TAMWORTH REGIONAL COUNCIL

ANNEXURES
for
ORDINARY COUNCIL AGENDA

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Tamworth Regional Council On-site Wastewater Management Plan

Tamworth Regional Council

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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.

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Executive Summary

The Tamworth Regional Council On-site Wastewater Management Plan (OWMP) aims to provide a comprehensive reference document for effectively managing the assessment, design, installation, and operation of on-site wastewater management systems associated with new and existing development in un-sewered areas of the LGA.

The OWMP captures and addresses all development types including domestic, non-domestic, and subdivisions.

Effectively and proactively managing the assessment and design aspects at the application and approval stage of a development provides several advantages including:

- Improved and sustainable environmental and public health outcomes.
- An improved decision-making framework and planning tool for the approval and installation of wastewater systems and long-term planning strategies.
- A greater level of consistency in assessment and certainty in outcome for developers, property owners, planning and wastewater consultants, system installers and Council staff.
- A greater level of community awareness and support knowing that Council have implemented an LGA specific wastewater assessment guideline, and
- Reduced reputational and legal risk to Council associated with the approval of applications for the installation of on-site wastewater systems.

The *Local Government Act* and *Local Government (General) Regulation* address applications relating to the management of waste including the application process for wastewater systems, the determination of applications for approval, conditions of approval and prescribed performance standards. The provisions while adequate are quite broad in context with some assessment requirements open to interpretation by individual Councils and Council staff. The development and implementation of the OWMP has been created with data specific to the Tamworth LGA, Council, and community.

The principal basis of the plan is the identification and determination of the physical limitations or constraints known to influence the long-term sustainable operation of wastewater systems. These constraints, that include elements such as soil type, climate, and slope were used to build an assessment matrix for subsequent development of a land capability map. The land capability map is further enhanced at an allotment scale through integration with allotment size, flood prone status and proximity to a defined list of sensitive receptors. The final output is a map that assigns a '*classification*' to each allotment which is a broad indication of the constraints that may influence the selection, design, construction, and operation of an on-site wastewater system. The assigned classification can then be used to determine the level of assessment required by developers, consultants and property owners when making application to Council for the installation of a wastewater system, land rezoning or subdivision development. The three classifications adopted from lowest to highest allotment limitation are level 1, level 2, and Level 3. The three classifications were further refined to two classifications.

For un-sewered domestic development, a simpler and easier application and approvals process has been developed for allotments classified Level 1. Persons applying on a Level 1 allotment can choose to use a '*Suitable Design Solutions*' approach whereby the size of commonly installed On-site Wastewater Systems has been predetermined with selection based on the outcomes of a site and soil assessment checklist. Persons applying on a Level 2 allotment don't have access to the Suitable Design Solution process however can choose to select, size, and design the system based on the outcomes of a site and soil assessment checklist and conventional calculations.

For unsewered non-domestic and subdivision developments, the classifications assist to determine the level of assessment and content of the supporting information.

The OWMP provides a scientifically defendable risk and merit-based tool for the assessment of future development applications and the assessment requirements for land capability evaluations.

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1 Introduction

Tamworth Regional Council is a Local Government Area (LGA) located in the New England region of NSW. The LGA covers an area of 9,892km2 with an estimated population of 63,070 (Census 2021). The major population centres include the city of Tamworth, and the towns/villages of Manilla, Nundle, Bendemeer, Attunga, Barraba, Duri, Moonbi, Somerton, Woolomin and Woolbrook.

While the city of Tamworth is serviced by reticulated sewerage, several towns and villages are reliant on On-site wastewater management systems.

1.1 Plan Purpose

Implementation of the OWMP aims to minimise the environmental, public health and economic risks associated with the assessment and installation of all On-site Wastewater Management Systems in the area.

The plan has been developed based on an assigned rating determined from the key physical and environmental limitations that restrict or influence the ability of properties to receive, treat and contain effluent from wastewater systems. The purpose of the plan is to provide all potential users with:

- An easy-to-understand rating method that identifies the physical limitations to treatment and application of wastewater at allotment scale.
- A plan that captures all development types including domestic, non-domestic, land rezoning and un-sewered subdivisions.
- A plan where the level of land capability evaluation is proportionate to the determined risk rating.
- A planning tool that permits consideration of the wastewater servicing requirements in strategic planning decisions for un-sewered development.
- A framework designed to assist decision making on the level of assessment required for land capability evaluations.
- A reference document that provides wastewater practitioners with guidance on the selection, design, and construction of on-site wastewater systems.

The plan is not designed to replace legislative provisions or relevant published standards and guidelines. Where appropriate, the plan will provide references or hyperlinks to relevant sections of published standards and guidelines for the user to refer.

1.2 Plan Overview

This plan is intended to provide information about the assessment, selection, design, and reporting requirements associated with On-site Wastewater Management Systems for existing or proposed development on un-sewered allotments. It is intended as a ready reference document to assist installers of wastewater systems, wastewater consultants, planning consultants, developers, and property owners. The plan is underpinned by the On-site Wastewater Technical Manual and supported by Councils On-site Wastewater Strategy, relevant Australian Standards, and the NSW Environment and Health Protection Guidelines (EHP). In all situations, relevant legislative provisions take precedence over this guideline.

Persons wishing to submit an application that involves the installation or alteration of an On-site Wastewater Management System will require supporting documentation. The level of detail of the documentation will in part depend on the type and scale of the development, the intended development location, and the complexity of the allotment. For example, non-domestic development and some development applications that result in an increase in existing unsewered dwelling entitlements or rezoning of land will typically require a Wastewater Management Report. Most of the time, preparation of the application and supporting documentation will require assistance from one or more persons such as a planning consultant, wastewater or environmental consultant, or On-site wastewater system installation company.

Minimum Standards apply to most aspects of the assessment, design, and approval process. The process is divided into the following components:

- Site and Soil Assessment,
- System Selection and Sizing,
- Constructability, and
- Off-site and Cumulative Impacts (where relevant).

The plan does however provide flexibility for individual applicants wishing to develop innovative or site-specific system designs by allowing a performance-based approach if supported by an appropriate level of assessment and design material. In most cases, the plan will reduce the uncertainty associated with the level of information required with applications and streamline / expedite the approval process.

On-site Wastewater Management Plan

OWMP content		Other Guidance
Domestic Development **Section 2**	• Level 1 Allotments • Level 2 Allotments	**Regulatory Framework** • Local Government Act and Local Government (General) Regulation • Environmental Planning and Assessment Act and Regulation • State Environmental Planning Policies
Non-domestic Development **Section 3**	• Assessment Selection • Level 1 Assessments • Level 2 Assessments	**Standards and Guidelines** • AS1547 domestic onsite management • Other Australian Standards • Environment and Health Protection Guidelines
Effluent Pump-out Systems **Section 4**	• Domestic Systems • Non-domestic Systems	**OWMP Technical Manual** • On-site Wastewater mapping • Minimum Allotment Size • Cumulative Impacts • Suitable Design Solutions
Subdivisions **Section 5**	• Assessment Selection • Level 1 Assessments • Level 2 Assessment	
Supplementary Information	• Section 6 – Supplementary Guidance • Section 7 – Risk Management Guidance • Section 8 - Treatment System Guidance • Section 9 – Land Application Area Guidance • Section 10 – Construction and Installation Guidance	

1.3 Information for Property Owners

What is the On-site Wastewater Management Plan (OWMP)?

The OWMP sets out the levels of investigation applicable for the management of sewage in unsewered areas. All unsewered allotments in the Local Government Area have been assigned an On-site Sewage Management classification; either Level 1 or Level 2. The classification is a broad indication of the constraint level of the allotment to On-site Wastewater Management. The plan and classification level also provides guidance on the level of supporting information for development applications and applications to install or alter sewage management systems. Further information explaining how the allotment classifications were developed can be found in the On-site Wastewater Management Technical Manual.

Why has my property been given a classification?

Sewage management risk mapping has been completed as part of a technical study titled Sustainable Development of On-site Sewage Management Systems for Tamworth Council. Adoption of a risk-based approach enables Council to approve wastewater applications on lower risk residential allotments with limited delay or the need for detailed studies. Allotments assigned a Level 2 classification will require a higher level of scientific and engineering input to demonstrate that the proposed on-site system is sustainable.

The allotment classification is applicable for all un-sewered development type including domestic, non-domestic and subdivision. The assessment and reporting requirements have however been carefully considered to recognise the different and unique characteristics associated with each development type.

2 Domestic Development

This section of the plan addresses assessment and approval requirements for individual on-site sewage management systems proposed for single residential allotments. It applies where an applicant proposes one or more of the following.

- To install, construct or alter an on-site sewage management facility under Section 68(C5) of the *Local Government Act*.
- To support development applications (DA's) for dwelling developments under the *Environmental Planning and Assessment Act*.

For this section, domestic development includes single residential dwellings, secondary dwellings, and dual occupancy developments however excludes multi-unit dwellings and tourist accommodation.

The specific levels of assessment and supporting information required to accompany an application will vary according to classification of the allotment.

2.1 Level 1 Allotments

Level 1 allotments are typically characterised by site, soil and environmental features that are classified as a low limitation to sustainable on-site sewage management. On-site systems proposed for Level 1 allotments can generally be managed through a conventional wastewater design in accordance with AS/NZS 1547:2012. Notwithstanding, it is important that all stakeholders are satisfied that the allotment characteristics align with the Level 1 criteria during the assessment, selection, design, construction, and approval assessment process. The following subsections provide applicants with guidance on the assessment process and Suitable Design Solution process including Level 1 allotment criteria. Figure 1 provides an overview of the process.

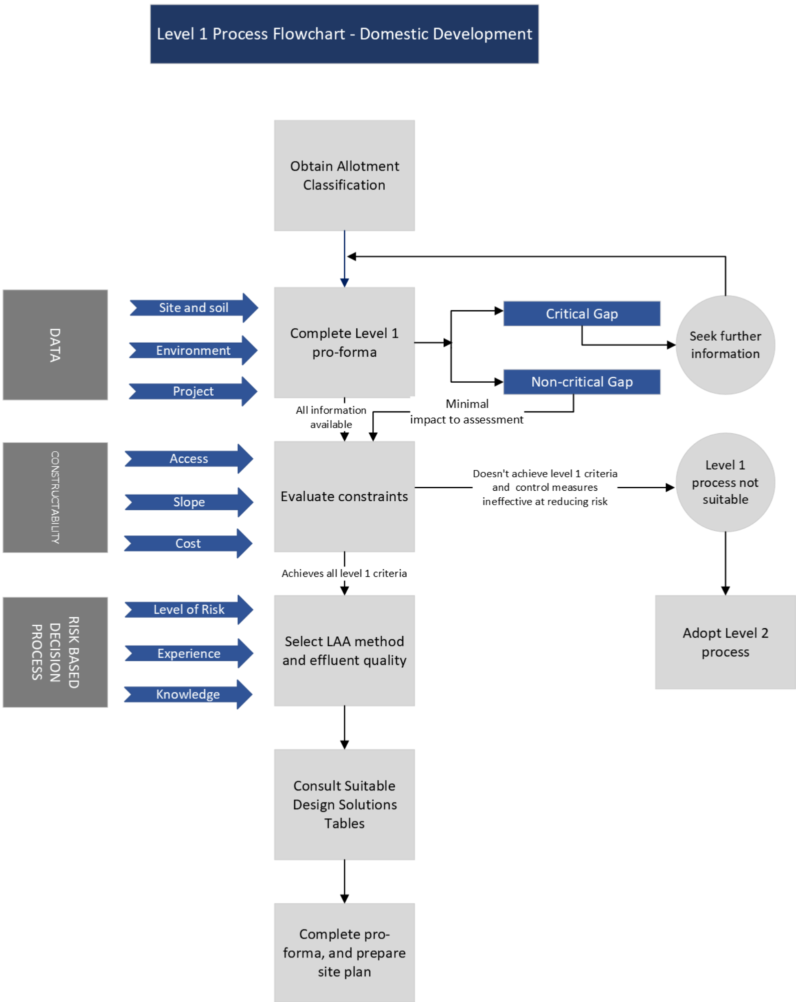

Figure 1 Level 1 Process Flowchart

2.1.1 Level 1 Assessment and Acceptance Criteria

The following tables can be used to guide both assessment and acceptance to verify when an allotment achieves the Level 1 criteria and that a Suitable Design Solutions pathway is available. Where the outcomes from the site and soil assessment indicate the allotment is unable to achieve the Level 1 criteria, the Level 2 process should be followed.

Table 1 Level 1 Assessment Criteria (Domestic)

Element	Assessment Criteria
Site and soil assessment	The site and soil assessment has been performed in accordance with Section 6.1 and achieves all the documented criteria for the assigned classification. The outcomes from the site and soil assessment have been documented in the Level 1 Site and Soil Assessment proforma.
System selection, sizing, and design	The wastewater generation rate has been determined in accordance with Section 1.1.
	Selection of the on-site wastewater system has been determined in accordance with Section 8.
	The size of the land application area has been determined in accordance with the Suitable Design solutions process documented in Section 2.1.2 and Appendix 1
	The design of the land application area has been determined in accordance AS1547.
	The treatment system selected holds accreditation (in-force) with NSW Health per LG Reg, Section 41
	A site plan has been prepared in accordance with Section 6.3.
Constructability	Installation and construction of the treatment system and land application area has been assessed by the installation company against the following criteria. - Access to the location for the treatment tank and LAA is readily available for construction and maintenance. - Access for services such as power and plumbing to the treatment tank and LAA is readily available. - The relative cost for installation and construction is considered appropriate.

Table 2 Level 1 Acceptance Criteria (Domestic)

Primary Site and Soil Features	Level 1 Acceptance Criteria
Land area	The size of the allotment is >4,000m^2
Flood potential	The location of the treatment system is above the 1% Annual Exceedance Probability (AEP). The location of the LAA[1] is above the 5% Annual Exceedance Probability (AEP).
Slope	The slope of the land in the location of the proposed LAA is less than 15%
Setback distances	The setback distances to site, environmental and development receptors achieve those prescribed in Section 9.4, table 27.
Drinking water catchment	The allotment is not located within a gazetted drinking water catchment.
Vegetation removal	Construction of the LAA does not involve the removal of mapped biodiversity values or vegetation identified as Endangered Ecological Community (EEC)
Soil category	The soil category is 2 – 6. - Note: conventional absorption trenches and ETA beds on category 5 and 6 soils may require special design and construction requirements to be considered an acceptable design solution. These are discussed in Appendix 1.1
Depth to hardpan or bedrock	The depth of suitable soil below the base of the LAA or pipework (whichever applicable) is generally >0.6m depending on the selected LAA approach.
Secondary Site Features – design, construction, or operation consideration only	
Exposure to sun and wind	- The location of the LAA generally receives a high level of sun and wind
Run-on and seepage	- The LAA is impacted by low to moderate run-on and seepage able to be controlled with a

[1] LAA = land application area

Primary Site and Soil Features	Level 1 Acceptance Criteria
	diversion drain and/or cut drain of a suitable design
Site drainage	- There are minimal visible signs of dampness across or above the LAA
Fill	- The LAA does not contain unsuitable fill material
Boulders, rock outcrops	- There is minimal surface or subsurface boulders, rocks, and fragments.

2.1.2 Suitable Design Solution Process

A Suitable Design Solution process is available to verified Level 1 allotments. The process offers an opportunity for applicants to select a wastewater servicing concept that is considered an effective and safe option for most low hazard situations. The Suitable Design Solution process also allows Council an opportunity to expedite the approvals process in the knowledge that the proposed system can achieve suitable performance standards and an appropriate level of environmental and human health protection.

Council have developed a suite of Suitable Design Solutions for on-site sewage management that aim to streamline the approval process for systems proposed for Level 1 allotments. It recognises that lots with few constraints to sustainable on-site sewage management require a reduced level of investigation and design effort. Council's Suitable Design Solutions are considered conservative wastewater servicing options that provide a high level of assurance that the plan objectives will be met. Correct use of the Suitable Design Solution process will typically result in prompt assessment and approval of installation applications by Council.

The Suitable Design Solution comprises a set of common system types and sizes determined to be appropriate for specific site and soil conditions in the Tamworth LGA. Essentially, the user can select a type of on-site system and minimum basal area for the land application area based on four fundamental characteristics of the development. For some development sites with very few constraints, a wide range of Suitable Design Solution options will be available. For other moderately constrained sites, some design options may be excluded. The user should follow the decision tree provided in Figure 2 below to find the Suitable Design Solution table that matches their site and classification.

The rationale and methodology for development of the Suitable Design Solution process is described in the TRC OWM Technical Manual.

Note

The Suitable Design Solution (SDS) process is only available for domestic on-site sewage management systems proposed on Level 1 allotments. Its use is not compulsory however, and this does not prevent property owners from adopting a more traditional approach and engaging a wastewater consultant. Owners and applicants can prepare and submit site specific designs subject to provision of the relevant supporting information and calculations applicable to the property and development.

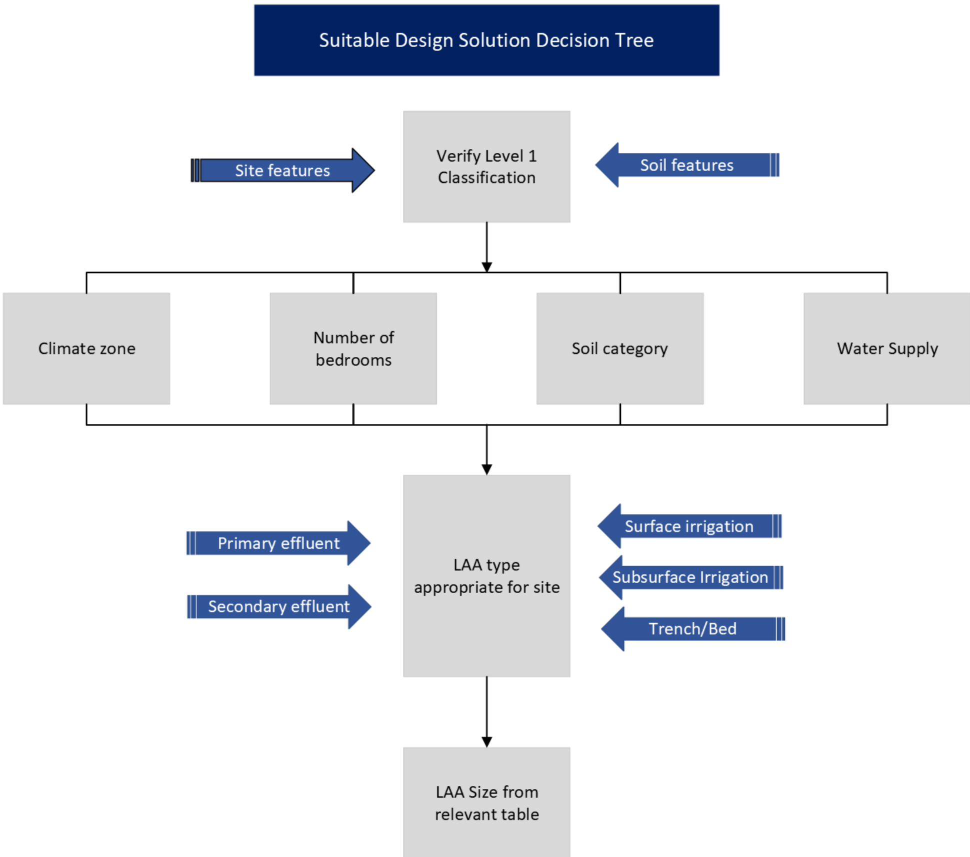

Figure 2 Suitable Design Solution Decision Tree

2.1.3 Site and Soil Assessment

A site and soil assessment pro-forma for Level 1 has been developed based on legislative provisions, AS/NZS1547 and other published guidelines where applicable. Increased flexibility has been built into the assessment process for these classifications that recognises that the degree of influence that the site and soil characteristics can have on selection, design and sizing of the system is typically at the lower or midpoint of the constraint scale.

The forms contain common site and soil assessment sections with criteria for the corresponding characteristics and features reflective of each classification. Accurate completion of the form and integration of the outcomes in the selection and design process will provide an appropriate level of environmental and human health protection.

Completion of the assessment forms can be undertaken by a variety of persons however a level of knowledge and experience in site and soil assessment for on-site wastewater systems is considered necessary. Examples of persons considered suitable to Council include soil scientists, environmental consultants, and on-site wastewater installation company staff with experience and preferable training in site and soil assessments and knowledge of AS/NZS1547. Guidance on important site and soil features including a list of resources for additional information is presented in Section 6.1.

2.1.4 System Selection and Sizing

Evaluation and interpretation of the outcomes from the site and soil assessment are used in the system selection and sizing process. Guidance on system selection can be found in Section 8, Section 9 and AS/NZS1547:2012.

Verified Level 1 site and soil assessment outcomes in conjunction with the Suitable Design solutions process, standard sizing tables and adoption of standard design principles will typically result in a streamlined selection and design process. In most situations, this approach will also typically result in an efficient approvals process through Council subject to all information being available with the application document package.

Where a Suitable Design Solution is not adopted for system selection and sizing, applicants will be required to undertake a more detailed level of assessment in accordance with the Level 2 assessment requirements.

2.1.5 Constructability Assessment

Assessment of constructability forms an important stage of the overall selection and design process as it can influence the long-term sustainability and performance of the proposed system. The term '*constructability*' can be thought of as a qualitative or semiquantitative measure of the ease and cost of installing the selected treatment system and land application area in the identified locations on the property.

Various factors contribute to the measure of constructability including:

- The relative ease of installing and constructing both the treatment system and land application area. Factors contributing to this measure may include system location, site access, slope, vegetation, size, and value of the development (whether existing or proposed) to be serviced.
- The cost of obtaining and constructing the system (capital cost). In addition to the system cost other key costs can include transport, access to services (e.g., plumbing, and electrical) and temporary works required to enable access,
- The recurrent costs associated with operating and maintaining the system (operating cost). Examples of key other costs include routine maintenance by external contractors (if applicable), availability of local installers/service technicians, desludging of septic tanks/anaerobic chambers, power (if applicable), and replacement components (e.g., pumps, blowers)

The involvement of the property owner and/or operator of the system is also important at the selection and design stage of the process. To acknowledge that the property owner understands the proposed system design, Council's application form contains a declaration to be signed by the property owner.

The Level 1 site and soil assessment proforma contains a section addressing constructability. Due to the relatively low level of site and soil constraints associated with these sites, the constructability assessment involves completion of a declaration section.

2.1.6 Reporting

There are reporting requirements associated with an application to install or alter a wastewater system (S68 application) for Level 1 allotments. The potential list of documents for submission to Council with the application are provided below.

- Application to install or alter a Wastewater treatment System,
- Level 1 Assessment Proforma,
- Site plan,
- Development plans,
- Land application plan and associated detail where required, and
- Treatment system specifications.

2.2 Level 2 Allotments

Allotments assigned a Level 2 classification typically contain site and soil characteristics that are poorly suited to on-site wastewater systems. In these circumstances it is appropriate that the allotment is subject to a more comprehensive assessment, selection, and design process than the lower and medium classifications. Assessment for this classification will be undertaken by an external consultant with qualifications and experience in soil and environmental evaluations, decentralised / on-site wastewater systems and the local government regulatory framework. The outcomes of the assessment, selection, design, and associated works will be documented in a Wastewater Management Report or equivalent document.

2.2.1 Site and soil assessment

Assessment of Level 2 allotments require a more comprehensive assessment of the site and soil characteristics than the level contained in the pro-forma checklist. The site and soil features must be assessed, evaluated, and described in sufficient detail that demonstrates to the reader each characteristics constraint level and therefore the relationship and influence that each characteristic may have in the system selection and design process.

It is good practice that site and soil assessment procedures follow nationally recognised published standards and guidelines for soil and land survey and on-site sewage management. The report should reference any specific procedures undertaken including the classification systems used to describe and assess the site and soil conditions. Council may request further information from the author where the assessment or elements of the assessment are not undertaken in accordance with the recognised standards and are not sufficiently referenced in the report.

General guidance on the level of assessment considered appropriate for Level 2 classifications is provided in Section 6.1 which contains a list of commonly assessed site and soil characteristics. It is good practice that the observation, result or value for each assessed characteristic is supported with a documented explanation of the implication of that characteristic on system selection, design, or possibly remedial measures for the LAA.

Note

Additional site and soil characteristics not listed in Section 6.1 may be observed on a site-specific basis for which an assessor may need to evaluate for inclusion in the report.

2.2.2 System Selection, Sizing, and Design

Level 2 allotments generally display substantial constraints to sustainable on-site sewage management resulting in the need for a cautious approach to system selection and design. In most situations a higher level of engineering design input will be required to satisfactorily manage or control the identified constraints.

Identifying and evaluating the site and soil assessment information will provide an indication on the degree of constraint that the assessed feature represents to each land application option. Constraint levels are categorised as Nil/minor, moderate and major.

- **Nil/minor constraint**: this outcome indicates that the result for the assessed feature is within the Suitable Design criteria range for the LAA option.
- **Moderate constraint**: this outcome indicates that the result for the assessed feature is on the outer limits of the Suitable Design criteria range for the LAA option. A moderate result may still be Suitable Design; however, consideration could be given to suitable control measures or through a modification to the LAA design if determined to be necessary.
- **Major constraint**: this outcome indicates that the result for the assessed feature is outside the criteria range for the LAA option. This result is generally indicative of an unsuitable Design feature result for the specific option and where available and feasible, alternative options should be considered. Where there are no lower risk feasible alternatives, it will be necessary to introduce suitable control measures or to manage or at least minimise risk through design modification.

Several tools may assist during this stage including:

- GIS: Geographic information systems are a contemporary and valuable tool commonly used by assessors and designers.
- Maps: Examples of maps include soil landscapes, biodiversity, groundwater, registered bores etc
- Literature: Published standards, guidelines and reference documents are available on a wide range of wastewater related topics that can be useful to assessors and designers.

The assessor/designer should evaluate the constraint and level of limitation against known criteria outlined in the published standards to determine suitable effluent dispersal options.

The outcomes from the constraint's identification stage will, in most situations, result in a list of LAA options most appropriate for the site.

On Level 2 sites, it is possible that all the assessed features could result in the constraint level identified as all major or a combination of moderate and major. In this situation, it is the role of the assessor/designer to use their experience and knowledge to critically assess the outcomes against the development and adopted performance principles and objectives to determine if a suitable and sustainable solution is available. This can involve completing an amount of design calculations and siting of the LAA to confirm if there are suitable risk control options available and if they represent the best practicable solution for the site. If no feasible and Suitable Design option can be identified, designers should consult with Council on the specific project.

2.2.3 Constructability

Like Level 1 allotments, constructability forms an important selection and design consideration however due to the higher level of constraints likely on Level 2 sites, additional requirements are considered appropriate.

The effective operation of an on-site system is in part related to alignment between system construction and system design. To manage the relationship between design and construction, installation approvals on Level 2 allotments will be conditioned to include a level of conformity surveillance by the system designer at prescribed milestones during system construction. The outcome will be the preparation and submission to Council of a '*Statement of Design Conformity*'. This is not a certification against the approval and does not replace inspections by Council. The statement provides a certain level of certainty that the design as approved is what has been constructed.

Requirements for Level 2 applications:

- Inclusion of a constructability assessment in the report,
- Completion of the declaration section of the application form by the property owner verifying that the details and implications (including costs) of the proposed system have been explained to them and that they understand the nature of the proposal; and
- Statement of design conformity by the system designer/consultant after construction of the system.

2.2.4 Reporting

The structure and content of Level 2 Wastewater Management Reports must expand beyond that of the Level 1 checklist. The reports will need to include sections documenting the outcomes of the site-specific assessment, selection, and design evaluation.

Suggested structure and content for an example Wastewater Management Report are set out in Table 3.

Table 3 Wastewater Management Report Structure

Element	Sub-element	Detail
Introduction and site information	Introduction	Brief overview of project
	Consultants' details	Name and contact details
	Site Details	Address, Lot, and DP
		Owner or applicant name
		Allotment Size
		Land zoning
		Development description
		Water supply source
		Power supply source
		Availability to sewer
		Hazard Class
		Locality Plan
Performance Objectives	Legislation	Summary of NSW legislation forming the basis for the application and assessment e.g., Acts, Regulations, SEPP's and EPI's
	Policies	Summary of policy information that may be relevant to the assessment. E.g., DCP, strategies
	Standards and Guidelines	Summary of published standards and guidelines. E.g., AS1547
Site, Soil and Environmental Assessment	Site	Documented outcomes from site assessment – include observations and evaluation.
		Assessment of the existing condition of the receiving environment and sensitivity to on-site system impacts

Element	Sub-element	Detail
		Inclusion of photos of relevant site, environmental and built features.
		Site assessment plan prepared in GIS (or equivalent) containing details of site, soil, environmental and built features relevant to the project
		Flood level information and influence
	Soil	Soil assessment method and objectives including date of assessment
		Summary of available published soil information
		Soil assessment with reference to Section 6.1
		Summary of soil profile characteristics (depth, structure, texture colour, etc.)
		Evaluation of the implications of the observed soil features on system selection and design.
	Setback distances	Documented outcomes of an assessment of the distance of environmental, site and surrounding features from potential land application areas identified within the site. Reference to AS1547 Appendix R
	Outcomes of site and soil assessment	Summary of outcomes from site and soil assessment including proposed control and management measures
Selection and Design	Wastewater servicing options	Documented outcomes from an evaluation of potential treatment and land application systems considerate of advantages, disadvantages, and constructability. Brief statement justifying progressed system
	Design wastewater characteristics and flows	Summary of wastewater generating activities associated with the proposed development. Summary of wastewater (influent) characteristics. Summary of assumptions used to determine wastewater flows. Outcomes from wastewater flow calculations including basis of calculation.
	Treatment System	Hydraulic sizing calculations Summary of selected treatment system and confirmation of required effluent quality criteria
	Land application	Hydraulic sizing calculations using both monthly water balance and AS1547 simple equation.

Element	Sub-element	Detail
		Nutrient (annual) balance calculations
	Wastewater Site Plan	Location of development, treatment system and land application area. Location of boundaries, hydroareas, hydrolines, and other sensitive receiving environments.
Constructability	Degree of difficulty	Nomination of the degree of difficulty and comparison of the relative degree of difficulty when compared to alternative on-site system options considered. Identification of critical design elements and system components that will require non-standard or complex installation/construction procedures.
	Costs[2]	Estimated installation cost range, including a breakdown of significant components such as treatment unit, land application pipework, excavation etc. Estimated annualised operating cost for the selected on-site system.
	Operation and maintenance	Brief list of regular and intermittent operation and maintenance activities associated with the system.
Appendices	Appendix 1	Soil Assessment
	Appendix 2	Design Calculations
	Appendix 3	Other information as required

[2] Costs associated with system construction and operation may only be required for non-standard and complex projects.

3 Non-domestic Development

This section of the plan addresses assessment and approval requirements for on-site sewage management systems proposed for non-domestic development. For the purposes of this guideline, non-domestic development includes:

- Commercial or industrial activities including human and non-human wastewater sources,
- Institutional facilities such as schools, community halls, and recreation facilities,
- Multi-dwelling and accommodation developments of a commercial nature, and
- Wastewater collection systems servicing subdivision or commercial/industrial developments that convey sewage or effluent to an existing sewerage system.

Non-domestic development can capture several types and sizes ranging from small scale, tourist accommodation to large scale industrial businesses. Correspondingly, the characteristics and flow rates of the generated wastewater can vary from simple low flow situations to complex, variable wastewater flows comprising both human and non-human sources.

Due to the potential variability in wastewater characteristics and flows associated with non-domestic development, the level of assessment, system selection and system design needs to align with the nature and scale of the development and the determined allotment classification. That is, as the complexity of the development and land capability increases, the level of detail required for investigation and system design should also increase.

A 2-tiered assessment approach for non-domestic development has been developed based on the allotment land capability outcome and wastewater characteristics for the development. This endeavours to assign an appropriate level of assessment that is reflective of the characteristics of the development, allotment and receiving environment.

Note

A Suitable Design Solutions process is not available to Non-domestic Development.

3.1 Assessment Selection

Selection of the most appropriate assessment process for non-domestic development is based on the land capability assessment outcome (i.e., allotment classification), wastewater source (domestic or non-domestic) and wastewater flow rate. Selection of the most appropriate assessment process is detailed in Table 4.

Table 4 Assessment Selection Guide (Non-domestic)

<table>
<tr><th>Allotment Classification →</th><th colspan="2">Level 1</th><th colspan="2">Level 2</th></tr>
<tr><td>Wastewater Source[3] [4] →</td><td>D</td><td>ND</td><td>D</td><td>ND</td></tr>
<tr><td>Wastewater Flow Rate ↓</td><td colspan="4">Assessment Process</td></tr>
<tr><td><2,000L/Day</td><td rowspan="2">Level 1</td><td>Level 1[5]</td><td colspan="2" rowspan="2">Level 2</td></tr>
<tr><td>2,000 – 10,000L/Day</td><td>Level 2</td></tr>
<tr><td>>10,000L/Day</td><td colspan="4">Level 2</td></tr>
</table>

3.2 Level 1 Non-domestic Assessments

A Level 1 assessment reflects the less constrained nature of the allotment, development and wastewater characteristics and flows.

The assessment uses the process and Assessment Proforma detailed in Section 2.1.1 above.

3.2.1 Additional Guidance

- The Level 1 Non-domestic Site and Soil Assessment Proforma is to be used for Level 1 assessments.
- A Level 2 assessment must be used for non-domestic development with flow rates <2,000L/Day and where the wastewater characteristics are complex or pose a potential risk to the environment and human health.

[3] D = domestic like effluent quality. Refer Section 6.2.3.
[4] ND = non-domestic effluent quality. Refer Section 6.2.3.
[5] Not available to developments generating complex trade wastes.

3.3 Level 2 Non-domestic Assessments

A Level 2 assessment reflects the more complex nature of the allotment, development and wastewater characteristics and flows. The assessment and design processes are like that of the Level 2 domestic allotments documented in Section 2.2 above however the following additional guidance is provided.

3.3.1 Site and Soil Assessment

General guidance on the level of assessment considered appropriate is provided in Section 6.1 which contains a list of commonly assessed site and soil characteristics. It is good practice that the observation, result, or value for each assessed characteristic is supported with a documented explanation of the implication of that characteristic on system selection, design, or possibly remedial measures for the LAA.

Note

Additional site and soil characteristics not listed in Section 6.1 may be observed on a site-specific basis for which an assessor may need to evaluate for inclusion in the report.

3.3.2 Wastewater Characterisation

The accurate characterisation of wastewater from non-domestic developments forms a critical part of the system selection and design process. Characterisation refers not only to the physical and chemical characteristics but also to the flow rate and flow profile.

Understanding the wastewater characteristics requires a robust understanding of the existing or proposed development and collection of good data. The level of detail required is highly dependent on the nature and scale of the development. Smaller scale developments generating predominantly domestic like wastewater will require less data than larger developments generating mixed wastewater streams. Further information about wastewater generation can be found in Section 1.1 below.

The following Table provides examples of the type of data that may be necessary for characterising wastewater from non-domestic developments.

