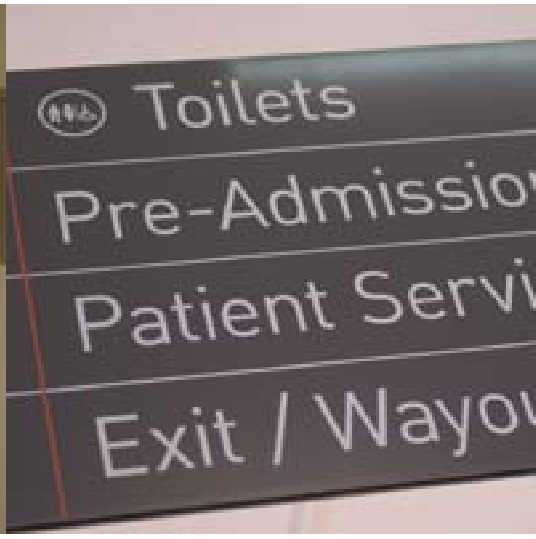
Guidelines for water reuse and recycling in Victorian health care facilities

Non-drinking applications



A Victorian Government initiative

Victoria
The Place To Be

Guidelines for water reuse and recycling in Victorian health care facilities

Non-drinking applications

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Foreword

Each year the Department of Health and agencies in Victoria consume considerable quantities of water in the delivery of essential health services.

As a result of the extended drought conditions in the state, the department is committed to reducing the environmental impact associated with its service delivery and is leading the Victorian Government's goal to reduce water consumption.

As a leader in water conservation the department is promoting the adoption of an integrated water management approach in the health sector. This entails a concerted effort to reduce demand of drinking water through conservation measures and adopting the use of alternative water supplies where appropriate.

This guideline has been developed to help health care facilities with risk management when accessing alternative water supplies for non-drinking applications and planning for water security. The guide is underpinned by Victoria's *Safe Drinking Water Act* 2003 and the Australian Guidelines for Water Recycling (NRMMC, EPHC and AHMC 2006) and is intended for use in conjunction with the water management plans for health services.

Central to finalising the guideline is its endorsement by the Victorian Advisory Committee on Infection Control.

An important feature of the guideline is its focus on sustainability. It is imperative that investments in water recycling do not have an adverse impact on our efforts to reduce our energy consumption and subsequently contribute further to climate change. As such, the guidelines promote the adoption of inherently low risk alternative water supplies and options that utilise minimal energy and resources.

I would like to recommend it to health services and agencies for use in making design and operational decisions and acknowledge the important contribution from a wide range of departmental and health industry stakeholders who assisted in the development of these guidelines.

The department is committed to working with health care providers to ensure safe, secure and sustainable water supplies for hospitals and health care facilities.

Fran Thorn
Secretary
Department of Health

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Glossary

Closed process	Industrial process where workers or the public are not exposed to the system water.
Greywater	Wastewater from the hand basin, shower, bath, spa bath, washing machine, laundry tub, kitchen sink and dishwasher. Kitchen water is generally too greasy and oily to be reused without significant treatment.
Non-potable water	Any source of water that is unsuitable for drinking.
Open process	Industrial process where workers or the public are exposed to the system water.
Rainwater	Water collected directly from roof runoff after rain.
Recycle	Using harvested water for the same or a different function, after treatment.
Reuse	Direct use of harvested water for the same or a different function, without treatment.
Sewage	Material collected from internal household and other building drains. Includes faecal waste and urine from toilets, shower and bath water, laundry water and kitchen water. Sometimes referred to as 'blackwater'.
Stormwater	Water that runs off all urban surfaces such as roofs, pavements, carparks, roads, gardens and vegetated open space, as a result of rainfall events.
Treated water	Water that is physically or chemically treated in a significant way and has characteristics different from those at the source.
Untreated water	Water that is not treated in any significant way and has characteristics similar to those at the source.
Industrial or process water	Wastewater produced from processes at industrial or commercial premises, including health care facilities. It includes all waterborne waste from these facilities except sewage.

1. Introduction

1.1. Objective and scope of the guidelines

Security and quality of water supply is vital for a number of key processes within health care facilities (HCF), such as hospitals, aged care facilities, medical centres and mental health facilities. Many HCF however consume large volumes of potable water and as the population of Victoria continues to grow and climate change reduces inflows to traditional water storages increased pressure is placed on potable water supplies.

As such there is a need for HCF to consider ways to reduce their reliance on reticulated potable water through conservation or augmentation with alternative water supplies for non-drinking applications. Augmentation can be achieved through either alternative water supplies such as rainwater, onsite reuse (direct use of water for the same or another function without the need for treatment) or recycling (treatment of water) of water sources. Community benefits to such an approach include both reduced potable water consumption and reduced trade waste discharge.

These *Guidelines for Water Reuse and Recycling in Victorian Health Care Facilities* (the guidelines) have been developed to supplement existing Federal and State guidelines on safe and sustainable water reuse and recycling, with information specific to HCF. It is intended that the guidelines provide a framework to guide and inform the decision making processes of hospital executives, engineering staff, external consultants and contractors.

In particular the guidelines focus on the management of human health risks associated with reusing and recycling water for 'non-potable' purposes within HCF, specifically detailing the:

- typical HCF water consuming activities and potential water sources
- Federal and State water reuse and recycling regulatory framework
- process for determining the suitability of projects through project screening
- risk management approach and key issues for consideration in the design, construction and operation of a water reuse and recycling project.

It is the responsibility of health care service providers to exercise duty of care and ensure that the use of alternative water supplies is protective of public health. Managing risks associated with water reuse and recycling schemes in a HCF requires a long-term commitment by the CEO and Board, to ensure the protection of human health and the environment.

Water reuse or recycling schemes in HCF should be managed in a manner that is safe and sustainable. This requires the adoption of the risk-based hierarchy approach which promotes water conservation, followed by choosing the most appropriate alternative water supply with the lowest risk, and lowest use of energy and resources for each situation.

The guidelines should be used alongside other critical documents and guidelines including water management plans, demand management and essential services risk management plans.

2. Water consumption and sources in HCF

2.1. Water consuming activities

An assessment of the largest water consuming activities within HCF may assist to identify priority projects for water conservation, reuse and recycling and should be the initial step when considering a water management strategy.

The water consuming activities within hospitals have been used as a surrogate to represent all HCF and this should be borne in mind when reviewing.

Principal water consuming activities within HCF are:

- **hygiene** washing, cleaning
- **sanitation** flushing of wastes to sewer
- **ingestion** drinking, food preparation
- **process** cleaning, sanitising, sterilising, laundering, heating, cooling, water filtering and softening
- **irrigation** ornamental garden and lawn watering.

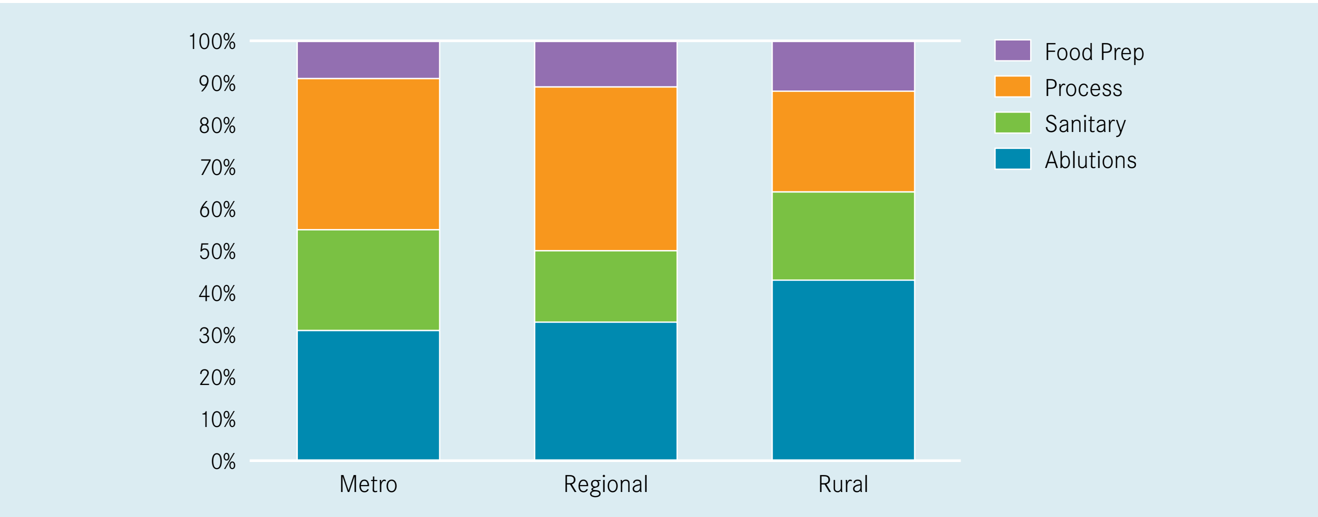
Table 2-1 summarises the proportional use of water in HCF based on information from water audit reports for a sample of hospitals throughout Victoria.

