Wastewater Management Report – Hillview Quarry

ADW Johnson Pty Ltd

67 Maytoms Lane, Booral NSW 2425

26/03/2024

DOCUMENT CONTROL

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REVISION/CHECKING

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Acknowledgement

DWA acknowledges the Traditional Custodians throughout Australia and their continuing connection to land, water, culture and community, and pays respect to their Elders past, present and future.

Limitations Statement

This report and the associated services performed by Decentralised Water Australia (DWA) relate solely to the scope, budget, time, and access constraints as set out in the engagement agreement and quotation between DWA and the Client. DWA accept no liability for any use or reliance on this Report for any purpose not documented in this agreement and quotation by the Client. It has been prepared for the exclusive use of the Client and DWA accepts no liability for any use of or reliance upon this report by any third party.

The outcomes and recommendations contained in this report may have relied upon a range of information and data sources including information and discussions with the client, field investigations (limited to those described in this report), publicly available information and other sources. DWA have not verified the accuracy of third-party data and any inaccuracies or inadequacies may influence the accuracy of our findings. Similarly, both the inherent variability of environmental and ground conditions and the passage of time can lead to changes in ground conditions and other factors which may affect the accuracy of our findings. The Client should seek advice from DWA on the accuracy of findings after more than six months has passed or where changes in relevant conditions are known to have occurred. Data and information collected during field investigations should not be taken as accurate and complete for all depths and locations across the site.

The report and services have been completed in accordance with relevant industry standards, guidelines, and government legislation as of the date of publication unless stated otherwise. Where an engineering design is included, this design has been based on site and construction plans as provided by the Client and/or their representative and documented in the report. DWA accepts no liability for the impact of any changes to site conditions and / or building layout and extents on our design where DWA were not notified of the changes prior to completing our services. Additional costs may be incurred where work has already been completed.

Table of Content

Table of Figures

Table of Contents

1 Introduction

This Wastewater Management Report (WMR) has been prepared by Decentralised Water Australia (DWA) for ADW Johnson Pty Ltd. The report summarises the outcomes from a land capability assessment and proposed design for an on-site wastewater management system to support a proposed hard rock quarry development to be located at 67 Maytoms Lane, Booral NSW 2425.

MidCoast Council (MCC) will require submission of a Wastewater Management Report (WMR) to confirm the suitability of the site for management of wastewater from the proposed development as part of the Development Application (DA) process. The report will demonstrate that adequate arrangements for the management and disposal of sewage are achievable in accordance with the provisions of Councils Local Environmental Plan. The WMR will also be suitable for submission to Council in support of an application to install a wastewater treatment system in accordance with the *Local Government Act*.

This report outlines the outcomes of the project, which involved site and soil assessment, concept design and comprehensive environmental assessment for an on-site wastewater management system to accept, treat and land apply wastewater from the proposed development.

Notwithstanding several identified limitations, the site is generally well suited to on-site wastewater management. Based on the outcomes of the site and soil assessment, it was determined that an on-site sewage management solution is feasible for the site.

1.1 Site Information

The site, which comprises several separate lots is identified as 67 Maytoms Lane, Booral NSW 2425. The site, which is approx. ~400ha in size, is irregular in shape with connectivity to Maytoms Lane available from several of the lots. Slope across the various lots is extremely variable as is landform. The office, amenities and associated structures for the proposed development are to be located on the eastern side of lot 63. Vegetation across the lot comprises grassed open paddocks and dense timbered areas. Several non-perennial watercourses traverse the lot including Double Creek due to the topography and landform.

The location of the site is shown in Figure 1 with details of the site are summarised in Table 1.

Table 1 Summary of Site Information

Site Information	
Property Details	67 Maytoms Lane, Booral NSW 2425 Lot 1 DP 159902 Lot 60 DP 1094397 Lots 62 & 63 DP 95029 Lot 64 DP 95030
Owner / Applicant	ADW Johnson Pty Ltd
Allotment Size	~400ha
Land Zoning	RU2
Development Type	Non-domestic
Description of proposed development	Amenities to service a hard rock quarry development.
Water Supply	Tank Supply
Power Supply	Grid connected
Sewer Availability	Not available
Local Government Area	MidCoast Council (MCC)

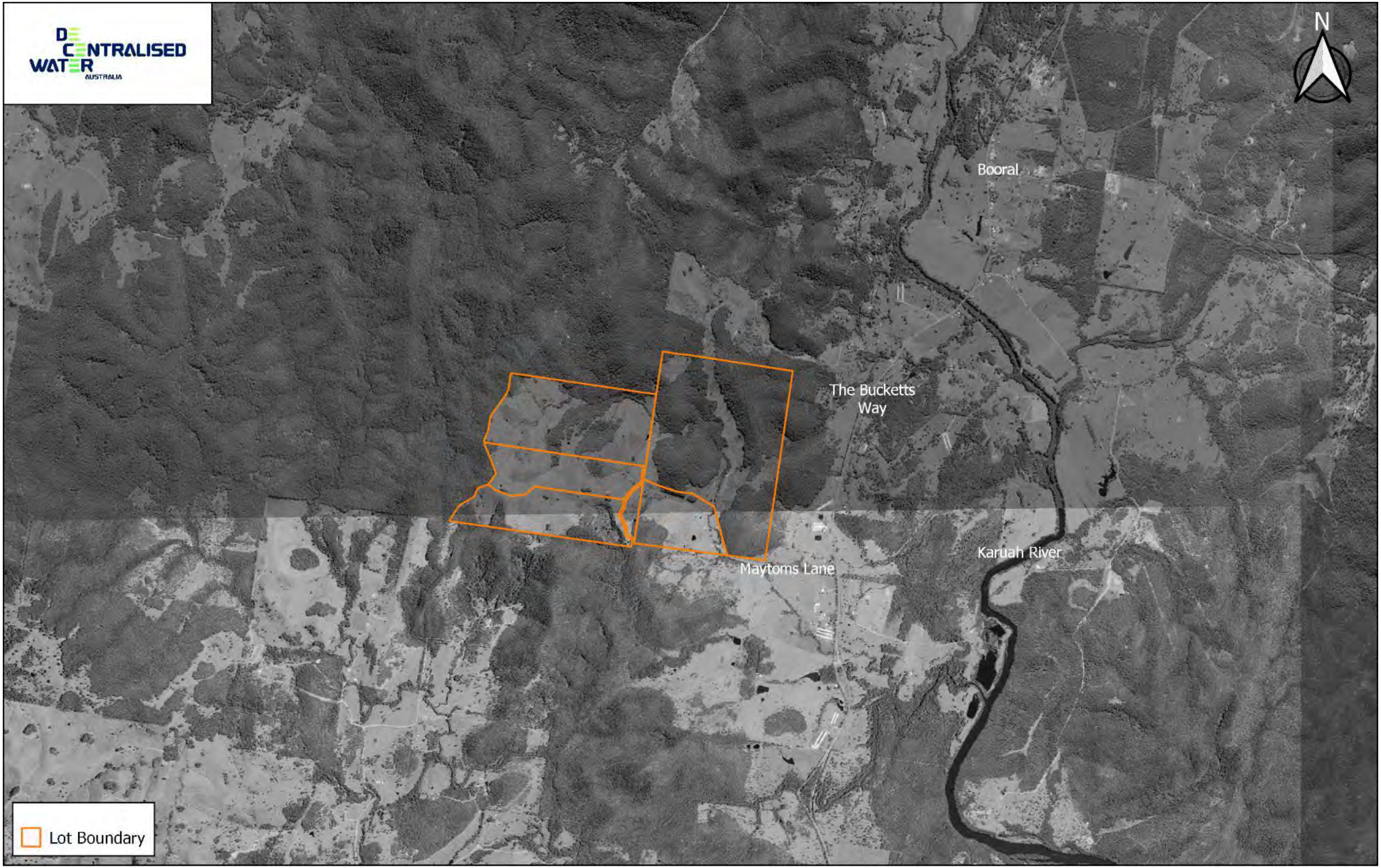

Figure 1 Locality Plan

0 500 1,000 1,500 m

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2 Performance Objectives

2.1 Legislation

2.1.1 Development Applications

Development applications made under the *Environmental Planning and Assessment Act* and the Great Lakes Environmental Plan 2014 require that adequate arrangements must be made for the provision of essential services that are appropriate for the proposed development. Essential services are generally addressed in the LEP and includes the provision of adequate arrangements for the disposal and management of sewage. Given the development site is in an area not provided with reticulated sewer, alternative suitable arrangement must be developed by the applicant.

2.1.2 Future On-site Sewage Management System Approvals

The NSW local Government Act prescribes matters that apply to the installation and operation of Wastewater Management Systems. Under Chapter 7, Part 1 of the Act the installation and operation of systems are activities that require the approval of the Local Council. That is, a person may only carry out an activity specified in the Table of Approvals under Section 68 of the Act with the prior approval of the council, except in so far as this Act, the regulations or a local policy adopted under Part 3 allows the activity to be carried out without that approval.

The *Local Government (General) Regulation* prescribes further requirements and guidance. A Council must not approve an application for an approval relating to sewerage work unless it is satisfied that the activity as proposed to be carried out will comply with applicable standards and any applicable requirement of the Regulation. This applies to the installation of a new, or upgrade of an existing Wastewater Management System as well as the ongoing operation of these systems.

The installation of a wastewater management system requires from Council an approval to install under Section 68(C5) of the Act. In determining an application for approval to install, construct or alter a Wastewater System the Council must consider environmental and health protection performance matters that are prescribed in the Regulation. These include:

- Preventing the spread of disease by micro-organisms,
- Preventing the spread of foul odours, contamination of water and degradation of soil and vegetation,
- Discouraging insects and vermin,

- Ensuring that persons do not come into contact with untreated sewage or effluent (whether treated or not) in their ordinary activities on the premises concerned,
- The re-use of resources (including nutrients, organic matter and water),
- The minimisation of any adverse impacts on the amenity of the land on which it is installed or constructed and other land in the vicinity of that land.

The council must also consider any matter specified in guidelines or directions issued by the Director-General in relation to the matters referred to in the above performance objectives.

Additionally, the council must not grant an application for an approval to install, construct or alter a waste treatment device or sewage management facility unless it is satisfied that the activity as proposed to be carried out will comply with any applicable standards established by this Regulation or by or under the Act.

Note: While there are no standards established by the Regulation or Act it is accepted that AS1547: 2012 On-site domestic wastewater management and Environment and Health Protection Guidelines (DLG: 1998) are 2 appropriate reference documents commonly used in the assessment and design of On-site Sewage Management Systems.

The continued operation of Wastewater Management Systems is also addressed in the Regulation. Systems must be operated in a manner that achieves the same installation performance standards mentioned above. Additionally, systems must be operated in accordance with relevant operating specifications and procedures for the system and allow the removal of any treated sewage in a safe and sanitary manner. Further conditions of approval require that the system is maintained in a sanitary condition and that he operation of the system must not discharge into any watercourse or onto any land other than the effluent application area.

The proposed development must also consider the following legislation relevant to wastewater management.

- *Environmental Planning and Assessment Act (1979).*
- *Protection of the Environment Operations Act (1997).*

2.1.3 Policies, Standards and Guidelines

The key policies used in this assessment may include:

- NSW Groundwater Policy (specifically the Groundwater Quality Policy),
- Local Planning for Healthy Waterways using NSW Water Quality Objectives,
- NSW Oyster Industry Sustainable Aquaculture Strategy (2016), and
- Using the ANZECC Guidelines and Water Quality Objectives in NSW.

