Local Government Association of South Australia

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South Australian Community Wastewater Management System (CWMS) Design Criteria

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Prepared jointly by

South Australian Local Government Association; and
South Australian Department for Health and Wellbeing

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SA Health

Foreword

The *South Australian Community Wastewater Management System (CWMS) Design Criteria* has been jointly prepared by the Local Government Association of South Australia (LGA) and the Department for Health and Wellbeing (DHW). It replaces the *Septic Tank Effluent Drainage Scheme (STEDS) Design Criteria* (LGA, DHW).

South Australia has a large number of STEDS which were designed using the *STEDS Design Criteria*. In recent years there has been a shift towards sewerage systems or combinations of the two, along with the introduction of new technologies and changes to industry practices. The need for a review of the *STEDS Design Criteria* was identified in light of these industry changes.

The South Australian Community Wastewater Management System (CWMS) Design Criteria has been prepared with the objective of providing design criteria for all types of CWMS with particular focus on South Australian conditions. This document is to be reviewed and updated every five years.

The LGA CWMS Management Committee is proud to have provided the impetus and support towards the development of this valuable sector wide resource.

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1 INTRODUCTION

1.1 What is a Community Wastewater Management System (CWMS)?

A CWMS is used to collect, treat and reuse/dispose of wastewater produced in the community in a safe, cost effective and environmentally sustainable manner. The term CWMS can encompass many different types of wastewater schemes including collection, treatment and reuse methods to manage wastewater including sewage, septic tank effluent, or combinations of the two. CWMS components are outlined in Figure 1.

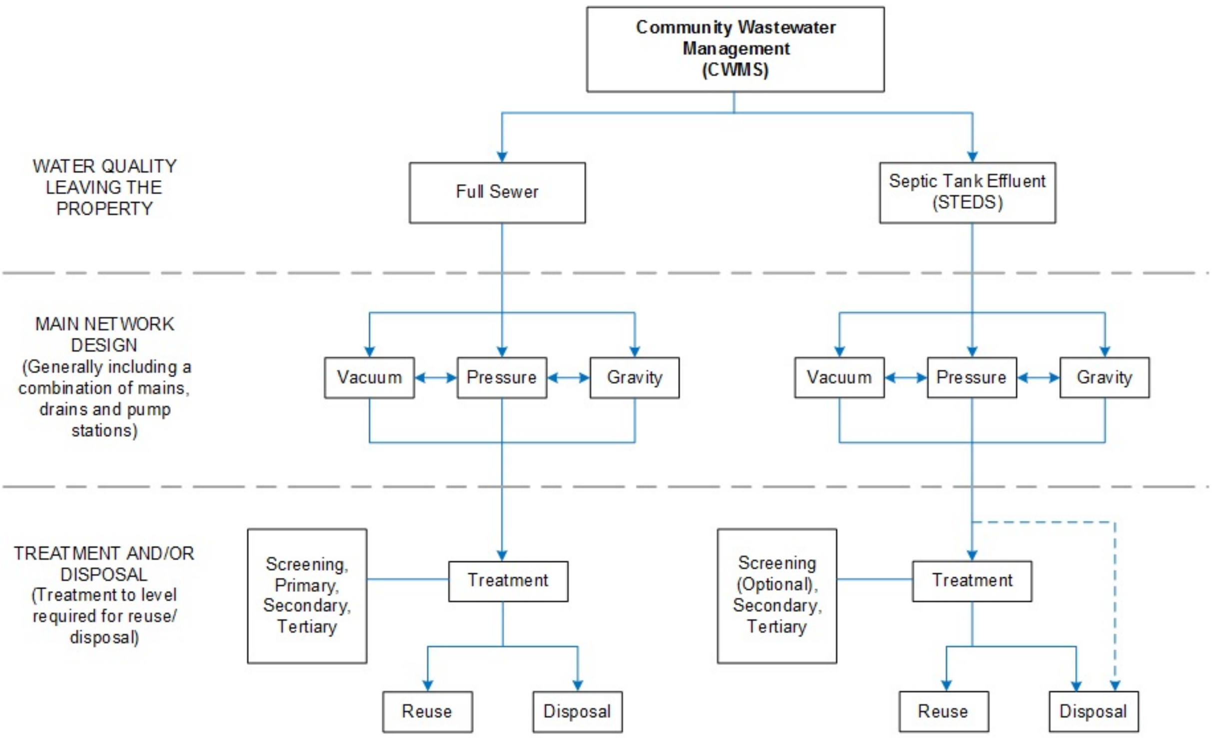

Figure 1: Community wastewater management system components

A community wastewater management system (CWMS) is defined under the South Australian Public Health Regulations 2013 as: “a system for the collection and management of wastewater generated in a town, regional area or other community, but does not include SA Water sewerage infrastructure.”

Systems that collect septic tank effluent for treatment and reuse or disposal are commonly known as septic tank effluent drainage schemes (STEDS). South Australia has a large number of STEDS which were designed based on the Local Government Association (LGA) STEDS Design Criteria.

Note: In some cases STEDS has also been known as a ‘septic tank effluent ***disposal*** *scheme’. For the purpose of this document, the acronym STEDS will be referred to as ‘septic tank effluent drainage scheme’, as this is the definition given in DHW’s prescribed codes.*

South Australia also has a number of sewerage schemes, and schemes which collect a combination of sewage and STEDS effluent.

This document has been developed by the LGA and DHW to:

- provide a single point of reference for CWMS design criteria that covers STEDS as well as sewerage systems in South Australia;
- review and replace the STEDS Design Criteria, as STEDS design requirements are not included in any industry code;
- provide a methodology for determining CWMS design loads;
- reflect new technologies and changes to industry practices; and
- help designers and Water Industry Entities (WIEs) prepare designs that comply with LGA and DHW requirements in South Australia.

1.2 Document scope

This document outlines design criteria for CWMS in South Australia including wastewater collection systems, treatment processes and recycled water disposal or reuse systems. It covers sewerage schemes, STEDS and schemes which have a combination of sewage and STEDS effluent. All new schemes, and extensions to existing schemes, can be designed using this document. Existing schemes do not need to be retrofitted to meet the requirements of this document. SA Water schemes are not included in the definition of CWMS under the South Australian Public Health Regulations 2013 and therefore are not included in the document scope.

Water Services Association of Australia (WSAA) codes of practice shall be adopted when designing sewerage schemes that include gravity, vacuum and pressure collection networks. However, this document outlines some variants that designers shall consider when developing a CWMS in South Australia. These variances only apply to CWMS that are subject to DHW approval in South Australia. Water Industry Entity's (WIE) are not obliged to accept any variations from the WSAA codes and therefore the relevant WIE should be consulted before a CWMS is designed.

Note: Combinations of requirements from various codes along with the use of this document is not permitted. Designs are to be based on one code or guideline only, for example, Table 5.6 of WSA02-2014 cannot be used to determine maximum equivalent connections for gravity sewers, as the definition of equivalent persons is different under WSAA codes compared to the definition in the CWMS Design Criteria. See Appendix A for maximum equivalent connections for gravity sewers using the CWMS Design Criteria.

This document should be read in conjunction with the most recent revisions of the Community Wastewater Management System Code (DHW), relevant WSAA codes, Environment Protection Authority (EPA) guidelines and policies, Office of the Technical Regulator guidelines and requirements, current legislative requirements and additional requirements of the WIE, as defined under the *Water Industry Act 2012*.

Note: This document assumes the WIE is the scheme owner. Where this is not the case, the WIE will need to consult with the scheme owner on all matters relating to CWMS design, installation, operation and maintenance.

2 DESIGNING OR EXTENDING A CWMS

2.1 Designing a CWMS

The first step in designing a CWMS is to understand the legislative and approval requirements (Section 3) and then calculate the design loads of the CWMS (Section 4). Existing site conditions, WIE requirements, and the proposed end-use of the recycled water will all influence the most appropriate type of collection and treatment system – whether it's a STED system (Section 5) or sewerage system with gravity, pressure, vacuum or combination drainage systems (Sections7–9). Pump stations are covered in Section 6.

Once a collection system is chosen, the next step is to consider treatment and storage facilities (Sections 10 and 11) to align with the proposed end-use of the recycled water (Section 12). Management plans (Section13) need to be prepared at certain stages throughout the design process, and as-constructed drawings (Section 14) are needed once the CWMS is constructed (as a condition of DHW approval).

2.2 Water Industry Entity (WIE) requirements

The WIE requirements are to be read in conjunction with this document and accounted for within the final design. These may include the use of specific equipment to allow for standardisation and to optimise operational and maintenance activities and costs, or specific operational and/or contingency requirements for a scheme. The WIE may nominate increases to the design loads required by this document, but a reduction in design load shall not be permitted.

Designers are responsible for confirming design requirements with the WIE and should include acknowledgement of the required criteria as part of the DHW application.

2.3 General design considerations

CWMS design considerations will vary depending on scheme complexity, reuse application, DHW requirements, and local WIE and/or LGA requirements.

Designers are to provide a methodology for the scheme's operation/operability as a part of their system design.

Designers and WIEs shall consider coordinating the design across the various components of the scheme to make sure that each component is designed within the requirements of the scheme as a whole. For example; if the wastewater treatment plant (WWTP) is procured separately to the collection network, then interface issues and design responsibilities and liabilities are to be clearly identified to all parties.

Scheme designers should consider the following aspects as a part of the design process:

- design loads (as outlined in Section 4)
- the extent of the CWMS collection area, the treatment process and the method of reuse or disposal of treated wastewater
- confirmation of the wastewater source(s)
- components within the scheme (e.g. sizes of pipework, tanks, chambers, pumps, aerators, filters or any other equipment)

- the name, make, model, size, description, function, location, material used, classification, duty, capacity, and type of all components and equipment within the scheme
- treatment for noise and odour control
- buffer distances to various scheme components
- site screening
- perimeter fencing and access gates
- vehicular access and manoeuvring
- existing land use
- land title particulars
- identification of property easement proposals where applicable
- emergency storage provisions
- scheme water balance that shows no overflow from the scheme in a 1:10 wet year (Section 11)
- production of management plans (Section 13) and timing in relation to when they need to be produced and approved
- confirmation from the relevant WIE that they are satisfied with SCADA (and associated data management), WWTP/pump station lighting and security facilities
- DHW approval is conditional on the works being certified by an independent suitably qualified and experienced wastewater engineer prior to the scheme becoming operational. Scheme owners should consider this upfront so that appropriate provisions can be made during construction for the certifying engineer to inspect and verify the works. Construction and procurement procedures must allow for system certification, which may include site inspections, hold points, witness points, provision of ITP records etc to allow the certifying engineer to assess the suitability of the construction in accordance with DHW approval conditions.

2.4 Pipe identification

It shall be noted by scheme designers that pipe identification forms an important part of the contract documentation. Pipe colour coding and the use of pipe identification tape shall be strictly in accordance with WSAA requirements. Drinking water pipework, including blue line polyethylene (PE) pipe **shall not** be used for wastewater or recycled water applications.

Scheme certifiers must include pipe identification in their certification process. The correct pipe colour coding and use of pipe identification tape must be confirmed before a scheme is certified in accordance with DHW requirements.

2.5 Collection system considerations

When designing a collection system, consider:

- design parameters for drains and pumping mains as well as pump station size, including provisions for emergency storage, system scour, rising main retention times, noise, visual amenity, flood impacts etc.
- drawings of the collection network, including details of the drain line gradient, pipe size, pump stations and other associated structures
- specifying the reinstatement requirements, making sure that they comply with the relevant road authority's requirements, be that Department of Planning, Transport and Infrastructure (DPTI), council or a private entity.

2.6 Treatment facility considerations

When designing a treatment facility, consider:

- recycled water end-use, minimum treatment requirements and corresponding treated water quality targets, including but not limited to pathogen log reduction targets, water quality targets for BOD_5, suspended solids, E. coli, and residual chlorine, and other targets such as salinity, nitrogen, phosphorus, alkalinity, turbidity etc. Note that DHW may have specific operational and monitoring requirements.
- design parameters, including inflow wastewater quality and quantity (BOD_5, nitrogen, phosphorous and suspended solids etc)
- non-residential flow volume and quality
- trade waste (considering the WIE's trade waste policy)
- operating philosophy, process and instrumentation diagram (PID) and process flow diagram
- a site plan, which shows the location and layout of the treatment plant; proximity of residential dwellings; any associated storage tanks, lagoons, channels, drains, water courses and bores; soil sampling locations; and the land area to be used to reuse or dispose of treated wastewater
- wet weather impacts
- flood protection
- noise and odour impacts
- a contour plan across the treatment plant and reuse or disposal area
- the land area occupied by the plant and the reuse or disposal area
- sludge volume and storage, handling and disposal techniques
- a plant fault alarm system, including remote alarm monitoring, messaging and SCADA
- plant redundancy.

2.7 Storage, reuse or disposal considerations

When designing storage lagoons and reuse or disposal systems, consider:

- a site and soil assessment of the recycled water irrigation site or the disposal site (including proximity to housing, public areas, roads, watercourses, bores and marine environments) as well as irrigation application methods and irrigation system technical design details. A sustainable irrigation rate shall be determined for reuse applications. An application rate of 4.5 $L/m^2/d$ as stated in the Onsite Wastewater Systems Code should not be applied to the irrigation area by default
- the proposed use of the irrigated area (e.g. public access, food crop, stock grazing etc.)
- the proposed method of irrigation (e.g. surface spray, drip, subsurface etc.) and irrigation rate in L/s and $L/m^2/day$
- an irrigation design and layout plan with sprinkler type, range, droplet size, direction of throw, and height
- storage requirements and water balance showing no overflow for a 1 in 10 wet year
- nutrient balance
- retention or withholding periods
- the times when irrigation will occur
- the soil infiltration rate
- flood risk (e.g. 1 in 10 year event for system capacity and 1 in 100 year event for site operation and access)
- rainfall and evaporation details (from BOM)
- runoff mitigation measures

- monitoring requirements
- other disposal options (evaporation, transpiration, soakage trenches etc).

