Local Government Association of South Australia

The voice of local government.

# High Rate Algal Pond (HRAP) Design Guideline

# - an element in CWMS Wastewater Treatment Trains

**Prepared jointly by**

South Australian Local Government Association;

Flinders University; and

South Australian Department for Health and Wellbeing

**ISBN 978-1-76083-131-8**

Government of South Australia

SA Health

# Foreword

The High Rate Algal Pond (HRAP) Design Guideline (the Guideline) has been developed to provide guidance on designing a validated HRAP for wastewater treatment that will achieve a minimum of 1 log reduction of viral pathogens. The design criteria in this Guideline is based on a validated design that has been approved for use by Water Industry Entities (WIE) by the South Australian Department for Health and Wellbeing. This is the first validated wastewater treatment design guideline in South Australia.

This Guideline is the culmination of work undertaken by the Local Government Association (LGA) Community Wastewater Management System (CWMS) Committee. As part of the Committee's commitment to continuous improvement within the sector and the development of low cost, low carbon footprint, low maintenance sustainable wastewater solutions they sponsored research and subsequent $Log_{10}$ Reduction Validation (LRV) of the High Rate Algal Pond System developed by Professor Howard Fallowfield of the Flinders University in South Australia.

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

The Committee would like to acknowledge the following organisations for their contribution to this project:

- District Council of Loxton Waikerie
- District Council of Light
- Department for Health and Wellbeing
- Flinders University

Special acknowledgements to Professor Howard Fallowfield, Professor Nancy Cromar and Dr Neil Buchanan from Flinders University, who undertook the research that this guideline is based on.

# Table of Contents

# 1 INTRODUCTION

A Community Wastewater Management System (CWMS) is used to collect, treat and reuse/dispose of wastewater produced in the community in a safe, cost effective and environmentally sustainable manner. CWMS are typically installed in regional and outer metropolitan areas of South Australia (SA) that are not serviced by SA Water. The first CWMS in South Australia was installed in Pinnaroo in 1962.

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. There are now over 180 CWMS installed throughout SA and these are operated primarily by local Councils and a small number of private Water Industry Entities (WIE). Wastewater treatment typically consists of combinations of facultative lagoons or mechanical treatment plants and treated water is typically stored over winter in storage lagoons for beneficial reuse in the warmer months.

Both facultative lagoons and mechanical treatment plants have their advantages and disadvantages. Facultative lagoons are cost effective to operate, however, require large land footprints and lose large amounts of water via evaporation due to the long retention times required to achieve treatment. Mechanical treatment plants such as Sequencing Batch Reactors and other activated sludge processes have smaller footprints but have high capital and operating costs, require power and need experienced operators who may not be available in the regional and remote areas where CWMS are typically installed.

A goal of the LGA CWMS Management Committee is to ensure that CWMS that are installed throughout the state are operationally sustainable, cost effective and meet all relevant environmental and public health standards. A gap in the available treatment processes was identified by the committee and the high rate algal pond (HRAP) treatment process was identified as meeting this need. The Committee formed a partnership with Flinders University and funded the development and research into the HRAP in 2007, together with input from the Department for Health and Wellbeing (DHW). A HRAP system was constructed at Kingston on Murray and this site was used to test various wastewater treatment scenarios.

A requirement of DHW was independent validation to demonstrate that this new process could achieve a minimum $\log_{10}$ reduction of pathogens in line with the Australian National Guidelines for Water Recycling: Managing Health and Environmental Risks (NHMRC, 2006). Validation testing was undertaken in 2013 using an approved validation testing protocol and was verified by an independent National Association of Testing Authorities (NATA) accredited laboratory.

These Guidelines are based on the research undertaken by Flinders University, the results of the validation and experience through the installation of the first post-validation HRAP systems in Peterborough, SA (Figure 1.1). This Guideline includes the operational specifications that were used for validation of the system as well as the treated water quality parameters. By following the design specifications and the required operational monitoring that are included in this Guideline, the system installed will in winter, produce a minimum of 1 $\log_{10}$ reduction of viral pathogens in the prevailing temperate, Mediterranean climate.

Figure 1.1: The HRAPs at Peterborough were commissioned in 2019. The HRAPs are each 5000m$^2$. The system, including two anaerobic ponds, was designed to treat a total of 475m$^3$/ of wastewater per day. This was the first HRAP built using the validated design in this Guideline.

## 1.1 Document scope

This document is a reference guide for designers and WIE that wish to adopt the use of a HRAP as part of the selected treatment train for a CWMS in South Australia.