At a broad level, the ANZECC Water Quality Guidelines for Fresh and Marine Waters (2000) and NSW Oyster Industry Sustainable Aquaculture Strategy have been used (in accordance with NSW policy) to determine water quality objectives for the system (where applicable).

The following guidelines and technical references are used by local and state government in assessing applications for systems of this scale.

- AS/NZS1547:2012 On-site domestic wastewater management.
- Environment and Health Protection Guidelines: On-site Sewage Management (NSW DLG, 2023 Draft).

3 Site and Soil Evaluation

A site and soil evaluation of the property was undertaken based on AS/NZS 1547:2012, Section 5.2 and several Appendices including B and D. The broad goal of the site and soil evaluation was to collect sufficient information about the site, soil and local environmental constraints. This information enables good decision making on the suitability for land based on-site wastewater systems for the development and if appropriate, inform the design, location and operation of the system.

The assessment was performed in two stages.

Stage 1 was a desktop study with the objective to collect, in advance, regulatory, planning, and environmental information for the site, development and general area. DWA also used its Geographic Information System (GIS) to identify spatial and geographic data relevant to the site and broader area to help inform decisions during site assessment and in the system selection and design process.

Stage 2 involved a visit to the site to undertake a site and soil assessment having regard to an overall evaluation of not only the individual lot but the broader surrounds. Of importance during this stage is an evaluation of the land within and surrounding the study area with an emphasis on the interaction between surface shape, surface gradient, and water regime. The site visit also allows for the identification, inspection and analysis of sensitive receptors that may influence suitability and subsequent design tasks. A soil survey was completed across the study site with soil samples collected for characterisation and laboratory testing. The complexity of the soil survey is dependent on the size of the lot and the variability in land and soils. While AS1547 (D3.1.1) suggests that an evaluation of 3 representative soil observation boreholes within the lot should be inspected, the exact number will be dependent on several factors including the size of the lot and the homogeneity of the landform and soils across the lot.

Soil test pits were excavated to a suitable depth using a shovel and auger with soil samples collected and photographed for examination, laboratory analysis and reporting.

The overall aims of the assessment were to:

- Provide sufficient information for deciding whether the lot is suitable to sustain an on-site system,
- Provide detailed site-specific information identifying the site-and-soil characteristics to be considered when selecting and designing the on-site system,
- Identify, analyse, and evaluate any risks posed by site-and-soil characteristics which might compromise the long-term effectiveness of the on-site system,

- Identify, analyse, and evaluate any risks of contamination of groundwater or surface water and of associated health risks, and
- Develop and refine measures required to reduce and monitor identified risks that can be considered in the design phase of the study.

The field investigation was undertaken on **11 May 2023.**

The outcomes of the site assessment are presented in Section 3.1, with the soil assessment information in Section 3.2 and overall outcomes presented in Section 3.3. A plan showing the site and surrounding area is presented in Figure 2 with photos also provided for context.

3.1 Site Assessment

Site assessment observations for the lot were determined based on AS1547, Section 5.2 (Site and Soil Evaluation). The evaluation utilised methodologies and procedures from Appendices B, C and D of AS1547 as well as the NSW Environment and Health Protection Guidelines, Section 4.3.3 and Table 4 (Site Assessment: Rating for On-site Systems).

Results and corresponding outcomes from the site assessment are presented in Table 2

Table 2 Desktop Site Assessment

Site Feature	Observation	Classification	Outcome
Flood potential	Site located above Council defined flood levels	Minor limitation	Minimal impact on design
Exposure	High sun and wind	Minor limitation	Minimal impact on design
Slope % (pre-development conditions)	~18%	Moderate limitation	Consider the degree of slope in the design and location of the LAA. Ensure that the adopted LAA design is appropriate for the observed slope in accordance with AS1547, Table K1.
Slope % (post-development conditions)	<5%	Minor limitation	Minimal impact on design

Site Feature	Observation	Classification	Outcome
Landform (pre-development conditions)	Linear divergent. Good water shedding surface, spreads run-off but no acceleration.	Minor limitation	Minimal impact on design
Landform (post-development conditions)	Linear planar. Natural drainage but less effective with distance from crest. No spreading or acceleration.	Minor limitation	Minimal impact on design
Run-on and seepage	None, low	Minor limitation	Minimal impact on design
Erosion potential	No signs of erosion observed	Minor limitation	Minimal impact on design
Site drainage	No visible signs of surface dampness	Minor limitation	Minimal impact on design
Fill	No fill observed	Minor limitation	Minimal impact on design
Rocks and rock Outcrops	Surface rock covering <10% LAA observed	Moderate limitation	Consider moderate to major levels of surface rock in the design and location of the LAA. Suitable control measures may be required to reduce the impacts of surface rock such as civil works, increased LAA footprint or surface LAA designs.
Vegetation	Mixed grass and trees	Minor limitation	Minimal impact on design
Watercourses and sensitive receptors	The development site is characterised by several surface dams both naturally existing and proposed processing dams. The closest naturally occurring waterbody to the proposed LAA is ~100m.	Minor limitation	Minimal impact on design

Site Feature	Observation	Classification	Outcome
	Several non-perennial watercourses are located within the development site. The closest existing non-perennial watercourse to the proposed LAA is located between the LAA and office building. This will be removed through approved civil works.		
Soil water regime	250mm of moderately structured loam with very few coarse fragments over a further 80mm of moderately structured loam with few coarse fragments. Pit terminated at 330mm on weather stone.	Major limitation	Consider level of treatment and LAA design to manage poorer soil water regimes. Adopt conservative design loading rate (DLR) to ensure adequate hydraulic performance.
Acid Sulfate Soils[1]	N/A	Minor limitation	Minimal impact on design
Biodiversity Values Map[2]	No biodiversity values mapped	Minor limitation	Minimal impact on design
Drinking Water Catchment[1]	No	Minor limitation	Minimal impact on design
Aquaculture Areas[3]	No aquaculture mapped	Minor limitation	Minimal impact on design

[1] NSW Government eSpatial Planning Viewer
[2] NSW Government Biodiversity Values Map and Threshold Tool
[3] NSW Fisheries Spatial Data Portal

3.1.1 Site Photos

Photo 1: Entry to the property

Photo 2: Existing dwelling & rural shed

Photo 3: Test pit location

Photo 4: Surface rock out crop

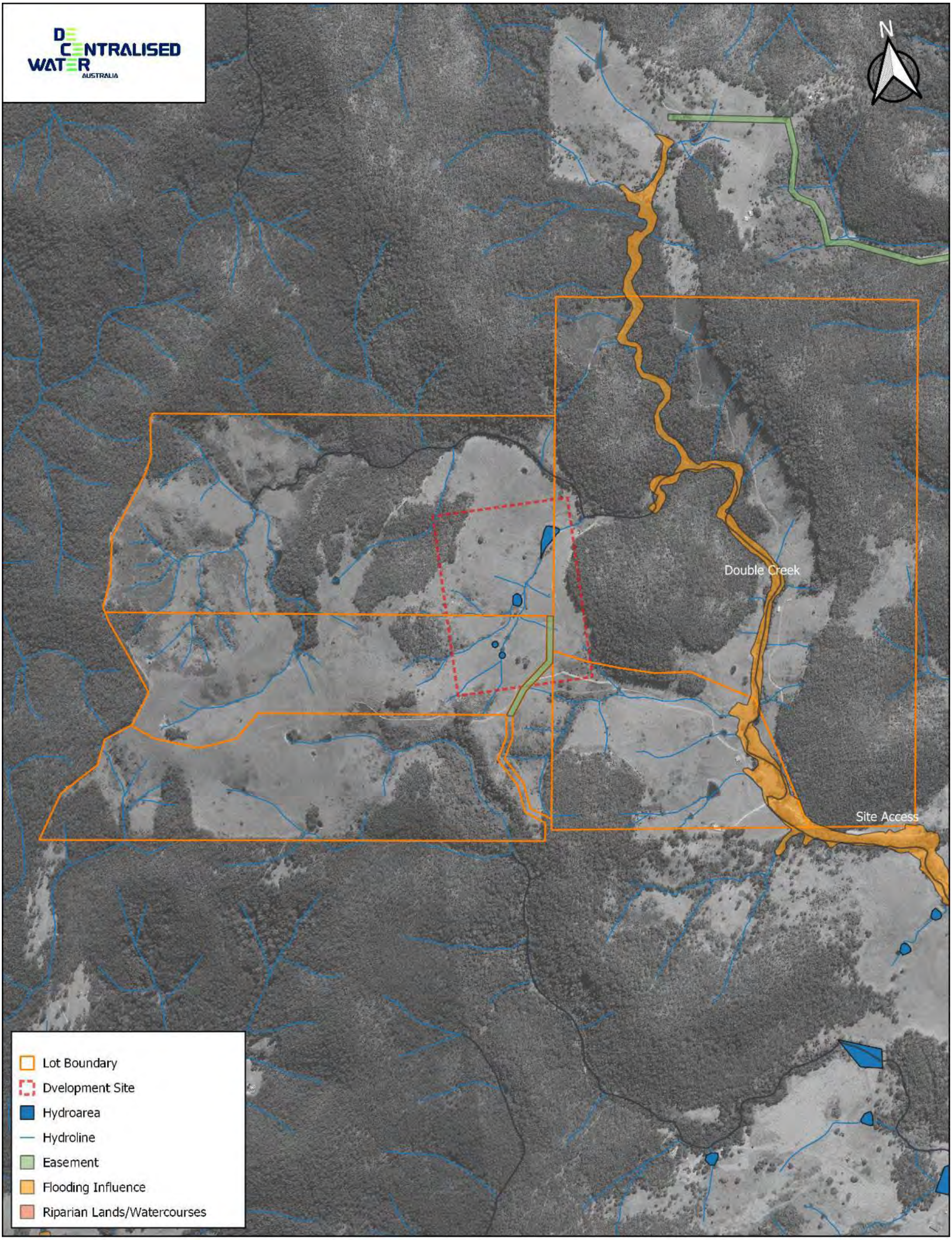

Figure 2 Site Assessment Plan (Overview)

