ATTACHMENT 2 – LAND CAPABILITY ASSESSMENT

McMahon
EARTH SCIENCE

LAND CAPABILITY ASSESSMENT
2368 WEST ROAD & LOTS 102 & 104 BOORGA ROAD
NERICON NSW 2680

January 2015

Project brief
At the request of Andrew Ryan of ARB Farming P/L a land capability assessment was carried out to assess the site for a proposed residential development in January 2015. The document provides information about the site conditions from desktop assessment, field observations and laboratory analysis.

Site identification
Address: 2368 West Road and Lots 102 & 104 Boorga Road, Nericon NSW 2680
Real property description: Lots 309 & 610 DP751743 & Lots 102 & 104 DL1018460
Centre co-ordinate: 410885 6214050 MGA GDA z55
Property size: 181ha approximately
Owner: c/o ARB Farming P/L
Local Council Area: Griffith
Present use: Farming block
Development Application Reference: not known

Certification

Name	Signed	Date	Revision Number
David McMahon BAppSc GradDip WRM	[signature]	11/03/15	1

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Physical characteristics of the site
A desktop review and investigation of the topography, hydrology, soil, lithology, geology and hydrogeology of the site has been undertaken and are as follows:

Topography
The Nericon 1:25,000 Topographic Map (Sheet 8129-4-S) indicates that the site is located at an approximate elevation range of 110 to 122 AHD. The site landform is very low gently undulating rises and the slope class is gently to very gently inclined.

Vegetation
The site is mostly completely cleared farmland.

Hydrology
The site is adjacent to Lake Wyangan which is a recreational man-made water body that was inundated in the 1950s. Prior to being a lake the area was gypsum mine and swap area (Australian Explorer 2015). The lake is a closed drainage basin receiving run-off from surrounding agricultural land and water is pumped out of south Lake Wyangan into a Murrumbidgee Irrigation drainage channel to maintain a constant height. Lake Wyangan is classified as a 'highly disturbed system' by reference to ANZECC 2000 and is prone to algal blooms in the warmer months. The nearest natural named waterway is the Mirrool Creek 15km to the south west of the site. There are also numerous irrigation supply canals, drainages and tile drains in the locale. Due to the relative incline and soils of the site, rainfall is likely to infiltrate into the relatively permeable topsoil with minimal run off. The site currently has two irrigation water entitlements one being 76 Megalitres (ML) of high security and the other 200ML of general security.

Weather
The average rainfall is approximately 401.6 mm per annum, with the wettest months being March, August and October. Mean daily evaporation ranges from 1.4mm in June to 8.7mm in January. Griffith is characterised by cool wet winters and hot dry summers with mean maximum temperatures ranging from 14.5 °C in July to 33.0 °C in January and mean minimum temperatures ranging from 3.5 °C in July to 17.4 °C in February. Rainfall and temperature data from Griffith Airport AWS 075041, 3.6km away and evaporation data from Griffith CSIRO 075028, 11km away (www.bom.gov.au).

Soil & Landform
The site lies within the soil mapping unit coded as Mx4 from the Digital Atlas of Australian Soil (BRS, 1991). The map unit key Mx4 is described as:

"Undulating plains with low and very low dune forms, kunkar, and areas of large melon-hole depressions; buried soil layers occur: chief soils are alkaline and neutral red earths (Gn2.13 and Gn2.12) with brown calcareous earths (Gc1.12 and Gc1.2). Associated are brown sands (Uc5.1) on dunes; and (Dr2.33) soils in small flats. Other soils are likely. As mapped, minor areas of unit My6 are included. Data are limited. Occurs on sheet(s): 3"

Soil maps of the Mirrool Irrigation Area have been sourced and the mapped area does not cover the investigated site. However the soils investigated can be broadly classified as Lake View Loam by reference to Taylor and Hooper, 1979. The Lake View Loam soil description is as follows.

Lake View Loam
Fringing the Wyangan loam at Lakeview, particularly on the west side of the section, is a narrow strip of non-stony red loam soil with a light profile. The deep subsoil is

sandy, and it contains carbonates to only a minor degree. The type is not extensive, but has the advantage over adjacent soils in that it is almost invariably suited to citrus growing. The profile, without significant depths, is as follows:

Red to red-brown loam, with coarse sand grains
Light red-brown clay loam or loam to clay loam
Light brown or light red-brown clay loam to sandy clay loam
Light brown loam to clay loam weakly cemented and with light soft carbonates
Subplastic SP(III)

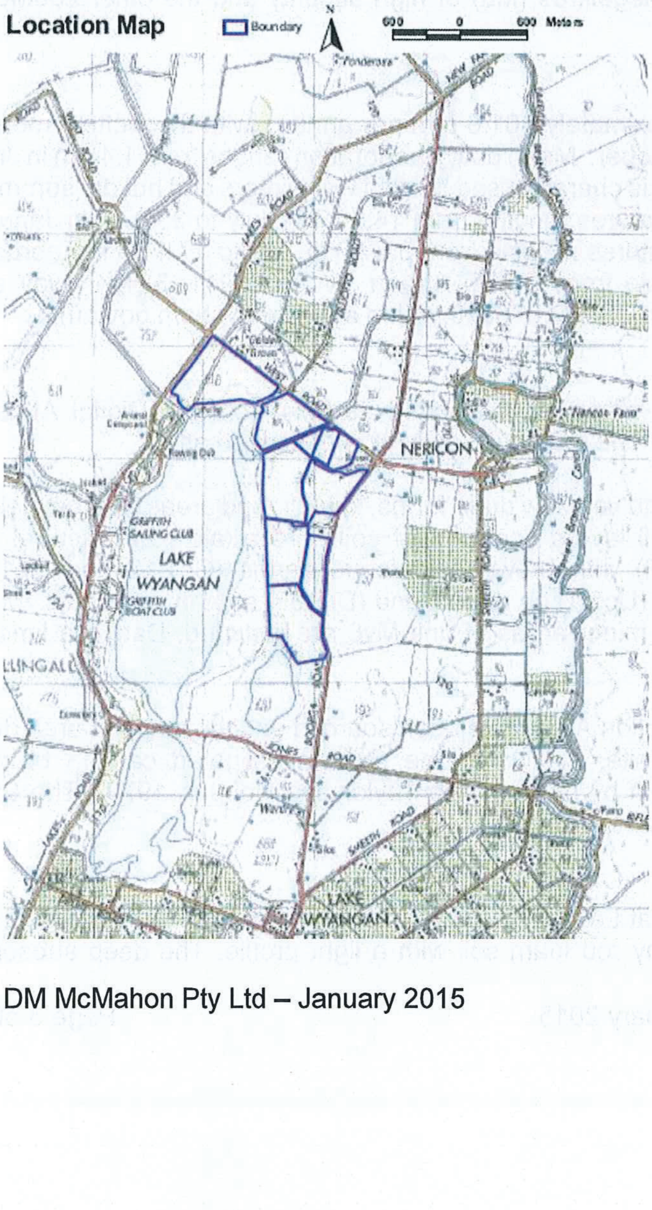
Light brown sandy clay loam, light soft and hard carbonates. The profile is allied to the less calcareous phase of Tharbogang loam. The surface soil may be deep and when wet has a gritty and sticky feel.

Lithology and Geology
The site geology is distributed over one unit: Sedimentary Rocks. Lithology is distributed over one unit being Cainozoic residual and aeolian sands.

Hydrogeology
From the Geoscience Australia hydrogeology dataset the groundwater beneath the site is described as fractured or fissured extensive aquifers of low to moderate productivity. A more detailed assessment is provided later in this document.

As follows is a map showing the location of the property in relation to the surrounding area.

Location Map



Introduction

This document provides an overview of the land capability and proposed wastewater management for a proposed 181 hectare subdivision to the North and East of Lake Wyangan in Griffith. The site is zoned R5 – Large Lot Residential and has a minimum lot size of 5ha by reference to the Griffith Local Environment Plan (LEP) 2014. This report assesses the suitability of utilising individual Aerated Wastewater Treatment Systems (AWTS) as part of the development as opposed to connecting to a pressured municipal sewerage system. The assessment will determine the suitability of the site and soil for individual AWTS' based on a lot size of 5 hectares or less and discussion on suitable buffer distances from Lake Wyangan. This report presents the results of the investigations and provides recommendations for sustainable management at the site.

Scope of Work

The assessment was carried out to:

- Undertake soil survey to:
  - confirm the suitability of the site for the planned development using AWTS;
  - assess the physical characteristics of the soil and landform; and
  - identify any 'moderate' soil limitations that will require special management practices by reference to DEC 2004.
- Conduct in-house soil analysis for pH, Electrical Conductivity (EC) and Emerson Aggregate Class Number;
- Utilise comprehensive nutrient analysis undertaken in 2014 from YARA Laboratories; and
- Conduct in-situ permeability testing using a well permeameter by reference to AS1547:2012 and McKenzie et al., (2002).

Report

- Interpret results of all site, soil and chemical investigations to determine suitability for the implementation of the planned wastewater treatment and irrigation system;
- Use previous studies carried out by EA Systems Pty Limited as reference for site suitability report, in regard to the site's hydrological/hydrogeological characteristics;
- Use information supplied by Griffith City Council and Murrumbidgee Irrigation regarding the locale's soil and hydrogeological characteristics as reference for the site suitability report;
- Predict the likely quality and quantity and wastewater generated at the site;
- Undertake hydraulic and nutrient balance modelling to assess the minimum effluent land application area requirements; and
- Prepare written report discussing results and recommendations for the wastewater treatment and irrigation system.

Proposed Wastewater Treatment and Irrigation System

The proposed development is planning to use individual AWTS for each single residential lot to manage domestic wastewater. Guidance as to the sizing of the AWTS irrigation areas is provided by reference to Standards Australia AS/NZS 1547-2012 On-site Domestic Wastewater Management. Greywater management guidelines are provided in Greywater Reuse in Sewered Single Domestic Premises, NSW Health 2000. The NSW Health guidelines usually apply for larger sites but in the case of single residential sites they are still relevant regarding public safety.

The AWTS and irrigation management must be done in such a way as to provide long term sustainable management of hydraulic and nutrient loads. The AWTS has been preferred over other options as it provides the highest level of onsite treatment with practical and sustainable reuse of the treated wastewater by irrigation. AWTS' are regularly serviced and inspected as part of ongoing maintenance so the reliability of this system is superior to other onsite options. Owing to the comparatively large lot sizes of the development the irrigation area is not constrained in that respect.

An overview of the proposed onsite wastewater management system is as follows:

- Installation of AWTS in all single residential lot;
- The AWTS will have the hydraulic loading capacity of around 1500L/day or 10 Equivalent Persons (EP);
- The AWTS will have a secondary quality effluent of:
  - BOD equal to or less than 10mg/L.
  - Suspended Solids equal to or less than 10mg/L.
  - Thermotolerant Coliforms less than 10cfu/100ml.
- The AWTS be Accredited by NSW Health in accordance with the Sewage Management Facility Accreditation Guidelines May 2005;
- Irrigation of treated effluent at each lot by low pressure surface spray/drip or subsurface drip;
- Adequate buffer zones from irrigated areas to the Lake Wyangan high water mark be stipulated; and
- At least annual maintenance of AWTS.

Greywater is to be irrigated on a scheduled basis as determined by the type of plants, seasonal conditions and wastewater availability. If greywater is stored for any significant length of time microbial water quality declines which can give rise to offensive odours and cause micro-organisms to reproduce rapidly. Therefore the AWTS wastewater must be irrigated on a regular basis and the use of surge tanks is only recommended for short periods of time. The minimum irrigation areas have been calculated to have a zero storage factor.

Greywater quality and quantity

Although the AWTS wastewater quality is very good it is important that all residents are aware of activities and substances that can impede the treatment process. A treatment system that is under lower load will use less electricity to run the AWTS, have an improved performance, will have a lower pollutant and hydraulic load and will have increased irrigation water quality. It is recommended that new residents are informed of the suggested greywater enhancement as follows:

- Minimise the amount of water entering the AWTS. Simple water saving measures and fittings in households can easily achieve this;
- Reduce the amount of sodium entering the wastewater. Recommend use low sodium detergents or use liquid detergents;
- Reduce nutrients in greywater by using low phosphorous detergents and by reducing the quantities of chemicals and foods entering the waste systems;
- Minimise the amount of organic waste, oils and fats entering the system. Sink mounted garbage disposal units should be discouraged;
- Cleaning compounds such as bleach and disinfectants should not be disposed of down the sink in any other than in normal diluted cleaning water;
- Medicines, drugs, cosmetics, pharmaceuticals should not be disposed of down the sink or toilet; and
- Avoid placing chemicals such as fuel, pesticides, acids, herbicides or other agents in the wastewater treatment system.

The proposed effluent quality from the AWTS is superior to than the target effluent quality outlined in the following table which is derived by reference to relevant guidelines (e.g. AS/NZS 1547:2012; DLG (1998); NSW EPA (2004); ARMCANZ & ANZECC (2000)).

Treated wastewater quality target values

Parameter	Target Value
pH	6.5 – 8.5
Biochemical Oxygen Demand (BOD5)	< 20 mg/L
Suspended solids	< 30 mg/L
Total Nitrogen	< 20 mg/L
Phosphorus	< 10 mg/L
Total dissolved solids (salinity)	< 1,000 mg/L
Thermotolerant coliforms	< 10,000 cfu/100 mL
Pathogen contamination	negligible
Odour	negligible

The volume of wastewater generated is calculated by reference to AS1457:2012 and is shown in the following table.