Table 2-1. Summary of proportional water uses in Victorian HCF (based on water audits)

Use of water	Typical proportional use
Ablutions (basins, showers, sinks)	20–40%
Sanitary flushing (toilets, pan sanitisers)	15–30%
Process (sterilisers, laboratories, cooling)	15–40%
Food preparation (kitchen)	5–25%

Figure 2-1 highlights the changes in water consumption between metropolitan, regional and rural locations. It is important to note that these values exclude significant usage for dialysis, laundry, cogeneration and pools, as these were not present in every hospital for which data was analysed.

Figure 2-1. Summary of proportional water uses in Victorian HCF (based on water audits)



2.2. Water sources

Within HCF there are a number of existing processes that may provide alternative sources of water. These include:

- fire service testing water
- reject water from reverse osmosis filtration plants
- cooling water from high pre-vac sterilisers
- vacuum pump seal water from high pre-vac sterilisers
- cooling tower basin bleed water
- final rinse water from laundry washing machines.

This water may be reused or recycled for sanitation, irrigation or other processes.

Water sources and uses presenting the most common opportunities for reuse and recycling are summarised in Table 2-2. 'Traditional' sources and uses are those that are not specific to HCF. Detailed guidance has previously been developed for these and is referred to in this document, rather than being reproduced. 'Process' sources and uses are mostly specific to HCF and the guidelines focus on these sources.

Table 2-2. Common sources and uses for reuse and recycling in HCF

Sources	Uses
• Traditional sources: – rainwater – stormwater – greywater – sewage.	• Traditional uses: – irrigation – toilet and urinal flushing – washing floors, walls, windows, plant, vehicles and equipment – ornamental water features – fire protection systems.

• Process sources:
– water from fire service testing
– reverse osmosis reject water (from dialysis suites, disinfection and sterilising systems, and boilers)
– steriliser wastewater (from condensers and pump streams)
– dry basin cooler wastewater
– cooling tower wastewater
– backwash water from boiler water softening plants
– backwash from pool filters.
	• Process uses:
	– Closed system
	  – boilers and co-generation make-up
	  – hot water for heating
	  – chilled water for cooling steriliser condenser
	  – water for macerators and pan sanitisers.
	– Open system
	  – flusher system top-up
	  – cooling tower make-up water and flushing
	  – surface cooling water
	  – fire protection system water (storage, charge water and test water)
	  – steriliser condenser and pump seal water
	  – laundries.

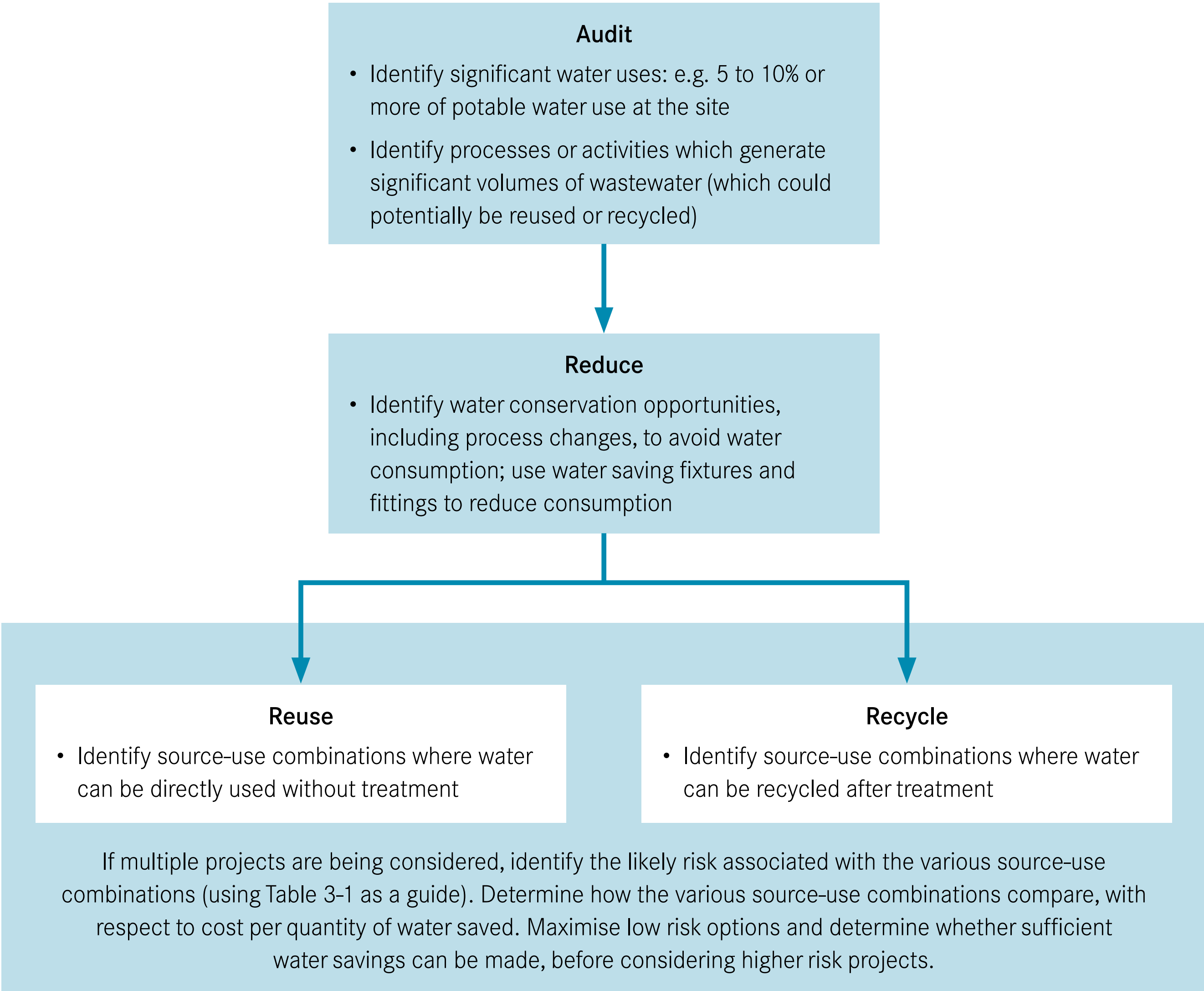
3. Project screening

3.1. Overview

The process of initially identifying a project for consideration as part of an overall water management process involves two stages:

- a water audit
- project screening risk assessment.

Figure 3-1. Project screening process



3.2. Water audit

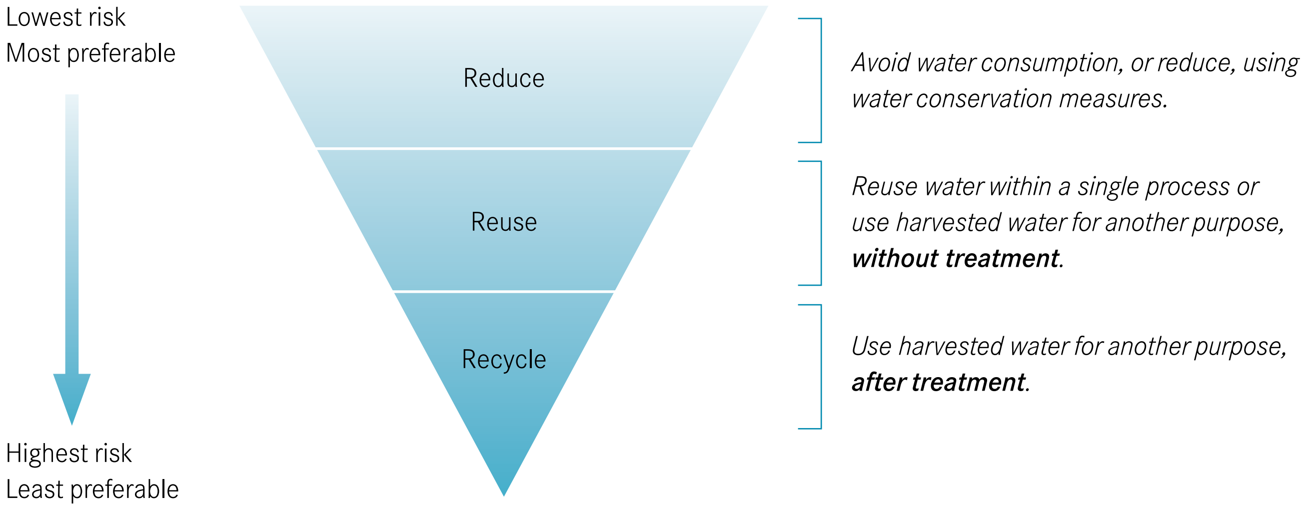
A water audit is necessary to identify both the water conservation opportunities and to consider projects that successfully balance the factors of water savings realised, risks to health, sustainability and cost. An indicative project screening process is mapped in Figure 3-1.

3.3. Risk assessment

3.3.1. Project screening assessment

Prior to determining the projects to be initiated as part of an overall approach to water management within HCF it is necessary to undertake a process of project screening. Screening involves assessing potential projects against the water management risk hierarchy as provided in Figure 3-2. It is necessary to ensure the project selection process incorporates consideration of not only the volume of water saved, but the health risks posed by a particular option and the project costs.