0 200 400 600 m

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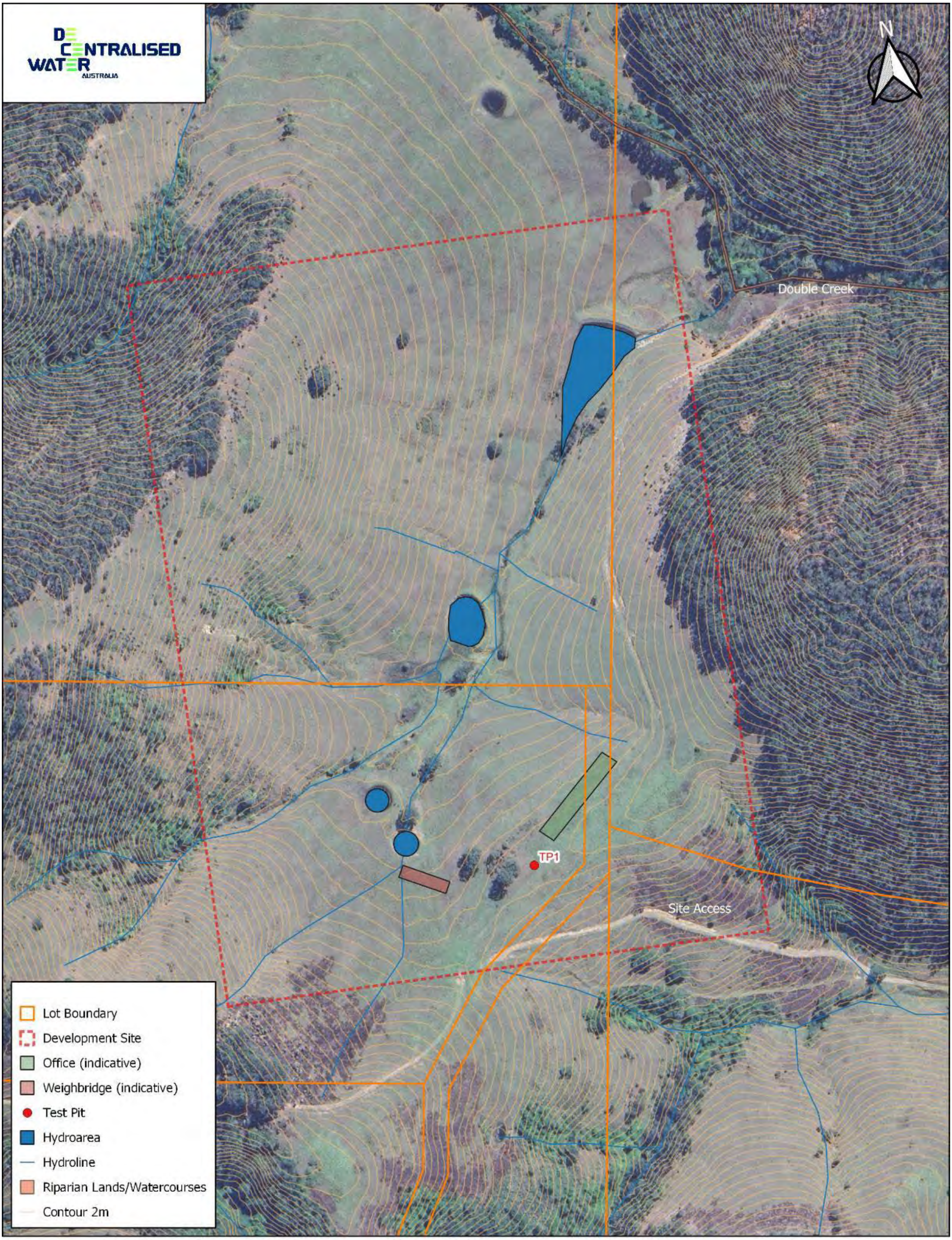

Figure 3 Site Assessment Plan (Detailed)

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3.2 Soil Assessment

The site is located on the Ten Mile Road (tm) soil landscape as mapped on the Soil Landscapes of the Dungog 1:100 000 Sheet. This Erosional soil landscape typically consists of undulating low hills on Carboniferous sediments and acid volcanics in the Clarencetown Hills regions. Relief is between 40 – 80 m; elevation 70 – 180 m; slopes 5 – 10%. Uncleared open forest is typical for the area. Soils comprise moderately deep to deep, well to imperfectly drained brown Soloths (Brown Kurosols), yellow Soloths (Yellow Kurosols) and shallow, well-drained Bleached Loams/Lithosols (Bleached-Leptic Tenosols). Qualities and Limitations include high water erosion hazard; high run-on; seasonal waterlogging. Localised shallow soils are common with soils strongly to extremely acid of low fertility.

A composite soil sample of the same test pit was submitted to an appropriately qualified and experienced laboratory for chemical analysis.

A summary of the sub-surface profile is presented in the table below.

Table 3 Summary of soil profile characteristics

Test Pit	Depth (mm)	Texture[4]	Structure	Colour	Coarse Fragments
TP1	0 – 250	Loam (3)	Moderate	Brown	<2% Very few
	250 – 330	Loam (3)	Moderate	Brown	2-10% Few
	Pit terminated on weathered stone.				

3.2.1 Soil Laboratory Results and Interpretation

This section presents the outcomes from the laboratory analysis of both the discrete and composite samples. The information below provides information about each soil test with a summary of the soil results and interpretation presented in Table 4. Interpretation is based on information contained in Hazelton and Murphy (2016). Recommendation of suitable soil remediation or other control measures, if required, are presented at the bottom of Table 4.

[4] Soil category in brackets

3.2.1.1 pH

The pH value of the soil can influence the soil conditions, vegetation growth and the mobility/availability of nutrients and metals. The pH range most suitable for plant growth is between 5.5 – 9.0 with remediation a consideration if the results fall outside the range. Soi pH can be adjusted with the addition of lime at a rate calculated for the soil result.

3.2.1.2 Salinity and Sodicity

Soil salinity is the accumulation of water-soluble salts in the soil. The predominant cations and anions that contribute to salinity are sodium, calcium, and magnesium in the form of chlorides, sulphates, or carbonates. Elevated salinity can impact plant growth and contribute to erosion and a change in soil texture. Salinity is directly proportional to the measured electrical conductivity of a soil - water extract with the standard units being decisiemens per metre (dS/m). The EC result is converted to ECe to reflect the estimated water-holding capacity of the soil with the conversion factor a function of the soil texture.

Hazelton and Murphy (2016) states that soils with a salinity (ECe) <2 dS/m are considered non-saline and will have negligible effects on plant growth. Soils with a salinity above 4dS/m may start to impact plants.

Sodicity is defined as the level of exchangeable sodium cations in the soil with implications of dispersion on wetting and shrink-swell properties. According to Hazelton and Murphy (2016), soils that are sodic can exhibit the following properties that may be detrimental to the application of wastewater:

- Surface crusting,
- Low infiltration and hydraulic conductivity,
- Hard and dense sub-soils,
- Susceptibility to gully and tunnel erosion.

Sodicity is determined using Exchangeable Sodium Percentage which is calculated as a function of the soluble sodium and cation exchange results. ESP of > 10% (Environment and Health Protection Guideline) is considered a major limitation which should be addressed.

A further indication of sodicity can be obtained from the results of the Emerson Aggregate Test (EAT). Generally, soils with an EAT class of 3(2), 3(1), 7 and 8 are unlikely to be sodic. EAT class of 3(3), and 2(1) may be sodic with class 2(2), 2(3) and 1 most likely to be sodic.

3.2.1.3 Cation Exchange Capacity

The cation exchange capacity (CEC) is the ability of soil particles to retain cations at a given pH and is useful in understanding the ability of a soil to retain pollutants. CEC provides pH buffering and can influence availability of nutrients, calcium levels and soil structural changes. Exchangeable cations are a measure of the most abundant cation sodium, potassium, calcium, magnesium, and aluminium. CEC tends to vary according to soil type with clay soils more likely to exhibit higher results due to the greater ability to bind cations.

3.2.1.4 Phosphorus sorption capacity

The phosphorus sorption capacity is an indicator of the capacity of a soil to absorb phosphorus as effluent moves through the soil profile. According to the EHP Guidelines (DLG 1998), the expected rate of phosphorus sorption by the soil is expected to be in the range 25 – 50% of the P-sorption capacity result beyond which leaching may occur. An optimum soil P-sorption capacity is in the order of 50-years based on the soil phosphorus concentration.

Table 4 Summary of Soil Results and Interpretation

Test parameter [5]	Result	Desirable Range Lower limitation		Higher limitation	Interpretation
pH	6.4	6.0 – 9.0	5.0 – 6.0	<5.0	The pH is at the lower end of limitation range indicating a satisfactory result. Adjustment of the soil pH within the LAA is not required.
Electrical conductivity (ECe dS/m)	0.19	<2	2 – 8	>8	The electrical conductivity of the soil is at the lower end of limitation range. Remediation of soil within the LAA is not required.
Exchangeable sodium percentage (ESP%)	2	<6	6 – 15	>15	The ESP result is within the desirable range. Remediation of soil within the LAA is not required.
Emerson aggregate test (EAT)	Class 3(3)	3(1), 3(2), 4, 7, 8	3(3), 2(1), 2(2)	1, 2(3)	The EAT result is indicative of a low risk. Remediation of soil within the LAA is not required.
Cation exchange capacity (cmol/kg)	6.3	>25	6.0 - 25	<6.0	The CEC result is within the desirable range and a low risk. Remediation of soil is not required.
Phosphorus sorption capacity	360	>250	125 - 250	<125	The P-sorption result is within the desirable range and a low risk.

[5] Composite sample result for all parameters except EAT. EAT result represents most limiting from discrete sample results.

Test parameter [5]	Result	Desirable Range Lower limitation	Higher limitation	Interpretation
(mg/kg @70%)				
Remediation and Control Measures		Nil		Not required

3.3 Effluent Management Area Suitability Evaluation

This section evaluates the property to establish:

- The availability of sufficient useable land suitable for use as an effluent management area, and
- The determination of available setback distances for various site features documented in Appendix R of AS1547.

A setback distance analysis was performed to determine appropriate setback distances for various site features that are referenced in AS1547 – 2012 Appendix R1/R2. As stated in the standard, local conditions and sensitive receiving environments typically require different setback distances. The table is used in conjunction with the outcomes from the site and soil evaluation to provide guidance on what would be an appropriate setback distance for the adopted land application method and design effluent quality against each relevant site feature.

Appendix R of the standard applies a risk-based approach to the determination of setback distances for the various site features. Each setback distance is a range rather than a single prescribed value with the physical horizontal or vertical setback distance determined as a function of a constraint scale for each site or system feature. Selection of a higher or lower distance for each relevant feature is based on the assessor's knowledge and experience using guidance notes included in the Appendix.

Table 5 presents the adopted or available setback distance for each site feature with Table 6 providing further information on the site features and other contributing factors that may influence selection and design of the treatment system and LAA.

Table 5 LAA Setback Distance Assessment

Site Feature	Distance available/ adopted	AS1547 Range Table R1	Contributing Factors Table R2
Horizontal setback			
Property boundary	>50m	1.5 – 50m	Microbial (A) Slope (D) LAA Method (J)
Buildings/houses	>6m	2.0 - 6m	
Surface water	>100m	15 – 100m	Microbial (A) Surface water (B) Slope (D) Location of LAA (E) Drainage (F) Flood potential (G) LAA Method (J)
Bore/well[6]	>50m	15 – 50m	Microbial (A) Groundwater (C) Geology and soils (H) LAA Method (J)
Recreational areas such as swimming pools and play equipment	N/A to this development	3 – 15m	Microbial (A) Location of LAA (E) LAA Method (J)
In-ground water tank	N/A to this development	4 – 15m	
Retaining walls, embankments, and escarpments	N/A to this development	3.0m or 45° angle from toe of wall	Slope (D) Flood potential (G) Geology and soils (H)
Vertical Setback			
Groundwater	>1.5m	0.6 - $\geq$1.5m	Microbial (A) Groundwater (C) Drainage (F) Flood potential (G) Geology and soils (H) Landform (I) LAA Method (J)

[6] National Groundwater Information System, Bureau of Meteorology (Australian Government)

Site Feature	Distance available/ adopted	AS1547 Range Table R1	Contributing Factors Table R2
Hardpan or bedrock	>1.5m[7]	0.5 - ≥1.5m	Microbial (A) Groundwater (C) LAA Method (J)

[7] Noting the results from the soil test pit, the design and construction of the land application area will ensure a minimum depth of soil in accordance with AS1547 Appendix K.