2.8 Control and data acquisition

The requirements for remote asset monitoring and control will vary from scheme to scheme. The WIE shall be consulted in relation to their requirements for control and data acquisition. The DHW should also be contacted for specific control and data acquisition requirements that protect public health. In the event of no other guidance being provided, the system designer should consider:

- Accessibility to the system control and data acquisition interface over secure fast data links.
- Linking pump stations to the SCADA, messaging or radio systems to provide basic alarms for single pump failure and critical alarms for two pumps failed and failure of the communication link. This hardware can provide pump control as well as basic information about the state of the controls.
- Capturing information on the flow into the wastewater treatment facility. Specifically for wastewater treatment plants, this should include instantaneous flow trended over at least one week (and preferably over at least 30 days), weekly flow data for at least eight weeks, monthly flow data for at least one year, and annual flow data for five years. This will help predict future upgrade requirements and forecast service life, water balance, and flow management data allowing reuse and disposal strategies to be optimised.
- WWTP monitoring; inlet screen condition (if installed); balance tank levels; bioreactor states, including levels, current operation states (aerators on or off; fault or availability/absence of power supply); and the operational state of any transfer pumps, including no flow conditions or overpressure/under pressure protections; dissolved oxygen (if required) and water temperature.
- Capturing information on flow out of the wastewater treatment plant. This should include discharge water pH; discharge flow rates for contact time and residual total chlorine or free chlorine; filter condition; and turbidity on discharge.
- Capturing irrigation data, including flow and discharge pressure as well as system status or system alarms.

3 LEGISLATIVE AND APPROVAL REQUIREMENTS

3.1 General legislative and approval requirements

The establishment of a CWMS is subject to, but not limited to, the following legislative requirements:

- The approval of the Department for Health and Wellbeing under the provisions of the South Australian Public Health (Wastewater) Regulations 2013.
- Licensing under the provisions of the Environment Protection Act 1993, as follows[1]:
    - In the case of works located wholly or partly within a water protection area: CWMS with the capacity to treat, during a 12 month period, more than 5 megalitres of wastewater
    - In the case of works located wholly outside of a water protection area: CWMS with the capacity to treat, during a 12 month period, more than 50 megalitres of wastewater
- Licencing and other requirements for Water Industry Entities under the provisions of the Water Industry Act 2012.
- Approval of the Development Assessment Commission or planning authority (for example where the works involve the construction of a facultative or storage lagoon) or where required by overarching planning and building related legislation or local government planning rules (pursuant to the Development Act 1993).
- The requirements of the Office of the Technical Regulator (OTR).
- Any other Acts or regulations for which approval is required to undertake the works associated with the establishment or operation of a CWMS.

3.2 Relevant codes, guidelines and standards

The codes and guidelines that apply to CWMS design include the:

- Australian Guidelines for Water Recycling (AGWR): Managing Health and Environmental Risks (Phase 1) (2006). Natural Resource Management Ministerial Council, Environmental Protection and Heritage Council, Australian Health Minister's Conference.
- Community Wastewater Management Systems Code. Department for Health and Wellbeing (formally Department for Health and Ageing), Government of South Australia.
- Onsite Wastewater Systems Code. Department for Health and Wellbeing, Government of South Australia.
- Guidelines for Non-drinking Water in South Australia, Office of the Technical Regulator (OTR) including:
    - Part 0 – Glossary of terms, abbreviations and references
    - Part 1 – Infrastructure
    - Part 2 – On-site plumbing.

The following WSAA codes also apply to CWMS design:

- WSA 01 – Polyethylene Pipeline Code of Australia
- WSA 02 – Sewerage Code of Australia
- WSA 03 – Water Supply Code of Australia (Supplement) Dual Water Supply Systems
- WSA 04 – Sewage Pumping Station Code of Australia
- WSA 06 – Vacuum Sewerage Code of Australia
- WSA 07 – Pressure Sewerage Code of Australia

[1] Information correct at time of publishing. Contact the EPA for licensing requirements.

- WSA 302 – SCADA Guidelines.

Technical design criteria for STEDS are included within this document, as STEDS are not included in any WSAA code.

Other documents relating to STEDS include:

- LGA STEDS technical specifications and standard STEDS drawing details (note that these shall be applied to STEDS designs only. They shall not be applied to full sewage sewerage schemes).
- LGA Standard Brief for Designing, Calling Tenders and Superintending Construction of STEDS in South Australia.
- South Australian STEDS – Guidance Notes for the Preparation of an Operation and Maintenance Manual (2005). Environment Protection Authority

The following Australian Standards have been referenced in this document:

- AS/NZS 1260 PVC-U pipes and fittings for drain, waste and vent applications
- AS1345 Identification of the contents of pipes, conduits and ducts
- AS/NZS 1477 PVC pipes and fittings for pressure applications
- AS1646 Elastomeric seals for waterworks purposes
- AS1725.1 Chain link fabric fencing security fences and gates – general requirements
- AS/NZS 2032 Installation of PVC pipe systems
- AS/NZS 2033 Installation of polyethylene pipe systems
- AS/NZS 2280 Ductile iron pipes and fittings
- AS2566.1 Buried flexible pipelines structural design
- AS2566.1 Buried flexible pipelines installation
- AS/NZS 3500 Plumbing and drainage
- AS/NZS 3500.2 Plumbing and drainage Part 2:sanitary plumbing and drainage
- AS3735 Concrete structures retaining liquids
- AS/NZS 4087 Metallic flanges for waterworks purposes
- AS/NZS 4130 Polyethylene (PE) pipes for pressure applications
- AS/NZS 4441 Oriented PVC (PVC-O) pipes for pressure applications (ISO 16422:2014, MOD)
- AS/NZS 4765 Modified PVC (PVC-M) pipes for pressure applications
- AS 4883 Air valves for sewerage
- AS/NZS 5065 Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications.

AS/NZS 3500 Plumbing and Drainage shall be read in conjunction with this document to determine the connection depth requirements for each allotment.

Where Australian and international standards are quoted in this document, the latest revision of that standard shall be applicable. If a standard is not referenced here, or throughout this document, that does not exclude a designer's obligations to comply with all relevant standards.

The EPA Acts, policies and guidelines to be read in conjunction with document include:

- The Environment Protection Act 1993
- Evaluation distances for effective air quality and noise management (August 2016)
- Wastewater Lagoon Construction Guidelines (October 2018)
- Septic Tank Sludge Management Guidelines (2016)
- Draft – South Australian Biosolids Guidelines for the Safe Handling and Reuse of Biosolids (April 2017)
- Liquid Storage Guidelines – Bunding and spill management (2016)

- Relevant environmental protection policies.

The latest edition of each code, standard or guideline should be applied when designing a CWMS and it is the designers' responsibility to ensure that the latest editions are used.

3.3 Department for Health and Wellbeing approval

Under the South Australian Public Health (Wastewater) Regulations 2013, DHW approval is required prior to undertaking wastewater works. The definition of *wastewater works* includes:

- the installation of a CWMS (including a temporary system) or part of a CWMS; or
- the alteration of a wastewater system involving a change to the capacity of the system or a change in the type of system used for collecting or managing wastewater (including changes to the reuse or disposal path); or
- the decommissioning of a wastewater system (excluding a temporary system); or
- the connection of a wastewater system to a CWMS or the disconnection of a wastewater system from a CWMS; or
- the connection of a CWMS to SA Water sewerage infrastructure of the disconnection of a CWMS from SA Water sewerage infrastructure.

Note: Extensions to CWMS also require DHW approval.

The DHW approval applies conditions to the installation, operation and management of the CWMS. Requests for modifications to approval conditions also need DHW approval.

The submission details required when seeking DHW approval will depend on the type of scheme, the scheme's complexity and type of reuse or disposal. Applicants are referred to the Community Wastewater Management Systems Code for application requirements. It is recommended that the WIE consult with the DHW early in the design process.

A total Equivalent Population (EP) is required by DHW to identify the capacity of a CWMS. For the purposes of DHW applications the scheme EP will be defined using the following equation.

EP = (ADF at the WWTP) / FEP (refer to Section 4.2 and 4.3)

4 CWMS DESIGN LOADS

4.1 Introduction

When determining CWMS design loads a number of factors need to be considered. These include:

- the number of persons using the system
- the amount of wastewater generated by each person
- the amount and quality of wastewater generated by non-residential premises
- the potential for seasonal influxes into the CWMS
- the impact of climatic conditions on treatment and disposal / reuse
- existing flow data
- historic population data

Each component of the CWMS needs to be sized appropriately to ensure that the likelihood of overflows is minimised, that adequate treatment is achieved by providing appropriate residence times through treatment processes and to ensure that storage lagoons and reuse or disposal systems are sized appropriately.

This section provides a method for calculating CWMS design load in terms of the Average Daily Flow (ADF). The ADF is based on a combination of residential and non-residential flows including the Number of Connections (NC), Flow per Equivalent Person (FEP) and the Rate of Occupancy (RO).

This section also provides a methodology for calculating peak flows. Each component of the CWMS must be sized appropriately to accommodate peak flows. This is represented by the term Hydraulic Design Load (HDL). The hydraulic design load is different for each component of the CWMS. It is calculated by applying peaking factors to the ADF.

Each CWMS also has a non-hydraulic design load which is used to design the wastewater treatment facility. For the purpose of this document, the non-hydraulic design load refers to the Biological Oxygen Demand (BOD) and Suspended Solids (SS) load.

4.2 Average Daily Flow

The Average Daily Flow (ADF) can be estimated using the following equation:

$$ADF = (NC \times FEP \times RO) + NRF$$

Where:
ADF = average daily flow (L/day)
NC = number of residential connections
FEP = flow per equivalent person (Section 4.3)
RO = rate of occupancy (Section 4.4)
NRF = non-residential flows (Section 4.5).

Note that the adopted ADF shall account for reasonable growth, which may be determined from township zoning, strategic plans or in consultation with the local council's planning department.

4.3 Flow per equivalent person

The design flow is based on the Flow per Equivalent Person (FEP):

FEP = 170 L/p/d (litres per person per day)

The FEP can be reduced to 140 L/person/day where a reticulated town water supply is not available (i.e. the dwellings rely only on rainwater). A design FEP of 170 L/p/d shall be adopted where properties are located in the River Murray region and draw water direct from the river through a private supply, even if there is no potable mains water supplied to the site.

Note that the FEP does not vary between STEDS and full sewage schemes (historically, lower per person flow rates had been used for STEDS).

The EP is the total equivalent population for the scheme. The scheme EP will be defined using the following equation:

EP = (ADF at the WWTP) / FEP

4.4 Rate of occupancy

The Rate of Occupancy (RO) shall be assumed to be 2.6 p/d (persons per residential dwelling).

This rate will apply to any new schemes being designed for a greenfield site. The occupancy rate may be varied where a scheme is being retrofitted to a township if it is supported by census or ABS data and an approved development plan, subject to approval by the local council, WIE and DHW.

4.5 Non-residential flows and trade waste

Non-Residential Flows (NRF) for brownfield sites shall either use actual flow data or shall be estimated using Appendix E of the South Australian Onsite Wastewater Systems Code.

Non-residential flows for greenfield sites shall be determined using Table B1 of WSA02, unless sufficient information is available to enable the use of Appendix E of the South Australian Onsite Wastewater Systems Code.

Non-residential premises with trade waste shall not be connected to the scheme unless specific design load parameters have been established and the WIE has confirmed that such a connection can be accepted. Industrial loads shall be calculated using actual data or in accordance with the South Australian Onsite Wastewater Systems Code and advice from relevant authorities.

WIE's shall determine the impacts of including trade waste into the CWMS, including the pre-treatment required and the impact of:

- hydraulic, biological, organic and non-organic loads on the system
- chemicals on system materials and treatment processes
- impact of chemicals on the disposal path.

WIE's are required to prepare a trade waste policy if trade waste is to be accepted into the scheme.

4.6 Hydraulic design load

Hydraulic Design Loads (HDL's) shall be adopted for CWMS that collect and treat wastewater (septic tank effluent or full sewage).

The HDL represents peak flows in the CWMS. The HDL is calculated according to the system component and reflects the risk associated with peak flows detrimentally impacting that component of the scheme. For example, components with little capacity to buffer peak flows (such as pipes and pump stations) have larger peaking factors, and components with large storage buffers have lower peaking factors due to their ability to buffer short term peak flows.

Historical data has shown that certain regions in South Australia have different peaking factors. These regions can best be defined by the average annual rainfall (from BOM). This difference is likely to reflect differing water use associated with geographical location. The peaking factor is not directly related to expected infiltration rates caused by high rainfall.

Wet weather flows have not been included in the assessment of HDL. Requirements for wet weather flows will be at the determination of the WIE.

The HDL shall be equal to the ADF multiplied by the peaking factor (PF). The contribution from any upstream pumped flows, including domestic pumped discharges and network pumps, need to be added to the HDL.

$$HDL = (ADF \times PF) + \text{sum of upstream pumped flows}$$

The peaking factors for each scheme component shown in Table 1 shall be applied to the scheme ADF to determine the HDL for each component.

Table 1: System peaking factors

System component	Rainfall less than or equal to 400 mm per year	Rainfall between 401 mm and 599 mm per year	Rainfall 600 mm or greater per year
Reticulation network*†	3	4	5
Pump duty†	3	4	5
Pump station† emergency storage	1	1.25	1.5
Lagoon treatment system	0.75	1	1.25
High rate algal ponds (HRAP)	0.75	1	1.25
Winter storage/irrigation	0.75	1	1.25
Non-lagoon WWTP†‡	1	1.25	1.5

Note: rainfall is the mean rainfall for that area as stated by BOM.