Figure 3-2. The risk hierarchy for water conservation, reuse and recycling projects

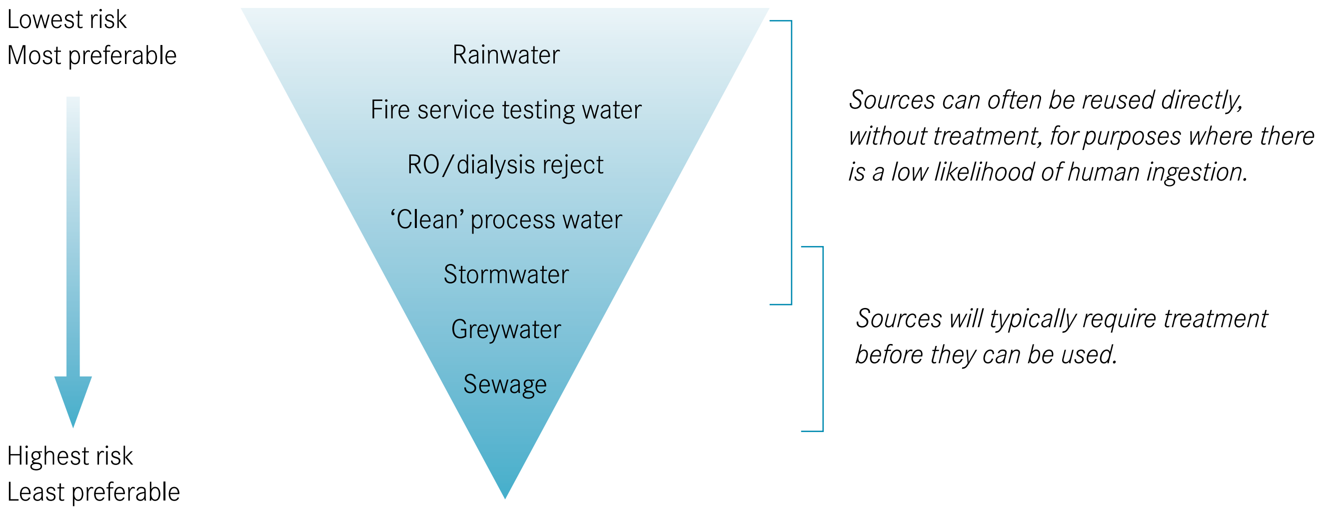


Within this context the hierarchy illustrates that water conservation measures will often represent low risk, whereas water recycling projects, such as sewage and greywater, are considered to be of a higher risk and are least preferable. The risk hierarchy also often reflects costs and as such high risk projects typically have expensive treatment and monitoring requirements, compared with lower risk water conservation projects.

When screening projects as part of a water management strategy a decision maker should aim to maximise water savings, while minimising risk and cost. Water conservation projects are more preferable as they represent a reduction in water consumption at a lower risk and cost.

If, following screening against the water management hierarchy, it is determined that reuse and recycle projects are suitable for HCF then reference is to be made to Figure 3-3.

Figure 3-3. The risk hierarchy for sources of harvested water (for reuse or recycling) in HCF



This diagram considers the level of risk for specific recycle and reuse projects that should be considered as part of a HCF water management strategy. It highlights that those projects where water can be directly reused, such as 'RO/dialysis reject' or 'clean process water', represent the lowest risk and are therefore more preferable. Those that require treatment are of a higher risk and less preferable.

3.3.2. Water source risk assessment

To assist in the risk assessment process a water source and use indicative risk table has been developed. Table 3-1 provides the indicative level of risk associated with common HCF water sources and uses for water reuse and recycling projects. This table provides an indicative list to inform the project screening process. As detailed in Section 5, a thorough risk assessment process is to be conducted as part of a project design and development.

Table 3-1. Indicative health risk[1] associated with common source-use options for water reuse and recycling

	Use									
Source	**Closed process**	**Subsurface irrigation[2]**	**Drip irrigation[2]**	**Water features[2]**	**Spray irrigation[2]**	**Wash down[2]**	**Toilet flushing/pan sanitisers/macerators**	**Fire protection systems**	**Laundry**	**Open process**
Water from fire service testing	L	L	L	L	L	L	L	L	L	L
Reverse osmosis (RO) reject water	L	L	L	L	L	L	L	L	L	L
Steriliser wastewater (condensers and pump streams)	L	L	L	L	L	L	L	L	L	L
Cooling system wastewater (where no biocides/chemicals are used)	L	L	L	L	L	L	L	L	L	L
Filter backwash from water softening plants	L	L	L	L	L	L	L	L	L	L
Rainwater	L	L	L	L	L	L	L	L	L	L
Cooling tower wastewater (with biocides/chemicals)	L	L	TBD[3]	TBD[3]	TBD[3]	TBD[3]	TBD[3]	TBD[3]	TBD[3]	TBD[3]
Stormwater	L	L	L	L/M[4]	M	M	M	H	H	H
Filter backwash from swimming pools	M	M	M	H	H	H	H	H	H	H
Greywater	M	M	H	H	H	H	H	H	H	H
Sewage	H	H	H	H	H	H	H	H	H	H

L = low risk—will not typically require site controls to minimise human exposure to water and/or treatment.

M = moderate risk—typically requires site controls to minimise human exposure to water and/or treatment.

H = high risk—typically requires treatment and may also require site controls to minimise human exposure to water.

Notes:

1. This risk rating only considers impacts on human health. It does not address issues such as physio-chemical contaminants causing scaling or corrosion of fixture or fittings, or contaminants that may affect the environment if water is being used for irrigation or in water features.
2. Assess whether contaminants are present at levels that may cause environmental effects.
3. TBD (to be determined) by a risk assessment, based on concentration and type of chemical/biocide present.
4. Stormwater used in a water feature may pose a moderate risk, if it includes a fountain or other mechanism that produces aerosols or spray drift.

4. Regulatory framework

4.1. Introduction

Prior to the establishment of a water reuse or recycling project HCF must ensure that the relevant approvals have been obtained and guidelines considered. Approvals need to be considered for both the operation of the specific water source and for supplementary requirements, such as plumbing connections. This section of the guidelines details the requirements for both sets of approvals and the applicable guidance documentation.

Victoria's regulatory framework for water reuse and recycling generally reflects the risk hierarchy, whereby lower risk activities, such as rainwater harvesting, require no regulatory approval. By contrast, higher risk activities, such as recycling sewage or greywater, require a rigorous approvals process. This relationship is highlighted in Figure 4-1. The risks within HCF by water source are detailed in Section 5.

4.2. Water source requirements

4.2.1. Overview

A summary of the regulatory framework for different water reuse and recycling options within Victoria is provided in Table 4-1 while a more detailed consideration of each water source is provided in Section 4.2.2.

Table 4-1. Regulatory framework for water reuse and recycling

Water source	Regulatory approvals	Relevant guidelines	Notes
Rainwater	No approval required.	*Rainwater use in urban communities* (DHS 2007)	
Stormwater	No approval required.	Victorian Government stormwater policy http://www.epa.vic.gov.au/water/stormwater/stormwater-harvesting.asp Australian Guidelines for Water Recycling (AGWR): Managing Health and Environmental Risks (Phase 2) Stormwater Harvesting and Reuse (2009)	Vic Govt policy adopts AGWR
Industrial or process water (not derived from sewage or greywater)	EPA approval may be required.	Industrial Water Reuse Guidelines (EPA publication IWRG632, 2009)) Australian Guidelines for Water Recycling (AGWR): Managing Health and Environmental Risks (Phase 1) (2006) for best practice risk management	
Greywater ≤ 5,000 litres per day	Local council permit required. EPA-approved system must be installed.	Guidelines for Environmental Management: Code of Practice—Onsite Wastewater Management (EPA publication 891.2, 2008)	At the time of publication, EPA guidelines were being reviewed and may be subject to change. Sewage recycling not permitted.
Greywater or sewage > 5,000 litres per day	EPA approval required if end-use includes discharge to the environment (e.g. through irrigation). Department of Health endorsement required if these are Class A schemes.	Guidelines for Environmental Management: Use of Reclaimed Water (EPA publication 464.2, 2003) Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes (EPA publication 1015, 2005) Australian Guidelines for Water Recycling (AGWR): Managing Health and Environmental Risks (Phase 1) (2006)	At the time of publication EPA guidelines were being reviewed and may be subject to change. Closed-loop systems (e.g. industrial use or toilet flushing with discharge to sewer or back to recycling plant) are not currently regulated. Publication 1015 or AGWR should be referred to for water quality objectives.

Figure 4-1. Relevant polices and guidelines for water reuse and recycle projects in Victoria

Lowest risk → Highest risk

Water sources	Rainwater	Process water	Stormwater	Greywater	Sewage
Relevant policies and guidelines	*Rainwater use in urban communities:* *Guidelines for non-drinking applications in multi-residential, commercial and community facilities*[1]	*Guidelines for water reuse and recycling in Victorian health care facilities*[2] *Industrial water reuse guidelines*[3]	*Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) Stormwater Harvesting and Reuse*[4]	***Greywater (≤ 5,000 litres per day)*** *Guidelines for Environmental Management: Code of Practice—Onsite Wastewater Management*[5] ***Sewage or greywater (> 5,000 litres per day)*** *Guidelines for Environmental Management: Use of Reclaimed Water*[6] *Guidelines for Environmental Management: Dual pipe water recycling schemes—Health and environmental risk management*[7] *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1)*[8]	

1 Department of Human Services 2007

2 Department of Human Services 2009

3 Environment Protection Authority 2009

4 Natural Resource Management Ministerial Council, Environmental Protection and Heritage Council, National Health and Medical Research Council 2009

5 Environment Protection Authority 2008

6 Environment Protection Authority 2003

7 Environment Protection Authority 2005

8 Natural Resource Management Ministerial Council, Environmental Protection and Heritage Council, Australian Health Ministers Conference 2006

For each potential water source the regulatory approvals required are identified. In certain cases, approval must be sought through the municipal environmental health function, and/or the approval procedures existing within the specific HCF.