Table 6 Site Features/Contributing Factors Evaluation

Site or system feature	Constraint Scale Lower constraint		Higher constraint	Notes/Comments
Microbial (A)	☒ Lower microbial levels (e.g., secondary effluent + disinfection) ☐ Off-site management	☐ Some microbial reduction (e.g., secondary effluent)	☐ Higher microbial levels (e.g., primary effluent)	Secondary treatment with disinfection proposed
Surface water (B)	☒ Cat 1 – 3 soils ☒ >100m to downslope surface water ☐ Lower rainfall area ☒ No resource/environmental values in proximity	☐ 50 - 100m to downslope surface water	☒ Cat 4 – 6 soils ☐ <50m to downslope surface water ☐ Higher rainfall area ☐ High resource/environmental value	
Groundwater (C)	☐ Cat 5 – 6 soils ☒ Lower environmental value	☒ Cat 3 – 4 soils	☐ Cat 1 – 2 soils ☐ Gravel aquifer ☐ High environmental value	
Slope (D)	☐ 0 - 6% surface ☒ 0 - 10% subsurface	☐ 6 - 10% surface ☐ 10 - 30% subsurface	☐ >10% surface ☐ >30% subsurface	
Location of LAA (E)	☒ Most site and environmental features located upgradient	☐ Some site and environmental features located downgradient	☐ Most site and environmental features located downgradient	

Site or system feature	Constraint Scale Lower constraint		Higher constraint	Notes/Comments
Drainage (F)	☐ Cat 1 – 2 soils ☒ Gently sloping	☒ Cat 3 - 5 soils	☐ Cat 6 soils ☐ Visible seepage, moisture tolerant plants, or low-lying areas	
Flood potential (G)	☒ >1:20 AEP LAA ☒ >1:100 AEP System	–	☐ <1:20 AEP LAA ☐ <1:100 AEP System	
Geology and soils (H)	☒ Cat 3 – 4 soils ☐ Suitable geology	☐ Cat 2 & 5 soils	☐ Cat 1 & 6 soils ☒ Less suitable geology	Noting the results from the soil test pit, the design and construction of the land application area will ensure a minimum depth of soil in accordance with AS1547 Appendix K.
Landform (I)	☒ Hill crests, convex side slopes and plains	-	☐ Drainage plains and incise channels	
Application method (J)	☒ Sub-surface ☐ Sub-soil ☐ Mound	-	☐ Surface	

3.4 Site, Soil and EMA Availability Evaluation Outcomes

The outcomes from the site, soil and land suitability evaluation assessment have identified the following major or moderate pre-development limitations:

3.4.1 Major Limitations

- Soil depth and soil water regime.

3.4.2 Moderate Limitations

- Rock outcrops, and
- Slope and landform.

A treatment system, land application approach and civil works has been identified in Section 4 that is considered the most suitable wastewater management option taking into consideration the above site constraints.

DWA has also identified the following management controls to address the constraints identified and ensure the preferred system is designed correctly for the site:

- Completion of hydraulic and nutrient balance calculations to size the land application area using assumptions and criteria from published standards, guidelines, and references.
- Demonstration of appropriate horizontal and vertical setbacks to site features, development features and sensitive receptors as outlined in AS1547 (2012 - Appendix R).
- Selection of a treatment system, land application area design and effluent quality standard that is suitable for the observed site, soil, environmental and development features, and subsequent related limitations.
- Completion of civil works across the land application area to improve soil depth and mitigate limitations resulting from the proximal non-perennial watercourse, slope, landform, and soil water regime.

4 Design Basis

The outcomes from the detailed site and soil assessment have determined that the site is generally suitable for a wide range of on-site wastewater management options. These options and a final design basis are discussed in further detail in the following sections.

4.1 Wastewater Servicing Options Evaluation

Several broad options for wastewater servicing solutions were initially considered by DWA that encapsulated the full range of servicing strategies available for this site. These were shortlisted to a single preferred servicing option following an initial screening process as summarised in Table 7 below.

Table 7 Outcomes of Initial Screening Process

No.	Potential servicing option – Treatment	Potential servicing option – LAA	Evaluation	Progress?
1	Sewer	N/A	- Sewer is not available to the property.	**No**
2	Primary	Conventional bed	- This is a commonly utilised wastewater management option where the outcomes from the site and soil evaluation have identified that primary treated effluent to a sub-soil land application method can achieve a satisfactory level of environmental and human health protection. This system is suitable for sites that are not constrained by sensitive receiving environments, have sufficient depth of soil of a suitable category and ground slope is <15%. Conventional beds are suitable for small sites where the area of useable land is limited. - Based on the outcomes of the site and soil evaluation, this option has not been carried forward due to the depth of in-situ soils.	**No**
3	Secondary	Sub-surface irrigation	- This is a commonly utilised wastewater management option where the outcomes from the site and soil evaluation have identified that secondary treated effluent to a surface land application method can achieve a satisfactory level of environmental and human health protection. This system is suitable for sites that are not constrained by sensitive receiving environments, have sufficient depth of soil of a	**Yes**

No.	Potential servicing option: Treatment	Potential servicing option: LAA	Evaluation	Progress?
			suitable category and a relatively gentle ground slope (<10%). The use of spray irrigation provides a cost-effective land application method in comparison to subsurface methods. - Based on the outcomes of the site and soil evaluation, this option has been carried forward due to the improved effluent quality and protections afforded by secondary treated effluent and subsurface irrigation.	

Assessment of sub-surface irrigation option against AS1547 (2012) Appendix K

Assessment Feature	Detail	Result (Post development)
Slope Gradient	Sufficient land available with slope gradient <30%	Yes
Soil depth	0.6m below dripline desirable	Yes
Soil category	Suitable soil category available on all lots. LAA size reflective of adopted DLR.	Yes
Depth to seasonal water table	Preferably > 1.2m	Yes
Duration of continuous seasonal soil saturation	Not considered a limitation within the upper soil profile.	Yes
Dispersive (sodic) soil	Soil landscape is typically non-dispersive	Yes
Climatic factors	Not significant – considered in LAA sizing	Yes
Lot size	All lots >1ha	Yes

No.	Potential servicing option: Treatment	Potential servicing option: LAA	Evaluation	Progress?
4	Secondary	Surface irrigation	- This is a commonly utilised wastewater management option that provides a high level of performance. Secondary treatment systems provide significantly improved effluent quality characteristics over primary systems. The subsurface land application method delivers enhanced levels of environmental and human health protection resulting from superior assimilation of the applied effluent and nutrients through soil and biological processes. - Based on the outcomes of the site and soil evaluation, this option has not been carried forward.	**No**
5	Effluent pump-out system	N/A	- It is acknowledged that Effluent Pump Out systems are not a very sustainable method for managing wastewater. They are however necessary where an on-site system utilising land application is unachievable and considered too risky due to identified site or soil limitations. - EPO's can typically be cheaper to install however they can be significantly more expensive to operate over the long term compared with other system types. These system types do not meet the principles of ecological sustainable development. Council will generally only approve them where no other system type can achieve the required environmental and human health objectives of the Regulation and guidelines. Notwithstanding the hesitancy of Councils to approved EPO's, there does not appear to be any legislative provision restricting their approval and are sometimes necessary as a system of last resort. - Based on the outcomes of the site and soil evaluation, this option can be suitable for non-domestic development however has not been carried forward in this situation due to the operational life of the development.	**No**

4.2 Wastewater Generation

It is accepted practice that design wastewater quantity is typically derived from site and development features such as water supply source, activity type and occupancy. The design basis for the proposed wastewater management treatment system has therefore been developed based on the proposed development, nature of occupancy and the available water source discussed further in 4.2.1. Information summarising the wastewater generation is presented in Section 4.2.2.

Evaluation of the wastewater quality (influent) and adoption of a suitable effluent quality are important considerations in the selection and design process. Effluent quality is typically evaluated and determined during the LAA selection and design processes being influenced by site, soil, environmental and development features. The process can be iterative where several system type/design and effluent quality scenarios need to be tested to achieve a satisfactory outcome. The adopted wastewater and effluent quality criteria are discussed further in Section 4.2.3.

4.2.1 Development Details

Details of the development summarised in Table 8 are based on information provided to DWA by the client or their agent.

Table 8 Summary of Development Details

Development Type	Persons	Water Supply	Nature of Occupancy[8]
Non-domestic	20	Roof capture and tank storage	Average occupancy
Description/Comments:	Information from the client suggests that there will be a maximum of 30 staff in total with the maximum number of staff on the site at any one time limited to 20.		

[8] The level of occupancy can influence system selection and design.

4.2.2 Wastewater Quantity

The wastewater design flow allowance has been selected in accordance with NSW Health, Septic Tank and Collection Well Accreditation Guideline 2001. The equivalent population (EP) has been estimated for the development based on advice from the client. A summary of the design wastewater flows used in design calculations are outlined in the following table.

Table 9 Design Wastewater Flow

Equivalent Persons	Adopted Wastewater Flow	Peak Design Wastewater Flow
20EP	36L/EP/Day	720L/day
Description/Comments:	A daily water usage of 36L/EP/Day has been adopted based on information for factories and offices from the NSW Health guideline (2001).	

4.2.3 Wastewater and Effluent Quality

Wastewater from factories, offices and non-domestic activities are typically derived from kitchens, bathrooms, and toilets. Wastewater typically comprises both blackwater and greywater depending on the source. AS1547 defines blackwater as '*Wastes discharged from the human body either direct to a dry-vault toilet or through a water closet (flush toilet) or urinal.*' Greywater is defined as '*Wastes from a bath, shower, basin, laundry, and kitchen, but excluding toilet and urinal wastes. Greywater may still contain pathogens.'*

Wastewater and effluent quality criteria adopted for this project are presented in Table 10.

Table 10 Wastewater and Effluent Quality Criteria

Parameter	Wastewater Value[9]	Adopted Effluent Value
Biochemical Oxygen Demand	200 – 300mg/L	<20mg/L (90th percentile value per AS1546.3: 2017)
Total Suspended Solids	200 – 300mg/L	<30mg/L (90th percentile value per AS1546.3: 2017)
Total Nitrogen	20 – 100mg/L	35mg/L (Typical for secondary treated effluent)
Total Phosphorus	10 – 25mg/L	12mg/L (Typical for secondary treated effluent)

[9] Environment and Health Protection Guidelines (DLG 1998)

Parameter	Wastewater Value[9]	Adopted Effluent Value
Faecal Coliforms	$10^3 – 10^6$ cfu/100mL	<30cfu/100mL (Maximum value per AS1546.3: 2017)

4.3 Land Application Design Basis

A land application method has been selected based on the outcomes from the site and soil assessment, site location and environmental considerations. The size of the LAA has been determined based on hydraulic and nutrient calculations.

Key design parameters are summarised in Table 11 and Table 12 with the calculations found in Appendix 3.