*This includes gravity drains, pressure sewerage pipes and vacuum system drains.

† See Section 4.7

‡Additional requirements for WWTPs are described in Section 4.8.

4.7 Seasonal loadings

Peaking factors shall be adjusted for townships or areas of townships impacted by seasonal loadings. These areas may include shack sites along the River Murray or coastal towns with large proportions of holiday homes. The designer, in consultation with the WIE and the Council shall identify these areas using local development plans (where available) and local knowledge on property use.

For areas impacted by seasonal loadings the peaking factors in Table 1 shall in the absence of actual flow/population data be increased by a further 50% for each of the following downstream scheme components:

- reticulation network
- pump duty
- pump station emergency storage
- non-lagoon WWTP's
- irrigation areas with no buffering capacity provided by a storage lagoon

If reliable flow or population data is available the designer may determine a scheme specific seasonal factor with agreement of the WIE, Council and DHW.

The increased flow generated from areas impacted by seasonal influxes needs to be applied to all downstream infrastructure.

The additional load factor represents increased occupation and hydraulic loading due to seasonal influxes.

Therefore, HDL (from the area nominated as being affected by seasonal loading) is equal to the ADF of the gravity network multiplied by 1.5 times the PF for the scheme components affected. The sum of the upstream pumped discharges also needs to be added.

$$HDL = (ADF \times 1.5 \times PF) + \text{sum of upstream pumped flows}$$

The annualised flow based on ADF is not adjusted and remains the same as specified in Section 4.2.

Note: The annualised flow is not increased, as most areas impacted by seasonal influxes have corresponding periods with minimal occupation. However the WIE may choose to increase annual flows to assist their management of the scheme. The WIE should be consulted to determine if an increase in annual volumes should be applied.

4.8 WWTP design requirements

4.8.1 WWTP emergency storage

WWTPs shall have the capacity for emergency storage (for power outage and plant failures/maintenance) equal to 50% of the ADF, calculated as per the equation in Section 4.2. The WWTP must have the capacity to treat the total emergency storage load over the following 72-hour period. Alternatively, the designer can outline other emergency response measures or procedures in lieu of treating the water over 72 hours. However, measures to manage the increased risk for alternative proposals must be documented and approved by DHW and the WIE prior to construction.

The WIE shall be consulted to ensure that they are satisfied with an emergency storage capacity of 50% ADF. The WIE may require greater volumes. The DHW will accept higher storage requirements at the WIE's request. However, the emergency storage capacity shall not be reduced below 50% ADF.

4.8.2 WWTP wet weather event peak flows

The wet weather event peaking factors for WWTPs (Table 2) shall be applied directly to the ADF to determine the peak wet weather flow for the plant. The proposed method of catering for wet weather flows shall be detailed in the DHW application and documented in the operations manual. Methods may include (but are not limited to) use of in-line or off-line storages or use of wet weather cycles to allow for larger flows and/or more cycles per day. Emergency storage (Section 4.8.1) can also be used to cater for wet weather events.

The WWTP must have the capacity to treat the peak wet weather flow.

It should be noted that the wet weather peaking factors, outlined in Table 2, are not additional to the peaking factors provided in Table 1. The wet weather peaking factor in Table 2 is used to determine a one-off event flow for the WWTP and is applied directly to the ADF. The peaking factors in Table 1 are applied to work out the normal design flows through the plant.

Table 2: Daily wet weather peaking factor for wastewater treatment plants (WWTPs)

System component	Rainfall equal to or less than 400 mm/year	Rainfall between 401 mm/year and 599 mm/year	Rainfall equal to or greater than 600 mm/year
WWTP wet weather peaking factor	1.5	2	3

For existing CWMS, the wet weather peak flow may be varied if it is supported by wet weather flow data, subject to approval by the local council, WIE and DHW.

4.9 Non-hydraulic design criteria

The non-hydraulic design criteria for lagoons and WWTPs are outlined in Table 3. It is accepted that BOD and SS values can vary from scheme to scheme. The designer shall determine how the design would cater for loads that vary by +/- 50% from the values in Table 3.

If real data is available for the system in question then it can be used, allowing for reasonable variations in the baseline loads.

Table 3: Typical non-hydraulic wastewater load rates for residential schemes

Wastewater type	BOD	SS
STEDS effluent	40 g/EP/d	25 g/EP/d
Sewage	60 g/EP/d	50 g/EP/d

5 SEPTIC TANK EFFLUENT DRAINAGE SCHEMES

5.1 Introduction

This section outlines design criteria for septic tank effluent drainage schemes (STEDS) only. It shall not be used for design of sewage schemes.

The LGA standard STEDS technical specifications and LGA standard STEDS drawing details can be found on the LGA website.

5.2 Gravity STEDS drains

All gravity STEDS drains shall be designed to comply with AS/NZS2566.1 Buried flexible pipelines – Structural design and AS/NZS2566.2 Buried flexible pipelines – Installation, and the additional criteria outlined in this section.

5.2.1 Pipe sizes

A pipe with a 100 mm diameter (DN100) shall be used at a minimum.

A 150 mm diameter pipe should be adopted to ensure adequate ventilation where design flows indicate that a 100 mm diameter pipe will flow at more than 60% of full pipe flow capacity at the ultimate HDL. Similarly, the next available larger size of pipe should be used when the design flow exceeds 60% of the full pipe flow capacity of the pipe initially considered.

Gravity drains shall be designed to cater for maximum system flow in that segment of the drain, including input from rising mains and individual property pumps as applicable.

5.2.2 Minimum grades

The minimum pipe grades for STEDS drains are shown in Table 4.

Table 4: Minimum pipe grades

Pipe Size	Minimum Grade
100 mm diameter	0.4%
150 mm diameter	0.25%
≥ 225 mm diameter	0.15%
Directionally-drilled drain (all sizes)	1%
Top end of drain (all sizes)	1%

The top end of each drain shall be laid at 1% until the HDL contribution exceeds 0.1 L/s. Where directional drilling is used at the top end of the drain, a minimum grade of 2% shall be applied until the HDL exceeds 0.1 L/s.

The minimum grade is based on flow rate and not pipe size. Pipes of a larger size than would be required to carry the HDL (i.e. oversized pipes that have been used to provide additional emergency storage) shall not be laid at lower grades. The minimum grade for the upsized pipe segment shall be selected in accordance with the minimum grade required for the minimum pipe size applicable to that pipe segment. For example, if a 225 mm pipe is used to provide storage when a 100 mm pipe would be sufficient based on the HDL, then the minimum grade shall be 0.4%.

The minimum design grade on any directionally-drilled section of drain shall be specified as 1% (2% at top end of drain). This has been set to allow for variances in the drilled grade. If the pipe grade after construction does not meet 1% but complies with minimum pipe grades for non-bored pipe, then that pipe shall be deemed to be at a compliant grade.

Minimum grades should not be used as a standard, they should only be applied where drain depth is critical due to ground conditions or topography. Designers shall account for soil conditions, founding of the pipeline and the impact of likely pipe settlement on future system performance when setting the minimum grade of the drain lines.

5.2.3 Steep gradients

The designer shall consider the impact of steep gradients within the STEDS network, particularly with regard to odour control and the need for trench stops to prevent water accumulation around the drains.

Additional venting requirements shall also be considered (see Section 5.14).

5.3 Materials

Materials for gravity drains and rising/pumping mains shall comply with all the relevant Australian Standards and shall be as follows.

5.3.1 Gravity drains

Rigid unplasticised polyvinyl chloride (PVC-U)

PVC-U pipes and fittings shall comply with AS/NZS1260. PVC-U pipes and fittings shall be installed in accordance with AS/NZS2032, AS/NZS 3500.2 and AS/NZS 2566.2

Except for expansion joints, pipes and fittings shall have ends formed for solvent-welded joints. They shall be joined using a cleaning fluid and solvent cement suitable for use with the pipe and fittings in accordance with the manufacturers' directions.

The minimum stiffness shall be SN8.

Polyethylene (PE) pipes

PE pipelines shall comply with WSA01 Polyethylene Pipelines. PE pipes and fittings for gravity sewers shall comply with AS/NZS 5065.

Pressure pipes that meet AS/NZS 4130 can also be used at a designer's discretion and where directional drilling requires pressure pipes.

PN 12.5 is the minimum pipe class for HDPE pipe used as gravity drain.

PE pipe is typically used when directional drilling is used to install the gravity drain. The pipe shall have an internal diameter no less than the equivalent nominal diameter of the adjoining PVC drain.

PE pipe used for gravity drains shall be supplied in lengths and shall not be installed from a coil/roll.

The designer shall specify the details for connecting from the PE drain to the adjoining PVC drains and shall account for thermal expansion and root intrusion.

All joints shall be made by electrofusion welding or with flanges using stainless steel backing rings with stainless steel bolts, washers and nuts. The contractor shall seek written approval from the WIE for an alternative to stainless steel. Compression fittings are not acceptable, only electrofusion butt welding shall be used for pipe jointing where directional drilling is used.

5.3.2 Rising/pumping mains

Rising main hydraulic design criteria is included in Section 6.

Rigid unplasticised polyvinyl chloride (PVC-U)

PVC pipes shall be of a minimum Class 12 pressure rating.

The following PVC pipes can be used for pressure applications:

- PVC-U pipes to AS/NZS 1477
- PVC-M pipes to AS/NZS 4765
- PVC-O pipes to AS/NZS 4441.

PVC-U fittings shall comply with AS/NZS 1477 and be at least a class higher than that of the rising/pumping main. Ductile iron fittings which comply with AS/NZS 2280 can be used where PVC fittings of a higher class (strength) are not available.

PVC pipes up to 40 mm in internal diameter shall be joined by solvent cement only. Pipes and fittings larger than 40 mm in internal diameter shall have ends formed for rubber ring joints. Rubber rings shall comply with AS1646 and may be made of natural rubber or of styrene-butadiene.

Polyethylene (PE)

PE pipes shall comply with AS/NZS 4130, WSA01 Polyethylene Pipelines and shall comply with a minimum pressure rating of PN12.5.

All joints shall be made by butt welding, electrofusion welding or with flanges using stainless steel backing plates.

Blue line PE pipe is not to be used for sewer or recycled water applications (even if sleeved).

Other Pipe Materials

Other material approved for use in a high sulphide environment can be used at the discretion of the designer in consultation with the WIE.

5.3.3 Gravity drains and rising/pumping mains above ground

Where gravity drains and rising/pumping mains are above ground (e.g. creek crossings), ductile iron cement lined (DICL) that meets AS/NZS 2280 shall be used. Cement lining shall be suitable for sewer application (calcium aluminate) and epoxy lining for fittings shall be used. Other pipe materials such as polyethylene, fibreglass and stainless steel may be considered.

Pipe and fitting joints shall be either flanged or connected using a spigot and socket with a jointing mechanism such as a tyton joint. All fittings shall be in accordance with AS/NZS 2280. All flanges shall be in accordance with AS/NZS 4087.

If DICL piping is installed below ground it shall be protected by a loose polyethylene sleeving as well as a bituminous coating in accordance with the manufacturer's directions.

All stainless-steel piping, fittings, brackets, fixings, bolts, nuts etc. shall be of grade 316.

PE pipe shall comply with AS/NZS 4130 Polyethylene (PE) pipes for pressure application. Consider the thermal expansion of the pipe when designing above-ground pipe sections. Isolation valves are required either side of the above-ground segment to allow isolation in the event of a pipe break/burst. All concrete structures that will be exposed to effluent shall have a mix design accounting for exposure to significant hydrogen sulphide levels to comply with AS1379.

A risk assessment associated with pipe failure shall be undertaken when considering above-ground structures and the required protection measures.

5.4 Excavation, bedding and cover

5.4.1 General

Excavation to install gravity drains, rising/pumping mains and associated structures shall be to the depths required to allow their construction at the specified depth and/or gradient. The floor of the trench/excavation shall be trimmed to remove all intrusions and loose material to produce a firm subgrade at a depth that will provide a uniform sand or aggregate bedding beneath the drain, rising main or structure. Specialist geotechnical advice should be sought where the trench subgrade is not firm.

5.4.2 Bedding

Gravity drains and rising/pumping mains shall be bedded on sharp, non-plastic sand that will provide a sound, compact and continuous base to support the pipe at the required grade. The sand shall be obtained from naturally-occurring deposits or from rock crushing and be free from clay lumps, organic matter (including noxious weeds) and other foreign material.

The bedding material shall be spread and compacted over the full width of the trench. The bedding material shall not exceed 75 mm in thickness unless aggregate is used or specific arrangements are made to ensure adequate compaction of the bedding material. Where water is encountered in trenches, pipes shall be bedded on 10 mm coarse aggregate or other material as may be deemed necessary by a suitably qualified and experienced engineer.

The designer or a qualified geotechnical engineer shall determine whether geofabric is required when screenings are used as bedding.

5.4.3 Cover over drains

The initial cover over the pipe shall be sand where sand is used as the bedding material for gravity drains and rising/pumping mains. The pipe shall be embedded at least 150 mm above the top of the pipe before final backfill with excavated material that has a maximum aggregate size of 75 mm.

The initial sand cover should be increased to 300 mm where the excavated backfill material includes rock exceeding 75 mm but not greater than 150 mm. The designer is to specify the minimum required cover based on the material used and these may be greater than stated in this clause.

The drain and rising main shall be covered with 150 mm of 10 mm aggregate where groundwater is encountered above the base of the trench and 10 mm coarse aggregate has been used as the bedding material.

A layer of geotextile fabric (weight not less than 180 g/m^2) shall be placed over the aggregate cover prior to back fill with the excavated material when aggregate is used as a bedding and cover material. The designer shall specify whether geofabric wrapping of the screenings is required to prevent future subsidence and protect pipe integrity.