For the calculation of the required treatment loads and all other components of the CWMS from collection, through treatment to reuse and/or disposal designers should refer to the latest version of the South Australian Community Wastewater Management System (CWMS) Design Criteria (2019).

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 current legislative requirements and additional requirements of the WIE, as defined under the *Water Industry Act 2012*.

## 1.2 Document review

Further validation testing will be undertaken in 2020 to investigate daytime only paddle wheel operation. Once this work has been completed this document will be updated. Please check the LGA website for updates to the Guideline (www.lga.sa.gov.au).

# 2 HIGH RATE ALGAL PONDS

## 2.1 What is a High Rate Algal Pond?

HRAPs are shallow, raceway ponds that consist of a series of interconnecting baffled chambers. Pond depth is typically between 300mm and 500mm. Theoretical hydraulic retention times (THRT) are short, between 4 and 10 days, to achieve adequate treatment. Mixing is achieved using a low-power paddlewheel, which circulates the wastewater through the channels. Continuously mixing the wastewater avoids thermal stratification and maintains a homogenous chemical environment throughout the channels. This environment helps to maximise the breakdown of organic waste and removal nutrients via algal and bacterial growth. The shallow depth combined with mixing helps to maximise pathogen inactivation via sunlight (Young et al., 2016; Buchanan et al., 2018a; Lian et al., 2018).

HRAPs can be designed using several configurations that are selected based primarily on the site topography. The two most common configurations are the single loop as used at Kingston on Murray (Figure 2.1) or a serpentine channel configuration, which was used at Peterborough (Figure 1.1). Wastewater is transferred into the base of the pond immediately before the paddle wheel. The paddlewheel mixes the influent with the wastewater already in the channel and maintains a consistent surface flow velocity through the system. The pond side walls are normally vertical and the raceways are lined with a suitable pond liner such as high density polyethylene (HDPE). The design and operation of HRAPs for wastewater treatment was recently reviewed (Young et al., 2017). HRAP design details can be found in Section 5 of this document.

**Figure 2.1:** Two single loop HRAPs at the Kingston on Murray research site.

## 2.2 Why consider the use of a HRAP?

High rate algal ponds offer a sustainable, efficient and lower cost option to the systems currently in use in regional South Australia. Designers and WIE's may consider using a HRAP system as they:

- Offer a smaller footprint solution than that of a traditional facultative lagoon (up to 50% reduction) due to the reduced THRT (Buchanan et al., 2018a). This also reduces the capital costs for construction.
- The smaller footprint due to the shorter THRT reduces the evaporation losses when compared to traditional facultative lagoon systems, providing the opportunity to maximise beneficial reuse.
- Superior ammonia removal compared to facultative ponds. Ammonia reduction in HRAPs range between 59 and 74% (Buchanan et al., 2018a).
- They require less power than the various mechanical treatment plant options available on the market, i.e. activated sludge, Sequencing Batch Reactor (SBR), Membrane Bioreactor (MBR) or Moving Bed Bioreactor (MBBR).
- Power is required for the paddle wheel motor drive and can be supplied by solar voltaic cells with battery storage (Figure 2.3).
- They provide a lower carbon footprint than other treatment systems
- They require less operator interaction and attendance at the site than typical mechanical plants
- HRAPs are suitable for towns that experience seasonal fluctuations in population e.g. holiday towns, as the depth of the pond can be increased or decreased to cater for varying loads.
- HRAPs are an independently validated system and depending on the end use and the treatment LRVs required, further treatment such as chlorination may not be required (contact DHW for further advice). This provides assurance that public health risks are being adequately managed.

**Figure 2.3:** Solar panels with battery storage at Kingston on Murray HRAP wastewater treatment plant.

A comparison of the suitability of various types of treatment plant for various site constraints is summarised in Table 2.1.

**Table 2.1:** Comparison of the suitability of different wastewater treatment technologies for various site constraints

| Site constraints | Facultative lagoon | Mechanical treatment | HRAP |
|---|---|---|---|
| Limited power available | Y | N | Y |
| Limited land footprint | N | Y | Y |
| High evaporation rates due to climate | N | Y | Y |
| Limited access to experienced operators | Y | N | Y |
| Public Health Requirements<br>Validated 1 LRV (for virus removal) through wastewater treatment plant | N | N | Y |
| Holiday towns (peaking flows) | Y | N | Y |

## 2.3 Validation methodology and HRAP $Log_{10}$ Reduction Values

The validation testing undertaken at the Kingston on Murray HRAP was based on requirements specified by the Department for Health and Wellbeing (Fallowfield et al., 2018); specifically the determination of $log_{10}$ reduction values of the faecal indicator organisms *E. coli* and F-RNA coliphage. The LRV indicates the degree of inactivation of microorganisms (see Glossary of terms) by the treatment process. Validation protocol is described below.