Table 5 Non-domestic Development - Wastewater Characterisation Data

Data Type	Comments
Physical and chemical characteristics	- Highly dependent on nature of development. May have single source characteristics such as human wastewater (i.e., domestic) or include multiple sources from human and trade wastes. - Trade wastes may contain chemicals of concern. - Commercial kitchen waste can contain high levels of BOD, TSS and Oil/Greases. - Wineries and brewery waste can contain very high levels of BOD, COD, and variable pH.
Flow Rate	- Obtain actual flow data if available especially for trade wastes. - Use assumptions for the development: occupancy (e.g., staff, patrons, guests, employees full-time, employees part-time), equipment (e.g., pump data, specific machinery data). - Obtain industry specific data from literature sources.
Flow Profile	- Frequency and timing of wastewater generation (i.e., wastewater profile). May be consistent, intermittent, or seasonal. - Commercial/Industrial businesses: consider full time vs part-time staff, 7-day operation, shift work. - Wineries/breweries: batch vs continuous production, vintage time. - Hospitality businesses: seasonal and climatic influences, number of restaurant sittings per day, bar only vs food.

3.3.3 System Selection and Design

To account for the unique and variable nature of some non-domestic developments, the following should be considered:

- Engagement of consultant with suitable experience in non-domestic scale systems.
- Inclusion of site-specific design calculations in the Wastewater Management Report.

- System selection and design that follows a feasibility and process design procedure reflective of good engineering practice as set out in Crites and Tchobanoglous (1998).
- Development and inclusion of a specification that describes all system components to a sufficient level of detail to allow tendering for design and construction.

3.3.4 Reporting

The structure and content for the Wastewater Management Reports must include sections documenting the outcomes of the site-specific assessment, selection, and design evaluation. The structure and content for an example Wastewater Management Report is like that suggested for Level 2 Allotment set out in Table 3 of Section 2.2.

For large developments with complex wastewater streams, additional design information may be required as summarised in Table 6.

Table 6 Non-domestic Development - Additional Design Information

Report Element	Details
Design	Detailed wastewater characterisation (quality and quantity) including temporal variation using existing data for the subject site or similar facilities. Establishment of clear, site-specific design criteria based on typical or published performance. Process design in accordance with *Tchobanoglous and Burton* (2003) or *Crites and Tchobanoglous* (1997) detailing the rationale, assumed performance and capacity to manage design flows and loads. Process performance should be supported by published data or information that demonstrates the suitability of the process to the site and development. Daily water, nutrient and pathogen modelling to size any land application areas (refer Technical Manual). Hydraulic design of collection, treatment, and land application components to demonstrate viability of the process. Design drawings (CAD or similar) and specifications for the system including system components.

3.3.5 Constructability

To manage the relationship between design and construction, installation approvals for Level 2 assessments may be conditioned to include a level of conformity surveillance by the system designer at prescribed milestones during system construction. The outcome will be the preparation and submission to Council of a '*Statement of Design Conformity*'. This is not a certification against the approval and does not replace inspections by

Council. The statement provides a certain level of certainty that the design as approved is what has been constructed. Requirements for Level 2 applications include:

- Inclusion of a constructability assessment in the report,
- Completion of the declaration section of the application form by the property owner verifying that the details and implications (including costs[2]) of the proposed system have been explained to them and that they understand the nature of the proposal; and
- Statement of design conformity by the system designer/consultant after construction of the system.

3.3.6 Commissioning and Performance Validation Plan

Given the site-specific nature of some non-domestic systems, greater consideration of system commissioning and performance validation may be necessary to ensure performance objectives are achievable. An example commissioning and performance validation plan is summarised in the following table.

Note

The level of detail required in the Commissioning and Performance Validation Plan will be dependent on the scale and nature of the development.

Element	Details
Site plans and as-built drawings	Scaled plans showing the location of: - Development buildings and infrastructure. - Treatment and storage tanks. - Land application and associated components. As-built drawings and documentation for the system
Certificate of installation	Written statement from installer declaring that the system has been installed / constructed in accordance with the Approval. Written statement from the system designer confirming that the system has been installed / constructed in accordance with the design (If a requirement of the Approval). A written statement from any third-party peer reviewer (If a requirement of the Approval).
Validation Monitoring	Development of a performance-based monitoring plan appropriate for the wastewater characteristics, and treatment system design. Consideration should

Element	Details
	be given to the following plan inclusions: - Wastewater volumes entering and discharging the system (e.g., hourly, or other appropriate frequency) - Monitoring of influent and effluent. - Parameters monitored i.e., pH, electrical conductivity, turbidity, BOD, COD, TSS, TN, TON, NH_3, TKN, TP, Faecal coliforms, other microbiological organisms, chemical of emerging concern (CEC), other analytes as required. Frequency of testing: - Daily, weekly, monthly or another appropriate timescale. - Variable frequency on a reducing timescale. Length of monitoring plan: as deemed appropriate to demonstrate that the system is operating as designed. Preparation of a Validation Report including analysis of the outcomes of the monitoring and assessment against system performance objectives. Third party peer review of Validation Report (If a requirement of the Approval). Other site-specific monitoring as required by Council or the system designer.
Operation, Monitoring and Maintenance Plan	Potential inclusions: - Site plans and as-built drawing(s). - Description of major system components, design capacities, operation and performance expectations, diagrams, and schematic drawings. - Checklist and frequency of maintenance requirements. - Operational monitoring requirements. - Standard Operating Procedures (if relevant). - Records. - Troubleshooting advice. - Contact details for key personnel including service and maintenance technician(s), site operator and emergency contact. - Complaints register and procedure.

4 Effluent Pump-out Systems

Effluent pump-out systems utilise a collection tank (collection well) that stores liquid effluent once it has passed through a primary septic tank. The stored liquid effluent is removed by an effluent contractor on a frequency that allows safe operating levels to be maintained within the tank. The capacity of the system is influenced by the wastewater generated in the connected buildings and the nominated storage period (e.g., seven days). The construction costs for installation of effluent pump-out systems are generally less than treatment systems but the operational costs can be significantly more over the life of the system.

Tanker removal systems can be subject to several social and sustainability issues involving noise, odour, increased truck movements, increased damage to local roads and misuse by property owners. In some cases, there can be limits on the type and volume of sewage from tankers that can be accepted at local wastewater treatment plants. Effluent pump-out systems are not typically considered a sustainable long-term sewage management option. This section sets out situations where effluent pump-out systems will be considered for approval and the minimum standards that may be applicable.

This type of on-site sewage system can be a legitimate long-term management option where appropriate and sustainable. They should be considered either a temporary option for areas where future reticulated sewerage is planned or as a risk mitigation measure on existing properties where full on-site management is not sustainable. Effluent pump-out are typically not used to enable inappropriate or unsustainable development in unsewered areas. Notwithstanding, consideration will be given to pump-out systems in circumstances where Council determines it appropriate.

The following table summarises the types of allotments and developments where effluent pump-out systems will be considered.

Table 7 Effluent Pump-out System Permissibility

<table>
<tr><th>Development Scenario</th><th>>4,000m² Lot Size</th><th>2,000 - 4,000m² Lot Size</th><th><2,000 m² Lot Size</th></tr>
<tr><td>Domestic – proposed</td><td>Not permitted</td><td rowspan="2">With justification[1,2,4]</td><td rowspan="2">Permitted[3,4]</td></tr>
<tr><td>Domestic – existing</td><td>Specific circumstances only[1]</td></tr>
<tr><td>Non-domestic</td><td>Not permitted</td><td>With justification[1,2,4]</td><td>Permitted[3,4]</td></tr>
</table>

Note 1: Refer to Section 4.1 for a description of Minimum Standards for justifying effluent pump-out.

Note 2: Only permitted without further justification where the nearest sewer connection is >75 metres from the property and/or the property is located within a potable water supply protection area.

Note 3: Applications for effluent pump-out on small lots may need to be supported by a detailed constructability information.

Note 4: Will be permitted where it has been demonstrated that no other on-site sewage management option is feasible for the site.

4.1 Minimum Standards for Justification of Effluent Pump-out

In situations where Council is willing to consider an effluent pump-out system, a report must be prepared and submitted that demonstrates it is an appropriate system choice for the site and development. The report is to address the following points.

- An evaluation of the site and soil characteristics and/or constructability constraints indicate that:
- An on-site wastewater management approach does not align with environmental and human health protection objectives and/or the environmental and health protection matters in the *Local Government (General) Regulation*, and
- There is unlikely to be sufficient area to contain a sustainable on-site sewage management system.

A constructability assessment outlines how the pump-out system with be installed for the specific site including key design details. Further guidance for effluent pump-out systems is provided in Section 8.3.3

5 Subdivision of Land

This section of the plan applies to any unsewered development proposal that has the potential to increase dwelling entitlements. This may include the rezoning or subdivision of land but can also capture boundary realignments where the proposed alteration to property boundaries enables an applicant to utilise a dwelling entitlement that was previously constrained. This section can also be used to address development applications where existing allotments are to be consolidated into fewer lots.

Comprehensive site and soil assessments conducted prior to the creation of new lots and dwelling entitlements provides important data that can be used in the broader wastewater assessment process for determining the suitability and sustainability of the proposed development.

Information on Planning Proposals for rezoning should be directed to Council.

5.1 Level 1 Subdivision Assessments

For development applications (DAs) that involve an increase in unsewered building entitlements on Level 1 allotments, the OWMP provides opportunities for a simplified assessment of the on-site wastewater component. This streamlined process has been determined based on the outcomes of work documented in the *On-site Sewage Technical Manual*. This study established baseline standards for unsewered development that where adopted will provide Council with a high degree of confidence that (subject to correct construction, operation, and management) on-site systems will provide adequate ecosystem and human health protections.

The plan contains criteria for a Suitable Design Solution (SDS) approach which if achieved will likely enable a speedier approvals process. Where an SDS approach cannot be achieved a more detailed assessment and design process will be required. Note: an applicant may choose to engage a consultant to prepare a Wastewater Management Report rather than apply the SDS approach.

Where the Level 1 assessment criteria do not apply or the outcomes from the Level 1 site and soil assessment are unable to be achieved, the Level 2 process should be followed.

Table 8 Level 1 Assessment Criteria (Subdivision)

Subdivision Feature	Level 1 Criteria	Comment
Number of created lots	<5 lots	Inclusive of residual lot
Size of allotments	>4,000m^2	All lots inclusive of residual lot

Subdivision Feature	Level 1 Criteria	Comment
Site and Soil Assessment	Achieves all site and soil assessment criteria detailed in Table 9.	All created lots
Drinking Water Catchment	Proposed subdivision is not located within a drinking water catchment.	-

Table 9 Level 1 Site and Soil Acceptance Criteria (Subdivision)

Primary Site and Soil Features	Level 1 Acceptance Criteria
Flood potential	- The location of the LAA's can achieve the 5% Annual Exceedance Probability (AEP).
Slope	- The slope of the land in the location of any proposed LAA's is generally less than 15%.
Setback distances	- It can be demonstrated that the setback distances from the LAA's to site, environmental and development features generally achieve those prescribed in Section 9.4
Vegetation removal	- Sufficient land outside of mapped biodiversity values or vegetation identified as Endangered ecological community (EEC) is available for effluent management.
Soil category	- The soil category is 2 – 6
Depth to hardpan, bedrock or groundwater	- Sufficient separation distance to the limiting layer is available depending on the selected effluent management approach.

5.1.1 Site and Soil Assessment

The site and soil assessment will need to be performed in accordance with Section 2.1.3

5.1.2 System Selection, Sizing and Design

A broad treatment system and effluent management approach will need to be determined to demonstrate to Council that a sustainable wastewater solution is available for the proposed development. For subdivisions, Potential Effluent Management Areas (PEMA) are typically determined to demonstrate that sufficient suitable land is available for effluent management at a wastewater design flow/load typical for the type of development. In the case of a residential subdivision, this may be a 5-bedroom dwelling.

Factors that can have an influence system selection, size and design include:

- The zoning and land use (i.e., residential, or commercial)
- Scale of the development
- The outcomes from the site and soil assessment
- Sensitive receiving environments and available setbacks
- The water supply source (i.e., reticulated, tank or other)

Applications for Level 1 allotments simply need to demonstrate that sufficient useable land suitable for effluent management is available on each created allotment. In less constrained situations a wide range of treatment and land application systems is typically available and as such there is limited need to provide specify detail at the subdivision or boundary realignment phase.

5.1.3 Reporting

Sufficient information must be provided with the Development Application to demonstrate that a suitable and sustainable wastewater servicing solution is available.

5.2 Level 2 Subdivision Assessments

Subdivisions on all allotments assigned a Level 2 classification or where the Level 1 criteria cannot be achieved require a more comprehensive assessment, selection, and design process. Assessment for this classification will be undertaken by an external consultant with qualifications and experience in soil and environmental evaluations, decentralised / on-site wastewater systems and the local government regulatory framework. The outcomes of the assessment, selection, design, and associated works will be documented in a Subdivision Wastewater Management Report or equivalent document.

5.2.1 Site and soil assessment

Assessment of Level 2 allotments require a more comprehensive assessment of the site and soil characteristics than the level contained in the pro-forma checklist. The site and soil features must be assessed, evaluated, and described in sufficient detail that demonstrates to the reader each characteristics constraint level and therefore the relationship and influence that each characteristic may have in the system selection and design process.

It is good practice that site and soil assessment procedures follow nationally recognised published standards and guidelines for soil and land survey and on-site sewage management. The report should reference any specific procedures undertaken including the classification systems used to describe and assess the site and soil conditions. Council may request further information from the author where the assessment or elements of the assessment are not undertaken in accordance with the recognised standards and are not sufficiently referenced in the report.

General guidance on the level of assessment considered appropriate for Level 2 classifications is provided in Section 6.1 which contains a list of commonly assessed site and soil characteristics. It is good practice that the observation, result, or value for each assessed characteristic is supported with a documented explanation of the implication of that characteristic on system selection, design, or possibly remedial measures for the LAA.

Note

Additional site and soil characteristics not listed in Section 6.1 may be observed on a site-specific basis for which an assessor may need to evaluate for inclusion in the report.

5.2.2 System Selection, Sizing, and Design

Level 2 allotments generally display substantial constraints to sustainable on-site sewage management resulting in the need for a cautious approach to system selection and design. In most situations a higher level of engineering design input will be required to satisfactorily manage or control the identified constraints.

Identifying and evaluating the site and soil assessment information will provide an indication on the degree of constraint that the assessed feature represents to each land application option. Constraint levels are categorised as Nil/minor, moderate and major.

- **Nil/minor constraint**: this outcome indicates that the result for the assessed feature is within the Suitable Design criteria range for the LAA option.
- **Moderate constraint**: this outcome indicates that the result for the assessed feature is on the outer limits of the Suitable Design criteria range for the LAA option. A moderate result may still be Suitable Design; however, consideration could be given to suitable control measures or through a modification to the LAA design if determined to be necessary.
- **Major constraint**: this outcome indicates that the result for the assessed feature is outside the criteria range for the LAA option. This result is generally indicative of an unsuitable Design feature result for the specific option and where available and feasible, alternative options should be considered. Where there are no lower risk

feasible alternatives, it will be necessary to introduce suitable control measures or to manage or at least minimise risk through design modification.

Several tools may assist during this stage including:

- GIS: Geographic information systems are a contemporary and valuable tool commonly used by assessors and designers.
- Maps: Examples of maps include soil landscapes, biodiversity, groundwater, registered bores etc
- Literature: Published standards, guidelines and reference documents are available on a wide range of wastewater related topics that can be useful to assessors and designers.

The assessor/designer should evaluate the constraint and level of limitation against known criteria outlined in the published standards to determine suitable effluent dispersal options.

The outcomes from the constraint's identification stage will, in most situations, result in a list of LAA options most appropriate for the site.

On Level 2 sites, it is possible that all the assessed features could result in the constraint level identified as all major or a combination of moderate and major. In this situation, it is the role of the assessor/designer to use their experience and knowledge to critically assess the outcomes against the development and adopted performance principles and objectives to determine if a suitable and sustainable solution is available. This can involve completing an amount of design calculations and siting of the LAA to confirm if there are suitable risk control options available and if they represent the best practicable solution for the site. If no feasible and Suitable Design option can be identified, designers should consult with Council on the specific project.

5.2.3 Reporting

The structure and content of Level 2 Wastewater Management Reports must expand beyond that of the Level 1 reporting. The report will need to include sections documenting the outcomes of the site-specific assessment, selection, and design evaluation.

Suggested structure and content for an example Wastewater Management Report are set out in Table 3.

Table 10 Wastewater Management Report Structure

Element	Sub-element	Detail
Introduction and site information	Introduction	Brief overview of project
	Consultants' details	Name and contact details
	Site Details	Address, Lot, and DP
		Owner or applicant name
		Allotment Size
		Land zoning
		Development description
		Water supply source (proposed or existing)
		Power supply source
		Availability to sewer
		Locality Plan
Performance Objectives	Legislation	Summary of NSW legislation forming the basis for the application and assessment e.g., Acts, Regulations, SEPP's and EPI's
	Policies	Summary of policy information that may be relevant to the assessment. E.g., DCP, strategies
	Standards and Guidelines	Summary of published standards and guidelines. E.g., AS1547
Site, Soil and Environmental Assessment	Site	Documented outcomes from site assessment – include observations and evaluation.
		Assessment of the existing condition of the receiving environment and sensitivity to on-site system impacts
		Inclusion of photos of relevant site, environmental and built features.
		Site assessment plan prepared in GIS (or equivalent) containing details of site, soil, environmental and built features relevant to the project
		Flood level information and influence
	Soil	Soil assessment method and objectives including date of assessment
		Summary of available published soil information

Element	Sub-element	Detail
		Soil assessment with reference to Section 6.1
		Summary of soil profile characteristics (depth, structure, texture colour, etc.)
		Evaluation of the implications of the observed soil features on system selection and design.
	Setback distances	Documented outcomes of an assessment of the distance of environmental, site and surrounding features from potential land application areas identified within the site. Reference to AS1547 Appendix R
	Outcomes of site and soil assessment	Summary of outcomes from site and soil assessment including proposed control and management measures
Selection and Design	Wastewater servicing options	Documented outcomes from an evaluation of potential treatment and land application systems considerate of advantages, disadvantages, and constructability. Brief statement justifying progressed system
	Design wastewater characteristics and flows	Summary of wastewater generating activities associated with the proposed development. Inclusion of several design basis scenarios such as wastewater flows associated with 3, 4, and 5-bedroom dwellings. Summary of wastewater (influent) characteristics. Summary of assumptions used to determine wastewater flows. Outcomes from wastewater flow calculations including basis of calculation.
	Treatment System	Hydraulic sizing calculations. Summary of selected treatment system and confirmation of required effluent quality criteria. Summary of installation, operation and maintenance advantages and limitations for each system type.
	Land application	Hydraulic sizing calculations using both monthly water balance and AS1547 simple equation. Nutrient (annual) balance calculations if appropriate.
	Wastewater Site Plan	Soil test pit locations. Location of building footprints. Delineation of PEMA.

Element	Sub-element	Detail
		Elevation contours (max 10m) Location of boundaries, hydroareas, hydrolines, and other sensitive receiving environments.
Appendices	Appendix 1	Soil Assessment
	Appendix 2	Design Calculations
	Appendix 3	Other information as required

6 Supplementary Information

This section contains practical guidance on various elements and activities associated with the assessment, selection, and design process. The contents of this section are intended to be used as a reference once an applicant has determined the minimum requirements for supporting information to be provided with their application. This section is informative to facilitate flexibility in selecting the most appropriate approach that aligns with the property and development.

6.1 Site and Soil Assessments

It is important that assessment of site and soil features conform to published standards, guidelines, or recognised reference. Table 11 and Table 12 provides information and resource guidance for site and soil physical features.

Table 13 provides guidance about the soil chemical assessment requirements.

Table 11 Site Assessment Guidance

Site Feature	Explanation	Additional Resources
Slope	- The slope of the site, particularly the proposed Land Application Area (LAA), may be measured in the field using a clinometer or estimated using survey information or visual checks. Slope is reported in percent.	Australian Soil and Land Survey Field Handbook (CSIRO, 2009) and AS/NZS 1547:2012
Exposure	- This parameter should be determined in the field from noting the amount of tree cover (which provides shading), and the direction that the slopes face (aspect) where land application of effluent is likely to take place.	
Vegetation	- The general type of vegetation cover over the proposed LAA should be recorded, preferably even specific species. An assessment of the coverage of vegetation on the ground surface and general vigour should be made.	
Flood Potential	- If possible, information regarding the flood annual exceedance probability (AEP) elevations for the site should be obtained from Council. In the field, proximity to watercourses (both intermittent and permanent) should be noted, as well as position in the landscape (for example on a floodplain).	Council Development and Approvals staff
Run-on and Up-slope Seepage	- Evidence of run-on to the proposed LAA should be noted (such as sediment dams on the surface). The presence of wet ground or seepage upslope should also be recorded.	Australian Soil and Land Survey Field Handbook (CSIRO, 2009) and AS/NZS 1547:2012
Site Drainage	- From the field investigation, a record of observation and a description of the shape of the land should be provided to indicate whether water will be shed or will soak in. This gives an evaluation of the surface drainage. Sub-surface drainage can be determined by the presence of mottled colours in the soil profile, which indicates waterlogging. The moisture content of the soil during dry periods also reflects the capacity for drainage.	
Depth to Limiting Horizon	- A hole or pit should be dug, by hand or machine, to at least 1.0 metres below the base of the LAA or to refusal. The depth of the excavation should be recorded, along with the depth of each distinctive soil layer or horizon. The presence of hardened layers (hardpans) should also be recorded.	

Site Feature	Explanation	Additional Resources
Setback distances	- Setback distances to site, sensitive receptors and development features should be measured and recorded. Guidance is provided in Section 9. In the field, note the distance to relevant features from this table from both treatment systems and proposed LAAs.	On-site Sewage Management Technical Manual
Depth to Groundwater (permanent or episodic)	- If water enters the excavation from the surrounding soil the depth to which it comes should be recorded. Grey greyed or heavily mottled sub-soils can also provide an estimate of permanent and episodic groundwater levels. Groundwater maps and bore logs, available from the NSW Office of Water website, can be included with the Pro-forma to support the application.	Australian Soil and Land Survey Field Handbook (CSIRO, 2009) and AS/NZS 1547:2012
Presence of Fill	- Any imported fill material should be identified and described. The fill maybe clean soil from nearby excavation or fill containing construction rubble or of a material that is poorly suited to land application. Fill should be described consistently with the natural soil profile.	
Rocks and Rock Outcrops	- The nature and amount of rock (particularly bedrock – both general size and percent coverage of site) protruding from the ground that is observed over the site should be recorded in the report.	

Table 12 Soil Physical Assessment Guidance

Soil Feature	Explanation	Additional Resources
Soil Texture	- Texture is determined by manipulating a small amount of moist soil (a bolus) between the fingers. This provides an indication of the relative amount of sand, silt, loam, and clay of the soil sample. The technique for this procedure is described in McDonald et al (1990).	Australian Soil and Land Survey Field Handbook (CSIRO, 2009) and AS/NZS 1547:2012
Soil Structure	- Soil structure is the distinctness, size, and shape of the peds. A ped is a natural soil aggregate consisting of a cluster of primary particles and separated from adjoining peds by surfaces of weakness (Brewer, 1960). Soil structure should be described from a fresh vertical exposure (it cannot be taken from an augured hole). Further information on pedality may be found in McDonald et al (1990). At the very least, the degree (for example strong, moderate, or weak) of pedality of each layer, and the shape of the peds, should be shown in a report.	
Coarse Fragments	- The size and percentage of course fragments (stones and segregations) in each soil layer should be assessed and recorded.	
Depth to Limiting Horizon	- A hole or pit should be dug, by hand or machine, to at least 1.0 metres below the base of the LAA or to refusal. The depth of the excavation should be recorded, along with the depth of each distinctive soil layer or horizon. The presence of hardened layers (hardpans) should also be recorded.	

Table 13 Soil Chemical Assessment Guidance

Soil Feature	Explanation	When Required	
		Subdivision	Single Site
pH	- The pH of 1:5 soil/water suspensions is measured using a handheld pH/EC meter. Alternatively, samples may be sent to a laboratory for the test to be performed. The assessor should test the pH trend down through the profile, for example acid, neutral, or alkaline. Acid soils (pH < 5) or alkaline soils (pH > 8) may provide an unsuitable environment for plant growth, and the assessor may recommend the use of ameliorants.	Level 1 and Level 2	Level 1 and Level 2
ECe	- The electrical conductivity of the saturated extract (ECE) is calculated by measuring the electrical conductivity of 1:5 soils in water suspensions multiplying by a soil texture factor to convert to ECE. This figure infers the salinity of the soil and its potential impact on plant growth. Assessors can measure it in the field with a hand-held meter or through laboratory analysis.	Level 1 and Level 2	Level 1 and Level 2
Emerson Aggregate Class	- The Emerson Aggregate Test is used to assess soil dispersibility and susceptibility to erosion and structural degradation. It provides a simple, field-based assessment of aggregate stability and dispersibility.	Level 1 and Level 2	Level 1 and Level 2
Cation Exchange Capacity (Cations)	- CEC is the capacity of the soil to hold and exchange cations. It is a major controlling agent of stability of soil structure, nutrient availability for plant growth, soil pH and other factors. A low CEC means the soil has a low resistance to changes in soil chemistry that are caused by land use (Hazelton and Murphy, 2007). The levels and relative proportions/ratios of the key cations (calcium, magnesium, potassium, and sodium) can also provide useful information on the capacity of a soil to accept wastewater and potential amelioration measures.	Level 2	No
Exchangeable Sodium Percentage (ESP)	- ESP is the proportion of sodium on the cation exchange sites reported as a percentage of exchangeable cations. Levels above 6% may cause soil structural problems and reduced permeability. ESP should be considered in conjunction with Emerson Aggregate Class and cation levels to determine if amelioration of the soil within the LAA is required.	Level 2	No

Soil Feature	Explanation	When Required	
		Subdivision	Single Site
Phosphorus sorption	- This test is used to calculate the immobilisation of phosphorus by the soil. Sandy soils typically have low P sorption concentrations with clay soils and soils high in iron and/or aluminium often higher in P-sorption. The most useful information is obtained from a multi-point test (5-point isotherm). - In the absence of laboratory data or data from other literature sources the following typical P-sorption values may be suitable subject to Council acceptance (Reference: Table 4-7, Environment Health Protection Guidelines (Draft, 2023). - Category 1, 50mg/kg - Category 2, 100mg/kg - Category 3, 200mg/kg - Category 4, 400mg/kg - Category 5, 500mg/kg - Category 6, 600mg/kg	Level 2	Level 2

6.2 Wastewater Generation

The wastewater generated by the specific development must be satisfactorily characterised to enable an adequate and suitable system design. Typical and irregular wastewater flows should be determined to adequately capture the variability in flow for consideration in the system design. The wastewater and effluent quality characteristics are also an important consideration especially with non-domestic developments.

This section outlines the calculation of flow rates, occupancy and organic loads and provides guidance on consideration of variable flowrates and non-domestic wastewater flow rates and loads.

6.2.1 Occupancy

Domestic Premises

The equivalent population (EP) of residential dwellings for the purposes of calculating design wastewater flow rates is obtained by assuming 2 EP for the first two bedrooms and 1 EP for each subsequent bedroom. This considers that typical occupancy does not increase linearly with the number of bedrooms. As an example, a four-bedroom dwelling has and EP of 6.

In some situations, other rooms in the dwelling may need to be included as a bedroom for the purpose of calculating occupancy if it can potentially be used as a bedroom. Examples of rooms include studies, media rooms, and craft rooms. Room features that may assist determine the potential use as a bedroom include the room size, closable entry doors, and provision for wardrobes.

Non-Domestic Premises

The occupancy for non-domestic developments can be highly variable being dependent on the activity, scale, location, and popularity. Determining the occupancy of these premises should be given significant consideration and be based on a site-specific investigation. Where possible the following occupancy data should be sought to enable the development of a true wastewater profile for the development.

For accommodation facilities:

- Maximum capacity derived from number of rooms and beds,
- Water use data (e.g., water bills), and

- Historical and representative occupancy information. In the absence of occupancy data, provision of typical minimum, mid, and peak season daily or weekly occupancy numbers or percentages.

For food and beverage establishments:

- Estimated low, mid, and peak season daily patrons over a typical week,
- Number of seats and sittings,
- Water use information (e.g., water bills), and
- Licenced capacity.

Where the development has significant seasonal variability in flows, the development of an annual wastewater flow profile with an appropriate timestep (e.g., daily, weekly, or monthly) should be considered. For existing sites, the installation of a flow meter to obtain site specific wastewater generation rates should be considered as this data will be most representative for the development.

6.2.2 Flow Rates

Domestic Premises

Design wastewater flow rates for domestic development has been adopted from AS1547 2012 (Appendix H and Table H1). The allowances presented in have been reproduced from AS1547.

Table 14 Domestic Wastewater Allowances

Water Supply	Wastewater Allowance L/Person/Day
Reticulated Supply, Bore Supply or River/Creek Supply	150
Roof Supply	120

Wastewater flow rates can still vary, and as such the following development specific factors should be considered when determining the design flows.

- The number of bedrooms,
- Average and peak occupancy,
- Type of water supply,

- Type of water fixtures (e.g., water saving fixtures installed), and
- Wastewater treatment plant and land application design and the resilience of these systems to variable hydraulic loads.

The flow rates for residential premises are based on the number of bedrooms within the dwelling. The daily household wastewater generation rate is calculated by multiplying the occupancy (represented as EP) by the adopted wastewater flow rate.

Non-Domestic Premises

Wastewater generation rates for non-domestic premises can be highly variable and, like occupancy, depend significantly on the type of development and activities. Discussions with the site manager or owner should be undertaken to determine what wastewater generating activities are being undertaken at the site. Whilst the installation of a flow meter to obtain site specific wastewater flow rate information is always beneficial, it is understood that there is often insufficient funds or time available to obtain this information. In the absence of this information, it is often possible to examine the water use data in the form of water bills to calibrate approximate wastewater flow rates per person. However, this data may also be unavailable for rural sites which utilise rainwater harvesting as the primary source of water supply.

6.2.3 Wastewater Characteristics

Domestic

Domestic wastewater from dwellings is derived from kitchens, bathrooms, laundries, 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 values typical from domestic development is presented in

Table 15.

Table 15 Wastewater and Effluent Quality Criteria

Parameter	Domestic Wastewater Value[6]
Biochemical Oxygen Demand (BOD)	200 – 300mg/L
Total Suspended Solids (TSS)	200 – 300mg/L
Total Nitrogen (TN)	20 – 100mg/L
Total Phosphorus (TP)	10 – 25mg/L
Faecal Coliforms	10^3 – 10^6 cfu/100mL
Organic Load [7]	70g BOD/Person/Day

Non-Domestic

Wastewater from non-domestic development can range from simple to complex depending on the type of development and wastewater source.

Wastewater of a human nature will typically have similar characteristics to domestic wastewater however the following potential differences should be identified and considered.

- Apart from some accommodation businesses, commercial and industrial enterprises may not include a laundry. This could affect the concentration of phosphorus due to reduced detergent consumption.
- Hospitality businesses with large commercial kitchens that typically generate increased organic loads (BOD, TSS and oils/greases). This can be managed through a suitable grease arrestor sized in accordance with the local water and sewer authority requirements.

Note

Wastewater from non-human sources commonly referred to as trade wastes must be assessed on a development specific basis. If not assessed and managed appropriately, some trade wastes can affect treatment system biological processes and can be harmful to the environment, ecosystems, and human health.

[6] Environment and Health Protection Guidelines (DLG 1998)
[7] Based on 150L/person/day (Standards Australia, 2012).

Businesses commonly generating trade wastes include:

- Wineries and breweries,
- Service stations, automotive mechanical repairers, spray painting and businesses operating wash bays, and
- Industrial businesses generating unique trade wastes and chemical of emerging concern.

6.2.4 Maximum Daily and Surge Flows

It is important to consider the maximum instantaneous peak flow variations in wastewater generation from domestic and non-domestic developments to ensure system performance. The system design should be capable of treating and dispersing irregular and surge flows applicable to the development. Alternatively, flow balancing, or equalisation can be implemented to reduce flow variability.

6.2.5 Further information

Further information about occupancy, flow rates, and wastewater characteristics can be obtained from the following sources.

- AS/NZS 1547: 2012.
- NSW Health Sewage Management Facility Vessel Accreditation Guideline (2016).
- Crites and Tchobanoglous (1998) Small and Decentralised Wastewater Treatment Systems.
- USEPA (2002) On-site Wastewater Treatment Manual.
- SA Health On-site Wastewater Systems Code (2013).

6.3 Site plans

Site plans form an important element of the assessment and reporting process. They provide a valuable visual technique for presenting, locating, and identifying important site, environmental, built and development features including dimensions, and directions. Site plans are addressed in several sections of AS1547 2012 as well as an example site plan for an individual lot (AS1547 Figure D1).

For some development applications where there is a significant quantity of information, it may be necessary to develop several plans that capture and convey the relevant information about the development, the site, assessment, and system.

Further information about the various types of plans is provided in Table 16.

Table 16 Types of Layout Plans.

Plan Type	Description	Typical Information
Locality Plan	Locality plans are a simple way of spatially locating the property on which the on-site wastewater system is proposed in the context of the broader area. A locality plan can be a useful inclusion in reports where the target audience is unfamiliar with the area.	- The property (i.e., boundary indication) - Road names (i.e., roads surrounding the property) - Key points of reference (e.g., towns or other main features)
Site Assessment Plan	Site assessment plans typically focus on the outcomes of the site and soil investigation. Site, soil, environmental and built features either observed from the site investigation or identified from GIS mapping data or other sources are included on the plan. The plan can be useful in conveying the degree of limitation that the features may pose to onsite wastewater management.	- Property boundaries - Existing buildings, structures, driveways, and easements - Water features such as drains, groundwater bores, dams, waterways. - Sensitive receiving environments - Topography and terrain features - Soil test pit locations - Elevation contours of an appropriate resolution and/or indication of ground slope and direction - Aerial photography (if applicable and available) - Plan information, legend, scale, and northing
On-site Wastewater Plan	On-site wastewater plans focus on the selected wastewater system determined to be most appropriate for the site. This type of plan provides readers with the ability to conceptualise how the location and footprint of the selected treatment and effluent dispersal system integrates with the built environment (i.e., the development) and the site, environmental and surrounding characteristics. The level of information captured in the onsite wastewater plan will vary depending on the complexity of the development and property features. Depending on the size of the property, it may be necessary to prepare several plans such as a broader overview plan and a separate more detailed plan of the on-	- Property boundaries - Existing and proposed buildings and other structures - Treatment tank(s) location - Primary and reserve effluent dispersal areas including any design features. - Buffer or exclusion zones that may be relevant to the system design. The annotation of measured distances between the LAA and identified features can be a helpful inclusion.

