

LAND CAPABILITY ASSESSMENT

REPORT 2020

SOUTH WEST PRECINCT
NARRANDERA NSW 2700

JOB NO: 6736

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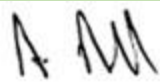

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Executive summary

This document provides an initial assessment of the land capability for the south west Narrandera On Site Sewage Management System (OSSMS) scoping study. The scoping study covers an area of south west Narrandera approximately 286ha, referred to as the subject site. The subject site consists of the areas known as Dixonville, Sand Hills, South West Narrandera, Cemetery and Brewery Flat. A map of the subject site can be seen in **Attachment A**.

The site investigation and assessment has been conducted by reference to industry standards and guidelines namely:

- Standards Australia AS1547-2012 On-site Domestic Wastewater Management.
- Environmental guidelines, Use of Effluent by Irrigation, Department of Environment and Conservation, DEC (2004).

The site investigation included a land study, soil survey and groundwater investigation with the results compared to the criteria as described in the standard and guideline above.

The results of the investigation found a soil and landscape with low limitations regarding treated effluent application. The risk to on or offsite environmental receptors (i.e. surface water and groundwater) is low given the adequate buffer distance and recommended management controls are adhered to. As such, the recommended wastewater treatment system is an Aerated Wastewater Treatment System (AWTS) and the size of the land application area will be site specific dependant on the size and nature of the development.

In conclusion, the assessment shows that the site is suitable for land application of treated effluent on a per lot basis with low risk to human health and the environment given an AWTS with drip or spray irrigation is used with appropriate regulatory controls and recommendations adhered to within this report.

It is recommended that a site-specific assessment of each lot is conducted for land application of treated effluent sizing as part of the Development Application process once plans are lodged with Council. This will ensure adequate sizing of the irrigation areas based on the household wastewater flow volume and design irrigation rates supplied in this report.

1.0 Introduction

The background and scope of works for this assessment are as follows.

Background

At the request of Neil Smith of Building & Environmental Services Today (BEST), a Land Capability Assessment (LCA) was carried out on the site. Narrandera Shire Council requested the report as part of the OSSMS scoping study to assess the suitability of the subject site to receive domestic treated wastewater on a per lot basis.

Scope of work

This report assesses the suitability of the site for land disposal of treated effluent disposal from domestic sources. The assessment has been carried out after a site investigation and comparison of the results to industry standards and guidelines, namely:

- Standards Australia AS1547-2012 On-site Domestic Wastewater Management.
- Environmental guidelines, Use of Effluent by Irrigation, Department of Environment and Conservation, DEC (2004).

The investigation conducted on site includes:

- Conducting a soil survey for the soil landscape physical and chemical characteristics.
- Investigating the physical and chemical groundwater conditions underneath the site.

The assessment on the results of the investigation includes:

- Confirm the relevance of the physical characteristics of the soil, landform and groundwater on site from a desktop review and on-site investigation in relation to residential treated effluent disposal.
- Assess the soil, landform and groundwater conditions to identify suitability and/or limitations relevant to the residential treated effluent disposal.
- Confirm the suitability of the site or otherwise for the proposed residential treated effluent disposal.
- Identify any 'moderate' soil limitations that will require special management practices by reference to AS1547:2012 and DEC 2004.
- Identify the minimum disposal area for the site based on potential house sizes and likely quality and quantity and wastewater generated at the site.
- Undertake hydraulic and nutrient balance modelling to assess the minimum treated effluent land application area requirements.
- Prepare a written report discussing results and recommendations for the wastewater treatment and disposal system.

2.0 Site identification

Details of the subject site identification can be seen as follows, **Table 1**.

Table 1: *Site identification*

Identifier	Details
Address	South west precinct Narrandera NSW 2700
Real property description	Various
Centre co-ordinate	457725E 6155240N MGA GDA z55
Study area	286ha approximately
Owner	Various
Local Government Area	Narrandera Shire Council
Present use	Residential Agricultural Recreational Utilities
Zoning	Ru5 – Village In2 – Light Industrial
Development Application reference	Unknown

3.0 Physical characteristics of the site and surrounds

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 Bogolong Hills and Berembred Weir 1:50,000 Topographic Maps (Sheets 8228-N & 8228-S) indicates that the site is located at an elevation range of approximately 150 to 170m AHD. The site generally slopes towards the south from the sandy low rises associated with the Dixonville and Cemetery precinct and to the grey clayey high floodplain of the Murrumbidgee River. Site relief of the sandy low rises is classed as very low (<20m) with a gently to very gently inclined modal terrain slope (3-6%). The site relief of the high floodplain is classed as extremely low (<5m) with a level to very gently inclined modal terrain slope (<1-3%) with some minor variation associated with the Murrumbidgee River floodplain, low levees, channels and backplains. The landform pattern is classed as low rises and plains with unidirectional stream channels. There is continuously active sheet flow, creep and channelled stream flow altering the site and surrounding landform.

Vegetation

The vegetation formation of the subject site is mapped as 'cleared' with 'forested wetland' (Inland Riverine forest) to the south and 'grassy woodland' (floodplain transition woodland) to the north west, as classified by Keith and Simpson (2005).

The landscape that hosts the vegetation is complex and is mapped in order of ascending elevation by Mitchell (2002) as:

Murrumbidgee - Tarcutta Channels and Floodplains

Channels, floodplain and terraces of Murrumbidgee tributaries on Quaternary alluvium, general elevation 200 to 400m, local relief 25m. Undifferentiated organic sand and loam on the floodplain, brown gradational loam and yellow texture-contrast soils on higher terraces. River red gum gallery woodland on banks, yellow box and grey box open woodland on floodplain and terraces.

Murrumbidgee Source-bordering

Sandy rises adjacent to river channels and along prior streambeds, deep red and brown sands and loams, relief 3 to 12m. Often heavily grazed and subject to wind erosion. White cypress pine, needlewood, hooked needlewood, wilga, bull oak, emu bush, miljee, yarran, native quince, thorny saltbush, western pittosporum, belah, some bimble box, narrow-leaf hopbush with sparse grasses. Black bluebush occurs in the shrub layer in western areas.

Murrumbidgee Scalded Plains

Quaternary alluvial plains with extensive scalding interpreted as relic floodplains or terraces. Grey, brown and red cracking clays, red brown texture-contrast soils with scalds. Levees traces evident, relief generally <1m, up to 5m on associated pans, swamps and lunettes. Low shrublands and grasslands of bladder saltbush, other annual saltbushes, numerous burrs, cottonbush, bush minuria, white-top grass, windmill grass, and hill wallaby grass.

Cocoparra Ranges and Footslopes

Steep crested ranges, ridges, hills and associated footslopes of Quaternary colluvium with outcrops of upper Devonian sandstone, conglomerate and siltstones. Cliff faces to 30m, bouldery hill slopes with overall relief to 260m. Extensive rock outcrop, shallow sandy lithosols, acid, neutral and calcareous red earths on slopes and deep sandy alluvium in creek lines. On ranges; scattered white cypress pine, currawang, Dwyer's mallee gum, and red ironbark; locally dense broombush, hill tea-tree, urn heath, wedge-leaf hopbush, punty bush, cough bush, sugarwood, grey box, wilga, and Deane's wattle; rock fern, wire grass, mulga grass,

short grasses and forbs. On lower slopes bumble box, white cypress pine, mallees, yarran, wilga, emu bush and various acacia with grasses and forbs.

At the time of the site inspection the site groundcover was annual and perennial grasses and broadleaf species with eucalypt, pine and exotic tree species. This description is not to be relied as a definitive flora survey and should be used as a general observation as it is outside of the scope of works and area of expertise of McMahon.

Natural Resources Sensitivity

There are areas mapped as biodiversity in the Narrandera Local Environmental Plan (LEP) 2013. These areas are generally associated with the wooded areas on the lower ground.

Hydrology

The subject site is part of the Murrumbidgee catchment under the Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012. The site lies in a highly modified hydrological environment being the Main Canal (part of Murrumbidgee Irrigation's supply network) intersecting and forming part of the south west boundary of the study area. The Murrumbidgee River and associated floodplain forms the southern boundary of the subject site with an unnamed unidirectional drainage following the near levee environs of the high floodplain. Generally, natural stream channels along the floodplain in the area are widely spaced forming interrupted and integrated channel networks of a tributary to non-tributary pattern. The Murrumbidgee River flows west as a major tributary of the Murray River within the Murray–Darling basin system.

There is a 3ha dam on Bridge Street in the eastern extent of the subject site.

Areas between the Main Canal and Murrumbidgee River are likely to be inundated during a 1% Annual Exceedance Probability (AEP) and extreme flood events, Narrandera Shire Council (2019).

Climate

The average rainfall for Narrandera is approximately 445mm per annum, with the wettest months being June, August and October. Annual mean evaporation is approximately 17862mm with mean daily evaporation ranges from 1.3mm in June to 9.2mm in January. Narrandera is characterised by cold wet winters and hot dry summers with mean maximum temperatures ranging from 14.1°C in July to 33.0°C in January and mean minimum temperatures ranging from 3.3°C in July to 17.2°C in January and February. Rainfall, temperature and evaporation data from the long term (1890-2020) patched point data drill for Narrandera Post Office (Station 074082 Latitude -34.75 Longitude 146.55), QLD Govt (2020).

Soil & landform

The site lies within the mapping unit **B11** from the Digital Atlas of Australian Soils, BRS (1991). The map unit **B11** is described as:

Sandhills and sand sheets: chief soils are siliceous sands (Uc1.22 and Uc1.23). Associated are sandy neutral and alkaline yellow mottled soils (Dy5.42 and Dy5.43) and other, undescribed soils. As mapped, narrow areas of unit Gb5 occur along the river. Gb5 is described as: River terraces and flood-plains with lagoons and swamps, well drained to poorly drained, some areas subject to periodic inundation: chief soils are probably dark porous loamy soils (Um6.11) on terraces and levee formations with various (Uc) and (Um) soils on present flood-plains. Associated are variable areas of the soils recorded for unit Va15 on terrace remnants and adjoining slopes. Data are limited. As mapped, areas of soils of the adjoining units may be included. Occurs on sheet(s): 3"

From the site inspection and sampling the soils on site are synonymous with B11 soil classification with aeolian addition on the sandy low rises and near flood plain grey and brown clays with some red-brown earth associated with high floodplain environs.

Geology

The subject site in the north is underlain by the Cocoparra group sediments that are largely obscured by residual and alluvial deposits. The lower lying areas of the subject site in the south area the Murrumbidgee River floodplains of black and red clayey silt, sand and gravel.

Hydrogeology

The site lies within the Mid Murrumbidgee alluvial basin which contains two main regional layers that are not distinct aquifers but represent a gradual layering of water bearing deposits. The Cowra Formation extends from the surface to about 40m depth at Narrandera and consists of moderately yielding poorly sorted gravel layers interlayered with clay and silt. The Lachlan Formation underlies the Cowra Formation from about 40-160m below ground level with high yields in clean grey quartz sands and gravels, with intermittent layers of grey clay. Basement rock underlies thereunder providing a water bearing resource at the contact margin between the alluvium and bedrock.

There are 15 registered groundwater bores within the subject site and a map of their locations, and the available works summaries can be seen in **Attachment B**. A summary of the details of the bore's construction are shown as follows, BOM (2020), **Table 2**.