***Operation of the Kingston on Murray site during validation testing.***

- 2 HRAPs (each of 200m$^2$) were operated in series to achieve a combined THRT of 10 days.
- HRAP operational depth was 300 mm.
- Mean surface flow velocity was 0.2 m/s
- Mean daily inflow of septic tank effluent was 12 m$^3$/day. Inflow was measured by a Magflow meter (ABB Ltd) and was transferred to the first HRAP 6 times a day.
- Septic tank effluent used during the validation from the township of Kingston on Murray had the following composition (Fallowfield et al., 2018):
  - $BOD_5$ median 205.5 mg/L; mean 18.8 ± 72.55 (or equivalent to 40g/EP/day)
  - SS median 61 mg/L; mean 56.7± 14.17 (or equivalent to 25g/EP/day)

***The validation methodology.***

- 20 samples were collected from both the inlet and outlets to HRAP 1 and 2 over a 10-week period in winter when below average solar radiation and temperature conditions obtained. Samples were typically collected on Mondays and Thursdays.
- Native indicator organisms were used as surrogates for bacteria, virus and protozoa, as agreed to by DHW. Surrogates tested were:
  - *E. coli* for bacteria
  - F-RNA coliphage for viruses
  - Aerobic spores for protozoa
- Microbiological analysis and verification of LRVs was undertaken by the Australian Water Quality Centre (AWQC), a NATA accredited laboratory. Flinders University also

undertook microbiological analysis and results reported by both laboratories were comparable (Fallowfield et al., 2018).

- Data was also collected by Flinders University for wastewater suspended solids (SS), turbidity and $BOD_5$.
- 5th percentile LRVs were calculated as the difference in counts of the respective organisms between samples of influent to HRAP 1 and outlet samples (final treated effluent) from HRAP 2.

DHW reviewed the LRV data from the NATA accredited laboratory and awarded the process the Approved LRV. A summary of LRVs achieved by the HRAP system is provided in Table 2.2. Note that significantly higher LRVs were achieved during the warmer months when irrigation is likely to occur and a summary of these results can be found in Young et al., 2016.

**Table 2.2:** LRV, independently determined by AWQC, achieved by two HRAPs operated in series in winter at Kingston on Murray, depth = 300mm, combined THRT = 10 days (Fallowfield et al., 2018)

| **Pathogen** | Median (LRV) | 5th percentile (LRV) | **DHW Approved LRV** (LRV) |
|---|---|---|---|
| Bacteria (*E. coli* as surrogate) | 2.9 | 1.82 | **1** |
| Virus (F-RNA as surrogate) | 2.08 | 1.61 | **1** |

The treated effluent also had a $BOD_5$ >20mg/L and an *E. coli* count of <10,000/100mL, which also met the Australian Guidelines for Water Recycling (NHMRC (2006)) requirements. Based on the information provided by Flinders University showing that depth does not significantly affect pathogen removal (Buchanan et al., 2018a) DHW permitted the variation of the HRAP operational wastewater depth between 300 and 500mm for the purpose of this Guideline. Permission was also granted to use the HRAP to treat sewage provided that an anaerobic pond or other primary treatment was used prior to the HRAP.

# 3 PLANNING CONSIDERATIONS FOR DESIGN OF HRAP FOR CWMS

## 3.1 General design considerations

Reference should be made to the latest revision of the CWMS Design Criteria when preparing the design of any component of a CWMS.

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.

The general design planning considerations are outlined in Section 2.1 of the CWMS design Guidelines. Designers or WIE's considering the use of a HRAP as part of their CMWS should consider the following:

- design loads (as outlined in Section 4 of the CWMS Design Guidelines)
- confirmation of the wastewater source(s)
- treatment for noise and odour control
- buffer distance requirements 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 11.3 of the CWMS Design Criteria)
- production of management plans (Section 13 of the CWMS Design Criteria) 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), 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.
- 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
- flood protection and plant access
- the land area occupied by the plant and the reuse or disposal area
- sludge volume and storage, handling and disposal techniques
- plant redundancy.