Backfill and compaction requirements shall conform to the local road authority requirements. Designers shall ensure that backfill requirements satisfy the road authority and the WIE. The designer is to specify the compaction requirements expected to prevent later subsidence where drains are laid adjacent to kerbs or under kerbs.

5.5 Trench stops/bulkheads

Trench stops shall be used where pipe grades exceed 15% and the designer shall specify trench stop details. The designer shall consider whether trench stops are required for grades less than 15%.

The designer shall consider line creep/line pack that may cause future main failure due to joint separation where there are long stretches of rising main installed on steep grades and RRJ PVC rising mains are used. Bulkheads shall be used in accordance with the designer's requirements to prevent line creep.

5.6 Hydraulic coefficients (gravity drains)

The following roughness coefficients shall be used in Manning's formula to calculate flow velocities and drain pipe capacities:

- PVC-U pipe 0.0128
- PE 0.0128

These coefficients allow for biological growth, slime deposits, encrustation and disturbances by flow from branches.

5.7 Maintenance holes

Maintenance holes must be installed:

- adjacent (prior) to pump stations
- at intersections of three or more drains where the HDL in each drain exceeds 0.6 L/s
- at other locations deemed required by the designer.

The minimum diameter of maintenance holes for effluent schemes shall be 1050 mm. All maintenance holes shall be precast concrete unless approved otherwise by the WIE. The designer shall liaise with the WIE to determine whether an inert lining over the exposed concrete surface is required.

There shall be a 3% gradient as a minimum through a maintenance hole.

Consider future system flushing and how debris (e.g. sand) will be removed from the drain.

Tolerances for finished levels are to be agreed prior to installation and the requirements noted on the drawings or contract specification.

5.8 Inspection openings (IO) and flushing points (FP)

Combined inspection/flushing point openings shall be used to facilitate the location, inspection and regular flushing of drains. They shall be located:

- at the terminal end of gravity drains
- at all changes of direction 15° or greater
- at the junction of two or more drains where a maintenance hole is not required
- at any change in pipe diameter on a through drain
- every 120 metres along the line of drain.
- at jump ups within the main drain (a FP is not required where a property connection drain directly enters the main drain via a vertical jump up)

The combined inspection/flushing point riser shall:

- be of the same diameter as the gravity drain or greater (for drains greater than 150 mm diameter then a minimum 150 mm riser shall be used)
- enter the drain using a standard inspection opening
- be installed immediately downstream of changes in direction, drain junctions and pipe size changes
- not have a swept junction used at the base of the FP or IO.

Intermediate inspection/flushing points shall be positioned at equal distance between those at drain junctions and/or changes in direction. FPs are not specifically required at changes of grade unless the change of grade coincides with one of the above situations. Top stones for all IOs and FPs, including property connections, are to include a stamped identification that it is a sewer FP/IO.

5.9 Gradient through changes in direction

Where a drain is laid at a grade less than two per cent and changes direction by 45 degrees or greater, the fall through the bend shall be increased to compensate for the frictional head loss through the bend. This applies to all bends outside of maintenance holes (fall through a maintenance hole is outlined in Section 5.7).

The guidelines for fall through the bend are:

- if 45° < bend <135°, then a minimum 15 mm fall is required
- if the bend >135°, then a minimum 30 mm fall is required.

A grade increase through the bend is not required when the gradient exceeds two per cent. Where a change of direction exceeds 90 degrees, the change shall be made with two or more bends.

5.10 Expansion joints

Expansion joints shall be fitted at the ingress side of each pump sump and each side of a maintenance hole where PVC-U pipe is used.

The expansion joint shall be wrapped in Denso™ tape to seal against entry of dirt and tree roots. Each turn of Denso tape shall overlap by half the width of the tape and shall extend 100 mm beyond each side of the expansion joint as per the manufacturer's instructions.

5.11 Pipe junctions and size changes

5.11.1 Pipe junctions

The junction of branch and connection drains into a main or through-drain shall be made so that the branch drain invert at point of entry is at or above the centre line of the main or through drain.

Where drain junctions occur at invert levels sufficient to allow a vertical jump-up, such jump-ups shall be incorporated in a standard combined inspection/flushing point. Property connection drains that connect to the main drain do not require an IO/FP at the junction.

The higher drain shall enter the combined inspection/flushing point riser using an 88° junction. The combined inspection/flushing point riser shall enter the main or lower drain using an 88° bend or a standard inspection opening.

Where a jump-up occurs at a maintenance hole it shall be made external to the maintenance hole. The junction between the graded drain and the vertical riser shall be made using an inverted 45° junction and bend. The designer, in consultation with the WIE, shall determine whether the graded drain is extended through the maintenance hole wall and sealed with a screwed cap.

Where invert level differences at pipe junctions are less than required to construct a jump-up, the drains shall be graded to match inverts as per the first paragraph of this section (5.11.1).

5.11.2 Pipe size changes

Pipes of different sizes will meet soffit to soffit (level obvert) to allow uninterrupted air passage, as shown in Figure 2. Where pipe size changes occur at a maintenance hole, the gullet shall be varied so that the reduced pipe size is internal to the maintenance hole.

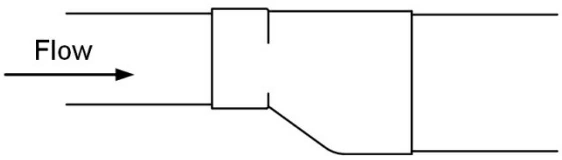

Figure 2: Change in pipe size

5.12 Minimum cover on gravitational pipes and rising mains

The minimum cover on all pipes shall be as specified in the relevant code and manufacturer's recommendations for the pipe type.

The minimum cover on gravity drains will be determined by connection depths. The minimum cover of a connection drain is given in Section 5.13. The minimum cover at the top end of a gravity drain shall be 1.2m.

The minimum cover for rising mains is shown in Table 5.

Table 5: Minimum cover for rising mains

	Minimum cover (mm)
Pipes – not subject to vehicular loading	500
Pipes subject to vehicular loading:	
not in roadways	600
in sealed council roadways	750
in unsealed council roadways	750
pipes in embankments or subject to construction equipment loading	750

Pipelines constructed in DPTI roads shall be reinstated in accordance with the current DPTI requirements inclusive of minimum cover.

The location of cross services or obstructions should be taken into account when determining the depths of drain lines and/or their connections.

Where minimum depths cannot be achieved due to localised obstructions (i.e. swale drain), mechanical protections shall be applied to the pipe as specified by the designer and agreed with council.

5.13 Connections

The minimum diameter of all property connections off a main drain shall be 100 mm. Property connections shall be laid at a minimum grade of one per cent and have sufficient depth to allow connection of the existing onsite wastewater drainage.

Connection depths shall be determined for all existing properties.

The designer is responsible for determining the depths of septic tanks and sanitary drainage connections, in all brownfields / retrofit schemes.

Determination of connection depths using WSA02 for areas serviced on a block is not permitted for a scheme being established to service existing houses.

The minimum depth of all connections should be one metre to the top of the pipe however this should not be used as the default connection depth. Lesser connection depths may be acceptable where site sanitary waste system depths are known or where the site falls towards the connection point. The designer needs to provide justification if connection depths are less than 1m. The designer shall also consider other service crossings and the required separation between services when determining connection depths.

Where a connection services a vacant block, the connection depth shall be determined by the designer to, where practical, ensure that a gravity connection can be provided. In the case of vacant land, allow for future connection in accordance with WSA02 requirements. Should a gravity connection not be practical, then the design and as-constructed drawings shall indicate the method of future connection of the block.

5.14 System venting

Generally, the scheme will be vented through the head vents on buildings served by the scheme. The induct vent, provided initially to vent the septic tank, is to be removed when the septic tank is connected to the STED scheme.

Venting shall also be undertaken at the pump station. Pump sumps shall be vented with an educt vent, carbon filter or biofilter. See section 6.2.7 for pump sump venting requirements.

6 PUMP STATIONS

6.1 Introduction

This section provides design criteria for CWMS network pump stations and rising mains. It applies to septic tank effluent drainage schemes (STEDS) and full sewage schemes. Note that some venting and rising main design criteria specific to STEDS systems is located in Section 4.

This section does not apply to onsite domestic pump units. See the Onsite Wastewater Management System Code (DHW) for onsite systems.

6.2 General

All pump stations shall be equipped with a minimum two pumps – each capable of full independent duty at HDL for the area under consideration.

The pumps shall operate by automatic control so that one pump acts as a duty pump and the second pump as a standby pump.

The pumps shall not run concurrently in normal operation. However, both pumps may operate at the same time in the event of a high-level alarm. The WIE and designer are responsible for ensuring that downstream infrastructure is assessed to determine the impact of two pumps operating concurrently. Once the level in the well has dropped below the high level, the pumps shall revert to duty standby operating mode.

In general, both positive displacement and centrifugal (submersible) pumps have been found suitable for use on CWMS. Impeller clearances are not critical provided the installation is protected both electronically and mechanically. The hydraulic design will determine the installation type.

The pumps shall be suitable for use with sewage (even where the scheme is a STEDS) without undue corrosion or wear to the casing, shaft, impeller or seals. The final selection of the pumps shall be made in consultation with the WIE.

Pump stations shall be fitted with a means of supplying or connecting to a backup power supply.

Designers shall liaise with the WIE to determine their pump system preferences. Priority should be given to aligning new pump systems with existing systems to enable easy maintenance. The designer should confirm with the WIE if pump sump lining is required.

The WIE may adopt WSA-04 in lieu of using these guidelines. The designer shall clarify with the WIE whether WSA-04 is applicable or whether these guidelines can be adopted.

6.2.1 Connecting pipework

The pipework connecting the pumps with the rising/pumping main shall be stainless steel, flanged ductile iron, high density polyethylene (HDPE), or combination of these materials to the standard expressed in this document and as required by the WIE. The pipe class selected for use in the pump stations shall be in accordance with section 6.3.4. Strainers shall not be fitted on any suction pipes.

6.2.2 Pump operation

Each pump shall be called to duty by an automatic start regulator. Wiring should be arranged so that the pumps:

- will operate automatically between the start and stop regulators
- will alternate duty automatically on each consecutive start
- be capable of individual automatic operation
- be capable of individual manual selection and operation.

The pumps shall be shut off by an automatic stop regulator at a level above the suction inlet to the pumps, with due allowance for the impacts of vortexing.

Manual pump operation shall not override the stop level control nor any of the other pump control systems. This is to avoid a pump being left on and damaged due to pumping dry. However, the WIE may choose to have a function that temporarily manually overrides this control. This may be via a timer switch or a facility where the button must remain depressed. Unless specifically instructed by the WIE, designers should make sure that manual pump operation shall not override the stop level control nor any of the other pump control systems.

6.2.3 Pump control systems

High level control

Each pump station shall include a high-level float switch or other approved sensor to activate the alarm when the liquid level is 200 mm above the limit pump start regulator. The high-level switch shall not shut down the pumps. The designer may consider lessening the distance (below 200 mm) if the system has large diameter chambers or low flow rates. In this case they shall show how splashing or wave action has been accounted for in order not to trigger set points. Under no circumstances should the setting be less than 100 mm.

A high-high alarm float is to be fitted to all stations that can activate even during power outages. The high-high alarm may be used to activate the duty pump if it has not already activated. It may also be used to activate the standby pump to pump with the duty pump while the high-high alarm is active.

The period of time required for the battery backup is to be agreed with the WIE. It shall be long enough to send a power outage alarm as a minimum.

Over current

Each pump shall be fitted with a thermal overload relay with positive single phasing protection characteristics, set to suit the running current of the motor.

No flow control

Positive displacement pumps with an outlet size of 80 mm or greater should be protected by a no-flow switch that is activated by the non-return valve or other approved means. This will ensure that the operating pump does not operate for longer than that recommended by the pump manufacturer when there is no flow. Alternatively, where recommended by the manufacturer, consider installing an additional low-level stop regulator or other safeguard to ensure the pumps do not operate when the liquid level in the sump falls below the pump suction inlet.

A pressure relief valve shall be fitted where positive displacement pumps operate using a common rising main. The relief valve should be vented back into the pump sump.

Moisture probes

All submersible pumps shall be fitted with seal check probes and a relay to detect the ingress of water within the lower motor casing. This will make sure that the pump does not operate when moisture is present at a level exceeding that recommended by the pump manufacturer.

The WIE can choose to omit this requirement at their discretion. The decision to omit this requirement should not be made by the designer without consulting the WIE.

High pressure limiting switch

A pressure limiting switch shall be provided in the pump discharge main where positive displacement pumps are used. This will ensure that the pumps do not operate above a pressure recommended by the manufacturer and set by the designer.

Thermistors

Where the power rating of the pump motor is 4.0 kilowatts or greater, the motor should be fitted with a 1000 ohm thermistor in addition to any thermal overload (over current) protection.

Flow meter

All pump stations shall be fitted with flow meters. The flow meters shall show totalised and instantaneous flow. It is up to the WIE as to whether the flow meters shall be logged on SCADA. The flow meter can be used for no-flow protection at the WIE's discretion.

6.2.4 Pump alarm system

Each pump station shall be provided with an alarm system. The alarm system shall automatically shut down the operating pump and activate the alarm. The alarm shall remain active until cancelled manually by an alarm cancel function. The standby pump shall assume full normal duty, with the alternating pump-start call function being inhibited until such time that the system is reset. The high-level sensor and the high-high level alarm float are exceptions – they shall both activate the duty pump and, if deemed appropriate by the designer, activate the standby pump. The high-level sensor and the high-high level alarm float shall also activate the alarm.