Plan Type	Description	Typical Information
	site wastewater system area.	- Location of storm water and sub-soil water control measures (if applicable). - Topography and terrain feature relevant to the property and on-site wastewater system. - Elevation contours of an appropriate resolution and/or indication of ground slope and direction. - Plan information, legend, scale, and northing
Construction Plan	Construction plans are a set of documents that define the requirements for construction of the on-site wastewater system. Construction plans can assist the installation company by provision of additional details on the design, materials, location, dimensions, and construction technique. The plans can include both plan views and cross-section views and may form part of a system design specification package. The need for construction plans will depend on the scale and/or complexity of the LAA design and scope of works. Construction plans are typically not required for standard domestic projects. An intermediate option that can be useful for the system design and construction is the use of standard drawings and typical arrangements to support a conceptual design and On-site Wastewater Plan without preparing a site-specific design. These standard drawings can capture a wide range of important design and construction decisions that can be adapted to each site.	

6.4 Multi-residential Development

The Tamworth Development Control Plan (2010) currently does not permit dual occupancy or multi dwelling developments on unsewered land under deemed to satisfy provisions.

6.5 Flood Prone Land

The identification of flood prone land on a site is an important consideration in the selection, design, and location of both the treatment system and LAA.

Treatment systems generally contain electrical and mechanical components that can be rendered inoperable if not waterproof and subsequently inundated during flood and storm events. Treatment system openings and water sensitive electrical connections must be designed and located to prevent inundation. Techniques used to minimise the potential for water intrusion into the treatment tank and to protect water sensitive electrical components includes:

- Casting water and gas tight lids that achieve Australian Standard AS3996 into the tank lid,
- Locating the tank such that the lid and openings are above the level determined by the local authority. The recommended height is the 1% Annual Exceedance Probability (1:100) or the Flood Planning Level (FPL).
- Locating water sensitive control panels, aeration blowers and junction boxes on plinths, poles, or side of a building.

For all sites not affected by flooding or storm inundation, the on-site wastewater treatment system must be installed such that the top of the lid of the facility is located a minimum of 100mm above surrounding finished ground surface.

Effluent Land Application Areas must also be located or raised to ensure that the point of effluent application is at or above the 5% AEP.

7 Risk Management Guidance

Risk management measures are naturally embedded in the selection and design process however there may be sites and situations where additional assessment or control measures will be required. This section provides guidance to assist evaluate risk and develop appropriate measures with the objective of reducing the risk and potential consequences to acceptable levels. Information about the risk management process can be found in *AS1547: 2012* (Appendix A).

Consideration of further risk evaluation or reduction measures may be necessary where the level of risk within a specific aspect of the project is unable to be adequately managed with standard assessment processes. Risk reduction may involve implementation of one or more physical, procedural, or administrative control measures by the system designer, installation company, Council, or a referral agency.

Physical and procedural risk reduction measures can be used to further enhance system design or the operation and maintenance of the system.

Examples of physical and procedural risk reduction measures include:

- Adoption of conservative assumptions where justified such as a reduction in the design loading rate.
- Provision of adequate surface and subsurface drainage controls.
- Consideration of nutrient and pathogen management.
- Consideration of flow balancing where the hydraulic profile indicates significant variability.
- Consideration of the need for increased oversight, monitoring and/or maintenance requirements, and
- Provision of educational information.

AS1547, Appendix A, Tables 1 and 2 contains further examples of design and operation and maintenance risk reduction measures.

Administrative risk reduction control measures can include:

- Further environmental assessments by wastewater practitioners to verify protection targets, assumptions, or system design. Examples include off-site impact assessment, pathogen die-off modelling, and cumulative impact assessment modelling.

- Verification of the technical performance of the proposed On-site wastewater treatment plant where available information is limited or unable to be easily evaluated.
- Technical peer review of the land Capability Assessment or associated design report. This may be requested by the regulatory agency when considered appropriate to do so.
- Inclusion of conditions in the permit application.

AS1547, Appendix A, Table 3 contains further examples of administrative risk reduction measures. The following sections provide guidance on common risk reduction measures.

7.1 Adjustment of Design Loading Rate

There may be circumstances where site and soil constraints and/or receiving environment sensitivity may warrant consideration of a reduced DLR/DIR as a risk reduction measure. Table 17 summarises key constraints that may trigger DLR reduction, guidance on adjustment, and additional resources available to assist in decision making (primarily AS1547:2012).

Table 17 Design Loading Rate Adjustment

Risk Factor	LAA Type	Considerations	Possible Reduction
Slope	- Shallow Subsurface and Surface	- Steeper slopes increase potential for downslope seepage, breakout, and migration of effluent.	- Table M2 from AS1547:2012
Depth to limiting layer	- All	- Site where >0.6m of unsaturated soil cannot be achieved between point of application and limiting layer (e.g., hardpan, rock or watertable)	- 10 - 25%
Apedal and/or sodic Category 6 soils	- All	- Primary effluent dosed LAA	- 25 - 50%
		- Secondary effluent dosed LAA	- 10 - 25%
High rainfall / low ET	- Trenches and beds	- Void storage can provide a buffer for constrained climates.	- 10 - 25%
	- Shallow subsurface and surface	- Heavily reliant on soil water content of upper horizons.	- 25 - 50%
	- Mounds	- Operate effectively in a wide range of climatic conditions.	- None

7.2 Stormwater Control

Surface water and sub-soil moisture can have a detrimental effect on the performance of an LAA. Consideration should be given to the design and installation of appropriate control measures where the potential for upslope surface and sub-soil water inflows exists. The design process should include identification of site water management infrastructure and any natural flow paths or areas of subsurface water flow with the potential to impede performance. These may include (but not be limited to) LAA locations:

- Downslope of impervious areas such as roads, roofs, hardstands, driveways, and other vegetation, sealed or compacted areas,
- Downslope of or near breaks in slope and other landscape positions prone to surface water accumulation and/or subsurface water discharge,
- Overland flow paths created through landscaping and development of a site (LAA should by design be setback from natural or constructed drainage flow paths),
- Sites subject to episodic or permanent high groundwater or lateral subsurface water flow, and
- Discharge points for constructed stormwater systems.

Suitable surface water control measures can include diversion drains, spoon drains, dish drains or 'V' drains. On steeper sloping land, sub-soil drainage may be required. Sub-soil moisture can be controlled through the design and installation of deeper drainage measures such as cut drains. Subsurface drainage should be installed as close to the limiting layer impeding vertical drainage as possible (e.g., heavy clay or rock). On low lying sites where permanent watertable requires management to maintain adequate vertical separation, relief or curtain drains require engineering design (American Society for Civil Engineers, 1993) and a legal and suitable point of discharge.

When correctly designed and installed, both control measures can assist in keeping the land application area drier. Either measure shall be constructed in such a way that protects the land application area without impacting neighbouring properties through re-directed flows. Wherever possible diversion drainage should be integrated with the broader property water management system.

An example of a design for stormwater control measures is provided in the Appendices.

7.3 Raised Effluent Dispersal Systems

In situations where the point of effluent application is less than 0.6 metres from a limiting layer it may be possible to overcome this constraint through raising the level of the LAA via importation of fill. The fill must be of a suitable quality and texture for effluent dispersal and plant growth. It is also crucial to ensure the existing natural ground is suitably prepared prior to careful laying. Gentle compaction of the fill should be performed to reduce the potential for preferential flow along the interface between the fill and existing ground.

The work of Converse and Tyler (1994) suggested that Linear Loading Rates (LLR) are a crucial consideration with any LAA subject to restrictions to vertical drainage, but, more so with raised systems. Where an LAA is proposed to be raised, it is recommended that the suitable LLRs are adopted for determination of the width of a raised LAA.

7.4 Pathogen and Nutrient Management

Outcomes from the system selection process may indicate site and soil features (e.g., risk to groundwater) or end use activities that requires a treatment and LAA system capable of producing a higher effluent quality. While effluent quality is typically associated with the type of treatment system, selection of the right LAA in combination with the treatment system can result in enhanced environmental and human health protections. An important decision point in the selection and design process is the adoption of pathogen and/or nutrient management measures. The requirement for one or both management measures and the degree of reduction will be a function of the required level of human health and environmental protection.

Pathogen reduction is typically achieved through chemical and physical disinfection methods associated secondary and advanced secondary treatment systems (e.g., chlorine and ultra-violet systems). However, it is acknowledged that LAA systems also provide a level of attenuation through physical and biological processes.

Nutrient reduction, in general terms, can be achieved by an improvement in the level of treatment (i.e., nutrient concentrations from secondary treatment systems are lower than primary treatment systems) however, LAA systems also provide a level of attenuation and removal through physical and biological processes. The design of LAA systems can also be enhanced to include additional nutrient management measures where specific nutrient targets are determined through the selection and design process (e.g., amended soil systems).

7.5 Impact Assessment and Modelling

There are some sites and LAA design scenarios where it is not possible to adequately mitigate risks through design and construction strategies. In these cases, it may be possible to undertake a more detailed site-specific analysis of LAA performance and off-site impact to evaluate the risk associated with any design concessions required. The following table summarises some of the tools available for undertaking impact assessments of proposed LAA.

Table 18 Available Tools for Off-site and Cumulative Impact Assessment

Assessment Type	Component	Tools
Overall LAA Environmental and Health Risk		- Application of the Health and Environmental Risk Assessment methodologies documented in AGWR
Off-site Impact Assessment	LAA performance	- Long-term continuous daily water and nutrient balance modelling (e.g., MEDLI or similar).
	Effluent migration / plumes	- Viral die-off (Cromer *et al* 2001) - Pathogens and dissolved nutrients: steady state one dimensional groundwater plume modelling (Domenico or Ogata-Banks equations – Alvarez and Illman, 2006) - Steady state or dynamic groundwater modelling (e.g., MODFLOW) - Comparison of steady state concentrations at receiving environment to the appropriate Environmental Guideline.
	Background water quality	- MUSIC can be used to characterise background pollutant loads from the site to provide context in terms of the percentage increase attributable to the LAA.
Cumulative Impact Assessment		- Two methodologies provided in Jellife (2000) and Dungog Shire Council (NSW) On-site Sewage Management Technical Manual (2015)

These tools require expert understanding of LAA function and receiving environment modelling and should be undertaken by experienced and suitably qualified practitioners.

7.6 Reserve Area

A reserve area is a duplicate land area of equal size to the designated land application area which may be used if the original area fails, is inadequate or needs to be rested. A reserve area is required for all trench and bed systems (including ETA and LPED systems), unless Council is satisfied based on evidence from a comprehensive LCA that there is a low risk of negative impact to the environment or human health. *AS1547* provides extensive guidance on reserve areas with text box C5.5.3.4 describing when reserve areas are normally used, when they can be reduced and when they may not be applicable. For example, *AS1547* advises that the requirement for a reserve area with a size equivalent to the primary area is normally applied to septic tank and conventional land application systems.

8 Treatment System Guidance

To achieve regulatory performance objectives the choice of treatment system must be matched to the environmental and topographical constraints of the property, the method of land application, the future requirements of the property and potential resource re-use opportunities. System selection can also consider several important economic factors such as the capital cost, operational and maintenance costs. In larger and more complex projects, life cycle costs may also be a determining factor in system selection.

The effluent quality criteria for the treatment system will be determined by the capability of a site to assimilate effluent, the sensitivity of the receiving environment and the method of land application. Constrained sites typically require a higher effluent quality and, in some situations, improved control of dosing and distribution within the land application area. Less constrained sites can typically be serviced by simpler systems producing primary effluent. Selection of the treatment system should always be on a '*fit for purpose*' basis and only as complex as required to allow safe and sustainable land application of the treated effluent.

This section contains further guidance on other topics relating to treatment systems.

8.1 Effluent Quality

Treatment systems can be categorised against effluent quality. Table 19 provides minimum effluent quality standards and typical system types able to meet the assigned quality criteria. Many types of treatment systems are available commercially that can meet either secondary or advanced secondary effluent quality standards.

Table 19 Effluent Quality Standards

Treatment Standard	Minimum Effluent Quality (90th Percentile)		System Types
Primary	None provided		- Septic tank
Secondary	Biochemical Oxygen Demand (BOD)	20mg/L	- Standard Aerated Wastewater Treatment System (AWTS)[a] - Some wet composting systems [b.]
	Total Suspended Solids (TSS)	30mg/L	
	Thermotolerant Coliforms	30cfu/100mL	
Advanced Secondary	Biochemical Oxygen Demand (BOD)	10mg/L	- Aerobic media filter[c]

Treatment Standard	Minimum Effluent Quality (90th Percentile)		System Types
	Total Suspended Solids (TSS)	10mg/L	- Some Biofilters[d] - Some Membrane Bioreactors[d] - Textile Filters
	Thermotolerant Coliforms	10cfu/100mL	
	Nutrients: Nitrogen and phosphorus	- Environmental conditions or Council may require specific effluent nutrient concentrations	

Notes:

a. A proprietary AWTS's will be considered a secondary treatment system unless effluent quality data demonstrates the system can consistently achieve a higher level of treatment.

b. A wet composting system may be accepted as a secondary treatment system unless effluent quality data demonstrates a higher level of treatment.

c. Aerobic media filters must meet appropriate design standards acceptable to the Council. The installation of a suitable disinfection system will be required if surface or sub-surface land application is proposed.

d. Biofilters and mechanical treatment systems may be accepted as secondary or advanced treatment systems if effluent quality data demonstrates the system can consistently achieve the required level of treatment.

8.2 System Accreditation

NSW legislation[8] includes provisions that the design of a sewage management facility to be installed or constructed must hold a certificate of accreditation. The requirement captures most standard wastewater systems including systems that discharge to a sewerage system and common effluent drainage scheme. In effect, applications to Council seeking approval for the installation of a wastewater system must be accompanied with a Certificate of Accreditation (in-force) issued by NSW Health for the proposed wastewater treatment system.

In broad terms, sewage management facilities or situations where the requirement for an accreditation does not apply are listed below[9].

- Sewage management facilities intended to treat:

[8] NSW *Local Government (General) Regulation*
[9] The reader is directed to Clauses 40 and 41 of the NSW *Local Government (General) Regulation* for further details.

   - Sewage of a non-domestic nature,
   - Sewage from premises normally occupied by more than 10 persons, or
   - An average daily flow of sewage exceeding 2,000 litres.
- The land application area connected to the system,
- Sewage management facilities:
   - Installed or constructed as a model for the purposes of testing, or
   - Designed, and is to be constructed, by the owner or occupier of the premises on which it is to be installed, or
   - Designed, by a person other than the owner or occupier of the premises on which it is to be installed, specifically and uniquely for those premises.

8.3 Septic Tanks, Collection Tanks and Pump Wells

Correct sizing of septic tanks, collection tanks and pump wells is important for the long-term performance of the system, reducing operational risks and maintaining human health protections.

8.3.1 Septic Tanks

Septic tanks with increased hydraulic retention generally result in less frequent desludging which has been shown to significantly improve system performance and the longevity of the land application area. Desludging tanks too frequently prevents the establishment of good anaerobic digestion of sludge and scum, which reduces effluent quality and increases sludge build-up. Guidance to assist the selection of a septic tank for a domestic development is provided in Table 20.

Given the unique and variable characteristics of non-domestic domestic development, site and development specific design including the treatment system sizing will be required. Where warranted, system selection and design should follow a feasibility and process design procedure reflective of good engineering practice as set out in Crites and Tchobanoglous (1998).

8.3.2 Pump Wells

Some system designs can include a pump well where the method of effluent distribution requires a pump or when the location of the land application area is situated above the treatment tank. The size of pump wells is important in establishing adequate storage capacity in situations of power outages. Key sizing and design elements for pump wells are provided below.

- The capacity of the pump well should allow for 24 hours of emergency storage above the high-level alarm. Where a duty and standby pump are installed, the emergency storage capacity can be reduced to 12-hours.
- Pump wells must be fitted with a high-level alarm to detect and notify of pump or pipework malfunction.
- Where pump operation is controlled by a timer, a low-level pump-off and high-level pump-on float switch or sensor shall be installed to override the timer.

8.3.3 Effluent Pump-out Systems

Guidance to assist the selection of a septic tank and collection well for a domestic system is provided in Table 20. Selection of tank capacities and specific design requirements for non-domestic developments are to be determined on a case-by-case basis.

As with pump wells, high-level alarms must be fitted to all collection tanks to monitor and notify excessive effluent levels.

Table 20 Septic/Collection Tank Size Guidance (Domestic)

Bedrooms	Septic Tank Capacity[1, 2] (Litres)	Collection Well Capacity[1] (Litres)
3	3,000[3]	5,250[4]
4	3,500	6,500
5	4,000	7,500
6	4,500	8,500

[1] Assumes reticulated water supply.
[2] Capacity represents operational volume
[3] Minimum volume stated in AS1547.
[4] NSW Health recommended minimum

Typical construction considerations for draw-off lines and standpipes are provided below.

- Draw-off lines are typically constructed of Class 9 PVC pipe that conforms to the relevant Australian Standard. The diameter of the draw-offline shall be a minimum of 80mm for collection wells with a capacity up to 10kL and 100mm diameter for >10kL systems. The draw-offline is typically buried below ground to protect the pipework from UV and physical damage however other protection measures can be implemented.
- Standpipes are to be constructed of a suitable material resistant to damage by ultra-violet rays and minor physical damage. Suitable materials may include

corrosion resistant metals such as galvanised metal. The standpipe is to be securely supported by a suitable fixing method.

- The provision of a suitable connector for tanker connection is fitted to the end of the standpipe such as a screw on adapter or camlock inclusive of an end-cap.
- A shut-off or stop valve shall be fitted where the height of the standpipe outlet is physically lower than the lid of the collection well.
- The position of the standpipe is important with consideration to permitting safe parking of the effluent removal tanker. The standpipe should not be located outside the property boundary.

8.4 Pumps and Hydraulics

The correct size and type of pump is critical to the operation and longevity of the system for on-site wastewater systems that contain a pump to transfer treated effluent to the LAA and/or pressure dose an LAA. Consideration should be given to pump selection and key hydraulic design criteria during the design process to confirm feasibility. It is common for pump selection to be undertaken by the installer as part of pricing and final design. The following considerations should be made when specifying and/or selecting a pump for an on-site wastewater application:

- Liquid Properties / Effluent Characteristics,
- Proposed Pump Duty,
- Maintenance and safety,
- Hydraulic Performance,
- Transfer to a gravity dosed Land Application Area or Tank,
- Pressure Compensating Drip Irrigation, and
- Low Pressure Effluent Dosing (LPED) including Wisconsin Mounds.

8.4.1 Liquid Properties and Effluent Characteristics

Pump selection must be matched to the effluent being conveyed with consideration given to characteristics such as the solids content (soft and hard solids), chemical characteristics (particularly pH), temperature and depth of submergence.

Some pumps will specify a millimetre particle size they are capable of conveying. Dirty water style pumps are typically warranted for secondary quality effluent suspended solids levels (30 mg/L) but may handle primary effluent. Vortex (open impeller) pumps have a greater ability to transfer larger solid materials but may not handle raw sewage. Macerator and grinder pumps are designed to transfer raw sewage in a macerated form.

8.4.2 Proposed Pump Duty

The pump duty and operating conditions must be considered including the pump operating frequency. In most on-site wastewater pumping scenarios, pumps with a high number of rated starts per day are usually desirable.

8.4.3 Maintainable and Safe

It is preferable that pumps used in OWMS are not 'hard wired' to the available power supply but connected through a general-purpose outlet rated for its location (typically IP65).

The maintenance requirements for pumps, including accessibility and removal should also be considered. It is preferable that a suitable removal device is installed that facilitates the safe and effective removal of pumps (e.g., chains or similar mechanisms that are constructed to withstand corrosive environment of a wastewater chamber). The use of barrel union or camlock style connections (or other suitable alternatives) can also make maintenance more practical.

8.4.4 Hydraulic Performance

The most important consideration in selecting a pump is selecting one with a performance curve (flow versus operating head) that matches the end duty. This will depend on the type of EDS or transfer. All hydraulic systems – such as LPED pipe, pressure compensating subsurface irrigation or DN100 slotted pipe –will have a different operating curve depending on operating pressure (known as the system curve). The point where the pump curve and the system curve intersect is the duty point of the system. This is shown in Figure 17.

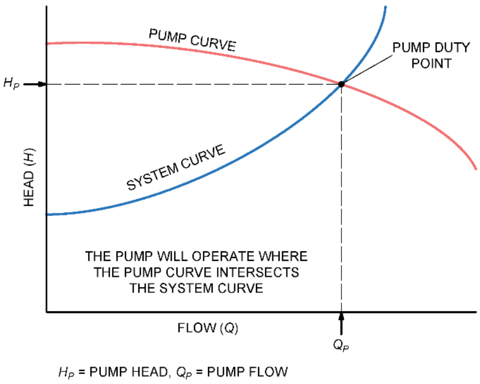

Figure 3 Example Pump Curve

8.5 Alarm Systems

Alarm systems are an important component of a wastewater treatment systems where mechanical or electrical equipment is installed or where the water level of a tank needs to be monitored. Alarm systems are not limited to treatment systems but are equally important for pump wells and effluent pump-out systems. Alarm systems are designed to detect and notify the property owner or system operator of a malfunction of a pump, aeration blower, disinfection system or high-water level.

Alarm systems are addressed in AS1546 and AS1547 however as a rule, an alarm should include the following general provisions:

- An audible and visual alarm signal component,
- A muting facility that automatically resets after a prescribed period has elapsed (i.e., after 24hrs - Ref: AS1546 and AS1547),
- Have an alarm panel that is in a position that is readily visible and audible to the occupants or operators,
- A power supply that is permanent (hardwired) with consideration to battery back-up,
- Remote monitoring where the development, scale and situation warrants. Remote monitoring is typically utilised for non-domestic systems.

8.6 Septic Tank Outlet Filters

A septic tank outlet filter is a '*coarse screen device*' that is installed in the outlet junction of the primary tank of a wastewater treatment system. The filter is designed to enhance the quality of the effluent by intercepting coarse solids and particulates before they reach either the secondary treatment part of the system or land application area. Correctly operating and maintained outlet filters can prolong the life of land application areas.

Outlet filters are recommended to be installed however they do require regular maintenance to ensure that they do not fully block which can create the sanitary drainage to back-up. In some circumstances, it may be necessary to install a high-level alarm to indicate when flow through the filter is significantly impeded due to blockage.

Several types of outlet filters are available from plumbing, septic tank, and wastewater system suppliers.

9 Land Application Area Guidance

This section provides guidance on the selection, design, and supplementary considerations for land application areas.

9.1 Effluent Quality

9.1.1 Primary Effluent

Primary treated effluent is usually achieved by septic tanks which treat raw wastewater prior to discharge to an LAA or secondary treatment plant. Primary treatment plants do not have a specific water quality standard, however, can be expected to achieve the following effluent quality ranges (Tchobanoglous, 1998):

- Biochemical Oxygen Demand (BOD): 100 - 250 mg/L
- Total Suspended Solids (TSS): 20 - 140 mg/L

9.1.2 Secondary Effluent

Secondary treatment systems receive either raw sewage or primary treated effluent from septic tanks and treat wastewater prior to discharge to an LAA. The required secondary treatment effluent quality is as follows (90^{th} percentile):

- BOD: <20 mg/L.
- TSS: <30 mg/L; and
- Faecal coliforms (where disinfection is used): <10cfu/100mL.

Disinfection is not mandatory for secondary treated effluent, however, is required for surface irrigation LAA and may be utilised by designers or required by Council Officers on highly constrained sites.

9.1.3 Advanced Secondary Effluent

Advanced secondary treatment plants accept either raw sewage or primary treated wastewater from a septic tank and discharge to an LAA. The required advanced secondary treatment effluent quality is as follows (90^{th} percentile):

- BOD: <10 mg/L
- TSS: <10 mg/L; and
- Faecal coliforms: <10cfu/100mL.

Table 21 outline the effluent quality required for discharge into different LAA types. Whilst advanced secondary treatment systems can be used for all LAA types and are required for recycling systems, these systems may increase the installation or maintenance cost of systems and as such should not be designed or installed as a blanket approach. However, they are a useful design tool which should be used on constrained sites which may have sensitive receiving environments, reduced setback distances or on properties with limited area available for the application of effluent. It should also be noted that chlorine disinfection is not suitable for systems which rely on microbial breakdown of effluent within a distribution bed as the chlorine can kill bacteria. Such systems include trenches, beds, and mounds.

Table 21 LAA Effluent Quality Requirements

<table>
<tr><th>Effluent Quality</th><th>Trenches and Beds</th><th>ETA</th><th>Surface Irrigation</th><th>Subsurface Irrigation</th><th>Mounds</th></tr>
<tr><td>Primary</td><td rowspan="4">Y[10]</td><td rowspan="4">Y</td><td>N[11]</td><td>N</td><td rowspan="4">Y</td></tr>
<tr><td>Secondary</td><td>N</td><td rowspan="3">Y</td></tr>
<tr><td>Secondary + Disinfection</td><td rowspan="2">Y</td></tr>
<tr><td>Advanced Secondary</td></tr>
</table>

9.2 LAA Sizing Methods

There are three commonly used calculation methods for sizing LAA systems. These include the simple hydraulic equation (AS1547), monthly water balance calculation and nutrient balance calculations. Best practice would be to apply all three methods when determining the size of the LAA as this will indicate the most limiting design factor (i.e., hydraulic, nitrogen or phosphorus limited). While it is not always practical or necessary to size the LAA to the most limiting design factor, the severity of all design factors should be identified to facilitate satisfactory design decisions or consideration of suitable and feasible risk reduction measures. For the purposes of this guidance document selection of the sizing method is related to the allotment classification and development type.

Section 9.2.1 provides guidance on which sizing method should be adopted based on site specific constraints, allotment classification and development type.

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[10] Y denotes that the LAA is suitable for effluent treated to this quality.
[11] N denotes that the LAA is not suitable for effluent treated to this quality.

9.2.1 Calculation Method Selection

Generalised guidance on the suitability of each sizing method is presented in Table 22. Sizing method suitability is highly dependent on the site constraints including climate, receiving environments buffers, soil permeability and LAA type. Generally, the guidance below is influenced by the impact of climate on water balance calculations and the rate at which nutrients are transported within the soil or groundwater at the site. Where nutrients are the limiting design characteristic, nutrient balance results should be considered as a suitable design sizing tool as this could result in pollution of nearby sensitive receiving environments. Sites which are hydraulically limited may result in very large or oversized LAA's where water balance calculations are used. In situations where the most limiting design parameter is resulting in what could be an oversized LAA, consideration should be given to determining if it is the correct sizing method for the site. Where it is deemed to be the most appropriate method and the LAA is still considered oversized, consideration should then be given to completing a more detailed analysis which may include daily numerical modelling of soil water conditions or nutrient balance and / or groundwater plume modelling to determine attenuation rates of nutrients.

It should be noted that the guidance presented in Table 22 is for guidance purposes only and the suitable sizing method should be determined on a site-by-site basis by a suitably qualified person. It is often the case that multiple sizing methods are calculated for comparative purposes to aid in determining the most suitable sizing method.

Table 22 Guidance on Calculation Method Suitability

Calculation Method	Suitability Indicator: More Suitable	Suitability Indicator: Less Suitable	Potential Applicability
Simple Hydraulic Equation	- Low to moderately constrained sites where sufficient site and soil information has been collected to adjust the DLR using a risk management approach.	- Highly constrained sites where there is insufficient information available to assess risks and determine an appropriate DLR. - Sites near sensitive receiving environments where nutrients are likely to be the most limiting design parameter.	- Domestic Classification Levels 1, 2 and 3 - Non-domestic development (Some)
Monthly Water Balance	- Locations with moderate to dry climates where rainfall only minorly exceeds evaporation for up to two months of the year. This is most typical of inland regions of Australia. - Sizing of soil absorption and evapo-transpiration trenches and beds.	- Locations with wet climates where rainfall exceeds evaporation for many months of the year. - Sizing of irrigation LAA types as this will likely result in a very large and oversized areas. - Sizing of Wisconsin Mounds which should be sized using the techniques outlined in AS1547 (Appendix N).	- Domestic Classification Level 2 - Non-domestic development
Nutrient Balances	Sites with high permeability soils (Category 1 - 2) and near sensitive receiving environments. Nutrients are transported more rapidly under these conditions. Sites with shallow groundwater or perched aquifer conditions.	- Unconstrained sites with low permeability soils and no sensitive receiving environments.	- Domestic Classification Level 2 - Non-domestic development

9.2.2 Selection of Design Loading Rate

When selecting a Design Loading Rate (DLR), the guidance provided in *AS1547:2012* should be adopted to determine the maximum loading rate for the limiting soil characteristic within the soil. As outlined in Table 23, the limiting soil category is defined as the highest soil category, or soil with the highest clay content, within 600mm of the point of effluent application or injection. For example, the most limiting soil profile for a conventional bed system would be the highest soil category within 600mm of the base of the bed.

DLR values for the main LAA types can be found in *AS1547: 2012* with reference locations provided in Table 23. The DLR values referred to in the tables in AS1547 should be considered maximum values with a reduction in DLR evaluated where there are significant site or soil constraints.

Table 23 AS1547 References to DLR

EDRS Type	AS1547: 2012 Reference Location
Trenches, beds and ETA/ETS Systems	Table L1 in Appendix L
Irrigation Systems	Table M1 in Appendix M
Mounds	Table N1 in Appendix N

9.2.3 Simple Hydraulic Equation

The Simple Hydraulic Equation from AS1547 uses the design flow rate and DLR to determine the required basal area of the LAA. The Simple Hydraulic Equation is presented in Equation L1 in Section L4 of *AS1547*:2012 and reproduced below.

Equation L1

$$L = \frac{Q}{DLR\ x\ W}$$

Where:

L = Length in m
Q = Design daily flow in L/day
DLR = Design loading rate in mm/d
W = Width in m

AS1547:2012 recommends this equation and use of a DLR/DIR as a conservative benchmark for sizing of all LAA's. Notwithstanding it recognises that there will be some circumstances where the DLR may need to be reduced or can be increased subject to a site-specific assessment by a suitably qualified person.

The Simple Hydraulic Equation has advantages in its simplicity. With only two parameters (design wastewater flow and DLR), there is less potential for compounding errors associated with a larger number of assumed inputs required in other calculation methods (e.g., water balance). However, this method doesn't consider the nutrient uptake or adsorption capability of the soil or site limitations including wet climates, steep slopes, or shallow soils.

AS1547:2012 advocates a risk-based approach to selection of a DLR as a suitable method for considering a wider range of constraints as part of LAA sizing. Water and nutrient balance calculations are an example of resources that can be used to make these risk based DLR decisions.

Where significant site constraints are present, including wet climates or reduced setbacks to sensitive receiving environments, consideration should be given to reducing the DLR to adopt a larger LAA area to ensure the long-term sustainability of the treatment system. More specific guidance on the application of such a risk-based approach and guidance on DLR/DIRs can be found in *AS1547:2012 (*Section 5 and Appendix L, M and N).

9.2.4 Water Balance Calculation

Monthly water balance calculations are a mass balance equation for all water entering and leaving the LAA system over a monthly timestep. They are a relatively simple tool for evaluating the influence of climate on LAA performance over a single statistical year. There is no one correct or right answer to a water balance with the outcome merely an indication of the risk or benefit between climate and LAA performance.

This method provides some indication of the hydraulic capacity of the system over a monthly basis however it can also be a significant oversimplification of dynamic soil water processes. This can result in a significant oversizing of an LAA, particularly in wet climates where rainfall exceeds evapo-transpiration. Under these conditions, lumped monthly water balance calculations do not adequately simulate day to day soil moisture storage or dynamics especially for water balances conducted in regions with low winter evapo-transpiration and LAA types that have lower DLRs such as irrigation systems.

A water balance can however be used to inform a risk-based approach to sizing the LAA through a reduction in DLR based on professional judgment by a suitability qualified practitioner. Alternatively, other design elements may be altered to manage risk such as increased setbacks. Further guidance on risk management measures is provided in AS1547:2012.

For larger non-domestic development or highly sensitive and/or constrained sites, consideration can be given to completing daily numerical modelling which better represents soil water dynamics at a daily timestep. One application which is widely accepted for use is the Model for Effluent Disposal using Land Irrigation (MEDLI) (Department of Environment and Science, Queensland Government, 2015), however other models are available. Daily modelling is relatively complex and should be undertaken by an experienced practitioner.

Information about monthly water balances including calculation guidance can be found in the NSW EHP Guidelines (1998 and draft 20223).

9.2.5 Nutrient Balance Calculations

Nutrient balance calculations can be undertaken for nitrogen and phosphorus to determine a minimum area as an indication of the nutrient export potential from the LAA. Like water balance calculations, it can often be impractical to size and construct an LAA to the minimum nutrient balance size, particularly for sandy soils where reduced phosphorus sorption capacity is common. In some cases, the minimum LAA size based on nutrient export is determined for risk management decision purposes, however, may not result in that size being adopted.

Where the minimum LAA size is not achieved, consideration should be given to calculating the minimum setback distance (or indicative downslope buffer) required to achieve effective attenuation of nitrogen and phosphorus. For constrained sites, the minimum setback distance should be achieved prior to any sensitive receiving environments. Example calculations of minimum downslope buffer for nutrient setback is provided below.

Whilst AS1547 excludes nutrient balance procedures, detailed guidance on nutrients is provided in Appendix S of the standard. Information about nutrient balances including calculation guidance can also be found in the NSW EHP Guidelines.

Example Nutrient Buffer Guidance

An example nutrient buffer calculation scenario is provided below. In this example, the assessor has completed a calculation to determine the size of an LAA using the simple hydraulic equation, monthly water balance and nitrogen and phosphorus balances. The theoretical results are presented in Table 24.

Table 24: Example EDS sizing assessment

Calculation method	LAA size (m^2)
Simple hydraulic equation	270
Monthly water balance	1,090
Nitrogen balance	220
Phosphorus balance	370

Interpretation

Except for the monthly water balance calculation, the phosphorus balance can be the most limiting design factor. This scenario is common along the east coast of Australia, particularly on sites with permeable soils due to the lower phosphorus sorption capacity of sandy soils.

Climate conditions along the eastern seaboard can exhibit higher rainfall levels than total pan evaporation. Monthly rainfall levels during the cooler seasons can also be significantly higher than monthly pan evaporation rates compared to the warmer months where the reverse is typically observed. This can influence the monthly water balance calculation resulting in an LAA footprint that is very large as it relates specifically to the 'wettest' month. Therefore, use of the monthly water balance calculation must be carefully considered to ensure it is appropriate for the climatic conditions.

An LAA size of 300m^2 has been adopted as, in this example, there is limited suitable area available on the theoretical site, however, there are no sensitive receiving environments in proximity.

Therefore, an additional downslope area of 70m^2 is required outside of the adopted LAA footprint as a nutrient buffer. This is to attenuate the excess phosphorus which cannot be attenuated within the proposed LAA area for the life of this system (assumed 50 years). This area is determined by subtracting the adopted LAA size from minimum area required for the LAA determined for phosphorus (i.e., 370m^2–300m^2 = 70m^2).

If the width of the LAA (across the slope/contours) is assumed at 20m, the minimum downslope phosphorus setback distance required is calculated by dividing the required downslope buffer area by the width of the proposed LAA (i.e., $70m^2 \div 20m = 3.5m$).

The example LCA identified that the closest sensitive receiving environment is a non-perennial watercourse located ~40m from the closest boundary of the LAA. Given the proposed phosphorus setback distance of 3.5m is significantly less than the distance to the sensitive receiving environment, the proposed location and size of the LAA and nutrient buffer is considered appropriate.