## 3.2 HRAP Specific Design Considerations

Designers and WIE's preparing the HRAP design should consider the following specific issues:

- Pre-treatment requirements prior to feeding effluent into the HRAP.
- Configuration of the HRAP in order to achieve the 10-day hydraulic retention requirement (i.e. 1 race, multiple races, one by 10-day HRAP or a number of individual HRAP's in series).
- Post HRAP storage requirements, noting HRAP retention time is not to be used as part of any 25-day storage retention time calculations, if there is a retention requirement as a result of the recycled water end-use (refer to Section 11.3 of the CWMS Design Criteria).
- Maintenance requirements (i.e. what happens if the HRAP needs to be taken off-line for operational maintenance or repairs).
- Buffer storage requirements to balance inflows (refer to Section 4 of this document).
- Lining material (specifically lining material characteristics in relation to installation i.e. a 1.5mm HDPE liner is quite stiff and is difficult to mould to tight bends or changes in vertical alignment as such the layout may impact the liner type selected).
- Internal barrier design (wall or earth mound).
- Construction methodology (this can impact system integrity i.e. how to form the embankments to ensure stability under the liner).
- Access to outlet structures for maintenance.
- Water quality monitoring equipment (location and type) to allow system operational assessment and DHW reporting and operational monitoring requirements.

## 3.3 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).

# 4 LEGISLATIVE AND APPROVAL REQUIREMENTS

## 4.1 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 WIE 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.

## 4.2 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. When designing HRAP systems DHW should be consulted to determine tertiary treatment requirements (i.e. is chlorine disinfection required)

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

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

Wastewater Management Systems Code for application requirements. It is recommended that the WIE consult with the DHW early in the design process. In order to claim a 1 LRV virus reduction credit for the HRAP installation, submissions will need to refer to each Critical Control Point (CCP) in the system. Critical control points for the HRAP system have been identified as specific design criteria in Sections 5.2 and 5.4. Critical control points need to be either:

- Hard-designed infrastructure (for example to achieve the required water depth, gravity offtakes with level control riser or weir can be installed to ensure minimum depth is not breached); or
- monitored at all times (for example to achieve uniform flow rate into the HRAP, use of flow meters and flow balancing infrastructure).

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 of the CWMS Design Criteria).

# 5 DESIGN OF HRAP TREATMENT FACILITIES

This section is to be read with reference to the current version of the South Australian Community Wastewater Management System (CWMS) Design Criteria (Department for Health and Wellbeing and Local Government Association of South Australia).

## 5.1 Introduction

This section provides the design criteria for the inclusion of HRAPs into a CWMS treatment train. The calculation of design loads and other system requirements to enable reuse or disposal of effluent shall be based on the requirements set out in the following sections of the CWMS Design Criteria:

Section 4 – CWMS Design Loads
Section 11 – Recycled Water Storage Lagoons
Section 12 – Recycled Water Use or Disposal

## 5.2 High Rate Algal Pond (HRAP) design loads

Design loads for the HRAP are to be calculated using the CWMS Design Criteria with specific reference to Section 4.

When determining the Hydraulic Design Load (HDL) the specific HRAP peaking factors specified in Table 1, page 19, of the CWMS Design Criteria shall be used.

It should be noted that the design requirements set out in this document assume that the HRAP is being fed with STEDS effluent. Should the CWMS collection network that delivers wastewater to the plant be a full sewerage scheme or be from an industrial waste source then the wastewater is to be pre-treated to meet the following load requirements:

| | BOD | SS |
|---|---|---|
| STEDS effluent | 40g/p/d | 25 g/p/d |

The designer shall determine an appropriate pre-treatment system to achieve the non-hydraulic design criteria as outlined above. A variety of pre-treatment options may be used inclusive of but not limited to anaerobic lagoons, Imhoff tanks, large septic tanks, anaerobic digestors. Screening may also be required. The DHW shall be consulted when determining the appropriate pre-treatment systems.

The HRAP has been developed to take a constant steady feed flow.

Designers should seek to provide a uniform flow rate and avoid batch flows wherever possible. This can be achieved either through the feeding pump station control systems or buffer storage prior to the HRAP.

Should a constant feed rate not be economically viable or physically practical then the design flow rate shall not exceed 40% HDL over any 5 hour period (CCP).

## 5.3 Configurations

The HRAP shall be configured in either a single or series loop arrangement as outlined in Figure 5.1 and Figure 5.2 respectively. The selected configuration is likely to be governed by land shape and area available and the grade across the site.