Typical wastewater design flows

Residential Properties	Typical Wastewater design flows (L/person/day)	
	On-site roof water tank supply	Reticulated water supply
No water savings devices	120	150
Complying BASIX Certificate	115	140
Full water reduction fittings and fixtures as per AS1527	80	110

Griffith City Council adhere to the BASIX (Building Sustainability Index) to ensure equitable and effective water and greenhouse gas reductions. Therefore all houses in the Griffith area must be BASIX compliant at a minimum and further water reduction features can be undertaken if householders wish.

Therefore the wastewater generated at each residential lot will be based on the sites have a reticulated water supply with BASIX water reduction features with a typical design flow of 140 Litres per person per day.

As the design flow per person has been determined the amount of people per dwelling will be calculated to give an overall flow volume. As follows is a typical households total flow rate based on a flow design of 140L/day per person per day. By reference to AS1527:2012 the total flow rate is based on the Equivalent Persons (EP) in the household based on the number of bedrooms and living areas. Each household will have different configurations of bedrooms, living areas, studies and rumpus rooms but the table below acts as a general guide for typical family homes.

Typical household flow rates

Household Bedrooms	Household Living areas	EP	Total Household flow rate L/day
3	2	5	700
4	2	6	840
5	2	7	980

Irrigation of treated wastewater

The development is appropriate for irrigation of treated wastewater owing to the suitable soils, Griffith's relatively low rainfall and the sustainability of the AWTS for this development. Across the site there were no soils or landforms that were unsuitable for irrigation or had high limitations in regard to waste water reuse.

By reference to table MI of AS1547:2012 the site is broken into two main soil categories for Design Irrigation Rates (DIR) based on indicative permeability being Loams and Clay Loams and can be seen in tabular format as follows.

Soil Categories and Design Irrigation Rate

Soil texture	Indicative permeability mm/day	Design Irrigation Rate (DIR) mm/day	
		Drip Irrigation	Spray Irrigation
Loams	0.5 – 3.0	4	4
Clay Loams	0.06 – 1.5	3.5	3.5

It is noted that if drip irrigation is to be installed for Sandy Loams it should be to a depth of 100-150mm below ground level in good quality topsoil, whilst for Loams and Clay Loams a depth of 150-250mm is recommended in good quality in situ or imported topsoil to slow soakage and assist with nutrient reduction.

AS1547:2012 offers a calculation for minimum irrigation area based on flow rate and the DIR which is as follows:

A = Qw/DIRw

Where:

A = Irrigation area in m^2

Qw = Design weekly flow in litres

DIRw = Design Irrigation Rate (DIR) in mm/week

Minimum irrigation area from AS1547:2012

Flow rate L/day	Irrigation rate mm/day	
	3.5	4
	Required minimum irrigation area m^2	
700	200	175
840	240	210
980	280	245

The AS1547:2012 calculations do not take into account the climatic conditions and a zero storage factor therefore a water balance calculation should be used in addition to the AS1547:2012 method for comparison.

A water balance has been undertaken to determine the total irrigation area requirements per residential lot based on the hydraulic load, average rainfall, evaporation, run-off and zero storage factor. The calculations are based on the houses having a reticulated town water supply, 100% occupancy and BASIX water reduction features. The following table shows the required minimum irrigation area for the two soil categories with the three flow rates for a three, four and five bedroom house. In the water balance, to gauge irrigation requirements, Evapotranspiration (ET_o) has been calculated by multiplying evaporation by a crop of 0.6 to 0.8 which is seasonally adjusted and a conservative value. Year round active turf and perennial grasses have a crop factor of 0.95 and 1.05 respectively which are year round figures so the 0.6 to 0.8 crop factor used is very conservative, Allen at al 1998.

Minimum irrigation area from water balance

Flow rate L/day	Irrigation rate mm/day	
	3.5	4
	Required minimum irrigation area m^2	
700	217	188
840	261	226
980	304	263

The water balance calculations can be seen in the appendix.

A nutrient balance was also calculated to determine the minimum irrigation area for nitrogen disposal which has been given a design wastewater of strength 10mg/L and the nitrogen uptake factor of 220kg/ha/annum. The nitrogen uptake factor is for pasture and is viewed as being at the lower end of the scale. Irrigated grasses can uptake up to 400kg/ha/annum, Reuter & Robinson 1997

Minimum irrigation area from Nutrient Balance

Flow rate L/day	Required minimum irrigation area m^2
700	93
840	111
980	130

From the above calculations it can be seen that the minimum irrigation areas for the nutrient loads are negligible when compared to the water balance and AS1547:2012. The AS1547:2012 calculation for minimum irrigation area based on hydraulic load is lower than the water balance method owing to the AS1547:2012 method not incorporating climatic conditions and a zero storage factor into the equation. It is therefore recommend that the water balance minimum irrigation area calculations be used as opposed to the AS1547:2012 method as it gives a more reliable output.

Site Assessment

A detailed soil investigation was carried out to:

- confirm the suitability of the proposed irrigation site;
- identify any 'moderate' soil limitations that will require special management practices by reference to AS1547:2012 and DEC 2004; and
- identify the minimum irrigation area for each residential lot.

A hybrid survey technique was used incorporating the EM-31 data, desktop and landform assessment. The hybrid survey used quantitative methods from the EM-31 and elevation survey data as well as using the soil surveyor's expert judgement and experience from previous studies undertaken in the locale. The results of the land evaluation are analysed, synthesised and summarised as follows bearing in mind that:

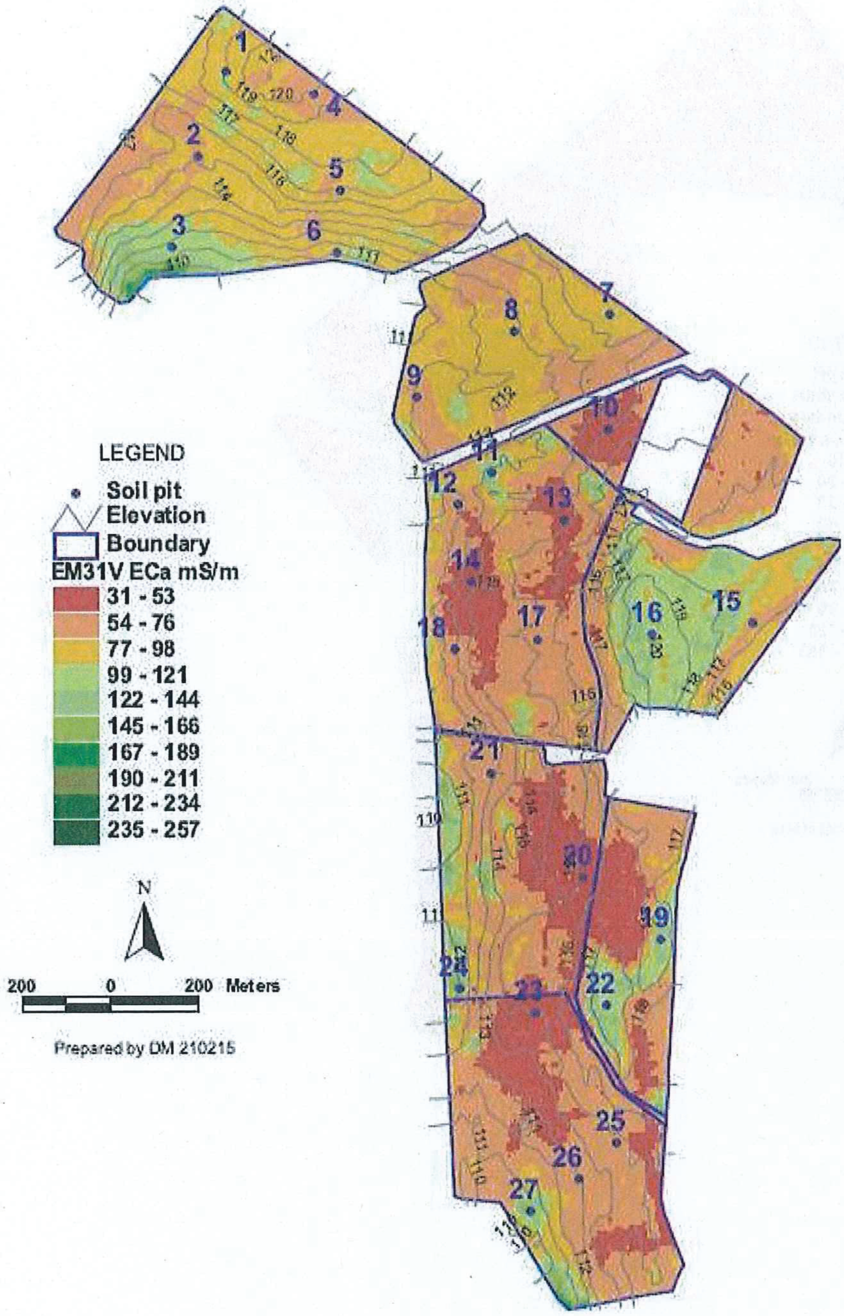
- In a special or project-oriented survey the effort must be concentrated on the particular land qualities and interpretations considered relevant for the intended use;
- Due to narrowly defined objectives, the survey was selective in data collection and presentation and this report is therefore closely tailored to the land's intended single use and cannot serve equally well for other purposes; and
- Because of a sampling methodology and regime, only conclusions can be drawn for the intended end use of the land at that time.

By reference to the 'Guidelines for Surveying Soil & Land Resources' McKenzie et al 2008, a detailed soil and land resource survey was carried out. Detailed surveys have an inspection density of 1 point per 5 to 25ha and the objectives are for 'moderately intensive uses at field level and detailed project planning'. The survey had 27 investigation points for the 181 hectares which gives a physical sampling density of 1 point per 6.7 hectares which is at the intensive end of the density range.

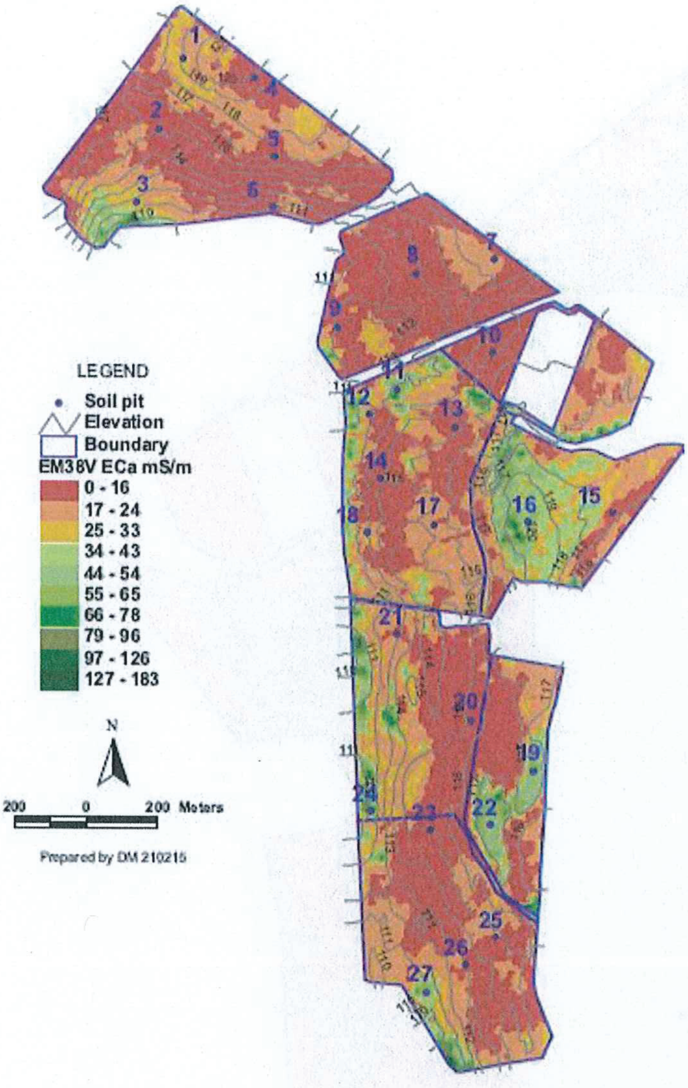
The field assessment included investigation with a backhoe to 1.8 metres depth where the soil profile and basic chemical characteristics were assessed as well as undertaking in-situ permeability which will be the definitive guide to sizing the AWTS disposal areas. The permeability tests were undertaken using a well permeameter by reference to AS1547:2012 and McKenzie et al., (2002). In the absence of a Griffith City Council AWTS policy, AS1547:2012 and DEC 2004 will be referenced for soil assessment factors and constraints.

A map of the EM-31 and EM-38 survey with elevation contours and pit locations can be seen as follows.