Table 2: Groundwater bore construction details

Bore ID	Drilled depth (m)	Date drilled	Purpose)	Works summary
GW401216.1.1	18.29	1996-04-01	Water Supply	No
GW020307.1.1	65.5	1963-05-01	Water Supply	Yes
GW402642.1.1	21.2	2004-01-30	Water Supply	No
GW416587.1.1	109	2013-02-16	Water Supply	No
GW416586.1.1	87	2013-10-10	Water Supply	No
GW403580.1.1	90	2006-05-05	Unknown	No
GW401953.1.1	44	2002-02-03	Unknown	No
GW404225.1.1	27	2007-12-16	Water Supply	Yes
GW400914.1.1	15	1999-06-23	Water Supply	Yes
GW030724.1.1	107	1977-11-01	Water Supply	Yes
GW025526.1.1	58.5	1965-04-01	Water Supply	Yes
GW416682.1.1	80	2015-07-30	Water Supply	No
GW030718.1.1	61	1977-11-01	Water Supply	Yes
GW030717.1.1	103	1977-03-01	Water Supply	Yes
GW030723.1.1	109	1977-08-01	Water Supply	Yes

From the data, it is assessed that a water bearing zone is unlikely to be intercepted within the near surface (<5m) across the subject site.

4.0 Site investigation

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

- In a special or project-oriented investigation, the effort must be concentrated on the particular site qualities and interpretations considered relevant for the intended use;
- Due to narrowly defined objectives, the investigation was selective in data collection and presentation and this report is therefore closely tailored to the site'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 site at that time.

By reference to the 'Guidelines for Surveying Soil & Land Resources' McKenzie et al 2008, a detailed investigation was carried out. Detailed investigations have an inspection density of 1 point per 5 to 25ha and the objectives are for 'detailed project planning'. The investigation had 19 investigation points for the 286 hectares which gives a physical sampling density of 1 point per 15 hectares which is at the coarse end of the density range.

4.1 Soil and landscape investigation

The field assessment included investigation with an auger to a maximum of 3m depth but generally 0.5m depth where the soil profile and physical characteristics were assessed as well as undertaking in-situ permeability which will be the representative guide to sizing the treated effluent disposal areas. McMahon has undertaken previous soil surveys within the subject site, especially in the Dixonville area, McMahon (2017). McMahan's observations and site knowledge from these jobs (2017) and others form part of the findings of this report. The permeability tests were undertaken using a well permeameter by reference to AS1547:2012 and McKenzie et al., (2002). AS1547:2012 and DEC 2004 will be referenced for soil assessment factors and constraints.

From the investigation and McMahon's knowledge of the subject site, the soils for effluent management can be loosely grouped into two management classes:

1. The soils on the lower ground site belong to the Dermosol and Chromosols soil classification and are respectively defined as: lacking a strong texture contrast between the silty clay A and structured clayey B horizon; and having strong texture contrast between the loamy A and sandy clay B horizons and with a pH of >5.5 in the B horizon. These soils are derived from the geomorphological processes of the Murrumbidgee River floodplain with soils becoming darker coloured and finer textured proximal to paleochannels. These alluvial soils of the floodplain have varying amounts of sand, clay and organic matter typical of the Murrumbidgee River complex.

The Dermosol profile mainly consists of two horizons:

1. A darker sandy to sandy loam organic surface layer (A horizon).
2. A lighter silty clay subsoil with moderate structure (B/C Horizon).

The Chromosol profiles mainly consist of three horizons:

1. A darker silty clay to silty clay loam organic surface layer (A horizon).
2. A slightly darker subsurface silty clay to clay horizon with moderate angular blocky structure (B horizon) with some sand addition noted throughout.
3. A lighter clayey subsoil that is characterised by the accumulation of sand and negligible pedological arrangement, (B/C horizon).

These soil types have a typical conservative permeability of 0.5-1.5m/day.

2. The soils on the higher ground site belong to the Rudosols and Chromosols soil classification and are respectively defined as: having negligible pedological organisation; and having strong texture contrast between the sandy A and clayey loam to sandy clay B horizons and with a pH of >5.5 in the B horizon. They are derived from windblown sands from the Murrumbidgee floodplain overlying thick alluvial sequences of Murrumbidgee River or slope-washed clayey sediments from hillslopes.

The Rudosols profiles mainly consists of two horizons:

1. A darker sandy organic surface layer (A horizon).
2. A lighter sandy subsoil with negligible structure (B/C Horizon).

The Chromosol profiles mainly consist of two horizons:

1. A darker fine sandy organic surface layer (A horizon).
3. A lighter clayey loam to sandy clay subsoil (B/C horizon) with negligible pedological arrangement (B/C horizon).

These soil types have a typical conservative permeability of 1.4-3.0m/day.

A copy of the bore logs with the laboratory and permeability results can be seen in **Attachment C**.

4.2 Soil analysis

26 soil samples were field tested for properties outlined by reference to DEC 2004. Soils were tested for pH, Electrical Conductivity (EC), and aggregate stability. Field testing results can be seen in the attached bore logs.

Topsoil Analysis

- Topsoil pH is classed as slightly acid 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.
- Aggregate stability tests returned nil to partial dispersion, which has nil or slight limitations by reference to DEC guidelines.

Subsoil Analysis

- pH is classed as neutral to strongly alkaline, Rayment and Bruce 1982.
- EC is a salinity indicator and samples are classified as nil to slightly saline, Charman and Murphy, 1991.
- Aggregate stability tests returned nil to partial dispersion, which has nil or slight limitations by reference to DEC guidelines.

A map of the investigation area and sample points is in **Attachment D**.

5.0 Site suitability

Following is a comparison to site suitability in relation to accepted standards and guidelines.

5.1 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 site constraint items of specific concern being bedrock, hardpans, surface waters, bores, groundwater, boundaries, recreation areas and utilities, **Table 3**.

Table 3: 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.
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 1.0m of the surface and depth to groundwater is at least 20m in an off-site bore.
Hardpan or bedrock	No hardpan or bedrock was encountered during the investigation.

5.2 Site suitability in relation to the DEC guidelines

The soil on site is suitable for irrigation of treated effluent when compared to the DEC guidelines owing to most parameters returning a nil to slight limitation for irrigation systems. The following DEC guidelines were used as a guide for identifying soil and site limitations and selecting appropriate amelioration measures if required, **Table 4** and **Table 5**.

Table 4: Typical site and soil characteristics 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 (EC _e) (dS/m at 0–70 cm)	< 2	2–4	> 4	Excess salt may restrict plant growth
Salinity measured as electrical conductivity (EC _e) (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 (K _s , 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 pH _{CaCl2} (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

Table 5: Site suitability in relation to DEC guidelines

Property	Comments
Exchangeable sodium percentage (0–40 cm)	Not tested but Emerson Aggregate test was used as an indicator and indicates the soil to be non to slightly sodic.
Exchangeable sodium percentage (40–100 cm)	Not tested but Emerson Aggregate test was used as an indicator and indicates the soil to be non to slightly sodic.
Salinity measured as electrical conductivity (EC) (dS/m at 0–70 cm)	Field tests of EC were all less <0.4 dS/m. Once calculated to ECe it indicates generally nil, slight or moderate limitations.
Salinity measured as electrical conductivity (EC) (dS/m at 70–100 cm)	Field tests of EC were all less <1 dS/m. Once calculated to ECe it indicates generally nil, slight or moderate limitations.
Depth to top of seasonal high-water table (metres)	No free groundwater was encountered during within 3m of the ground level. Groundwater data collected from registered bores indicate deep aquifers.
Depth to bedrock or hardpan (metres)	No bedrock or hardpans were experienced during excavation to 3m.
Saturated hydraulic conductivity (Ks, mm/h, 0-100 cm)	The kSat is classed as highly to “moderately permeable” with no problems associated with impaired infiltration, water logging or excessive runoff. Some investigation points returned ~120 to 210 mm/h infiltration rates which is viewed as a nil to slight limitation.
Available water capacity (AWC, mm/m)	AWC is calculated to be generally 80-100mm/m for the sands and 130-190mm/s for the heavier soils which is highly suitable for irrigation.
Soil pH_{CaCl2} (surface layer)	Field testing indicated slightly neutral to moderate acidity (CaCl ₂) which is a nil or slight limitation.
Effective cation exchange capacity (ECEC, cmol (+)/kg, average 0–40 cm)	Not tested but from the investigators local knowledge is likely to be >15 which is a nil to slight limitation.
Emerson aggregate test (0–100cm)	Samples returned results that have nil or slight limitations.
Phosphorus (P) sorption (kg/ha at total 0–100 cm)	Not tested.

6.0 Setback distances

Following is a comparison to site setback distances in relation to accepted standards and guidelines. It is important to note that specific development information (i.e. house and system location etc.) was not available to the investigator at the time of assessment and this information will be required to accurately measure setback distances.

6.1 Setback distances in relation to AS1547:2012

Setback distances by reference to AS1547:2012 are as follows, **Table 6**.

Table 6: *Setback distances in relation to AS1547:2012*

Site feature	Setback distance range (m)	Comments
	Horizontal setback distance (m)	
Property boundary	1.5 – 50	Subject to site specific assessment.
Buildings/houses	2.0 – 6	Subject to site specific assessment.
Surface water	15 – 100	Subject to site specific assessment.
Bore, well	15 – 50	Subject to site specific assessment.
Recreation areas (Children's play areas, swimming pools and so on)	3 – 15	Subject to site specific assessment.
In-ground water tank	4 – 15	Subject to site specific assessment.
Retaining walls and embankments, escarpments, cuttings	3.0m or 45° angle from top of wall (whichever is greatest)	Subject to site specific assessment.
	Vertical setback distance (m)	
Groundwater	0.6 - >1.5	No groundwater within 1.5m of the surface
Hardpan or bedrock	0.5 - >1.5	No hardpans or bedrocks were encountered during investigations

7.0 Design flow assumptions

Guidance as to the sizing of the treated effluent disposal systems 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. Typical wastewater design flows are as follow, **Table 7**.

Table 7: Typical wastewater design flows

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

Narrandera Shire Council adhere to the BASIX (Building Sustainability Index) to ensure equitable and effective water and greenhouse gas reductions. Therefore, all new houses in the Council area must be BASIX compliant at a minimum and further water reduction features can be undertaken if householders wish to. Therefore, the wastewater generated at new residences will be based on the sites having 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 the 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 potential bedrooms and living areas, **Table 8**.

Table 8: Potential 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

8.0 Disposal of treated effluent

The development is appropriate for disposal of treated effluent by Aerated Wastewater Treatment System (AWTS) owing to the suitable soils, Narrandera's relatively low rainfall and the sustainability of the system.

By reference to table MI of AS1547:2012 the soil is categorised for Design Irrigation Rates (DIR) based on the indicative permeability and the two conservative management classes being 'sandy loams' and 'loams/clays loams' and can be seen in tabular format as follows, **Table 9**.

Table 9: Soil categories and DIR/DLR

Soil texture	Indicative permeability mm/day	DIR mm/day	
		Drip Irrigation	Spray Irrigation
Sandy loams	1.4-3.0	4	4
Loams/clay loams	0.5-1.5	5	5

8.1 DIR and irrigation area

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

$$A = Q_w / \text{DIR}_w$$

Where:

A = Irrigation area in m²

Q_w = Design weekly flow in litres

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

This has been calculated based on the potential flow rates based on different sized homes, **Table 10**.

Table 10: Minimum irrigation area from AS1547:2012

Flow rate L/day	Irrigation rate mm/day	Irrigation rate mm/day
	Sandy loams Required minimum irrigation area m ²	Loams/clay loams Required minimum irrigation area m ²
700	140	175
840	168	210
980	196	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. In addition, where both spray and drip irrigation are applied to the surface this assists with evapotranspiration, however for design purposes this effect is ignored.

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 soil category with the flow rates for a different flow rates for 3, 4 and 5 bedroom hoses. In the water balance, to gauge irrigation requirements, Evapotranspiration (ET_o) has been calculated by multiplying evaporation by a crop of 0.7 to 1.0 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 0.7 to 1.0 crop factor used is very conservative, Allen et al 1998. The water balance calculations can be seen summarised in **Table 11** and the calculations can be found in **Attachment E**.