To be granted an LRV of 1 by DHW a 10-day detention time is required to be achieved within the HRAP configuration. The HRAP is required to be continuously mixed. Designers are not limited to achieving the detention time in a single HRAP. Multiple HRAP's may be used in series in order to achieve the required detention time.

Designers may consider multiple HRAPs in order to:

- Fit within the topographical site constraints
- To allow operational maintenance to be undertaken
- To cater for peak flows (i.e. in areas with high seasonal population fluctuations)

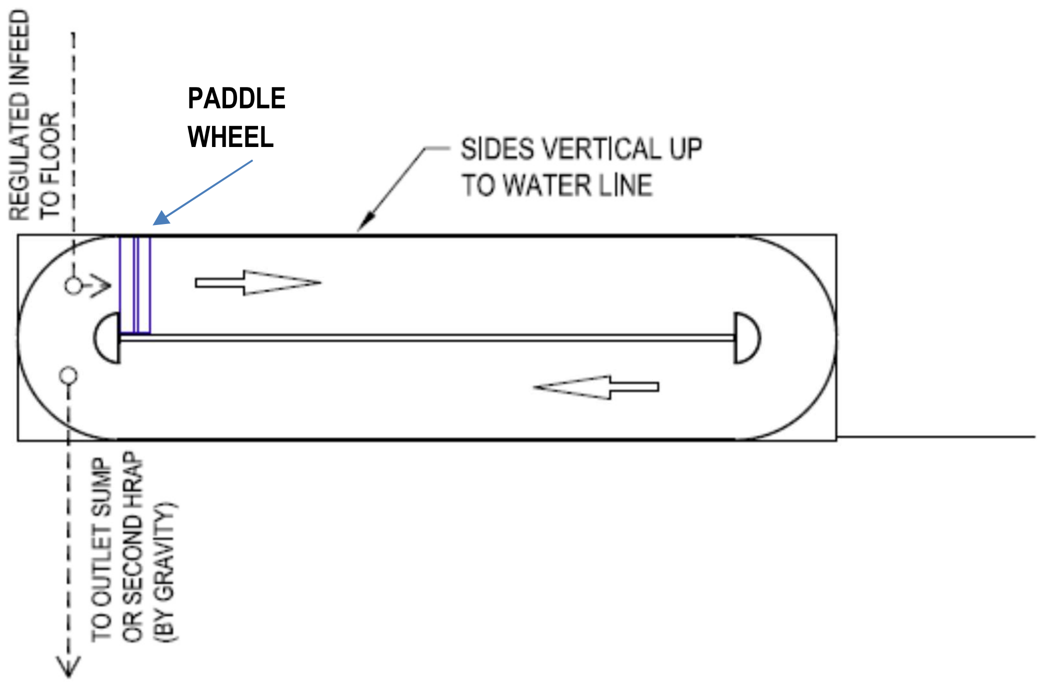


Figure 5.1: HRAP configuration showing the Single Loop Option

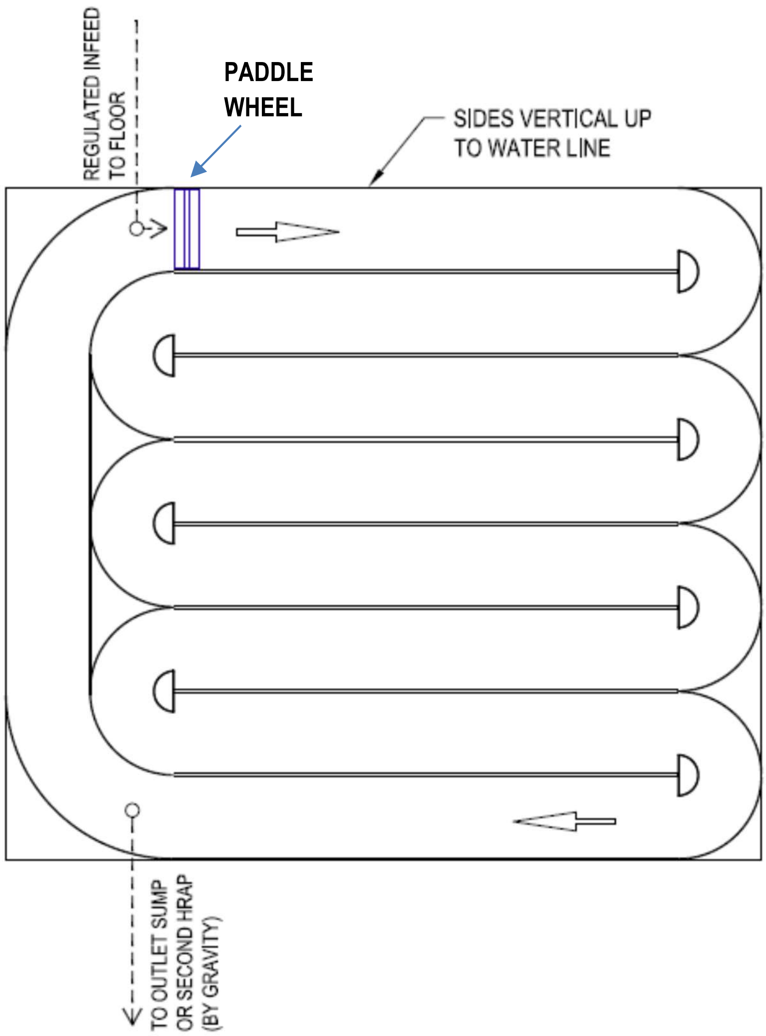


Figure 5.2: HRAP configuration showing the Series Loop Option

## 5.4 Design Parameters for the HRAP Treatment System

The following design parameters shall be adhered to in designing the HRAP system:

i) Channel: overall channel length to total channel width, shall not be less than 6:1 for single channel designs (refer Fig 5.3)
ii) Width and channel: HRAP orientation shall be selected to minimise wall shading.
iii) Wastewater depth (CCP): must be operated between 300mm and 500mm deep. The designer shall stipulate whether they wish to operate the HRAP at a fixed depth of 500mm to minimise surface area (and minimise evaporation), or at variable depth between 300mm and 500mm as one means of accommodating variable inflow rates (refer to Figure 5.3)
iv) Freeboard: HRAP channels must have a minimum of 300mm freeboard. Note that designers should consult with the EPA to confirm freeboard requirements for specific projects. The freeboard on the internal wall or flow divider can be determined by the designer and shall be specified in the DHW application for approval.
v) Detention time and Volume (CCP): the volume of the HRAP (combined if in series) shall be not less than 10 days at HDL.

