten carbide tip, (V) = v-shaped tip	SFA[1]
Sonic drilling	SON[1]
Vibrocore	VC[1]
Wash bore (unspecified bit type)	WB[1]
Existing exposure	X
Hand tools (unspecified)	HT
Predrilled	PD
Specialised bit (refer report)	SPEC[1]
Diatube	DT[1]
Hollow flight auger	HFA[1]
Vacuum excavation	VE

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

Appendix B

Borehole Logs (Bores 3 to 4)

BOREHOLE LOG

CLIENT: Willoway Farming Pty Ltd
PROJECT: Proposed Dwelling
LOCATION: 1685 Opal Miners Way, Wilcannia

SURFACE LEVEL: 89.6
COORDINATE **E:**706465.7 **N:** 6521970.6
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 3
PROJECT No: 224043.00
DATE: 19/07/23
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
19/07/23, No free groundwater observed	89	0.0 / 0.05 TOPSOIL/ (CL-CI) Silty CLAY, with sand; red brown; clay fraction low to medium plasticity; sand fraction fine		TOP	NA	<PL		D		0.0		
		(CL-CI) Silty CLAY, with sand, trace gravel; red brown; clay fraction low to medium plasticity; sand fraction fine; gravel fraction fine, sub-angular			F TO ST			SPT		0.1	SPT	1,2,3 N=5
								D		0.45 / 0.5		
				AEO		<PL						
	1				VST					1.0		
								SPT			SPT	9,11,14 N=25
										1.45		
	1.5 / 88	Borehole discontinued at 1.50m depth Limit of investigation						D		1.5		
	2 / 87									2		

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: DT100
METHOD: Solid Flight Auger V Bit to 1.5m
REMARKS: Coordinates and surface level recorded using dGPS in "fix" mode which has typical accuracy of ±0.1 m

OPERATOR: Ground Test (Hickman)
CASING: Nil

LOGGED: Ross

EXPORTED 30/08/23 09:34. TEMPLATE ID: DP_101.02.00_SOILLOG

BOREHOLE LOG

CLIENT: Willoway Farming Pty Ltd
PROJECT: Proposed Dwelling
LOCATION: 1685 Opal Miners Way, Wilcannia

SURFACE LEVEL: 89.4
COORDINATE E:706454.2 **N:** 6522023.2
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 4
PROJECT No: 224043.00
DATE: 19/07/23
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
19/07/23, No free groundwater observed	89	0.0 / 0.05 TOPSOIL/ (CL-CI) Silty CLAY, with sand; red brown; clay fraction low to medium plasticity; sand fraction fine		TOP	NA			D		0.0		
		(CL-CI) Silty CLAY, with sand, trace gravel; red brown; clay fraction low to medium plasticity; sand fraction fine; gravel fraction fine, sub-angular		AEO	F TO ST			D		0.1		
								SPT			SPT	1,1,2 N=3
										0.45		
								D		0.5		
	88	1			H			D		1.0	PP	>400
								SPT			SPT	15,18,25 N=43
										1.45		
		1.5 Borehole discontinued at 1.50m depth Limit of investigation						D		1.5		
	87	2								2		

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: DT100
METHOD: Solid Flight Auger V Bit to 1.5m
REMARKS: Coordinates and surface level recorded using dGPS in "fix" mode which has typical accuracy of ±0.1 m