This method can also be used where nitrogen may be the limiting feature.

9.3 Land Application Area Types

Effluent management systems typically proposed will be consistent with AS1547 (2012). This does not however preclude consideration of innovative and non-traditional system types where it can be demonstrated that they are appropriate and comply with regulatory requirements. The table below lists the system categories and external reference.

Table 25 EDRS Categories and References

System Category	Details	External Reference
Soil Absorption and Evapo-transpiration Systems	Conventional absorption trenches and bed systems	AS1547 Appendix L
	Evapo-transpiration trenches and bed Systems	
	Amended soil systems	Designing and Installing On-site Wastewater Systems (Water NSW)
Shallow Subsurface and Surface Systems	Shallow sub-surface irrigation	AS1547 Appendix M
	Low pressure effluent distribution (LPED)	
	Surface Irrigation	
Wisconsin Mound Systems		AS1547 Appendix N Converse and Tyler (1994) Converse and Tyler (2000)
Greywater Recycling Systems	Indoor recycling	AS1546.4
	Outdoor recycling	Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1, November 2006, EPHC)

9.4 Setback Distances to Receptors

The determination of appropriate setback distances from receiving environments is a critical element in the selection and design process especially where the receptor is identified as environmentally sensitive or a higher risk to human health. Research, monitoring and modelling of on-site systems consistently recognises that the implementation of realistic and achievable setback distances is an effective and cost-effective risk management strategy. However, it is also evident that distances necessary to prevent downslope or off-site impacts can be site-specific due to the variability in site, soil and development features.

A 2-tier approach has been developed that provides flexibility in setback distance selection. Tier 1 adopts the setback distances documented in the Environment and Health and Protection Guidelines (NSW EHP Guidelines, 2023 draft) with Tier 2 based on setbacks from AS1547 (Appendix R). Both methods use a buffer range approach which is further described in the text box below.

Tier 1 Method – NSW EHP Guidelines (2023, draft)

Setback distances (also referred as buffer distances) contained in the revised NSW Guideline now reflects a risk-based approach like that of AS1547. While buffer ranges in both documents are the same for some receptors, some receptors in the EHP Guideline have a greater maximum distance (E.g., property boundaries). The receptor list in the EHP Guideline also captures a broader receptor list such as differentiating between permanent and intermittent water bodies. Applications for domestic Level 1 allotments proposing to adopt the Suitable Design Solution pathway must be able to meet the maximum distance for each listed receptor relevant to the site and development.

Tier 2 Method – AS1547 Appendix R

The approach documented in Appendix R of AS/NZS 1547:2012 is risk-based. It can be applied in specific cases where Tier 1 buffers are not achievable; or assessors and designers wish to determine if reduced buffers are appropriate and justifiable. This approach is acceptable where site specific information on land capability is used in conjunction with peer reviewed published technical information to support the risk classification. Importantly, there will be some cases where this approach will result in an increase in setback distances. In addition, where annual nutrient balance calculations are performed for higher risk sites, the assessor may confirm that sufficient downslope buffer exists to adequate manage the nutrients in the long-term based on the proposed wastewater management system.

Further guidance for the selection and application of the 2 setback distance methods is provided in the following Table.

Table 26 Setback Distance Method Suitability

Method	Suitability Criteria
Tier 1 Maximum distance from NSW EHP Guideline for the selected receptor	Domestic development - Level 1 allotments adopting a Suitable Design Solutions (SDS) pathway.
Tier 2 AS1547 Appendix R	Domestic development - Level 1 allotments NOT adopting a SDS pathway.
	Domestic development – Level 2 allotments.
	Non-domestic development – all allotment classifications.
	Subdivision development – all allotment classifications.

9.4.1 Tier 1 Method

This method adopts the maximum setback distances from the NSW Environment and Health Protection Guidelines On-site Sewage Management. The setback distances should be used where no site-specific determination of risk has been performed and the prescribed distance is achievable. This approach is mandatory for domestic Level 1 allotments The information form the EHP Guideline is reproduced in Table 27. Further information explaining the relationship between setback and site/system constraints and subsequent selection of receptor distance can be found in the guidelines.

Table 27 Tier 1 Setback Distances

Receptor	Recommended Distance
Property boundaries	15m
Buildings and structures	6m
Driveway, paths, and walkways	6m
Swimming pools, and recreational areas	15m

Receptor	Recommended Distance
In-ground water tanks and services	15m
Retaining walls, embankments, and cuttings	3m or 45° angle from toe of wall (whichever is the greater)
Intermittent water bodies[12] such as farm dams, drainage channels	40m
Permanent surface water bodies such as: lakes, rivers, creeks, and streams[13]	100m
Domestic groundwater wells and bores	100m
Groundwater, bedrock, and hardpan	1.5m vertical distance

[12] Intermittent Watercourse can be a low point with no or little defined bed or channel that carries water during rainfall events but dries out quickly when rainfall stops. A gully or incised drainage depression can also be an intermittent watercourse.

[13] Permanent Watercourse can be any river, creek, stream, or chain of ponds, whether artificially modified or not, in which water usually flows, either continuously or intermittently, in a defined bed or channel.

9.4.2 Tier 2 Method

This method adopts the approach and setback distances from Appendix R of AS1547. The method uses two tables designed to help guide the user determine suitable horizontal and vertical setback distances for a list of site features (Table R1) when siting the selected system on the property. Site and system constraint elements of specific concern relevant to each site feature are provided in Table R2 along with examples of sensitive features.

Selection of the setback distance from the distance range in Table R1 is influenced by the relevant site/system features constraint scale from Table R2. Both tables include a series of guidance notes for each site or system feature that are important considerations in adoption of appropriate distances. Determining suitable setback distances is influenced by effluent quality (treatment system type) and land application design.

Important guidance from Appendix R of AS1547 is listed below.

- The overall setback distance should be commensurate with the level of risk to public health and the environment (R1, note 1).
- The setback distance should be based on an evaluation of the constraint items and corresponding sensitive features in Table R2 and how these interact to provide a pathway or barrier for wastewater movement (R1, note 1).
- It may be appropriate for adoption of the maximum setback distance where site/system features are on the high end of the constraint scale (R1, note 1).
- Setback distance from surface waters is defined as the areal edge of the land application system to the edge of the water (R1, note 4).
- In the case of surface irrigation, the setback distances are based on a spray plume with a diameter not exceeding 2 m or a plume height not exceeding 0.5 m above finished surface level (R1, note 9).
- The level of microbial removal for any on-site treatment system needs to be determined and it should be assumed that unless disinfection is reliably used then the microbial concentrations will be like primary treatment. Low risk microbial quality value is based on the values given in ARC (2004), ANZECC and ARMCANZ (2000), and EPA Victoria (Guidelines for environmental management: Use of reclaimed water 2003) (R2, note 3.).
- The regulatory authority may reduce or increase setback distances at their discretion based on the distances of the land application up or downgradient of sensitive receptors (R2, note 6).

Guidance Note

Adoption of horizontal or vertical setback distances that are at the lower end of the setback distance range for any site feature must be supported with sufficient information that satisfactorily demonstrates the appropriateness of the value. Examples that may be considered include:

- Treatment system selection and effluent quality e.g., advanced secondary effluent quality.

- Treatment system design e.g., redundancy in disinfection, flow balancing, additional system monitoring and alarms.

- Land application selection e.g., sub-soil or sub-surface method, mounds.

- Land application design e.g., pressure dosing of effluent, use of amended media to reduce phosphorus, improvement of soil within the area to mitigate identified deficiencies (i.e., lime or gypsum).

- Development of site-specific control measures e.g., surface, and sub-soil control drains.

- Calculation of downslope nutrient buffers for nitrogen and phosphorus.

- Determination of viral die-off distances using several pathogen log-reduction scenarios

- Determination of site-specific nutrient attenuation rates to establish the distance required to achieve adopted water quality targets.

- Verification of the long-term performance of the system through daily wastewater and steady state effluent plume modelling.

9.5 Soil Improvement

Soil characteristics can directly or indirectly influence the long-term efficiency and performance of effluent management areas. In some situations, the outcomes from the soil assessment may identify one or more soil characteristics that at the level detected is outside the optimum range for that characteristic. Examples of soil characteristics capable of influencing LAA performance include pH, salinity, sodicity, dispersiveness, cation exchange capacity (CEC) and heavily compacted soils.

To manage the identified deficiency, soil improvement work may be required where it has been determined that the surface or sub-surface soils within the land application area is considered unsuitable for plant growth or effluent assimilation. In some situations, it may be recommended as a preventative measure (e.g., application of gypsum to maintain a lower Exchangeable Sodium Percentage).

Soil improvement work should be carefully designed and correctly performed. In most situations, the recommendation for soil improvement work should be determined by a suitably qualified and experienced person as there may be other factors or approvals that must be considered. Examples of soil improvement works may include the addition of gypsum, lime, and/or organic matter. Improvement work can also include the importation of a suitable fill material, importation of amended soil (higher phosphorus sorption capacity), removal of rock (i.e., floaters and loose boulders), ploughing the soil within the land application area (i.e., typically to a depth of 200mm) or laying turf, application of seed or planting of suitable vegetation species.

9.5.1 Acidic Soils

Acidic soils have the potential to mobilise pollutants and significantly impact plant growth which can affect LAA performance. Lime application is recommended for acidic soils, particularly if the pH in the upper 100mm is <5.5. The table below outlines the lime application rate based on effective cation exchange capacity and pH of the soil within the upper 100mm.

Table 28 Soil Lime Requirement

Effective Cation Exchange Capacity (cmol+/kg)	Lime Application Rate Required to Raise the pH of the Upper 100mm of Soil[14]			
	pH from 4.0 to 5.2	pH from 4.3 to 5.2	pH from 4.7 to 5.2	pH from 5.2 to 5.5
1	0.2	0.1[15]	0.03	0.02
2	0.2	0.1	0.1	0.04
3	0.4	0.2	0.1	0.1
4	0.4	0.2	0.1	0.1
5	0.5	0.3	0.1	0.1
6	0.6	0.3	0.1	0.1
7	0.6	0.3	0.1	0.1
8	0.7	0.4	0.2	0.1
9	0.8	0.4	0.2	0.1
10	0.9	0.5	0.2	0.1
15	1.3	0.7	0.3	0.2

9.5.2 Sodic Soils

Absorption trench systems are typically not suitable in Sodic soils. Clay soils that tend to be dispersive require special design and construction attention. During construction gypsum may be applied at 1 kg/m^2 to the base of the trench or bed to prevent the clay dispersing. The trench shall be closed in as soon as possible to protect the gypsum from rain impact.

[14] Values in table are adopted from Soils: their properties and management (Soil Conservation Commission of New South Wales, 2000)
[15] It is recognised that low rates are difficult to apply, however over-limiting can cause nutrient deficiencies.

9.6 Wet Weather Storage

In most domestic situations, the requirement for wet weather storage can be managed through other design approaches rather than physical storage facilities. Where sufficient land is available, wet weather storage can be designed into the physical size of the land application area or managed through conservative loading rates. The incorporation of physical storage facilities as a practical method of handling excess effluent during periods of rainfall should only be considered in specific circumstances and subject to careful design of monitoring and control systems. Wet weather storage may be necessary for non-domestic systems or reuse facilities.

10 Construction and Installation Guidance

This section provides guidance on ancillary matters that can, if relevant to the specific property and project, influence the design, construction, and performance of the system.

10.1 Plumbing, Drainage and Electrical Work

To meet regulatory requirements and to ensure correct operation, all plumbing and electrical work associated with installation of the on-site wastewater system must be undertaken by suitably qualified, licenced, and experienced tradespersons using recognised standards.

Sanitary drainage and other pipes, fixtures and fittings must meet Australian Standards where applicable. Relevant Australian Standards include:

Table 29 Australian Standards

Reference	Title
AS2698.2	Plastic pipes and fittings for irrigation and rural applications
AS/NZS 3000: 2018	Electrical installations
AS/NZS 3500.2 (set)	Plumbing and drainage Part 2: Sanitary plumbing and drainage
AS/NZS 4129: 2020	Fittings for polyethylene (PE) pipes for pressure applications
AS/NZS 4130: 2018	Polyethylene (PE) pipes for pressure applications

10.2 Excavation, Anchoring and Backfilling

10.2.1 Excavation

Correct excavation and preparation of the hole for the tank or treatment system is an important part if the overall installation process. Important considerations when excavating the tank hole include:

- The type and stability of the soil,
- The size and dimensions of the tank(s),
- Maintaining the correct excavation slope,
- The required hole depth to ensure correct plumbing grade,
- The requirement for a riser ring,

- Addition of a suitable type and depth of base material, and
- Safe working practices.

10.2.2 Anchoring

Correct anchorage of tanks is an important consideration during the installation phase to protect the tank against hydrostatic uplift pressures that can result in floatation of the tanks. Tank floatation is generally limited to areas of high or variable water table but can occur when installed in poorly drained clay soils followed by significant rainfall where the tank has not been filled and anchored correctly. Floatation can also occur during system maintenance where the tank is emptied or partially emptied. Similarly, tanks where liquid levels vary (e.g., pump wells) can be susceptible to floatation in some circumstances.

In situations where flotation of the tank is possible, suitable, and effective means of anchoring the tank into the ground must be provided. AS1546.1 advises that '*Anchorage shall be designed and provided on tanks where the deadweight of the empty tank and applicable soil loads are less than 1.5 times the force due to hydrostatic uplift*'.

Several anchorage methods are available including hydrostatic flanges, anchor collars, starter bars/concrete and tie down loops.

Hydrostatic flange: A horizontal projection on the wall of the tank designed to prevent the tank being forced out of the ground by hydrostatic pressure in areas having a high-water table. Sometimes called an anchor collar, or ground retention lip.

Anchor collar: an L-shaped anchor collar section constructed not less than 65 mm wide and not less than 6 mm thick to be fixed to the outside circumference of the tank with durable material protected from the corrosive environment. The collar may be continuous around the circumference or may be in at least two sections each not less than 600 mm long and fixed to opposite sides of the tank. For a vertical cylindrical tank, the flange is fixed not more than 300 mm from the base and for a horizontal cylindrical tank the flange is situated along the line of the greatest horizontal perimeter.

Loops: Each 'side' of the tank is held into the ground by a piece of pipe, typically 100 mm PVC sewer grade pipe, attached to the tank by durable ties. These ties are anchored to the tank via the anchor points provided and have a loop in the other end at excavation ground level. The pipes have a length of not less than the diameter of the tank and each is passed through two loops. Backfilling then covers the pipes.

10.2.3 Backfilling

Before backfilling the hole, the tank must be filled with water, correctly anchored and pipework and connections finalised. The material selected to backfill the hole must be suitable for the intended purpose. Suitable backfill materials include crusher dust or sand with an appropriate density and characteristics. The tank manufacturer will be able to provide further information.

Installation of the tank or treatment system, including hole preparation, anchoring, and backfilling must be in accordance with the manufactures recommended instructions.

10.2.4 Risers and Saddles

The installation of saddles and tank risers (extensions) may be necessary to obtain the minimum grade for the sanitary drainage or where it is necessary to install the tank and lid below ground level. These should be fixed to the tank using a flexible, durable waterproof sealant which should be applied both inside and outside the riser/saddle. Installation of saddles are mandatory for primary septic tanks to achieve a minimum finished tank height of 100mm above finished ground level.

10.3 Civil Works and Retaining Walls

Works involving the addition/removal of soil or the construction of retaining wall(s) may be proposed as part of the development or may be proposed as a design element for the selected effluent dispersal system. In all situations careful consideration of the implications of the works will be necessary to evaluate potential impacts on the land application area such as constructability, system performance and unintentional downslope environmental consequences (i.e., preferential pathways).

10.3.1 Cutting or terracing

This is a process of moving soil from one place to another to make the ground on which the LAA is to be constructed more level. Terracing may be required on sloping sites and involves the creation of a series of level pads on which the LAA is constructed. Cutting or terracing are common techniques used in the construction of an LAA however the technique carries certain disadvantages and risks. These include:

- Disturbance of the natural level of soil compaction and creation of preferential flow paths or subsurface seepage breakout points
- Removal of higher soil horizons that are typically a soil category better suited to effluent application, and
- Change in depth of soil and subsequent reduced vertical separation distance to a limiting layer.

Cutting or tiering should be avoided where possible when siting the LAA, particularly trench and bed systems. Where shallow subsurface systems are proposed, engineering design may be required for the earthworks and drainage. It is also recommended that a minimum of 250mm of organic topsoil is established on the terrace through either in situ topsoil retention and/or importation.

10.3.2 Filling or raising

This is a process of importing soil to level the site on which the LAA is to be constructed. Filling beneath the base of an LAA design such as a raised pressure dosed bed may also be an explicit design consideration to elevate the point of effluent application. For example, raising an LAA may be required because of groundwater levels or the flood prone nature of the property. Filling and raising land are a technique that carries certain disadvantages and risks. These include:

- Creation of a '*lens*' effect resulting from introducing imported soil over in-situ soil. This can result in the creation of preferential pathways and movement of effluent.
- Stability issues associated with imported soil on sloping land.
- Requirement to carefully evaluate and select a compatible soil to import and use.

An LAA located in raised fill material should be designed by an experienced practitioner and may require engineering input with respect to geotechnical risks on sloping sites. Linear Loading Rates (LLR) are critical to the hydraulic performance of raised all systems not just Wisconsin Mounds. Stormwater control is also essential to ensure raised systems operate effectively.

10.3.3 Retaining walls

Retaining walls are vertical structural devices used to hold back (retain) soil to prevent it from moving downslope. The principal objective of retaining walls is being able to withstand the pressure exerted by the retained material under different situations however additional operational and environmental considerations will be required when proposed as an element of the LAA design. Retaining walls proposed as part of an LAA are not recommended unless there are no alternatives. If implemented the designer will need to consider the potential effects on the wall from construction and long-term operation of the system especially soil moisture conditions. Retaining walls create an artificial dam for subsurface seepage (including applied effluent) and drainage measures designed to protect the stability of the wall may '*short circuit*' LAA processes if constructed too close to the system itself.

Appendix R of AS/NZS1547 provides setback distance information for retaining walls and embankments, escarpments, and cuttings.

Note

The height, design and location of the wall will influence the level of engineering required and the requirement for approval from the local Council.

10.3.4 Vegetation

The selection of appropriate vegetation for the surface of the completed LAA is an important design consideration as not all vegetation is suited to all system types. While grass cover is suitable for most systems (and typically provides higher water and nutrient uptake in a residential setting), plants, shrubs, and trees are only suited to some designs. Large trees are not recommended as they can affect the performance from:

- Damage caused by root intrusion; and
- Reduced evapo-transpiration resulting from shading and maturation of the tree (dependent on species).

The following table provides a guide to the selection of vegetation for each EDS type.

Table 30 Vegetation Suitability

ED System	Suitable Vegetation
Surface and sub-surface Irrigation systems	Grass Gardens with plants and shrubs
Absorption trenches, beds, and ETA systems	Grass
Wisconsin Mounds	Grass
Vegetative systems	Species selection by supplier

10.3.4.1 Vegetation Removal

In some situations, vegetation removal may be necessary to enable construction of the LAA. This may not always be the case as some types and designs can be integrated with existing vegetation. As an example, sub-surface irrigation designs can be incorporated onto the surface of vegetated areas by pinning and overlaying with mulch however the species of vegetation must be considered.

In all situations vegetation removal should only be considered where necessary. When this is required consultation with Council is recommended prior to the works to determine local requirements.

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Appendix 1 Suitable Design Solutions Tables

Climate Zone (CZ)	LAA Type	Effluent Quality	Table
CZ1	Conventional Absorption Trench and ETA Beds	Primary	Table 35
	Conventional Absorption Trench and ETA Beds	Secondary	Table 36
	Surface and Shall Sub-surface Irrigation	Secondary	Table 37
CZ2	Conventional Absorption Trench and ETA Beds	Primary	Table 38
	Conventional Absorption Trench and ETA Beds	Secondary	Table 39
	Surface and Shall Sub-surface Irrigation	Secondary	Table 40

The following guidance should be considered for the Suitable Design Solutions outlined in the tables below.

Table 31 SDS Suitability Guidance[16]

LAA Type	Slope Suitability	Soil Depth Suitability	Soil Category Limitations	Notes
Conventional absorption trench	<15%	600mm depth of soil below the base of the trench to the determined limiting layer (e.g., hardpan, watertable or other limitation).	Category 1 and 2 soils may require effluent dosing by a pumped distribution design. Category 5 and 6 soils may result in larger LAA size.	Category 5 and 6 soils may require special design requirements, non-standard distribution techniques or soil modification (AS1547 Table L1, Note 2). LAA size calculation based on water balance (AS1547 Table L1, Note 3).
ETA bed	<10%	600mm depth of soil below the base of the bed to the determined limiting layer (e.g., hardpan, watertable or other limitation).	Suitable for category 4 – 6. Suitable for category 1 -3 subject to assessment of groundwater and distribution techniques.	Category 5 and 6 soils may require special design requirements, non-standard distribution techniques or soil modification (AS1547 Table L1, Note 2). LAA size calculation based on water balance (AS1547 Table L1, Note 3). Category 6 soils require secondary effluent quality (AS1547 Table L1, Note 5).
Surface irrigation	<10%	600mm depth of soil below the distribution lateral to the	Suitable for category 1 -2 subject to assessment of	No notes.

[16] Adapted from AS1547 (2012) Appendix K.

LAA Type	Slope Suitability	Soil Depth Suitability	Soil Category Limitations	Notes
		determined limiting layer (e.g., hardpan, watertable or other limitation).	groundwater. Category 4 – 6 may result in larger LAA size.	
Sub-surface irrigation	<30%	600mm depth of soil below the dripline to the determined limiting layer (e.g., hardpan, watertable or other limitation).	Suitable for category 1 -2 subject to assessment of groundwater. Category 4 – 6 may result in larger LAA size.	For Category 3, 4 and 5 soils the drip irrigation system needs to be installed in an adequate depth of topsoil (in the order of 150 – 250 mm of in situ or imported good quality topsoil). This is to slow the soakage and assist with nutrient reduction (AS1547 Table M1, Note 1). For Category 1 and 6 soils the drip irrigation system requires a depth of 100 – 150 mm of good quality topsoil (see AS1547 CM1 and M3.1) (AS1547 Table M1, Note 2).

Appendix 1.1 Guidance for Conventional Absorption Trenches and ETA Beds

As stated in Table L1 of AS1547 (2012), special design requirements, non-standard distribution techniques or soil modification may be required for weakly and moderately structured category 5 and category 6 soils of all structures. The following information should be used for guidance purposes only.

Appendix 1.1.1 Effluent Distribution Methods

The method of distribution selected to convey effluent from the treatment system to and within the LAA is an important design consideration to ensure satisfactory hydraulic performance, even distribution and long-term operation.

The effluent conveyance methods used commonly are gravity dosed, dose loaded (using a pump or siphon) and LPED systems. Gravity dosed and dose loaded systems can distribute effluent by either slotted distribution pipe or a self-supporting arch, while pressure dosed trenches are dosed with an LPED or perforated pipe design.

Designers and installers should consider the advantages and disadvantages of the available conveyance methods for the site and soil conditions to determine the most appropriate method. The distribution methods are discussed in Table 32.

Table 32 Effluent Conveyance and Distribution Methods

Technique	Advantages	Disadvantages	Suitability Considerations
Gravity	- Passive, no pump required. - Lower capital, operational and maintenance costs. - Simple and easy to construct.	- Requires adequate grade (slope) from the treatment tank to the LAA. - No control over timing of effluent dosing to the treatment tank and LAA. - Can result in surge/batch loading. - A maximum trench or bed length of 20m is recommended without special design (AS1547). - Lower effluent volumes within the distribution	- Suitable for relatively unconstrained sites where gravity fall is available from the treatment tank to the LAA. - Suitable for category 3 and 4 soils subject to evaluation of site constraints and project characteristics. - Less suitable for category 5 and 6 soils.

Technique	Advantages	Disadvantages	Suitability Considerations
		network can result in inefficient distribution and localised overloading of the infiltration surface. This can result in poorer treatment and progressive soil clogging. (Bouma, 1975; McGauhey & Winneburger, 1964; Robeck et al., 1964.	- Less suitable for category 1 and 2 soils where shallow groundwater may be a limitation.
Dose loaded (pump)	- Provides improved dosing control of infiltrative surface. - Provides periods of rest of the infiltrative surface which is beneficial for maintenance soil pores through aerobic breakdown. - Enables trenches and beds to be located higher than the treatment tank. - Enables alternate or sequenced LAA dosing which can manage constraints relating to low or high (pollution hazard) permeability soils.	- Less passive than gravity as it requires a pump. - Higher capital, operational and maintenance costs than gravity. - Dose loading doesn't ensure even distribution of effluent throughout the LAA. - Hydraulic engineering is generally required to determine the pump, mainline and sub-mains specifications.	- Suitable for sites where the location of the LAA is above the treatment tank. - Can be useful where the LAA design incorporates two or more trench/bed (subject to a suitably designed distribution box or alternate distribution method).
Pressure distribution (LPED)	- LPED enables the highest level of dosing control to the LAA. - Typically reduces the incidence of surge loadings. - Is generally the preferred approach for highly constrained sites with low hydraulic conductivity soils or highly permeable	- Less passive than gravity as it requires a pump. - Higher capital, operational and maintenance costs than gravity. - Hydraulic engineering is generally required to determine the pump, mainline and	- Suitable for sites where the location of the LAA is above the treatment tank. - Suitable for constrained sites with sensitive receiving environments. - Suitable for category 5 and 6 soils.

Technique	Advantages	Disadvantages	Suitability Considerations
	sites within sensitive receiving environments. - The length of trenches or beds can exceed 20m given hydraulic calculations show even distribution can be achieved.[17]	distribution manifold specifications.	

Appendix 1.1.2 Conventional Absorption Trench and Bed Design and Construction

Design assumptions for conventional trenches and beds can be adjusted to align with site and soil characteristics. Design assumptions include trench or bed length, width, depth of aggregate and spacing between adjacent trenches or beds. Table 33**Error! Reference source not found.** outlines situations when designers may want to change the design parameters. Appendix L of AS/NZS 1547:2012 should be referenced for specific conventional trench and bed design requirements.

Table 33 Design Considerations for Conventional Trenches and Beds

Design Consideration	Considerations for Maximising the Parameter	Considerations for Minimising the Parameter
Trench/Bed length	- Increasing the trench/bed length (where suitable) decreases the linear loading rate (LLR) thereby reducing the potential for downslope effluent breakout or sodden soils. - Should be considered for low permeability soils such as category 5 and 6. - Longer trench/bed lengths can increase the nutrient and pathogen attenuation rate as groundwater plumes travel downslope. This can	- Trench lengths longer than 20m for gravity dosed systems should be avoided. - It is acknowledged that shorter LAA lengths may be required to position the LAA in the optimal site location on the property.

[17] The length of the LPED line should be hydraulically designed to ensure adequate residual pressure can be achieved. Care should be taken when designing longer trenches due to the difficulty of maintaining a level base during construction. Bases that are no level in low permeability soils offset the benefit of installing pressure dosed systems.

Design Consideration	Considerations for Maximising the Parameter	Considerations for Minimising the Parameter
	result in reduced setback distances to sensitive receiving environments.	
Trench/Bed width	- Increasing the trench/bed width is not recommended as this can result in a shorter trench/bed length, resulting in a higher LLR. This is less of a concern for trenches compared with beds as the difference between minimum and maximum widths is typically small. - It is acknowledged that trench/bed widths may need to be maximised on sites with limited available land to enable optimal positioning of the LAA.	- Where possible, trench/bed widths should be minimised to reduce LLR and improve nutrient and pathogen attenuation capacity.
Depth of aggregate	- Maximising this parameter increases the effluent and water storage capacity of the trench or bed, which decreases the LAA size (applicable when water balance calculation is used as the sizing tool). - Increased depth of aggregate provides additional sites for aerobic and anaerobic bacteria to form biofilm facilitating nutrients and pathogens treatment. - Depth of aggregate can be increased where a greater depth to limiting layer is available.	- Depth of aggregate can be reduced on sites which are relatively unconstrained, where setback distances are achievable and the climate is suitable (i.e., evaporation exceeds rainfall most of the time).
Trench/bed spacings	- A distance between adjacent trenches/beds of greater than 1m can in some situations reduce the likelihood of poor hydraulic performance through proximal influence (i.e., the higher trench/bed hydraulically impacting the lower trench/bed). However, increasing the separation distance to greater than 2m is not required as it is unlikely to result in further improved hydraulic performance.	- A minimum spacing of 1m can be adopted on sites with limited area available for installation of LAA.

Design Consideration	Considerations for Maximising the Parameter	Considerations for Minimising the Parameter
Effluent quality	- The design loading rate (DLR) for secondary treated effluent is higher that primary effluent resulting in a smaller LAA footprint (Table L1 of AS/NZS 1547:2012). - Adopting a secondary effluent quality can reduce the required trench or bed size which may be beneficial on highly constrained or small sites. - Improved effluent quality may be necessary on category 5 and 6 soils and sites with sodic clay soils.	- Primary treated effluent requires a larger LAA size than secondary effluent due to the higher DLR values. - Primary systems are better suited to unconstrained sites and those not restricted by availability of suitable land, soil depth or soil category.

Table 34 Construction Guidance

Construction Element	Guidance Information
Distribution and splitter boxes	- Distribution boxes are small watertight vessels typically constructed of plastic though other materials may be suitable. They contain a single inlet point from the treatment tank and one or more outlet pipes. The number of outlets from the box is related to the number of trenches/beds and the number of hydraulic zones within each trench/bed. Outlet pipes are constructed at an identical height to facilitate even effluent distribution. Distribution boxes must be constructed on a level surface to effect correct operation. - Suitable on sites which have relatively minor slopes and no cross fall. - Mainly used for gravity dosed systems though can be used in dose loaded systems with careful design and installation. - Suitable for both primary and secondary effluent quality. - Passive approach with low operation and maintenance costs.
Sequencing (indexing) valves	- Sequencing valves (indexing valves) are installed within pumped systems to distribute wastewater to different hydraulic zones. They are activated when enough pressure is applied to open the outlet to the first hydraulic zone, which occurs when the pump turns on and discharges effluent. When the pump turns off the sequencing valve indexes (rotates) to the next outlet, distributing effluent to the next hydraulic zone. Sequencing valves index through all the hydraulic zones before reaching the start of the sequence again.

Construction Element	Guidance Information
	- Several sequencing valves can be installed to distribute effluent to multiple zones of larger complex LAA's. - Simple, reliable, and cost effective to construct and install for pumped systems. - Can be used for both primary and secondary treated effluent noting that the risk of blockage is increased when used for primary treated effluent.
Trench/bed base	- Construction of larger trench systems and those in category 5 and 6 soils requires that the base is level along the full length. Level bases can be obtained using careful excavation techniques and laser level devices. - Multiple trench systems associated with category 5 and 6 soils on sloping sites require that each individual trench is constructed along the ground contour. This may result in curved rather than linear trench shapes. - Civil and excavation work should not be performed during wet weather.
Sodic soils	- Sodic soils can cause severe surface crusting, low infiltration (reduced hydraulic conductivity) and very hard/dense subsoils. Sodic soils can strongly reduce the long-term effluent loading capacity of the soils (Hazelton & Murphey, 2016). - Consider adopting a lower DLR to increase the LAA footprint and reduce application rate per unit area. - Apply gypsum at a suggested rate of 1 kg/m^2 to the base of the trench or bed to help minimise dispersion. Close the trench/bed as soon as practicable to prevent exposure to rain.

Table 35 SDS - Primary Conventional Absorption Trenches/ETA Beds (Climate Zone 1)

No. Bedrooms	1		2		3		4		5	
Water Supply →	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank
Soil Class ↓	**Land Application Size (m²)**									
Sand (1)	20	20	30	30	40	30	50	40	60	50
Sandy Loam (2)	20	20	40	40	50	40	60	50	70	60
Loam (3)	30	30	60	50	80	60	90	80	110	90
Clay Loam (4)	50	40	100	80	130	100	150	120	180[18]	140
Light Clay (5)	60	50	120	100	150[18]	120	180[18]	150[18]	210[18]	170[18]
Med/Heavy Clay (6)	60	50	120	100	150[18]	120	180[18]	150[18]	210[18]	170[18]

[18] Refer to Appendix 1.1 for design and construction guidance.

Table 36 SDS - Secondary Conventional Absorption Trenches/ETA Beds (Climate Zone 1)

No. Bedrooms	1		2		3		4		5	
Water Supply →	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank
Soil Class ↓	**Land Application Size (m²)**									
Sand	10	10	20	10	20	20	20	20	30	20
Sandy Loam	10	10	20	20	30	20	30	30	40	30
Loam	10	10	20	20	30	20	30	30	40	30
Clay Loam	20	20	30	30	40	30	50	40	60	50
Light Clay	40	30	80	60	100	80	120	90	140	110
Med/Heavy Clay	60	50	120	100	150[18]	120	180[18]	150[18]	210[18]	170[18]

Table 37 SDS - Surface and Shallow Sub-surface Irrigation (Climate Zone 1)

No. Bedrooms	**1**		**2**		**3**		**4**		**5**	
Water Supply →	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank
Soil Class ↓	**Land Application Size (m²)**									
Sand	100	50	150	100	150	150	200	150	250	200
Sandy Loam	100	50	150	100	150	150	200	150	250	200
Loam	100	100	150	150	200	150	250	200	300	250
Clay Loam	100	100	200	150	250	200	300	250	300	250
Light Clay	100	100	200	200	250	200	300	250	350	300
Med/Heavy Clay	150	150	300	250	400	300	450	400	550	450

Table 38 SDS - Primary Conventional Absorption Trenches/ETA Beds (Climate Zone 2)

No. Bedrooms	1		2		3		4		5	
Water Supply →	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank
Soil Class ↓	**Land Application Size (m²)**									
Sand	20	20	40	30	40	40	50	40	60	50
Sandy Loam	30	20	50	40	60	50	70	50	80	60
Loam	40	30	70	60	80	70	100	80	120	90
Clay Loam	60	50	110	90	140	110	170[18]	140	200[18]	160[18]
Light Clay	70	60	140	110	170[18]	140	200[18]	160[18]	240[18]	190[18]
Med/Heavy Clay	70	60	140	110	170[18]	140	200[18]	160[18]	240[18]	190[18]

Table 39 SDS - Secondary Conventional Trenches/ETA Beds (Climate Zone 2)

No. Bedrooms	**1**		**2**		**3**		**4**		**5**	
Water Supply →	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank
Soil Class ↓	**Land Application Size (m²)**									
Sand	10	10	20	10	20	20	20	20	30	20
Sandy Loam	20	10	30	20	30	30	40	30	40	30
Loam	20	10	30	20	30	30	40	30	40	30
Clay Loam	20	20	40	30	40	40	50	40	60	50
Light Clay	40	40	80	70	100	80	120	100	140	120
Med/Heavy Clay	70	60	140	110	170[18]	140	200[18]	160[18]	240[18]	190[18]

Table 40 SDS - Surface and Shallow Sub-surface Irrigation (Climate Zone 2)

No. Bedrooms	1		2		3		4		5	
Water Supply →	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank	Reticulated	Tank
Soil Class ↓	**Land Application Size (m²)**									
Sand	100	100	150	150	200	150	200	200	250	200
Sandy Loam	100	100	150	150	200	150	200	200	250	200
Loam	100	100	200	150	250	200	300	250	300	250
Clay Loam	100	100	200	200	250	200	300	250	350	300
Light Clay	150	100	250	200	300	250	400	300	450	350
Med/Heavy Clay	200	200	400	350	300	400	600	500	700	600

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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.