Table 11: *Minimum irrigation area from water balance*

Flow rate L/day	Irrigation rate mm/day	Irrigation rate mm/day
	Sandy loams Required minimum irrigation area m ²	Loams/clay loams Required minimum irrigation area m ²
700	164	214
840	197	256
980	229	299

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. A summary of the minimum irrigation area based on the nutrient balance can be seen in **Table 12**.

Table 12: *Minimum irrigation area from nutrient balance*

Flow rate L/day	Required minimum irrigation area m ²	Required minimum irrigation area m ²
	Sandy loams	Loams/clay loams
700	93	93
840	111	111
980	130	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 recommended that the water balance minimum irrigation area calculations be used as opposed to the AS1547:2012 method as it gives a more reliable output.

The nutrient balance calculations can be seen in **Attachment F**.

9.0 Proposed wastewater treatment and disposal system

This assessment considers the use of an AWTS with irrigation to manage the treated domestic wastewater on site.

9.1 Concept AWTS and irrigation system

The AWTS is the most preferable sustainable option, given the comparatively higher level of wastewater treatment compared to septic tanks and flexibility and sustainability of land application through irrigation. It is recommended surface drip or spray irrigation are used in garden beds and subsurface drip in the grassed areas. Dripper pipes in clay soils are to be spaced up to a maximum of 0.8m apart in the irrigation areas. Shallow subsurface drip is generally installed to 100mm depth.

The AWTS and irrigation management must be done in such a way as to provide long term sustainable management of hydraulic and nutrient loads. Although setback constraints apply, the AWTS is 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.

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

- Installation of AWTS in a single residential lot;
- The AWTS will have the hydraulic loading capacity of around to suit the household size;
- 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 drip, subsurface drip or spray;
- Adequate buffer zones as per AS1547:2012 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.

It is important to note that the system is to be designed by a 'designer' as referenced in AS1547:2012 and installed by an 'installer/contractor' as defined by the same standard.

9.2 Greywater quality for AWTS

Although the AWTS wastewater quality is 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 of 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 form other than in normal diluted cleaning water;
- Medicines, drugs, cosmetics and 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 13** which is derived by reference to relevant guidelines (e.g. AS/NZS 1547:2012; DLG (1998); NSW EPA (2004); ANZGFMWQ (2018)).

Table 13: *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

10.0 Conclusion and recommendations

In conclusion, the assessment shows that the site is suitable for land application of treated effluent on a per lot basis with low risk to human health and the environment given an AWTS with drip or spray irrigation is used with appropriate regulatory controls and recommendations adhered to within this report.

It is recommended that a site-specific assessment of each lot is conducted for land application of treated effluent sizing as part of the development application process once plans are lodged with Council. This will ensure adequate sizing of the irrigation areas based on the household wastewater flow volume and design irrigation rates supplied in this report.

11.0 Reference

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12.0 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 representation 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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14.0 Attachments

A. Plan of subject site	1 page
B. Groundwater data	18 pages
C. Borelogs and results	8 pages
D. Sample locations	1 page
E. Water balances	6 pages
F. Nutrient balances	6 pages



DOCUMENT ATTACHMENTS

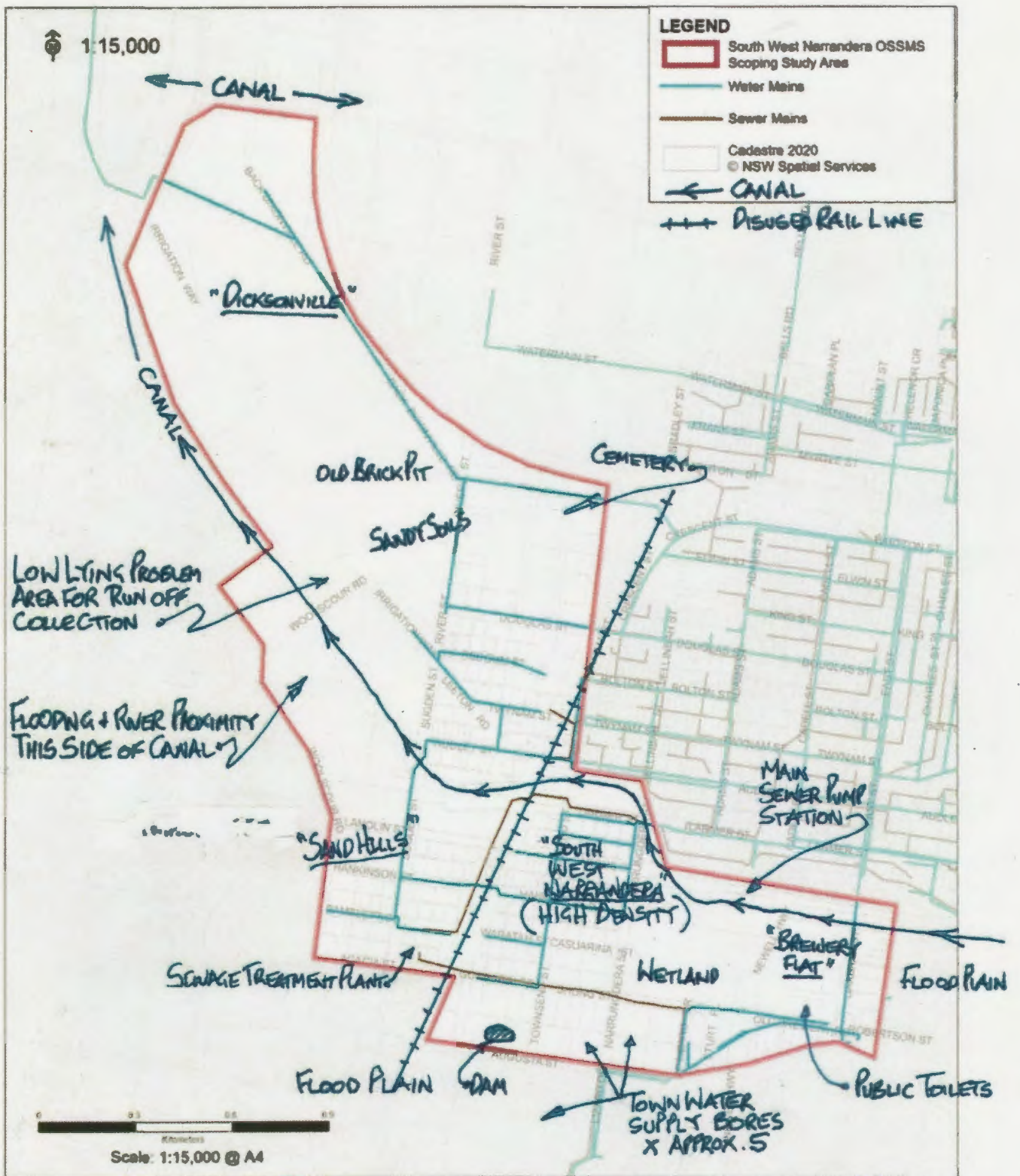
REPORT 6736


DM McMahon Pty Ltd
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Wagga Wagga NSW 2650

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Attachment A : *Plan of subject site*

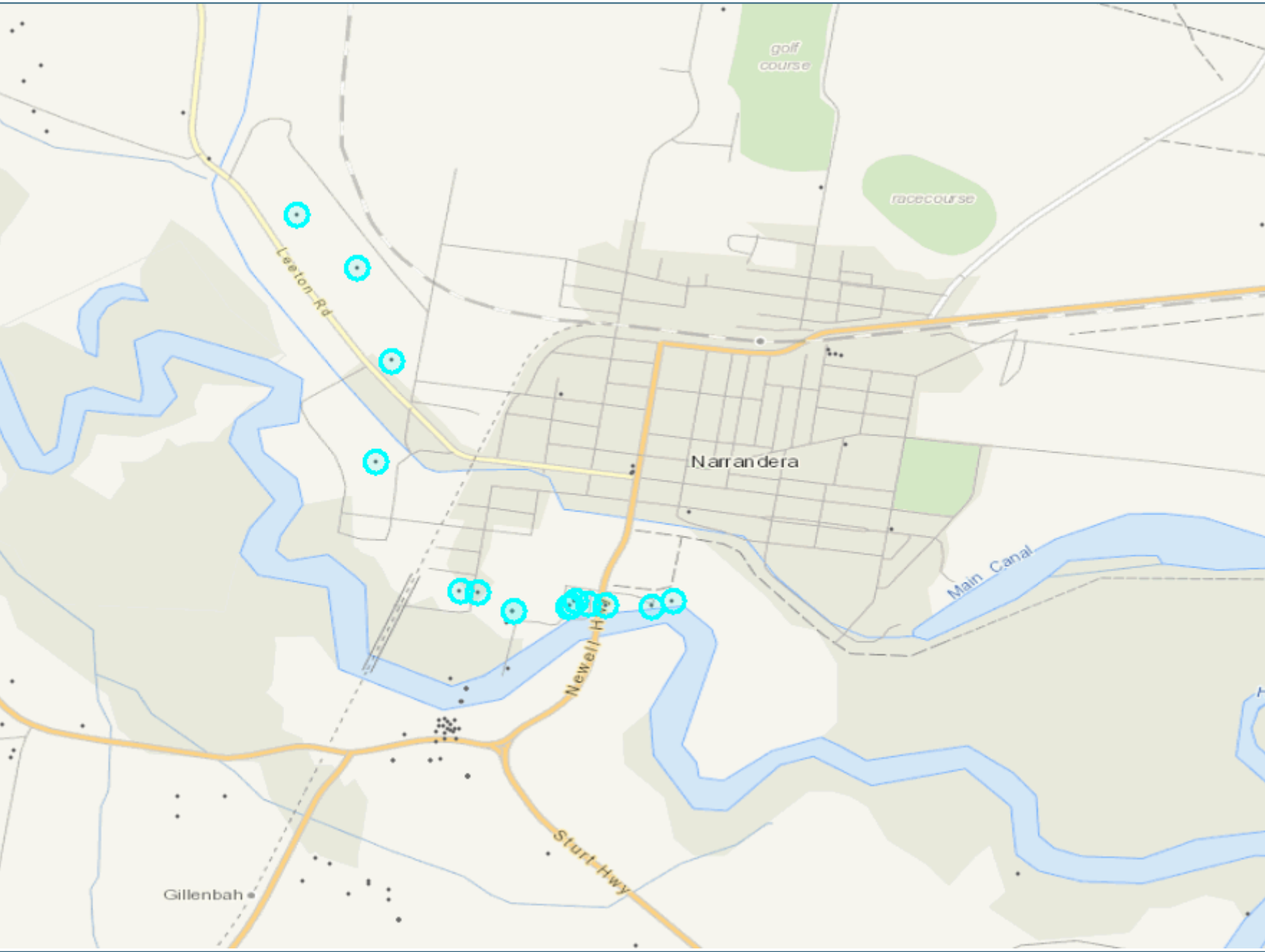


 <p>NARRANDERA SHIRE COUNCIL 141 East Street Narrandera NSW 2700 Ph: 02 6060 6610</p>	<h2>South West Narrandera OSSMS Scoping Study</h2> <p><small>This map is a representation of the information currently held by Narrandera Shire Council. While every effort has been made to ensure the accuracy of the product, Council accepts no responsibility for any errors or omissions.</small></p>	<p>Date: 12/02/2020 Compiled by: GIS NSC Co-ordinate System: MGA 94 Zone 55 Ref: 2020-003</p>
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SITE NOTES 20/2/2020, FIELD INSPECTION