OPERATOR: Ground Test (Hickman)
CASING: Nil

LOGGED: Ross

EXPORTED 30/08/23 09:34. TEMPLATE ID: DP_101.02.00_SOILLOG

Appendix C

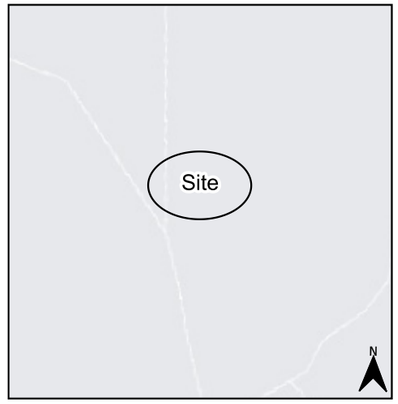
Drawing 1 – Test Location Plan

Drawing 2 – Indicative ETA Bed Layout Plan

Drawing 3 – Typical ETA Bed Arrangement

Drawing 4 – Indicative Traditional Absorption Bed Layout Plan

Drawing 5 – Typical Absorption Bed Arrangement



Site Location

Legend

Approximate Borehole Locations

Approximate Groundwater Well Location

0 10 20 30 40 50 m

NOTE:
1. Drawing adapted from aerial imagery from Google dated April 2018
2. Test locations are approximate only and were located using differential GPS typically accurate to ± 0.1 m depending on satellite coverage

Douglas Partners
Geotechnics / Environment / Groundwater

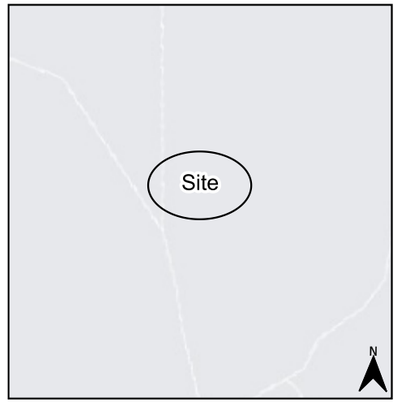
CLIENT: Willoway Farming Pty Ltd		
OFFICE: Port Macquarie	DRAWN BY: JRC	
SCALE: 1:2000 @A3	DATE: 22.August.2023	

TITLE: **Test Location Plan**
Proposed Dwelling
1685 Opal Miners Way, Wllcannia

N

Project:	224043.00
DRAWING No:	1
REVISION:	0

DP.QGIS.A3LandscapeDrawingLayout.3.26.3 - P:\224043.00 - WILCANNIA, 1685 Opal Miners Way, GEO\7.0 Drawings\7.2 Out\224043.00.D.Master.qgz



Site Location

Legend

Approximate Borehole Locations

Approximate Minimum Effluent Application Area

ETA Bed (100 m²)

Possible Reserve Application Area

0 10 20 30 40 50 m

NOTE:
1. Drawing adapted from aerial imagery from Google dated April 2018
2. Test locations are approximate only and were located using differential GPS typically accurate to ± 0.1 m depending on satellite coverage

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Willoway Farming Pty Ltd		
OFFICE: Port Macquarie	DRAWN BY: JRC	
SCALE: 1:500 @A3	DATE: 22.August.2023	

TITLE: **Indicative ETA Bed Layout Plan**
Proposed Dwelling
1685 Opal Miners Way, Wllcannia

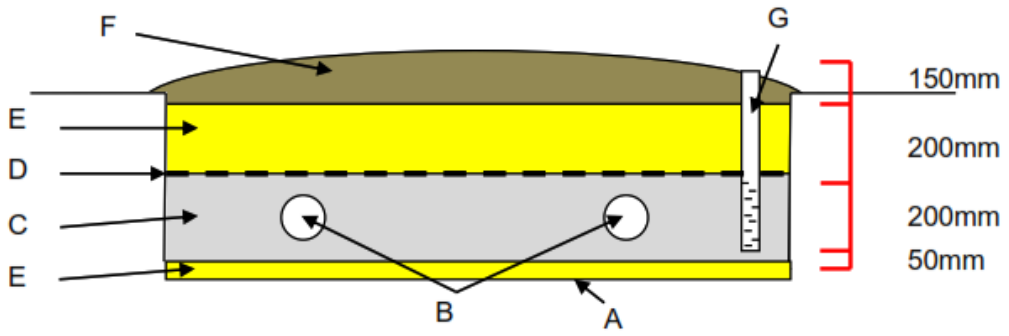
N

Project:	224043.00
DRAWING No:	2
REVISION:	0

DP.QGIS.A3LandscapeDrawingLayout.3.26.3 - P:\224043.00 - WILCANNIA, 1685 Opal Miners Way, GEO\7.0 Drawings\7.2 Out\224043.00.D.Master.qgz