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1 Introduction

Decentralised Water Australia (DWA) has developed an On-site Wastewater Management Plan (OWMP) for the Tamworth Regional Council (TRC) Local Government Area (LGA). Several towns and villages within the LGA are unsewered and rely on on-site wastewater management systems to treat wastewater. As such, preparation of an OWMP has been sought to provide all potential users with a simple system which identifies property limitations to on-site wastewater management using a constraint rating system. A framework has been developed to assist decision makers on the level of assessment required for land capability evaluations.

This project involved a broad scale land capability assessment of the Tamworth LGA to develop LGA specific guidance for safe, effective on-site wastewater management. This guidance is based on characteristics which influence a properties ability to adequately manage wastewater on-site including land capability, cumulative impacts (lot density) and lot size. This information was used to develop an LGA wide Land Capability Classification Map using a prescriptive and tested mapping methodology to provide constraint ratings for individual properties.

A Land Capability Constraint rating was assigned based on the level of risk to on-site wastewater management. Properties were identified as being Lower Constraint, Moderate Constraint and Higher Constraint. Using this constraint rating, an On-site Wastewater Management (OSM) Classification Map was developed to identify Section 68 documentation requirements for properties of two classifications:

- Level 1: Properties classified a lower or moderate constraint; and
- Level 2: Properties classified a higher constraint.

These classifications were used to streamline the approval process for on-site wastewater systems on lower to moderate constraint (Level 1) properties and provide application and assessment requirements for higher constraint (Level 2) properties. Both the Land Capability Classification Map and the OSM Classification Map are key outcomes and deliverables of this project.

1.1 Aims and Objectives

This On-site Sewage Management Technical Manual (the Technical Manual) has been prepared to:

- Provide a transparent technical rationale for the methodology used to develop the Land Capability Classification Map and the On-site Sewage Management Classification Map and calculate and determine the minimum allotment size; and
- Provide guidance on scientific and engineering assessment procedures which are required to meet the Assessment Criteria specified in the OWMP for Higher Constraint properties. This includes design procedures and reporting requirements for unsewered developments which have an increase in dwelling entitlements and non-domestic systems.

1.2 Use of the Technical Manual

This Technical Manual has been developed for wastewater or environmental consultants who are completing wastewater management investigations for the installation of individual on-site wastewater management systems and unsewered development applications which involve an increase in dwelling entitlements. Specifically, the Technical Manual can be used to:

- Confirm the basis and reasoning for a particular properties On-site Wastewater Management classification; and
- Confirm the basis for minimum allotment sizes / maximum allotment densities identified in the OWMP.

2 Technical Basis for the OWMP

The Technical Manual documents the technical basis that underpins the framework, assumptions and procedures presented in the OWMP. The key components which make up the Framework include the following:

- Assignment of an On-site Sewage Management Classification to unsewered lots in the LGA based on a range of bio-physical and built characteristics. The classifications provide a general guide to the potential for allotment land capability characteristics to impair the performance of on-site systems.
- Identification of sustainable minimum allotment size(s) that ensure sustainable, safe and efficient sewage management can take place for the life of a development.
- Determination of maximum sustainable on-site system densities for new unsewered developments to provide protection to human health and the environment. Maximum system densities are determined by undertaking a cumulative impact assessment.
- A set of Acceptable Solutions for on-site sewage management on allotments classified as Level 1 to allow Council to promptly approve systems/developments with confidence that they will deliver long-term sustainability.

3 On-site Sewage Management Mapping

3.1 Methodology Overview

3.1.1 Land Capability Classification Map

Geographical Information System (GIS) software and data was used to complete an LGA broadscale Land Capability Assessment and OWM Classification Maps for all unsewered lots. The land capability assessment methodology used to develop the maps aligns with the site and soil assessment procedures specified in the *Environmental and Health Protection Guidelines* (DLG, 1998) and AS*NZS1547:2012.* The classification map incorporates all key built and natural features into the constraint classification methodology where suitable and sufficiently robust datasets are available.

Calculation of the land capability classification involved a comprehensive analysis of land capability characteristics which can influence the sustainability of on-site wastewater systems. Land capability parameters were assessed and assigned a characteristic classification based on the likelihood of increased risk of on-site wastewater management system failure, enhance pollutant export and increased design, installation or operation complexity. Land capability classification represents a relatively simple risk assessment of the likelihood and consequence associated with a land capability characteristic.

Example

Sites with slopes less than 10% typically do not restrict options for the design, construction, and operation of on-site systems and as a result a low classification is assigned.

Sites with slopes greater than 15% can reduce servicing options for sustainable on-site sewage management and as such a high classification is applied.

The method for assessing and calculating the land capability classification was undertaken in two stages. Stage One calculated a Base Land Capability Classification which represents the constraints to design, construction, and operation of an effluent land application area (i.e., characteristics that influence the relative risk of failure). This class was based on the slope, soil, and climate characteristics of each allotment. The Stage Two classification adjusted the Base Land Capability Classification by incorporating the proximity and sensitivity of nearby receiving environments (i.e., the likely consequence of any failure) and any red flags to on-site wastewater containment. Receiving environments include watercourses, waterbodies, riparian zones, and groundwater bores. Red flags include significant land capability or receiving environment constraints and smaller lots where land availability and the ability to achieve guideline setbacks can be challenging. A schematic showing how the Land Capability Classifications are derived in presented in Figure 1.

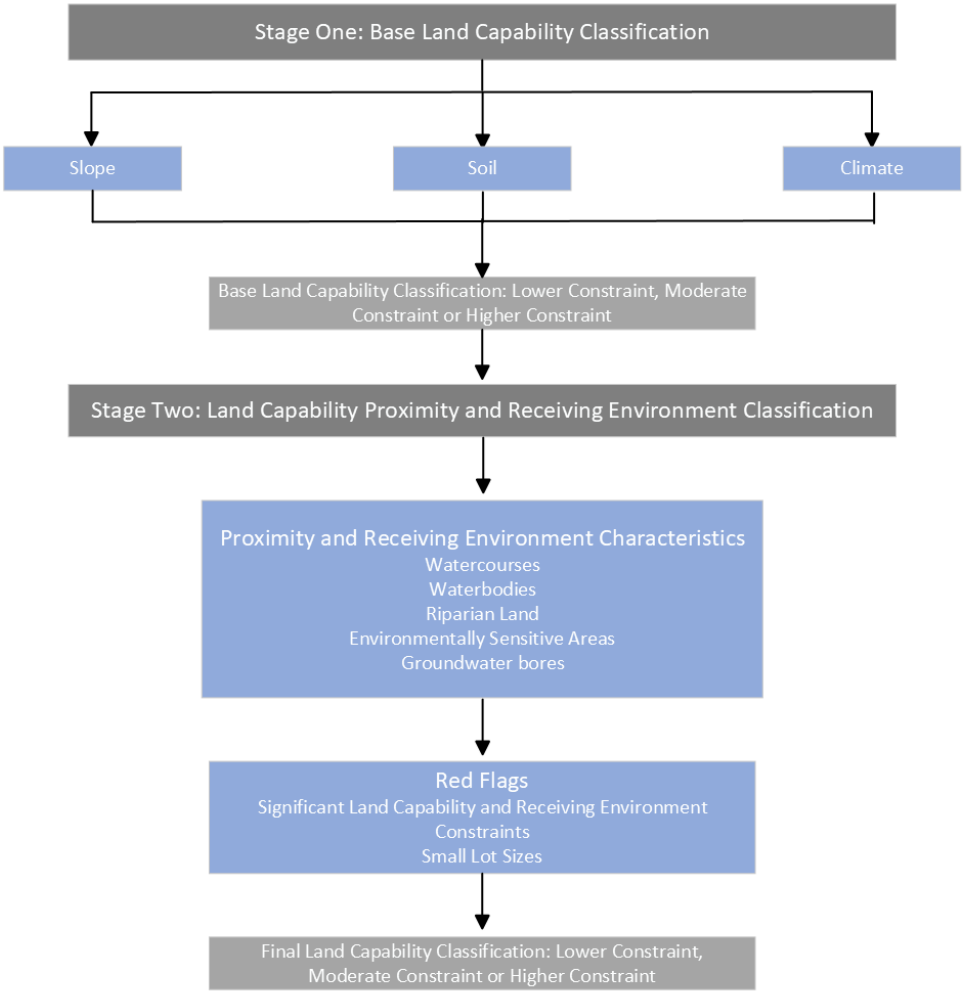

Figure 1 Land Capability Classification

3.1.2 On-site Wastewater Management Classification Map

Following determination of the Land Capability Classification, each property was also assigned an On-site Wastewater Management (OWM) Classification.

During the land capability classification process, a large proportion of properties across the LGA were identified as a Moderate Constraint (~47% of classified properties). This was due to the significant number of environmental receptors present across the LGA such as watercourses, waterbodies (including dams) and groundwater bores. A review of classified properties identified that whilst most Moderate Constraint properties did have receiving environments either within the property or encroaching the property boundary (buffer), these properties also had sufficient land available to meet setbacks to receiving environments and ancillary development. As such, it was determined that the same level of site and soil assessment for both Lower and Moderate Constraint properties could be performed with the same procedure and proforma (i.e., Level 1 Classification). Where requirements or targets are unable to be achieved, the applicant will be required to undertake a site and soil assessment like properties assigned a Level 2 OWM Classification.

Figure 2 provides a schematic of the OWM Classification Framework.

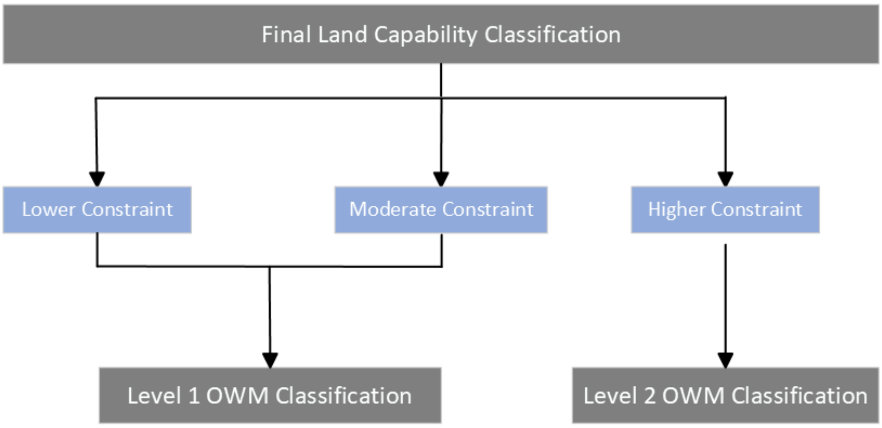

Figure 2 On-site Wastewater Management Classification Framework

3.2 Review of Available Data and Information

Data were sourced from both Tamworth Regional Council and the NSW Government online data portal for undertaking the onsite hazard mapping for the Tamworth LGA. These data are summarised in Table 1.

Table 1 Summary of Available Data and Information Sources

Data	Description	Source
Topographic / Elevation Data	A Digital Elevation Model was utilised with a grid size of 25m and was used to create a slope grid.	Tamworth Regional Council
Ortho-photography	Google Satellite imagery was used in the absence of LGA wide ortho-photography layers.	Google Maps
Soil type (landscape) data	The Australian Soil Classification was predominately used due to its wide coverage across the LGA. Where applicable, the Tamworth Soil Landscapes map was used to inform soil hazard classes.	Sharing and Enabling Environmental Data (SEED) Portal (NSW Government) Soil Landscapes of Tamworth 1:100,000 Sheet (NSW Department of Land and Water Conservation, Sydney)
Watercourses (All)	LGA wide watercourse (hydroline) layer	Spatial Information Exchange (SIX) Maps 'Clip & Ship' (NSW Government)
Hydroareas (waterbodies)	LGA wide hydroareas layer	Spatial Information Exchange (SIX) Maps 'Clip & Ship' (NSW Government)
Groundwater bores	Groundwater bore locations and available data (potable / non-potable)	Bureau of Meteorology (BoM) Australian Groundwater Explorer online mapping (http://www.bom.gov.au/water/groundwater/explorer/map.shtml)
Planning Overlay	LGA wide land zoning in accordance with the TRC LEP. This information was used to spatially identify environmental conservation, reserve, and management areas.	Tamworth Regional Council
Property boundaries	LGA wide cadastral boundaries.	Tamworth Regional Council and Spatial Information Exchange (SIX) Maps 'Clip & Ship' (NSW Government).

3.3 Stage 1 - Base Land Capability Classification

Stage one of the process utilised three spatial data layers:

- Soil Classification: this information was derived from existing soil landscape mapping and associated soil characteristics. The logic for assignment of soil classification is documented in Section 3.3.1 and Appendix 1.
- Climate Classification: climate information was derived from the soil parameters and monthly rainfall data. The logic for assignment of climate classification is documented in Section 3.3.3; and
- Slope Classification: Slope was derived from the Digital Elevation Model. Areas where slopes are <10% were assigned a low classification, 10 - 15% as a medium classification, 15 - 30% as a high classification and >30% as a very high classification. This is described further in Section 3.3.2.

These three layers were combined to assign a Base Land Capability Classification using the matrix presented in Table 2.

Note

When reviewing this table, it should be noted that the Tamworth LGA has two climate zones (considered low and medium risk) due to the relatively low rainfall and high evapo-transpiration.

The low to moderate climate classifications reduce the Land Capability Classification of a large portion of the LGA which is representative of a reduced risk of on-site wastewater treatment system failure due to predominately favourable climatic conditions.

Table 2 Base Land Capability Classification Assessment Matrix

				Slope			
				Low (<15%)	**Medium (10-15%)**	**High (15-30%)**	**Very High (>30%)**
Soil	**Low**	**Climate**	Low	Low	Low	Medium	High
			Medium	Low	Low	Medium	High
			High	Low	Low	Medium	High
	Medium		Low	Low	Low	Medium	High
			Medium	Low	Low	Medium	High
			High	Low	Medium	High	High
	High		Low	Low	Medium	High	High
			Medium	Low	Medium	High	High
			High	Medium	Medium	High	High

The Base Land Capability Classification from the Assessment Matrix were then adjusted for allotments located within a specified proximity (or buffer) to sensitive receptors in Stage Two.

How the soil, slope and climate classifications have been derived is outlined in Sections 3.3.1, 3.3.2 and 3.3.3.

3.3.1 Soil Classification

Soil characteristics relevant to on-site wastewater management have been evaluated using the parameters / system documented in Table 3 and Table 4.

The broad-scale 1:250,000 Australian Soil Classification (ASC) spatial dataset (Department of Planning, Industry and Environment, 2021) was used to identify soil facets across the entire LGA. This was the most thorough and only LGA wide soil landscape information available. Typical characteristics of ASC soils were used to approximate depth, hydraulic and potential attenuation characteristics of the soil. These soil characteristics were then input into the equation outlined in Table 4 to determine the overall soil classification of each soil facet. Where ASC soil facets overlayed Soil Landscapes of Tamworth 1:100,000 Sheet (Banks, 2001), this higher resolution information was used to inform the classification of the ASC soil facet.

Table 3 Soil Classification Characteristics

Characteristic	Parameter	Classification	Description	
Depth	Profile Depth	Low	Greater than 1.5 metres profile depth	Greater depths of unsaturated soil provide increased treatment of effluent and reduced potential for lateral water movement.
		Medium	0.8 – 1.5 metres profile depth	
		High	Less than 0.8 metre profile depth	
Hydraulic	Texture	Low	Pedal loam to clay loam soils with mid-range permeability and moderate to free drainage.	
	Structure	Medium	Generally, imperfectly drained, weakly structured clay loams and light clays or deep, rapidly drained sands (e.g., sand hills).	
	Indicative Permeability	High	Generally, shallow, structureless clays and sands in either very rapidly or very poorly drained landscapes.	
	Drainage			
Pollution Attenuation Potential	Nutrient Retention	Low	Generally, soils with high cation exchange (CEC) and / or phosphorus sorption capacity, no sodicity potential and good organic content in topsoil.	

Characteristic	Parameter	Classification	Description
	Sodicity	Medium	Generally, soils with moderate CEC, phosphorus sorption capacity, minor sodicity potential and moderate organic content in topsoil.
	Organic Content	High	Generally, soils with low CEC, phosphorus sorption capacity, sodicity potential and/or limited organic content.

Table 4 Weighted Soil Characteristics and Soil Classification Calculation

Soil Characteristic	Weighting	Final Soil Classification Calculation
Depth	1.5	**Final Soil Classification** = [(Depth HS x w) + (Hydraulic HS x w) + (Pollution HS x w)] / 3 **Weighted Average Hazard Class** 1 – 1.5 = Low Soil Hazard 1.5 – 2.5 = Medium Soil Hazard 2.5 – 3 = High Soil Hazard
Hydraulic	1	
Pollution	0.5	

3.3.2 Slope Classification

A Digital Elevation Model (DEM) with 25m grid size was available for the entire LGA and a slope grid was created within QGIS based on this information. The slope grid created from the DEM provided a broad desktop assessment of slope variability, from which assumptions were evaluated and verified during ground truthing. Slope was not found to be a major land capability constraint as a large proportion of the Shire is relatively uniform in slope and developed areas are predominately flat with a low slope classification.

3.3.3 Climate Classification

A general climate analysis was undertaken across the LGA to provide an assessment of the degree to which climate limits or enhances opportunities for the land application of effluent. The climate classification is based on the number of average climate months where rainfall exceeds potential evapo-transpiration (PET) over a 40m (1,600m^2) grid size. This provides a general representation of:

- Areas with large portions of the year where rainfall exceeds PET and there is increased deep drainage and/or surface surcharge of effluent leaking land application areas; or

- Areas where there are limited or no months where PET is greater than rainfall which indicates a reduced risk of Land Application Area hydraulic failure and increased attenuation ability.

The baseline data layers used included:

- ~1 km^2 grid of mean monthly rainfall (Bureau of Meteorology Climate Atlas) http://www.bom.gov.au/climate/averages/climatology/average-rainfall-metadata.shtml
- 10 km^2 grid of mean monthly areal Potential Evapo-transpiration grid (BoM Climate Atlas)

  http://www.bom.gov.au/climate/averages/climatology/gridded-data-info/metadata/md_ave_et_1961-90.shtml

The rainfall and evapotranspiration data for each month were converted from latitude/long co-ordinates to an MGA projection and then converted to a 40m grid cell size for consistency.

The final output of the RF minus PET monthly grid analysis approximated from the excess rainfall for each month of an average statistical year. The results of this were used to determine an appropriate spatial climate hazard level across the LGA.

The climate hazard layer was created through classification of grid cells in accordance with the following conditions:

- Low classification: ≤3 months where RF > PET
- Medium classification: 4 to 5 months where RF > PET
- High classification: ≥6 months where RF > PET

The majority of the TRC LGA was classified as low except for some areas in the southeast corner of the LGA. There were no areas with a high classification within the LGA.

3.4 Stage 2 - Proximity and Receiving Environment Characteristics

Proximity and receiving environment characteristics were assigned the relevant sensitivity classification and applied to each of the unsewered properties within the LGA where there is potential for impact from on-site wastewater treatment systems. A receiving environment proximity classification of 3 (high) was applied to each property in which the relevant hazard polygon or line intersected the property boundary. If the receiving environment (RE) buffer (setback) area intersected the property boundary, a RE proximity classification of 2 (medium) was assigned. The Riparian Corridors and Environmental Conservation, Reserve and Management Areas were not buffered and therefore were assigned a uniform RE proximity classification of 2 (medium). For large lots >10ha, the maximum RE proximity and sensitivity classification for any watercourses, waterbodies, groundwater bores and riparian corridors within these lots was reduced to medium. This decision was based on the very high likelihood that a land application area could be installed with sufficient setback to reduce the risk of impact from on-site wastewater management systems. Details of each of the specific RE constraints which were considered are discussed below.

A proximity and sensitivity classification were derived for the hazards identified in Table 5. In addition to the land capability proximity and receiving environment characteristics, consideration was also given to the inclusion of flood prone areas as an additional proximity and receiving environment characteristic to account for the potential increased risk of off-site impacts by the inundation of Land Application Areas. However, the available information is not available for the entire LGA and is inconsistent in its form.

Note

Flood extent was provided for some areas and 1% and 5% flood areas were provided for key towns, some of which are sewered. Given that insufficient data was available to consistently apply a proximity and receiving environment classification across the entire LGA, flood prone land has not been included in the land capability classification.

Table 5 Land Capability Proximity and Receiving Environment Classification

Characteristic	Buffer Distance	Proximity Classification	Sensitivity Classification	Comment
Watercourses[1]	Permanent: 100m	Within Property: High	High	For properties ≥10ha, a maximum RE Proximity and Sensitivity hazard of medium was assigned to capture the increased ability for a land application area to be located on larger lots with sufficient setback to this constraint. The standard High RE Proximity and Sensitivity hazards was assigned if the property was <10ha where these sensitive receiving environments are present.
	Intermittent: 40m	Buffer Intersects Property: Medium	Medium	
Waterbodies[1]	Small Waterbody (e.g., Farm Dam): 100m	Within Property: High	High	Due to the generally flat nature of the area, many drainage depressions and low-lying areas were also mapped within the waterbodies. As these low-lying areas would periodically be flooded and filled with water, they were included within the hazard mapping to accommodate flooded areas (available flood layers were inconsistent and have not been utilised).
	Large Waterbody (e.g., Large Lake): 40m	Buffer Intersects Property: Medium	Medium	
Groundwater Bores[1]	Potable: 100m	Within Property: High	High	There is some uncertainty around currency, accurateness and completeness of groundwater bore data and therefore bores assigned as non-potable were only classified if they are located within the property (i.e., no buffer distance has been incorporated).
	Non-potable: Within	Buffer Intersects Property: Medium	Medium	

[1] For properties ≥10ha, a maximum RE Proximity and Sensitivity hazard of medium was assigned to capture the increased ability for a land application area to be located on larger lots with sufficient setback to this constraint. The standard High RE Proximity and Sensitivity hazards was assigned if the property was <10ha where these sensitive receiving environments are present.

Characteristic	Buffer Distance	Proximity Classification	Sensitivity Classification	Comment
Riparian Corridors[1]	Within	Medium	Intermittent WC / Riparian Corridor: Medium Permanent WC / Riparian Corridor: High	Watercourse layers were buffered to enable the Land Capability Classification to represent riparian corridors as a sensitive receiving environment. Riparian zones were classified as being 40m either side of permanent watercourses and 20m either side of intermittent watercourses. These setback adoptions broadly represent the *Guidelines for Riparian Corridors on Waterfront Land* (NSW Office of Water, 2012) for 2nd order (intermittent) and 4th order (permanent) watercourses.
Environmental Conservation, Reserve and Management Areas	Within	Medium	High Value Environmental Conservation and Reserve Areas: High Low Value Environmental Management Zones: Medium	High and low value environmental areas were assigned based on the LGA wide land zoning layer provided by TRC and were assigned based on the Local Environmental Plan 2010 (LEP). Areas zoned as Environmental Conservation Zone (C2) and National Parks and Nature Reserves (C1) were classified as a high value environmental conservation and reserve area. Areas zoned as Environmental Management Zone (E3) were classified as low value environmental management zones.

3.5 Primary Land Capability Classification Framework

The base land capability classification and proximity and receiving environment classifications were weighted and summed to determine the Final Land Capability Classification. The land capability classification was calculated based on Equation 1.

(1) Final Land Capability Classification = (Base Land Capability Hazard x 0.5) + (Proximity Classification x 0.25) + (Receiving Environment Classification x 0.25)

The primary land capability classification framework is presented in Table 6.

Table 6 Land Capability Classification Framework

Head Criteria	Description	Classification	Score	Weight	Description
Land capability hazard	Hazard score <0.95 in Land Capability hazard score	Low	0	50%	Few / minor land capability constraints to on-site wastewater management.
	Hazard score >=0.95 and <2 in Land Capability hazard	Medium	1		Some moderate land capability constraints to on-site sewage with potential to increase failure rates
	Hazard score >=2 in Land Capability hazard score	High	2		Significant land capability constraints which have a high potential to increase failure rates
Receiving Environment Proximity	Property outside of setback area	Low	0	25%	Limited to no proximity risk
	Receiving environment setback intersects boundary	Medium	2		Risk may be elevated, particularly where other constraints exist
	Receiving environment itself intersects boundary	High	3		High risk - careful design and oversight required as likelihood of impact high in failure event
Receiving Environment Sensitivity	None present / >setback distance	Low	0	25%	Self-explanatory – acceptable risk
	Stormwater drain				Typical swale drains on street or piped system
	Degraded or cleared intermittent drainage line.				Gully lines with predominantly grass cover and some scattered trees and shrubs.
	Dam / small waterbody	Medium	2		Farm dams possibly used for irrigation of edible crops or watering livestock
	Intermittent WC / Riparian Corridor				2nd order riparian corridors

Head Criteria	Description	Classification	Score	Weight	Description
	Low Value Environmental Management Zones				Environmental Management Zone (E3)
	Non-potable groundwater bore				Domestic stock and irrigation bores from available data
	Potable groundwater bore	High	3		Protection of human health (priority)
	Permanent watercourse / waterbody				Perennial or near perennial streams and rivers, or large lakes and reservoirs.
	Permanent WC / Riparian Corridor				4th order riparian corridors
	High Value Environmental Conservation and Reserve Areas				Environmental Conservation Zone (C2) and National Parks and Nature Reserves Zone (C1).

3.6 Red Flags

Red Flags have been included in the Land Capability Classification Framework to identify and represent areas with significant or extreme land capability conditions which are likely to increase risk of failure of on-site wastewater systems or off-site impact to receiving environments. Red Flags automatically classify the allotment with the red flag as a Level 3 classification to increase the level of design and assessment required by Environmental and Wastewater Consultants, reducing the risk of failure and off-site impacts. The Red Flags adopted in the Land Capability Classification Framework are outlined in Table 7.

Table 7 Red Flags

Red Flag	Outcome	Purpose
Allotment size is <2500m^2	Final Land Capability Classification is automatically assigned as High	The ability of small lots to manage wastewater on-site will be highly dependent on-site specific land capability constraints and proximity to sensitive receiving environments. A more detailed LCA and design process is likely to be required to ensure wastewater can sustainably be managed on-site. A higher level of treatment and greater construction and operational oversight is typically required.
Base Land Capability Classification is High		Prevent significant and extreme (e.g., steep slopes and shallow soils) constraints on large lots from being underestimated. This is particularly the case for large lots which do not have proximity or sensitivity constraints.
Proximity Classification is High		Captures otherwise unconstrained lots that either contain or are immediately adjacent to sensitive receiving environments (i.e., if failure occurred there is limited assimilative capacity).
Receiving Environment Classification is High		Like a high proximity classification however captures the need for greater vigilance where an on-site system is close to a high value or highly sensitive receiving environment (e.g., permanent watercourse).

3.7 Land Capability and OWM Classification Maps

The Base Land Capability Classification Map, Final Land Capability Classification Map and OWM Classification Map for the whole of Tamworth are presented in Figure 3, Figure 4 and Figure 5 respectively. The Base Land Capability Classification Map is predominately classified as Lower Constraint due to the relatively low risk associated with base land capability constraints of slope, soil and climate. The Final Land Capability Classification map presents the Constraint Classification whereby 10% of properties are classified as Lower Constraint, 57% of properties are Moderate Constraint and 43% are Higher Constraint. This increase in classification between the two maps is driven by the significant number of sensitive receiving environments within the LGA, including watercourses, waterbodies (e.g., dams), groundwater bores and riparian zones which impact a large proportion of properties, especially those with lot area greater than ~2ha. The presence of these receiving environments on a significant portion of the properties has caused an increase in classification to Moderate Constraint or Higher Constraint. After a review of the classification mapping, it was determined that these constraint classifications are justified based on the significant constraints to on-site wastewater management due to sensitive receiving environments.

A large portion of the Higher Constraint properties are located on steep terrain or are very small lots (<2,500m^2). As such, these properties are highly constrained with respect to on-site wastewater management and should require a higher level of assessment for Section 68 Application.

The OWM Classification Map shows that most larger properties with relatively low base land capability constraints are classified as Level 1. Properties classified as Level 2 are generally located in areas of higher base land capability constraint or are smaller lots with generally limited area available for on-site wastewater management. This can be identified by comparing the areas of Higher Constraint in Figure 3 and Level 2 Classification on Figure 5. Of all classified properties, 57% are classified as Level 1 and 43% are classified as Level 2.