Attachment B : *Groundwater data*



All bores

- Bore

All bores

- All bores

Bore density per 25km2

- 1 - 5
- 6 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 200
- More than 200

Mainland outline

N

1:28,970

Kilometres 0.5 1.0

Data Source: Bureau of Meteorology, Geoscience Australia and State/Territory lead water agencies. Refer to metadata for further information: [Click here](#)

Australian Albers GDA94



WaterNSW

Work Summary

GW020307

Licence:

Licence Status:

Authorised Purpose(s):
Intended Purpose(s): PUBLIC/MUNICIPAL

Work Type: Bore
Work Status: Test Hole
Construct.Method: Cable Tool
Owner Type: Local Govt

Commenced Date:
Completion Date: 01/05/1963

Final Depth: 65.50 m
Drilled Depth: 65.50 m

Contractor Name: (None)

Driller:
Assistant Driller:

Property:

GWMA:
GW Zone:

Standing Water Level (m):
Salinity Description: 0-500 ppm
Yield (L/s):

Site Details

Site Chosen By:

County: COOPER
Parish: NARRANDERA
Cadastre: SEC 81
Form A: Licensed:

Region: 40 - Murrumbidgee
River Basin: 410 - MURRUMBIDGEE RIVER
Area/District:

CMA Map: 8228-3N
Grid Zone: **Scale:**

Elevation: 0.00 m (A.H.D.)
Elevation (Unknown) Source:
Northing: 6154083.000
Easting: 459030.000
Latitude: 34°45'16.4"S
Longitude: 146°33'08.5"E

GS Map: - **MGA Zone:** 55 **Coordinate Source:** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Threaded Steel	0.00	53.90	152			
1	1	Opening	Screen	53.30	58.80	127		1	

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
7.60	16.10	8.50	Unconsolidated	2.70					
20.70	34.10	13.40	Unconsolidated	4.60					
36.60	43.00	6.40	Unconsolidated	4.60					
49.10	62.20	13.10	Unconsolidated	4.60		27.47			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	7.62	7.62	Clay	Clay	
7.62	10.36	2.74	Sand Grey Fine Water Bearing	Sand	
10.36	10.97	0.61	Gravel White Water Bearing	Gravel	
10.97	15.54	4.57	Sand Coarse Gravel Water Bearing	Sand	
15.54	16.15	0.61	Gravel Fine Water Bearing	Gravel	
16.15	17.37	1.22	Sand Puggy	Sand	
17.37	20.73	3.36	Gravel Clay	Gravel	
20.73	22.56	1.83	Gravel Fine Water Supply	Gravel	
22.56	26.82	4.26	Gravel Fine Sand Water Supply	Gravel	
26.82	28.04	1.22	Silt Fine Water Supply	Silt	
28.04	34.14	6.10	Sand Coarse Water Supply	Sand	
34.14	35.97	1.83	Silt Fine Clay	Silt	
35.97	36.58	0.61	Clay Grey	Clay	
36.58	38.40	1.82	Sand Grey Coarse Water Supply	Sand	
38.40	39.32	0.92	Gravel Coarse Water Supply	Gravel	
39.32	42.98	3.66	Gravel White Clean Water Supply	Gravel	
42.98	49.07	6.09	Clay Grey Silty	Clay	
49.07	58.83	9.76	Sand Grey Clean Water Supply	Sand	
58.83	62.18	3.35	Sand Grey Drift Fine Water Supply	Sand	
62.18	63.09	0.91	Silt Black Grey	Silt	
63.09	65.53	2.44	Clay White	Clay	

Remarks

13/08/1980: NARRANDERA TWS TEST BORE

*** End of GW020307 ***

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WaterNSW

Work Summary

GW404225

Licence:

Licence Status:

Authorised Purpose(s):
Intended Purpose(s): STOCK, DOMESTIC

Work Type: Bore
Work Status: Supply Obtained
Construct.Method: Rotary Mud
Owner Type: Private

Commenced Date:
Completion Date: 16/12/2007

Final Depth: 27.00 m
Drilled Depth: 32.00 m

Contractor Name: DAYMAN DRILLING & ENGINEERING
Driller: Brian Keith Dayman
Assistant Driller:

Property:

Standing Water Level 8.000 (m):

GWMA:
GW Zone:

Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

County Form A: COOPER
Licensed: **Parish** NARRANDERA **Cadastre** 12//129171

Region: 40 - Murrumbidgee
River Basin: 410 - MURRUMBIDGEE RIVER
Area/District:

CMA Map: 8228-N
Grid Zone: **Scale:**

Elevation: 0.00 m (A.H.D.)
Elevation Unknown
Source:

Northing: 6154908.000 **Latitude:** 34°44'49.4"S
Easting: 457563.000 **Longitude:** 146°32'10.9"E

GS Map: -

MGA Zone: 55

Coordinate GIS - Geogra
Source:

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	27.00	250			Rotary Mud
1	1	Casing	Pvc Class 12	0.00	22.50	125	115		Screwed and Glued

1	1	Opening	Slots - Horizontal	18.50	22.50	125		0	Stainless Steel, Screwed and Glued, SL: 40.0mm, A: 1.25mm
1	1	Casing	Pvc Class 12	22.50	24.50	125	115		Suspended in Clamps, Screwed and Glued, S: 26.50-27.00m
1	1	Opening	Slots - Horizontal	24.50	26.50	125		0	Stainless Steel, Screwed and Glued, SL: 20.0mm, A: 1.25mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
18.50	22.50	4.00	Unknown	8.00	22.00				
24.50	26.50	2.00	Unknown	8.00	22.00			05:00:00	576.00

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	2.00	2.00	CLAY - GREY	Clay Bands	
2.00	3.00	1.00	CLAY - RED	Clay Bands	
3.00	7.00	4.00	CLAY - BROWN	Clay Bands	
7.00	9.00	2.00	SAND - FINE BROWN - CEMENTED	Invalid Code	
9.00	11.00	2.00	SAND - GREY - FINE - CLAYBOUND	Invalid Code	
11.00	15.00	4.00	GRAVEL - RIVER - COARSE	Gravel	
15.00	17.00	2.00	SAND - GREY - FINE - CEMENTED	Invalid Code	
17.00	23.00	6.00	SAND - GREY AND WHITE AND GRAVEL - MEDIUM TO COARSE	Invalid Code	
23.00	25.00	2.00	SAND - GREY - FINE - GML	Invalid Code	
25.00	28.00	3.00	GRAVEL - MEDIUM TO COARSE - GML	Gravel	
28.00	29.00	1.00	SAND - CLAYBOUND	Invalid Code	
29.00	32.00	3.00	CLAY - GREY	Clay Bands	

Remarks

16/12/2007: Form A Remarks:
ENTERED BY PATRICIA EWERS ON 28TH FEBRUARY 2008.

INFORMATION NOT PROVIDED ON FORM:

NO INFORMATION ON YIELD
NO INFORMATION ON WATER TASTE
NO INFORMATION ON PUMPING TESTS ON BORE COMPLETION
NO DETAILS ON SLOT ATTACHMENT METHOD
NO DETAILS ON BORE DEVELOPMENT
NO INFORMATION ON WHO CHOSE BORE LOCATION

23/09/2011: Slot Length and Width adjusted due to data entry errors with advice from Madhwan Keshwan. GDS Data Cleanup project 2011.

23/09/2011: Slot Length and Width adjusted due to data entry errors with advice from Madhwan Keshwan. GDS Data Cleanup project 2011.

*** End of GW404225 ***

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WaterNSW

Work Summary

GW030724

Licence: 40CA412447

Licence Status: CURRENT

Authorised Purpose(s): TOWN WATER SUPPLY
Intended Purpose(s): PUBLIC/MUNICIPAL

Work Type: Bore
Work Status:
Construct.Method: Cable Tool
Owner Type: Local Govt

Commenced Date:
Completion Date: 01/11/1977

Final Depth: 107.00 m
Drilled Depth: 107.00 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: NARRANDERA TOWNSHIP
Cnr Lizard Drive And Sturt
Place NARRANDERA 2700
NSW
GWMA: 013 - MID MURRUMBIDGEE
(U/S NARRANDERA)
GW Zone: -

Standing Water Level (m):
Salinity Description: 0-500 ppm
Yield (L/s):

Site Details

Site Chosen By:

County	Parish	Cadastre
Form A: COOPER	NARRANDERA	SEC 27
Licensed: COOPER	NARRANDERA	LOCATED NEAR 1/26/758757

Region: 40 - Murrumbidgee
River Basin: 410 - MURRUMBIDGEE RIVER
Area/District:

CMA Map: 8228-3N

Grid Zone:

Scale:

Elevation: 145.00 m (A.H.D.)
Elevation Source: Est. Contour >15M.

Northing: 6154081.000
Easting: 458547.000

Latitude: 34°45'16.4"S
Longitude: 146°32'49.5"E

GS Map: -

MGA Zone: 55

Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Annulus	(Unknown)	0.00	107.00	610			
1	1	Casing	Welded Steel	-2.20	54.80	406			
1	1	Opening	Screen	54.80	58.70	406		1	Stainless Steel, A: 3.00mm
1	1	Casing	Welded Steel	58.70	74.40	406			
1	1	Opening	Screen	74.40	77.50	406		2	Stainless Steel, A: 3.00mm
1	1	Casing	Welded Steel	77.50	95.90	406			
1	1	Opening	Screen	95.90	99.90	406		3	Stainless Steel, A: 3.00mm
1	1	Casing	Welded Steel	99.90	100.80	406			
1	1	Opening	Screen	100.80	103.90	406		4	Stainless Steel, A: 3.00mm
1	1	Casing	Welded Steel	103.90	106.30	406			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
50.00	61.50	11.50	Unconsolidated						
62.00	68.70	6.70	Unconsolidated						
69.00	107.00	38.00	Unconsolidated						

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.20	1.20	Topsoil	Topsoil	
1.20	4.00	2.80	Clay Yellow	Clay	
4.00	5.00	1.00	Clay Yellow Stoney	Clay	
5.00	11.00	6.00	Clay Yellow Grey	Clay	
11.00	12.00	1.00	Clay Grey Sandy	Clay	
12.00	20.00	8.00	Gravel Coarse	Gravel	
20.00	23.00	3.00	Clay Grey Sticky	Clay	
23.00	27.00	4.00	Gravel Coarse Multicoloured	Gravel	
27.00	33.00	6.00	Clay Gravel	Clay	
33.00	35.00	2.00	Clay	Clay	
35.00	38.00	3.00	Clay Dark Grey Silty	Clay	
38.00	42.00	4.00	Silt Grey Sandy	Silt	
42.00	43.00	1.00	Clay Dark Grey	Clay	
43.00	45.00	2.00	Sand Grey	Sand	
45.00	47.00	2.00	Clay Grey Sticky	Clay	
47.00	50.00	3.00	Clay Grey Silty	Clay	
50.00	53.00	3.00	Sand Grey Water Supply	Sand	
53.00	61.50	8.50	Gravel Grey Medium Sand Water Supply	Gravel	
61.50	62.00	0.50	Clay Grey	Clay	
62.00	68.70	6.70	Gravel Grey Medium Sand Water Supply	Gravel	
68.70	69.00	0.30	Clay Black	Clay	
69.00	74.00	5.00	Sand Grey Medium-coarse Gravel Water Supply	Sand	
74.00	77.00	3.00	Gravel Grey Fine Water Supply Wood Decomposed Clay Water Supply	Gravel	
77.00	88.50	11.50	Gravel Grey Fine Sand Water Supply	Gravel	
88.50	89.00	0.50	Gravel Fine Sand Water Supply Clay Bands Water Supply	Gravel	
89.00	91.00	2.00	Gravel Grey Very Coarse Sand Water Supply	Gravel	
91.00	94.50	3.50	Gravel Grey Medium Sand Water Supply	Gravel	
94.50	103.50	9.00	Gravel Grey Coarse Sand Water Supply	Gravel	
103.50	107.00	3.50	Gravel Grey Coarse Sand Water Supply Clay Bands	Gravel	

Remarks

12/10/1987: ADJ B/N 30718 BETWEEN SECS 26&27 NARRANDERA

12/10/1987: NARRANDERA TOWN WATER SUPPLY

18/04/1998: Video and geophysical inspection by Hydroilex/Panorama drilling Co., November 1996.