Indicative ETA Bed Arrangement

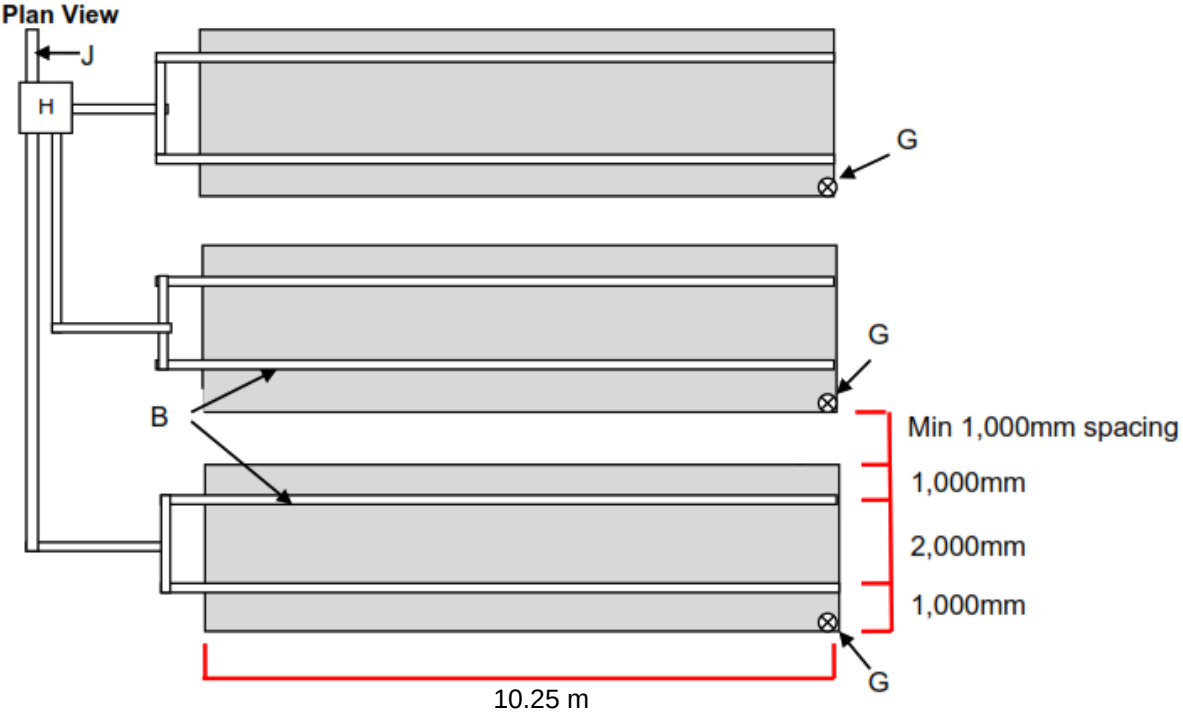
Cross Section



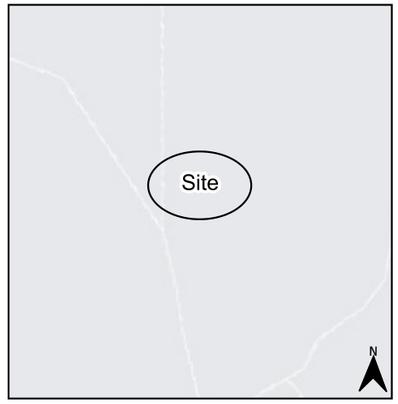
Notes:

A – Base of the bed must be level to ensure even distribution
B – 90-100 mm slotted PVC
C – 20-40 mm distribution aggregate
D – Geotextile
E – Fine Sand (0.5-1 mm)
F – Topsoil, slightly mounded
G – Inspection port on downhill side of bed (50 mm PVC pipe, perforated in aggregate)
H – Splitter box or automatic sequencing valve, to distribute effluent evenly between multiple pipes
J – Feed from tank

Plan View



Douglas Partners Geotechnics / Environment / Groundwater	Proposed Dwelling	Project: 224043.00
	1685 Opal Miners Way, WIlcannia	DWG No: 3 Rev: 0
	Client: Willoway Farming Pty Ltd	Date: August 2023