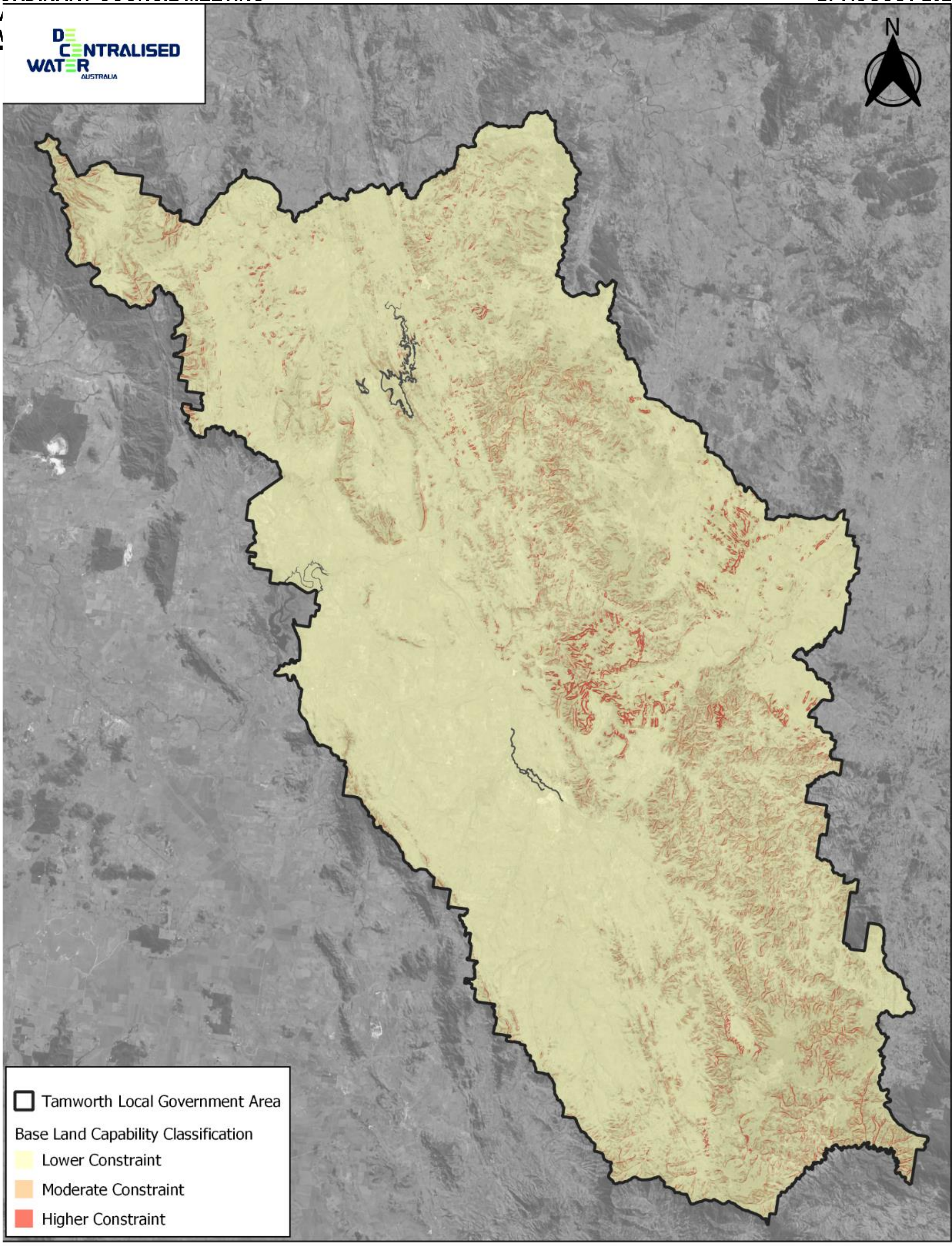

Figure 3 Base Land Capability Classification Map

0 10 20 30 km

Project: 0544
Drawn: 05/04/2023
Revision: 00

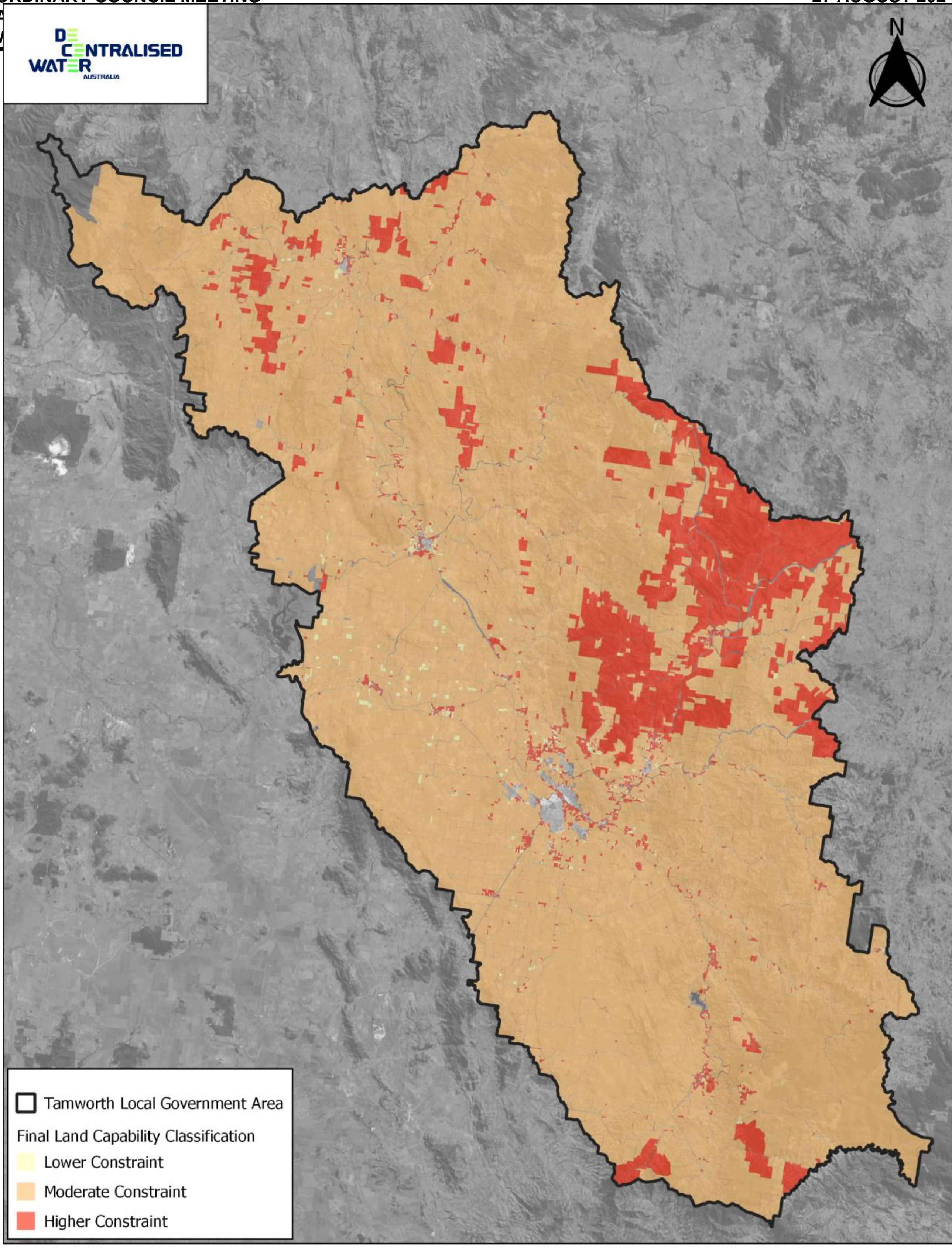

Figure 4 Final Land Capability Classification Map

0 10 20 30 km

Project: 0544
Drawn: 05/04/2023
Revision: 00

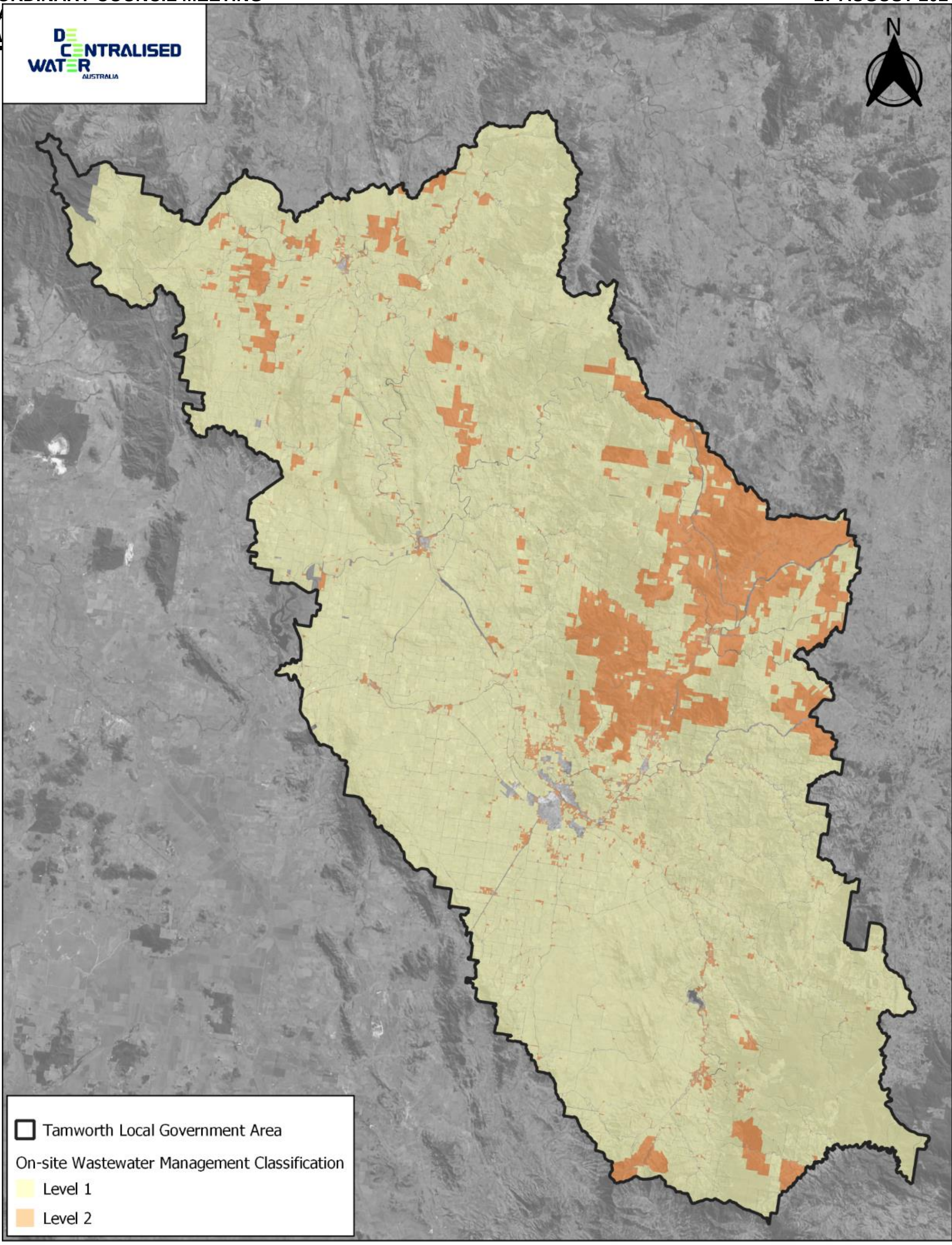

Figure 5 On-site Wastewater Management Classification Map

Project: 0544
Drawn: 05/04/2023
Revision: 00

3.8 Map Verification

A desktop verification process to '*ground truth*' the land capability and on-site sewage management classification maps was performed with the objective of establishing the accuracy of the assumptions and outcomes. Twenty (20) sites were assessed based on the Land Capability Classification Framework detailed in Section 5. Sites were selected to maximise benefits of field evaluation by:

- Assessing locations and characteristics where land capability inputs were likely to influence the final Land Capability Classification,
- Examining areas where there was observed uncertainty in the individual parameters used to assign a hazard class such as areas near a soil landscape boundary or areas of high slope variability; and
- Assessing areas with higher densities of on-site systems or known performance issues (as identified by TRC).

Ground truthing involved visual checking of each site against the matrix in Table 5 and Table 6 using GIS interrogation and Google Street View™. Checking soil facet classifications against key criteria set out in Section 3.3 was also undertaken. The location of the selected sites and results are presented in Appendix 1.

Overall, the results of the ground truthing were favourable, finding no significant discrepancies in the On-site Sewage Management Hazard Class and observed data. The ground truthing process established accuracy of the maps and data sets. On all sites assessed, almost all the constraints identified upon inspection were appropriately accounted for in the OSWM mapping process. A few unmarked water bodies were identified that were not shown in the hydoarea GIS layer however this is not unexpected on rural properties. As with all limitations, it is still necessary for a site-based assessments to occur as part of the on-site wastewater system approval process.

The results found the Final Land Capability Classification Map represented the actual situation appropriately which is consistent with similar projects involving ground truthing (i.e., Greater Taree and Great Lakes hazard mapping).

3.9 Limitations of the Land Capability Classification Mapping

The final Land Capability Classification and OSM Classification Maps assign a classification to individual unsewered allotments in the TRC LGA. It is important to recognise that this site-specific classification was derived using a range of data collected at a range of scales. DEM data sourced for creation of slope grids provides a relatively high level of detail when compared to the Australian Soil Classification facets which are mapped at a 1:250,000 scale and digitised. Essentially, the classification assigned to each allotment should be considered a broad scale on-site sewage management classification. However, this does not preclude the Classification Maps from being used at the individual lot scale if the limitations and uncertainty associated with scale and data source is recognised.

A limitation of the mapping process was the inability to include flood prone land as a constraint characteristic. This was primarily due to the limited availability of LGA wide data. While inclusion of this data into the Land Capability Classification mapping would have been preferred, this hazard is picked up to some extent by the '*waterbodies*' layer which includes some low-lying areas. It is also recognised that assessment of the flood prone nature of the lot under assessment remains a key feature addressed during the site and soil assessment and application process.

The OWMP uses the Classification maps to guide the level of detail required in supporting information for applications to install on-site systems or unsewered development. They have not been used to prescribe site specific conditions of approval relating to system selection, design, and construction. They simply establish a Minimum Standard of supporting information that assist in establishing a level of certainty that a proposed unsewered development is sustainable. In fact, where broad scale hazard mapping has identified a higher classification, Council may require a higher level of assessment to be undertaken as part of the On-site Wastewater Management application process. There will be a minority of occasions where these field investigations will identify lots where data scale and accuracy may have resulted in an inaccurate hazard classification.

Several activities were undertaken to minimise the potential for data scale errors and inaccuracy associated with the maps. These include the following:

- Extensive desktop ground truthing of the Land Capability Classification maps throughout the LGA to confirm that land and allotments have been appropriately classified.
- Iterative testing and refinement of the Land Capability Classification map methodology based on the outcomes of ground truthing.

As a result of this study, all known unsewered lots in the Tamworth LGA have been assigned an On-site Sewage Management Classification. This Classification is based on 2 levels which provides a technically justifiable basis for setting requirements for supporting information to be submitted with applications for on-site systems and unsewered development.

4 Minimum Allotment Size

A review was undertaken of sustainable minimum allotment sizes for on-site sewage management within the TRC LGA. This was based on collation and review of previous data obtained from historical projects involving several unsewered regions across New South Wales and Victoria. Sustainable minimum lot size was considered to allow for typical levels of site development in addition to a conservatively sized land application system and provision of adequate separation distances from sensitive receptors.

This assessment included consideration of existing allotments and potential future rezoning and subdivision. The intention of this assessment was to establish a conservative lot size that is considered adequate to provide TRC with a high degree of confidence that an effective, safe, and sustainable on-site sewage management service can be accommodated.

4.1 Methodology

Based on previous studies and experience, a conservative land area requirement for sustainable on-site sewage management has been calculated through application of the following methodology. The methodology was applied using rainfall from local stations and gridded potential evapo-transpiration data from Bureau of Meteorology (BoM) within each LGA previously assessed.

- A design occupancy of 6 persons for a 4-bedroom house (using reticulated water) was adopted to represent a typical residential development scenario.
- A typical system configuration of secondary treatment and surface/subsurface irrigation was assumed. This permitted a conservative approach due to an increased land area requirement compared to primary dosed trenches and beds. As such, this scenario also allowed for primary dosed trenches and beds (discussed further below).
- Hydraulic and annual nutrient balance was undertaken based on the above occupancy assuming a Design Loading Rate (DLR) of 3 mm/day (Category 5 – light clays). This DLR was selected on the basis that it strikes an appropriate balance between typical limiting soil types.

The outcomes of these water and nutrient balance calculations were then used to examine minimum Land Application Area sizes required for most sites and dwellings likely to be encountered.

An assessment was then undertaken of a sample of allotments within unsewered zones of the LGA's. These allotments were assessed to determine the capacity to provide available area for sewage management while making allowance for development and separation distances from features such as:

- Built features including driveways and paths,
- Swimming pools and recreational areas (e.g., tennis courts),
- Activities involving livestock,
- Property boundaries,
- Dams, intermittent and permanent watercourses; and
- Groundwater bores.

The assessment was undertaken through orthophoto investigations and GIS creation of buffers around the abovementioned objects. Statistics on the area of land and proportion of total lot area occupied by each component (inclusive of buffers) were recorded for analysis. The lots assessed were selected to provide a representative sample of typical development across a variety of unsewered areas. The data also consists of ~800 lots in Monbulk (Victoria) where site-specific available area for effluent management was measured on-properties, providing a high level of data accuracy and resolution.

Statistics obtained from these assessments were analysed to identify any patterns or relationships between lot size, land use zones and area available for effluent Land Application Areas. Multiple scatter plots of lot size and the average area available for effluent management were created. This was completed for several allotment size ranges to determine relationships for these allotment ranges that could be applied LGA wide. Data was also utilised from previous assessments in Dungog Shire, Greater Taree, Great Lakes, and Monbulk (Victoria) to compare the corresponding relationship developed for the Tamworth LGA.

4.2 Results

Based on the outcomes of water and nutrient (annual) balance assessments, a Land Application Area of 650 – 850 m^2 was determined. To ensure sufficient area is available to allow for installation of treatment tanks, supply mains and other on-site wastewater management infrastructure required, a total Effluent Management Area (EMA) of approx. 1,000 m^2 was considered appropriate.

Primary dosed trenches and beds typically occupy approximately half the land area of a secondary dosed irrigation system. However, allowance for a reserve area must be made for primary dosed subsurface systems which results in a comparable land area requirement to that of a secondary dosed irrigation system (AS1547, 2012).

This typical on-site wastewater management footprint is considered appropriate for planning purposes and makes allowance for uncommon situations (e.g., irregular shaped areas, slope etc). It is important to note that the outcomes of this minimum allotment size assessment should not be used in a prescriptive or deterministic manner. Individual applicants should be able to undertake additional site-specific investigations to confirm the appropriateness of Council's general minimum lot size for their site. Additionally, this approach does not replace or influence land zoning requirements under Councils Local Environmental Plan and legislation.

A low to moderate relationship between lot size and land area available for effluent management was previously observed in the total sample data. The less-than-optimal correlation can largely be attributed to the reasonable number of lots (regardless of lot size) observed to be severely constricted by the presence of one or more watercourses, waterbodies, or groundwater bores.

The relationship was then compared to adoption of an average available area approach which was found to be more applicable and more practical to the broader study area. This involved determining the relationship between average available area and allotment size for a range of allotment sizes. Figure 6 contains the results of this analysis.

Tamworth presents a good exponential correlation between allotment size and average potential effluent management areas with a correlation (R^2) of 0.89. Tamworth showed a similar relationship to Monbulk and Kempsey, which had correlation values of ~0.87 and 0.84 respectively. Considering Monbulk provided a very high level of field gathered data, the relationship equations developed are deemed representative given the data set analysed (~800). The exponential relationship equations shown in Figure 6 were used to calculate available area estimation curves for a range of lot sizes as shown in Figure 7.

The relationship curves shown in Figure 7 were used to determine the typical lot size related to an EMA of 1,000m^2. As shown on Figure 7, the minimum lot size to enable this sized EMA across the four LGA's tested ranged from ~3,500m^2 to 4,400m^2. This range is consistent with previous minimum lot size analyses competed as part of similar investigations that are considered representative of properties within the Tamworth LGA. It should be highlighted however that land available and suitable as an EMA can be influenced by receiving environments which may be located within or adjacent to the property.

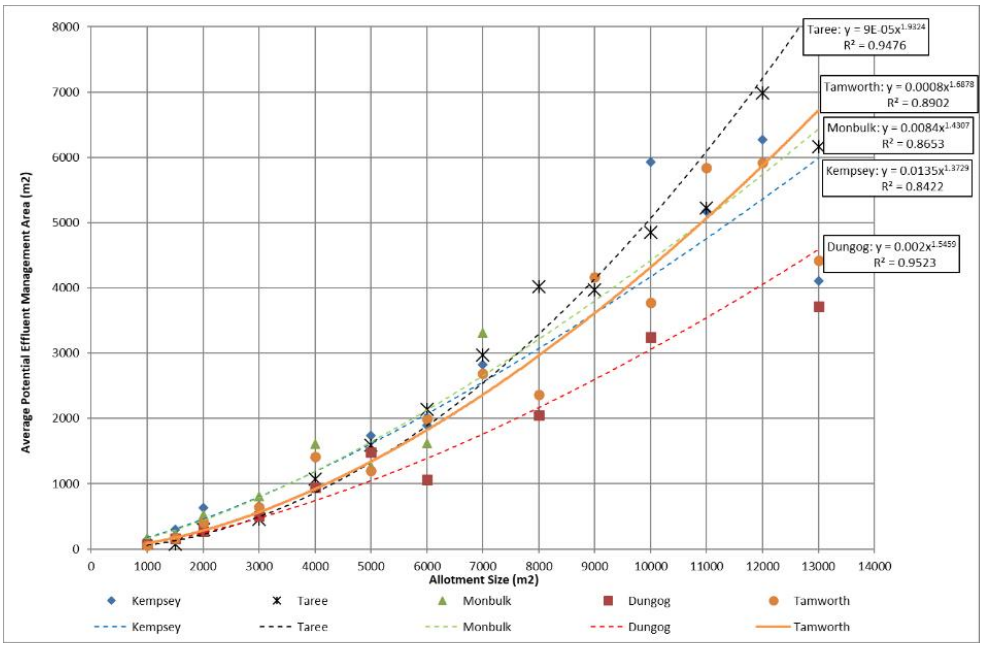

Figure 6 Average Available Area and Allotment Size Evaluation

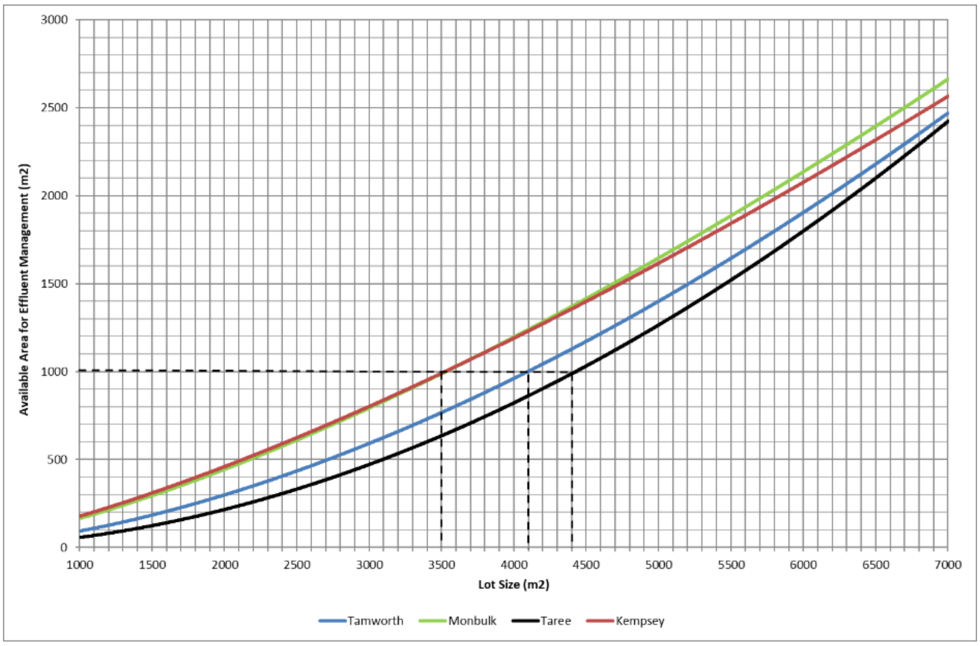

Figure 7 Effluent Management Available Area and Lot Size Relationship

4.3 Outcomes

The outcome from the lot size analysis has determined that a lot size of approx. 4,000 m^2 is generally suitable to permit the safe and sustainable operation of an on-site sewage management system under the conditions tested. Council may choose to use this information to inform future land planning processes.

5 Cumulative Impacts (On-site System Density)

In addition to minimum lot size, on-site system density is also an important metric. The range of natural and built environments throughout the LGA display different capacities to receive and safely assimilate effluent loads from on-site systems. A third element of this study included undertaking a cumulative impact assessment for on-site systems to determine a sustainable on-site wastewater system density for new unsewered development. The methodology for undertaking the cumulative impact assessment has been developed to strike a balance between useability, technical rigour, and the ability to account for critical factors influencing the impact of multiple systems on a receiving environment.

Cumulative impact modelling has been undertaken for a potential greenfield development site at Nemingha, located <10km southeast of Tamworth. The outcomes of this assessment are discussed in the following report sections.

Local Councils are faced with a great deal of uncertainty when assessing and predicting the long-term performance of existing and proposed decentralised (on-site and cluster) wastewater management systems. Resources are rarely available for collection of sufficient field data to isolate and quantify the magnitude and frequency of impacts from on-site wastewater systems with adequate certainty. These limitations have led to the development of a range of water cycle modelling tools to assist in decision making by highlighting areas of uncertainty. When used in conjunction with realistic quantities of field data, modelling tools can greatly assist in reducing or at least defining uncertainty in a working environment challenged by available resourcing.

Affordable modelling tools that can practically be applied to on-site and cluster wastewater management system assessment are available that utilise fields such as hydrology, catchment modelling, groundwater assessment and water sensitive urban design. This chapter presents a summary of the greenfield cumulative impact assessment and recommendations on how they should be applied to policy development regarding on-site system density for new unsewered development.

5.1 Sustainable Unsewered Development

The Tamworth Regional Council Development Control Plan (2010) states that unsewered subdivisions are to create lots which are greater than 4,000 m^2. Based on the outcomes of the Minimum Allotment Size analysis completed in Section 4, this lot size aligns with the minimum lot size required to physically site and install a suitable sized on-site wastewater management system.

The objective of the cumulative impact assessment is to establish a sustainable on-site system density which if applied, can help reduce cumulative impacts from on-site wastewater systems. Where a proposed development involves an increase in on-site system density that aligns with the adopted criteria, consideration of further cumulative impacts is unlikely to be required.

The assessment aimed to estimate the relative impact of properly designed, constructed, and maintained on-site systems on long-term nutrient and pathogen loads to receiving environments. In completing this assessment, the following assumptions were made.

- Each lot was capable of being serviced by an on-site system designed, sized, constructed, and operated in accordance with TRC requirements. This includes land application areas sized to prevent hydraulic surcharging in an average climate year.
- Localised impacts arising from poorly performing on-site systems were assumed to be within acceptable levels (e.g., surface hydraulic surcharging and the associated health risks).
- All land application areas comply with separation distances relevant to constructed and natural water bodies and drainage lines.

This assessment does not preclude the subdivision of unsewered land above the on-site system density level considered sustainable. Additionally, a proposal may be submitted that proposes reduced setback distances to receiving environments. In both these cases, Council may require the applicant to demonstrate that the proposed development will not negatively impact the environment and that broader environmental and human health targets can be achieved. This can be demonstrated in several ways, such as completing numerical modelling using the Model for Effluent Disposal using Land Irrigation (MEDLI) or similar or completing annual nutrient balance calculations to demonstrate sufficient setback distances have been achieved.

5.2 Methodology

Available desktop data was used to build a spatial model to simulate hydrology, catchment pollutant export, on-site system operation, groundwater recharge / pollutant discharge and nutrient / pathogen attenuation in groundwater flow for the selected sites. The models operate on a daily timestep (except for groundwater pollutant attenuation) and have been parameterised using the highest resolution desktop data available to provide the best representation of actual conditions considering limited/no data for calibration.

The models have been used to estimate the long-term hydraulic, nutrient and pathogen loads exported from the study area under existing conditions and the indicative long-term average concentrations of site runoff and groundwater discharge. The greenfield development case study has been used to simulate unsewered subdivision of the site at a range of lot densities for quantitative comparison to the existing situation. Models can also provide an estimate of the frequency, magnitude, and distribution of any surface failure of wastewater management systems to assist in estimating local risks to human health and community amenity impacts.

Wastewater management system loads were generated using Model for Effluent Disposal by Land Irrigation (MEDLI) and '*background*' catchment hydrology / water quality was assessed using Model for Urban Stormwater Improvement Conceptualisation (MUSIC).

Analysis was also undertaken of the pathway of on-site system hydraulic, and pollutant loads away from the effluent land application area to the receiving environment (i.e., stream or aquifer). A range of chemical and bio-physical processes occur along these pathways that influence attenuation of nutrients, pathogens, and hydraulic loads.

Pollutant attenuation factors were determined and applied to on-site system (MEDLI) loads prior to inclusion in the study area catchment mass balance. This enables the pollutant attenuation that occurs between the point of discharge and the receiving environment to be accounted for. Attenuation factors were applied to pollutant loads in both the surface runoff and subsurface deep drainage.

Attenuation rates were derived from 2D groundwater modelling and a steady state analytical approach using the Domenico Equation. The Domenico equation calculates pollutant concentration at a given point from a finite, planar, continuous source of pollutant under steady state (equilibrium) conditions. A full description of the equation is provided in Alvarez and Illman (2006). This approach is generally consistent with the Water NSW *Neutral or Beneficial Effect* (NorBE) tool used in Sydney's drinking water catchments.

5.3 Cumulative Impacts for New Development - Nemingha Case Study

The town of Nemingha was identified as a suitable case study site to identify the potential implications of Greenfield developments within the region. The Nemingha case study site is located on the western side of the Cockburn River and contains several named and unnamed watercourses. The study area is ~370 ha and contains several large, developable properties typical of the Nemingha township. The study area defined for the purpose of this Cumulative Impact Assessment is shown in Figure 8.

The soil landscapes present across the study area include Chromosols (~90% of the site) and Ferrosols (~10% of the site) as defined by the Australian Soil Classification. Typical soil parameters were adopted based on the soil hazard classification undertaken as part of the Land Capability Classification map and topsoil and subsoil information available on eSPADE (NSW Department of Planning and Environment, 2022).

A range of potential on-site wastewater management systems were modelled within MEDLI for the case study to capture the potential impacts for each if they were adopted across all potential future lots. These were modelled for a range of lot sizes to determine the relative impact on nutrient loads discharging to receiving waters (e.g., intermittent waterways) in addition to residual health risks.

The new potential wastewater management systems assumed to be installed within the greenfield sites included:

- Primary treatment system to trenches or beds,
- Secondary treatment with subsurface irrigation; and
- Secondary treatment with surface Irrigation noting that an allowance was made for effluent run-off during rain events with reduced attenuation of pollutants.

Nine MEDLI scenarios were modelled for the total development area in which the maximum number of systems was modelled for the available area based on the specific lot sizes. The modelled greenfield scenarios are based on the Nemingha site area of 370 ha and details are outlined in

Table 8.

Table 8 Greenfield Development Scenarios

Lot Size	0.1 ha	0.2 ha	0.3 ha	0.4 ha	0.6 ha	0.8 ha	1 ha	1.5 ha	2 ha
Total Land					370 ha				
Total Systems	3,700	1,850	1,233	925	617	463	370	247	185

Lot density scenarios between 0.1 ha and 2 ha were assessed. In the case of lots less than 4,000 m^2, an on-site system sized using the Simple Hydraulic Equation (AS1547, 2012) was assumed. As detailed in Section 4, it is unlikely that lots less than 4,000 m^2 will be capable of containing a sustainable system, however, this theoretical assumption allowed testing of the minimum lot size assessment outcomes in conjunction with lot-density.

The modelling conducted for this lot density assessment is designed for use as a decision-making tool, but it is not designed to accurately reflect measured pollutant loads to receiving waters. Instead, it aims to conduct a site mass balance that can allow users and decision makers to assess predicted increases in pollutant loads against existing conditions. As discussed previously, the purpose of this assessment is to determine the maximum lot density to inform decision makers regarding minimum lot size of new subdivisions.

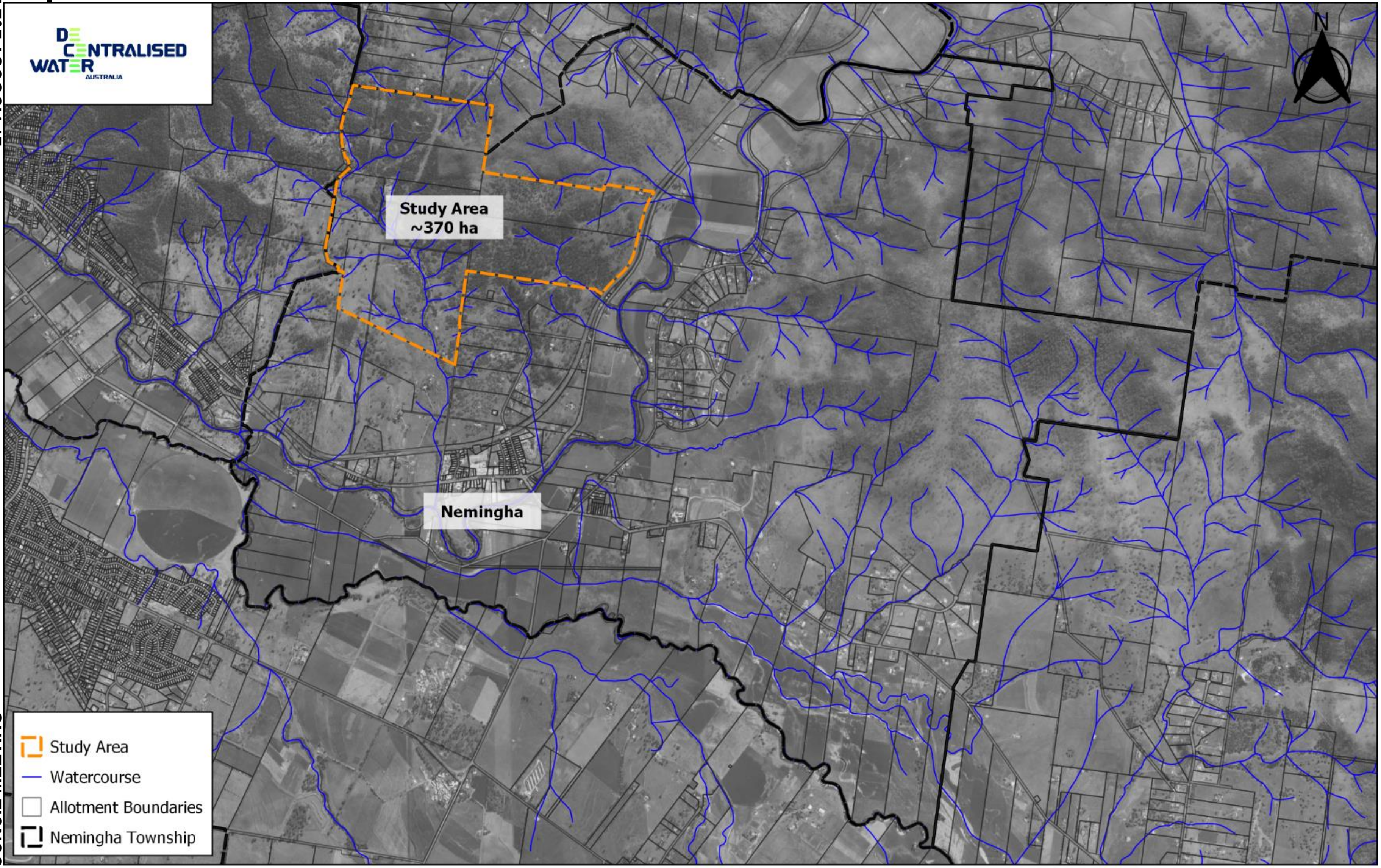

Figure 8 Cumulative Impact Assessment - Case Study Boundary

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5.4 Pollutant Attenuation

There are several bio-chemical and physical processes that occur when effluent from a Land Application Area (LAA) moves initially vertically through the soil profile and then horizontally as unsaturated flow, a perched watertable or following discharge into an unconfined aquifer. Some of these processes result in the loss, biodegradation, inactivation, or retardation of pollutants which can generally be described as attenuation. Estimating the attenuation of pollutants in effluent plumes as they are assimilated into the receiving environment can assist in evaluating potential impacts from on-site systems where typical factors of safety are not present or achievable.

Pollutant attenuation rates were calculated for use in the Cumulative Impact Assessment to determine maximum lot densities for the Nemingha study area.

5.4.1 Subsurface Rates

Simplistic two-dimensional (2D) groundwater modelling was undertaken to estimate average annual attenuation of total nitrogen, total phosphorus, and viruses in groundwater (subsurface deep drainage) flow at specific distances from the point of discharge. Modelling was undertaken for a selection of representative on-site systems and an assumed point of discharge to watercourse or waterbody. Sensitivity testing of groundwater modelling was completed to provide an indication of the level of accuracy of results.

A 2D steady state analytical approach using the Domenico Equation was adopted for the following reasons.

- There is consistently a lack of available data to construct and calibrate a numerical groundwater model for most unsewered development proposals under 100 lots.
- Modelling of average annual pollutant loads in deep drainage indicates that the risk of export through groundwater flow and discharge to sensitive receiving environments is very low in most scenarios.
- Steady state analytical modelling has been undertaken adopting very conservative input parameters and assumes an almost unrealistic worst-case scenario for upper bound estimates.

The Domenico equation calculates pollutant concentration at a given point from a finite, planar, continuous source of pollutant under steady state (i.e., equilibrium) conditions. A full description of the equation is provided in Alvarez and Illman (2006). Analytical modelling was applied to average annual leaching concentrations from on-site systems to give an order of magnitude assessment of pollutant loads and risks to use of shallow groundwater. Modelling of unsaturated groundwater flow (i.e., lateral flow along limiting layers) was not specifically undertaken. Instead, attenuation rates obtained for saturated flow were assumed under all flow conditions. This is conservative as unsaturated flow typically results in greater attenuation of pollutants.

The outcome of groundwater modelling was a set of steady state (average annual) pollutant attenuation factors for the chosen study area. These attenuation factors were then applied to average annual on-site system loads estimated from the MEDLI modelling. A range of potential scenarios were tested to derive a suitably realistic but conservative attenuation rate that could be applied broadly to comparable environments. The limitations of this approach are recognised by the authors however it represents a method that is consistent with other groundwater management fields where risks to groundwater are low (UK Environmental Agency, 2013). It is also important to recognise the limited benefit in adopting more complex methods of estimating subsurface pollutant attenuation for on-site sewage management system assessment. The data required to undertake site specific monitoring programs or build transient numerical groundwater models will almost never be cost effectively collected for developments of this nature.

Attenuation modelling was undertaken for the following on-site system types in each receiving environment.

- Secondary treatment system to subsurface irrigation,
- Secondary treatment system to surface irrigation; and
- Primary treatment to trenches or beds.

Attenuation was undertaken assuming the following assumptions:

- Plume thickness of 5 x the Design Loading Rate (DLR) for conservatism,
- Hydraulic gradient of 10%,
- Worst case (800 MPN/L) and 95th percentile (8,000 MPN/L) virus concentration in effluent,
- Average annual nutrient concentrations in deep drainage (from MEDLI); and
- Horizontal saturated hydraulic conductivity of 0.25 m/day (based on weighted vertical conductivity of soil profile 1 for conservatism).

5.4.2 Surface Attenuation

Surface attenuation was based on the F factors used by Jelliffe (2000) in Appendix E of OSRAS. These factors (which are the inverse of an attenuation factor) are based on research from comparable environments by Martens and Warner (1996).

- Flow Length > 50m = 70% attenuation
- Flow Length < 50m = 50% attenuation

5.4.3 Attenuation Results

Inputs and derived attenuation rates are provided in Appendix 2. The following key points can be observed:

- Effectively complete attenuation of nutrients and pathogens was achieved based on standard LAA sizing and setback distances (40m) for the Nemingha greenfield site under all (typical to worst case) scenarios and on-site system types,
- This excludes the impact of surface runoff on surface irrigation LAAs,
- Modelled attenuation rates of 99.5-100% were typical, and
- ANZECC low risk trigger concentrations for nitrate and phosphate were achievable.

This confirms that the LAA sizing and setback distance requirements of the OWMP are suitably conservative benchmarks for sustainable unsewered developments in typical clay soil environments where seepage along bedrock to surface water is the primary discharge pathway for on-site systems in the TRC LGA.

Additional sizing methodologies including nutrient balance, water balance and attenuation modelling (for CIA calculations) may be required where primary treatment to ETA trench/bed systems are proposed, and setback distances are compromised.

5.5 Results and Outcomes

Results of cumulative impact modelling for the greenfield development case study are presented below. Adoption of each of the system types (refer Section 5.4.1) on lots across the entire greenfield site have been tested and compared.