18/04/1998: Report on video/geophysical inspection in Leeton library.

03/02/2000: Re-lined in Dec 99 with 3 mm s/steel spiral weld casing OD 361 mm, ID 355 mm. Swages, consisting of annealed s/steel with vulcanised rubber seals placed immediately above and below screens. Work supervised by John Lee of Hydroilex. Re-lining carried out as a precautionary measure only.

***** End of GW030724 *****

Warning To Clients: This raw data has been supplied to the WaterNSW by drillers, licensees and other sources. WaterNSW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

WaterNSW

Work Summary

GW025526

Licence: 40CA412447

Licence Status: CURRENT

Authorised Purpose(s): TOWN WATER SUPPLY
Intended Purpose(s): PUBLIC/MUNICIPAL

Work Type: Bore
Work Status:
Construct.Method:
Owner Type: Local Govt

Commenced Date:
Completion Date: 01/04/1965

Final Depth: 58.50 m
Drilled Depth: 58.50 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: NARRANDERA TOWNSHIP
Cnr Lizard Drive And Sturt
Place NARRANDERA 2700
NSW
GWMA: 013 - MID MURRUMBIDGEE
(U/S NARRANDERA)
GW Zone: -

Standing Water Level (m):
Salinity Description: 0-500 ppm
Yield (L/s):

Site Details

Site Chosen By:

County	Parish	Cadastre
Form A: COOPER	NARRANDERA	SEC 25
Licensed: COOPER	NARRANDERA	Whole Lot 5/25/758757

Region: 40 - Murrumbidgee
River Basin: 410 - MURRUMBIDGEE RIVER
Area/District:

CMA Map: 8228-3N

Grid Zone:

Scale:

Elevation: 145.00 m (A.H.D.)
Elevation Source: Est. Contour >15M.

Northing: 6154051.000
Easting: 458928.000

Latitude: 34°45'17.4"S
Longitude: 146°33'04.5"E

GS Map: -

MGA Zone: 55

Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Welded Steel	-0.30	49.60	305			Cemented
1	1	Casing	Pressure Cemented	0.00	18.30	305			
1	1	Casing	Welded Steel	0.00	18.30	457			Cemented
1	1	Opening	Screen	48.60	58.50	254		1	Stainless Steel, A: 2.36mm

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	2.07	2.07	Clay Grey	Clay	
2.07	8.23	6.16	Clay Yellow Sandy	Clay	
8.23	17.37	9.14	Sand Yellow Gravel	Sand	
17.37	18.14	0.77	Clay	Clay	
18.14	24.38	6.24	Gravel Grey Heavy Quartz Pebbles/pebbly	Gravel	
24.38	28.04	3.66	Gravel Sand	Gravel	
28.04	28.80	0.76	Clay	Clay	
28.80	37.16	8.36	Clay Silty	Clay	
37.16	39.62	2.46	Sand Pebbles White	Sand	
39.62	40.84	1.22	Sand Fine Puggy Clay	Sand	
40.84	43.28	2.44	Sand Coarse	Sand	
43.28	45.26	1.98	Clay Stiff	Clay	
45.26	46.94	1.68	Clay Silty	Clay	
46.94	47.85	0.91	Sand Grey Fine	Sand	
47.85	53.80	5.95	Sand Grey Coarse	Sand	
53.80	55.02	1.22	Sand Grey Fine	Sand	
55.02	58.22	3.20	Sand Grey Coarse	Sand	
58.22	58.52	0.30	Clay Grey Dark	Clay	
46.94	47.85	0.91	Pebbles Coarse	Gravel	

Remarks

13/08/1980: LOT 5 SECTION 25 NARRANDERA
13/08/1980: NARRANDERA TWS BORE

*** End of GW025526 ***

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WaterNSW

Work Summary

GW030718

Licence: **Licence Status:**

Authorised Purpose(s):
Intended Purpose(s): PUBLIC/MUNICIPAL, MONITORING BORE

Work Type: Bore
Work Status: Manual Observations,6-12 Months
Construct.Method: Rotary Mud
Owner Type: NSW Office of Water

Commenced Date: **Final Depth:** 61.00 m
Completion Date: 01/11/1977 **Drilled Depth:** 129.80 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: **Standing Water Level (m):**
GWMA: **Salinity Description:** 0-500 ppm
GW Zone: **Yield (L/s):**

Site Details

Site Chosen By:

County: COOPER
Parish: NARRANDERA
Cadastre: SEC 27

Form A: Licensed:

Region: 40 - Murrumbidgee
CMA Map: 8228-3N

River Basin: 410 - MURRUMBIDGEE RIVER
Grid Zone: **Scale:**

Area/District:

Elevation: 148.01 m (A.H.D.) **Northing:** 6154063.000 **Latitude:** 34°45'17.0"S
Elevation (unknown): **Easting:** 458611.000 **Longitude:** 146°32'52.0"E
Source:

GS Map: - **MGA Zone:** 55 **Coordinate Source:** GPS - Global

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Backfill	Backfill	61.00	129.80	200			
1	1	Casing	P.V.C.	-3.00	61.00	63			
1	1	Casing	Withdrawn	0.00	111.70	152			

1		Casing	Casing Protector	0.00	0.00	152			
1	1	Opening	Screen	55.00	60.90				2
1	1	Opening	Slots	55.00	58.00	63			1
1	1	Opening	Screen	74.30	78.70				3
1	1	Opening	Screen	96.00	102.00				4

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
16.00	18.20	2.20	Unconsolidated						
20.90	22.80	1.90	Unconsolidated						
28.80	31.40	2.60	Unconsolidated						

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.83	1.83	Topsoil	Topsoil	
1.83	11.89	10.06	Clay Grey Sandy	Clay	
11.89	13.72	1.83	Gravel Fine Sandy	Gravel	
13.72	17.37	3.65	Gravel Coarse Fine Sandy Water Supply	Gravel	
17.37	20.12	2.75	Silt Fine Sandy Water Supply	Silt	
20.12	21.95	1.83	Clay Grey Water Supply	Clay	
21.95	23.77	1.82	Sand Fine Water Supply	Sand	
23.77	29.26	5.49	Gravel Coarse Water Supply	Gravel	
29.26	32.00	2.74	Sand Fine Water Supply	Sand	
32.00	41.15	9.15	Clay Grey	Clay	
41.15	43.89	2.74	Sand Coarse	Sand	
43.89	48.46	4.57	Clay Grey	Clay	
48.46	50.29	1.83	Sand Coarse Fine	Sand	
50.29	52.12	1.83	Clay Grey Fine Sand	Clay	
52.12	62.18	10.06	Gravel Coarse Fine Sandy	Gravel	
62.18	69.49	7.31	Gravel Coarse Sand	Gravel	
69.49	84.12	14.63	Gravel Coarse Sand	Gravel	
84.12	95.10	10.98	Gravel Coarse Sand	Gravel	
95.10	96.01	0.91	Gravel Coarse	Gravel	
96.01	99.67	3.66	Gravel Coarse Boulder	Gravel	
99.67	100.58	0.91	Silt Fine Sandy	Silt	
100.58	106.07	5.49	Gravel Coarse Petrified Wood	Gravel	
106.07	108.81	2.74	Gravel Coarse	Gravel	
108.81	120.70	11.89	Silt Fine Sandy	Silt	
120.70	129.84	9.14	Silt Fine Sandy	Silt	
0.00	1.83	1.83	Clay Grey	Clay	
17.37	20.12	2.75	Clay Grey Bands	Clay	
21.95	23.77	1.82	Clay Grey Bands	Clay	
23.77	29.26	5.49	Sand Fine	Sand	
29.26	32.00	2.74	Clay Grey	Clay	
32.00	41.15	9.15	Silt Fine Sandy	Silt	
62.18	69.49	7.31	Petrified Wood	Petrified Wood	
84.12	95.10	10.98	Petrified Wood	Petrified Wood	
99.67	100.58	0.91	Some Coarse Gravel	Unknown	
100.58	106.07	5.49	Boulders	Boulders	
106.07	108.81	2.74	Silt Fine Sandy	Silt	
108.81	120.70	11.89	Some Coarse Gravel	Unknown	
120.70	129.84	9.14	Clay Black	Clay	
23.77	29.26	5.49	Clay Grey Bands	Clay	
106.07	108.81	2.74	Petrified Wood Some Clay	Petrified Wood	

Remarks

06/03/1987: BETWEEN SECTS 26 & 27 NARRANDERA

06/03/1987: NARRANDERRA TWS TEST BORE
06/03/1987: PRODUCTION BORE NO 30724 ADJ
06/03/1987: OBS BORE FOR P/TESTING OF 30724
03/12/2001: GPS COORDS TAKEN 8/10/01 - OLD COORDS 458430/6153885

***** End of GW030718 *****

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WaterNSW

Work Summary

GW030717

Licence:

Licence Status:

Authorised Purpose(s):
Intended Purpose(s): PUBLIC/MUNICIPAL

Work Type: Bore
Work Status: Test Hole
Construct.Method: Rotary Mud
Owner Type: NSW Office of Water

Commenced Date:
Completion Date: 01/03/1977

Final Depth:
Drilled Depth: 121.30 m

Contractor Name: (None)

Driller:
Assistant Driller:

Property:

GWMA:
GW Zone:

Standing Water Level (m):
Salinity Description: 0-500 ppm
Yield (L/s):

Site Details

Site Chosen By:

County Form A: COOPER
Parish: NARRANDERA
Cadastre: SEC 28
Licensed:

Region: 40 - Murrumbidgee
River Basin: 410 - MURRUMBIDGEE RIVER
Area/District:
CMA Map: 8228-3N
Grid Zone:
Scale:

Elevation: 145.00 m (A.H.D.)
Elevation Est. Contour >15M. Source:
Northing: 6154018.000
Easting: 458242.000
Latitude: 34°45'18.4"S
Longitude: 146°32'37.5"E

GS Map: -
MGA Zone: 55
Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Backfill	Backfill	0.00	121.30				
1	1	Casing	Withdrawn	0.00	104.90	152			
1	1	Opening	Withdrawn	78.00	83.00			1	
1	1	Opening	Withdrawn	97.60	103.00			2	

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
67.00	71.60	4.60	Unconsolidated						
79.00	105.00	26.00	Unconsolidated						