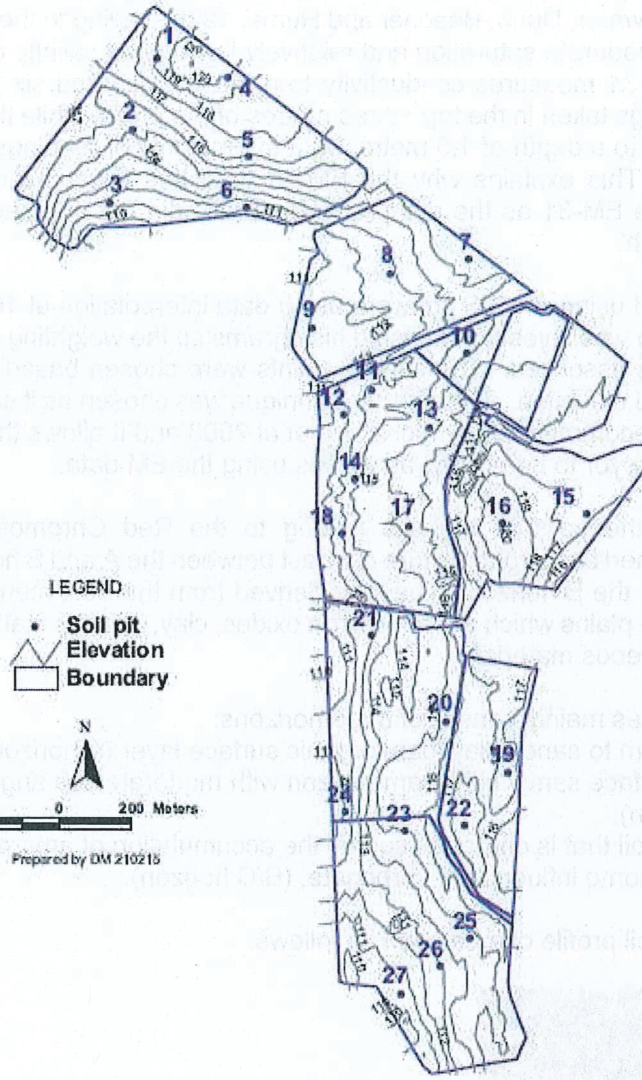
EM-31


LEGEND
Soil pit
Elevation
Boundary
EM31V ECa mS/m
31 - 53
54 - 76
77 - 98
99 - 121
122 - 144
145 - 166
167 - 189
190 - 211
212 - 234
235 - 257
N
200 0 200 Meters
Prepared by DM 210215

EM-38


LEGEND
Soil pit
Elevation
Boundary
EM38V ECa mS/m
0 - 16
17 - 24
25 - 33
34 - 43
44 - 54
55 - 65
66 - 78
79 - 96
97 - 126
127 - 183
N
200 0 200 Meters
Prepared by DM 210215

Elevation


LEGEND
Soil pit
Elevation
Boundary
N
200 0 200 Meters
Prepared by DM 210215

The EM survey results indicate that the site overall has low apparent conductivity (ECa). ECa is influenced by: the type of material being tested; its degree of saturation; and the salinity of the soil water, Dunn, Beecher and Hume, 1998. Owing to the sandy textured soil profile, the moderate saturation and relatively low overall salinity the low ECa is evident. The EM-31 measures conductivity to a depth of around six metres with the majority of readings taken in the top ~three metres of the profile while the EM-38 measures conductivity to a depth of 1.5 metres with the majority of readings taken in the top ~one metre. This explains why the EM-38 data has lower overall EM readings compared to the EM-31 as the soil profile generally did get comparatively heavier textured with depth.

The EM data was mapped using ArcGIS software using data interpolation at 10m cell size. The data distribution was investigated using histograms so the weighting of data to sample points could be assessed. The sample points were chosen based on the EM data, the landform and elevation. This survey technique was chosen as it satisfies the sampling density as recommended by McKenzie et al 2008 and it allows the local knowledge of the soil surveyor to be utilised as well as using the EM data.

From the investigation, the soils of the site belong to the Red Chromosol soil classification and are defined as: strong texture contrast between the A and B horizons and with a soil pH >5.5 in the B horizon. They are derived from the dust mantle and dune-fields of the Riverine plains which are rich in iron oxides, clay, organic matter with varying amounts of calcareous material.

The Red Chromosol profiles mainly consist of three horizons:
1. A darker fine sandy loam to sandy clay loam organic surface layer (A horizon);
2. A slightly lighter subsurface sandy clay loam horizon with moderate sub angular blocky structure (B horizon);
3. A clayey and silty subsoil that is characterised by the accumulation of amorphous organic compounds and some influence of carbonate, (B/C horizon).

A photograph of typical soil profile can be seen as follows.

The class of carbonate mainly found was fine soil carbonate or a compact mixture of loamy sand to sandy clay containing less than 20% calcrete fragments. The carbonate found indicates a decreasing age of the geological material in which the carbonate has accumulated therefore the fine earth carbonate is older than the fragments.

Soil Analysis
56 soil samples were taken for analysis and tested for properties outlined by reference to DEC 2004. Soils were tested for:
Topsoil 56 individual and one composite sample: pH, Electrical Conductivity (EC), Total Nitrogen, Total Phosphorus, Exchangeable Sodium Percentage (ESP), Cation Exchange Capacity (CEC), Available Phosphorus, and Emerson Aggregate Test (EAT). Subsoil samples were analysed for: pH, EC & EAT. Laboratory results are attached.

Topsoil Analysis

pH & EC
Topsoil pH is classed as neutral to mildly alkaline by reference to Rayment and Bruce 1982.

EC is a salinity indicator and samples are classified as non-saline to slightly saline, Charman and Murphy, 1991.

CEC and ESP
CEC is 10.89 which is typical of the nature of soils in the locale. The soil is classed as non-sodic, Hazelton and Murphy 2007.

Total Nitrogen, Total & Available Phosphorus and Phosphorus Sorption Capacity
Nutrients appear in check and are typical of agricultural soils in the locale.

Emerson Aggregate Test
Emerson Aggregate Tests returned class numbers 3 and 5, which has nil or slight limitation by reference to DEC guidelines.

Subsoil Analysis
Subsoil samples were collected at discrete depths and were analysed for: pH, EC & EAT.

pH & EC
pH is classed as neutral to mildly alkaline, Rayment and Bruce 1982.

EC is a salinity indicator and samples range from having nil to moderate subsoil salinity, Charman and Murphy 1991. The subsoils at sites 11, 14, 16, 19 and 24 are moderately saline with the rest of the sites being non-saline to slightly saline. The five sites with moderate subsoil salinity are distributed randomly across the site with no real correlation to EM data or landform.

Emerson Aggregate Test
Emerson Aggregate Tests returned predominantly class numbers 3 and 5. This indicates a soil that 'is unlikely to be sodic', Hazelton and Murphy 2007.

Site Suitability in relation to AS1547:2012

The Australian Standard provides less specific soil recommendations when compared to the DEC guidelines as they largely focus on the site constraint scale for development of setback distances. The Standard gives setback distance ranges from site constraint items of specific concern being bedrock, hardpans, surface waters, bores, groundwater, boundaries, recreation areas and utilities.

Recommended setback distance range

Site Feature	Setback distance range (m)
	Horizontal setback distance (m)
Property boundary	1.5 – 50
Buildings/houses	2.0 – 6
Surface water	15 – 100
Bore, well	15 – 50
Recreation areas (Children's play areas, swimming pools and so on)	3 – 15
In-ground water tank	4 – 15
Retaining walls and Embankments, escarpments, cuttings	3.0m or 45° angle from toe of wall (whichever is greatest)
	Vertical setback distance (m)
Groundwater	0.6 - >1.5
Hardpan or bedrock	0.5 - >1.5

Site suitability in relation to Australian Standards

Site Feature	Comments
Property boundary	Subject to local rules and council recommendations.
Buildings/houses	Recommend irrigation adhere to CSIRO Foundation Management and Footing Performance: A Homeowner's guide, BTF-2011.
Surface water	Recommended to be 100m from the high water mark owing to Griffith being a lower rainfall area and the soils on site being in category 1 to 3 of the Standard. Lake Wyangan is a man-made water body which is classified as a 'highly disturbed system' by reference to ANZECC 2000, owing to it being affected by human activity, namely storm water, horticultural run-off, grazing and recreational activities.
Bore, well	50m recommended from irrigation bores and any domestic supply bores liaison with NSW Office of Water is required.
Recreation areas (Children's play areas, swimming pools and so on)	Where effluent is applied to the surface by covered drip or spray irrigation, the maximum value is recommended.
In-ground water tank	It is recommended that land application of treated effluent be down gradient of in-ground water tanks.
Retaining walls and Embankments, escarpments, cuttings	3.0m is adequate owing to the moderately permeable soil and gentle slope which would eliminate the requirement for retaining walls of any great size.
	Vertical setback distance (m)
Groundwater	No free groundwater was encountered within 1.8m of the surface and depth to piezometric surface is 3.4m in one of the on-site bores.
Hardpan or bedrock	No hardpan or bedrock was encountered during the investigation.

Site suitability in relation to the DEC guidelines
The site is highly suitable for irrigation of treated wastewater when compared to the DEC guidelines owing to most parameters returning a nil to slight limitation for irrigation systems. Some isolated soils had moderate limitations such as a slightly low topsoil Cation Exchange Capacity and five samples return moderate salinity in the subsoil which is inherent to the locale. The following DEC guidelines were used as a guide for identifying soil and site limitations and selecting appropriate amelioration measures if required.

Typical site and soil characterises for effluent irrigation systems

Property	Limitation			Restrictive Feature
	Nil or Slight	Moderate	Severe	
Exchangeable sodium percentage (0–40 cm)	0–5	5–10	> 10	structural degradation and waterlogging
Exchangeable sodium percentage (40–100 cm)	< 10	>10	–	structural degradation and waterlogging
Salinity measured as electrical conductivity (ECe) (dS/m at 0–70 cm)	< 2	2–4	> 4	excess salt may restrict plant growth
Salinity measured as electrical conductivity (ECe) (dS/m at 70–100 cm)	< 4	4–8	> 8	excess salt may restrict plant growth, potential seasonal groundwater rise
Depth to top of seasonal high water table (metres)	> 3	0.5–3	< 0.5	poor aeration, restricts plant growth, risk to groundwater
Depth to bedrock or hardpan (metres)	> 1	0.5–1	< 0.5	restricts plant growth, excess runoff, waterlogging
Saturated hydraulic conductivity (Ks, mm/h, 0-100 cm)	20–80	5–20 or >80	<5	excess runoff, waterlogging, poor infiltration
Available water capacity (AWC, mm/m)	> 100	< 100	–	little plant-available water in reserve, risk to groundwater
Soil pHCaCl2 (surface layer)	> 6–7.5	3.5–6.0 > 7.5	< 3.5	reduces optimum plant growth
Effective cation exchange capacity (ECEC, cmol (+)/kg, average 0–40 cm)	> 15	3–15	< 3	unable to hold plant nutrients
Emerson aggregate test (0–100cm)	4, 5, 6, 7, 8	2, 3	1	Poor structure
Phosphorus (P) sorption (kg/ha at total 0–100 cm)	high	moderate	Low	unable to immobilise any excess phosphorus

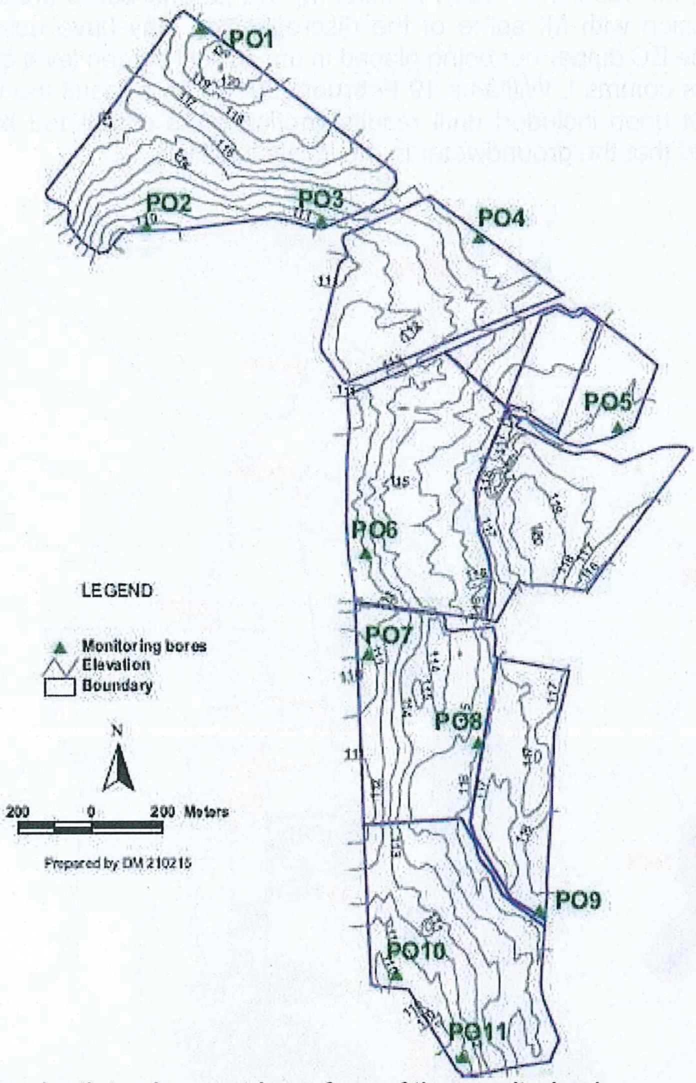
Site suitability in relation to DEC guidelines

Property	Comments
Exchangeable sodium percentage (0–40 cm)	ESP in the topsoil is 2 which is considered low. Emerson Aggregate test were also undertaken and results indicate a soil that is unlikely to be sodic.
Exchangeable sodium percentage (40–100 cm)	Not tested but Emerson Aggregate test was used as an indicator.
Salinity measured as electrical conductivity (EC) (dS/m at 0–70 cm)	EC were all less <1 dS/m. Once calculated to ECe it indicates generally nil to slight limitations.
Salinity measured as electrical conductivity (EC) (dS/m at 70–100 cm)	EC in the sub soil were <1 dS/m with the exception of 5 of the 56 samples in holes 11, 14, 16, 19 and 24 which once calculated to ECe indicates a moderate limitation to the subsoil.
Depth to top of seasonal high water table (metres)	No free groundwater was encountered during excavation to 1.8m depth. Of the 13 monitoring bores on site the depth to piezometric surface level ranges from 3.4m to 5.6m below ground level. Of the 13 bores nine are dry. This indicates nil to slight risk.
Depth to bedrock or hardpan (metres)	No bedrock or hardpans were experienced during excavation and plant roots were found in all profiles to the excavated depth of 1.8 metres.
Saturated hydraulic conductivity (Ks, mm/h, 0-100 cm)	The mean kSat is classed as "moderately permeable" with no problems associated with impaired infiltration, water logging or excessive runoff. Some investigation points returned >80mm/h infiltration rates in the sandier soils which is viewed as a moderate limitation.
Available water capacity (AWC, mm/m)	AWC is calculated to be generally ~120mm/m which is highly suitable for irrigation.
Soil pHCaCl2 (surface layer)	Surface layer soil pH H_2O is neutral to mildly alkaline which is nil to slight limitations. Soil pH when tested in CaCl2 is usually slightly lower than the H_2O method so the nil to slight limitation would still apply.
Effective cation exchange capacity (ECEC, cmol (+)/kg, average 0–40 cm)	CEC was suitable a reading of 10.89.which is classed as a moderate limitation but this is deemed typical of most soils in Southern NSW.
Emerson aggregate test (0–100cm)	Samples returned results that have Nil or Slight limitations with the exception of pits 24 and 27 with a class number 2.
Phosphorus (P) sorption (kg/ha at total 0–100 cm)	Not tested but available Phosphorus (Colwell) are slightly low indicating that the addition of Phosphorous by fertiliser or in treated wastewater would be beneficial.