Critical lot density was determined based on achievement of long-term nutrient and pathogen protection targets. A suitable long-term nutrient target for on-site systems was identified as the point where combined new on-site system pollutant loads result in no more than a 10% increase in undeveloped background loads. This target has been carried through from similar projects for consistency. This target was adopted because:

- It is unlikely to be possible to develop land without increasing long-term nutrient loads,
- The relatively small contribution to catchment nutrient loads made by on-site systems; and
- There is sufficient uncertainty in the modelling process to warrant allowance for a +/-10% error.

It is generally agreed that new on-site systems should deliver full pathogen removal prior to receiving waters under average long-term conditions. As such the target for cumulative impacts was set at <1 MPN/100ml virus concentration at the receiving water as an annual average. In terms of residual health risks (i.e., risks associated with in-situ surcharging of effluent off-site), all land application areas were sized to ensure hydraulic failure accounts for only 5% of total wastewater generated (i.e., 95% containment via evapo-transpiration and deep drainage).

It should be noted that this hypothetical greenfield assessment ignored available area (i.e., the capacity of smaller lots to fit a land application area sized to modern standards). Lots less than 4,000 m^2 would typically not be able to fit such an LAA.

Figure 9 and Figure 10 show the combined on-site system and background loads under each scenario. Background loads (+10%) are also shown to identify the critical lot size in which each system type can achieve the CIA targets discussed above.

Modelling of cumulative impacts indicated that the 10% increase target for average annual nitrogen could be achieved under any lot density when trenches / beds or subsurface irrigation were installed. There was no minimum lot size for subsurface irrigation due to the high level of treatment experienced by this effluent management approach and the critical lot size for trenches was ~1,500 m^2. As such, these approaches meet the minimum lot size required by the DCP of 4,000 m^2. The critical lot size based on the scenario of 50% trenches / beds and 50% surface irrigation installation across all sites where the critical lot size was ~5.5 ha. Similarly, the critical lot size for 100% surface irrigation was >10 ha. This was largely due to the significant amount of rainfall days (average 112 days where >0 rainfall occurs each year), albeit with minimal depth of rain, which attribute to surface runoff (refer to Section 5.4.2 for further information on this approach).

Based on average annual phosphorus loads, there was no critical lot size for subsurface irrigation (as with TN loads), and the critical lot size for trenches / beds was ~3,500 m^2. As such, these approaches also meet the minimum lot size required by the DCP of4,000 m^2 based on both annual nitrogen and phosphorus loads. The critical lot size based on the

50% installation of surface irrigation and 50% trenches / beds approach and the 100% surface irrigation approach is >10 ha. Similarly, to the nitrogen loads assessment, this can be attributed to the significant number of average annual rainfall days in any one year. These large critical lot sizes (i.e., >4,000m^2) are not considered to be a sustainable option for new greenfield development based on the current minimum lot size for subdivisions within the TRC LGA. As such, it is recommended that the minimum lot size of 4,000m^2 is adopted.

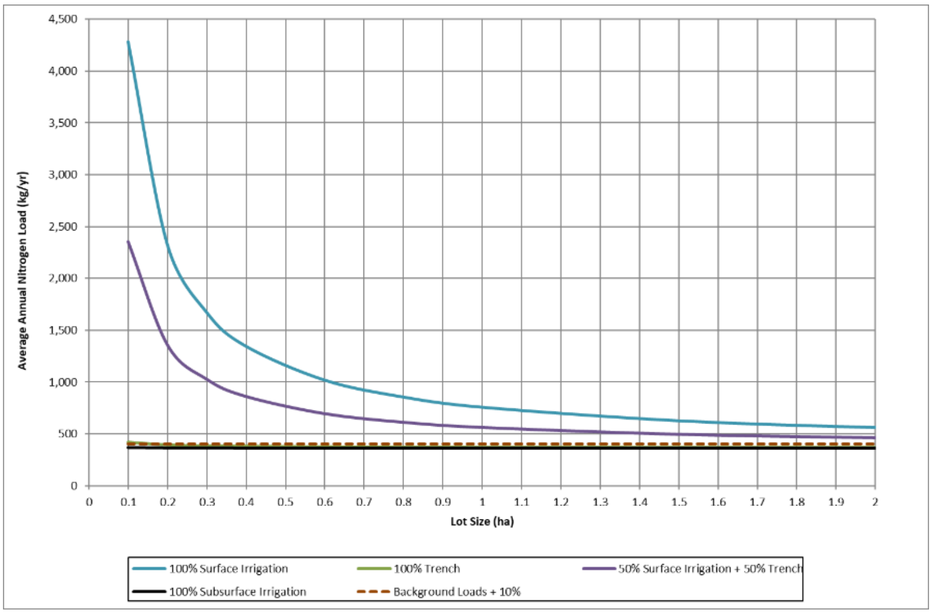

Figure 9 Nemingha Site CIA Results - Average Nitrogen

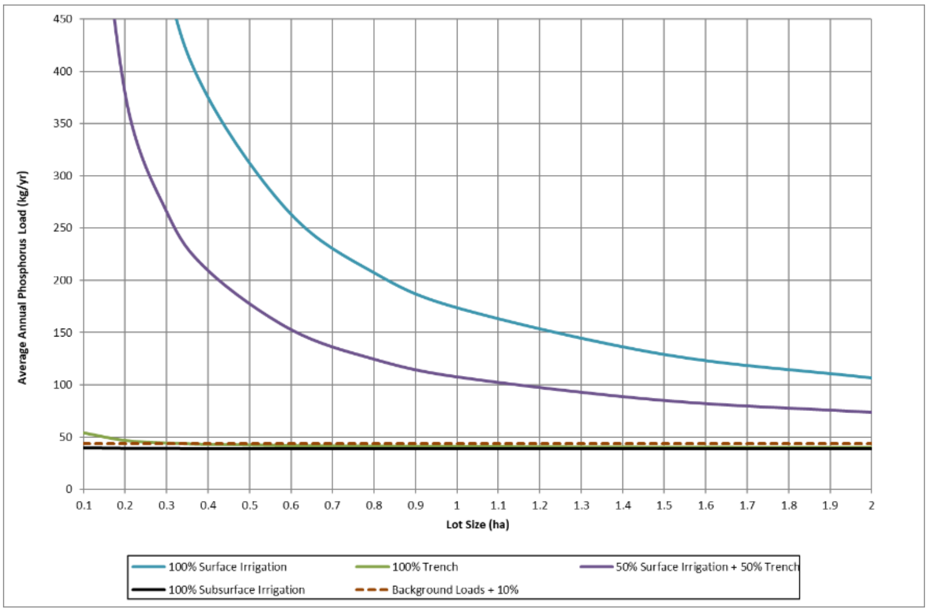

Figure 10 Nemingha CIA Results - Average Phosphorus

6 Rationale for Suitable Design Solutions

As part of the OWMP, a series of Suitable Design Solutions were developed for properties with an OSM Classification of Level 1 to reduce the design and assessment requirements for sites with lower to moderate constraints to on-site wastewater management and expedite the Section 68 assessment and approval process. The Suitable Design Solutions identify the minimum land application area sizes (in m^2 basal area) for a range of common residential development scenarios within the Tamworth LGA. The Suitable Design Solutions are comprised of minimum sustainable land application areas (LAA) required for five common on-site system types. The tables present minimum land application area sizes (in m^2 basal area) for a wide range of residential development scenarios possible throughout the LGA. A total of 600 possible combinations were modelled using monthly water balances, nutrient balances and the Simply Hydraulic Equation varying the following broad characteristics:

- Two climate zones,
- Six soil types,
- Two water supply system types,
- Number of bedrooms (1 - 5), and
- Five wastewater system types.

The on-site wastewater management system configurations with Suitable Design Solutions Tables include the following:

- Primary treated trenches,
- Primary treated beds,
- Secondary treated trenches,
- Secondary treated beds; and
- Secondary treatment to irrigation (surface and subsurface).

Suitable Design Solutions Tables are outlined in Appendix 1 of the TRC OWMP as a system selection and design option for Level 1 allotments.

6.1 Inputs for Acceptable Solutions Assessment

6.1.1 Climate

The Tamworth LGA was broken down into two Climate Zones (Zone 1 and Zone 2), as shown in Figure 11. As discussed in Section 3.3.3, climate zones were assigned using gridded average monthly rainfall and PET from the BoM Climate Atlas and are based on the number of months whereby rainfall exceeds evaporation in an average year. Each climate zone was assigned monthly values for rainfall, evaporation and crop factor based on climate data from appropriate local BoM stations or SILO (Queensland Government, 2023) where local climate stations were not available. The monthly values for the relevant local BoM gauges are shown in Table 10.

Detailed land application system modelling was used to support design experience in the sizing of land applications within the TRC LGA. A Climate Adjustment Factor (CAF) was developed to enable design loading rates to be adjusted to reflect the degree to which climate influences hydraulic performance. They have been determined based on analysis of the frequency and magnitude of hydraulic failure for a range of on-site system types in different climate regions (consistent with the climate zones developed as part of the Land Capability Classification mapping).

The CAF was used to reduce the Design Loading Rate (DLR) in locations of wetter climates. The DLR was then used to calculate the LAA size for each Suitable Design by using the Simple Hydraulic Equation from *AS1547:2012* outlined in Equation L1. Design loading rates should be obtained from ASNZS1547:2012. Given the relative accuracy of any hydraulic design equations, rounding of minimum LAA sizes is acceptable to the nearest 10m^2.

For further information on this equation and other LAA sizing techniques, refer to Section 9.2.2 of the OWMP.

Table 9 presents the Climate Adjustment Factors for each climate zone.

Equation L1

$$L = \frac{Q}{DLR \ x \ W}$$

Where:

L = Length in m
Q = Design daily flow in L/day
DLR = Design loading rate in mm/d
W = Width in m

Table 9 Climate Adjustment Factors for LAA Sizing Calculation

Climate Zone	Climate Adjustment Factor (CAF) (mm/day)
Zone 1	0
Zone 2	0.5

These CAFs were calculated based on an average annual water balance utilising the inputs summarised in Table 10. Due to limited evaporation data from weather stations within the LGA, SILO climate data (Queensland Government, 2023) was used to approximate average long-term average pan evaporation data. SILO extrapolates Bureau of Meteorology (BoM) datasets to provide point data (centroid within larger grid) across Australia.

Table 10 Summary of Input Data for CAF Calculations

BoM Climate Stations	Tamworth Airport (AWS)	Attunga (Garthowen)	Orabah (Manilla (Warrabah))	Nundle Post Office	Dungowan (Ravencroft)	Hanging Rock (Andeva)
Average Annual Rainfall (mm/yr)	648	635	730	840	779	1007
Volumetric Runoff Coefficient	0.14	0.13	0.16	0.19	0.17	0.23
Pan Evaporation (mm/yr)	1720	1705	1748	1430	1460	1147

In very wet climates, the CAF works by reducing the DLR to reflect the limitation placed on hydraulic capacity by consistently high soil moisture. In dry climates, the CAF may increase the DLR based on a higher evapo-transpiration output of applied effluent. Using the Simple Hydraulic Equation with the CAF to reduce the DLR in Climate Zone 2, the resulting LAA size is comparable to that obtained from a monthly water balance with respect to rigour of design. The benefit to this method is a simpler and more efficient calculation approach that removes the potential for data entry error or artificial manipulation of results.

It should be noted that whilst the Simple Hydraulic Equation was used to calculate the Suitable Design Solutions, consideration was given to nutrient balance and/or water balance calculations. A comparison of several nutrient balance and water balance sized LAAs with the Simple Hydraulic equation identified the following:

- Nutrient balance calculations resulted in LAA sizes ~300% larger than LAA's calculated with the Simple Hydraulic Equation and water balance calculation; and
- The size of LAA's calculated using both the water balance and simple hydraulic equation methods were comparable (<10% difference).

Considering the Suitable Design Solutions can only be adopted with Level 1 assessments, this approach is considered appropriate for sites where constraints are lower.

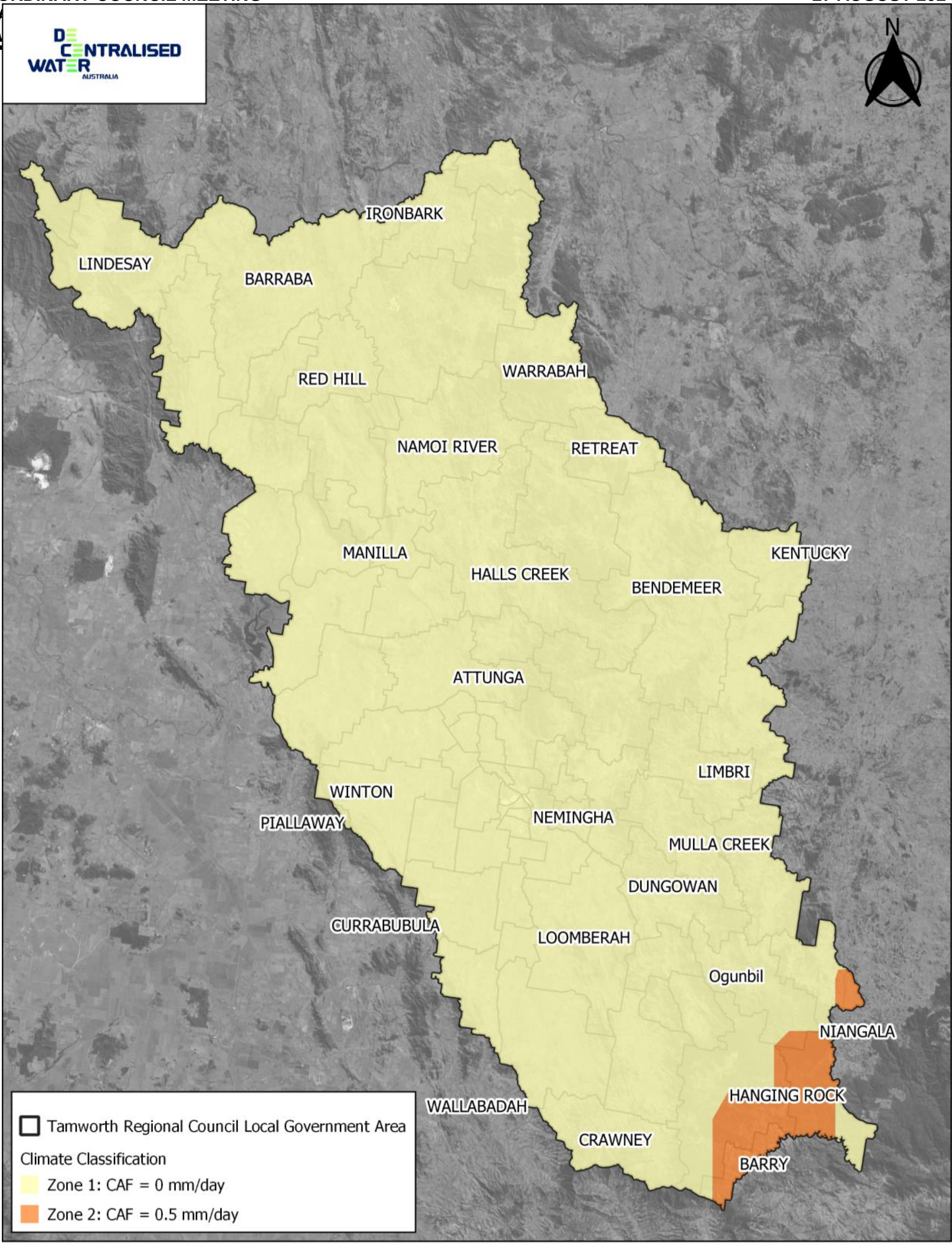

Figure 11 Climate Zone Classification Map

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6.1.2 Wastewater System Inputs

Six soil categories were considered ranging from sand to medium/heavy clays. Each soil type was assigned a value for phosphorous sorption (mg/kg) and DLR (mm/day) as shown in Table 11. These soils were considered as '*design*' soils (i.e., the most limiting soil horizon used to design an on-site system land application area). DLRs were adapted from ASNZS1547:2012 with phosphorus sorption values adopted based on experience conducting site and soil assessments.

Table 11 Soil Types and Adopted Parameter Values

Soil Type	Soil P-sorption (mg/kg)	Design Loading Rate (mm/day)		
		Primary Trenches / Beds	Secondary Trenches / Beds	Irrigation
Sand	100	20	50	5
Sandy Loams	150	15	30	5
Loams	200	10	30	4
Clay Loams	300	6	20	3.5
Light Clays	350	5	8	3
Medium / Heavy Clays	400	5	5	2

The daily design wastewater flow was estimated based upon the number of bedrooms per dwelling (1 - 5) and type of water supply (reticulated or tank). The design wastewater flow values are shown in Table 12. Occupancy and per capita wastewater generation were based on *ASNZS1547:2012.*

Table 12 Design Wastewater Flow

Number of Bedrooms	Number of Occupants	Design Wastewater Flow (L/day)	
		Reticulated Water Supply	Tank Supply
1	2	300	240
2	4	600	480
3	5	750	600
4	6	900	720
5	7	1,050	840

Five wastewater system types were considered including primary and secondary trench systems; primary and secondary Evapo-transpiration / Absorption (ETA) bed systems; and (subsurface) irrigation systems. Given that the Suitable Design Solutions tables will only be used for proposed systems on lots with a Level 1 Classification, more traditional primary dosed trenches and beds have been included. However, it is acknowledged that opportunities for adoption of primary dosed trenches and beds are limited and, in some cases, may not be as cost effective as secondary treatment and subsurface irrigation. A value for void space ratio, Total Nitrogen (TN) and Total Phosphorous (TP) effluent concentrations, maximum depth of storage in trenches/beds, and percentage of nitrogen lost to soil processes were assigned for each system type as shown in Table 13.

Table 13 Wastewater System Type Characteristics

System Type	Void Space	Max. Depth (mm)	Effluent TN (mg/L)	Effluent TP (mg/L)	%N lost to soil
Primary Trench	0.3	450	60	18	0.4
Secondary Trench	0.3	450	30	12	0.2
Primary ET Bed	0.3	300	60	18	0.4
Secondary ET Bed	0.3	300	30	12	0.2
Irrigation	1.0	-	30	12	0.2

6.2 Assignment of Minimum Land Application Areas

The input parameters summarised above were compiled into a macro enabled land application area hydraulic sizing spreadsheet which used the Simple Hydraulic Equation to size minimum Land Application Areas. The macro enabled hydraulic sizing calculations to be completed for each of the possible combinations of on-site system scenario and the 600 results output into a table. Results were then assessed and reduced through consideration of several practical and design limitations associated with the various land application system types. Values were also rounded up to the nearest practical value (i.e., an installer is unlikely to vary sizes by small increments). This is considered acceptable given the relative accuracy of design procedures. Further justification for not using a monthly water balance is provided in Section 9.2 of the OWMP.

It is important to recognise that the Suitable Design Solutions have been offered as a conservative standard design option for applicants on lots with an OSM Classification of

Level 1 who wish to fast track their approval whilst providing Council with confidence that their proposal is sustainable. They will not be permitted for adoption on lots classified as Level 2, commercial / industrial development or any lot with constraints not identified through the hazard mapping process.

The following points summarise how raw outputs from modelling were reduced and simplified. Further details can be found in the OWMP.

- Limitations were placed on maximum allowable slope for trenches and beds to be considered a Suitable Design Solution.
- Limitations were placed on allowance of gravity dosing of trenches and beds where even distribution of effluent could prove difficult.
- A minimum of 600mm of soil must be present between the base of any land application system and any limiting layer or water table.
- Limitations were placed on the maximum basal area allowable for trenches and beds considered a Suitable Design Solution based on construction challenges associated with achieving level bases across large areas.

6.3 Outcomes

A set of Suitable Design Solutions have been included in Appendix 1 of the OWMP for use as a '*deemed to comply*' option for system selection and design on lots with an OSM classification of Level 1. The minimum land application system sizes are considered conservative for a range of possible development scenarios. Applicants are however free to complete site specific design calculations to derive their own sizing.

Figure 12 presents a decision tree for the calculation and derivation of Suitable Design Solutions and their minimum Land Application Area.

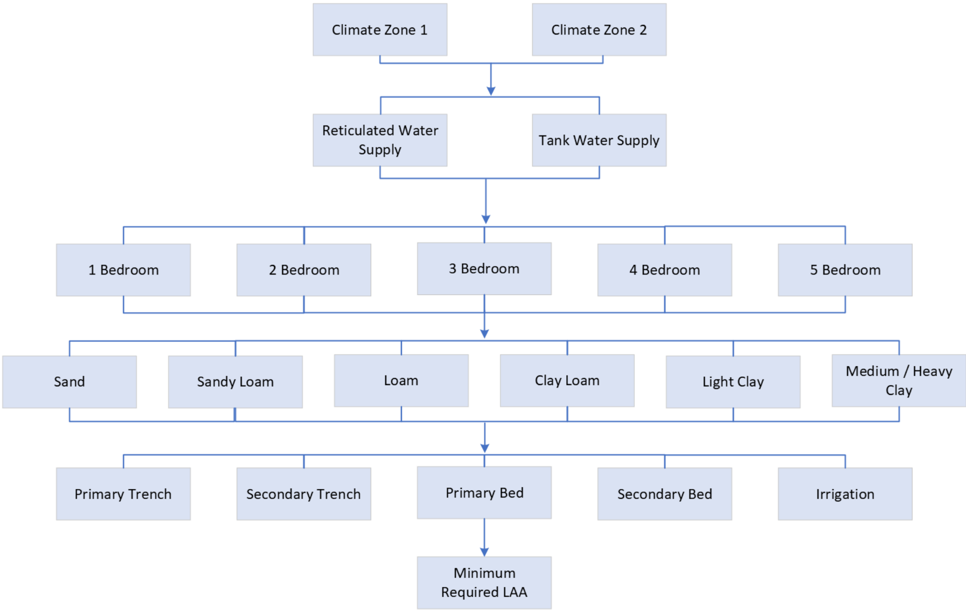

Figure 12 Decision Tree for Suitable Design Solutions

7 References

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Appendix 1 Soil Hazard Classes

Appendix 2 Groundwater Attenuation Modelling

Appendix 3 Ground Truthing Sites

Table 14 Ground truthing outcomes

House Number	Street Name	Locality	Postcode	Lot Area (m^2)	Lot Number	Plan Label	Comments
-	Nemingha Heights Road	Nemingha	2340	116294	12	DP712553	Observed proximity to nearby creek but lot size being greater than 10 ha negates effect of creek buffer
178	Nundle Road	Nemingha	2340	23256	41	DP580145	Several non-potable bores on the site, combined with a lot size of < 10 ha make this a level 2 classification
-	Oaklands Drive	Nemingha	2340	3798924	18	DP1199163	Multiple intermittent watercourses present on the lot, along with Environmental Management Zone. Greater than 10 ha lot size caps CoS class at medium, resulting in an OSWM Class of 1
-	Cowsby Road	Niangala	2354	16182567	18	DP753709	One permanent along with multiple intermittent watercourses present on the lot, along with Environmental Conservation Zone. Greater than 10ha lot size caps CoS class at medium, resulting in an OSWM Class of 1
-	Head of the Peel Road	Nundle	2340	98154	5	DP755349	Permanent watercourse as well as water body combined with <10 ha lot size result in level 2 OSWM Class

House Number	Street Name	Locality	Postcode	Lot Area (m²)	Lot Number	Plan Label	Comments
65	Point Street	Nundle	2340	1485	5	DP835782	Lot size < 0.25 ha has resulted in level 2 OSWM class
-	New England Highway	Gowrie	2340	30038	2	DP1111150	Intermittent watercourse passing through property and lot size < 10 ha, so level 2 OSWM class
14089	New England Highway	Timbumburi	2340	2334010	211	DP1113006	Both permanent and intermittent watercourses present on the property, but large lot size negates impact of this so overall OSWM level 1 is appropriate
55	Duri Dungowan Road	Duri	2344	15556	69	DP755343	Non-potable groundwater bore present on the site, in combination with a lot size <10 ha has resulted in a level 2 OSWM rating
6	Racecourse Road	Somerton	2340	64160	2	DP1031669	Potable bore present on the site gives a classification of level 2
2179	New England Highway	Moonbi	2353	4281566	65	DP753838	Land capability class is high due to soils on the site, so OSWM class is automatically level 2
290	Hobden Road	Borah Creek	2346	2998599	30	DP752198	Intermittent watercourses, water bodies and a high-level soil classification have all combined to result in a level 2 OSWM rating

House Number	Street Name	Locality	Postcode	Lot Area (m²)	Lot Number	Plan Label	Comments
69	Coonoor Road	Ironbark	2347	689126	10	DP752188	Large lot size has minimised the impact of nearby constraints, namely permanent and intermittent watercourses
1281	Old Bundarra Road	Ironbark	2347	3499883	76	DP752188	OSWM level 2, due to soils along with watercourses and water bodies
17	Watsons Creek Tilmunda Road	Watsons Creek	2355	10475	7	DP753839	The presence of an intermittent watercourse, combined with a smaller lot size has resulted in an OSWM level 2 rating
41	Gunnalong Road	Bendemeer	2355	2007885	214	DP753831	A combination of poor soils and the presence of water courses and water bodies has resulted in a level 2 rating
2174	New England Highway	Moonbi	2353	263085	191	DP753841	Lot area >10 ha negates the impact of a groundwater bore and intermittent watercourse
29	Betts Lane	Kootingal	2352	162552	51	DP849812	Lot area >10 ha negates the impact of a groundwater bore, water body and intermittent watercourse
94	Attunga Street	Attunga	2345	1768	3	DP786965	Small lot size of < 2500 m² immediately gives this an OSWM classification of level 2

House Number	Street Name	Locality	Postcode	Lot Area (m²)	Lot Number	Plan Label	Comments
1267	Moore Creek Road	Moore Creek	2340	1049887	11	DP1218154	Large lot size has minimised the impact of nearby constraints, namely intermittent watercourses & water bodies

SMARTER ADAPTIVE SOLUTIONS

DECENTRALISED WATER AUSTRALIA

enquiries@decentralisedwater.com.au
(02) 4962 2067
www.decentralisedwater.com.au

RISK MANAGEMENT PLAN

Pollie Pedal 2024

OVERVIEW

The Risk Management Plan has 11 columns:-

a	Number	Number of risk
b	Risk Type	Description of risk
c	Consequence	Consequence of an occurrence (Scale at Annex A)
d	Likelihood	Evaluation of likelihood of occurrence (Scale at Annex B)
e	Level of Risk	Function of consequence and likelihood of risk (Scale at Annex C)
f	Risk Priority	Priority of risk (Scale at Annex C)
g	Risk Treatment	Actions to be undertaken to mitigate risk
h	Responsibility	Person responsible for risk treatment actions prior to event (List at Annex D)
i	Timetable	Timetable for completion of risk treatment actions prior to event
j	Monitoring Agent	Person responsible for monitoring risk and risk treatment actions during event (List at Annex D)
k	Comments	Comments on entries against risk type

Annex D comprises a list of all participants and emergency contact details. To be completed and distributed to all race officials immediately prior to the event.

RISK TREATMENT PLAN

No	Risk Type	Consequence (1-5)	Likelihood (1-5)	Level of Risk (c x d)	Risk Priority (A-E)	Risk Treatment	Responsibility	Timetable	Monitoring Agent	Comments
(a)	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
1	Claims made against PP 2024 for incidents which occur during event	3	2	Low	D	• Public Liability Insurance policy • Event specific insurance policy	Audie Moldre Secretary Wandering Warriors ED	1 month prior to event	RD	Public Liability insurance. Event specific insurance coverage is also taken out.
2	Confirmed threat of terrorist attack	5	1	Sig.	C	• Event cancelled	RD	Ongoing monitoring	RD	Event may be cancelled at any time if terrorist attack threats occur
4	Extreme heat during event (over 38º degrees)	3	3	Low	C	• Water available at all times • Sodium replacement liquid available at all times • Damp towels to be made available if required • Air conditioned vehicles available at all times • Support staff to note early signs of heat exhaustion • Participants showing signs of heat exhaustion will be withdrawn • Daily rides planned for mornings outside of main heat of the day • First aid kits in each support vehicle	R.D. Riders	Temperature checked prior to each day of riding	RD Riders	Extremely unlikely heat will be a risk

No	Risk Type	Consequence (1-5)	Likelihood (1-5)	Level of Risk (c x d)	Risk Priority (A-E)	Risk Treatment	Responsibility	Timetable	Monitoring Agent	Comments
(a)	(b)	I	(d)	I	(f)	(g)	(h)	(i)	(j)	(k)
5	Extreme cold during event (under 0°)	2	3	Low	C	• Riders will be provided with winter riding kit • Warm drinks will be provided at regular intervals • Recovery vehicles fitted with air conditioning • Support staff monitoring conditions • Participants showing signs of hypothermia will be withdrawn • If ice is a risk, the start time will be delayed • First aid kits including thermal blankets in at least 1 vehicle with each riding group	RD Riders	Temperature checked prior to each day of riding	RD Riders	
6	Other extreme conditions on day of event (torrential rain fall, heavy winds, ice, fog, bush fires etc.)	2	2	Low	D	• Advance marshals will report any extreme conditions • Adjustments made to kilometres planned for the day • Participants to cease riding until extreme conditions have passed	R.D. Marshals Riders	Conditions checked prior to and on the morning of ride thru the BOM website and local authorities	RD	If extreme bad weather or dangerous conditions are evident before or during that day's ride, leg will become a transit stage.
7	Participants veer off course	1	2	Neg	D	• Course maps and detailed route description provided to all riders prior to event • Course maps and detailed route description studied night prior to daily ride • 2 * Support vehicles available with maps • Debris / other obstacles unable to be cleared to be brought to participants attention	R.D. Marshalls Support personnel	Ongoing monitoring of maps Ongoing monitoring for potential obstacles	RD	Lead vehicles are equipped with route maps and in radio contact with advance vehicles and bunch leaders

No	Risk Type	Consequence (1-5)	Likelihood (1-5)	Level of Risk (c x d)	Risk Priority (A-E)	Risk Treatment	Responsibility	Timetable	Monitoring Agent	Comments
(a)	(b)	I	(d)	I	(f)	(g)	(h)	(i)	(j)	(k)
8	Traffic hazards on Route (bad bridges, badly sealed roads, traffic on highway)	4	2	Significant	D	• Safety booklet supplied to riders prior to ride • Ride Director to give overview of route the evening before the daily ride • Rider briefing conducted before each stage • Traffic hazards clearly listed on detailed route notes used by escort vehicles • Escort vehicles communicate hazards found en route to bunch leaders • 2 ‘floating’ support vehicles to warn cyclists of hazards • Support vehicles with clearly marked ‘CAUTION CYCLISTS’ signs • Local police notified of event and details prior to event	R.D. Support Vehicles	Ongoing monitoring of maps Ongoing monitoring for potential hazards	RD Marshalls	**NOTE:** The Assistant Ride Director will inspect the route and road conditions when he drives ahead of the riders **NOTE:** Police escorts will be requested where road or traffic conditions create any danger to riders or other road users
9	Minor Dehydration	2	2	Low	D	• Water available at all times • Sodium replacement liquid available at all times • Scheduled breaks planned • 2* ‘floating’ vehicles available to obtain additional supplies if required • Volunteer support staff to be aware of possible signs of dehydration • Air conditioned vehicles available at all times • If Participant shows signs of dehydration requested to cease competing • First Aid kits in each support vehicle	R.D. Riders Support Vehicles	Ongoing Ongoing monitoring for dehydration	RD Marshalls Support vehicles Riders	Hydration is mentioned in the rider briefing each day

No	Risk Type	Consequence (1-5)	Likelihood (1-5)	Level of Risk (c x d)	Risk Priority (A-E)	Risk Treatment	Responsibility	Timetable	Monitoring Agent	Comments
(a)	(b)	I	(d)	I	(f)	(g)	(h)	(i)	(j)	(k)
10	Major Dehydration	3	1	Low	D	• Water available at all times • Sodium replacement liquid available at all times • Scheduled breaks planned • 2* 'floating' vehicles available to obtain additional supplies if required • Volunteer support staff to be aware of possible signs of dehydration • Air conditioned vehicles available at all times • If Participant shows signs of dehydration directed to cease competing • First Aid kits in each support vehicle • Transport suspect rider urgently to nearest medical centre for assessment	R.D... Support vehicles Riders	Ongoing Ongoing monitoring for dehydration	RD Marshalls Support vehicles Riders	Hydration is mentioned in the rider briefing each day
11	Medical emergency (participant experiences severe chest pains, etc.)	4	3	Sig.	C	• First Aid Kits in each support vehicle • All participants requested to provide training regime and a medical history in month prior to event • Provide details of emergency contact details prior to event and this is available in each support vehicle • Riders to cease if experiencing problems • All support vehicles have mobile phones to contact doctor/ambulance • Local police notified of event and details prior to day of event. • Medical practitioners are included in the rider group	R.D. Support vehicles Riders	Ongoing monitoring for medical emergencies	**RD** Marshalls Support vehicles Riders	Medical practitioners have medical bags in support vehicles

No	Risk Type	Consequence (1-5)	Likelihood (1-5)	Level of Risk (c x d)	Risk Priority (A-E)	Risk Treatment	Responsibility	Timetable	Monitoring Agent	Comments
(a)	(b)	I	(d)	I	(f)	(g)	(h)	(i)	(j)	(k)
12	Participants knocked down by traffic **NOTE:** The escort vehicles will be positioned to enable queuing traffic to see the riders following or in front of the escort vehicles. The escort vehicle is to have a yellow warning sign with black lettering as per Police reqts and a flashing light. The Ride Director is to induct each escort vehicle driver in the SOPs and safe distances.	4	4	High	A	• Safety briefing delivered to riders prior to ride commencing • Ride Director to give overview of safety the evening before the daily ride • First Aid kit in each support vehicle • All participants provide emergency contact details prior to event and this is available in each support vehicle • All support vehicles have mobile phones to contact doctor/ambulance • Bike helmet compulsory and in accordance with TA specifications • Local police notified of event and details prior to day of event • Escort vehicles are well signed with caution riders ahead with headlights, amber flashing lights and hazard lights operating • Riders will be directed to remain in groups no wider than 2 abreast • Where there are narrow lanes – riders will be directed to ride in single file • Where possible riders will ride in the shoulder lane • Bunch 'leaders' will have radio contact with escort and follow vehicles to warn of any imminent hazard or danger	R.D. Support vehicles Riders		RD Marshalls Support vehicles Riders	
13	Other accident during event	3	2	Significant	C	• First Aid kit in each support vehicle • All participants provide emergency contact details prior to event and this is available in each support vehicle • All support vehicles have mobile phones to contact doctor/ambulance • Australian Approved standard helmet compulsory and in accordance with TA specifications • Local police notified of event and details prior to day of event	R.D. Support Vehicles Riders	Ongoing monitoring	RD	