In addition to the required regulatory approvals, Table 4-1 identifies for each water source relevant guidelines at a Federal and Victorian level. It is important to review these guidelines, as while there may not be a regulatory approval required, the relevant guidelines can assist in significantly reducing the risk associated with the establishment of a reuse or recycled water source.

A more detailed explanation of each of the guidelines referred to in this section is provided in Appendix A and contact details for the relevant approval authorities are provided in Section 6. It is recommended that, for clarification on regulatory aspects of specific schemes, proposals are referred to the relevant authority as there may be additional regulations on specific aspects of your scheme and the regulatory environment is subject to change.

4.2.2. Specific regulatory requirements

Industrial or process water

Recycling industrial or process water in HCF may require approval by the Victorian Environment Protection Authority (EPA). Readers should refer to the *Industrial Water Reuse Guidelines 2009* for guidance.

These guidelines provide information on health risk management measures for the most commonly anticipated industrial or process reuse and recycling scenarios, as detailed in section 5. For other sources and uses, the framework in the *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) 2006* can be used as a basis for risk assessments.

Rainwater

While the installation and use of rainwater (roofwater) harvesting systems in some settings is subject to specific regulation in Victoria, the quality and acceptable uses of rainwater are not regulated. Despite this, HCF considering rainwater as an alternative water supply should ensure that the water is safe for its intended use. It is recommended that the Department of Human Services' *Rainwater Use in Urban Communities—Guidelines for Non-drinking Application in Multi-residential, Commercial and Community Facilities 2007* is considered when establishing rainwater systems in HCF.

Using rainwater for drinking in HCF is not prohibited and in some instances, may be the only source of drinking water available. However, it is recommended that rainwater is not used for drinking and food preparation in areas where a water authority supplies reticulated drinking water. This is because the quality of rainwater is generally not as reliable as reticulated drinking water supplies, which are already treated to a level safe for human consumption.

Stormwater

Like rainwater, the use and required quality of stormwater is not subject to specific health regulation, and approvals for stormwater recycling schemes are not required. However, the right to harvest stormwater may be subject to regulation in certain circumstances. Refer to the Victorian Government's advice on stormwater recycling (www.epa.vic.gov.au/water/stormwater/stormwater-harvesting.asp) for further information.

National guidelines have been developed for the safe use of stormwater, *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) Stormwater Harvesting and Reuse (2009)*. These national guidelines should be considered.

Greywater (up to 5,000 litres daily)

Greywater systems that treat up to 5,000 litres per day are classified as septic tanks under the *Environment Protection Act 1970.* A local council permit is required for the installation of any 'septic tank', and only EPA-approved systems can be installed. The *Guidelines for Environmental Management: Code of Practice—Onsite Wastewater Management 2008* should be referred to for details on the approvals process, and the acceptable uses of greywater.

It should be noted that for commercial premises, including HCF, greywater recycling from systems treating less than 5,000 litres per day is only permitted for irrigation. Refer to the Code of Practice for permitted irrigation methods. Recycling sewage from these systems is not permitted in areas where a water authority provides a reticulated sewerage network.

Sewage or greywater (more than 5,000 litres daily)

Sewage or greywater schemes that treat more than 5,000 litres per day and use recycled water in a manner that may place the environment at risk (*e.g.* irrigation), require EPA approval under the *Environment Protection (Scheduled Premises and Exemptions) Regulations 1996.* Under this regulatory framework, Class A schemes, which use recycled water for purposes where direct human contact is likely (*e.g.* irrigation and toilet flushing, or irrigation and use in cooling towers), also require an endorsement from the Department of Health's Environmental Health Unit. The Department of Health should be consulted during the initial planning phase if considering a Class A recycling scheme. 'Class A' is the quality of recycled water required for high exposure uses (e.g. toilet flushing and irrigation of public open spaces where access is unrestricted).

For Class A schemes, the EPA *Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes 2005* should be considered. The EPA *Guidelines for Environmental Management: Use of Reclaimed Water 2003* should be referred to for non-Class A schemes—for example, where recycled water will solely be used for sub-surface irrigation with restricted public access.

For uses of recycled water that are not addressed in the current EPA guidelines, see the *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) 2006* and contact the EPA or the Department of Health for further advice.

There is currently a significant gap in the regulatory framework. Closed-loop sewage and greywater recycling schemes, for example toilet flushing or cooling towers with no irrigation component (i.e. no discharge to the environment), are not covered under the *Environment Protection Act* 1970, and therefore do not require approval from a regulatory authority. However it is strongly recommended that the aforementioned guidelines are followed as 'best practice' when considering such a scheme.

The recycling of sewage or greywater in HCF is a high risk activity as further explained in Box 4-1.

Box 4-1. Risks of recycling sewage or greywater in HCF

Recycling sewage or greywater for purposes where there is potential for direct human contact is a high-risk activity and must be undertaken with safety as the foremost requirement. It demands rigorous risk management and a high level of expertise in operating and managing treatment systems. Therefore, it should only be attempted in a HCF where there is unwavering organisational commitment to the project—including ongoing resources for the operation, maintenance and oversight of the system.

If recycled water of a suitable quality is available from a water utility operated treatment plant this should always be preferred to the onsite treatment of sewage or greywater.

4.3. Supplementary regulatory requirements

4.3.1. Plumbing regulations

Within Victoria all plumbing and drainage works are subject to regulation. Specifically, all plumbing work must comply with Part 12A of the *Building Act 1993* and the *Plumbing Regulations 2008—see www.pic.vic.gov.au.* Part 12A of the *Building Act 1993* sets out the legal framework for the registration and licensing of plumbing practitioners, the regulation of plumbing work and related matters. The *Plumbing Regulations 2008* are derived from the *Building Act 1993* and set out the requirements that apply to all plumbing works relating to water recycling. The *Plumbing Regulations 2008* make extensive reference to the *National Plumbing and Drainage Code* (AS/NZS 3500).

4.3.2. Legionella regulations

Cooling towers and warm water systems must be managed in accordance with the *Health (Legionella) Regulations 2001.* People responsible for cooling towers have additional obligations under the *Building Act 1994.* These requirements must be met, regardless of the source of water being used and further information can be found at http://www.health.vic.gov.au/environment/legionella.

It is also recommended that reference be made to *Cooling towers and recycled water* (Department of Human Services 2008).

4.3.3. Off-site supply of water

If through a water reuse or recycling project HCF are considering supplying water off-site or to third party users then it is recommended that legal advice be sought. Legislation such as the *Environment Protection Act 1970, Fair Trading Act 1999* and *Water Act 1989* may apply.

Off-site supply of recycled water derived from sewage, greywater or industrial process water may need approval from the EPA. Contact the EPA for further information.

5. Risk management and hazard analysis

5.1. Introduction

5.1.1. Overview

All water reuse and recycling projects should be established and operated using preventive risk management principles and a Risk Management Plan (RMP).

Preventive risk management means identifying and managing risks in a proactive way rather than reacting when problems arise. By actively preventing events that could produce substandard water quality (such as contamination or treatment process failure) the risk to human health is reduced.

The framework normally applied to water reuse and recycling is described in detail in the *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks* (2006). It encompasses four main areas:

1. commitment to responsible use and management of recycled water
2. system analysis and management
3. supporting requirements
4. review.

The remainder of this section provides further information on each of these areas with reference to the process of developing the RMP, a template for which is included in Appendix B Risk Management Plan template. A scheme checklist is provided in Appendix C. Scheme proponents are encouraged to use this checklist to ensure that all elements relating to risk assessment and management for the scheme have been implemented.

This section specifically describes:

- key areas of the preventive risk management framework and how they should be addressed in more detail
- specific hazards within the HCF environment to be considered
- risks associated with each of the potential reuse and recycle water sources that need to be managed.

HCF may choose to go beyond the scope of this summary and manage additional risks, using additional controls. Note that novel processes, although innovative, would need to have a substantive body of evidence to demonstrate their efficacy under field conditions, before being used in HCF.

5.2. RMP development process

As a project develops, it will usually progress through a number of distinct stages. The RMP should be created and updated as part of project development and should be reasonably complete prior to construction as outlined in Box 5-1.

Box 5-1. Sample chronological sequence for RMP development and application

1. Initiation of project and in-principle approval by relevant parties (such as the CEO or board of the HCF)
2. Concept design
3. Develop Risk Management Plan (RMP)
4. Detailed design, incorporating controls required under the RMP
5. Submission of detailed design, along with draft RMP for in-principle regulatory approval (if required)
6. Approval to construct
7. Construction
8. Commissioning and proving, incorporating the validation required under the RMP
9. Submission of proof testing results and RMP for final regulatory approval (if required)
10. Approval to operate
11. Routine operation in accordance with the RMP.