Table 11 Land Application Design Sizing Parameters

Parameter	Value	Basis
Design Loading/Irrigation Rate	3mm/day	AS1547: 2012 Table M1 Category 4 soil
Soil Depth to Limiting Layer	0.7m	Based on TP1 and proposed civil works to ensure adequate depth of soil below sub-surface drip line.
Climate Data – Rainfall	SILO Data	SILO Data (Lat -32.50, Long 151.90 with elevation 118m)
Climate Data - Evaporation	SILO Data	
Typical Effluent Quality **Total Nitrogen**	35mg/L	Secondary Effluent Quality
Typical Effluent Quality **Total Phosphorus**	12 mg/L	
Adopted crop nitrogen uptake	250 kg/ha/year	25% of typical mixed grass (to account for reduced clippings removal and soil health).
Adopted crop phosphorus uptake	30 kg/ha/year	
P-sorption capacity	360mg/kg	Assumed based on laboratory analysis
Depth of soil for P-sorption	0.7m	Based on Test Pit and final LAA design using in-situ soils

Parameter	Value	Basis
Bulk density	1.4 g/cm^2	Typical
Soil P-sorption effectiveness	70%	Conservative value
Nitrogen lost to soil processes	20%	Geary and Gardner (1996)

Table 12 Design Basis for Proposed System

Calculation Method	LAA Size	Comment		
Hydraulic Calculations				
Hydraulic Equation	240m^2	AS1547 (2012) equation		
Monthly Water Balance	774m^2	Result reflects maximum land area required for zero storage (June). This result is driven by the high rainfall in comparison to the evaporation. Further explanation about the limitations of monthly water balances is provided in 4.3.2		
	476m^2	Result for next largest LAA size based on zero storage (May)		
	155m^2	Result for smallest (minimum) LAA size based on zero storage		
	10	Months of the year balanced based on adopted LAA size		
Nutrient Calculations		**Nutrient Utilisation Area (NUA) Data**		
		NUA	**LAA Width**[10]	**Downslope Buffer**
Nitrogen Balance	294m^2	0m^2	25m	0m
Phosphorus Balance	380m^2	0m^2		0m
Adopted LAA Size	**400m^2**	A risk-based approach has been applied to the adoption of the LAA size using the outcomes from the hydraulic, monthly water balance and nutrient calculations.		

[10] Indicative LAA width selected.

4.3.1 Land Application Area Design and Construction

The approved civil works proposed for Stage 1 of the development will result in site and topographical conditions that are different to the existing setting. It is understood that the Stage 1 civil works will involve removal and relocation of soil and rock material as part of the site access works and construction of the office building. The works provides an opportunity to design and construct the land application area (LAA) to consider and align with the resulting site conditions. The LAA, which will be located on the north side of the office building, will have a footprint of 400m^2 with dimensions 25m(L) x 16m (W). The final depth of the area will be a minimum of 700mm which will be achieved through re-use of the in-situ category 3 soils. Access to the LAA will be suitably restricted from persons and vehicles and to prevent damage.

4.3.2 Comment on Monthly Water Balance

While the monthly water balance method provides some indication of the hydraulic capacity of the system over a monthly basis, it can be a significant oversimplification of dynamic soil water processes and can lead to significant oversizing of land application areas (LAA's), particularly in wet climates (i.e., high rainfall and low evapo-transpiration). Under these conditions, lumped monthly water balance calculations do not adequately simulate day to day soil moisture storage or dynamics and will often result in significantly large LAA's that are not feasible or cost effective to construct. This is especially the case for water balances conducted in regions with low winter evapo-transpiration (such as Barrington) and LAA types that have lower DLRs such as irrigation systems.

Where this is the case, a water balance can be used to inform a risk-based approach to sizing the LAA through measures such as a reduction in the DLR based on professional judgment by a suitability qualified practitioner or alternatively, other design elements may be altered to manage risk (e.g., increased setbacks). For this project, the size of the LAA for both development types have been informed by all calculation methods. The resulting sizes of both LAA's are considered appropriate having regard to the contained LAA method, site and soil assessment outcomes, selection of setback distances and selection of effluent quality and treatment system type.

4.4 Treatment System Design Outcomes

A treatment system has been selected based on the outcomes from LAA selection process, site and soil assessment, site location and environmental considerations. The selected treatment system and associated features is presented in Table 13.

Table 13 Adopted Treatment System Design

System Feature	Outcome
Effluent Quality	Secondary
Disinfection	Yes
Treatment system Type	Secondary treatment system
Treatment Tank Capacity	Per manufacturers specifications
Pump or Collection Well Capacity	Per manufacturers specifications
Description/Comments:	The treatment system is to have a minimum treatment capacity of 1,200L/Day.

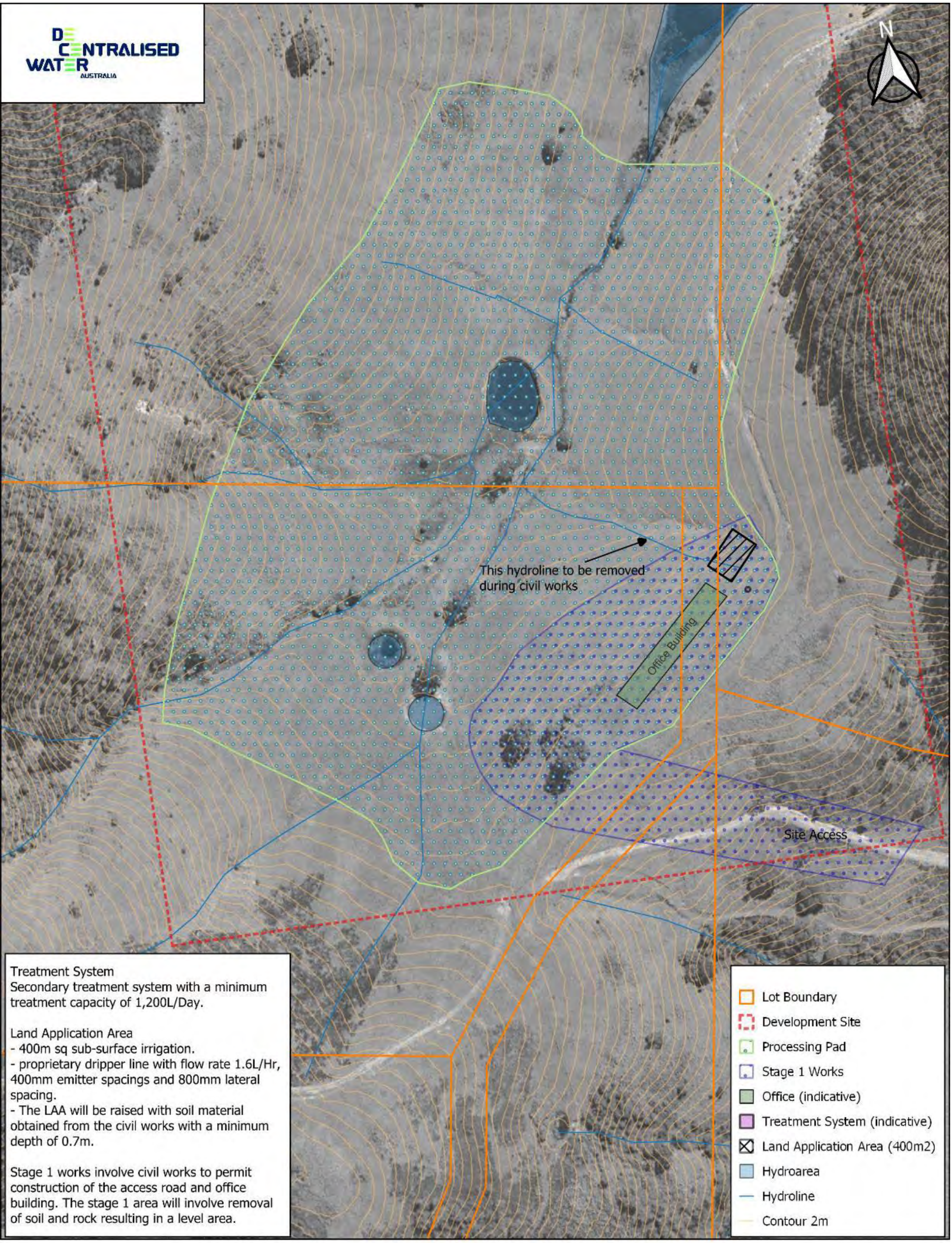

Figure 4 On-site Wastewater Management Plan

0 25 50 75 m

Project: 0715
Drawn: 7/11/2023
Revision: 00

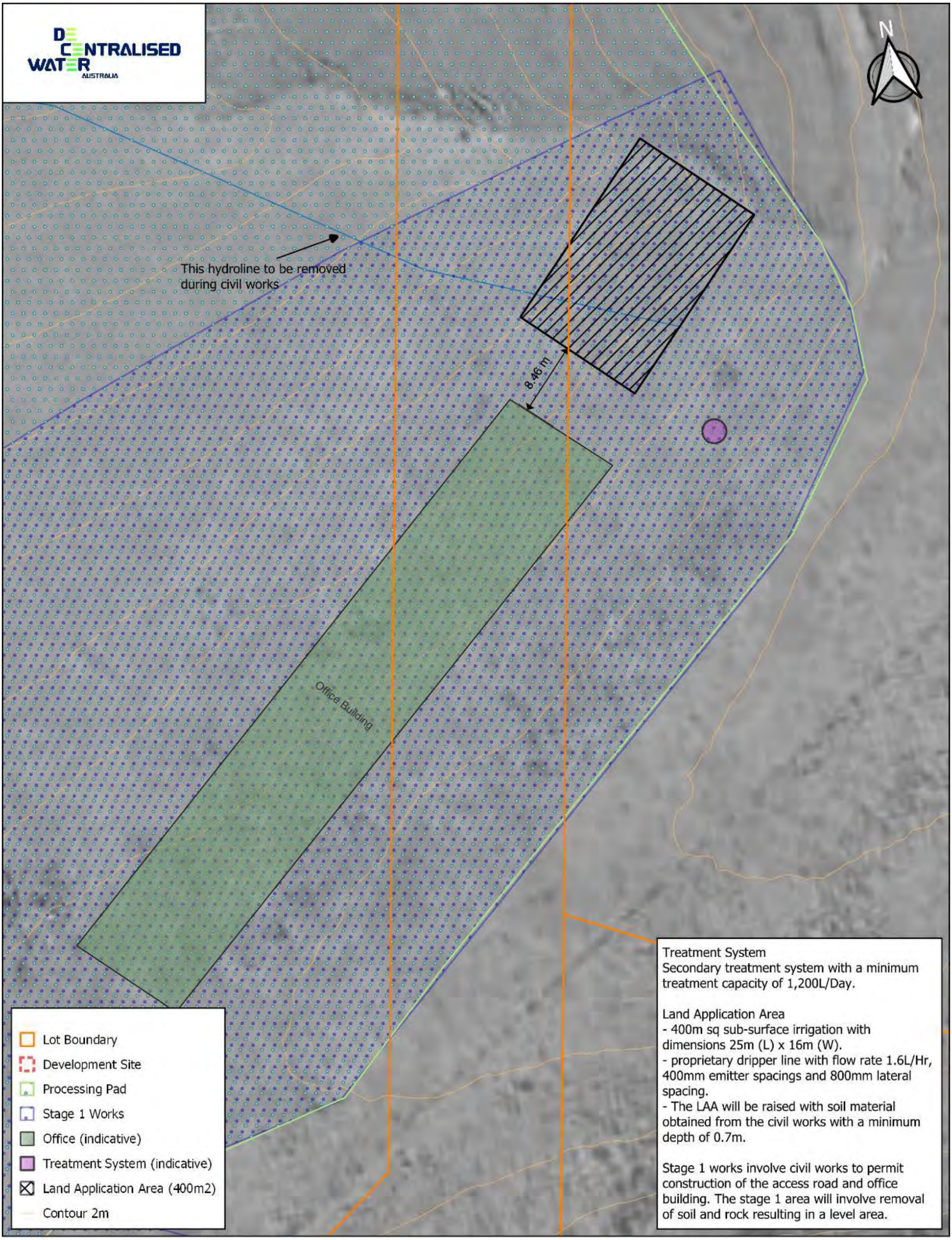

Figure 5 On-site Wastewater Management Plan (detailed)

0 10 20 30 m

Project: 0715
Drawn: 7/11/2023
Revision: 00

5 Operation and Maintenance

The wastewater management concept described above has been developed as a relatively low maintenance option. Notwithstanding, AS1547 (T5) provides advice on several operational and maintenance concepts for treatment systems and land application areas that should be considered by owners and occupiers.