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	2.13	2.13	Topsoil Clay Grey	Topsoil	
2.13	9.14	7.01	Clay Grey Sandy	Clay	
9.14	10.67	1.53	Silt Sandy Clay Fine	Silt	
10.67	11.58	0.91	Clay Grey Sandy	Clay	
11.58	15.24	3.66	Gravel Fine Sandy	Gravel	
15.24	17.98	2.74	Gravel Sandy	Gravel	
17.98	18.90	0.92	Gravel Coarse	Gravel	
18.90	20.73	1.83	Gravel Coarse Sandy Water Supply v	Gravel	
20.73	22.56	1.83	Clay Grey Gravel Fine Sandy Water Supply	Clay	
22.56	23.47	0.91	Clay Grey	Clay	
23.47	30.78	7.31	Gravel Coarse Fine Sandy Water Supply Clay	Gravel	
30.78	32.61	1.83	Silt Grey Fine Sandy Water Supply	Silt	
32.61	37.19	4.58	Clay Grey Gravel	Clay	
37.19	43.59	6.40	Gravel Coarse Fine Sandy Clay	Gravel	
43.59	47.24	3.65	Clay Grey Sandy Some Fine Gravel	Clay	
47.24	57.30	10.06	Clay Fine-coarse Gravel	Clay	
57.30	60.96	3.66	Gravel Fine-coarse Sandy	Gravel	
60.96	61.87	0.91	Clay Grey Sandy Silt	Clay	
61.87	67.36	5.49	Clay Coarse Fine Gravel	Clay	
67.36	71.02	3.66	Gravel Coarse Fine	Gravel	
71.02	71.93	0.91	Wood	Unknown	
71.93	72.85	0.92	Gravel Fine Sandy	Gravel	
72.85	77.42	4.57	Clay Grey Sandy	Clay	
77.42	78.33	0.91	Gravel Fine Clay Grey	Gravel	
78.33	86.56	8.23	Gravel Coarse Fine	Gravel	
86.56	91.14	4.58	Silt Fine Gravel	Silt	
91.14	93.88	2.74	Silt Fine Sandy	Silt	
93.88	97.54	3.66	Sand Fine	Sand	
97.54	108.51	10.97	Gravel Fine Coarse Some Wood	Gravel	
108.51	112.17	3.66	Gravel Fine Sandy	Gravel	
112.17	116.74	4.57	Gravel Coarse Fine	Gravel	
116.74	121.31	4.57	Gravel Fine Coarse Silt	Gravel	

Remarks

12/10/1987: SECTION 28 NARRANDERA
 12/10/1987: NARRANDERA TWS TEST BORE
 12/10/1987: PRODUCTION BORE NO 30723 ADJ

*** End of GW030717 ***

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WaterNSW

Work Summary

GW030723

Licence: **Licence Status:**
Authorised Purpose(s):
Intended Purpose(s): PUBLIC/MUNICIPAL

Work Type: Bore
Work Status:
Construct.Method: Cable Tool
Owner Type: Local Govt

Commenced Date: **Final Depth:** 109.00 m
Completion Date: 01/08/1977 **Drilled Depth:** 109.00 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: **Standing Water Level (m):**
GWMA: **Salinity Description:** 0-500 ppm
GW Zone: **Yield (L/s):**

Site Details

Site Chosen By:

County Form A: COOPER **Parish:** NARRANDERA **Cadastre:** SEC 28
Licensed:

Region: 40 - Murrumbidgee **CMA Map:** 8228-3N
River Basin: 410 - MURRUMBIDGEE RIVER **Grid Zone:** **Scale:**
Area/District:

Elevation: 145.00 m (A.H.D.) **Northing:** 6154018.000 **Latitude:** 34°45'18.4"S
Elevation Est. Contour >15M. **Easting:** 458242.000 **Longitude:** 146°32'37.5"E
Source:

GS Map: - **MGA Zone:** 55 **Coordinate Source:** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Annulus	(Unknown)	0.00	109.00	610			Graded
1	1	Casing	Welded Steel	-3.90	80.10	406			
1	1	Opening	Screen	80.10	88.30	406		1	Stainless Steel, A: 3.00mm
1	1	Casing	Welded Steel	88.30	100.30	406			

1	1	Opening	Screen	100.30	106.30	406		2	Stainless Steel, A: 3.00mm
1	1	Casing	Welded Steel	106.30	108.40	406			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.00	1.00	Loam Grey	Loam	
1.00	3.00	2.00	Clay Grey	Clay	
3.00	4.00	1.00	Clay Grey	Clay	
4.00	6.00	2.00	Clay Grey Sandy	Clay	
6.00	9.00	3.00	Clay Grey Sandy	Clay	
9.00	12.00	3.00	Clay Grey Silty	Clay	
12.00	17.00	5.00	Gravel Fine	Gravel	
17.00	22.00	5.00	Gravel Medium	Gravel	
22.00	27.00	5.00	Gravel Coarse	Gravel	
27.00	28.00	1.00	Sand Grey Fine Gravel	Sand	
28.00	31.00	3.00	Gravel Coarse	Gravel	
31.00	34.00	3.00	Sand Yellow Coarse	Sand	
34.00	36.00	2.00	Gravel Fine Sand Yellow	Gravel	
36.00	38.00	2.00	Gravel Fine Sand Yellow Clay	Gravel	
38.00	44.50	6.50	Gravel Grey Fine Sand	Gravel	
44.50	51.00	6.50	Clay Grey	Clay	
51.00	61.50	10.50	Gravel Grey Fine Sand	Gravel	
61.50	64.00	2.50	Clay Grey Sticky	Clay	
64.00	66.00	2.00	Gravel Grey Medium Sand	Gravel	
66.00	72.00	6.00	Gravel Grey Coarse Sand	Gravel	
72.00	74.50	2.50	Gravel Grey Medium Sand	Gravel	
74.50	77.00	2.50	Clay Black	Clay	
77.00	93.50	16.50	Gravel Grey Fine Sand	Gravel	
93.50	95.50	2.00	Clay Black Sandy Wood Decomposed	Clay	
95.50	100.50	5.00	Sand Grey Fine Gravel Coarse	Sand	
100.50	101.00	0.50	Clay	Clay	
101.00	105.00	4.00	Gravel Grey Coarse Sand	Gravel	
105.00	108.00	3.00	Gravel Coarse Stoney Sand Grey	Gravel	
108.00	109.00	1.00	Gravel Grey Coarse Sand Clay	Gravel	

Remarks

12/10/1987: ADJ B/N 30717 SEC 28 NARRANDERA
12/10/1987: NARRANDERA TOWN WATER SUPPLY

*** End of GW030723 ***

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Attachment C : *Borelogs and results*



Job No:	6736	Sheet:	1 of 3
Hole No:	BH01	Date:	27/03/2020
Drilled by:	L.Nilsen	Conditions:	Clear
Logged by:	L.Nilsen	Position:	458234 E
Drill Method:	6.5.3 - Power	(MGA94 GDA z 55)	6153693 S
Location:	Narrandera - Riverside		

Depth (RL) metres	Sample No.	Description	AS1726:2017 Group Symbol	Moisture Condition	Consistency	Plasticity	Remarks
		Silty CLAY +B	OL	D	Firm	Low	TOPSOIL
0.25	1.1	Clayey SAND -B	SC	D	Firm	Low	Alluvial
0.50	1.2	CLAY +B	CI	M	Stiff	Low/Med	Alluvial, Traces of fine sand.
0.75	1.3	CLAY -G	CL	M	Stiff	Med	Alluvial, Traces of fine sand.
1.00							
1.25							
1.50							
1.75							
2.00							
2.25							
2.50							
2.75							
3.00							

General comments:



Job No:	6736	Sheet:	2 of 3
Hole No:	BH02	Date:	27/03/2020
Drilled by:	L.Nilsen	Conditions:	Clear
Logged by:	L.Nilsen	Position:	458215 E
Drill Method:	6.5.3 - Power	(MGA94 GDA z 55)	6153978 S
Location:	Narrandera - Creekside		

Depth (RL) metres	Sample No.	Description	AS1726:2017 Group Symbol	Moisture Condition	Consistency	Plasticity	Remarks
		Silty CLAY +B	OL	T	Firm	Low	TOPSOIL
0.25	2.1	Silty CLAY +YB	CI	W	Stiff	Low/Med	Alluvial
0.50	2.2	Sandy CLAY +BY	SC	T	Stiff	Low/Med	Alluvial, fine sand.
0.75							
1.00	2.3	Clayey SAND +BY	SC	W	Soft	Low	Alluvial, fine sand
1.25							
1.50							
1.75							
2.00							
2.25	2.4	SAND BY	SP	T	Soft	Nil	Alluvial, very fine
2.50	2.5	Clayey SAND +BY -G Mottles	SC	M	Stiff	Low/Med	Alluvial, fine
2.75							
3.00							

General comments:



Job No:	6736	Sheet:	3 of 3
Hole No:	BH03	Date:	27/03/2020
Drilled by:	L.Nilsen	Conditions:	Clear
Logged by:	L.Nilsen	Position:	458526 E
Drill Method:	6.5.3 - Power	(MGA94 GDA z 55)	6154093 S
Location:	Narrandera - Next to Newell highway		

Depth (RL) metres	Sample No.	Description	AS1726:2017 Group Symbol	Moisture Condition	Consistency	Plasticity	Remarks
		Silty CLAY +B	OL	D	Firm	Low	TOPSOIL
0.25	3.1	Silty CLAY +B	CI	T	Firm	Low	Alluvial
0.50							
0.75							
1.00							
1.25							
1.50							
1.75	3.2	Sandy CLAY -BY	SC	T	Stiff	Low/Med	Alluvial, fine sand
2.00							
2.25							
2.50							
2.75							
3.00							

General comments:



Job No: 6736	Landform: Flat to simple slope
Client: BEST	Slope: Level to gently inclined
Site: Narrandera	Vegetation/Surface: SAND to CLAY
Date: 27/03/2020	Logged By: L.Nilsen

Sheet: 'Geotech Field Sheet_rev2'

Sampling Method: AS1289.1.2.1-1998: cl. [] 6.5.1 - Hand Excavated [x] 6.5.2 - Hand Auger [] 6.5.3 - Power Auger [] 6.5.4 - Machine Excavated Other: _____

Site Identity	Sample	Co-ordinates MGA GDA94 z55	Depth to Top of Layer (m)	Depth to Bottom of Layer (m)	Classification (AS1726:2017 Table 9 & 10)	Soil Name (BLOCK LETTERS)	Grain Size (Fine / Coarse)	Primary Colour	Mottle Colour	Plasticity	Consistency (Cohesive soils)	Moisture	Soil Origin	Comments (Coarse Fragments, Size, %, Structure (Zoning, Defects, Cementing etc.))
WP01	1	458058 E 6154311 S	0.0	0.5	SP	SAND	C	BR	*	NIL	F	D	Aeolian	-
WP02	2	458290 E 6154484 S	0.0	0.5	SP	SAND	C	BR	*	NIL	F	D	Aeolian	-
WP03	3	458255 E 6154746 S	0.0	0.5	SP	SAND	C	BR	*	NIL	F	D	Aeolian	-
WP04	4	457981 E 6154523 S	0.0	0.5	SP	SAND	C	BR	*	NIL	F	D	Aeolian	-
WP05	5	457381 E 6154546 S	0.0	0.5	CI	Silty CLAY	F	+B	*	L	ST	D	Alluvial	-
WP06	6	457649 E 6154882 S	0.0	0.5	SP	SAND	C	BR	*	NIL	F	D	Aeolian	-
WP07	7	457927 E 6154936 S	0.0	0.5	SP	SAND	C	BR	*	NIL	F	D	Aeolian	-
WP08	8	457944 E 6155096 S	0.0	0.5	SP	SAND	C	RB	*	NIL	F	D	Aeolian	-
WP09	9	457775 E 6155400 S	0.0	0.5	SP	SAND	C	RB	*	NIL	F	D	Aeolian	-
WP10	10	457535 E 6155487 S	0.0	0.5	SP	SAND	C	BR	*	NIL	F	D	Aeolian	-
WP11	11	457529 E 6156186 S	0.0	0.5	SP	SAND	C	BR	*	NIL	F	D	Aeolian	-
WP12	12	456937 E 6156490 S	0.0	0.5	SC	Clayey SAND	F/C	RB	*	L	F	D	Aeolian	-
WP13	13	458920 E 6154124 S	0.0	0.5	CI	Silty CLAY	F	+B	*	L/M	ST	D	Alluvial	-
WP14	14	457795 E 6155752 S	0.0	0.5	SP	SAND	C	BR	*	NIL	F	D	Aeolian	-
WP15	15	457255 E 6155900 S	0.0	0.5	SP	SAND	C	BR	*	NIL	F	D	Aeolian	-
WP16	16	457119 E 6156812 S	0.0	0.5	SP	SAND	C	BR	*	NIL	F	D	Aeolian	-