RMP template incorporating the above principles is provided in Appendix B. The template is to be used for low risk process water sources such as RO reject water, steriliser water, cooling system wastewater, filter backwash water and fire service testing water. For rainwater, stormwater, greywater and sewage recycling schemes, RMPs should be developed with reference to the published guidance referenced in Appendix A. Refer to Section 4 for details of specific regulatory requirements and guidance.

5.3. Hazard Analysis

5.3.1. Risk factors related to HCF

Most guidelines and practices for water recycling are predicated on the health risks and risk management measures appropriate to the 'general community'. Therefore, it is important to consider special risk factors relating to HCF that may not have been allowed for in general guidance.

- **Immunocompromised patients:** Many HCF have one or more facilities housing those with impaired immunity, such patients with severely damaged skin, patients with diseases of the immune system or undergoing immunosuppressive therapies, premature babies or very elderly persons.
- **Pathogenic inputs to source:** There may be an increased concentration of pathogenic inputs to wastewater streams in HCF, due to the presence of severely infected individuals whose bodily secretions are discharged via wastewater.
- **Chemical inputs to source:** Some substances used in HCF are not commonly found in the general community and may be hazardous to water recycling. These substances might be hazardous to the health of persons exposed (such as toxins or radionuclides), hazardous to the intended use of the recycled water (such as herbicidal substances), or hazardous to treatment systems (such as biocides that can damage biological treatment processes).
- In addition some HCF provide mental health services. Impaired judgement by some patients may result in unintended exposure to recycled water.

5.3.2. Enteric pathogens

Enteric pathogens are a serious hazard in water supply and recycled water supply (ADWG 2004; AGWR 2006). They cause most water-borne and water-related disease outbreaks, and the majority of the burden of water-related disease. In developed countries, a relatively small number of pathogens are present: *Cryptosporidium* spp., *Giardia* spp., pathogenic *E. coli*, *Campylobacter* spp., *Salmonella* spp. and human Norovirus. These pathogens are all derived from faeces and become a problem when faecal matter enters the water supply.

The need to avoid faecal-oral transmission via all routes, including water, is well understood in HCF environments. Water recycling in HCF does not necessarily present any additional risks than recycling for the general community. The 'tolerable' risk targets for exposure to enteric pathogens used to develop the AGWR (2006; 2009) were based on the general population through all normal life stages—but not severely immunocompromised patients. These are patients kept in isolation and for whom release into the normal environment would not be medically advised.

The dose response models used to estimate infection risks relied upon information from feeding trials and clinical observations relating to otherwise healthy adults, not sensitive sub-populations. Therefore, it is important to note that dedicated guideline values have not been established for sensitive sub-populations.

Where people in HCF environment are similar in their immunity to the general population, risks associated with enteric pathogens in alternative water supplies can be managed in accordance with AGWR (2006; 2009). However, in the absence of dedicated guidance, it is recommended that alternative water sources derived from faecally contaminated sources (sewage, greywater, and stormwater) not be used where severely immunocompromised persons might become exposed.

Although highly effective, water treatment processes are not absolute barriers to pathogen transmission. Most commonly used water treatments reduce pathogen concentrations by between 99 and 99.99 per cent. Some traces of pathogens can pass through treatment processes and remain infectious. If a widespread outbreak of any communicable gastrointestinal infection were to arise within HCF, supply of any recycled water derived from greywater or sewage sources should cease until the outbreak subsides.

Potentially very high levels of enteric pathogens could be shed in an outbreak, exceeding the capabilities of the treatment system. For instance, Norovirus concentrations measured in samples from sewage downstream of nursing homes affected by outbreaks were approximately four orders of magnitude greater than for samples taken from the pooled municipal sewage at the sewage treatment plant (Lodder et al 1999). Although the AGWR (2006) considered peaks in normal sewage as supplied to sewage treatment plants, using the 95th percentile statistic to assign pathogen concentrations, concentrated sewage streams from specific buildings inhabited by a concentration of infected and shedding individuals was not considered.

Although simple to prevent in principle, cross-connections between recycled water and drinking water pipework do occur. The consequences are significant, both for health and for public perceptions of recycled water, particularly where immuno-compromised individuals may be exposed. Therefore it is critical that stringent controls are implemented to prevent cross-connections.

5.3.3. Infection control

All forms of water can potentially harbour infectious pathogens. Therefore, an important consideration for the supply of non-potable water within HCF is adequate infection control.

Existing guidance (AGWR) is considered suitably protective for the populations in HCF, with two exceptions:

- Water derived from sources likely to have human or animal faecal contamination (such as sewage, greywater and stormwater) should not be used in areas where severely immunocompromised persons might become exposed. These are people who would be kept in isolation and for whom release into the normal environment would not be medically advised.
- The likely level of faecal contamination in sewage and greywater derived from HCF may need a case-by-case assessment. Guidance for recycling sewage and greywater is based on the general population, not taking into account the potential for higher loads of particular pathogens that may be present in HCF environment—such as from wards that may hold a concentration of patients with gastrointestinal diseases caused by potentially waterborne pathogens.

5.3.4. Opportunistic pathogens

Water has on occasions been linked to infectious disease transmission in HCF (refer to Figure 5-1). Circumstances such as these represent special consideration for water quality management in HCF as they are not addressed in existing water recycling guidance.

HCF are familiar with the management of opportunistic pathogens, particularly Legionella spp. Recycled water doesn't necessarily present a greater risk than tap water or other water sources. The critical risk factors for the proliferation of unsafe levels of opportunistic pathogens are prolonged time and warm temperatures, nutrients, the absence of a disinfectant residual and an exposure pathway to a sensitive individual. As alternative water supplies may provide the right circumstances for the proliferation of opportunistic pathogens, their risk should be assessed and managed.

Figure 5-1. Nosocomial Infections related to hospital water supply

[Extract from Anaissie et al (2002). Note: *Legionella* spp. was selectively excluded from the scope of the review and is also commonly reported in this context.]

Organism	Source	Site(s) of Infection	Method(s) Used to Link Patient and Environmental Strain	Susceptibility of Organism†
Bacteria				
Pseudomonas aeruginosa	Trautmann et al, 2001	Blood, lungs, peritoneum, trachea, urine	AP-PCR	Not reported
	Bert et al, 1998	Lung, sinuses, urine	DNA macrorestriction analysis	Resistant
	Buttery et al, 1998	Blood, central venous catheter, skin, urine	PFGE	Resistant
	Ferroni et al, 1998	Urine	PFGE	Not reported
	Ezpeleta et al, 1998	Blood	ERIC-PCR, RAPD	Not reported
	Burucoa et al, 1995	Not reported	DNA fingerprinting	Susceptible
	Richard et al, 1994	Blood, lung, wound	DNA typing, serotyping	Resistant
	Kolmos et al, 1993	Blood	Phage typing, serogrouping	Susceptible
	Grundmann et al, 1993	Blood, CSF, trachea	Genotyping, serotyping	Not reported
	Worlitzsch et al, 1989	Urine	ExoA DNA probe	Not reported
Stenotrophomonas maltophilia	Weber et al, 1999	Peritoneum, respiratory tract, skin	PFGE	Resistant
	Verweij et al, 1998	Trachea	RAPD	Resistant
	Chachaty et al, 1998	Blood, stools	PFGE	Resistant
	Talon et al, 1994	Blood, stools, throat, urine	PFGE	Resistant
Serratia marcescens	Carlyn et al, 1998	Eye, stools	PFGE	Not reported
Acinetobacter baumannii	Pina et al, 1998	Skin, wound	PFGE, biotyping	Not reported
Aeromonas hydrophila	Picard and Goullet, 1987	Blood	Electrophoretic esterase typing	Not reported
Chryseobacterium species	De Schuijmer et al, 1998	Blood	AP-PCR	Not reported
Mycobacteria				
Mycobacterium avium	Von Reyn et al, 1994	Disseminated	PFGE	Not reported
Mycobacterium fortuitum	Kauppinen et al, 1999	Disseminated	AP-PCR	Susceptible
	Hector et al, 1992	Respiratory tract, wound	PFGE	Not reported
	Burns et al, 1991	Sputum	Phenotype analysis, plasmid profiles, PFGE	Partially reported
Mycobacterium xenopi	Benitez et al, 1999	Various	PCR-based techniques	Not reported
	Desplaces et al, 1995	Spine	Chromosomal restriction fragment patterns	Resistant
Mycobacterium kansasii	Picardeau et al, 1997	Abscess, blood, bone, sputum, stomach, urine	RFLP, PFGE, AFLP, PCR	Not reported
Mycobacterium chelonae and *Mycobacterium fortuitum*	Wallace et al, 1989	Sternal wound infection, prosthetic valve Sternal wound infection	Electrophoresis of enzymes, plasmid profiling	Resistant to doxycycline Susceptible to doxycycline
Fungi				
Fusarium solani	Anaissie, 1998	Disseminated	RFLP, RAPD, IR-PCR	Resistant
Exophiala jeanselmei	Nucci et al, 1998	Disseminated	RAPD	Not reported
Aspergillus fumigatus	Anaissie et al, 2002	Lungs	PCR, SSDP	Not reported

* AP-PCR indicates arbitrarily primed polymerase chain reaction; PFGE, pulse-field gel electrophoresis; ERIC-PCR, enterobacterial repetitive intergenic consensus sequence PCR; RAPD, random amplified polymorphic DNA; CSF, cerebrospinal fluid; ExoA, exotoxin A; RFLP, restriction fragment length polymorphism; AFLP, amplified fragment length polymorphism; IR-PCR, inter-repeat PCR; and SSDP, sequence-specific DNA primer analysis.