5.1 Operation – Treatment System

Reduce the potential for sludge build up and impacts in the treatment tank by:

- Using sink drainers and scraping plates before washing to reduce food scraps entering the system,
- Minimising disposal of oils and fats down the sink, and
- Disposing of hygiene products appropriately.

Reduce impacts on the biological processes within the treatment system and LAA by:

- Using soaps and detergents that are biodegradable, low-phosphorus and low in sodium,
- Avoiding the use of bleaches, whiteners, disinfectants, and nappy soakers,
- Not putting chemicals down the drain,
- Installing water conservations fixtures in the bathroom and laundry,
- Reducing the volume of water used in the house,
- Using water conserving washing machines, shower heads, toilets and dishwashers, and
- Avoiding excess washing on one day.

5.2 Maintenance – Treatment System

- Engage the services of a reputable company to periodically service the secondary treatment system on a frequency specified in the NSW Health accreditation for the system.
- Monitor the alarm panel for problems with the aeration blower or irrigation pump and contact the service technician if it activates.
- Monitor the treatment system for unusual sounds, smells or vibration and contact the service technician if it a problem is detected, and
- Periodically clean the irrigation filter if advised by the service technician.

5.3 Maintenance – Land Application Area

- Periodically mow the irrigation area and remove the grass clippings,
- Monitor the irrigation equipment for signs of damage or failure. Replace or repair as required or discuss with the service technician,
- Monitor the condition of the LAA for surface ponding and wet spots and discuss with the service technician if observed,
- Ensure that the appropriate effluent warning signs remain in place and visible to persons entering the LAA,
- Avoid the placement of children's play equipment within the LAA, and
- Restrict access to the LAA from vehicles and livestock.

6 References

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Appendix 1 Site and Soil Assessment Information

Sheet 1: Soil Sampling Schedule and Results of pH, EC and Emerson Aggregate Test Analysis

Site Address	Sample Name	Sample Depth (mm)	Texture Class	EAT [1]	Rating [2]	pH_f [3]	$pH_{1:5}$ [4]	Rating	$EC_{1:5}$ (dS/m)	ECe (dS/m) [5]	Rating	Other analysis [6]
Maytoms Lane Booral												
	Composite TP1	-	L	-	-		6.39	Slightly acid	0.02	0.19	Non-saline	

Notes: (also refer Interpretation Sheet 1)

[1] The modified Emerson Aggregate Test (EAT) provides an indication of soil susceptibility to dispersion.

[2] Ratings describe the likely hazard associated with land application of treated wastewater.

[3] pH measured in the field using Raupac Indicator.

[4] pH and EC are measured on 1:5 soil:water suspensions using a calibrated hand-held pH/EC/temp meter.

[5] Electrical conductivity of the saturated extract (Ece) = $EC_{1:5}$(µS/cm) x MF / 1000. Units are dS/m. MF is a soil texture multiplication factor.

[6] External laboratories used for the following analyses, if indicated:

- CEC (Cation exchange capacity)
- Psorb (Phosphorus sorption capacity)
- Bray Phosphorus
- Organic carbon
- Total nitrogen

Interpretation Sheet 1 - pH, EC & Emerson Aggregate Class

Interpretation of Soil pH (1:5 Soil:Water)
(rating based on Hazelton & Murphy (2016))

pH	Rating	
0.00 to 4.50	Extremely acid	
4.51 to 5.00	Very strongly acid	
5.01 to 5.50	Strongly acid	preferred range
5.51 to 6.00	Moderately acid	preferred range
6.01 to 6.50	Slightly acid	preferred range
6.51 to 7.30	Neutral	preferred range
7.31 to 7.80	Mildly alkaline	preferred range
7.81 to 8.40	Moderately alkaline	
8.41 to 9.00	Strongly alkaline	
9.01 to 14.00	Very strongly alkaline	

Multiplier Factors for Calculating ECe
(taken from Hazelton & Murphy (2016))

Texture Class	Applicable Soil Textures	MF
S	Sand, loamy sand, clayey sand	23
SL	sandy loam, fine sandy loam	14
L	loam, loam fine sandy, silty loam	9.5
CL	clay loam, sandy clay loam	8.6
LC	light clay	8.6
MC	medium clay	7.5
HC	heavy clay	5.8

Interpretation of ECe (1:5 Soil:Water)
(rating based on Hazelton & Murphy (2016))

Ece (dS/m)	Rating
0.00 to 2.00	Non-saline
2.01 to 4.00	Slightly saline
4.01 to 8.00	Moderately saline
8.01 to 16.00	Highly saline
16.00 up	Extremely saline

increasing hazard

Interpretation of Emerson Aggregate Class
(rating describes likelihood of dispersion)

EAT Class	Rating
1	High
2(1)	Mod
2(2)	Mod
2(3)	High
2(4)	High
3(1)	Low
3(2)	Low
3(3)	Mod
3(4)	Mod
4	Low
5	Low
6	Low
7	Low
8	Low

Results of External Laboratory Analysis

Site Name	Sample Name		CEC (cmol/kg))	Rating	Ca (mg/kg)	Rating	Mg (mg/kg)	Rating	Na (mg/kg)	Rating	K (mg/kg)	Rating	ESP (%)	Rating	P-sorp. (mg/kg)	Rating	Bray P (mg/kg)	Rating	Total Nitrogen (%)	Rating	Organic Carbon (%)	Rating
Maytoms Lane Booral	TP Composite		6.3	L	736	L	254	M	32	L	133	M	2.2	NS	360	MH	-	n/a	-	n/a	-	n/a

Interpretation Sheet 2 - CEC, P-Sorption, Bray P, Organic carbon, Total nitrogen

Interpretation of CEC
(rating based on Hazelton & Murphy (1992))

Rating	CEC (me/100g)			Ca (mg/kg)			Mg (mg/kg)			Na (mg/kg)			K (mg/kg)		
VL	0.00	to	6.00	0.00	to	400.00	0.00	to	36.50	0.00	to	23.00	0.00	to	78.20
L	6.01	to	12.00	400.01	to	1000.00	36.51	to	121.50	23.01	to	69.00	78.21	to	117.00
M	12.01	to	25.00	1000.01	to	2000.00	121.51	to	365.00	69.01	to	161.00	117.01	to	274.00
H	25.01	to	40.00	2000.01	to	4000.00	365.01	to	972.00	161.01	to	460.00	274.01	to	782.00
VH	40.01	up		4000.01	up		972.01	up		460.01	up		782.01	up	

VL=very low, L=low, M=medium, H=high, VH=very high

Interpretation of ESP
(rating based on Hazelton & Murphy (1992))

Rating	ESP (%)			Description
NS	0.00	to	6.00	Non-sodic
S	6.01	to	15.00	Sodic
SS	15.01	to	25.00	Strongly sodic
VSS	25.01	up		Very strongly sodic

increasing hazard

Interpretation of Phosphorus Sorption Capacity
(rating based on Hazelton & Murphy (1992))

Rating	P-sorption (mg/kg)			Description
L	0.00	to	125.00	Low
M	125.01	to	250.00	Medium
MH	250.01	to	400.00	Medium-High
H	400.01	to	600.00	High
VH	600.01	up		Very high

increasing hazard

Interpretation of Bray Phosphorus
(rating based on Hazelton & Murphy (1992))

Rating	Bray P (mg/kg)			Description
VL	0.00	to	5.00	Very Low
L	5.01	to	10.00	Low
M	10.01	to	17.00	Moderate
H	17.01	to	25.00	High
VH	25.01	up		Very high

Interpretation of Soil Nitrogen (TN)
(rating based on Hazelton & Murphy (1992))

Rating	TN (%)			Description
VL	0.000	to	0.050	Very Low
L	0.051	to	0.150	Low
M	0.151	to	0.250	Medium
H	0.251	to	0.500	High
VH	0.501	up		Very high

Interpretation of Soil Organic Carbon (OC)
(rating based on Hazelton & Murphy (1992))

Rating	OC (%)			Description
VL	0.00	to	1.50	Very Low
L	1.51	to	2.00	Low
M	2.01	to	3.00	Medium
H	3.01	to	5.00	High
VH	5.01	up		Very high

Soil Bore Log

Client	Name	Test Pit No	1

LGA	Mid Coast	Topography			
Site Address	Maytoms Lane Booral	Geology			
Logged by	SJ	Soil Type			
Date	11/05/2023	Slope	11 - 15	Aspect	
Project	0715	Drainage	Poorly drained	Exposure	High
Excavation method	Hand Auger and shovel	Surface condition	Undisturbed	Surface	Grass

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structural Grade	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
0.2		250mm		L	Moderate	Brown	-	-	D	
0.3		330mm		L	Moderate	Brown	-	10%	D	
0.4										
0.5										
0.6										
0.7										
0.8										
0.9										
1.0										
1.1										
1.2										
1.3										
1.4										
1.5										
1.6										
1.7										
1.8										
1.9										
2.0										

Key to Soil Borelogs

Symbols

W	Watertable depth	●	Sample collected
X	Depth of refusal		

Moisture conditions

D	Dry	**VM**	Very moist
SM	Slightly moist	**W**	Wet / saturated
M	Moist		

Coarse Fragments

VF	Very few <2%	**M**	Many 20 - 50%
F	Few 2 - 10%	**A**	Abundant 50 - 90%
C	Common 10 - 20%	**P**	Profuse >90%

Graphic Log and Textures

S - Sand LS - Loamy sand CS - Clayey sand	CL - Clay loam SCL - Sandy clay loam SiCL - Silty clay loam	Gravel (G)
SL - Sandy loam	LC - Light clay SC - Sandy clay	Parent material (stiff)
L - Loam LFS - Loam fine sandy SiL - Silty loam	MC - Medium clay HC - Heavy clay	Parent material (weathered)

SESL AUST.