vi) Liner: The liner is to be selected to satisfy EPA requirements for construction of wastewater lagoons. Consideration shall be given to the selected HRAP configuration and channel cross section, and the ability of the lining material to be installed.

vii) Liner Protection: the designer shall determine whether geotextile protection under the liner is necessary, and the required grade of geotextile. Anchoring of the liner shall be in accordance with manufacturer requirements. Designers shall specify the method of liner ballasting prior to the HRAPs being filled to avoid wind damage of the liners.

viii) Batter: Internal batter angle shall be stipulated to suit the channel formation material stability as per Engineer's advice.

ix) Paddlewheel rotation: ~ 12 rpm, 8 bladed, electric motor with reduction gearbox, direct drive coupling including shear pin. Consideration should be given to the requirement for a slipping clutch. Concrete base or similar rigid material laid under the paddlewheel to provide physical protection to the pond liner. The designer shall specify measures to ensure that the critical dimensions (e.g. paddle wheel clearances) are maintained in service. (refer to Figure 5.4)

x) Mean surface flow velocity (CCP): the paddle wheel and drive shall be configured to achieve a mean surface flow velocity of not less than 0.2m/s.

xi) Paddlewheel mounting: the area of the channel where the paddle wheel is installed shall have vertical side walls to minimise paddlewheel by-pass. The structure shall incorporate the channel transition from the general channel cross section to the vertical wall. The channel shall be designed to minimise wheel movement and prevent it coming into contact with the channel walls or floor. It is also to be used to protect the liner, which may be compromised should a wheel be installed over a flexible liner such as HDPE.

xii) The designer shall specify the jointing requirements between the paddle wheel channel section and the liner selected for the rest of the channel.