† Resistant means resistant to 2 or more classes of antibiotics.

5.3.5. Chemical hazards

As a general statement, the AGWR (2006, 2009) deems that chemical hazards are not a health hazard where water is not recycled for drinking purposes. However, the AGWR (2006) note that this conclusion applies to relatively large sewage catchment networks with high levels of dilution and good trade waste controls.

For small onsite or decentralised recycled water systems, such as hospitals, unusual chemical inputs and small dilution factors may present elevated risks that may be difficult to manage.

For example, high concentrations of sanitisers may cause failure of the biological treatment processes that are essential for pathogen control in recycled water. Similarly, hazardous chemicals (such as radionuclides) may be sufficiently diluted when discharged into the sewer, but not if recycled locally.

Therefore, a critical review of these chemical inputs is required. In practice, it may be simpler to only harvest source water from general access areas and not to harvest water that may be contaminated.

To apply the AGWR (2006) to greywater and sewage recycling, it is important to only allow general, non-hazardous sewage and greywater inputs into the water source. Source control strategies may avoid hazardous inputs, by selective plumbing of particular inputs and controlling what can be used in the recycled water harvesting process.

5.3.6. Process hazards

Although largely outside of the scope of these guidelines, process hazards in water recycling should be considered. This refers to substances that are hazardous to the water recycling assets, although not directly hazardous to health.

Some process waters and rainwater are of low pH and of low dissolved solids content and are therefore corrosive. Other process waters can include concentrated dissolved solids that might lead to excessive scale formation. Some types of lubricants might be non-toxic, but still foul membrane treatment systems. These types of hazards should be considered in water recycling schemes.

Where process hazards can impact on treatment reliability, there may be health implications. For instance, membrane systems or biological treatment processes may become damaged by strong oxidising biocides in the source water, allowing pathogens and other substances to pass through into the treated water at higher levels than allowed in design. Otherwise harmless dyes may be highly UV-absorbing, leading to failure of UV disinfection systems.

5.4. Water sources and uses

In principle, provided the final water is fit-for-purpose at the point of use, water can be supplied from a multitude of sources. The following sections provide a description of a risk management approach, for each of the following common water sources:

- Fire service testing water
- Reverse osmosis reject water
- Steriliser wastewater
- Cooling system wastewater
- Filter backwash
- Rainwater
- Stormwater
- Greywater
- Sewage.

Due to the variability in water sources there are numerous combinations that can constitute an augmentation scheme, each of which would require case-by-case consideration. Variables include:

- water sources and their characteristics, particularly if there are contaminants present
- performance and reliability of treatment systems
- permitted uses (including foreseen incidental uses and associated exposures)
- nature and reliability of exposure controls at the point of use
- volume of water produced

A case-by-case assessment is required to provide acceptable, safe combinations of treatment and/or exposure controls, given the characteristics of the source water and the specific intended use.

If considering a water source or use not specifically addressed in these guidelines then the *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) 2006* should be referred to for risk assessment and management.

5.5. Fire service testing water

5.5.1. Process description

Practices for maintaining fire sprinkler systems may generate considerable quantities of water. Fire sprinkler systems are critical infrastructure and the integrity of these systems must not be compromised. The Australian Standard 1851:2005 Maintenance of Fire Protection Systems and Equipment specifies test procedures that significantly reduce test water discharge. Components of the fire protection system include: towns mains water, break tank water supply, pumps, pipework, sprinklers, hydrants and storage tanks.

5.5.2. Risk management

Typically, potable quality water is used in fire service testing and therefore there are significant opportunities for capturing and reusing the test water in HCF. Due to the inherent low risk of this fire service testing water, treatment and site controls to minimise human exposure would not typically be required for the uses identified in Table 3-1. Appropriate backflow prevention measures will need to be implemented (e.g. registered air gap).

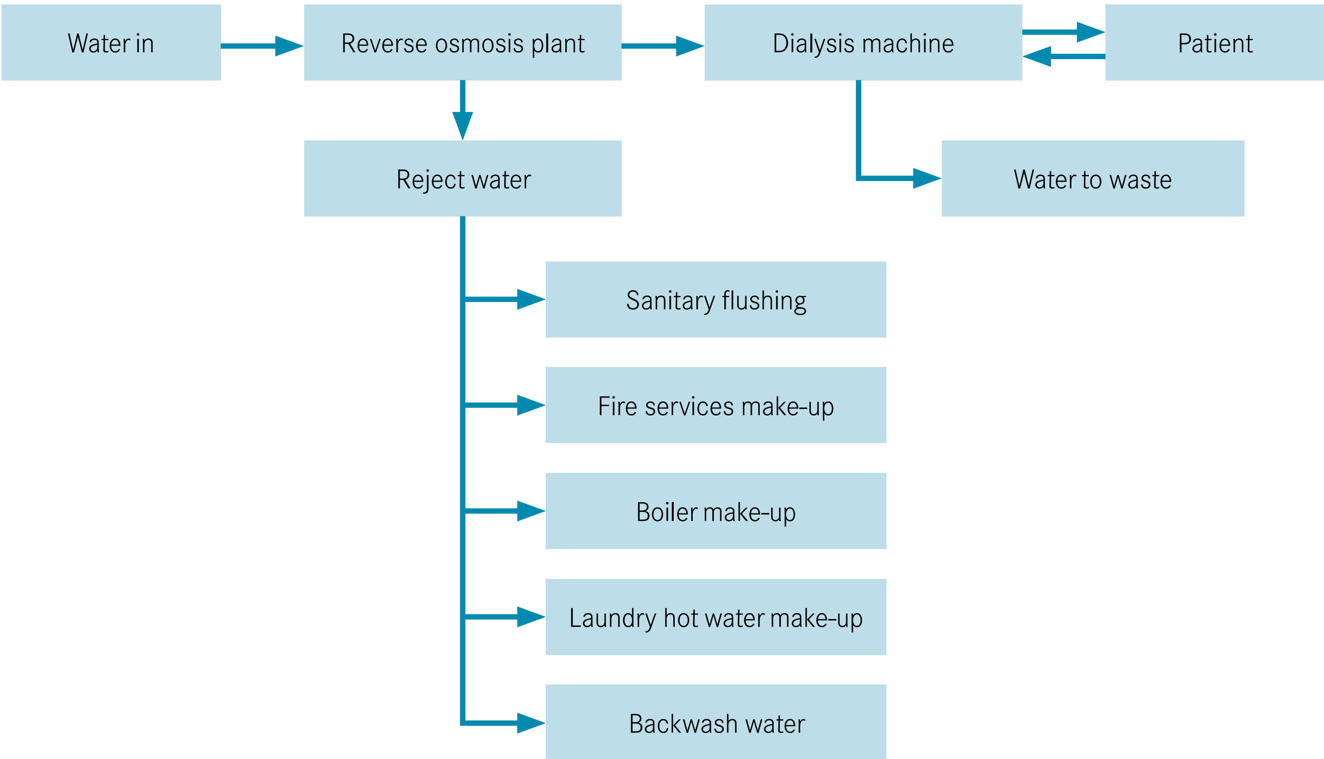
5.6. Reverse osmosis reject water

5.6.1. Process description

Dialysis machines and some laboratory equipment require ultra-clean water. A 'reverse-osmosis' process generally achieves this, removing impurities from the water by forcing it through a membrane under pressure. The membrane is 'backwashed' periodically to remove the impurities. Wastewater from the backwash process, the 'reject water' is typically discharged to sewer. The reject water is relatively clean, but no longer potable. Reverse osmosis water is potentially suitable for a number of applications, as shown in the simplified process in Figure 5-2 below.

Reject water from dialysis machines can replace between one and six per cent of potable water use.

Figure 5-2. Reverse osmosis process



5.6.2. Risk management

The dialysis machine process should protect the RO membrane and reject water from becoming contaminated with infectious agents.

The potential human health risks associated with RO reject water would be considered extremely low. The main risks to be considered in using RO reject (concentrate) water relate to the potential concentration of substances in the feed water, and their likely impact on assets or the environment, and are described in Table 5-1 below.

It should also be noted that the reject water is likely to be devoid of residual biocide (eg, chlorine) and potential for opportunistic pathogen growth should be considered.