The alarm system shall activate:

- an amber or red coloured pilot light on the front of the control panel
- a red alarm warning light on the top of the control cabinet or pump shed, until the reason for the alarm is ascertained and reset occurs
- a remote alarm warning system

Each fault indicator on the control panel shall be appropriately labelled.

In addition to a warning light operated by the alarm system, a remote communication device shall be installed at each pump station to enable the alarm to be received by WIE maintenance staff.

A HMI can be installed to enable system monitoring and control. However, HDMI installation does not remove the requirements outlined above.

Consider providing a SCADA system to monitor or control pump system operation. Designers shall consult with the WIE prior to finalising their design to determine SCADA requirements. System designers should consider the WSA 302 SCADA Guideline.

6.2.5 Control cabinet instrument requirements (minimum)

A time delay relay shall ensure that the on/off operation of either pump cannot be more frequent than 12 starts per hour or the manufacturer's recommendations, whichever is the lesser. The designer should also seek advice from the local power authority as they may limit the number of starts per hour based on their system operation and capacity. This limitation has nothing to do with the pump capabilities and is an external influence on the allowable number of pump starts.

The following shall be mounted on the front cover of the control cabinet:

- duty selector switch (auto-1-2)
- stop/reset push button
- control switch (man-off-auto) for each pump
- alarm cancel button
- labelled pilot lights for each alarm condition
- hour run indicators for each pump, reading 10 000 hours with 1/10th hour increments
- lamp test switch for external alarm warning light and all pilot lights
- flow meter display

Provisions shall be made for access to power and light at each pump station. All power outlets must be RCD protected. Flow meter readings shall be displayed within the control cabinet as a minimum. Provisions shall be made to connect a generator. A generator plug should be fitted to the switchboard, bypassing the control systems so that the system can run if the control panel is faulty. The generator connection should be physically tested as part of the pump station commissioning process.

6.2.6 Pump sump

The materials used to construct the pump sump shall be suitable for use in a high risk sulphide environment and, if concrete, shall incorporate sulphide resistant cement and calcareous aggregate as indicated under Section 5.3. They shall comply with AS 3735 Concrete Structures for Retaining Liquids, Exposure Classification 'D', Tables 4.2 and 4.3.

The designers will consult with the WIE and shall determine whether inert lining shall be placed over the exposed concrete surface (i.e. lining of the sump).

The high-level alarm shall be set below the invert level of the lowest incoming drain.

The sump must provide adequate storage capacity in the pumping range (between start and stop regulator) to ensure that the number of pump operations does not exceed the rating of the switchgear (usually a maximum of 12 starts per hour; refer also to Section 6.2.5).

The minimum spacing between pump control levels shall default to 200 mm. If the system has large diameter chambers or has low flow rates the designer may consider reducing the distance to less than 200 mm. When reducing the minimum setting distance to less than 200 mm, the designer shall show how splashing or wave action has been accounted for in order not to trigger set points. Under no circumstances should the setting be less than 100 mm.

There shall be an adequate depth between the sump base and the pump stop control to allow for the specified submersible pump's minimum depth and to avoid vortexing where positive displacement pumps are used.

Pump sumps shall be designed such that they can be isolated from the collection network for maintenance.

Designers shall provide a method that outlines how debris will be removed in the event of drain flushing.

6.2.7 Pump sump venting

Pump sumps shall be vented with an educt vent, carbon filter or biofilter. The vertical section of the educt vent shall be at least 150 mm in internal diameter, prefabricated from heavy gauge steel pipe (5.4 mm wall thickness) and hot-dip galvanised after manufacture.

The vent shall extend at least nine metres high above the top surface of the pump sump cover slab. Consider increasing the vent height to 12 metres where adjacent buildings or atmospheric conditions may limit gas dispersal. In such cases, the vent diameter may need to be increased to 200 mm to ensure stability.

The designer shall consider whether positive venting is required for the pump station. The designer shall determine the need for positive venting in consultation with the WIE.

The designer shall consider gas locks within the pipe networks where there are steep pipe grades, as odour could be caused by large volumes of air venting through the property header vents at the top end of long steep drains.

When selecting a venting arrangement, the designer shall consider:

- the impact on amenity
- security
- ongoing maintenance
- risk of odour impacts including odour impacts caused by steep grades.

6.2.8 Pump sump emergency storage

The sump and drainage system shall provide adequate capacity for emergency storage of incoming flows in the event of a power or major equipment failure. It is desirable to have an emergency storage capacity of 50% x HDL, particularly in remote areas (where 50% is equal to 12 hours flow).

The storage volume shall be calculated using the pump's high alarm level (as the lower level) and the invert of the lowest connection point on the drainage system or the point of system overflow.

Emergency storage volumes less than 50% x HDL may be considered where:

- remote alarm monitoring is incorporated into the pump control system
- the remote alarm monitoring system includes a critical pathway that identifies total equipment or power failure or activation of the high-level alarm regulator as well as reacting to all alarm conditions (i.e. an alarm is still raised in the event of total system failure)
- the WIE establishes a contingency plan to deal with flows during emergency situations.

In areas of high flow (e.g. main pump stations), emergency storage capacity may also be reduced to the average power failure duration of the area, based upon information obtained from the power authority. The WIE must still establish a contingency plan to deal with flows during emergency situations in this case. In any event, storage capacity should not be less than 20% of the HDL (where 20% is equal to 4.8 hours flow).

If there are no upstream pump station controls, then emergency storage calculations shall also include the upstream loads. Additional emergency storage is not required if controls are in place to prevent flow from the upstream station during an emergency event.

The contingency plan should include provisions for equipment such as a tanker or trailer-mounted pump or generator facilities as deemed required by the WIE or as determined and outlined in the scheme risk management plan.

6.2.9 Pump station control maintenance hole

A control maintenance hole shall be placed before the main pump sump. The maintenance hole is to be placed between the last junction and/or connection to the inlet drain and the pump station. The maintenance hole shall be used as a system pump out point in the event that the pump sump is isolated for maintenance. The designer shall ensure that the maintenance hole has adequate access to enable the pit to be pumped out.

6.3 Hydraulic calculations for pumping systems

6.3.1 Duty flow selection

The duty flowrate for a pumping system shall be determined in accordance with Section 4. A minimum pump duty flow of 1.5 L/s shall be adopted where the calculated HDL is lower than 1.5L/s.

6.3.2 Pump system calculation parameters

Pump station design shall account for upstream pump station inflows.

The static head for pumping systems shall be taken from the stop water level in the pump sump to the critical point in the system. Frictional head losses in pumping mains shall be calculated using either the Darcy–Weisbach frictional loss formula or the Hazen–Williams frictional loss formula. A design roughness height as stated in WSA 04 clause 10.3.3 shall be adopted in calculations of the friction factor when using the Darcy–Weisbach friction loss formula. A Hazen-Williams C value of 125 shall be adopted when using the Hazen–Williams formula. Friction factors shall allow for pipe sliming/sedimentation, minor losses and air entrainment. If manufacturer's charts are used to calculate frictional head losses, the calculated loss from the chart shall be increased by 20% to allow for biological growth, slime deposits and encrustation of the pipe.

The designer shall also prepare calculations using new pipe design roughness values to ensure that the lower frictional losses in initial conditions will not cause pump cavitation.

Where a proposed pump station discharges into a pressure pipe network shared by other pump stations, the designer shall undertake hydraulic modelling to assess the proposed station's impact on the other stations. This also applies when upgrading a pump model at an existing station.

The designer shall also prepare hydraulic calculations to assess pump system performance with both pumps operating in parallel. This will ensure the system will be able to operate adequately following the high level alarm trigger.

6.3.3 Rising/pumping main sizing

The pipe diameter shall cater for the HDL of the area under consideration (Section 4) and shall have a cleansing velocity of not less than 0.5 metres per second for STEDS, and as per WSA 04 for sewerage systems.

The designer shall liaise with the WIE to determine whether staging of the rising main construction is required to maintain system scour velocities (i.e. a smaller main installed initially) where significant growth is expected.

6.3.4 Rising/pumping main pressure rating

The minimum pipe class used for pressure mains shall be PN12.5 for HDPE pipe applications and PN12 for PVC. A hydraulic assessment shall be undertaken when selecting pipe strength requirements to determine: the operating pressure within the main; the impact of line pack; and fatigue over the design life of the pipe, where the minimum pipe life shall be 70 years.

6.3.5 Air valves

Air valves shall be suitable for use with sewage. Air valves shall comply with AS 4883 Air Valves for Sewerage. The designer shall review air valve locations to minimise their impact on the general public. The installation of air valves in underground chambers shall allow for isolation in the event of valve leakage, so that the operator does not have to come into contact with wastewater (i.e. the isolation valve shall not be placed in a pit beneath the air valve). Designers shall ensure that sufficient air valves are provided for system filling and operation.

Note: for STED schemes D-040 air valves are acceptable subject to WIE approval.

7 GRAVITY DRAINS FOR SEWERAGE SYSTEMS

7.1 General

Gravity sewerage schemes shall be designed based on the WSAA Sewerage Code of Australia (WSA 02). The method for determining a system's HDL shall be as per Section 4. The drains shall be sized based on the HDL calculated using the methods given in Section 4.6. Refer to WSA 02 for determination of pipeline capacity (noting that Table 5.6 in WSA 02-2014 is not applicable due to different design load assumptions). See Appendix A for a list of maximum equivalent connections for gravity sewers using the CWMS Design Criteria.

Designers shall incorporate the design criteria described in Section 7.2.

The Standard STEDS Technical Specification and Standard STEDS Drawing Details, as published by the LGA, shall not be applied to sewerage schemes.

Note that the gravity network for STEDS shall be designed in accordance with Section 5.

7.2 Maintenance structures

Maintenance structures include maintenance holes (MH's), maintenance shafts (MS's), inspection openings (IO's) and inspection shafts (IS's). Network designs that incorporate maintenance structures shall take into account the following:

- Maintenance Holes (MH's) shall be installed prior to the pump station and at any junction of three or more drains.
- Maintenance shafts (MS's) are required at the junction of any two drains.
- Maintenance structures are required for all changes of direction greater than 15 degrees.
- IO/IS shall not be used on drains larger than DN150– MS shall be used instead.
- The maximum distance between two maintenance structures (IO/IS, MS, MH) shall be 150 metres.
- IO's shall be installed at property connections.
- IS's shall be installed at the terminal end of drains. Except for at the terminal end, IS's may only be used between maintenance shafts and maintenance holes with a maximum spacing of 150 metres between the IS and MH/MS. The maximum spacing between maintenance shafts or maintenance holes is to be 240 metres when a connecting IS is present, otherwise a maximum spacing of 150 metres is required.

The schematic in Figure 3 shows the maximum distances between maintenance holes, maintenance shafts and inspection shafts.

All scheme access points including top stones, maintenance hole covers, and pump station lids are to be clearly identified as 'sewer'.

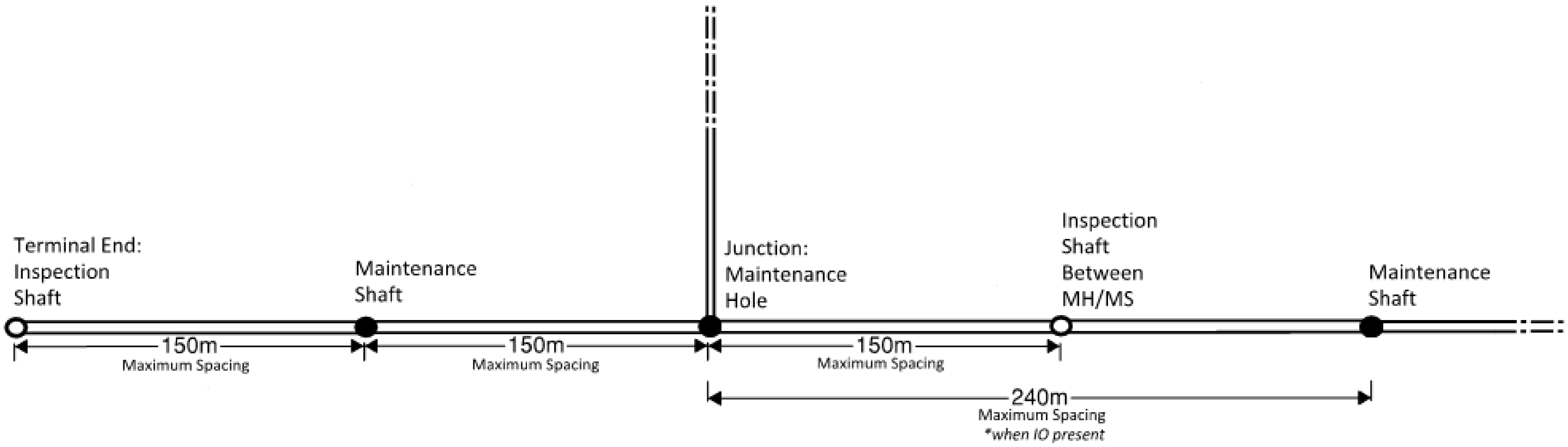

Figure 3: Maximum spacing for maintenance holes, maintenance shafts and inspection shafts

8 VACUUM SYSTEMS

Vacuum sewerage schemes and vacuum STEDS shall be designed based on the WSA 06 Vacuum Sewerage Code of Australia (WSA 06). Gravity drains forming part of a vacuum system shall be designed in accordance with Section 7.

The system HDL shall be determined using the method outlined in Section 4. Non-residential loads shall be determined based on WSA 06 and the South Australian Onsite Wastewater Systems Code (see Section 4.5 of the document). The drain size shall be based on the HDL calculated using methods given in Section 4.6 and pipeline capacity shall be based on WSA 06.