Site Location

Legend

Approximate Borehole Locations

Approximate Minimum Effluent Application Area

Absorption Trenches (90 m²)

Possible Reserve Application Area

0 10 20 30 40 50 m

NOTE:
1. Drawing adapted from aerial imagery from Google dated April 2018
2. Test locations are approximate only and were located using differential GPS typically accurate to ± 0.1 m depending on satellite coverage

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Willoway Farming Pty Ltd	
OFFICE:	Port Macquarie	DRAWN BY: JRC
SCALE: 1:500 @A3		DATE: 22.August.2023

TITLE: **Indicative Absorption Trenches Layout Plan**
Proposed Dwelling
1685 Opal Miners Way, Wllcannia

N

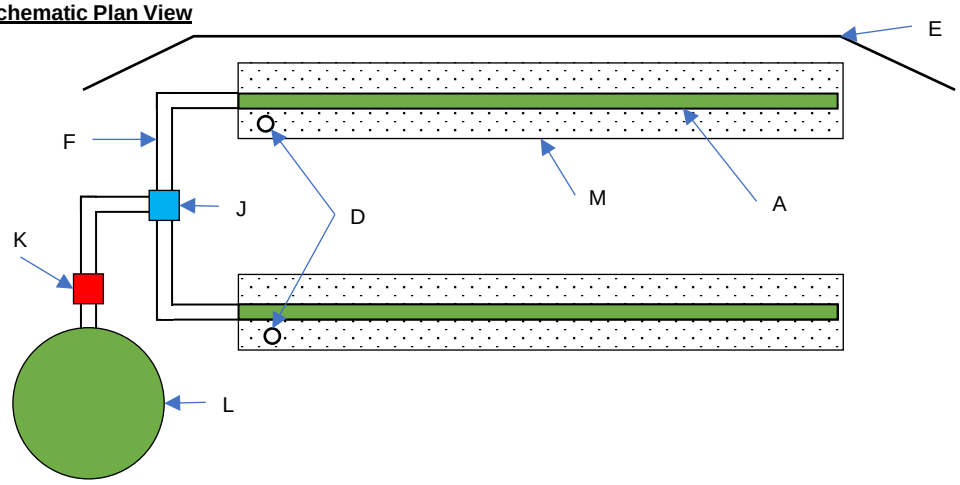
Project:	224043.00
DRAWING No:	4
REVISION:	0

DP.QGIS.A3LandscapeDrawingLayout.3.26.3 - P:\224043.00 - WILCANNIA, 1685 Opal Miners Way, GEO\7.0 Drawings\7.2 Out\224043.00.D.Master.qgz

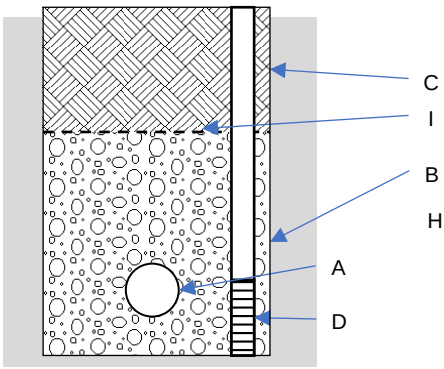
7 - Su

Indicative Absorption Bed Arrangement

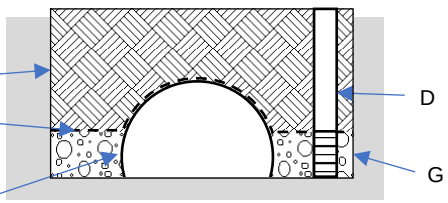
Schematic Plan View



Cross Section: Piped Trench



Cross Section: Arch



Key:

A	90 – 100 mm slotted PVC pipe
B	20 – 40 mm aggregate (minimum 100 mm thick)
C	Clean local or imported topsoil (sandy loam to clay loam) 150 – 200 mm thick
D	
E	Upslope stormwater diversion drain
F	90 – 100 mm PVC gravity dosing pipe
G	20 – 40 mm aggregate (300 – 400 mm thick)
H	Self-supporting arch (230 mm minimum height)
I	Geotextile filter cloth
J	Gravity splitter box / automatic sequencing valve
K	Filter
L	Treatment tank with disinfection
M	Trench

Notes:

1) Base of the trench must be level.
2) Allowance should be made for settlement of backfill.
3) Grass must be established across the area as soon as possible. Trench / bed surface must be slightly mounded.
4) Inspection port should be made of 50 mm PVC pipe with perforations in the aggregate level of trench.