Table 5-1. Reverse osmosis risks

Risks	Controls	Monitoring
The concentrations of substances (salts, minerals, toxins) may build up to levels that might be hazardous to assets through corrosion; to asset operability through scaling; hazardous to plants and soils.	Blend with other water to dilute salt, toxin and mineral concentrations to tolerable levels. Select water uses that are tolerant of salt, toxin and mineral concentrations. Select assets able to withstand salt concentrations that arise. Provide a separate, dedicated and appropriately constructed plumbing system to store and distribute the non-potable water. The *Australian Guidelines for Water Recycling* provide extensive detail on managing environmental risks associated with chemical contaminants in water that is used for irrigation.	Regular testing of water for level of impurities. Regular assessment of asset condition, to check for scaling and corrosion. Regular checking of irrigated environments, to check for impacts of water use.
Low or nil residual biocide	Add disinfectant or store for shorter periods, i.e < 24hrs	Regular testing, clean or disinfect as needed

5.7. Steriliser water

5.7.1. Process description

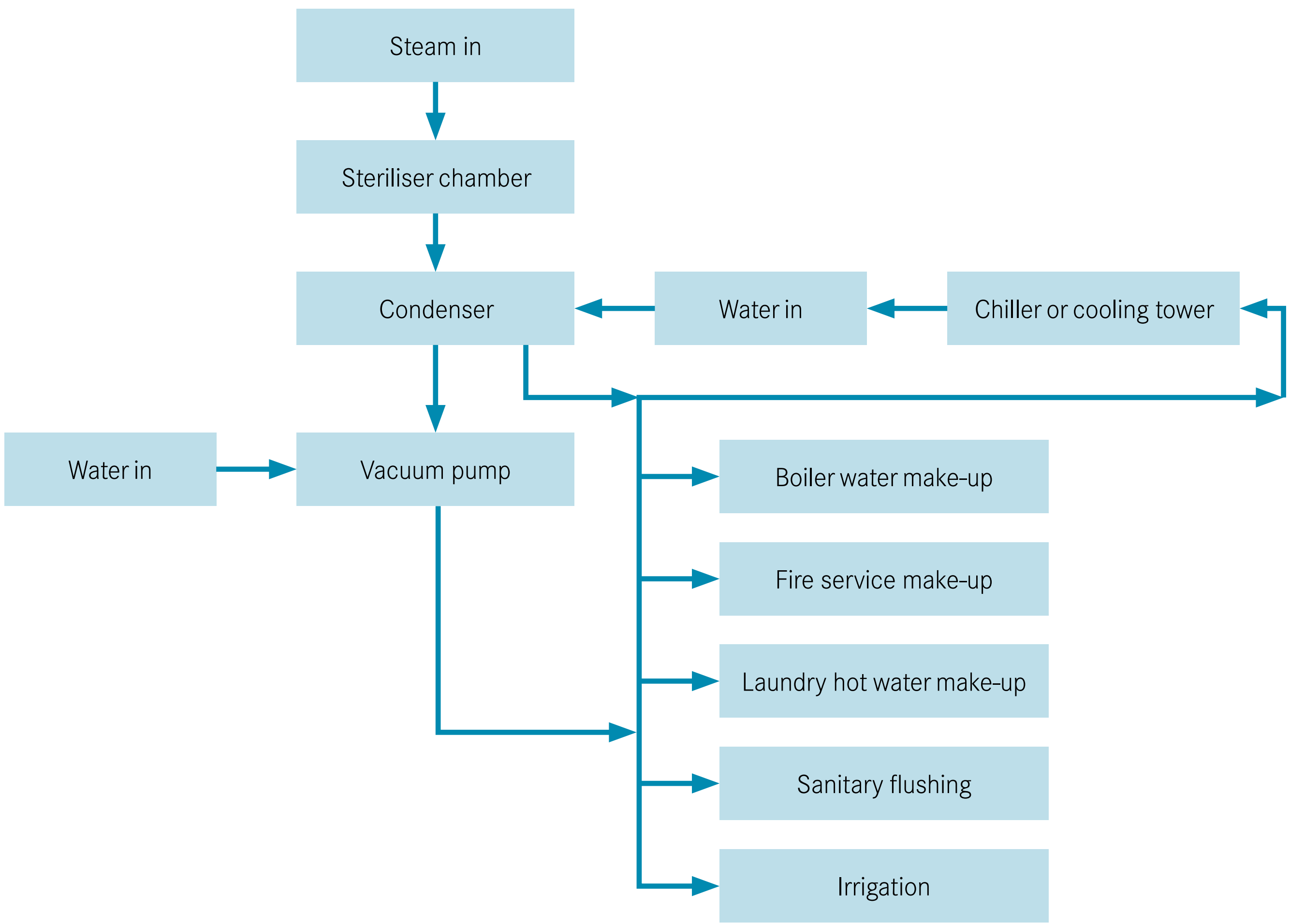
Sterilisers used to provide sterile stock and high pre-vac sterilisers use water in three ways:

- steam (from central boilers or local steam generators) to sterilise articles
- cooling water to cool the discharge from the steriliser chamber, prior to entry into the vacuum pump
- sealing water around the vacuum pump rotor, to allow effective chamber evacuation.

Water from condensers and pump sealing water may be reused or recycled for other purposes. Reusing condenser water for boilers or other hot water uses may have energy-saving benefits. Used steriliser wastewater is potentially suitable for a number of applications, as shown in Figure 5-3. Condensers can be used to condense captured steam back into water for reuse or recycling, and can be found in association with boilers and sterilisers.

Water flow rates through steriliser vacuum pumps and condensers may exceed 600 litres per cycle.

Figure 5-3. Steriliser water process



5.7.2. Risk management

All articles processed in high pre-vac sterilisers are cleaned before sterilisation. The physical separation between the source water and point of condensation should protect the condensate water from becoming contaminated with infectious or hazardous agents.

The potential human health risks associated with steriliser wastewater would generally be considered low. The main risk posed by condensate water is its low mineral content, and the affect this may have on assets (i.e. scaling) or the environment. Details about the risks of steriliser water can be found in Table 5-2 below.

Table 5-2. Steriliser water risks

Risks	Controls	Monitoring
Low mineral content water may be corrosive and strip metals from plumbing assets. Substances such as copper or lead, stripped from water storages or conduits, might reach concentrations that could be hazardous to plants, soil or other receiving environments.	Blend with other water to raise salt and mineral concentrations to acceptable level. Select water uses tolerant of salt and mineral concentrations that arise. Select assets able to withstand low salt concentrations that arise. Provide a separate, dedicated and appropriately constructed plumbing system to store and distribute the non-potable water.	Regular testing of water for level of contaminants. Regular assessment of asset condition for scaling and corrosion. Regular checking of irrigated environments for impacts of water use.
Hydrocarbons and anti-scalants from lubricants leaching into the used water.	Control the choice of lubricants and anti-scalants, to avoid hazardous substances being present in the water.	
Lint and other matter from sterile packaging could cause asset operation problems.	Install and maintain protective filters to protect components that may block.	Regular checking of filters.
Closed loop recycling is likely to lead to a build-up of organic matter in the water, unless further treatment is undertaken.	Carefully control wastage rates in closed loop recycling options.	Regular testing of water for level of contaminants.
Water may be too hot for recycling.	Additional chilled water capacity can be added to cool the water so that it is suitable for recycling through the steriliser condenser. This may be offset by re-turning chiller and/or re-balancing chilled water flows. Use buffer tank to minimise temperature variations.	Regular checking of water temperature.

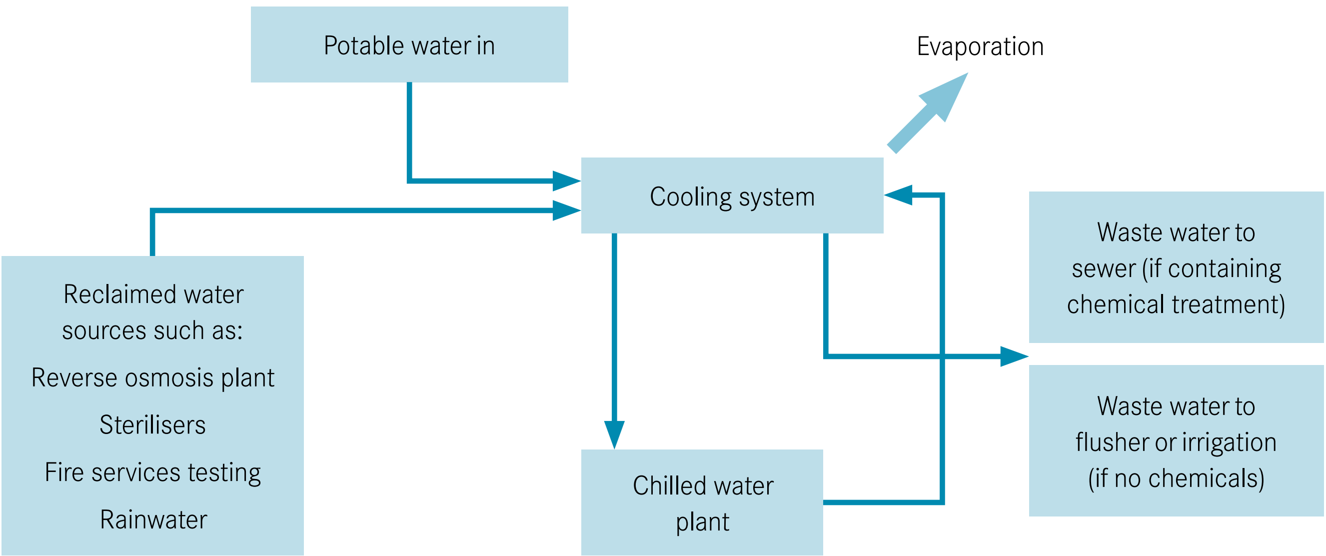
5.8. Cooling system wastewater

5.8.1. Process description

Cooling towers, as distinct from dry basin coolers, reject heat from process equipment (such as chilled water plant, air compressors) through evaporation. Traditional cooling towers incorporate a 'blowdown' or continuous bleed to manage concentrations of dissolved solids. Although these traditional cooling towers present opportunities to use recycled water, the 'blowdown water' from these cooling towers is not suitable for recycling.