Designers shall also address the following vacuum system requirements:

- The peaking factor applied to determine the number of valves shall be as per those given for pump duty selection in Table 1.
- Vacuum pit emergency storage shall be at least 50% x HDL unless an appropriate alarm system is installed to warn of valve failure and/or high level in the vacuum pit and the reduced emergency storage is agreed to by the WIE and DHW.
- Vacuum pit emergency storage capacity can be reduced to 20% x HDL when alarming or telemetry is included in the system to detect sump depth or pressure drop. Emergency storage requirements are to account for power failure history, which may increase the minimum storage requirements.
- The time for system evacuation shall be determined by the designer as it will differ for all schemes. System commissioning is to include a system-wide flooded pit test to determine the system’s response to prolonged power outage and compliance with the specified design requirements. The flood test is to show that the system can empty after a flooded pit scenario.
- Vacuum pits will require approval from the appropriate WIE.
- The designer shall consider Work Health Safety (WHS) issues associated with access and removal of vacuum valves. As a minimum, the valves shall be isolated from the wet sump.

9 PRESSURE SYSTEMS

Pressure sewerage schemes and pressure STEDS shall be designed based on the WSA 07 Pressure Sewerage Code of Australia (WSA 07). Design flows for the onsite component shall be as per the Onsite Wastewater Systems Code. The method for determining the system's HDL shall be as per Section 4.

Designers shall also include the following pressure system requirements:

- The onsite pump sumps will require product approval from DHW in accordance with the Onsite Wastewater Systems Code.
- Audio and visual alarms shall be installed as per the Onsite Wastewater Systems Code.
- Emergency storage for the onsite pump sump shall be at least 50% of the average daily flow as required by the Onsite Wastewater Systems Code.
- The designer shall consider other services when siting the connection location and determining the connection depth.
- Valve pits shall be placed at each property connection. The valve pit shall be located within 300 mm of the property boundary (outside of the property) to allow for 24-hour access to connection valves for maintenance. The tail of the connection shall extend 300 mm inside the property. The valve pit shall contain dismantling joints either side of the isolation and non-return valves. Isolation valves shall be installed on either side of the non-return valve. The valve assembly shall consist of dismantling joint–isolation valve–non-return valve–isolation valve–dismantling joint.
- The designer shall determine and specify on the drawings whether trafficable valve pits are required at each connection point.
- The connection pipe shall have a minimum internal diameter of 32 mm.
- Pressure sewer pipework on private property shall comply with AS1345 Identification of the Contents of Pipes, Conduits and Ducts.
- The designer shall develop a hydraulic model of the proposed pressure sewer system. Pipe sizes and pump selections shall be determined by either using a dynamic modelling approach as outlined in WSA 07, or by undertaking a series of single-step hydraulic simulations with the maximum probable daily number of pump systems operating simultaneously for each branch. If the dynamic modelling approach is adopted, the designer shall use suitable diurnal curves that correspond to the calculated ADF and reticulation network peaking factors, as outlined in Section 4.
- The hydraulic model shall demonstrate that a minimum scour velocity, as required by WSA 07, will be achieved with an appropriate frequency. The hydraulic model should also demonstrate the likely system recovery time after a prolonged power outage. The designer shall outline what impact high pressure events will have on the pump units and any mitigation measures required to protect the pumps from high pressure events. This information shall be included in the RMP and the DHW application.

10 TREATMENT FACILITIES

10.1 Introduction

This section outlines a range of design criteria and considerations for the appropriate selection and design of treatment facilities in South Australia.

Specific design criteria is not provided for all types of treatment facilities as it is recognised that the design of treatment systems is site specific and selection of treatment processes and technologies should not be restricted.

Facultative lagoons are one of the most predominant types of wastewater lagoon currently seen in South Australia. Design criteria for facultative lagoons have therefore been provided to enable designs which follow the design criteria to be approved with minimal supporting evidence.

Design criteria for High Rate Algal Ponds is published by the LGA and available on the LGA website.

10.2 Selection of treatment facilities

The selection of treatment facilities, and their design, shall consider:

- the proposed end-use of the recycled water and corresponding treatment requirements
- available land area
- resources available to the WIE and their ability to service the facility
- topography
- available buffer distances
- depth to groundwater
- depth to rock
- rainfall
- temperature
- future system expansion

Options for treatment include, but are not limited to:

- treatment lagoons – including facultative, anaerobic, high rate algal ponds (HRAP), and aerated lagoons.
- treatment plants – including sequencing batch reactors, intermittently decanted extended aeration plants, rotating biological contactor plants and membrane bioreactor plants.

10.3 Design loads

Design loads for treatment lagoons and treatment plants shall be in accordance with Section 4. Provisions shall be made to measure the total flow through the treatment facility using flow metering.

10.4 Trade waste

Non-residential premises with trade waste shall not be connected to the scheme unless specific design load parameters have been established as per Section 4.5. Industrial loads shall be

calculated using actual data or in accordance with the South Australian Onsite Wastewater Systems Code, WSA02 and advice from relevant authorities.
WIEs shall determine the impacts of including trade waste into the CWMS, including the impact of:

- any pre-treatment
- hydraulic, biological, organic and non-organic loads on the system
- chemicals on system materials and treatment processes
- chemical constitution on the disposal path.

Scheme owners are required to prepare a trade waste policy if trade waste is to be accepted into the scheme.

10.5 Wastewater lagoons

10.5.1 Introduction

This section outlines design criteria for wastewater lagoons.

Particular focus has been placed on facultative lagoons, being one of the most predominant type of wastewater lagoon seen in South Australia. Sections 10.5.9 to 10.5.13 refer specifically to facultative lagoon design. Design criteria for facultative lagoons has been provided to enable designs which follow the design criteria to be approved with minimal supporting evidence.

If designers wish to vary the facultative lagoon detention or system arrangements outlined in this document or design a facultative lagoon taking sewage flows they will be requested by DHW to document the design basis as part of the application for approval.

High rate algal ponds shall be designed in accordance with the Design Guideline for a High Rate Algal Pond (HRAP) – an element in Wastewater Treatment Trains as published by the LGA. Designers should ensure that they are using the latest version of the HRAP guidelines. Design loads for HRAP systems shall be in accordance with Section 4.

For other types of wastewater lagoons including aerated lagoons, anaerobic lagoons, and fully mixed and aerated facultative treatment systems, the designer will need to document the design basis of the proposed treatment train.

Emergency egress facilities (including appropriate signage) are to be provided for all treatment and storage lagoons.

10.5.2 Lagoon location

When locating lagoons, the designer should consider:

- the size or capacity of the lagoon
- the topography of the site and surrounding land
- screening from residential areas
- any meteorological conditions, such as prevailing winds
- the development zoning of the site and adjacent areas
- buffer distances
- potential future developments (adjacent to the site and to allow for facility expansion)
- geotechnical conditions at the lagoon site
- flood risk.

An application for development approval is required to construct lagoons under the provisions of the *Development Act 1993*. The designer shall consider EPA buffer distance requirements. EPA approval shall be sought for any proposed lagoon which does not comply with the guidelines. The EPA Guideline for Wastewater Lagoon Construction should be referenced when designing the lagoon system.

10.5.3 Geotechnical characteristics (floor and embankment construction)

Soil testing shall be conducted at the lagoon site with recommendations for:

- excavation techniques
- embankment design and construction – this includes the soil to be used in construction as well as the soil that needs to be discarded and any handling, placement, moisture and compaction requirements
- any special treatment of lagoon floors and embankments to prevent leakage
- any special requirements to control embankment erosion.

The scope of laboratory soil tests required will depend on the site's soil type variations, but the tests should at least include:

- soil classification, particle size and plasticity – with reports on its suitability for earthworks, erodibility and permeability
- in situ density, moisture, and compaction tests – with quantitative data on earthworks, including moisture requirements and 'bulking' or shrinkage from cut to fill
- permeability
- soil dispersion (erodibility).

The design shall be carried out in accordance with the soil test recommendations.

10.5.4 Batter slopes and freeboard

The batter slopes and freeboard requirements are that the:

- internal face is not to exceed 3H:1V batter
- external face is not to exceed 2H:1V batter. External batter slopes shall be determined in conjunction with the WIE and account for batter slope maintenance and vehicular access requirements (i.e. need for access ramps). Advice should be sought from a suitably qualified and experienced engineer or geotechnical technician.
- minimum top of bank width is 4.0 metres (unless agreed with the WIE)
- embankment freeboard is to be 600 mm at a minimum. Consider rainfall and wave action when determining the required freeboard.

The freeboard of internal dividing walls shall be determined by the designer – they are not specifically required to have a 600 mm freeboard.

The anchor trench for HDPE-lined lagoons shall be at least 500 mm from the edge of batter. The lagoon top of wall shall be surfaced with a quarry rubble access track three metres wide (minimum) and 150 mm thick. The edge of the rubble track shall be at least 0.5 m (minimum) from the edge of the internal lagoon wall. The WIE may, at its discretion, change the thickness requirements for the pavement material on the access tracks and vary the access track width. However, they shall demonstrate how lagoon maintenance will be managed if they reduce the requirements outlined in this document.

The external lagoon wall crest shall grade towards the external batter and not towards the water body, to reduce scour debris entering the lagoon.

Vehicle access ramps shall be provided and run from outside the lagoon to the top of the embankment. The designer, in consultation with the WIE, shall determine whether vehicle access ramps need to be extended into the lagoon.

A risk assessment shall be completed and documented in relation to safe vehicle access around the lagoon wall, which shall highlight any mitigating measures required for the specific site, i.e. marker posts, guard rails, fencing, signage, lighting etc.

10.5.5 Lagoon materials, leak detection and liner

Lagoons shall comply with the EPA guidelines Wastewater Lagoon Construction (November 2014 or latest update), including construction and the materials used. Leak detection systems shall comply with EPA requirements.

Where HDPE liners are used, the HDPE liner shall be a minimum of 1.5 mm thick. In the absence of any specification from the WIE or designer, the liner should meet the following specifications outlined in Table 6.

Table 6: HDPE liner specifications

Property	Value	Standard
Thickness	1.50 mm	ASTM D5199
Density	0.940 kg/m^3	ASTM D1505
Carbon black content	2.0 to 3.0%	ASTM D1603
Tensile strength at yield (min)	22 kN/m width	ASTM D6693 Type 4
Tear resistance (min)	187 N	ASTM D1004
Puncture resistance (min)	480 N	ASTM D4833
Dimension stability (max change)	+2%	ASTM D1204

The liner membrane shall be designed, constructed, installed and tested in accordance with AWWA/ANSI D130–96 and AWWA M25 as a minimum. The designer shall determine and clearly outline the method for anchoring the lagoon floor until there is sufficient water in place to anchor the liner. When preparing the contract specifications, the designer shall stipulate transport and storage requirements to reduce their impact on the liner's life.

Designers shall consider the impact that HDPE lining may have on the treatment system (i.e. storages that use HDPE liners tend to show an increase in pH of the stored treated effluent). This needs to be considered in the context of the recycled water end use, and any post lagoon disinfection requirements.

Gas relief systems shall be specified for any sludge lagoons or when a lagoon is relined. In all other circumstances, the designer and WIE shall jointly determine whether gas relief systems are required.

10.5.6 Maintenance and sludge management

The designer shall ensure that system maintenance is considered and outline maintenance procedures in the management manuals. The designer shall outline a sludge management plan for the lagoon, considering desludge frequency and sludge removal methods. Sludge disposal shall be in accordance with the Draft South Australian Biosolids Guidelines for the Safe Handling and Reuse of Biosolids (April 2017).

10.5.7 Perimeter fencing

The lagoon shall be fenced with a 1.830 metre high, man-proof, galvanised, chain-mesh fence with galvanised posts. The fence shall be located at least four metres from the external toe of the banks. A gate shall be included in the fence with a clear opening of at least 3.6 metres. The fencing shall be located so as to allow access to maintain the external batters.

Fencing shall be installed to prevent animals from moving under the fence. The fences are not required to be vermin proof but should prevent access by animals, such as foxes, dogs, kangaroos and so on. The fences shall have no more than a 50 mm gap between the base of the fence and the ground surface level. The fencing shall be specified in accordance with AS1725.1 and also have three strands of barbed wire, spaced 100 mm apart.

10.5.8 Inlet and outlet structures

The inlet structures of lagoons designed for STEDS effluent shall be designed so that the effluent is discharged above the operating level of the effluent in the lagoon. This is to allow for visual monitoring of inflows. The WIE may, at its discretion, situate the inlet below the water level as per systems designed for sewage. The inlet shall be below the water level in lagoons designed for sewage.

The inlet pipe shall be constructed to prevent the discharge of sewage/effluent from the lagoon via the inlet pipe (i.e. prevent backflow) in the event of a failure in the rising/pumping main.

The outlet structure (for a facultative lagoon) shall be located at the surface of the final compartment to maximise detention time and maintain a constant liquid depth. It shall be constructed in a way that avoids fouling by surface debris.

10.5.9 Facultative lagoon design

The general facultative lagoon configuration shall include a primary compartment followed by either four separate compartments or a series of compartments, with a serpentine flow path equal to at least three times the width of the lagoon. The minimum length to width ratio that shall be applied is 2:1. Lagoons should be designed to provide the maximum possible flow path and minimise the potential for short circuiting.

A series of lagoons is needed to produce an effluent low in soluble BOD, suspended solids and pathogens. Lagoons shall be designed to achieve a soluble BOD of 20 mg/L at the outlet. The water should be 1–1.5 metres deep. A depth of 1.2 metres is recommended.

The detention time of a facultative lagoon when treating STEDS effluent shall be 66 days to account for BOD loading and pathogen removal. However, shorter detention times can be negotiated with the DHW. This will depend on the proposed treatment train and end-use, and consideration of BOD surface loading rates, sludge deposition and potential for short circuiting. The

DHW may request design calculations to demonstrate BOD loading rates and sufficient BOD and pathogen removal.