xiii) Outlet by gravity offtake

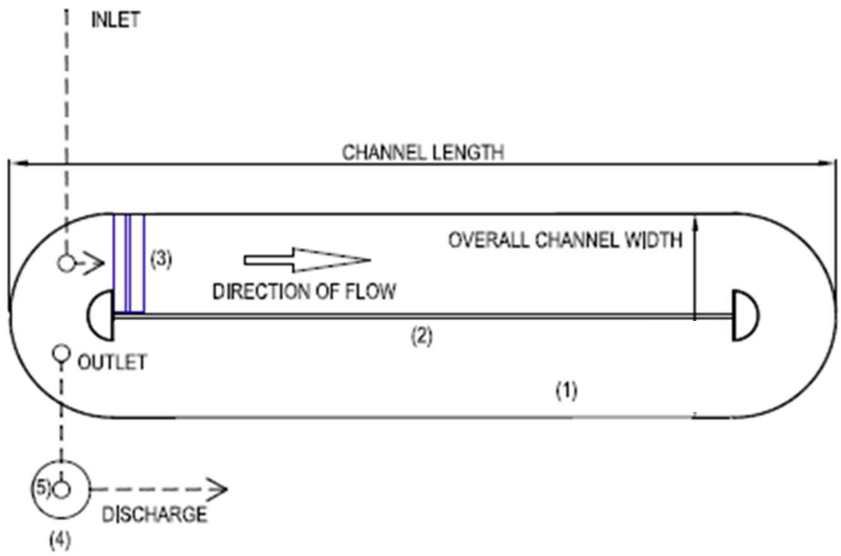


Figure 5.3 Channel Aspect Ratio

(1) High Rate Algal Pond Channel
(2) Central channel divider (note may be a vertical wall or barrier or a lined earthen embankment
(3) 12 rpm, 8 bladed, electric motor with reduction gearbox, direct drive coupling including shear pin and slipping clutch as required.

(4) HRAP outlet sump (noting level of the sump and weir is critical to the operation of the HRAP. Access to the maintenance chamber is to be provided for operational maintenance and monitoring. The HRAP weir shall be installed in the outlet maintenance chamber. The designer shall specify if the weir is to have an adjustable height. A drain facility shall be installed to enable the HRAP to be emptied for maintenance.
(5) HRAP level control riser or weir. (Refer Figure 5.5 for a typical outlet, noting the designer is to determine the appropriate outlet configuration.

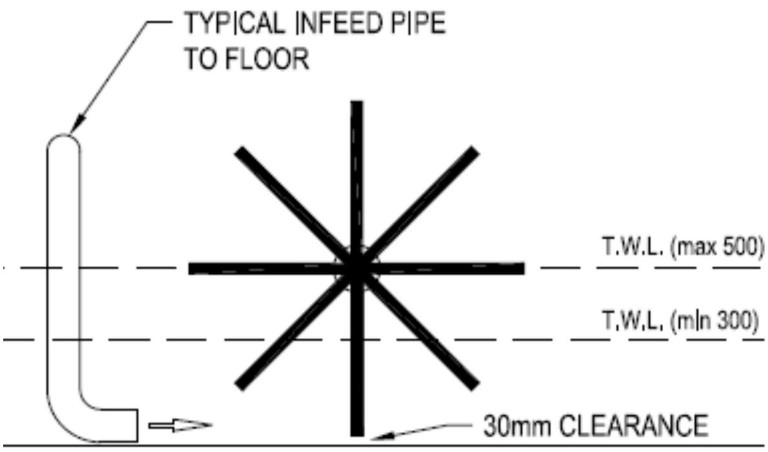


Figure 5.4– Paddle wheel and operating levels

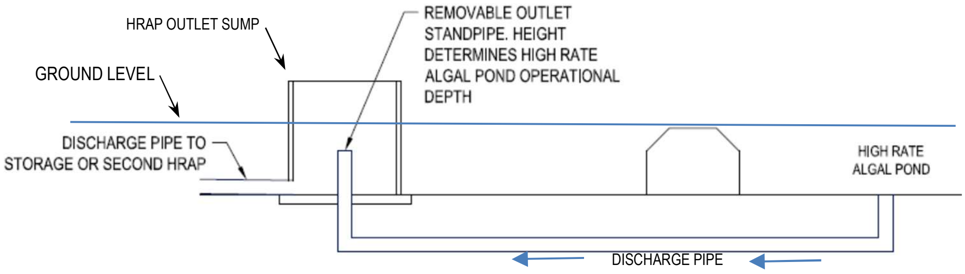


Figure 5.5 – Typical outlet Structure (example only)

## 5.5 Operational Monitoring

Operational monitoring is essential to ensure that the HRAP is being operated within the validated constraints for the system. At a minimum, the following shall be monitored:

- Depth should be measured for systems where the depth can be varied, to ensure minimum detention time CCPs can be achieved.
- Paddle wheel operation should be alarmed On/Off
- Flow rate into the HRAP to prevent overloading and to ensure minimum detention time is achieved. This can be achieved using a flow meter.

## 5.6 Post-HRAP Treatment Requirements

The post HRAP treatment requirements will depend on the proposed end use and DHW should be consulted to determine whether additional treatment is required.