Hydrogeological characteristics

There are 13 monitoring bores on site that were installed in 2007 as part of a development application for a medium density housing development. The bores range from around five to 14 metres deep and are installed around the site which can be seen as follows.

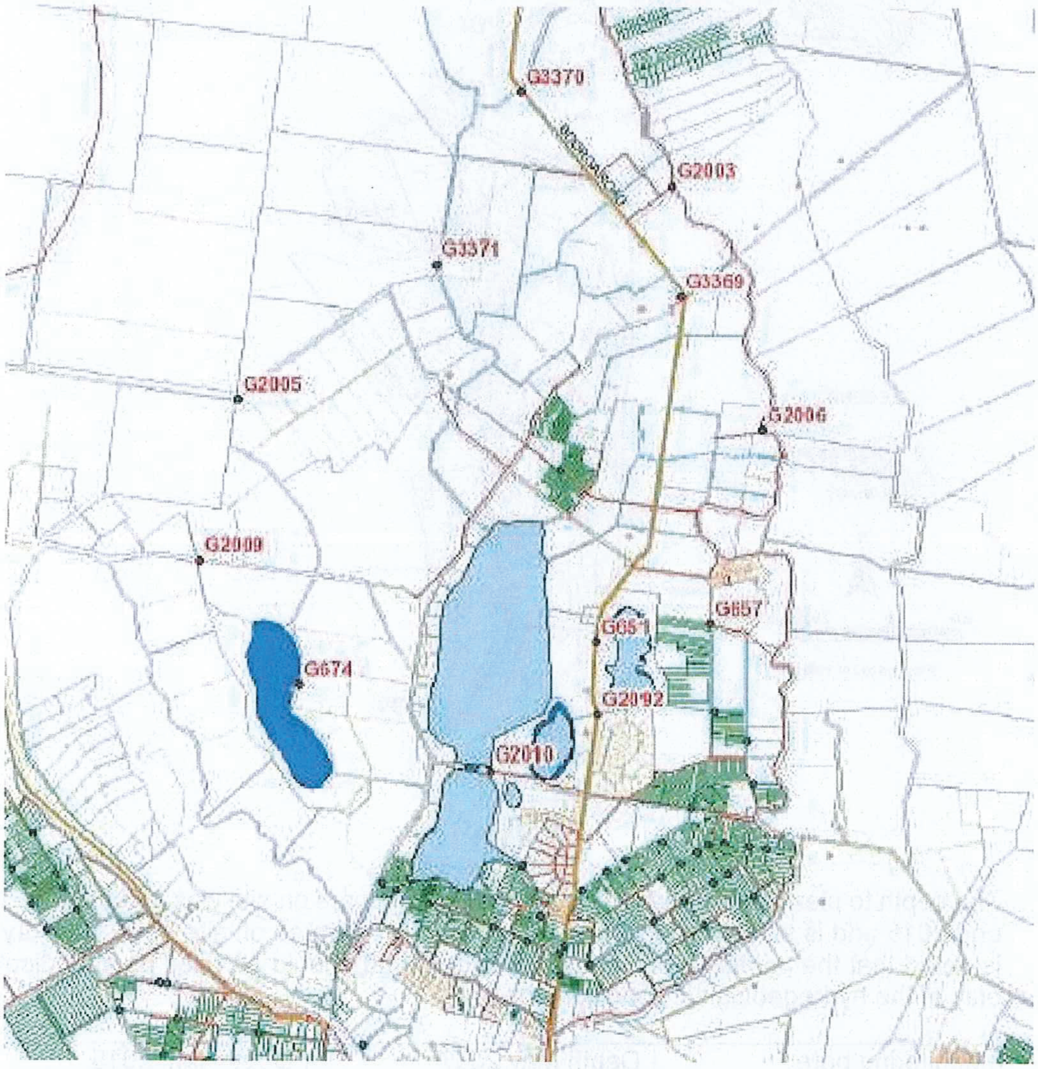
Monitoring bores



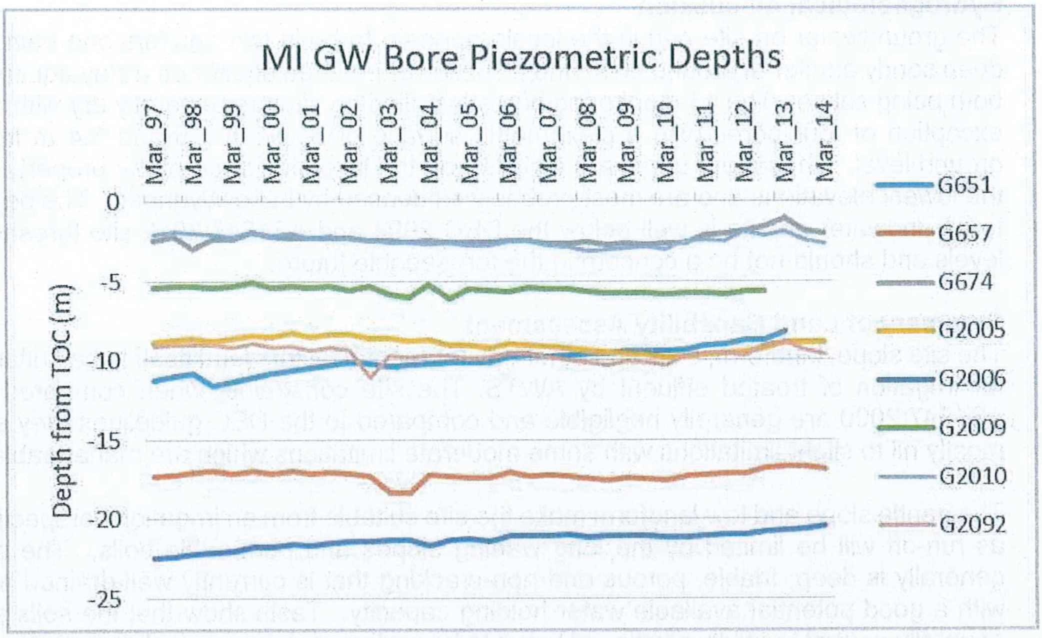
The depth to piezometric surface of the monitoring bores on site was recorded in 2007 and 2015 and is shown below. The remaining seven bores on site have been dry. It is noted that the sampling points are infrequent and should be used as an indication only of the hydrogeological conditions on site.

Monitoring bore	Depth May 2007	Depth Jan. 2015
PO2	-3.30	-3.40
PO5	-2.80	Dry
PO7B	Dry	-5.45
PO10	Dry	-5.60
PO11B	-5.30	-4.30

Murrumbidgee Irrigation Ltd (MI) has a series of monitoring bores within a 5 kilometre radius of the locale installed to depths of between 12 and 35 metres deep. The data has been supplied by MI and is recorded six monthly from 2007 to 2014. The data demonstrates that the piezometric water depth is highly variable and not knowing the construction details of the bores is difficult to comment whether the water table is that high or if it is the influence of a deeper aquifer under pressure. Department of Natural Resources in 2006 also noted that not knowing the construction of the bores may produce misleading results. Salinity information has been provided by MI for the surrounding bores and the results between monitoring events and bores are wildly variable. From discussion with MI some of the discrepancies may have occurred during collection with the EC dipper not being placed in the correct screen level and/or typographic errors, pers comms L Williams 19 February 2014. As a result the water quality results have not been included until results verification is completed by MI. However it can be noted that the groundwater in the locale is saline.



As follows is a representation of the depth to piezometric surface for the closest eight bores to the site which shows a generally steady groundwater depth with a slightly rising long term trend in bores G2006 and G651.



In 2007 EA Systems Pty Limited Conducted a Hydrological and Hydrological Assessment (Report 21762.16326) of the site and in summary they had the following findings:

The elevation of the two shallow piezometer water levels was approximately 104-114 m and the elevation of the two deeper piezometers installed in the water bearing zones was approximately 104 m in both holes. These results indicate that the static water level (SWL) within the shallow piezometers is variable, likely as a result of perching of surface waters and is therefore likely to be variable based on rainfall and surface water conditions. The water levels within the piezometers installed in deeper water bearing zones is relatively uniform at 104 m and is unlikely to be significantly influenced by climatic conditions.

The general conclusions from the report are as follows:

Current water bearing stratigraphic layers were encountered at depths ranging from 6 m to 20 m across the site and stabilised water levels of piezometers constructed in these formations are preliminary indicted at approximately 5 to 5.5 m below current ground surface. The stratigraphy indicates a potential for the perching of shallow groundwater overlying thick heavy clays under wet conditions at depths of 1.5 to 4.5 m below current ground surface levels. There is minimal published investigation data to indicate the behaviour of perched shallow groundwater. The elevation shallow piezometer water levels ranged from approximately 104 – 114 m (2.2-3.3 m below ground surface) and the elevation of the two deeper piezometers installed in water bearing zones was approximately 104 m in both holes.

The fluctuation of shallow groundwater within sand aquifers encountered at < 20 m across the site is likely to be predictable based on irrigation patterns. The behaviour of shallow perched waters is more difficult to predict, but results of the filed investigation indicate a potential for the formation of perched water tables in areas of shallow topsoil at less than two metres below ground surface levels. Soil chemistry data suggests that there is a potential for urban salinity, particularly on the eastern bank of north Lake Wyangan. The occurrence of a slat scald in the Nericon Swamp area less than one km to the east of the site and the results of the EC soil contouring indicate that there is potential for urban salinity impacts in this area.

Hydrogeological discussion
The groundwater on site and in the locale appears to be in two aquifers one being a deep sandy aquifer at around 20 m and a shallower perched aquifer on a clay aquitard, both being saline. The 13 monitoring bores installed on site are generally dry with the exception of four bores with a piezometric surface of between 3.6 and 5.4 m from ground level. These four bores are installed on the lake side edge of the property on the lowest elevations and are most probably influenced by Lake Wyangan. The depth to groundwater on site is well below the DEC 2004 and AS1547:2012 site threshold levels and should not be a concern in the foreseeable future.

Summary of Land Capability Assessment
The site slope, landform, soils and other environmental factors lend itself to be suitable for irrigation of treated effluent by AWTS. The site constraints when compared to AS1547:2000 are generally negligible and compared to the DEC guidelines they are mostly nil to slight limitations with some moderate limitations which are manageable.

The gentle slope and low landform make the site suitable from an irrigation perspective as run-off will be limited by the long waning slopes and permeable soils. The soil generally is deep, friable, porous and non-cracking that is currently well-drained and with a good potential available water holding capacity. Tests show that the soils are generally neutral to mildly alkaline pH, non to low saline and do not swell and disperse. In general, a combination of soil depth, slope, low salinity, open porosity, subsoil structure, physically unrestricted roots to the investigated depth and water penetration, large water holding capacity, good drainage, aeration, water and heat transmission, workability and trafficability, are some of the many advantages of these soils. These favourable properties make them suitable for the intended use.

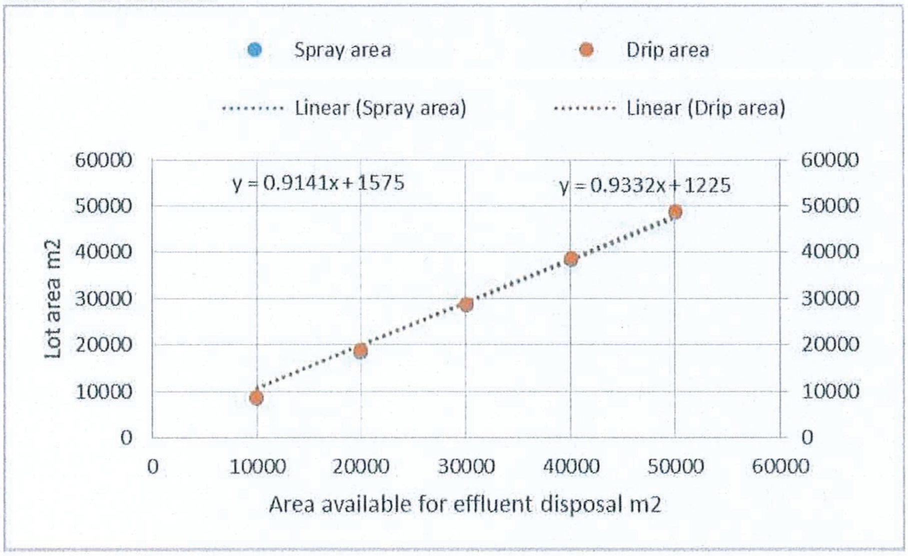
It is important to note that the site has a total irrigation water allocation of 276 ML per annum. If however the site is to be developed as 36 individual five hectare blocks the total irrigation amount at maximum daily flow of 980L/day based on seven EP and 100% occupancy would be 13 ML per annum which by contrast has less potential impact on the groundwater and surface waters at the site. A lesser development lot size of for example 1 ha would see the maximum amount of water irrigated at 64ML across the site which is still a lesser impact than agricultural or horticultural activities. The proposed development at present would have a negligible net recharge on the Lake Wyangan catchment given the comparably low total irrigation amount by AWTS and high quality of the treated effluent.