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Depth of auger hole [D] 50 cm
 Depth of water in auger hole [H] 40 cm
 Average radius of auger hole [r] 5 cm
 Depth to any impermeable layer [S] cm

Soil Permeability
 Using a well permeameter.
 AS/NZS 1547 Appendix G

JOB NO.: 6736

CLIENT: Building & Environmental Services Today

JOB DESCRIPTION: South West Narrandera OSSMS Scoping Study

Equipment ID: Well Permeameter

Test Hole:	WP01			WP02			WP03			WP04			WP05			WP06		
UTM:	458058 E 6154311 S			458290 E 6154484 S			458255 E 6154746 S			457981 E 6154523 S			457381 E 6154546 S			457649 E 6154882 S		
Tested By:	L.Nilsen			L.Nilsen			L.Nilsen			L.Nilsen			L.Nilsen			L.Nilsen		
Date:	27/03/2020			27/03/2020			27/03/2020			27/03/2020			27/03/2020			27/03/2020		
Depth (m)	Colour	Texture	Structure	Colour	Texture	Structure	Colour	Texture	Structure	Colour	Texture	Structure	Colour	Texture	Structure	Colour	Texture	Structure
0.0	BR	SAND	SG	BR	SAND	SG	BR	SAND	SG	BR	SAND	SG	W	Silty CLAY	Granular	BR	SAND	SG
0.1	BR	SAND	SG	BR	SAND	SG	BR	SAND	SG	BR	SAND	SG	W	Silty CLAY	Granular	BR	SAND	SG
0.2	BR	SAND	SG	BR	SAND	SG	BR	SAND	SG	BR	SAND	SG	B	CLAY	Granular	BR	SAND	SG
0.3	BR	SAND	SG	BR	SAND	SG	BR	SAND	SG	BR	SAND	SG	B	CLAY	Granular	BR	SAND	SG
0.4	BR	SAND	SG	BR	SAND	SG	BR	SAND	SG	BR	SAND	SG	B	CLAY	Granular	BR	SAND	SG
0.5	BR	SAND	SG	BR	SAND	SG	BR	SAND	SG	BR	SAND	SG	B	CLAY	Granular	BR	SAND	SG
Time (mm:ss)	Permeameter Level (mm)		Drop in level (mm)	Permeameter Level (mm)		Drop in level (mm)	Permeameter Level (mm)		Drop in level (mm)	Permeameter Level (mm)		Drop in level (mm)	Permeameter Level (mm)		Drop in level (mm)	Permeameter Level (mm)		Drop in level (mm)
0:00	300			300			300			200			300			300		
0:30	0		300	0		300	0		300	0		200	190		110	0		300
1:00	END			END			END			END			70		120	END		
1:30													0		70			
2:00													END					
2:30																		
3:00																		
3:30																		
4:00																		
4:30																		
5:00																		
5:30																		
6:00																		
6:30																		
7:00																		
7:30																		
Q (cm/min)	30			30			30			30			12			30		
K _{sat} (m/day)	3.509			3.509			3.509			3.509			2.69			3.509		
Soil Category	2a Sandy loams			2a Sandy loams			2a Sandy loams			2a Sandy loams			3a Loams			2a Sandy loams		

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Depth of auger hole [D] 50 cm
 Depth of water in auger hole [H] 40 cm
 Average radius of auger hole [r] 5 cm
 Depth to any impermeable layer [S] cm

Soil Permeability
 Using a well permeameter.
 AS/NZS 1547 Appendix G

JOB NO.: 6736

CLIENT: Building & Environmental Services Today

JOB DESCRIPTION: South West Narrandera OSSMS Scoping Study

Equipment ID: Well Permeameter

Test Hole:	WP07			WP08			WP09			WP10			WP11			WP12		
UTM:	457927 E 6154936 S			457944 E 6155096 S			457775 E 6155400 S			457535 E 6155487 S			457529 E 6156186 S			456937 E 6156490 S		
Tested By:	L.Nilsen			L.Nilsen			L.Nilsen			L.Nilsen			L.Nilsen			L.Nilsen		
Date:	27/03/2020			27/03/2020			27/03/2020			27/03/2020			27/03/2020			27/03/2020		
Depth (m)	Colour	Texture	Structure	Colour	Texture	Structure	Colour	Texture	Structure	Colour	Texture	Structure	Colour	Texture	Structure	Colour	Texture	Structure
0.0	BR	SAND	SG	RB	SAND	SG	RB	SAND	SG	BR	SAND	SG	BR	SAND	SG	RB	Clayey SAND	SG
0.1	BR	SAND	SG	RB	SAND	SG	RB	SAND	SG	BR	SAND	SG	BR	SAND	SG	RB	Clayey SAND	SG
0.2	BR	SAND	SG	RB	SAND	SG	RB	SAND	SG	BR	SAND	SG	BR	SAND	SG	RB	Clayey SAND	SG
0.3	BR	SAND	SG	RB	SAND	SG	RB	SAND	SG	BR	SAND	SG	BR	SAND	SG	RB	Clayey SAND	SG
0.4	BR	SAND	SG	RB	SAND	SG	RB	SAND	SG	BR	SAND	SG	BR	SAND	SG	RB	Clayey SAND	SG
0.5	BR	SAND	SG	RB	SAND	SG	RB	SAND	SG	BR	SAND	SG	BR	SAND	SG	RB	Clayey SAND	SG
Time (mm:ss)	Permeameter Level (mm)		Drop in level (mm)	Permeameter Level (mm)		Drop in level (mm)	Permeameter Level (mm)		Drop in level (mm)	Permeameter Level (mm)		Drop in level (mm)	Permeameter Level (mm)		Drop in level (mm)	Permeameter Level (mm)		Drop in level (mm)
0:00	300			300			300			300			300			300		
0:30	0		300	0		300	0		300	15		285	0		300	250		50
1:00	END			END			END			0		15	END			200		50
1:30										END						150		50
2:00																100		50
2:30																50		50
3:00																0		50
3:30																END		
4:00																		
4:30																		
5:00																		
5:30																		
6:00																		
6:30																		
7:00																		
7:30																		
Q (cm/min)	30			30			30			30			30			10		
K _{sat} (m/day)	3.509			3.509			3.509			3.509			3.509			1.17		
Soil Category	2a Sandy loams			2a Sandy loams			2a Sandy loams			2a Sandy loams			2a Sandy loams			4a Clay loams		

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Depth of auger hole [D] 50 cm
 Depth of water in auger hole [H] 40 cm
 Average radius of auger hole [r] 5 cm
 Depth to any impermeable layer [S] cm

Soil Permeability
 Using a well permeameter.
 AS/NZS 1547 Appendix G


JOB NO.: 6736

CLIENT: Building & Environmental Services Today

JOB DESCRIPTION: South West Narrandera OSSMS Scoping Study

Equipment ID: Well Permeameter

Test Hole:	WP013			WP14			WP15			WP16								
UTM:	458920 E 6154124 S			457795 E 6155752 S			457255 E 6155900 S			457119 E 6156812 S								
Tested By:	L.Nilsen			L.Nilsen			L.Nilsen			L.Nilsen								
Date:	27/03/2020			27/03/2020			27/03/2020			27/03/2020								
Depth (m)	Colour	Texture	Structure	Colour	Texture	Structure	Colour	Texture	Structure	Colour	Texture	Structure	Colour	Texture	Structure	Colour	Texture	Structure
0.0	B	Silty CLAY	Granular	RB	SAND	SG	RB	SAND	SG	RB	SAND	SG						
0.1	B	Silty CLAY	Granular	RB	SAND	SG	RB	SAND	SG	RB	SAND	SG						
0.2	B	Silty CLAY	Granular	RB	SAND	SG	RB	SAND	SG	RB	SAND	SG						
0.3	B	Silty CLAY	Granular	RB	SAND	SG	RB	SAND	SG	RB	SAND	SG						
0.4	B	Silty CLAY	Granular	RB	SAND	SG	RB	SAND	SG	RB	SAND	SG						
0.5	B	Silty CLAY	Granular	RB	SAND	SG	RB	SAND	SG	RB	SAND	SG						
Time (mm:ss)	Permeameter Level (mm)	Drop in level (mm)	Permeameter Level (mm)	Drop in level (mm)	Permeameter Level (mm)	Drop in level (mm)	Permeameter Level (mm)	Drop in level (mm)	Permeameter Level (mm)	Drop in level (mm)	Permeameter Level (mm)	Drop in level (mm)	Permeameter Level (mm)	Drop in level (mm)	Permeameter Level (mm)	Drop in level (mm)	Permeameter Level (mm)	Drop in level (mm)
0:00	300		300		300		300		300		300							
0:30	220	80	0	300	0	300	0	300	0	300								
1:00	100	120	END		END		END		END									
1:30	10	90																
2:00	0																	
2:30	END																	
3:00																		
3:30																		
4:00																		
4:30																		
5:00																		
5:30																		
6:00																		
6:30																		
7:00																		
7:30																		
Q (cm/min)	12			30			30			30								
K _{sat} (m/day)	2.339			3.509			3.509			3.509								
Soil Category	3a Loams			2a Sandy loams			2a Sandy loams			2a Sandy loams								

DM McMahon Pty Ltd PO Box 6118 WAGGA WAGGA NSW 2650 Ph: 0269 310 510		PAGE: 1 of 1 SUBMITTED BY: L.Nilsen DATE SUBMITTED: 27/03/2020 NO OF SAMPLES: 23 SAMPLING METHOD: 1289.6.5.2 JOB NO.: 6736
CLIENT: BEST		
JOB DESCRIPTION: Narranderra LCA		
Equipment ID: EC + pH meter		

Sample No.	EC (mS/cm)	pH	Dispersion
WP01	0.06	7.0	Nil
WP02	0.05	7.2	Nil
WP03	0.06	6.9	Nil
WP04	0.05	6.1	Nil
WP05	0.09	7.4	Partial
WP06	0.06	7.00	Nil
WP07	0.14	6.4	Nil
WP08	0.02	7.1	Nil
WP09	0.03	6.7	Nil
WP10	0.06	6.8	Nil
WP11	0.02	6.7	Nil
WP12	0.03	6.5	Partial
WP13	0.06	7.1	Partial
WP14	0.06	7.1	Nil
WP15	0.05	7.0	Nil
WP16	0.05	6.9	Nil
1.1	0.05	6.8	Nil
1.2	0.05	7.1	Nil
1.3	0.03	7.4	Nil
2.1	0.06	7.0	Nil
2.2	0.07	7.1	Partial
2.3	0.03	7.4	Partial
2.4	0.06	7.1	Nil
2.5	0.16	7.1	Nil
3.1	0.05	6.8	Nil
3.2	0.05	7.1	Nil

Tested By: LN
Checked By: DM
Comments:

Date: 31/03/2020
Date: 1/04/2020






Attachment D : *Sample locations*

OSSMS Scoping Study

South West Narrandera
Report No. 6736

Legend

-  Bore hole
-  Permeability test
-  Subject site



Google Earth

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1 km





Attachment E : *Water balances*

Land Capability Assessment

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations																	
Site Address:		Narrandera NSW 2700															
Date:		2,020			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	214	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	Narrandera Post Office (074082)			BoM Station and number													
Mean Monthly Pan Evaporation Data	Narrandera Post Office (074082)			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	35.3	29.5	34.5	37.1	39.2	45.3	37.3	41	37.3	43.3	34.2	31.1	445.1	
Evaporation	E		mm/month	286.5	231.8	191.1	109.3	63.1	39.7	41.3	64.2	100.6	154	211	270.1	1762.7	
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	229	185	134	77	38	24	25	39	70	123	169	216	1328.4	
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	353.2	297.44	257.8	196.5	161.9	143.8	148.8	162.5	190.4	247.2	288.8	340.1	2788.4	
INPUTS																	
Retained Rainfall	RR	RxRF	mm/month	35.3	29.5	34.5	37.1	39.2	45.3	37.3	41	37.3	43.3	34.2	31.1	445.1	
Applied Effluent	W	(QxD)/L	mm/month	101.4	91.6	101.4	98.1	101.4	98.1	101.4	101.4	98.1	101.4	98.1	101.4	1193.9	
Inputs		RR+W	mm/month	136.7	121.1	135.9	135.2	140.6	143.4	138.7	142.4	135.4	144.7	132.3	132.5	1639.0	
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	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-216.5	-176.4	-121.9	-61.3	-21.3	-0.4	-10.1	-20.1	-55.0	-102.5	-156.5	-207.6		
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	68	73	97	132	177	213	195	179	137	106	82	70	
MINIMUM AREA REQUIRED FOR ZERO STORAGE:					214.0												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:		Narrandera NSW 2700														
Date:		2,020				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	256	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	Narrandera Post Office (074082)			BoM Station and number												
Mean Monthly Pan Evaporation Data	Narrandera Post Office (074082)			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	35.3	29.5	34.5	37.1	39.2	45.3	37.3	41	37.3	43.3	34.2	31.1	445.1
Evaporation	E		mm/month	286.5	231.8	191.1	109.3	63.1	39.7	41.3	64.2	100.6	154	211	270.1	1762.7
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	229	185	134	77	38	24	25	39	70	123	169	216	1328.4
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	353.2	297.44	257.8	196.5	161.9	143.8	148.8	162.5	190.4	247.2	288.8	340.1	2788.4
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	35.3	29.5	34.5	37.1	39.2	45.3	37.3	41	37.3	43.3	34.2	31.1	445.1
Applied Effluent	W	(QxD)/L	mm/month	101.7	91.9	101.7	98.4	101.7	98.4	101.7	101.7	98.4	101.7	98.4	101.7	1197.7
Inputs		RR+W	mm/month	137.0	121.4	136.2	135.5	140.9	143.7	139.0	142.7	135.7	145.0	132.6	132.8	1642.8
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	0.0
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-216.2	-176.1	-121.6	-61.0	-20.9	-0.1	-9.8	-19.8	-54.7	-102.2	-156.2	-207.3	
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	82	88	117	158	212	256	234	214	165	128	99	84
MINIMUM AREA REQUIRED FOR ZERO STORAGE:					256.0											
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:		Narrandera NSW 2700														
Date:		2,020			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	299	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	Narrandera Post Office (074082)			BoM Station and number												
Mean Monthly Pan Evaporation Data	Narrandera Post Office (074082)			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	35.3	29.5	34.5	37.1	39.2	45.3	37.3	41	37.3	43.3	34.2	31.1	445.1
Evaporation	E		mm/month	286.5	231.8	191.1	109.3	63.1	39.7	41.3	64.2	100.6	154	211	270.1	1762.7
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	229	185	134	77	38	24	25	39	70	123	169	216	1328.4
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	353.2	297.44	257.8	196.5	161.9	143.8	148.8	162.5	190.4	247.2	288.8	340.1	2788.4
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	35.3	29.5	34.5	37.1	39.2	45.3	37.3	41	37.3	43.3	34.2	31.1	445.1
Applied Effluent	W	(QxD)/L	mm/month	101.6	91.8	101.6	98.3	101.6	98.3	101.6	101.6	98.3	101.6	98.3	101.6	1196.3
Inputs		RR+W	mm/month	136.9	121.3	136.1	135.4	140.8	143.6	138.9	142.6	135.6	144.9	132.5	132.7	1641.4
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	-216.3	-176.2	-121.7	-61.1	-21.1	-0.2	-9.9	-19.9	-54.8	-102.3	-156.3	-207.4	
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	96	102	136	184	248	298	273	250	192	149	115	98
MINIMUM AREA REQUIRED FOR ZERO STORAGE:					299.0	m ²										
CELLS																
		Please enter data in blue 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:		Narrandera NSW 2700														
Date:		2,020				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	164	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	Narrandera Post Office (074082)			BoM Station and number												
Mean Monthly Pan Evaporation Data	Narrandera Post Office (074082)			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	35.3	29.5	34.5	37.1	39.2	45.3	37.3	41	37.3	43.3	34.2	31.1	445.1
Evaporation	E		mm/month	286.5	231.8	191.1	109.3	63.1	39.7	41.3	64.2	100.6	154	211	270.1	1762.7
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	229	185	134	77	38	24	25	39	70	123	169	216	1328.4
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	384.2	325.44	288.8	226.5	192.9	173.8	179.8	193.5	220.4	278.2	318.8	371.1	3153.4
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	35.3	29.5	34.5	37.1	39.2	45.3	37.3	41	37.3	43.3	34.2	31.1	445.1
Applied Effluent	W	(QxD)/L	mm/month	132.3	119.5	132.3	128.0	132.3	128.0	132.3	132.3	128.0	132.3	128.0	132.3	1557.9
Inputs		RR+W	mm/month	167.6	149.0	166.8	165.1	171.5	173.3	169.6	173.3	165.3	175.6	162.2	163.4	2003.0
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	0.0
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-216.6	-176.4	-122.0	-61.4	-21.3	-0.5	-10.2	-20.2	-55.1	-102.6	-156.6	-207.7	
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	62	66	85	111	141	163	152	142	115	92	74	64
MINIMUM AREA REQUIRED FOR ZERO STORAGE:					164.0											
CELLS																
		Please enter data in blue cells														
		XX Red cells are automatically populated by the spreadsheet														
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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:		Narrandera NSW 2700														
Date:		2,020				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	197	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	Narrandera Post Office (074082)			BoM Station and number												
Mean Monthly Pan Evaporation Data	Narrandera Post Office (074082)			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	35.3	29.5	34.5	37.1	39.2	45.3	37.3	41	37.3	43.3	34.2	31.1	445.1
Evaporation	E		mm/month	286.5	231.8	191.1	109.3	63.1	39.7	41.3	64.2	100.6	154	211	270.1	1762.7
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	229	185	134	77	38	24	25	39	70	123	169	216	1328.4
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	384.2	325.44	288.8	226.5	192.9	173.8	179.8	193.5	220.4	278.2	318.8	371.1	3153.4
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	35.3	29.5	34.5	37.1	39.2	45.3	37.3	41	37.3	43.3	34.2	31.1	445.1
Applied Effluent	W	(QxD)/L	mm/month	132.2	119.4	132.2	127.9	132.2	127.9	132.2	132.2	127.9	132.2	127.9	132.2	1556.3
Inputs		RR+W	mm/month	167.5	148.9	166.7	165.0	171.4	173.2	169.5	173.2	165.2	175.5	162.1	163.3	2001.4
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	0.0
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-216.7	-176.5	-122.1	-61.5	-21.5	-0.6	-10.3	-20.3	-55.2	-102.7	-156.7	-207.8	
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	75	79	102	133	169	196	183	171	138	111	89	77
MINIMUM AREA REQUIRED FOR ZERO STORAGE:					197.0											
CELLS																
		Please enter data in blue cells														
		XX Red cells are automatically populated by the spreadsheet														
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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:		Narrandera NSW 2700														
Date:		2,020				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	229	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	Narrandera Post Office (074082)			BoM Station and number												
Mean Monthly Pan Evaporation Data	Narrandera Post Office (074082)			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	35.3	29.5	34.5	37.1	39.2	45.3	37.3	41	37.3	43.3	34.2	31.1	445.1
Evaporation	E		mm/month	286.5	231.8	191.1	109.3	63.1	39.7	41.3	64.2	100.6	154	211	270.1	1762.7
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	229	185	134	77	38	24	25	39	70	123	169	216	1328.4
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	384.2	325.44	288.8	226.5	192.9	173.8	179.8	193.5	220.4	278.2	318.8	371.1	3153.4
INPUTS																
Retained Rainfall	RR	RxRF	mm/month	35.3	29.5	34.5	37.1	39.2	45.3	37.3	41	37.3	43.3	34.2	31.1	445.1
Applied Effluent	W	(QxD)/L	mm/month	132.7	119.8	132.7	128.4	132.7	128.4	132.7	132.7	128.4	132.7	128.4	132.7	1562.0
Inputs		RR+W	mm/month	168.0	149.3	167.2	165.5	171.9	173.7	170.0	173.7	165.7	176.0	162.6	163.8	2007.1
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	0.0
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-216.2	-176.1	-121.6	-61.0	-21.0	-0.1	-9.8	-19.9	-54.7	-102.2	-156.2	-207.3	
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	87	93	119	155	198	229	213	199	161	129	103	89	
MINIMUM AREA REQUIRED FOR ZERO STORAGE:				229.0	m ²											
CELLS																
		Please enter data in blue cells														
		XX Red cells are automatically populated by the spreadsheet														
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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																



Attachment F : *Nutrient balances*

Nitrogen Balance

Site Address: **Narrandera NSW 2700**

SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE

93

m²

INPUT DATA¹

Wastewater Loading			Nutrient Crop Uptake					
Hydraulic Load	700	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	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	214	m ²
			Predicted N Export from LAA	-2.66	kg/year
			Minimum Buffer Required for excess nutrient	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 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: **Narrandera NSW 2700**

SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE **111** m²

INPUT DATA¹

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	256	m ²
			Predicted N Export from LAA	-3.18	kg/year
			Minimum Buffer Required for excess nutrient	0	m ²

CELLS

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Nitrogen Balance

Site Address: **Narrandera NSW 2700**

SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE

130

m²

INPUT DATA¹

Wastewater Loading			Nutrient Crop Uptake			
Hydraulic Load	980	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	1960	mg/day				
Remaining N Load after soil loss	7840	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	130 m ²	Nominated LAA Size	299	m ²
		Predicted N Export from LAA	-3.72	kg/year
		Minimum Buffer Required for excess nutrient	0	m ²

CELLS

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Nitrogen Balance

Site Address: **Narrandera NSW 2700**

SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE

93

m²

INPUT DATA¹

Wastewater Loading			Nutrient Crop Uptake					
Hydraulic Load	700	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	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	164	m ²
			Predicted N Export from LAA	-1.56	kg/year
			Minimum Buffer Required for excess nutrient	0	m ²

CELLS

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NOTES

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Nitrogen Balance

Site Address: **Narrandera NSW 2700**

SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE

111

m²

INPUT DATA¹

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	197	m ²
			Predicted N Export from LAA	-1.88	kg/year
			Minimum Buffer Required for excess nutrient	0	m ²

CELLS

	Please enter data in blue cells
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NOTES

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

Nitrogen Balance

Site Address: **Narrandera NSW 2700**

SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE **130** m²

INPUT DATA¹

Wastewater Loading			Nutrient Crop Uptake			
Hydraulic Load	980	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	1960	mg/day				
Remaining N Load after soil loss	7840	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	130	m ²	Nominated LAA Size	229	m ²
			Predicted N Export from LAA	-2.18	kg/year
			Minimum Buffer Required for excess nutrient	0	m ²

CELLS

	Please enter data in blue cells
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NOTES

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- Appropriate Peer Reviewed Papers
- Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households
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