Soil Chemistry Profile

Mehlich 3 - Multi-nutrient Extractant

Sample Drop Off: 16 Chilvers Road
Thornleigh NSW 2120

Mailing Address: PO Box 357
Pennant Hills NSW 1715

Tel: 1300 30 40 80
Fax: 1300 64 46 89
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 65309 | **Sample N°: 4** | **Date Received: 9/6/23** | **Report Status: Final**

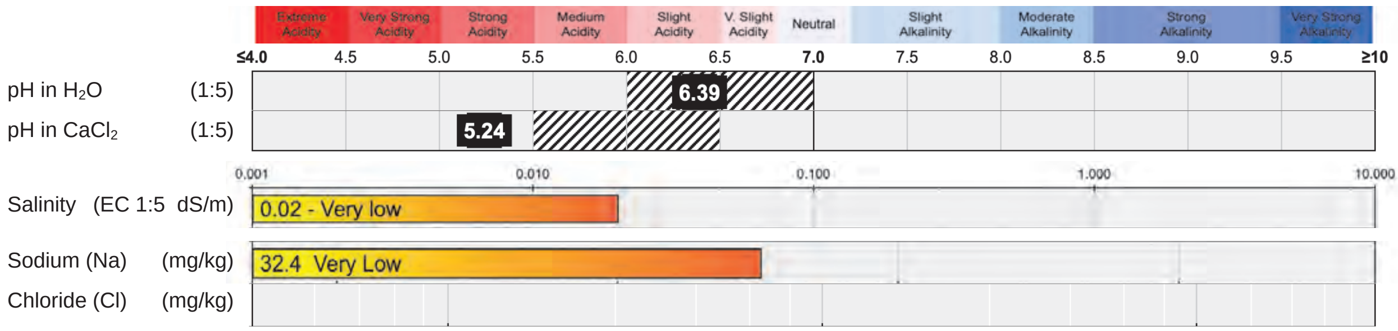
Client Name:	**Decentralised Water Consulting**	Project Name:	**0711**
		SESL Quote N°:	**Q11946**
Client Contact:	**Andrew Weekes**	Sample Name:	**Booral TP1B.C**
Client Order N°:		Description:	**Soil**
Address:	**2/ 12 Channel Rd** **Mayfield West NSW 2304**	Test Type:	**PSI_Curve_5, ECEC_M3**

RECOMMENDATIONS

Analysed by SESL Australia Pty Ltd NATA #15633

Results only requested.

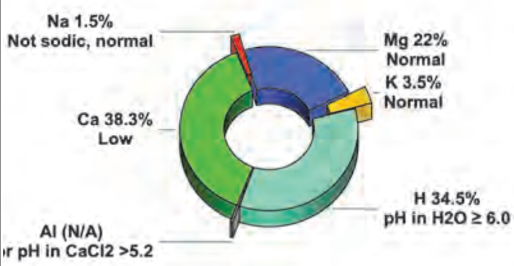
pH and ELECTRICAL CONDUCTIVITY

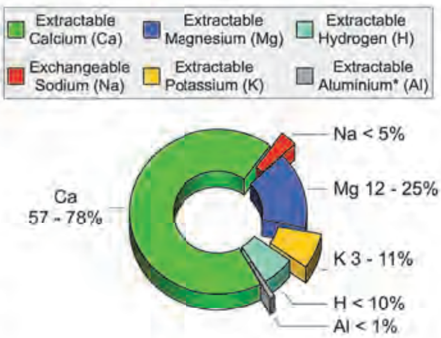


CATION BALANCE

EXCHANGEABLE CATION PERCENTAGE

Note: Hydrogen only determined when pH in $CaCl_2 \leq 5.5$
Al only determined if pH in $CaCl_2$ is ≤ 5.2





ACTUAL

IDEAL

CATION RATIOS

Ratio	Result	Target Range
Ca:Mg	1.7	4.1 – 6.0
Comment: Calcium low		
Mg:K	6.2	2.6 – 5.0
Comment: Potassium low		
K/(Ca+Mg)	0.06	< 0.07
Comment: Acceptable		
K:Na	2.4	N/A

EXCHANGEABLE CATIONS (cmol(+)/kg)

Na:	K:	Ca:	Mg:	H:	Al:
0.14	0.34	3.68	2.12	3.31	-

EFFECTIVE CATION EXCHANGE CAPACITY (eCEC) (cmol(+)/kg)

eCEC does not include correction for soluble salts as standard. Where exchangeable calcium exceeds 80 % of eCEC and/or salinity exceeds 0.75 dS/m, alternative methods are recommended to determine true eCEC.

The units of eCEC *cmol(+)/kg* are the SI unit and are equivalent to *meq/100g.*

Soil Chemistry Profile

Mehlich 3 - Multi-nutrient Extractant

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 65309 | **Sample N°: 4** | **Date Received: 9/6/23** | **Report Status: Final**

PLANT AVAILABLE NUTRIENTS

EFFECTIVE AMELIORATION DEPTH (mm): ◉ **100** ○ **150** ○ **200** DESIRED FERTILITY CLASS: ○ Low ◉ Moderate ○ High

Major Nutrients	Unit	Result	Very Low / Low / Marginal / Adequate / High	Result (g/sqm)	Desirable (g/sqm)	Adjustment (g/sqm)
Nitrate-N (NO_3)	mg N/kg	-		-	4	Did not test
Phosphorus (P)	mg P/kg	-		-	8.4	Did not test
Potassium (K)	mg/kg	133		17.7	29.3	11.6
Sulfur (S)	mg S/kg	-		-	9	9
Calcium (Ca)	mg/kg	738		98.2	208.3	110.1
Magnesium (Mg)	mg/kg	257		34.2	21.7	Drawdown
Iron (Fe)	mg/kg	-		-	73.4	Did not test
Manganese (Mn)	mg/kg	-		-	5.9	Did not test
Zinc (Zn)	mg/kg	-		-	0.7	Did not test
Copper (Cu)	mg/kg	-		-	0.8	Did not test
Boron (B)	mg/kg	-		-	0.4	Did not test

Explanation of graph ranges:

Very Low Growth is likely to be severely depressed and deficiency symptoms present. Large applications for soil building purposes are usually recommended. Potential response to nutrient addition is >90 %.

Low Potential "hidden hunger", or sub-clinical deficiency. Potential response to nutrient addition is 60 to 90 %.

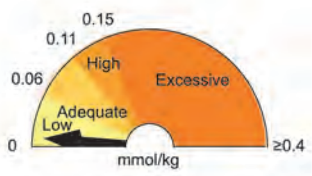
Marginal Supply of this nutrient is barely adequate for the plant, and build-up is still recommended. Potential response to nutrient addition is 30 to 60 %.

Adequate Supply of this nutrient is adequate for the plant, and and only maintenance application rates are recommended. Potential response to nutrient addition is 5 to 30 %.

High The level is excessive and may be detrimental to plant growth (i.e. phytotoxic) and may contribute to pollution of ground and surface waters. Drawdown is recommended. Potential response to nutrient addition is <2 %.

NOTES: Adjustment recommendation calculates the elemental application to shift the soil test level to within the **Adequate** band, which maximises growth/yield, and economic efficiency, and minimises impact on the environment.
Drawdown: The objective nutrient management is to utilise residual soil nutrients. There is no agronomic reason to apply fertiliser when soil test levels exceed **Adequate**.
• g/sqm measurements are based on soil bulk density of 1.33 tonne/m³ and effective amelioration depth.

Phosphorus Saturation Index



<0.01

Low. Plant response to applied P is likely.

Exchangeable Acidity

Adams-Evans Buffer pH (BpH):	**7.5**
Sum of Base Cations (cmol(+)/kg):	**6.3**
Eff. Cation Exch. Capacity (eCEC):	**9.6**
Base Saturation (%):	**65.63**
Exchangeable Acidity (cmol(+)/kg):	**-**
Exchangeable Acidity (%):	**-**

Lime Application Rate (g/sqm)
– to achieve pH 6.0: **0**
– to neutralise Al: **-**

Calculated Gypsum Application Rate (CGAR)
(g/sqm) to achieve 67.5 % exch. Ca: **321**

The CGAR is corrected for the selected effective amelioration depth (100 mm) and any Lime addition to achieve pH 6.0.

PHYSICAL DESCRIPTION

Texture:	-	Munsell Colour:	-	Organic Carbon (OC %):	-
Estimated clay content:	-	Structure Size:	-	Organic Matter (OM %):	-
Tactually gravelly:	-	Structural Organisation:	-	Est. Field Capacity (% water):	-
Tactually organic:	-	Structural Unit:	-	Est. Permanent Wilting Point (% water):	-
Calculated EC_{SE} (dS/m):	-	Potential infiltration rate:	-	Est. Plant Available Water (% water):	-
Requires EC and Soil Texture result.		Est. Permeability Class (mm/hr):	-	Est. Plant Available Water (mm/m):	-
		Additional comments:			

Date Report Generated 27/06/2023

Consultant: Neena Goundar

Authorised Signatory: Chantal Milner

METHOD REFERENCES:
pH (1:5 H_2O) - SESL CM0002; Rayment & Lyons 4A1-2011
pH (1:5 $CaCl_2$) - SESL CM0002; Rayment & Lyons 4B4-2011
EC (1:5) - SESL CM0001; Rayment & Lyons 3A1-2011
Chloride - Rayment & Lyons 5A2a-2011
Nitrate - Rayment & Lyons 7B1a-2011
Aluminium - SESL CM0007; Rayment & Lyons 15A1-2011
P, K, S, Ca, Mg, Na, Fe, Mn, Zn, Cu, B - SESL CM0007; Rayment & Lyons 18F1-2011
Buffer pH and Hydrogen - SSSA Methods of Soil Analysis 2007, Pt 3, Ch 17; Adams-Evans (1962)
Texture/Structure/Colour - PM0003 (Texture-
"Northcote" (1992), Structure* - "Murphy" (1991), Colour- "Munsell" (2000))

*Structure analysed in the laboratory is conducted on a disturbed sample, therefore is only a representation of the macro-structures that may be present in the field, which provide an indication of the soil physical characteristics and behaviours that may exist.