Lake Wyangan is frequently closed owing to algal blooms occurring in the summer months associated with warm and stable water conditions. Blue-green algae is a natural bacteria which are typical of freshwater environments in Australia, especially the Murray-Darling Basin. Stable water conditions, sunlight and nutrients are the three key contributors to algal blooms and Lake Wyangan being a closed drainage basin and Griffith having a warm and stable weather pattern in summer has made the Lake historically prone to blooms. Nutrients also play a part in the algal blooms with sufficient levels of Nitrogen and Phosphorous required to feed the algae. The Lake being a fixed drainage basin in the middle of agricultural and irrigated horticultural land would receive nutrient laden run-off from the catchment. The proposed residential development would see a far lower net irrigation rate than if the site was used as an irrigation farm therefore the risk off run-off into the lake is reduced considerably if the site is used for residential purposes. Modern AWTS's have a very low nutrient output and the low irrigation rate and highly suitable soil type combine to have a negligible run-off rate. Therefore it is considered that the prosed residential development will have a negligible contribution to nutrient levels in the lake which contribute to algal blooms.

In regard to block sizes the site is currently zoned for a minimum lot size of 5 hectares. Considering the largest minimum irrigation area for a DIR of 3.5 and daily flow rate of 908L is 304m² there is scope for a reduction in lot size for parts of the development to not less than 1 hectare with negligible impact. Allotments smaller than 1 hectare are seen to have higher risks for wastewater management, EPA 2003. The area available for irrigation on each lot would depend on a range of factors including end lot size and layout and the size and orientation of the building footprint and driveways etc. As the lot size in the development may vary it is necessary to determine the relationship between lot size and the area available for effluent irrigation. The area available for effluent irrigation was estimated for five different lot sizes from one to five hectares for the conceptual model. The conceptual setbacks were estimated at 10 metres from the front and side boundary, five metres from the building envelope for drip irrigation and 15 metres for spray irrigation with a building envelope estimated at 20 metres x 20 metres. Therefore two conceptual models were calculated being: area available for above ground irrigation; and area available for sub-surface drip irrigation and the relevant areas available for each type of irrigation based on lot size is as follows:

Lot area (m^2)	Available area for drip irrigation (m^2)	Available area for surface/spray irrigation (m^2)
10000	8425	8775
20000	18425	18775
30000	28425	28775
40000	38425	38775
50000	48425	48775

The data shown in a graph demonstrating the linear regression between the two data sets is as follows.



The regression equation can be used to calculate the lot size that would be required for a given effluent disposal area where:

LS = Lot size
EDA = effluent disposal area

For example, the lot size required to provide 280m^2 for spray effluent disposal would be:

LS = 0.9141 x 304 + 1575
= 1,853 m^2

And for 280m^2 for drip irrigation would be:

LS = 0.9332 x 304 + 1225
= 1,508 m^2

Based on the above calculations the conceptual minimum lot size is far lower than the estimated minimum one hectare sizing that is being suggested. However given that lot sizes of less than one hectare present higher risks for wastewater management (EPA 2003) the proposed minimum lot size of one hectare appears reasonable. It is recommended though that the above regression analysis be re-run once a more advanced plan of lot sizes and layout is developed to validate the model.

In summary the environmental impacts in relation to the development and a decreased lot size are considered negligible given that the:

- manageable minimum irrigation areas in relation to the irrigation and nutrient load;
- likelihood of run-off from the AWTS into Lake Wyangan is negligible owing to the existing buffer of approximately 150 to 300 metres in the form of the reserve surrounding the lake and the permeable soils;
- soils at the site are highly suitable for irrigation of treated effluent;
- wastewater quality from the AWTS is very good; and
- low likelihood of impact to groundwater on site.

Disclaimer

The information contained in this report has been extracted from field and laboratory sources believed to be reliable and accurate. DM McMahon Pty Ltd will not assume any responsibility for the misinterpretation of information supplied in this report. The accuracy and reliability of recommendations identified in this report need to be evaluated with due care according to individual circumstances. It should be noted that the recommendations and findings in this report are based solely upon the said site location and the ground level conditions at the time of testing. The results of the said investigations undertaken are an overall representations of the conditions encountered. The properties of the soil within the location may change due to variations in ground conditions outside of the tested area. The author has no control or liability over site variability that may warrant further investigation that may lead to significant design changes.

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Minimum Lot Size Map-Sheet LSZ-003b

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BORE LOGS

Site 1: 410197 6215130 –Very Gently Inclined Crest

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.2	Yellowish Red Loamy Sand	Moderate structure Roots present
B1 Horizon	0.2-0.55	Reddish Yellow Fine Sandy Loam Some carbonate coarse fragments 10% <10mm	Strong structure Roots present
B2 Horizon	0.55-1.3	Yellowish Red Fine Sandy Clay Loam Some carbonate coarse fragments 10% <10mm	Strong structure Roots present
C Horizon	1.3-1.8	Reddish Sandy Clay	Moderate structure Roots present

Site 2: 410131 6214939 – Very Gently Inclined Drainage Depression

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.45	Yellowish Red Loamy Sand	Moderate structure Roots present
B Horizon	0.45-0.7	Reddish Yellow Fine Sandy Loam	Strong structure Roots present
C Horizon	0.7-1.6	Brownish Yellow Sandy Clay Some carbonate coarse fragments 10% <10mm	Moderate structure Roots present

Site 3: 410071 6214737 – Very Gently Inclined Lower Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.2	Reddish Brown Sandy Loam	Moderate structure Roots present
A2 Horizon	0.2-0.45	Yellowish Red Sandy Loam	Moderate structure Roots present
B Horizon	0.45-1.0	Brownish Yellow Sandy Clay Some carbonate coarse fragments 50% <20mm	Strong structure Roots present
C Horizon	1.0-1.8	Greyish Silty Clay Some carbonate coarse fragments 20% <20mm	Massive structure Roots present

Site 4: 410394 6215081 – Very Gently Inclined Mid Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.2	Yellowish Red Loamy Sand	Moderate structure Roots present
A2 Horizon	0.2-0.8	Reddish Yellow Fine Sandy Loam	Strong structure Roots present
B Horizon	0.8-1.35	Yellowish Red Fine Sandy Clay Loam Some carbonate coarse fragments 20% <10mm	Strong structure Roots present
C Horizon	1.5-1.8	Light Reddish Sandy Clay	Moderate structure Roots present

Site 5: 410451 6214865 – Very Gently Inclined Crest

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.35	Reddish Brown Loamy Sand	Moderate structure Roots present
B Horizon	0.35-1.0	Brownish Yellow Sandy Clay Some carbonate coarse fragments 20% <10mm	Strong structure Roots present
C Horizon	1.0-1.8	Reddish Yellow Silty/Sandy Clay Some carbonate coarse fragments 10% <10mm	Massive structure Roots present

Site 6: 410444 6214725 – Very Gently Inclined Footslope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.4	Reddish Brown Sandy Loam	Moderate structure Roots present
B Horizon	0.4-1.0	Brownish Yellow Sandy Clay Some carbonate coarse fragments 20% <10mm	Strong structure Roots present
C Horizon	1.0-1.8	Reddish Yellow Silty Clay Some carbonate coarse fragments 10% <10mm	Massive structure Roots present

Site 7: 411056 6214585 – Very Gently Inclined Crest

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.25	Reddish Brown Fine Sandy Loam	Moderate structure Roots present
B Horizon	0.25-0.9	Reddish Fine Sandy Clay Some carbonate coarse fragments 20% <10mm	Strong structure Roots present
C Horizon	0.9-1.8	Reddish Light Clay Some carbonate coarse fragments 10% <10mm	Strong structure Roots present

Site 8: 410839 6214550 – Very Gently Inclined Mid Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.2	Reddish Brown Sandy Loam	Moderate structure Roots present
B1 Horizon	0.2-0.5	Reddish Brown Sandy Clay Loam	Strong structure Roots present
B2 Horizon	0.5-0.8	Reddish Yellow Fine Sandy Clay Some carbonate coarse fragments 20% <10mm	Strong structure Roots present
C Horizon	0.8-1.8	Greyish Sandy Clay Some carbonate coarse fragments 10% <10mm	Massive structure Roots present

Site 9: 410623 6214400 – Very Gently Inclined Lower Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.3	Reddish Brown Fine Sandy Loam	Moderate structure Roots present
B/C Horizon	0.3-1.8	Reddish Yellow Fine Sandy Loam	Strong structure Roots present

Site 10: 411052 6214329 – Very Gently Inclined Crest

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.2	Reddish Brown Sandy Loam	Moderate structure Roots present
B1 Horizon	0.2-0.55	Yellowish Red Sandy Clay Loam	Strong structure Roots present
B2 Horizon	0.55-1.1	Reddish Yellow Sandy Clay Loam Some carbonate coarse fragments 20% <10mm	Strong structure Roots present
C Horizon	1.1-1.8	Yellowish Grey Silty/Sandy Clay Some carbonate coarse fragments 10% <10mm	Massive structure Roots present

Site 11: 410790 6214231 – Very Gently Inclined Mid Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.2	Reddish Brown Sandy Loam	Moderate structure Roots present
B1 Horizon	0.2-0.55	Yellowish Red Sandy Clay Loam	Strong structure Roots present
B2 Horizon	0.5-1.1	Reddish Yellow Sandy Clay Loam Some carbonate coarse fragments 20% <10mm	Strong structure Roots present
C Horizon	1.1-1.8	Yellowish Grey Silty/Sandy Clay Some carbonate coarse fragments 10% <10mm	Massive structure Roots present

Site 12: 410712 6214160 – Very Gently Inclined Lower Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.3	Reddish Brown Fine Sandy Loam	Moderate structure Roots present
B/C Horizon	0.3-1.8	Reddish Yellow Fine Sandy Loam	Strong structure Roots present

Site 13: 410949 6214127 – Very Gently Inclined Mid Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.2	Reddish Brown Sandy Loam	Moderate structure Roots present
B1 Horizon	0.2-0.55	Yellowish Red Sandy Clay Loam	Strong structure Roots present
B2 Horizon	0.5-1.1	Reddish Yellow Sandy Clay Loam Some carbonate coarse fragments 20% <10mm	Strong structure Roots present
C Horizon	1.1-1.8	Yellowish Grey Silty/Sandy Clay Some carbonate coarse fragments 10% <10mm	Massive structure Roots present

Site 14: 410743 6213986 – Very Gently Inclined Lower Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.25	Greyish Brown Fine Sandy Clay Loam	Moderate structure Roots present
B Horizon	0.25-0.8	Greyish Brown Fine Sandy Clay Loam	Strong structure Roots present
C Horizon	0.8-1.8	Greyish Silty Loam	Granular structure Roots present

Site 15: 411376 6213894 – Very Gently Inclined Mid/Upper Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.3	Reddish Brown Sandy Clay Loam	Granular structure Roots present
B Horizon	0.3-0.55	Reddish Brown Fine Sandy Clay Loam	Strong structure Roots present
C Horizon	0.55-1.8	Reddish Yellow Sandy Clay Some carbonate coarse fragments 20% <20mm	Moderate structure Roots present

Site 16: 411149 6213869 – Very Gently Inclined Crest

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.25	Reddish Brown Sandy Clay Loam	Moderate structure Roots present
B1 Horizon	0.25-0.7	Yellowish Red Sandy Clay Loam	Strong structure Roots present
B2 Horizon	0.7-1.3	Reddish Yellow Fine Sandy Clay Loam Some carbonate coarse fragments 20% <10mm	Strong structure Roots present
C Horizon	1.3-1.8	Yellowish Grey Silty/Sandy Clay	Massive structure Roots present

Site 17: 410889 6213860 – Very Gently Inclined Crest

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.30	Reddish Brown Sandy Clay	Granular structure Roots present
B1 Horizon	0.30-0.5	Reddish Brown Fine Sandy Clay Loam	Strong structure Roots present
B2 Horizon	0.5-0.85	Reddish Yellow Fine Sandy Clay Loam Some carbonate coarse fragments 20% <10mm	Strong structure Roots present
C Horizon	0.85-1.8	Yellowish Grey Sandy Clay Loam	Massive structure Roots present

Site 18: 410707 6213839 – Very Gently Inclined Mid Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.25	Reddish Brown Sandy Clay Loam	Moderate structure Roots present
B Horizon	0.25-0.8	Yellowish Grey Fine Sandy Loam	Strong structure Roots present
C Horizon	0.8-1.8	Reddish Yellow Silty Clay Loam Some carbonate coarse fragments 10% <10mm	Granular structure Roots present

Site 19: 411162 6213189 – Very Gently Inclined Crest

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.4	Reddish Brown Sandy Clay Loam	Granular structure Roots present
B Horizon	0.4-1.0	Reddish Yellow Sandy Clay Some carbonate coarse fragments 20% <20mm	Strong structure Roots present
C Horizon	1.0-1.8	Yellowish Grey Silty/Sandy Clay Some carbonate coarse fragments 10% <10mm	Moderate structure Roots present