Douglas Partners Geotechnics / Environment / Groundwater	Proposed Dwelling	Project: 224043.00
	1645 Opal Miners Way, WIlcannia	DWG No: 5 Rev: 0
	Client: Willoway Farming Pty Ltd	Date: August 2023

Appendix D

Laboratory Test Results

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: EW231461		**Date of Issue:**	**10/08/2023**
Customer:	DOUGLAS PARTNERS PTY LTD	Report No:	1
Address:	Box 324 HUNTER REGION MAIL CENTRE NSW 2310	Date Received:	3/08/2023
		Matrix:	Soil
Attention:	Joel Cowan	Location:	224043.00 WILCANNIA
Phone:	0408615349	Sampler ID:	Client
Fax:	02-49609601	Date of Sampling:	19/07/2023
Email:	joel.cowan@douglaspartners.com.au	Sample Condition:	Acceptable

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

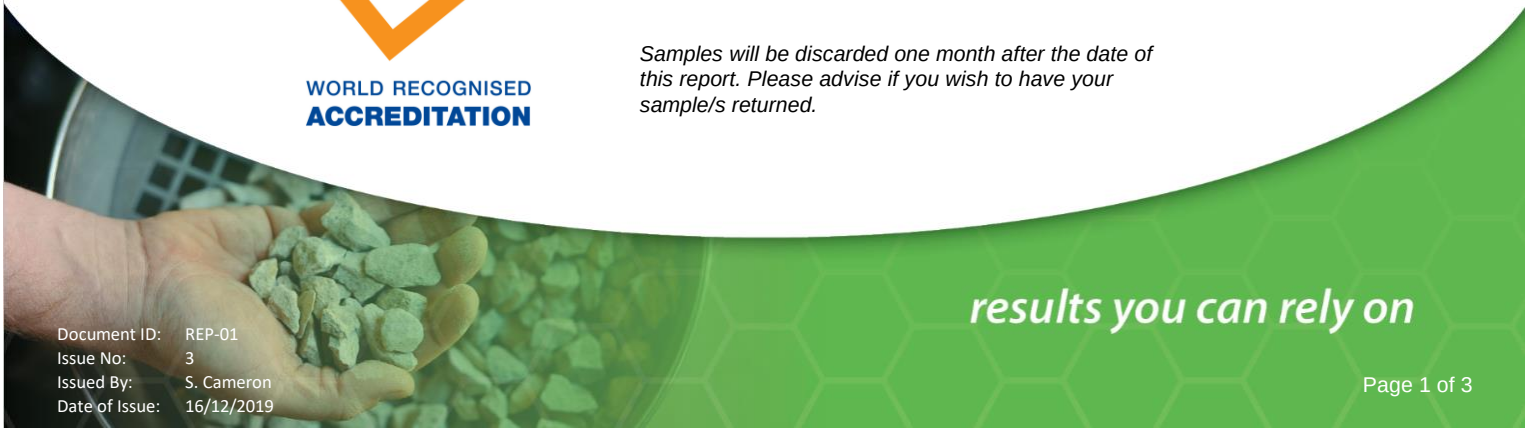
Signed: Anne Michie

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



ANALYSIS REPORT

PROJECT NO: EW231461 Location: 224043.00 WILCANNIA

				CLIENT SAMPLE ID	3	4		
				DEPTH	0.5m	1.0m		
Test Parameter	**Method Description**	**Method Reference**	**Units**	**LOR**	**231461-1**	**231461-2**		
pH (1:5 in CaCl2)	Electrode	R&L 4B2	pH units	na	8.11	8.05		
Electrical Conductivity	Electrode	R&L 3A1	dS/m	0.01	0.12	0.12		
Phosphorus Buffer Index	UV-Vis	PMS-12	mg/kg	10	69.0	273		
Phosphorus (Colwell)	Bicarb/UV-Vis	R&L 9B1	mg/kg	5	38.7	34.9		
Phosphorus Sorption Capacity	Calc	PMS-12	mg/kg	na	390	867		
Phosphorus Sorption Capacity	Calc	na	kg/ha	na	5450	12100		
Exchangeable Potassium	NH4Cl/ICP	R&L 15A1	mg/kg	10	428	188		
Exchangeable Calcium	NH4Cl/ICP	R&L 15A1	mg/kg	20	3849	4286		
Exchangeable Magnesium	NH4Cl/ICP	R&L 15A1	mg/kg	10	157	248		
Exchangeable Sodium	NH4Cl/ICP	R&L 15A1	mg/kg	10	102	168		
Exchangeable Aluminium	KCl/ICP	R&L 15G1	mg/kg	2	<2.00	<2.00		
Exchangeable Potassium	R&L 15A1	R&L 15A1	cmol/kg	na	1.10	0.48		