Note: The minimum detention time for pathogen removal through a facultative lagoon shall be 50 days. The recycled water may require additional disinfection depending on the selected method of reuse or disposal.

Introducing any non-residential waste into the system changes the basic design parameters. Before permitting any non-residential waste into a CWMS, consider:

- the nature of the waste and whether or not it is suitable to admit into the drainage and pumping system
- what pre-treatment, if any, is required to reduce the waste to similar BOD_5, suspended solid, fat, temperature and pH values as that of domestic wastewater post septic tank
- the amount of waste and whether additional lagoon capacity is required.

Facultative lagoons are to be lined in accordance with the EPA's guideline: Wastewater Lagoon Construction (November 2014 or latest update).

Emergency overflow facilities must be provided to prevent uncontrolled spillage over the walls during a critical 1:100 ARI storm event, during high wind events, or when the lagoon is full after an unplanned period of limited reuse. The designer shall assess the flow path of any spillage from the basin to ensure that it will not inundate private property.

Batter slopes shall comply with Section 10.5.4. Scour protection is to be detailed on the design drawings. Scour protection methods shall be considered for both internal and external batters.

10.5.10 Primary lagoon

The first lagoon should have a detention time of 36 days, based on the HDL, where the loading is domestic STEDS effluent or its equivalent.

If the lagoons are designed for sewage flows the designer shall ensure that the influent undergoes treatment such that it is equivalent to primary treated wastewater before the water enters the first lagoon.

10.5.11 Subsequent lagoons

Subsequent lagoons should be designed using a series of compartments, with either:

- four lagoons, each with 7.5 days of detention, based on the HDL, or
- a serpentine flow path equal to three times the width of the lagoon, which completes the balance of the required detention that would be provided by lagoon compartments.

10.5.12 Diversion structures

The scheme designer shall determine the most appropriate diversion structure to separate lagoon compartments. The following systems may be used to create a diversion structure:

- fencing
- earth bunds
- floating curtains.

Openings should be made in the diversion structures to create a flow pattern that will avoid short circuiting. Diversion structures must have adequate freeboard allowance (nominally 300 mm at a minimum). Avoid penetrating the liner (where possible) to install the diversion device when using HDPE liners. If a fence or curtain is used, there should be some openings at the bottom to avoid uneven pressures during filling and emptying. If curtains are used, the designer shall clearly demonstrate how short circuiting will be avoided at the wall interface.

Where baffle fences or curtains are used, holes in the fence shall be used to transfer effluent from section to section and be positioned to avoid short circuiting.

The size and location of diversion structure transfer mechanisms shall be clearly specified on the drawings.

10.5.13 Typical facultative lagoon arrangements

Typical lagoon arrangements that meet a 66 day detention time and are suitable to treat STEDS effluent or equivalent are shown in Figure 4 and Figure 5. Lagoons shall be designed to provide the maximum possible flow path and minimise the potential for short circuiting. The minimum length to width ratio that shall be applied is 2:1.

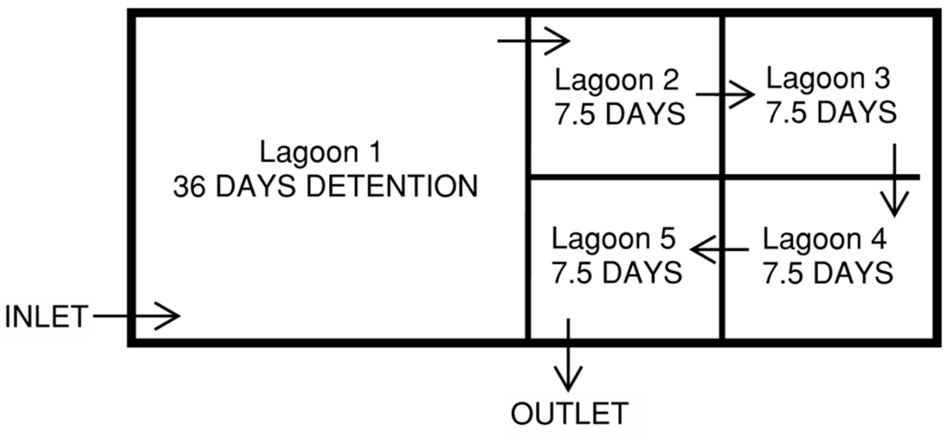

Figure 4: Lagoon layout 1

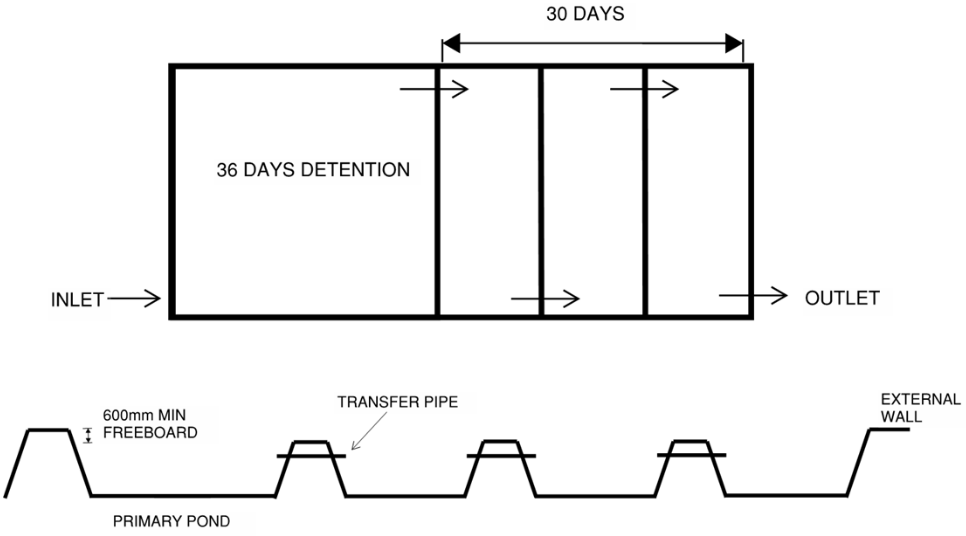

Figure 5: Lagoon layout 2

Note that internal dividing walls are not required to have a 600mm freeboard. A 300mm freeboard is recommended, however, internal freeboard shall be specified at the discretion of the designer.

10.6 Wastewater treatment plants

10.6.1 Introduction

This section outlines design criteria for wastewater treatment plants. Specific design criteria for each type of treatment has not been provided due to the range of systems available and so as not to restrict innovation. Treated water quality requirements also depend on the type of end-use and vary from scheme to scheme.

The designer will need to document the design basis of the proposed treatment plant after consultation with the WIE and the DHW.

10.6.2 The site

The treatment plant site should include a suitable buffer zone from the nearest habitable dwellings and public places and should be chosen with regard to the surrounding terrain and prevailing winds. Separation distances shall comply with the EPA guideline – Evaluation Distances for Effective Air Quality and Noise Management (August 2016).

The wastewater treatment plant should be sufficiently isolated to limit the impact of noise, odour and any other nuisance resulting from the plant's operation including spray drift, aerosols and any other public health factors. The economic feasibility of isolating a wastewater treatment plant (by distance or constructed buffer) should also be considered. Designers shall also check local planning requirements, as their buffer distances and flood restrictions may differ from EPA requirements.

Provide all weather access for maintenance personnel and vehicles.

10.6.3 General design considerations

The use and design of wastewater treatment plants in conjunction with CWMS should at least consider:

- the proposed end-use of the recycled water and corresponding treatment requirements
- capital costs
- operation and maintenance costs
- long term replacement costs
- plant location, distance to nearest habitable dwelling or public place and access for maintenance vehicles
- screening requirements (e.g. does the WIE require a screen for effluent systems? Will sewage be connected in the future?). Screening is required for any sewerage systems.
- noise and odour nuisance
- temperature
- planning authority requirements
- EPA and DHW requirements
- the population to be served by the plant
- wastewater characteristics, including quality and flow (instantaneous and daily)
- impact of wet weather flow events
- the potential for future extension
- the availability of experienced maintenance personnel
- the sensitivity of the plant to fluctuating flows
- further wastewater treatment prior to reuse or disposal
- biosolid containment, removal, disposal or reuse
- the future replacement of major components such as reactor tanks
- the potential impacts of natural disasters, e.g. bushfires, flooding, and strong winds.

10.6.4 Treatment plant design

Treated water quality

The requirements for treated water quality will depend on the proposed end-use in accordance with DHW requirements.

The wastewater treatment plant shall produce, at a minimum, secondary treated effluent in accordance with DHW requirements and with a microbiological quality as defined by the Australian Guidelines for Water Recycling. Allowable exceedances and statistical requirements for test results shall be in accordance with the DHW approval conditions for that specific plant.

Note: Nominally secondary treated effluent shall achieve a BOD_5 *of 20 mg/l and suspended solids concentration of less than 30 mg/l.*

The selection of treatment and disinfection processes shall be based on the log reduction requirements as outlined in the Australian Guidelines for Water Recycling and as required by the DHW. Filtration and disinfection may be required to achieve water quality targets depending on the selected method of reuse or disposal.

Designers should consider reducing the nitrogen and phosphorus levels in the recycled water, depending on the selected reuse or disposal option – refer to the Australian Guidelines for Water Recycling and EPA requirements. Nutrient reduction requirements shall be determined when developing the irrigation management plan (IMP).

Designers shall consider the impact of ammonia levels in the treated effluent and its impact on post treatment disinfection system performance. Consider reducing the amount of ammonia as part of the plant design.

Design loads and WWTP capacity

The plant shall be able to continuously operate over twenty four hours (24 hours). The HDL shall be determined in accordance with Section 4.

The treatment plant shall be able to accept seasonal or extreme variations in organic and hydraulic loads from tourist or other activities and shall be capable of producing adequate treatment despite load variations.

WWTP's that are not lagoon-based shall have a separate balancing storage (i.e. the balancing storage shall not be provided in the first reactor tank) at the head of the plant to ensure that short circuiting of the treatment process cannot occur. Where the WWTP is designed for batch processing (including but not limited to sequencing batch reactors and intermittently decanted extended aeration plants), the balance storage shall be designed to ensure that there is no flow into the reactor tank during the treatment (aeration, settlement and decant) phase. The balance tank shall be sized to enable the plant to cater for the HDL as determined in Section 4.

Provision shall be made in the treatment plant's design to provide emergency storage for incoming flows in the event of treatment plant failure due to interruption of the electricity supply and/or mechanical breakdown. Emergency storage requirements shall be in accordance with Section 4.8. The designer may choose to allocate capacity in the balance tank to provide the required emergency storage.

Provision shall also be made to cater for wet weather flows in accordance with Section 4.8.2.

Flow metering shall be included in the design to allow continuous measurement of the total effluent flow through the plant.

WWTP operation

The treatment plant shall be designed for unmanned operation (unless the WIE can demonstrate that they have the capacity to resource a full time operator at the plant) and be capable of both automatic and manual control. Regular inspections will be required. The WWTP shall incorporate operational monitoring of key processes in accordance with DHW requirements.

Operating life, maintenance and reliability

The treatment plant shall be designed to provide a **minimum** operating life of at least twenty-five (25) years (or as required by the WIE). Note that different components in the WWTP may be assigned different design life requirements.

The designer shall determine the impacts on the whole-of-life cost of the reactor and balance tank material selection and the methodology to allow future replacement.

The treatment plant and pumping systems shall be designed to provide standby facilities in the event of failure of the operating equipment as well as automatic remote monitoring fault alarm systems to indicate plant shutdown and/or equipment failure.

All materials and equipment used in the design and construction of the treatment plant shall be suitable for its purpose and capable of long efficient service as well as low operation and maintenance costs. They must be capable of operating in a corrosive environment and under the local ambient conditions (e.g. heat, dust etc.) in the area regardless of whether they are is inside or outside of a building.

Where possible, equipment and components should be interchangeable and compatible to provide a practical degree of standardisation between parts and be capable of local repair or replacement in the event of failure.

Particular attention should be given to abrasion and corrosion resistance in the design, and care should be taken to avoid contact between metals with differing electro-chemical potentials.

The parts of the treatment plant which will be subjected to continuous or repeated wetting or high humidity conditions shall be designed to eliminate moisture traps and other areas where water can collect or be mechanically-vented.

Provisions shall be made to connect an external portable power source to enable the plant to operate during a prolonged power outage.

A weatherproof shed or cabinet is required to protect the electrical and mechanical components.

Potential flooding of the plant shall be considered when determining the mounting heights of the instrument and control systems.

A drinking water supply should be provided to the treatment plant for wash down during maintenance operations and for personal hygiene. If a mains connection is not available, other provisions shall be made to ensure that a clean and fit-for-purpose water supply is available at the plant. If a holding tank is used then the tank is to be alarmed to ensure that it has water available when required.

The WWTP's lighting, security and SCADA system design shall be in accordance with the WIE's requirements.

Security provisions shall be in accordance with the WIE's requirements.

Sludge management

The treatment plant design shall provide for sludge containment, storage, treatment, handling and disposal.

Plant designers are required to specify a mixed liquor concentration and to provide methods to automatically remove sludge from the plant as liquid sludge and cart or pump it to an approved disposal site. The designer should consider the need for on-site thickening of sludge to a spadeable solid and appropriate methods of disposal where plants serve in excess of 1000 equivalent persons. Sludge disposal shall be in accordance with the *Draft – South Australian Biosolids Guidelines for the safe handling and reuse of biosolids*.

Contracts and commissioning

The contract to establish the treatment plant should consider providing a defects liability period of sufficient duration to prove treatment plant performance and provide for appropriate instruction/training on treatment plant operation for a person or persons nominated by the WIE.