Site 20: 410991 6213328 – Very Gently Inclined Upper Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.3	Reddish Brown Sandy Loam	Granular structure Roots present
B Horizon	0.3-0.7	Reddish Brown Sandy Clay Loam	Strong structure Roots present
C Horizon	0.7-1.8	Reddish Yellow Silty/Sandy Clay Some carbonate coarse fragments 30% <20mm	Moderate structure Roots present

Site 21: 410787 6213561 – Very Gently Inclined Lower Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.15	Reddish Brown Sandy Clay Loam	Granular structure Roots present
B Horizon	0.15-0.6	Reddish Brown Sandy Clay Loam	Strong structure Roots present
C Horizon	0.6-1.8	Reddish Yellow Sandy Clay Some carbonate coarse fragments 20% <20mm	Moderate structure Roots present

Site 22: 411043 6213042 – Very Gently Inclined Crest

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.35	Reddish Brown Sandy Clay Loam	Granular structure Roots present
B Horizon	0.35-1.1	Reddish Yellow Sandy Clay Some carbonate coarse fragments 20% <20mm	Strong structure Roots present
C Horizon	1.1-1.8	Yellowish Grey Silty/Sandy Clay Some carbonate coarse fragments 10% <10mm	Moderate structure Roots present

Site 23: 410880 6213026 – Very Gently Inclined Mid Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.25	Reddish Brown Fine Sandy Loam	Granular structure Roots present
B Horizon	0.25-0.7	Yellowish Red Sandy Clay Loam	Strong structure Roots present
C Horizon	0.7-1.8	Yellowish Brown Silty/Sandy Clay Some carbonate coarse fragments 20% <20mm	Moderate structure Roots present

Site 24: 410714 6213078 – Very Gently Inclined Footslope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.3	Reddish Brown Fine Sandy Loam	Granular structure Roots present
B Horizon	0.3-0.7	Yellowish Red Sandy Clay Loam	Strong structure Roots present
C Horizon	0.7-1.8	Yellowish Brown Silty/Sandy Clay Some carbonate coarse fragments 20% <20mm	Granular structure Roots present

Site 25: 411062 6212735 – Very Gently Inclined Upper Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.2	Reddish Brown Sandy Loam	Granular structure Roots present
B Horizon	0.2-0.55	Reddish Brown Sandy Clay Loam	Strong structure Roots present
C Horizon	0.55-1.8	Yellowish Grey Silty/Sandy Clay Some carbonate coarse fragments 20% <20mm	Moderate structure Roots present

Site 26: 410980 6212656 – Very Gently Inclined Mid Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.2	Reddish Brown Sandy Loam	Granular structure Roots present
B Horizon	0.2-0.65	Reddish Brown Sandy Clay Loam	Strong structure Roots present
C Horizon	0.65-1.8	Yellowish Grey Silty/Sandy Clay Some carbonate coarse fragments 10% <20mm	Moderate structure Roots present

Site 27: 410869 6212583 – Very Gently Inclined Lower Slope

Profile Description	Depth (m)	Soil Type	Properties
TOPSOIL	0-0.2	Reddish Brown Fine Sandy Loam	Granular structure Roots present
B Horizon	0.2-0.7	Reddish Brown Fine Sandy Clay Loam	Strong structure Roots present
C Horizon	0.7-1.8	Yellowish Brown Silty/Sandy Clay Some carbonate coarse fragments 20% <20mm	Moderate structure Roots present

WATER AND NUTRENT BALANCE

Land Capability Assessment

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations

Site Address:	West Rd & Boorga Road, Nericon NSW 2680			
Date:	2,015	**Assessor:**	David McMahon	

INPUT DATA

Design Wastewater Flow	Q	700	L/day	Based on maximum potential occupancy and derived from Table 5.2 AS1547:2012
Design Irrigation Rate	DIR	3.0	mm/day	Based on conservative soil texture class/permeability and derived from Table M AS1547:2012
Nominated Land Application Area	L	257	m^2	[1]
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type[2]
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Mean Monthly Rainfall Data	Griffith AWS (075041)			BoM Station and number
Mean Monthly Pan Evaporation Data	Griffith CSIRO (075028)			BoM Station and number

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Evaporation	E		mm/month	269.7	224	186	105	62	42	49.6	71.3	102	151.9	213	251.1	1727.6
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	216	179	130	74	37	25	30	43	71	122	170	201	1297.8
Percolation	B	DIRxD	mm/month	93.0	84	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	1095.0
Outputs		ET+B	mm/month	308.8	263.2	223.2	163.5	130.2	115.2	122.8	135.8	161.4	214.5	260.4	293.9	2392.8
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Applied Effluent	W	(QxD)/L	mm/month	84.4	76.3	84.4	81.7	84.4	81.7	84.4	84.4	81.7	84.4	81.7	84.4	994.2
Inputs		RR+W	mm/month	117.5	106.3	121.0	109.5	119.4	115.1	117.6	119.6	113.8	122.9	115.9	116.8	1395.7
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-191.2	-156.9	-102.2	-54.0	-10.8	-0.1	-5.1	-16.1	-47.6	-91.6	-144.5	-177.0	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	79	84	116	155	228	257	242	216	162	123	93	83	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 257.0 m^2

CELLS

	Please enter data in blue cells
XX	Red cells are automatically populated by the spreadsheet
XX	Data in yellow cells is calculated by the spreadsheet, DO NOT ALTER THESE CELLS

NOTES

[1] This value should be the largest of the following: land application area required based on the most limiting nutrient balance or minimum area required for zero storage

[2] Values selected are conservative and are suitable for pasture grass

Land Capability Assessment

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations

Site Address:	**West Rd & Boorga Road, Nericon NSW 2680**		
Date:	2,015	**Assessor:**	David McMahon

INPUT DATA

Design Wastewater Flow	Q	700	L/day	Based on maximum potential occupancy and derived from Table 5.2 AS1547:2012
Design Irrigation Rate	DIR	3.5	mm/day	Based on conservative soil texture class/permeability and derived from Table M AS1547:2012
Nominated Land Application Area	L	217	m^2	[1]
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type[2]
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Mean Monthly Rainfall Data	Griffith AWS (075041)			BoM Station and number
Mean Monthly Pan Evaporation Data	Griffith CSIRO (075028)			BoM Station and number

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Evaporation	E		mm/month	269.7	224	186	105	62	42	49.6	71.3	102	151.9	213	251.1	1727.6
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	216	179	130	74	37	25	30	43	71	122	170	201	1297.8
Percolation	B	DIRxD	mm/month	108.5	98	108.5	105.0	108.5	105.0	108.5	108.5	105.0	108.5	105.0	108.5	1277.5
Outputs		ET+B	mm/month	324.3	277.2	238.7	178.5	145.7	130.2	138.3	151.3	176.4	230.0	275.4	309.4	2575.3
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Applied Effluent	W	(QxD)/L	mm/month	100.0	90.3	100.0	96.8	100.0	96.8	100.0	100.0	96.8	100.0	96.8	100.0	1177.4
Inputs		RR+W	mm/month	133.1	120.3	136.6	124.6	135.0	130.2	133.2	135.2	128.9	138.5	131.0	132.4	1578.9
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-191.2	-156.9	-102.1	-53.9	-10.7	0.0	-5.1	-16.1	-47.5	-91.5	-144.4	-177.0	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	75	79	107	139	196	217	207	187	146	113	87	78	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 217.0 m^2

CELLS

(blue)	Please enter data in blue cells
XX (red)	Red cells are automatically populated by the spreadsheet
XX (yellow)	Data in yellow cells is calculated by the spreadsheet, DO NOT ALTER THESE CELLS

NOTES

[1] This value should be the largest of the following: land application area required based on the most limiting nutrient balance or minimum area required for zero storage

[2] Values selected are conservative and are suitable for pasture grass

Land Capability Assessment

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations

Site Address:	West Rd & Boorga Road, Nericon NSW 2680			
Date:	2,015	**Assessor:**	David McMahon	

INPUT DATA

Design Wastewater Flow	Q	700	L/day	Based on maximum potential occupancy and derived from Table 5.2 AS1547:2012
Design Irrigation Rate	DIR	4.0	mm/day	Based on conservative soil texture class/permeability and derived from Table M AS1547:2012
Nominated Land Application Area	L	188	m^2	[1]
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type[2]
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Mean Monthly Rainfall Data	Griffith AWS (075041)			BoM Station and number
Mean Monthly Pan Evaporation Data	Griffith CSIRO (075028)			BoM Station and number

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Evaporation	E		mm/month	269.7	224	186	105	62	42	49.6	71.3	102	151.9	213	251.1	1727.6
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	216	179	130	74	37	25	30	43	71	122	170	201	1297.8
Percolation	B	DIRxD	mm/month	124.0	112	124.0	120.0	124.0	120.0	124.0	124.0	120.0	124.0	120.0	124.0	1460.0
Outputs		ET+B	mm/month	339.8	291.2	254.2	193.5	161.2	145.2	153.8	166.8	191.4	245.5	290.4	324.9	2757.8
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Applied Effluent	W	(QxD)/L	mm/month	115.4	104.3	115.4	111.7	115.4	111.7	115.4	115.4	111.7	115.4	111.7	115.4	1359.0
Inputs		RR+W	mm/month	148.5	134.3	152.0	139.5	150.4	145.1	148.6	150.6	143.8	153.9	145.9	147.8	1760.5
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-191.2	-156.9	-102.2	-54.0	-10.8	-0.1	-5.1	-16.2	-47.6	-91.6	-144.5	-177.1	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	71	75	100	127	172	188	180	165	132	105	82	74	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 188.0 m^2

CELLS

	Please enter data in blue cells
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NOTES

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[2] Values selected are conservative and are suitable for pasture grass

Land Capability Assessment

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations

Site Address:	**West Rd & Boorga Road, Nericon NSW 2680**		
Date:	2,015	**Assessor:**	David McMahon

INPUT DATA

Design Wastewater Flow	Q	700	L/day	Based on maximum potential occupancy and derived from Table 5.2 AS1547:2012
Design Irrigation Rate	DIR	5.0	mm/day	Based on conservative soil texture class/permeability and derived from Table M AS1547:2012
Nominated Land Application Area	L	149	m^2	[1]
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type[2]
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Mean Monthly Rainfall Data	Griffith AWS (075041)			BoM Station and number
Mean Monthly Pan Evaporation Data	Griffith CSIRO (075028)			BoM Station and number

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Evaporation	E		mm/month	269.7	224	186	105	62	42	49.6	71.3	102	151.9	213	251.1	1727.6
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	216	179	130	74	37	25	30	43	71	122	170	201	1297.8
Percolation	B	DIRxD	mm/month	155.0	140	155.0	150.0	155.0	150.0	155.0	155.0	150.0	155.0	150.0	155.0	1825.0
Outputs		ET+B	mm/month	370.8	319.2	285.2	223.5	192.2	175.2	184.8	197.8	221.4	276.5	320.4	355.9	3122.8
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Applied Effluent	W	(QxD)/L	mm/month	145.6	131.5	145.6	140.9	145.6	140.9	145.6	145.6	140.9	145.6	140.9	145.6	1714.8
Inputs		RR+W	mm/month	178.7	161.5	182.2	168.7	180.6	174.3	178.8	180.8	173.0	184.1	175.1	178.0	2116.3
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-192.0	-157.7	-103.0	-54.8	-11.6	-0.9	-5.9	-16.9	-48.4	-92.4	-145.3	-177.8	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	64	68	87	107	138	148	143	133	111	91	73	67	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 149.0 m^2

CELLS

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XX	Data in yellow cells is calculated by the spreadsheet, DO NOT ALTER THESE CELLS

NOTES

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[2] Values selected are conservative and are suitable for pasture grass

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations

Site Address:	West Rd & Boorga Road, Nericon NSW 2680		
Date:	2,015	**Assessor:**	David McMahon

INPUT DATA

Design Wastewater Flow	Q	840	L/day	Based on maximum potential occupancy and derived from Table 5.2 AS1547:2012
Design Irrigation Rate	DIR	3.0	mm/day	Based on conservative soil texture class/permeability and derived from Table M AS1547:2012
Nominated Land Application Area	L	309	m^2	[1]
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type[2]
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Mean Monthly Rainfall Data	Griffith AWS (075041)			BoM Station and number
Mean Monthly Pan Evaporation Data	Griffith CSIRO (075028)			BoM Station and number

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Evaporation	E		mm/month	269.7	224	186	105	62	42	49.6	71.3	102	151.9	213	251.1	1727.6
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	216	179	130	74	37	25	30	43	71	122	170	201	1297.8
Percolation	B	DIRxD	mm/month	93.0	84	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	1095.0
Outputs		ET+B	mm/month	308.8	263.2	223.2	163.5	130.2	115.2	122.8	135.8	161.4	214.5	260.4	293.9	2392.8
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Applied Effluent	W	(QxD)/L	mm/month	84.3	76.1	84.3	81.6	84.3	81.6	84.3	84.3	81.6	84.3	81.6	84.3	992.2
Inputs		RR+W	mm/month	117.4	106.1	120.9	109.4	119.3	115.0	117.5	119.5	113.7	122.8	115.8	116.7	1393.7
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-191.4	-157.1	-102.3	-54.1	-10.9	-0.2	-5.3	-16.3	-47.7	-91.7	-144.6	-177.2	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	94	101	140	186	274	308	291	259	195	148	111	100	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 309.0 m^2

CELLS

(blue)	Please enter data in blue cells
XX (red)	Red cells are automatically populated by the spreadsheet
XX (yellow)	Data in yellow cells is calculated by the spreadsheet, DO NOT ALTER THESE CELLS