Where the end use may be accessed by stock, a 25 day minimum storage may be required by PIRSA for helminth removal. The 10 day minimum detention within the HRAP **shall not** be included in the 25 day provision (i.e. the 25 day storage is to be provided post HRAP), refer to Section 11.3 of the CWMS Design Criteria.

Disinfection requirements shall be determined in consultation with DHW.

Storage lagoons shall be designed in accordance with Section 11 of the CWMS Design Criteria.

All CWMS shall provide for the reuse or disposal of the treated wastewater. 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).

Reuse applications shall comply with Section 12 of the CWMS Design Criteria.

Management Plans are required for various components of a CWMS. Relevant management plans as specified in Section 13 of the CWMS Design Criteria shall be developed.

As Constructed Drawings are to be provided in accordance with Section 14 of the CWMS Design Criteria.

# 6 GLOSSARY AND COMMON TERMS USED IN WASTEWATER SYSTEMS

| | |
|---|---|
| ADF | Average daily flow |
| 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 |
| 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 Management Section, Health Regulation and Protection) |
| DO | Dissolved oxygen |
| EPA | Environment Protection Authority |
| EP | Equivalent population |
| FEP | Unit of flow per equivalent person |
| HDL | Hydraulic design load (scheme or component design flow) |
| HRAP | High rate algal pond (method of wastewater treatment) |
| IMP | Irrigation management plan |
| LGA | Local Government Association of South Australia |
| Log Reduction | “Log removal: Used in reference to the physical–chemical treatment of water to remove, kill, or inactivate microorganisms such as bacteria, protozoa and viruses (1-log removal = 90% reduction in density of the target organism, 2-log removal = 99% reduction, 3-log removal = 99.9% reduction, etc).” |
| OTR | Office of the Technical Regulator |
| PID | Process and instrumentation diagram |
| PIRSA | Primary Industries and Regions South Australia<br>Contact the Chief Veterinary Officer for minimum treatment requirements for recycled water used for stock feed/watering |
| RMP | Risk management plan (as required by DHW) |
| 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). |
| THRT | Theoretical Hydraulic Detention Time |
| UV | Ultraviolet |
| WIE | Water industry entity (pursuant to the Water Industry Act 2012). |
| WSAA | Water Services Association of Australia |

# 7 REFERENCES

Buchanan, N., Young, P., Cromar, N.J. and Fallowfield, H.J. (2018a) Comparison of the treatment performance of a high rate algal pond and a facultative waste stabilisation pond operating in rural South Australia *Water Science and Technology* 78 (1), 1-11 DOI: 10.2166/wst.2018.201

Buchanan, N., Young, P., Cromar, N.J. and Fallowfield, H.J. (2018b) Performance of a high rate algal pond treating septic tank effluent from a community wastewater management scheme in rural South Australia. *Algal Research*, 35, 325-332

Fallowfield, HJ, Young, P, Taylor MJ, Buchanan, N, Cromar, N, Keegan, A and Monis, P (2018) Independent validation and regulatory agency approval for high rate algal ponds to treat wastewater from rural communities. *Environmental Science Water Research & Technology*, 4, 195-205 DOI: 10.1039/c7ew00228a

LGA SA, South Australian Community Wastewater Management System (CWMS) Design Criteria, July 2019

Lian, Y., Mai, L., Cromar, N., Buchanan, N., Fallowfield, H. and Li, X. (2018). MS2 Coliphage and *E. coli* UVB inactivation rates in optically clear water: dose, dose rate and temperature dependence. *Water Science and Technology.* 78,2228-2238. doi: 10.2166/wst.2018.. 509

NHMRC (2006) Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1), ed. AHMC, Natural Resource Management Ministerial Council, Environment Protection and Heritage Council, Australian Health Ministers' Conference, Australia, 2006

Young, P, Buchanan, N and Fallowfield, H (2016) Inactivation of indicator organisms in wastewater treated by a high rate algal pond system. *Journal of Applied Microbiology,* 121 **(2), 577-586.** DOI: 10.1111/jam.13180

Young, P., Taylor, M., Fallowfield, H.J. (2017) Mini-review: High rate algal ponds, flexible systems for sustainable wastewater treatment *World J Microbiol Biotechnol* 33:117. DOI 10.1007/s11274-017-2282-x

Local Government Association of South Australia

The voice of local government.

148 Frome St
Adelaide SA 5000

GPO Box 2693
Adelaide SA 5001

T (08) 8224 2000

E lgasa@lga.sa.gov.au

**www.lga.sa.gov.au**