P Isotherm

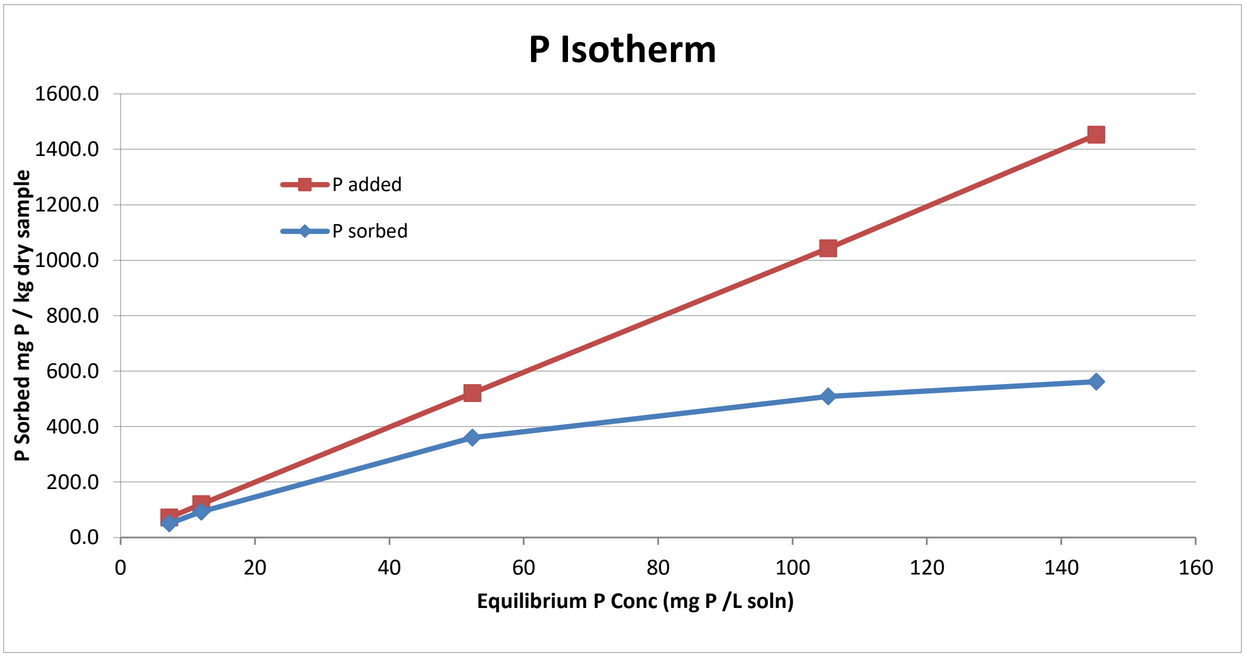
Method as per: R&L 9J (mod ICP-OES analysis)

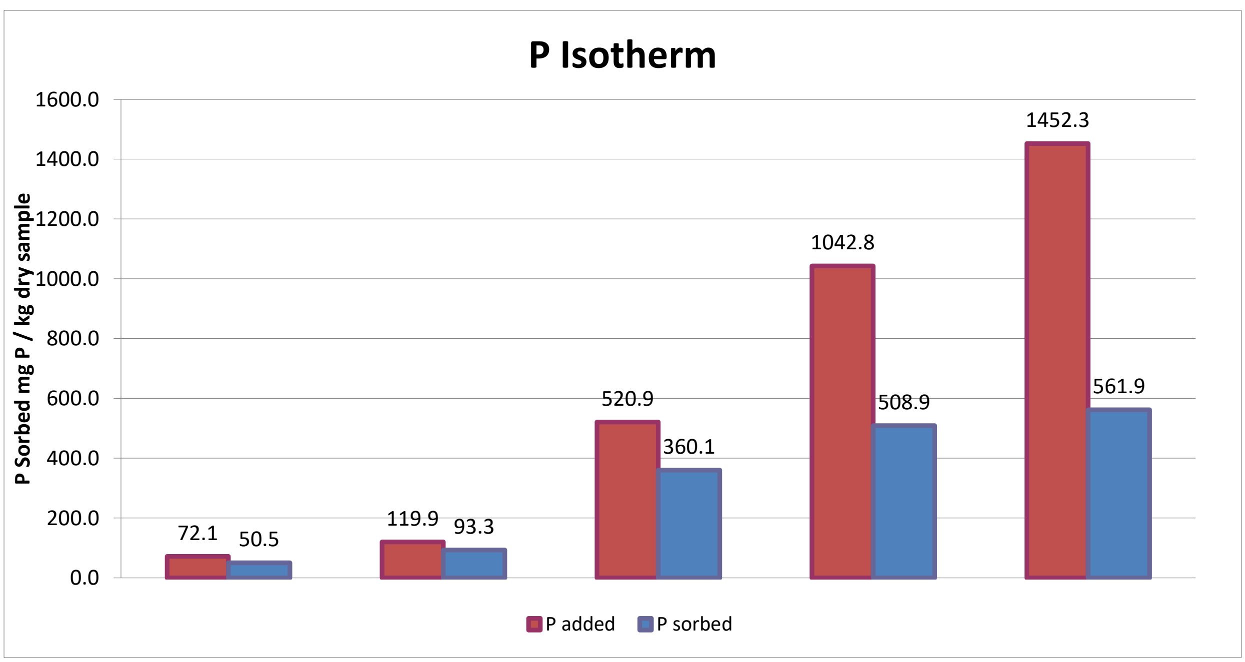
Report as per: Patterson, R.A (2001) Phosphorus Sorption for On-site Wastewater Assessments

Sample ID	65309-4
Sample Description	Booral TP1B.C

Amount of P for soil to sorb (requested)	mg P / kg & 1:10 ratio	50	100	500	1000	1500
Amount of P for soil to sorb (measured)	mg P / kg dry sample	72	120	521	1043	1452

Equilibrium P Conc, EPC	ug P / kg dry sample	**13731**
P Buffer Capacity, PBC	(mg P / kg dry sample) / log(ug P / L soln)	**318**





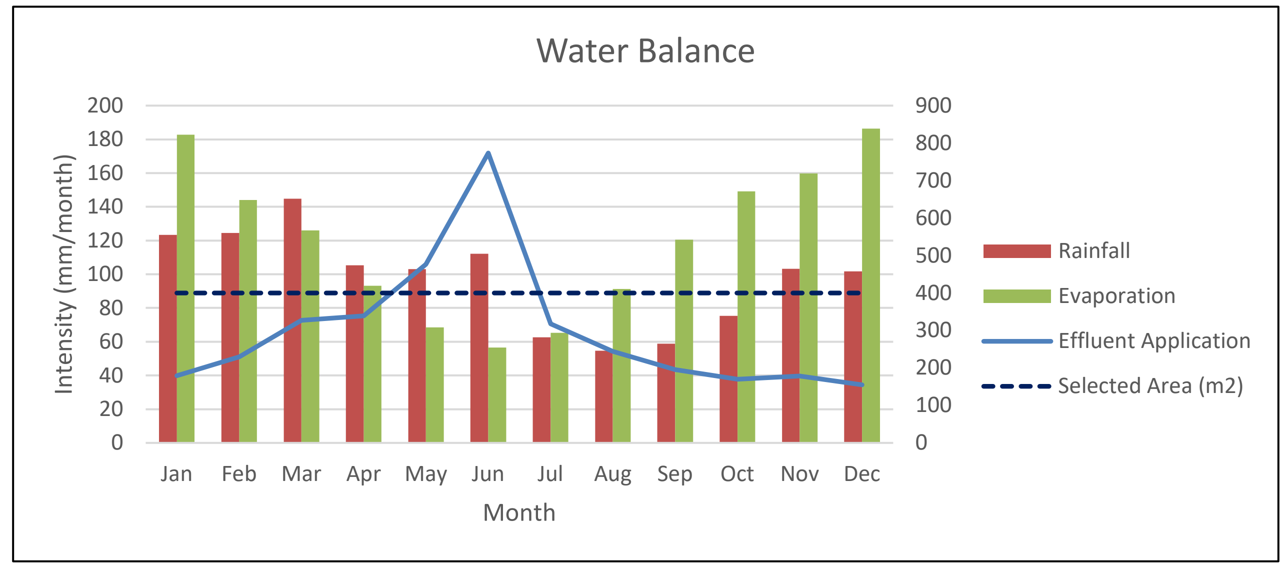
Appendix 2 Design Calculations

Water Balance & Storage Calculations

Project	715
Address	Hillview Quarry Booral
Date	26/03/24

INPUT DATA			
Design Wastewater Flow	Q	720	L/day
Daily Percolation Rate		3.00	mm/day
Nominated Land Application Area	L	400	m sq
Crop Factor	C	0	unitless
Void Space Ratio		1	
Retained Rainfall		0.78	untiless
Rainfall Data (Station #)		SILO (-32.50, 151.90)	
Evaporation Data (Station #)		SILO (-32.50, 151.90)	

Input Cells
Calculation
Output



DECENTRALISED WATER AUSTRALIA

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	123	124	145	105	103	112	63	55	59	75	103	102	1170
Evaporation	E	\	mm/month	183	144	126	93	69	57	65	91	121	149	160	186	1443
Crop Factor	C			0.70	0.70	0.70	0.60	0.50	0.45	0.40	0.45	0.55	0.65	0.70	0.70	-
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	128	101	88	56	34	25	26	41	66	97	112	130	905
Percolation	B	(DPR/7)xD	mm/month	93	84	93	90	93	90	93	93	90	93	90	93	1095
Outputs		ET+B	mm/month	221	185	181	146	127	115	119	134	156	190	202	223	2000
INPUTS																
Retained Rainfall	RR	R*0.75	mm/month	96	97	113	82	80	88	49	43	46	59	81	79	912
Effluent Application	W	(QxD)/L	mm/month	56	50	56	54	56	54	56	56	54	56	54	56	657
Inputs		RR+W	mm/month	152	147	169	136	136	142	105	98	100	115	135	135	1569
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	9.0	35.0	20.6	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-68.9	-37.5	-12.5	-9.7	9.0	26.1	-14.4	-35.6	-56.4	-75.4	-67.2	-88.2	-75
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	9.0	35.0	20.6	0.0	0.0	0.0	0.0	0.0	65
Maximum Storage for Nominated Area	N		mm	35.03												
	V	NxL	L	14012												
			ML	0.01												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	179	229	327	339	476	774	318	244	196	170	178	155	
MINIMUM AREA REQUIRED FOR ZERO STORAGE:			m^2	770												

Nutrient Balance

Project	715
Address	Hillview Quarry Booral
Date	26/03/24

DECENTRALISED WATER AUSTRALIA

LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING OF PHOSPHORUS OR NITROGEN	380	m^2

INPUT DATA

Wastewater Loading			Nutrient Crop Uptake					
Hydraulic Load	720	L/Day	Crop N Uptake	250	kg/ha/yr	which equals	68	$mg/m^2/day$
Effluent N Concentration	35	mg/L	Crop P Uptake	30	kg/ha/yr	which equals	8	$mg/m^2/day$
% Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal	Phosphorus Sorption					
Total N Loss to Soil	5040	mg/day	P-sorption result	360	mg/kg	which equals	3528	kg/ha
Remaining N Load after soil loss	20160	mg/day	Bulk Density	1.4	g/cm^2	Fill to be imported to achieve this		
Effluent P Concentration	12	mg/L	Depth of Soil	0.7	m			
Design Life of System	50	yrs	% of Predicted P-sorp.	0.75	Decimal			

NUTRIENT BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer		
Nitrogen	294	m^2
Phosphorus	380	m^2

Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nominated LAA Size	400	m^2
Nominated LAA Width	25	m
Predicted N Export from LAA	-2.6	kg/year
Predicted P Export from LAA	-0.2	kg/year
Phosphorus Longevity for LAA	54	Years
Minimum Buffer Required for excess nutrient	0	m^2
Downslope buffer length (based on LAA width)	0	m

PHOSPHORUS BALANCE

STEP 1: Using the nominated LAA Size

Nominated LAA Size	400	m^2			
Daily P Load	0.00864	kg/day	→ Phosphorus generated over life of system	157.7	kg
Daily Uptake	0.0033	kg/day	→ Phosphorus vegetative uptake for life of system	0.150	kg/m^2
Measured p-sorption capacity	0.3528	kg/m^2			
Assumed p-sorption capacity	0.265	kg/m^2	→ Phosphorus adsorbed in 50 years	0.265	kg/m^2
Site P-sorption capacity	105.84	kg	→ Desired Annual P Application Rate	3.317	kg/year
			which equals	0.00909	kg/day
P-load to be sorbed	1.95	kg/year			

SMARTER ADAPTIVE SOLUTIONS

DECENTRALISED WATER AUSTRALIA

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