NOTES

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[2] Values selected are conservative and are suitable for pasture grass

Land Capability Assessment

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations

Site Address:	**West Rd & Boorga Road, Nericon NSW 2680**		
Date:	2,015	**Assessor:**	David McMahon

INPUT DATA

Design Wastewater Flow	Q	840	L/day	Based on maximum potential occupancy and derived from Table 5.2 AS1547:2012
Design Irrigation Rate	DIR	3.5	mm/day	Based on conservative soil texture class/permeability and derived from Table M AS1547:2012
Nominated Land Application Area	L	261	m^2	[1]
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type[2]
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Mean Monthly Rainfall Data	Griffith AWS (075041)			BoM Station and number
Mean Monthly Pan Evaporation Data	Griffith CSIRO (075028)			BoM Station and number

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Evaporation	E		mm/month	269.7	224	186	105	62	42	49.6	71.3	102	151.9	213	251.1	1727.6
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	216	179	130	74	37	25	30	43	71	122	170	201	1297.8
Percolation	B	DIRxD	mm/month	108.5	98	108.5	105.0	108.5	105.0	108.5	108.5	105.0	108.5	105.0	108.5	1277.5
Outputs		ET+B	mm/month	324.3	277.2	238.7	178.5	145.7	130.2	138.3	151.3	176.4	230.0	275.4	309.4	2575.3
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Applied Effluent	W	(QxD)/L	mm/month	99.8	90.1	99.8	96.6	99.8	96.6	99.8	99.8	96.6	99.8	96.6	99.8	1174.7
Inputs		RR+W	mm/month	132.9	120.1	136.4	124.4	134.8	130.0	133.0	135.0	128.7	138.3	130.8	132.2	1576.2
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-191.4	-157.1	-102.3	-54.1	-10.9	-0.2	-5.3	-16.3	-47.7	-91.7	-144.6	-177.2	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	89	95	129	167	235	260	248	224	175	136	104	94	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 261.0 m^2

CELLS

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NOTES

[1] This value should be the largest of the following: land application area required based on the most limiting nutrient balance or minimum area required for zero storage

[2] Values selected are conservative and are suitable for pasture grass

Land Capability Assessment

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations

Site Address:	West Rd & Boorga Road, Nericon NSW 2680		
Date:	2,015	**Assessor:**	David McMahon

INPUT DATA

Design Wastewater Flow	Q	840	L/day	Based on maximum potential occupancy and derived from Table 5.2 AS1547:2012
Design Irrigation Rate	DIR	4.0	mm/day	Based on conservative soil texture class/permeability and derived from Table M AS1547:2012
Nominated Land Application Area	L	226	m^2	[1]
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type[2]
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Mean Monthly Rainfall Data	Griffith AWS (075041)			BoM Station and number
Mean Monthly Pan Evaporation Data	Griffith CSIRO (075028)			BoM Station and number

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Evaporation	E		mm/month	269.7	224	186	105	62	42	49.6	71.3	102	151.9	213	251.1	1727.6
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	216	179	130	74	37	25	30	43	71	122	170	201	1297.8
Percolation	B	DIRxD	mm/month	124.0	112	124.0	120.0	124.0	120.0	124.0	124.0	120.0	124.0	120.0	124.0	1460.0
Outputs		ET+B	mm/month	339.8	291.2	254.2	193.5	161.2	145.2	153.8	166.8	191.4	245.5	290.4	324.9	2757.8
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Applied Effluent	W	(QxD)/L	mm/month	115.2	104.1	115.2	111.5	115.2	111.5	115.2	115.2	111.5	115.2	111.5	115.2	1356.6
Inputs		RR+W	mm/month	148.3	134.1	151.8	139.3	150.2	144.9	148.4	150.4	143.6	153.7	145.7	147.6	1758.1
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-191.4	-157.1	-102.4	-54.2	-11.0	-0.3	-5.3	-16.4	-47.8	-91.8	-144.7	-177.3	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	85	90	120	152	206	225	216	198	158	126	98	89	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 226.0 m^2

CELLS

(blue)	Please enter data in blue cells
XX (red)	Red cells are automatically populated by the spreadsheet
XX (yellow)	Data in yellow cells is calculated by the spreadsheet, DO NOT ALTER THESE CELLS

NOTES

[1] This value should be the largest of the following: land application area required based on the most limiting nutrient balance or minimum area required for zero storage

[2] Values selected are conservative and are suitable for pasture grass

Land Capability Assessment

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations

Site Address:	West Rd & Boorga Road, Nericon NSW 2680		
Date:	2,015	**Assessor:**	David McMahon

INPUT DATA

Design Wastewater Flow	Q	840	L/day	Based on maximum potential occupancy and derived from Table 5.2 AS1547:2012
Design Irrigation Rate	DIR	5.0	mm/day	Based on conservative soil texture class/permeability and derived from Table M AS1547:2012
Nominated Land Application Area	L	178	m^2	1
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type[2]
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Mean Monthly Rainfall Data	Griffith AWS (075041)			BoM Station and number
Mean Monthly Pan Evaporation Data	Griffith CSIRO (075028)			BoM Station and number

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Evaporation	E		mm/month	269.7	224	186	105	62	42	49.6	71.3	102	151.9	213	251.1	1727.6
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	216	179	130	74	37	25	30	43	71	122	170	201	1297.8
Percolation	B	DIRxD	mm/month	155.0	140	155.0	150.0	155.0	150.0	155.0	155.0	150.0	155.0	150.0	155.0	1825.0
Outputs		ET+B	mm/month	370.8	319.2	285.2	223.5	192.2	175.2	184.8	197.8	221.4	276.5	320.4	355.9	3122.8
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Applied Effluent	W	(QxD)/L	mm/month	146.3	132.1	146.3	141.6	146.3	141.6	146.3	146.3	141.6	146.3	141.6	146.3	1722.5
Inputs		RR+W	mm/month	179.4	162.1	182.9	169.4	181.3	175.0	179.5	181.5	173.7	184.8	175.8	178.7	2124.0
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-191.4	-157.1	-102.3	-54.1	-10.9	-0.2	-5.3	-16.3	-47.7	-91.7	-144.6	-177.2	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	77	81	105	129	166	178	172	160	133	109	88	80	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 178.0 m^2

CELLS

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NOTES

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2 Values selected are conservative and are suitable for pasture grass

Land Capability Assessment

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations

Site Address:	West Rd & Boorga Road, Nericon NSW 2680		
Date:	2,015	**Assessor:**	David McMahon

INPUT DATA

Design Wastewater Flow	Q	980	L/day	Based on maximum potential occupancy and derived from Table 5.2 AS1547:2012
Design Irrigation Rate	DIR	3.0	mm/day	Based on conservative soil texture class/permeability and derived from Table M AS1547:2012
Nominated Land Application Area	L	360	m^2	1
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type[2]
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Mean Monthly Rainfall Data	Griffith AWS (075041)			BoM Station and number
Mean Monthly Pan Evaporation Data	Griffith CSIRO (075028)			BoM Station and number

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Evaporation	E		mm/month	269.7	224	186	105	62	42	49.6	71.3	102	151.9	213	251.1	1727.6
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	216	179	130	74	37	25	30	43	71	122	170	201	1297.8
Percolation	B	DIRxD	mm/month	93.0	84	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	1095.0
Outputs		ET+B	mm/month	308.8	263.2	223.2	163.5	130.2	115.2	122.8	135.8	161.4	214.5	260.4	293.9	2392.8
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Applied Effluent	W	(QxD)/L	mm/month	84.4	76.2	84.4	81.7	84.4	81.7	84.4	84.4	81.7	84.4	81.7	84.4	993.6
Inputs		RR+W	mm/month	117.5	106.2	121.0	109.5	119.4	115.1	117.6	119.6	113.8	122.9	115.9	116.8	1395.1
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-191.3	-157.0	-102.2	-54.0	-10.8	-0.1	-5.2	-16.2	-47.6	-91.6	-144.5	-177.1	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	110	118	163	217	319	359	339	302	227	173	130	116	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 360.0 m^2

CELLS

- (blue) Please enter data in blue cells
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NOTES

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2 Values selected are conservative and are suitable for pasture grass

Land Capability Assessment

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations

Site Address: West Rd & Boorga Road, Nericon NSW 2680

Date: 2,015 **Assessor:** David McMahon

INPUT DATA

Design Wastewater Flow	Q	980	L/day	Based on maximum potential occupancy and derived from Table 5.2 AS1547:2012
Design Irrigation Rate	DIR	3.5	mm/day	Based on conservative soil texture class/permeability and derived from Table M AS1547:2012
Nominated Land Application Area	L	304	m^2	[1]
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type[2]
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Mean Monthly Rainfall Data	Griffith AWS (075041)			BoM Station and number
Mean Monthly Pan Evaporation Data	Griffith CSIRO (075028)			BoM Station and number

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Evaporation	E		mm/month	269.7	224	186	105	62	42	49.6	71.3	102	151.9	213	251.1	1727.6
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	216	179	130	74	37	25	30	43	71	122	170	201	1297.8
Percolation	B	DIRxD	mm/month	108.5	98	108.5	105.0	108.5	105.0	108.5	108.5	105.0	108.5	105.0	108.5	1277.5
Outputs		ET+B	mm/month	324.3	277.2	238.7	178.5	145.7	130.2	138.3	151.3	176.4	230.0	275.4	309.4	2575.3
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Applied Effluent	W	(QxD)/L	mm/month	99.9	90.3	99.9	96.7	99.9	96.7	99.9	99.9	96.7	99.9	96.7	99.9	1176.6
Inputs		RR+W	mm/month	133.0	120.3	136.5	124.5	134.9	130.1	133.1	135.1	128.8	138.4	130.9	132.3	1578.1
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-191.2	-156.9	-102.2	-54.0	-10.8	-0.1	-5.1	-16.1	-47.6	-91.6	-144.5	-177.0	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	104	111	150	195	274	304	289	262	204	159	122	110	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 304.0 m^2

CELLS

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NOTES

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[2] Values selected are conservative and are suitable for pasture grass

Land Capability Assessment

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations

Site Address:	West Rd & Boorga Road, Nericon NSW 2680			
Date:	2,015	**Assessor:**	David McMahon	

INPUT DATA

Design Wastewater Flow	Q	980	L/day	Based on maximum potential occupancy and derived from Table 5.2 AS1547:2012
Design Irrigation Rate	DIR	4.0	mm/day	Based on conservative soil texture class/permeability and derived from Table M AS1547:2012
Nominated Land Application Area	L	263	m^2	1
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type[2]
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Mean Monthly Rainfall Data	Griffith AWS (075041)			BoM Station and number
Mean Monthly Pan Evaporation Data	Griffith CSIRO (075028)			BoM Station and number

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Evaporation	E		mm/month	269.7	224	186	105	62	42	49.6	71.3	102	151.9	213	251.1	1727.6
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	216	179	130	74	37	25	30	43	71	122	170	201	1297.8
Percolation	B	DIRxD	mm/month	124.0	112	124.0	120.0	124.0	120.0	124.0	124.0	120.0	124.0	120.0	124.0	1460.0
Outputs		ET+B	mm/month	339.8	291.2	254.2	193.5	161.2	145.2	153.8	166.8	191.4	245.5	290.4	324.9	2757.8
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Applied Effluent	W	(QxD)/L	mm/month	115.5	104.3	115.5	111.8	115.5	111.8	115.5	115.5	111.8	115.5	111.8	115.5	1360.1
Inputs		RR+W	mm/month	148.6	134.3	152.1	139.6	150.5	145.2	148.7	150.7	143.9	154.0	146.0	147.9	1761.6
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-191.1	-156.9	-102.1	-53.9	-10.7	0.0	-5.0	-16.1	-47.5	-91.5	-144.4	-177.0	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	99	105	140	177	241	263	252	231	185	147	115	104	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 263.0 m^2

CELLS

(blue)	Please enter data in blue cells
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NOTES

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[2] Values selected are conservative and are suitable for pasture grass

Land Capability Assessment

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations

Site Address:	**West Rd & Boorga Road, Nericon NSW 2680**
Date:	2,015
Assessor:	David McMahon

INPUT DATA

Design Wastewater Flow	Q	980	L/day	Based on maximum potential occupancy and derived from Table 5.2 AS1547:2012
Design Irrigation Rate	DIR	5.0	mm/day	Based on conservative soil texture class/permeability and derived from Table M AS1547:2012
Nominated Land Application Area	L	208	m^2	[1]
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type[2]
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Mean Monthly Rainfall Data	Griffith AWS (075041)			BoM Station and number
Mean Monthly Pan Evaporation Data	Griffith CSIRO (075028)			BoM Station and number

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R		mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Evaporation	E		mm/month	269.7	224	186	105	62	42	49.6	71.3	102	151.9	213	251.1	1727.6
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	216	179	130	74	37	25	30	43	71	122	170	201	1297.8
Percolation	B	DIRxD	mm/month	155.0	140	155.0	150.0	155.0	150.0	155.0	155.0	150.0	155.0	150.0	155.0	1825.0
Outputs		ET+B	mm/month	370.8	319.2	285.2	223.5	192.2	175.2	184.8	197.8	221.4	276.5	320.4	355.9	3122.8
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	33.1	30	36.6	27.8	35	33.4	33.2	35.2	32.1	38.5	34.2	32.4	401.5
Applied Effluent	W	(QxD)/L	mm/month	146.1	131.9	146.1	141.3	146.1	141.3	146.1	146.1	141.3	146.1	141.3	146.1	1719.7
Inputs		RR+W	mm/month	179.2	161.9	182.7	169.1	181.1	174.7	179.3	181.3	173.4	184.6	175.5	178.5	2121.2
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-191.6	-157.3	-102.5	-54.4	-11.1	-0.5	-5.5	-16.5	-48.0	-92.0	-144.9	-177.4	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	90	95	122	150	193	207	200	187	155	128	103	94	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 208.0 m^2