No	Risk Type	Consequence (1-5)	Likelihood (1-5)	Level of Risk (c x d)	Risk Priority (A-E)	Risk Treatment	Responsibility	Timetable	Monitoring Agent	Comments
(a)	(b)	I	(d)	I	(f)	(g)	(h)	(i)	(j)	(k)
14	Bike faulty causing accident	3	3	Sig	C	• Riders to physically check bike prior to daily riding • Helmets must meet safety standards • Spare tyres and tubes etc carried in support vehicles (rear) • Riders to cease riding if bike cannot be repaired • De Grandi Cycles supplies a bike technician in a specifically equipped van	Riders Support vehicles	Check of cycles completed on day of event, prior to commencement Check of spare equipment completed on day of event, prior to commencement	RD Support vehicles Bike technician	
15	Support vehicle in accident	4	2	Sig	C	• First Aid kits in each support vehicle • All participants provide details emergency contact details prior to event and this is available in each support vehicle • All support vehicles have mobile phones to contact doctor/ambulance • Local police notified of event and details prior to day of event • 2 * 'floating' vehicles to be used if necessary	R.D. Support vehicles		RD Support vehicles	If inadequate support vehicles are available, the event will be stopped until sufficient vehicles are in place
16	Support vehicle breakdown	2	2	Low	D	• 2 'floating' vehicles to be used if necessary • Vehicle check completed prior to event	Support vehicles	Ongoing monitoring	Support vehicle drivers	Late model vehicles are used

No	Risk Type	Consequence (1-5)	Likelihood (1-5)	Level of Risk (c x d)	Risk Priority (A-E)	Risk Treatment	Responsibility	Timetable	Monitoring Agent	Comments
(a)	(b)	I	(d)	I	(f)	(g)	(h)	(i)	(j)	(k)
17	Food preparation and handling	2	1	Low	D	• Riders instructed to wash and dry hands prior to beginning meals • Perishables purchased daily, leftovers not reused • Packeted foods resealed and stored in containers with lids to prevent vermin entry • Servers instructed to wash hands hygienically prior to distribution of plates, cutlery and foodstuff • Clean wipe cloths to be provided at all meals • All utensils to be washed thoroughly in hot water after use	R.D. Support crew Rapid Relief Team	Daily breakfasts Roadside snacks	R.D.	
18	Closing Event	3	2	Low	C	• Escort vehicles will be positioned to ensure safe entry to the finishing point • The site will be monitored 2 hours prior to the convoy arriving • All equipment is checked for faults prior to installation • Equipment will be anchored to prevent movement in windy conditions • Any food preparation will be as per 'Item 15' • Vehicles will be parked in designated parking areas	RD Escort drivers Promotion personnel	2 hours prior and during the event	RD	An area with adequate parking will be selected

19	COVID	5	3	Low	B	• Restrictions conditional at the time will be strictly adhered to
						• Other actions
						• Daily temperature checks if applicable
						• Check all personnel daily for
						  • Sore throat
						  • Runny nose
						  • Cough
						• Medical supplies
						• PPE supplies
						• Infection control training for key personnel
						• Adhere to bunch sizes & formation
							RD	Conditions to be obtained pre-ride and daily during the ride	RD	Riders, officials and volunteers will be addressed pre-ride by an appropriately qualified person

ANNEX A: RISK CONSEQUENCE

Rating	Description	Remarks
1	Insignificant	a. no injuries or fatalities b. little community disruption c. no environmental or other damage
2	Minor	a. small number of injuries b. no fatalities c. only first-aid required d. some environmental or other damage (but not lasting)
3	Moderate	a. hospital treatment required b. no fatalities c. some community inconvenience d. some environmental damage (small long-term affect) e. other damage
4	Major	a. extensive injuries b. significant hospitalisation c. some services unavailable d. extensive environmental damage (long term affect) e. other extensive damage f. some community displacement
5	Severe	a. fatalities b. injuries and extended hospitalisation periods c. widespread community displacement d. extensive and widespread damage e. significant short or long term environmental damage

ANNEX B: RISK LIKELIHOOD

Rating	Scale	Criteria
1	Remote	a. Would only occur in highly exceptional circumstances b. An extremely remote chance of an occurrence
2	Unlikely	a. Not likely to occur b. A small, but remote chance of occurrence due to the circumstances or situations that could arise
3	Possible	a. Likely to occur at least once, but not expected to occur much more than this
4	Likely	a. Likely to occur more than once, but not an 'everyday' occurrence b. Preconditions will arise at times
5	Almost Certain	a. Will occur b. Circumstances are likely to arise often throughout the period which will provide the opportunity for the crystallization of the risk c. Expect frequent/regular occurrences

ANNEX C: RISK LEVEL & RISK PRIORITY

RISK LEVEL

Consequence

Likelihood

Likelihood	INSIGNIFICANT	MINOR	MODERATE	MAJOR	SEVERE
REMOTE	Negligible	Negligible	Low	Low	**Significant**
UNLIKELY	Negligible	Low	Low	**Significant**	**Significant**
POSSIBLE	Low	Low	**Significant**	**Significant**	**High**
LIKELY	Low	**Significant**	**Significant**	**High**	**High**
ALMOST CERTAIN	**Significant**	**Significant**	**High**	**High**	**Extreme**

RISK PRIORITY

Description	Priority Ranking
Extreme	A
High	B
Significant	C
Low	D
Negligible	E

ANNEX D: RESPONSIBILITY & MONITORING AGENTS

Role	Emergency Contact Details			
	Name	Address	Contact Number	email
Event Director (ED)	Audie Moldre	Wandering Warriors	0427 216281	secretary@wanderingwarriors.org
Ride Director (RD)	Graeme Northey	13 Prell Street, Goulburn	0408 482828	graeme.northey@bigpond.com
Events Co–ordinator (EC)	Nicci Korff	Wandering Warriors	0414 292129	nicci.korff@wanderingwarriors.org

Graeme Northey
Ride Director
2 May 2024

POLLIE PEDAL 2024 - VEHICULAR CONVOY PLAN

NO	DESCRIPTION	SYMBOL	NOTES
THESE VEHICLES WILL BE PART OF THE RIDE CONVOY			
1	LEAD ESCORT VEHICLE **CAUTION CYCLISTS** UHF radio, Flashing light, Headlights	 300 metres	
2	A PACK – 10-20 Riders		
3	REAR ESCORT VEHICLE **CAUTION CYCLISTS** UHF radio, Flashing light, Headlights	 Min 500 metres	
4	LEAD ESCORT VEHICLE **CAUTION CYCLISTS** UHF radio, Flashing light, Headlights	 300 metres	
5	B PACK – 10-20 riders		
6	REAR ESCORT VEHICLE **CAUTION CYCLISTS** UHF radio, Flashing light, Headlights	300 metres  Min 500 metres	
7	LEAD ESCORT VEHICLE **CAUTION CYCLISTS** UHF radio, Flashing light, Headlights	 300 metres	
8	C PACK – 10-20 riders		
9	REAR ESCORT VEHICLE **CAUTION CYCLISTS** UHF radio, Flashing light, Headlights	300 metres 	
THE FOLLOWING VEHICLES WILL NOT FORM PART OF THE RIDE CONVOY			
10	SAG WAGON **CAUTION CYCLISTS** UHF radio, Flashing light, Headlights		Pick up dropped riders At least 500M behind ride convoy
11	RIDE DIRECTOR Floating UHF Radio, Headlights, Flashing Light when required		FLOATING Ensuring compliance
12	SERVICE VEHICLE (Bike mechanic, SMALL VAN) UHF radio, Flashing light, Headlights,		FLOATING Attending breakdowns where required
13	12 SEATER BUS **CAUTION CYCLISTS** UHF radio, Flashing light, Headlights		FLOATING Food & drink stops Pick up withdrawn and dropped riders
14	Medium size Van/truck to transport rider luggage & equipment Drives straight through to next camp site		<u>Not in convoy</u>
15	Wandering Warriors Support		<u>Not in Convoy</u>

POLLIE PEDAL 2024 DAILY RUN SHEET LOCAL GOVERNMENT AREAS

Day	From	TO	Via	Turn	Roads	KM	Map Link
Day 1	Gosford	Pokolbin		S	Vaughan Ave Gosford		PP24 Day 1
Sunday	9.00am	3.00pm	Cessnock	L	Mann St Gosford	124	
20 Oct				S	Pacific Highway Wyoming		Ride with GPS Day 1
	Vaughan Ave,	Pokolbin Gardens		L	Manns Rd Narara		
	Gosford Rotary	Harrigan's Hunter		R	Narara Valley Drive Narara		CENTRAL COAST
	Park	Valley		L	Pacific Highway Lisarow		COUNCIL
				L	Dog Trap Road Ourimbah		
				R	Wisemans Ferry Road Somersby		
				R	George Downes Drive Mangrove Mountain		
				R	Great North Road Bucketty		
				R	Wollombi Road Wollombi		
				L	Alexander Street Cessnock		
				S	Barrett Avenue Cessnock		
				L	Mount View Road Cessnock		
				R	Oakey Creek Road Pokolbin		CESSNOCK CITY
				L	Marrowbone Road Cessnock		COUNCIL
				L	Oakey Creek Road Pokolbin		
				R	McDonalds Road Pokolbin		
				L	Broke Road Pokolbin		

POLLIE PEDAL 2024 DAILY RUN SHEET LOCAL GOVERNMENT AREAS

Day	From	TO	Via	Turn	Roads	KM	Map Link
Day 2	Pokolbin	Merriwa		L	Broke Road Pokolbin		PP24 Day 2
Monday	7.00	3.00pm	Denman	R	Hermitage Road	139	
21 Oct				L	New England Highway, A15		Ride with GPS Day 2
	Popkolbin Gardens	Royal Hotel		L	Golden Highway		
	Harrigan's Hunter	Bettington St		L	Putty Road, B84, 27		CESSNOCK CITY
	Valley			R	Jerrys Plains Road		COUNCIL
				R	Golden Highway, B84, 27		
				L	Golden Highway,B84, 27		
				S	Denman Road, B84, 27		
				S	Merriwa Rd		SINGLETON COUNCIL
				S	Golden Highway, B84, 27		
				S			
					Golden Hwy		UPPER HUNTER SHIRE
					King George V Ave		COUNCIL

POLLIE PEDAL 2024 DAILY RUN SHEET LOCAL GOVERNMENT AREAS

Day	From	TO	Via	Turn	Roads	KM	Map Link
Day 3 Tuesday 22 Oct	Merriwa 8.00am Apex Park Vennacher St	Murrurundi 2.00pm Royal Hotel NE Hwy	Scone Toilets Elizabeth Park	S R L S S S S L L L R R R L S S S R	Vennacher Street Macartney Street Scone Road, 27 Bunnan Road High Street Bunnan Road Satur Road Liverpool Street, 27 Kelly Street Guernsey Street Liverpool Street, 27 Middlebrook Road Cressfield Road New England Highway, A15 Salisbury Street, A15 New England Highway, A15 Mayne Street, A15 Murulla Street	 115	PP24 Day 3 Ride with GPS Day 3 UPPER HUNTER SHIRE COUNCIL

POLLIE PEDAL 2024 DAILY RUN SHEET LOCAL GOVERNMENT AREAS

Day	From	TO	Via	Turn	Roads	KM	Map Link
Day 4 Wednesday 23 Oct	Murrurundi 7.00am War Memorial Oval NE Hwy	Tamworth 3.00pm The Long Yard Hotel Goonoo Goonoo Rd	Quirindi Wallabadah	S S L R L L S S L R S S S L S R L L L S L R U L	Mayne Street, A15 New England Highway, A15 Glenyalla Road Merriwa Road New England Highway, A15 Kamilaroi Highway, B51 Loder Street, 25 Nelson Street Hill Street Henry Street Dewhurst Street Wallabadah Road Maria street Coach Street, A15 New England Highway, A15 Lindsays Gap Road, 23 Lindsays Gap Rd Nundle Road Nundle Road, 23 O'Briens Lane Calala Lane Goonoo Goonoo Road, A15 The Ringers Road The Ringers Road Goonoo Goonoo Road, A15	149	PP24 Day 4 Ride with GPS Day 4 UPPER HUNTER SHIRE COUNCIL LIVERPOOL PLAINS SHIRE COUNCIL TAMWORTH REGIONAL COUNCIL

POLLIE PEDAL 2024 DAILY RUN SHEET LOCAL GOVERNMENT AREAS

Day	From	TO	Via	Turn	Roads	KM	Map Link
Day 5	Tamworth	Armidale	Kootingal	S	Kable Ave		PP24 Day 5
Thursday	8.00am	3.00pm	Moonbi	S	Darling St	121	
24 Oct			Bendemeer	L	Marius St		Ride with GPS Day 5
	Bicentennial	Royal Hotel	Uralla	R	Marius St		
	Park	Cnr Marsh &		R	Bligh St		
	Kable Ave	Beardy St		S	Forest Road		
				L	Bowdens Lane		TAMWORTH REGIONAL COUNCIL
				R	Thornbill Rd		
				L	Kingfisher Drv		
				R	Upper Moore Creek Road		
				R	Moonbi Gap Rd		
				R	Charles St		
				R	Charles St		
				L	New England Highway, A15		
					New England Hwy		
				S	Bridge St		URALLA SHIRE COUNCIL
				R	Uralla Road, B78		
				S	Kentucky Street		ARMIDALE REGIONAL COUNCIL
				S	Dangar St		
				R	Barney St		
				L	Marsh St		

POLLIE PEDAL 2024 DAILY RUN SHEET LOCAL GOVERNMENT AREAS

Day	From	TO	Via	Turn	Roads	KM	Map Link
Day 6 Friday 25 Oct	Armidale 8.00am Central Park Barney St	Dorrigo 2.00pm Hotel Dorrigo Hickory St	Wollomombi Ebor	S R L S R R R	 Central Park, Tingcombe Ln Faulkner St Barney St/B78 Waterfall Way Waterfall Way, B78 Karabin St/Myrtle St/B78 Maynards Plains Rd	 129	PP24 Day 6 Ride with GPS Day 6 ARMIDALE REGIONAL COUNCIL BELLINGEN SHIRE COUNCIL

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POLLIE PEDAL 2024 DAILY RUN SHEET LOCAL GOVERNMENT AREAS

Day	From	TO	Via	Turn	Roads	KM	Map Link
Day 7 Saturday 26 Oct	Dorrigo 8.00am Lookout Mountain Retreat Waterfall Way	South West Rocks 3.30pm Seabreeze Beach Hotel	Bellingen Urunga Nambucca Heads Macksville	S R R R L L R L S S S L L L S R	Maynards Plains Rd Waterfall Way, B78 Short Cut Road Giinagay Way, 16 Cooper St Scotts Head Road, 14 Grassy Head Road, 14 Ocean Ave Stuarts Point Reserve Ocean Ave (Back to Stuarts Point Rd) Stuarts Point Road, 14 Macleay Valley Way, 12 Plummers Lane, 12 South West Rocks Road, 12 Gregory Street, 12 Livingstone St	133	PP24 Day 7 Ride with GPS Day 7 BELLINGEN SHIRE COUNCIL NAMBUCCA VALLEY COUNCIL KEMPSEY SHIRE COUNCIL

POLLIE PEDAL 2024 DAILY RUN SHEET LOCAL GOVERNMENT AREAS

Day	From	TO	Via	Turn	Roads	KM	Map Link
Day 8 Sunday 27 Oct	South West Rocks 8.00am Horseshoe Bay Park	Port Macquarie 1.00pm Town Centre Horton St	Kempsey		Horseshoe Bay Park		PP24 Day 8
					South West Rocks	89	
				L	Memorial Ave		Ride with GPS Day 8
				R	Landsborough St		
				L	Gregory Street, 12		KEMPSEY SHIRE COUNCIL
				S	South West Rocks Road, 12		
				R	Smithtown Road		
				L	Macleay Valley Way, 12		
				S	Remembrance Way		
				R	Macleay Valley Way, 12		
				S	Smith Street		
				L	Lord Street		
				S	Lachlan Street		
				S	Macleay Valley Way		
				L	Slim Dusty Interchange		
				S	(Over A1 then right)		
				R	Pacific Motorway Onramp		
				V/L	Haydons Wharf Road		PORT MACQUARIE HASTINGS COUNCIL
				L	Telegraph Point Road		
				L	Hastings River Drive, 10		
				L	Park Street		
				R	Buller Street		
				S	William Street		
				L	Short St		
				R	Clarence St		
				STOP	Horton St		
						1001	

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WANDERING WARRIORS
POLLIE PEDAL 2024

BRIEF OUTLINE

Benefiting charity:	'Wandering Warriors'
Type of event:	Eight day charity bicycle ride starting at Gosford, NSW and finishing at Port Macquarie, NSW Approximately 1,000 kms
Number of participants:	Riders – no more than 50 per day Volunteers – 20
Start date:	Sunday 20 October 2024
Via:	Pokolbin, Merriwa, Murrurundi, Tamworth, Armidale, Dorrigo, South West Rocks
Finish date:	Sunday 27 October 2024

The following documents have been completed and are attached;

- Daily Run Sheet, schedule of start & finish times and location including list of Classified/Rural/Local roads to be used
- Hazard Analysis & Risk Management Plan
- Event Management Plan
- Vehicular Convoy Plan
- Insurance – Wandering Warriors Certificate of currency for public liability insurance will be provided prior to the ride
- Google Map links to Route Maps showing roads to be used

2/05/2024

EVENT MANAGEMENT PLAN

Overview of Wandering Warriors Pollie Pedal 2024

Each year since 1998, a number of federal politicians and business leaders have participated in a charity bike ride covering over 24,000km and raising over $7.5M for many charities.

In 2024 the Pollie Pedal charity bike ride will be conducted over 1001km in New South Wales in 8 days commencing in Gosford and finishing in Port Macquarie

This year's beneficiary is Wandering Warriors which is a not-for-profit ex-Service organisation and registered charity that supports veterans of Australia's Special Operations Command and their families transitioning from military to civilian life.

Wandering Warriors' website https://wanderingwarriors.org

KEY FEATURES OF POLLIE PEDAL

- This event is the 25th annual Pollie Pedal bike ride
- Previous Pollie Pedals have been held in all Australian states except Northern Territory
- All key organisers of this event have experience in race and event organisation, and cycling long distances
- The Ride Director has been directing Pollie Pedal for 10 years, is a National Level Cycling Commissaire and has vast experience running major cycling events
- The convoy will consist of three (3) groups of riders, each supported by a lead escort vehicle and a rear escort vehicle with approved signage and flashing lights and be located at least 300 metres in advance or rear of the bunch to provide ample warning to approaching vehicles.
  - This distance will be increased according to weather and road conditions such as winding, narrow or hilly sections
- A high standard of marshalling, rider instruction and signage are applied in the organisation and staging of each daily ride
- The hours of the event are set so that riders are riding in daylight hours and not in peak hour traffic in major population centres
- At all times regard will be given to minimal disruption to other road users

SUPPORT VEHICLES
Contained in the Convoy

- 1 lead escort vehicle for each group (3) with flashing light and signage
- 1 follow vehicle for each group (3) with flashing light and signage
- 1 follow vehicle (sag wagon) medium size van (or similar) with a sign displaying the words: "CAUTION – CYCLISTS'. This vehicle has the dual roles of first warning to following motorists and sag wagon to transport riders who have fallen behind
- One experienced and competent rider in each bunch will have radio communication with lead/follow vehicles to warn of approaching traffic and emergencies

2/05/2024

Not part of the Convoy

- 1 vehicle (12 seater bus) which will provide sustenance to the riders and transport riders who have retired from, or fallen behind the convoy
- 1 medium size Pantech truck or van to transport luggage, supplies and spare cycles between each overnight stop.
- 1 sedan to convey marshals and place / pick up signage
- 1 AWD wagon for ride director
- 1 Breakdown Van with bike mechanic

Vehicles will travel on sealed roads only and not off road. Drivers have been chosen due to their experience in performing these rolls in this and/or similar events.

INSURANCE

The Pollie Pedal bike ride is covered under public and products liability insurance of twenty million dollars ($20M) taken out by Wandering Warriors
The following are covered under this policy

- All ride organisers and volunteers
- NSW Police
- NSW Road Authorities
- Local Councils

A copy of the Certificate of Currency will be provided prior to the ride

EVENT MARSHALS

Where necessary, marshals will be stationed along the ride route at intersections to show riders the correct direction. These marshals will wear high visibility vests and instructed to remain at a safe distance from passing traffic. In addition, marshals will be stationed just prior to hazardous and dangerous locations to warn the riders of the conditions. All marshals will be over 21, have a current driver's licence, mobile phone, sunscreen, appropriate headwear and have adequate training in their duties.
*Marshalls will not stop traffic.

SIGNAGE

At approximately ten kilometre (10km) intervals, the Event Marshals will place an approved sign stating

"CAUTION - CYCLISTS AHEAD".

These signs will be positioned facing following and oncoming traffic at locations with good sight distance to warn vehicles that there will be cyclists ahead. The signs will be removed progressively by the support crews when the ride groups have passed the rear sign

2/05/2024

ADHERENCE TO ROAD RULES

Prior to the commencement of each day's ride, the Ride Director will brief all riders, volunteers and marshals on issues relevant to the day e.g. weather conditions, road surfaces, traffic volumes and safety measures. Each evening the Ride Director, at a post ride group meeting, will brief the riders on the standard of riding and address any faults or poor riding behaviour. Each rider must sign a declaration that he/she will adhere to the road rules and any direction given by the Ride Director, Police or local authorities.

ROAD CLOSURES

No road closures are required.

TRAFFIC LIGHTS

All riders and support crew are to comply with the normal operation of traffic lights.

RISK ASSESSMENT AND MANAGEMENT PLAN

A Hazard Assessment and Risk Management Plan has been prepared and is attached.

CONTINGENCY PLAN

The Ride Director will terminate / cancel all or part of each day's ride if the following situations occur:

- Heavy prolonged rainfall
- Extreme temperatures
- Icy road conditions
- Strong winds
- Snow falls
- Loose road surface
- Hailstorms
- Fires or accidents

LIST OF MAJOR ROADS TO BE USED

Where possible, the route will utilise minor roads. Where this is not possible, major roads will be used;

A list of roads to be used is included in the 'Daily Run Sheet' and includes links to Google Maps

Graeme Northey
Ride Director
PO Box 453
Goulburn NSW 2580
0408 482828
graeme.northey@bigpond.com

Zachary Hal...
Safe Work
PWZ
TCT0077758

2/05/2024

July 2024 Budget Variations

Description	*Reason*	*Budget Type*	*Budget Variation*	*Revenue*	*Reserves*	*Grants & Contributions*	*Loans*
Directorate Mgmt - Creative Comm & Exp							
Museum & Archive Collections Valuations	Valuation	Op Exp NR	10,500	0	10,500	0	0
Veness Letter Book Conservation & Digitisation	Book Conservation	Op Exp NR	7,680	7,680	0	0	0
W Kentridge Exhibition	Grant Project	Op Inc NR	(32,000)	0	0	(32,000)	0
W Kentridge Exhibition - Building & Exhibition	Grant Project	Op Exp NR	25,000	0	0	25,000	0
W Kentridge Exhibition - Education & Public Prog	Grant Project	Op Exp NR	5,000	0	0	5,000	0
W Kentridge Exhibition - Projector/Screen - Exp	Grant Project	Op Exp NR	2,000	0	0	2,000	0
	Sub Total		18,180 ↓	7,680 ↓	10,500 ↓	0	0
Learning Communities							
Centrelink Agency Income	Inc Decrease	Op Inc R	6,290	6,290	0	0	0
	Sub Total		6,290 ↓	6,290 ↓	0	0	0
Airport & Aviation Development							
Airport - Qantas Hangar 1 & 2 Repairs	New Project	Cap Exp	75,000	0	75,000	0	0
	Sub Total		75,000 ↓	0	75,000 ↓	0	0
Pilot Training Facility							
IFTT - Grant Application (Reg Precincts & Partnerships	New Project	Op Exp NR	40,000	0	40,000	0	0
IFTT - Aviation Consultant	New Project	Op Exp NR	30,000	0	30,000	0	0
IFTT E Block Renovations	New Project	Cap Exp	230,000	0	230,000	0	0
	Sub Total		300,000 ↓	0	300,000 ↓	0	0

July 2024 Budget Variations

Description	*Reason*	*Budget Type*	*Budget Variation*		*Revenue*		*Reserves*		*Grants & Contributions*		*Loans*
Operations & Projects											
TRC-Pavement Renewal Program-Southern	Grant Project	Cap Rec	518,637		0		0		518,637		0
Roads to Recovery Program-Grant	Increased Grant	Op Inc R	(2,546,448)		0		0		(2,546,448)		0
Burgmanns Lane Rehabilitation	Grant Project	Cap Exp	2,027,811		0		0		2,027,811		0
Kootingal Brigade Station Extension	New Project	Cap Exp	60,000		0		0		60,000		0
Tamworth Velodrome - Site Remediation	Inc Expenditure	Op Exp NR	180,000		0		180,000		0		0
Warwick Road Hillvue Shared Path Design - Exp	Grant Project	Op Exp NR	90,901		0		0		90,901		0
Warwick Road Hillvue Shared Path Design - Inc	Grant Income	Op Inc NR	(90,901)		0		0		(90,901)		0
		Sub Total	240,000	↓	0		180,000	↓	60,000	↓	0
Water & Wastewater											
Split Rock Dam Pump Station – Electrical & Control Re	New Project	Cap Exp	100,000		0		100,000		0		0
		Sub Total	100,000	↓	0		100,000	↓	0		0
		Grand Total	**739,470**	↓	**13,970**	↓	**665,500**	↓	**60,000**	↓	**0**

↓ Budget variation will reduce Council's forecast net operating result and/or bank balance

↑ Budget variation will increase Council's forecast net operating result and/or bank balance

0 If the amount is zero there has been no impact on the forecast operating result and/or bank account balance

Care needs to be taken with regards to analysis

Council spends money to provide services and renew infrastructure for the benefit of the community. Expenditure increases need to be assessed accordingly.

TAMWORTH REGIONAL COUNCIL INVESTMENT REGISTER AS AT 31 JULY 2024

Investment Type: Term Deposit

Financial Institution	S&P Credit Rating	IFRS Classification	Investment Type	Investment Date	Maturity Date	No of Days	Interest Rate	Term Deposit Value
NAB	AA-	Held to Maturity	Term Deposit	8/08/2023	13/08/2024	371	5.20%	4,000,000
CBA	A-1+	Held to Maturity	Term Deposit	17/08/2023	16/08/2024	365	5.55%	10,000,000
NAB	AA-	Held to Maturity	Term Deposit	8/08/2023	27/08/2024	385	5.23%	4,000,000
CBA	A-1+	Held to Maturity	Term Deposit	1/09/2023	30/08/2024	364	5.26%	8,000,000
NAB	AA-	Held to Maturity	Term Deposit	8/09/2023	10/09/2024	368	5.23%	3,000,000
NAB	AA-	Held to Maturity	Term Deposit	8/09/2023	24/09/2024	382	5.23%	3,000,000
CBA	A-1+	Held to Maturity	Term Deposit	8/11/2023	8/10/2024	335	5.35%	2,000,000
NAB	A-1+	Held to Maturity	Term Deposit	4/03/2024	8/10/2024	218	5.10%	2,000,000
CBA	A-1+	Held to Maturity	Term Deposit	8/11/2023	22/10/2024	349	5.35%	3,000,000
CBA	A-1+	Held to Maturity	Term Deposit	28/11/2023	4/11/2024	342	5.36%	3,000,000
Westpac	AA-	Held to Maturity	Term Deposit	16/08/2023	20/11/2024	462	5.20%	5,000,000
Westpac	AA-	Held to Maturity	Term Deposit	23/11/2021	22/11/2024	1095	1.73%	3,000,000
BOQ	BBB+	Held to Maturity	Term Deposit	5/12/2023	10/12/2024	371	5.40%	3,000,000
Westpac	AA-	Held to Maturity	Term Deposit	28/11/2023	17/12/2024	385	5.41%	2,000,000
Westpac	AA-	Held to Maturity	Term Deposit	5/12/2023	19/12/2024	380	5.35%	6,000,000
BOQ	BBB+	Held to Maturity	Term Deposit	5/12/2023	2/01/2025	394	5.40%	4,000,000
NAB	AA-	Held to Maturity	Term Deposit	19/12/2023	13/01/2025	391	5.10%	4,000,000
Westpac	AA-	Held to Maturity	Term Deposit	21/12/2023	14/01/2025	390	5.09%	5,000,000
NAB	AA-	Held to Maturity	Term Deposit	9/01/2024	28/01/2025	385	5.10%	6,000,000
NAB	A-1+	Held to Maturity	Term Deposit	27/02/2024	11/02/2025	350	5.05%	3,000,000
CBA	AA-	Held to Maturity	Term Deposit	24/02/2023	25/02/2025	732	5.00%	5,000,000
Westpac	A-1+	Held to Maturity	Term Deposit	27/02/2024	27/02/2025	366	5.12%	3,000,000
Westpac	AA-	Held to Maturity	Term Deposit	5/12/2023	4/03/2025	455	5.31%	6,000,000
Westpac	AA-	Held to Maturity	Term Deposit	8/03/2023	11/03/2025	734	4.80%	3,000,000
Westpac	A-1+	Held to Maturity	Term Deposit	4/03/2024	25/03/2025	386	5.11%	4,000,000
Westpac	A-1+	Held to Maturity	Term Deposit	4/03/2024	7/04/2025	399	5.07%	4,000,000
Westpac	A-1+	Held to Maturity	Term Deposit	18/04/2024	22/04/2025	369	5.12%	4,000,000
NAB	A-1+	Held to Maturity	Term Deposit	8/05/2024	6/05/2025	363	5.25%	3,000,000
NAB	A-1+	Held to Maturity	Term Deposit	22/05/2024	20/05/2025	363	5.15%	2,000,000
NAB	A-1+	Held to Maturity	Term Deposit	3/06/2024	3/06/2025	365	5.26%	5,000,000
Westpac	A-1+	Held to Maturity	Term Deposit	18/06/2024	17/06/2025	364	5.12%	8,000,000
NAB	AA-	Held to Maturity	Term Deposit	28/06/2024	1/07/2025	368	5.45%	6,000,000
NAB	AA-	Held to Maturity	Term Deposit	2/07/2024	15/07/2025	378	5.45%	6,000,000
NAB	AA-	Held to Maturity	Term Deposit	2/07/2024	29/07/2025	392	5.45%	6,000,000
NAB	AA-	Held to Maturity	Term Deposit	31/07/2024	12/08/2025	377	5.30%	4,000,000
Westpac	AA-	Held to Maturity	Term Deposit	8/03/2023	10/03/2026	1098	4.70%	2,000,000
					TOTAL		**5.12%**	**$ 154,000,000**

Investment Type: Floating Rate Note, Fixed Rate Bond

Financial Institution	S&P Credit Rating	IFRS Classification	Investment Type	Investment Date	Maturity Date	No of Days	Interest Rate	Purchase Value	# Maturity Value
NAB	AA-	Held to Maturity	Fixed Rate Bond	4/11/2022	30/05/2025	938	3.90%	1,000,000	1,000,000
Bendigo	BBB+	Held to Maturity	Floating Rate Note	19/01/2023	2/12/2025	1048	BBSW+0.52%	4,000,000	4,000,000
Bendigo	BBB+	Held to Maturity	Floating Rate Note	15/05/2023	15/05/2026	1096	BBSW+1.25%	3,000,000	3,000,000
Suncorp	A-1	Held to Maturity	Floating Rate Note	19/01/2023	15/09/2026	1335	BBSW+0.48%	5,000,000	5,000,000
NAB	AA-	Held to Maturity	Fixed Rate Bond	4/03/2024	25/02/2027	1088	2.90%	5,000,228	5,241,000
CBA	AA-	Held to Maturity	Floating Rate Note	18/10/2022	18/08/2027	1765	BBSW+1.02%	1,000,000	1,000,000
ANZ	AA-	Held to Maturity	Floating Rate Note	8/11/2022	4/11/2027	1822	BBSW+1.20%	4,000,000	4,000,000
					TOTAL			**$ 23,000,228**	**$ 23,241,000**

 # Floating Rate Notes can be purchased at a premium or a discount. The difference between the Purchase Value and Market Value is recognised by Council on a monthly basis as interest.

Investment Type: On Call, On Hold

Financial Institution	S&P Credit Rating	IFRS Classification	Investment Type	Date Invested	Due Date	No of Days	Interest Rate	Market Value at 31 July 2024
NAB	A-1+	N/A	On Call	N/A	N/A	N/A	4.65%	14,407,706
Westpac	A-1+	Held to Maturity	On Hold		90 Day Maturity		5.10%	5,651,077
					TOTAL			**$ 20,058,783**

TOTAL INVESTMENT REGISTER	**$ 197,299,783**

Comparative Rates

RBA Cash Rate:	4.35%
BBSW:	4.49%

I, Sherrill Young, Tamworth Regional Council Manager of Financial Services (Responsible Accounting Officer) certify as required under Section 16(1)(b) of the Local Government (Financial Management) Regulations 1999, that Council's investments have been made in accordance with the Local Government Act 1993, Regulations and Tamworth Regional Council Investment Policy.

Signed……………………………………………………………………………

Investment By Rating (excluding cash accounts)

S&P Credit Rating							Maturity	
Long Term	Short Term	Portfolio Limit	Counterparty Limit	Bank	Amount invested as at 31 July 2024 ($)	% of Total Investments	Less than 12 months ($)	One to five years ($)
AAA	A-1+	100%	100%			0.00%		
AA+ to AA-	A-1+	100%	100%	ANZ	4,000,000	2.26%	-	4,000,000
				CBA	32,000,000	18.08%	31,000,000	1,000,000
				NAB	67,000,228	37.87%	58,000,000	9,000,228
				Westpac	55,000,000	31.07%	53,000,000	2,000,000
A+ to A	A-1	100%	30%	Suncorp	5,000,000	2.82%	-	5,000,000
A-	A-2	40%	20%	Bendigo	7,000,000	3.95%		7,000,000
				BOQ	7,000,000	3.95%	7,000,000	-
BBB+	A-2	30%	10%	Australian Unity	-	0.00%	-	-
						0.00%		-
					$ 177,000,228	**100%**	**$ 149,000,000**	**$ 28,000,228**

The General Manager or his delegated representative is authorised to approve variations to Council's investment policy if the investment is to Council's advantage or due to revised legislation.

Council's investments are mostly comprised of restricted funds that have been received for specific purposes or funds held for future renewal works. The following table provides an indicative summary of investments held by each fund. The figures provided are based on opening balances from the last completed and audited financial year. The figures provide a guide on the proportion of total cash that is restricted in use:

Investments Held by Fund (including cash accounts)

Fund	Restriction	Amount	%
General	Unrestricted	6,432,278	3.26%
General	Internally Restricted	46,927,940	23.79%
General	Externally Restricted	25,202,634	12.77%
	General Fund Total	**$ 78,562,852**	**39.82%**
Water	Unrestricted	2,018,350	1.02%
Water	Internally Restricted	15,824,269	8.02%
Water	Externally Restricted	20,390,510	10.33%
	Water Fund Total	**$ 38,233,129**	**19.38%**
Sewer	Unrestricted	2,045,647	1.04%
Sewer	Internally Restricted	60,694,992	30.76%
Sewer	Externally Restricted	17,763,163	9.00%
	Sewer Fund Total	**$ 80,503,802**	**40.80%**
	Total Investments	**$ 197,299,783**	**100.00%**