Treated wastewater sampling shall be carried out during the defects liability period to ensure compliance with the standard set out herein, and to comply with the requirements of approving authorities. The timing of sampling events should consider the load on the treatment plant and seasonal variations.
Consideration should be given to establishing an operations contract with the plant installer during the defects liability period. Provision for the supply of any special tools and spare parts required for day-to-day operation and maintenance should be included as a part of the installation contract.

10.6.5 Perimeter fencing

The wastewater treatment plant shall be fenced with a 1.830 metre high, galvanised, chain-mesh fence with galvanised posts that is topped with three (3) rows of barbed wire and constructed to prevent human entry. The fence should be located to allow vehicular access to all components of the treatment plant. A gate shall be included in the fence with a clear opening of at least 3.6 metres to allow access for maintenance vehicles. Sufficient space shall be allowed within the perimeter fence to allow for vehicle manoeuvring for routine maintenance, including sludge removal and aerator removal.

10.6.6 Chemical storage

The designer shall comply with hazardous materials handling legislation and the EPA's Liquid Storage Guidelines – Bunding and spill management (2016) and include body and eyewash facilities (as required by the current legislation) along with signage.

10.6.7 Civil requirements

The civil requirements for the site should be provided by the WIE. However, as a minimum they shall consider:

- site access during a 1:100 year flood event
- hard stand areas to provide access for maintenance vehicles, including turn around areas
- site drainage
- spill containment
- noise mounds or screens (if required)
- surface material to allow all weather access (rubble, hotmix, spray seal etc.).

11 RECYCLED WATER STORAGE LAGOONS

11.1 Introduction

Recycled water storage lagoons are required to achieve water quality targets and store recycled water when reuse or disposal applications are unavailable or when inflow is temporarily higher than the reuse or disposal capacity.

11.2 Location

Separation or buffer distances between the lagoons and sensitive receivers are to comply with EPA requirements outlined in Evaluation Distances for Effective Air Quality and Noise Management (August 2016).

11.3 Storage lagoon design

The designer shall size the storage lagoon using an annual water balance, with a minimum calculation frequency of one month, to ensure no system overflow in a 1:10 wet year.

The calculations shall use BOM evaporation and rainfall figures and irrigation rates calculated from the IMP (for all reuse systems). Treated water inflows shall be calculated based on the HDL (as outlined in Section 4). Monthly inflow rates shall be adjusted to provide a more realistic representation of inflow variation where schemes have significant seasonal load variations (e.g. holiday homes and shack sites).

The DHW shall be consulted as to whether a minimum lagoon detention time (nominally 25 days) is required for pathogen removal. The designer shall determine the method to ensure the minimum detention time and obtain DHW approval. Any impacts from a minimum detention time on the storage lagoon water balance shall be incorporated into the water balance calculations.

Locate the lagoon inlet and outlet to provide the longest possible flow path through the lagoon. The designer shall consider the siting of the lagoon and prevailing wind and wind fetch when determining the lagoon's dimensions and orientation.

Provide emergency overflow facilities to prevent uncontrolled spillage over the walls during a critical 1:100 ARI storm event or when the lagoon reaches capacity. The designer shall assess the flow path of any spillage from the basin to ensure that it will not cause inundation of any private properties.

Batter slopes shall comply with Section 10.5.4 of this document.

Scour protection is to be detailed on the design drawings. Scour protection methods shall be considered for both internal and external batters.

Emergency egress facilities (including appropriate signage) are to be provided for all storage lagoons.

11.4 Operation and maintenance

The designer shall consider maintenance access requirements for the lagoon and what protection is required to maintain liner integrity. The lagoon must be able to be emptied for maintenance work. An isolation valve shall also be provided on the lagoon side of the egress pump to enable maintenance work. If a pump chamber is installed external to the lagoon, then an isolation valve shall be installed to enable the sump to be isolated.

11.5 Liners and leak detection

The lagoons are to be lined in accordance with the EPA's guideline – Wastewater Lagoon Construction (2018, or latest update).

A risk assessment shall be undertaken in accordance with EPA requirements to determine whether leak detection is required. Leak detection shall be in accordance with EPA requirements.

Ballast or anchoring is to be provided for the empty lagoon (either before water enters the lagoon, after construction or during maintenance) and clearly stipulated on the design drawings.

11.6 Fencing

Storage lagoons are to be fenced as per Section 10.6.5.

12 RECYCLED WATER USE OR DISPOSAL

12.1 General

All CWMS proposals shall provide for the reuse or disposal of the treated water. Reuse components shall comply with DHW and EPA requirements and shall be based on the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1).

Designers shall confirm treatment and disinfection requirements for various reuse options with DHW to ensure that their design accounts for the latest requirements.

Proposals shall include a water balance (see Section 11) and an IMP (as part of the RMP) for all reuse options.

Recycled water may be reused or disposed of using (but not limited to) the options specified in the following sections.

12.2 Reuse options

Recycled water could be used for a range of activities including: irrigating ovals, golf courses, reserves, parks, gardens and woodlots; agricultural production; and non-drinking domestic or industrial activities.

Recycled water use shall comply with the Australian Guidelines for Water Recycling and DHW requirements. Recycled water installations shall also comply with the OTR's Guidelines for Non-Drinking Water in South Australia.

Dual reticulation and unrestricted irrigation

Where recycled water for dual reticulation or unrestricted irrigation is proposed, the designer shall contact DHW to discuss treatment requirements prior to designing the scheme.

Critical control points (CCPs) shall be established and approved by DHW for all schemes that propose dual reticulation, unrestricted irrigation or similar application.

A risk management plan (see section 13) is required to be prepared and submitted as part of the DHW approval process for any scheme involving dual reticulation systems with treated wastewater.

12.3 Disposal options

12.3.1 Evaporation pans

Disposal by evaporation shall be calculated annually and based on 80% of the area's effective evaporation rate.

The facultative lagoon capacity may be reduced to a 36-day detention (for STEDS effluent or equivalent) period when evaporation is used as the disposal method and future recycled water reuse is not considered.

Evaporation pans are to be fenced as per Section 10.6.5.

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12.3.2 Soakage trenches

Soakage trenches shall be designed in accordance with the South Australian Onsite Wastewater Systems Code.

12.3.3 Other disposal methods

Seek advice from the DHW and EPA when proposing other forms of disposal, such as Wisconsin mounds or pressurised disposal beds.

13 MANAGEMENT PLANS

All CWMS require management plans. Some plans are required before a scheme becomes operational.

The following four plans are specifically required:

- Risk Management Plan (RMP) – this shall be developed based on the 12 elements outlined in the AGWR and as per the DHW's Community Wastewater Management Systems Code.
- Safety Reliability Maintenance and Technical Management Plan (SRMTMP) (as per OTR requirements).
- Safety in Design Report (to satisfy WHS legislative requirements)
- Irrigation Management Plan (IMP) – this is required as part of the design phase for all reuse schemes to ensure accurate water balance calculations.

The DHW shall be contacted to determine what is required to prepare and present the RMP. The RMP may be needed at different stages of the CWMS project and this will depend on the scheme's public health risk and CWMS code requirements.

The OTR shall be contacted to determine what is required to prepare and present the SRMTMP.

The following aspects also need to be addressed for CWMS:

- operations manual - operation maintenance requirements for the scheme as a whole
- operator training
- emergency response plans for all components of the system
- routine monitoring requirements for all scheme components
- soil and crop management monitoring.

These items can be presented in a format determined by the WIE or the consultant if the entity does not have specific requirements.

The WIE must clearly articulate the contents of the operations manual. If the WIE does not provide any guidance then the operation manual requirements shall default to those outlined in the EPA's South Australian STEDS –Guidance Notes for the Preparation of an Operation and Maintenance Manual.

14 AS CONSTRUCTED DRAWINGS

A scheme's 'as constructed' drawings are to be provided to DHW in accordance with the scheme's DHW approval. The WIE should also require as constructed drawings for their records management system.

The WIE shall specify the format of the as constructed drawings. If the WIE does not specify any requirements, then the minimum requirements shall be those specified by the LGA in the Standard Brief for Designing, Calling Tenders and Superintending Construction of Septic Tank Effluent Disposal Schemes in South Australia (summarised below).

The consultant/superintendent shall allow a set of as constructed drawings to be prepared and provided to the WIE.

The as constructed drawings shall show the:

a) location (relative to boundary alignment), depth below ground surface level and relative elevation (Australian height datum [AHD]) of all connections
b) location of all drain line flushing points, maintenance holes and any changes in the direction or alignment of any drain between flushing points and/or maintenance holes, relative to boundary alignments or other fixed reference points (two measurements from reference points are required to identify the location of any of the above-mentioned points)
c) length of the drain from '00' to each flushing point and maintenance hole, and any changes in grade between flushing points and maintenance holes
d) relative elevation (AHD) and depth below natural surface of all drains at flushing points, maintenance holes and changes in grade between flushing points and maintenance holes
e) drain line gradient between each change in grade
f) location of all rising mains relative to boundary alignments or other fixed reference point and the depth below natural surface at changes in direction and/or elevation and at 100 metre increments along the rising main
g) standard detail of all drains, rising mains, maintenance holes, flushing points, and pumping stations
h) location and layout of the treatment, storage and disposal/reuse facilities, providing all dimensions, depths, capacities, and process instrumentation.

15 GLOSSARY AND COMMON TERMS USED IN WASTEWATER SYSTEMS

ABS	Australian Bureau of Statistics
ADF	Average daily flow
ADWG	Australian Drinking Water Guidelines (NHMRC–NRMMC 2004)
AHD	Australian height datum
BOD	Biological oxygen demand. This is the amount of dissolved oxygen required by aerobic biological organisms to break down organic material in a given water sample.
BOD_5	The amount of dissolved oxygen consumed by bacteria over a five day period.
BOM	Bureau of Meteorology
CCP	Critical control point
Ct	The product of the residual disinfectant concentration (C) (in milligrams per litre) and the corresponding disinfectant contact time (t) (in minutes)*. A Ct can be used to achieve a quantified reduction in pathogenic (disease causing) microorganisms in recycled water systems. Free chlorine is typically used to achieve a Ct. **extracted with modification from the Australian Guidelines for Water Recycling*
CWMS	Community Wastewater Management System. As defined under the South Australian Public Health Regulations (2013), a CWMS: “means a system for the collection and management of wastewater generated in a town, regional area or other community, but does not include SA Water sewerage infrastructure.”
DHW	Department for Health and Wellbeing (Wastewater Section)
DO	Dissolved oxygen
DPTI	Department of Planning Transport and Infrastructure, South Australia
EPA	Environment Protection Authority
EP	Equivalent population
FEP	Unit of flow per equivalent person
Free chlorine:	The concentration of free residual chlorine present as dissolved gas, hypochlorous acid or hypochlorite in water (and not combined with ammonia or organic material). Free chlorine is a stronger disinfectant than combined chlorine.
HDL	Hydraulic design load (scheme or component design flow)
HDMI	High definition media interference

HMI	Human machine interface
HRAP	High rate algal pond (method of wastewater treatment)
IMP	Irrigation management plan
IS	Inspection shaft (relates to sewerage schemes)
IO	Inspection opening (relates to STEDS)
LGA	Local Government Association of South Australia
NTU	Nephelometric turbidity unit
NRF	Non-residential flows
NC	Number of residential connections
OR	Occupancy rate for a property
OTR	Office of the Technical Regulator
PID	Process and instrumentation diagram
RMP	Risk management plan (as required by DHW)
RRJ	Rubber ring joint (pipe)
SCADA	Supervisory control and data acquisition
SS	Suspended solids
STEDS	A community-based septic tank effluent drainage scheme (it does not apply to individual properties that manage their wastewater on site).
Total chlorine:	The sum of free and combined chlorine. Combined chlorine is the residual chlorine combined with ammonia or organic material. Combined chlorine is not as strong a disinfectant as free chlorine.
UV	Ultraviolet
WIE	Water industry entity (pursuant to the Water Industry Act 2012).
WSAA	Water Services Association of Australia

APPENDIX A

PIPELINE CAPACITY - MAXIMUM NO. OF EQUIVALENT RESIDENTIAL CONNECTIONS

Pipe Size	Grade	SYSTEM PEAKING FACTOR		
		3 Rainfall less than 400mm per annum	**4** Rainfall between 401mm and 599mm per annum	**5** Rainfall greater than 600mm per annum
DN 100	0.40%	137	103	82
	0.50%	154	115	92
	0.67%	177	133	106
	0.80%	194	146	117
	1.00%	217	163	130
	1.25%	243	182	146
	1.67%	281	210	168
DN 150	0.25%	300	225	180
	0.33%	347	260	208
	0.40%	380	285	228
	0.50%	425	318	255
	0.55%	445	334	267
	0.67%	490	368	294
	0.80%	537	403	322
	1.00%	600	450	360
	1.25%	671	503	403
	1.67%	775	581	465
DN 225	0.15%	763	572	458
	0.25%	985	739	591
	0.33%	1138	853	683
	0.40%	1246	935	748
	0.50%	1393	1045	836
	0.67%	1609	1207	965
	0.80%	1762	1322	1057
	1.00%	1970	1478	1182
	1.25%	2203	1652	1322
	1.67%	2544	1908	1526

NOTES:

1. *Rainfall is the mean rainfall for that area as stated by BOM*
2. *Pipe flow is reduced to 60% of full flow capacity*
3. *Manning's friction coefficient is n_m = 0.0128 equivalent to a Colebrook-White roughness of k = 1.5 mm*
4. *The rate of occupancy RO = 2.6 p/d (persons per dwelling)*
5. *The average dry weather flow ADWF = 170 L/p/d (Litres per person per day)*
6. *Internal pipe diameters are based from Iplex DWV stiffness classes SN8 for DN150 and DN225 and SN10 for DN100*
7. *For minimum pipeline sizes and grades refer to Section 5.2.1 and 5.2.2 for STEDS and Section 7.1 for Full sewerage schemes*

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