CELLS

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NOTES

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[2] Values selected are conservative and are suitable for pasture grass

Nitrogen Balance

Site Address:	**West Rd & Boorga Road, Nericon NSW 2680**							
SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE							93	m^2

INPUT DATA[1]

Wastewater Loading			Nutrient Crop Uptake				
Hydraulic Load	700	L/day	Crop N Uptake	220	kg/ha/yr	which equals	60.27 mg/m²/day
Effluent N Concentration	10	mg/L					
% N Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal					
Total N Loss to Soil	1400	mg/day					
Remaining N Load after soil loss	5600	mg/day					

NITROGEN BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer			Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nitrogen	93	m^2	Nominated LAA Size	257	m^2
			Predicted N Export from LAA	-3.61	kg/year
			Minimum Buffer Required for excess nutrient	0	m^2

CELLS

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NOTES

[1] Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as:

- *EPA Guidelines for Effluent Irrigation*
- *Appropriate Peer Reviewed Papers*
- *Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households*
- *USEPA Onsite Systems Manual*

Nitrogen Balance

Site Address:	**West Rd & Boorga Road, Nericon NSW 2680**					
SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE					111	m^2

INPUT DATA[1]

Wastewater Loading			Nutrient Crop Uptake					
Hydraulic Load	840	L/day	Crop N Uptake	220	kg/ha/yr	which equals	60.27	$mg/m^2/day$
Effluent N Concentration	10	mg/L						
% N Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal						
Total N Loss to Soil	1680	mg/day						
Remaining N Load after soil loss	6720	mg/day						

NITROGEN BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer			Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nitrogen	111	m^2	Nominated LAA Size	309	m^2
			Predicted N Export from LAA	-4.35	kg/year
			Minimum Buffer Required for excess nutrient	0	m^2

CELLS

(blue)	Please enter data in blue cells
XX (red)	Red cells are automatically populated by the spreadsheet
XX (yellow)	Data in yellow cells is calculated by the spreadsheet, DO NOT ALTER THESE CELLS

NOTES

[1] Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as:

- *EPA Guidelines for Effluent Irrigation*
- *Appropriate Peer Reviewed Papers*
- *Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households*
- *USEPA Onsite Systems Manual*

Nitrogen Balance

Site Address:	**West Rd & Boorga Road, Nericon NSW 2680**				
SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE				130	m²

INPUT DATA[1]

Wastewater Loading		
Hydraulic Load	980	L/day
Effluent N Concentration	10	mg/L
% N Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal
Total N Loss to Soil	1960	mg/day
Remaining N Load after soil loss	7840	mg/day

Nutrient Crop Uptake					
Crop N Uptake	220	kg/ha/yr	which equals	60.27	mg/m²/day

NITROGEN BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer		
Nitrogen	130	m²

Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nominated LAA Size	360	m²
Predicted N Export from LAA	-5.06	kg/year
Minimum Buffer Required for excess nutrient	0	m²

CELLS

	Please enter data in blue cells
XX	Red cells are automatically populated by the spreadsheet
XX	Data in yellow cells is calculated by the spreadsheet, DO NOT ALTER THESE CELLS

NOTES

[1] Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as:

- *EPA Guidelines for Effluent Irrigation*
- *Appropriate Peer Reviewed Papers*
- *Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households*
- *USEPA Onsite Systems Manual*

SOIL ANALYSIS

YARA

Analysis Results (SOIL)

Customer ANDY RYAN
C/- AG GROW AGRONOMY

Distributor AG GROW AGRONOMY
7 FRANCINE COURT
YOOGALI
NSW
2680

Sample Ref LAKE SOUTH 0-10
Sample No B071189A / SBB3250
Crop WHEAT

Date Received 26/02/2014

Analysis	Result	Guideline	Interpretation	Comments
pH [1:5 H2O]*	7.1	5.5 - 8.1	Normal	Ideal range = 5.5 - 8.1. pH is in the normal range.
pH [1:5 CaCl2]	6.4	4.9 - 7.5	Normal	Ideal range = 4.9 - 7.5. pH is in the normal range.
Organic Matter (%)	2.0	3.0 - 8	Slightly Low	Ideal range = 3 - 8%. Low organic matter has effects on CEC, moisture retention and soil structure as well as reducing potential nitrogen release. Incorporate organic matter where appropriate.
CEC (meq/100g)	10.89	12.00 - 40	Slightly Low	Ideal range = 12 - 40 meq/100g. Indicates a soil with slightly low nutrient holding capacity. Regular (annual) fertilizer applications will help reduce leaching. Addition of organic matter will help.
EC [1:5 H2O] (dS/m)	0.14	0.90 - 3	Low	Ideal range = 0.9 - 3.0. No problems of salinity expected with this soil.
NO3-N (ppm)	29.9	15.0 - 70	Normal	Normal level of nitrate-nitrogen is recorded indicating adequate supply of readily available nitrogen.
NH4-N (ppm)	2.0			
Phosphorus [Colwell] (ppm)	37	43 - 150	Slightly Low	Slightly low level of phosphorus is recorded.
Potassium[Am. Acet.] (meq/100g)	1.81	0.50 - 1.2	High	Level recorded is high and may interfere with uptake of magnesium and boron.
Calcium[Am. Acet.] (meq/100g)	6.05	5.00 - 15	Normal	Level recorded in the soil is in the normal range but this does not guarantee that developing crops will be adequately supplied with this essential nutrient.
Magnesium[Am. Acet.]* (meq/100g)	2.64	0.80 - 4.5	Normal	Level recorded is in the normal range.
Sulphur [MCP]* (ppm)	5	8 - 20	Slightly Low	Slightly low level of sulphur recorded. Sulphur is essential for normal crop development. Deficiency affects photosynthesis and reduces yield and quality of production.
Boron[CaCl2] (ppm)	1.0	1.0 - 5	Normal	Boron level recorded is in the normal range.
Copper [DTPA] (ppm)	1.0	2.5 - 20	Low	Low level of copper recorded. Copper is essential for normal crop development. Deficiency affects photosynthesis and reduces yield and quality of production.
Iron [DTPA] (ppm)	17	5 - 120	Normal	Level of iron recorded is in the normal range.
Manganese [DTPA] (ppm)	29.8	5.0 - 60	Normal	Level of manganese recorded is in the normal range.
Zinc [DTPA] (ppm)	0.7	5.0 - 15	Very Low	Very low level of zinc recorded. Zinc is essential for normal crop development and often results in stunted crops with small leaves.

YARA

Analysis Results (SOIL)

Customer	ANDY RYAN C/- AG GROW AGRONOMY	**Distributor**	AG GROW AGRONOMY 7 FRANCINE COURT YOOGALI NSW 2680
Sample Ref	LAKE SOUTH 0-10	**Date Received**	26/02/2014
Sample No	B071189A / SBB3250		
Crop	WHEAT		

Analysis	Result	Guideline	Interpretation	Comments
Sodium[Am. Acet.] (meq/100g)	0.2	0.3 - 3	Slightly Low	No problem.Low levels are desirable.
Aluminium[KCl] (meq/100g)	0.17	1.00 - 2.5	Low	No problem.Low levels are desirable.
Chloride* (ppm)	22	200 - 1100	Very Low	No problem.Low levels are desirable.
Ca base saturation (%)	55.6		Normal	Calcium base saturation is in desirable range (50-75%).
K base saturation (%)	16.6		High	Potassium base saturation is high (desired range is 2-5%). Check base saturations for Ca, Mg & Na.
Mg base saturation (%)	24.2		High	Magnesium base saturation is high (desired range is 5-15%). Check base saturations for K, Ca & Na.
Na base saturation (%)	2.0		High	Sodium base saturation is high (desired range is 1-2%). Check base saturations for K, Mg & Ca.
Al base saturation (%)	1.60			
Ca:Mg Ratio	2.3	2.5 - 3	Slightly Low	Ca/Mg ratio provided for reference only. Slightly low level indicates possible need for around 2 t/ha gypsum addition.
Texture	SANDYLOAM			
Colour	BROWN			
Aluminium (ppm)	15.0			
Sodium (ppm)	51.0			
Calcium (ppm)	1210.0			
Magnesium (ppm)	317.0			
Potassium (ppm)	706.0			
Lime Requirement (t/ha)	< 0.50			

YARA

Analysis Results (SOIL)

Customer	ANDY RYAN C/- AG GROW AGRONOMY	**Distributor**	AG GROW AGRONOMY 7 FRANCINE COURT YOOGALI NSW 2680
Sample Ref	LAKE SOUTH 0-10	**Date Received**	26/02/2014
Sample No	B071189A / SBB3250		
Crop	WHEAT		

Additional Comments

Aluminium (Al): 1 meq/100g equals 90 ppm Potassium (K): 1 meq/100g equals 390 ppm Sodium (Na): 1 meq/100g equals 230 ppm Magnesium (Mg): 1 meq/100g equals 120ppm Calcium (Ca): 1 meq/100g equals 200ppm You should consult your local agronomist and/or Yara representative before deciding upon any course of action based on this report.

Please Note

Whilst every care is taken to ensure that the Results from Analysis are as accurate as possible, it is important to note that the analysis relates to the sample received by the laboratory, and is representative only of that sample. No warranty is given by the laboratory that the Results from Analysis relates to any part of a field or growing area not covered by the sample received. It is important to ensure that any soil, leaf, silage or fruitlet sample sent for analysis is representative of the area requiring analysis and that samples are obtained in accordance with established sampling techniques. A leaflet containing instructions on how to take soil, leaf, herbage, silage and fruit samples for analysis is available from the laboratory on request.

This report has been generated by Yara's Megalab™ software.

This laboratory has been awarded a Certificate of Proficiency for specific soil and plant tissue analyses by the Australasian Soil and Plant Analysis Council (ASPAC). Tests for which proficiency has been demonstrated are highlighted in this report with an asterisk.

Phosyn Analytical, 1/60 Junction Road,
Andrews, Queensland 4220, Australia
Tel: +61 7 5568 8700
Fax: +61 7 5522 0720
Email: phosynanalytical@phosyn.com.au

Nursery & Garden Industry Australia PARTNER

AUSTRALIAN FORESTRY STANDARD AFS/01-44-12 CERTIFIED

ASPAC CERTIFIED

Date Printed : 28/02/2014

Analysis Results (SOIL)

Customer	ANDY RYAN C/- AG GROW AGRONOMY	**Distributor**	AG GROW AGRONOMY 7 FRANCINE COURT YOOGALI NSW 2680
Sample Ref	LAKE SOUTH 10-60	**Date Received**	26/02/2014
Sample No	B071189B / SBB3251		
Crop	WHEAT		

Analysis	Result	Guideline	Interpretation	Comments
NO3-N (ppm)	12.4	15.0 - 70	Slightly Low	Slightly low level indicates possible leaching of nitrate-nitrogen. If soil sampled at around 15cm, consider deeper sampling to ascertain subsoil nitrogen level.
NH4-N (ppm)	< 1.0			

Additional Comments

You should consult your local agronomist and/or Yara representative before deciding upon any course of action based on this report.

Please Note

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PHOSYN ANALYTICAL
Phosyn Analytical, 1/60 Junction Road, Andrews, Queensland 4220, Australia
Tel: +61 7 5568 8700
Fax: +61 7 5522 0720
Email: phosynanalytical@phosyn.com.au

SUMMARY OF SOIL ANALYSIS

Site	pH H_2O	EC mS/cm	EAT	Site	pH H_2O	EC mS/cm	EAT
1/1	7.56	0.15	5	15/2	7.74	0.20	3
1/2	7.52	0.61	3	16/1	7.25	0.32	3
2/1	7.61	0.04	3	16/2	7.32	1.19	3
2/2	7.21	0.10	5	17/1	7.03	0.10	3
3/1	7.60	0.11	5	17/2	7.50	0.21	5
3/2	7.89	0.31	3	18/1	6.79	0.13	3
4/1	7.79	0.08	3	18/2	7.43	0.17	5
4/2	7.75	0.12	3	19/1	7.25	0.23	5
5/1	7.70	0.10	4	19/2	7.58	0.36	3
5/2	7.76	0.18	3	19/3	6.91	1.50	6
5/3	7.74	0.26	3	20/1	6.84	0.10	3
6/1	7.55	0.12	3	20/2	7.44	0.15	5
6/2	7.83	0.17	3	21/1	6.88	0.14	3
6/3	7.80	0.30	3	21/2	7.36	0.21	6
7/1	7.81	0.05	3	22/1	6.92	0.22	3
8/1	7.79	0.32	5	22/2	7.16	0.47	3
8/2	7.96	0.16	5	23/1	6.51	0.14	3
9/1	7.79	0.11	5	23/2	6.98	0.11	6
10/1	7.26	0.09	3	23/3	7.36	0.15	3
10/2	7.70	0.09	5	24/1	7.05	0.31	3
11/1	6.99	0.10	3	24/2	6.69	1.72	2
11/2	7.90	1.03	6	25/1	6.92	0.20	3
12/1	8.06	0.22	5	25/2	7.40	0.38	3
13/1	7.28	0.12	3	26/1	6.94	0.29	5
13/2	7.90	0.20	5	26/2	6.65	0.30	3
14/1	7.14	0.29	3	27/1	6.18	0.14	2
14/2	7.35	1.07	5	27/2	7.09	0.11	3
15/1	7.06	0.16	3	27/3	7.24	0.46	3