Exchangeable Calcium	R&L 15A1	R&L 15A1	cmol/kg	na	19.2	21.4		
Exchangeable Magnesium	R&L 15A1	R&L 15A1	cmol/kg	na	1.31	2.07		
Exchangeable Sodium	R&L 15A1	R&L 15A1	cmol/kg	na	0.44	0.73		
Exchangeable Aluminium	Calculation	R&L 15J1	cmol/kg	na	0.02	0.02		
ECEC	Calculation	PMS-15A1	cmol/kg	na	22.1	24.7		
Ca/Mg Ratio	Calculation	PMS-15A1	cmol/kg	na	14.7	10.4		
K/Mg Ratio	Calculation	PMS-15A1	cmol/kg	na	0.84	0.23		
Exchangeable Potassium %	Calculation	PMS-15A1	%	na	4.96	1.95		
Exchangeable Calcium %	Calculation	PMS-15A1	%	na	87.0	86.7		

ANALYSIS REPORT

PROJECT NO: EW231461 **Location: 224043.00 WILCANNIA**

				CLIENT SAMPLE ID	3	4		
				DEPTH	0.5m	1.0m		
Test Parameter	**Method Description**	**Method Reference**	**Units**	**LOR**	**231461-1**	**231461-2**		
Exchangeable Magnesium %	Calculation	PMS-15A1	%	na	5.92	8.36		
Exchangeable Sodium %	Calculation	PMS-15A1	%	na	2.01	2.95		
Exchangeable Aluminium %	Calculation	PMS-15A1	%	na	0.10	0.09		
Emerson Aggregate Test	Class	PMS-21	Number	na	4	4		

This Analysis Report shall not be reproduced except in full without the written approval of the laboratory.

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

NB: LOR is the Lowest Obtainable Reading.

DOCUMENT END

Appendix E

NSW (1998)
Appendix 7: Vegetation Suitable for Land Application Areas

NSW (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).

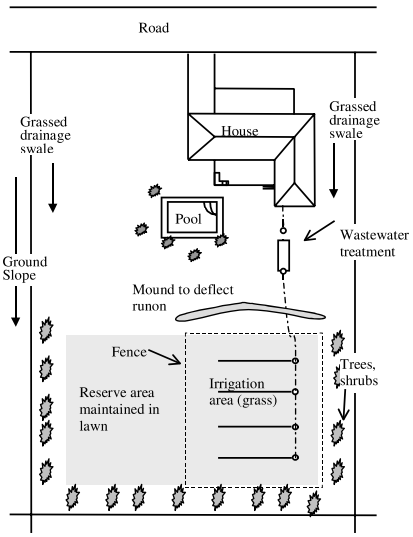
Soil absorption systems do not require highly treated effluent, and wastewater treated by a septic tank is reasonable as the solids content in the effluent has been reduced. Absorption systems release the effluent into the soil at a depth that cannot be reached by the roots of most small shrubs and grasses.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