Cooling systems that use water only when atmospheric conditions require (and dump basin water daily) do not generally need chemical treatment. Water dumped from these alternative systems is generally suitable for flusher water or irrigation. The system is represented schematically in Figure 5-4 below.

Figure 5-4. Cooling system wastewater process



5.8.2. Risk management

A number of risks are associated with the use of cooling system wastewater. These are documented in Table 5-3 below.

Table 5-3. Cooling system wastewater risks

Risks	Controls	Monitoring
Human health risks from biocides or corrosion inhibitors or bacteria	Case-by-case risk assessment to determine the level of treatment (if any) required for the intended use. Refer to the principles in the *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) 2006*	Monitor the treatment process, as per manufacturer specifications. Undertake verification testing of the final water quality emanating from the treatment system, to prove that treated water meets the desired water quality objectives.
The changed concentrations of substances (salts, minerals, organic matter) may be hazardous to assets through corrosion, to asset operability through scaling, or impact on biocide efficacy.	Blend with other water to dilute salt, mineral and organic matter concentrations to tolerable levels. Select assets that can withstand salt and mineral concentrations that arise. Select biocides, doses and dosing strategies that can maintain disinfection and are suitable for the end-use. Provide a separate, dedicated and appropriately constructed plumbing system to store and distribute the non-potable water.	Regular testing of water for level of impurities. Regular assessment of asset condition to check for scaling and corrosion. Regular testing of water for biocide and Legionella levels.
Where cooling tower wastewater is used for recycling, biocides may impact the intended use.	Select water uses that are tolerant of salt, mineral and biocide concentrations that arise. The *Australian Guidelines for Water Recycling* provide extensive detail on managing environmental risks associated with chemical contaminants in water that is used for irrigation.	Regular testing of water for level of impurities. Regular checking of irrigated environments to check for impacts of water use.

Note: The engineering services departments of HCF are usually involved in managing cooling towers. Under Victorian legislation, cooling towers require a RMP to minimise the risk of *Legionella* growth. Any change of water source will require a revision of the cooling tower's RMP, to deal with potential additional risks.

5.9. Rainwater

5.9.1. Process description

Rainwater can be captured from roofs and stored for use. The capture of rainwater from surfaces other than roofs is termed stormwater and is discussed below. Common uses of rainwater include toilet flushing, irrigation and, following appropriate treatment, personal washing and showering.

5.9.2. Risk management

If there is intent to use rainwater as a source for recycling for non-potable uses it is necessary to refer to *Rainwater Use in Urban Communities 2007* (refer to Appendix A for details). Specific consideration should be given to:

- Risk of pathogenic microorganisms presenting an infection risk to immunocompromised individuals.
- Monitoring of proper function of irrigation controls.

5.10. Stormwater

5.10.1. Process description

Stormwater can be captured from hard surfaces and stored for use. The capture of water exclusively from roof surfaces is rainwater and is discussed above.

5.10.2. Risk management

If there is intent to use stormwater as a source for recycling for non-potable uses, refer to the Victorian Government policy on stormwater use and the *Australian Guidelines for Water Recycling: Managing Health and environmental Risks (Phase 2) Stormwater Harvesting and Reuse 2009* (refer to Appendix A for details).

An example of a risk includes the risk of pathogenic microorganisms presenting an infection risk to immunocompromised individuals. The use of controls including physical separation (e.g. limiting irrigation to areas where persons are not present), or timed separation (e.g. irrigation between 1 am and 5 am to minimise public exposure to stormwater) would be required to reduce the risk to public health. This is particularly important when sensitive populations are likely to access irrigated areas. Monitoring for such a risk could involve checking of proper function of irrigation controls.

5.11. Filter backwash water

5.11.1. Process description

Swimming pools consume large amounts of water with backwashing of filters accounting for about 30% of this water. This backwash water is usually disposed of to sewer as it may contain a range of pathogenic micro-organisms, chemicals, oils, lotions, urine, detergents, saliva and disinfection by-products.

5.11.2. Risk management

Gastrointestinal outbreaks have been linked to swimming pools. In addition, Legionella has been detected in swimming pool backwash water and requires control.

Due to the potential microbial and chemical hazards, backwash water presents a high risk to public health and should only be used in applications that do not result in public exposure to the water. The level of treatment required will depend on the intended use and the exposure assessment.

A quantitative microbial risk assessment (QMRA) should be undertaken to determine the appropriate water quality objectives for the proposed end uses. These water quality objectives will inform the necessary treatment requirements.

5.12. Greywater

5.12.1. Process description

Greywater is harvested, captured and usually treated via specialist water treatment systems.

5.12.2. Risk management

To use greywater as a source for recycling for non-potable uses, refer to the relevant EPA guidelines (Refer to Appendix A for details). Examples of risks associated with greywater are:

- pathogenic microorganisms presenting an infection risk to individuals. Controls to minimise risk include:
  - using irrigation methods (e.g. sub-surface irrigation) which do not result in spray drift); and
  - physical separation (e.g. limiting irrigation to areas where persons are not present); or
  - timed separation (e.g. irrigation between 1 am and 5 am to minimise public exposure to greywater)
  - not using recycled water in areas where severely immunocompromised individuals may become exposed.
- additional HCF-specific chemical contaminants or loads that may affect efficacy of water treatment processes in removing pathogens. Potential controls for such a risk may include controls on where greywater is sourced (e.g. the choice of basins and facilities from which greywater is captured).
- HCF-specific pathogen loads overloading treatment processes (particular concern for 'Class A' schemes). Controls on where greywater is sourced (e.g. the choice of basins and facilities from which greywater is captured) may help reduce the risk, as may the quantification of pathogen loads, and adjustment of treatment process capability.

5.13. Sewage

5.13.1. Process description

Sewage is usually discharged to sewer and treated by centralised facilities. Recycling sewage on site does have the potential to replace alternative water sources, such as potable water, but would require significant treatment prior to any of the common recycled water uses. Note that sewage can only be recycled in schemes treating more than 5000 litres per day in sewered areas.

Recycling sewage is a high risk activity and is the least preferable option for recycling in HCF.

5.13.2. Risk management

If there is intent to use sewage as a source for recycling for non-potable uses, refer to the EPA *Guidelines for Environmental Management: Use of Reclaimed Water 2003* and / or *Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes 2005,* as appropriate (refer to Appendix A for details). Examples of risks associated with sewage are:

- pathogenic microorganisms presenting a risk to individuals. This would involve the use of controls including:
  - using irrigation methods (e.g. sub-surface irrigation) which do not result in spray drift); and
  - physical separation (e.g. limiting irrigation to areas where persons are not present); or
  - timed separation (e.g. irrigation between 1 am and 5 am to minimise public exposure to sewage)
  - not using recycled water in areas where severely immunocompromised individuals may become exposed
- additional HCF-specific chemical contaminants or loads that may affect the efficacy of water treatment processes in removing pathogens. Controls for such a risk could include controls on where sewage can come from, (e.g. the choice of basins and facilities from which sewage is captured).

- HCF-specific pathogen loads overloading treatment processes (particular concern for 'Class A' schemes). Potential controls for such a risk could include controls on where sewage is sourced, (e.g. the choice of basins and facilities from which sewage is captured) or quantification of pathogen loads, and adjustment of treatment process capability.
- recirculation of treatment process reject streams may concentrate the pathogen load in sewage. Therefore the treatment system should be designed to ensure all reject streams (e.g. filter reject, filter backwash, off-specification water) are discharged directly into the centralised sewerage system and not re-circulated in the HCF sewerage system.

5.14. Water treatment

5.14.1. General requirements

Likely contamination levels need to be carefully assessed, to identify whether treatment is necessary and what the appropriate treatment regime would be.

The management of water recycling schemes, particularly where extensive treatment is necessary, requires specialist expertise. HCF should assess their capabilities and ensure commitment to effectively manage water treatment processes early in the project planning phase.

5.14.2. Risks to be managed

Recycled water treatment systems can be highly effective, but can also fail for a whole range of underlying reasons. To ensure that they achieve the required outcomes, they need to be selected, designed, operated and maintained correctly. Examples of the risks that can arise in water treatment, and ways in which these risks can be managed are provided in Table 5-4. In addition, public and worker safety should be considered, particularly when storing and handling chemicals.

Table 5-4. Risks, controls and monitoring for water treatment systems*

Risks	Controls	Monitoring
The treatment plant selected and designed is not fit for purpose and does not provide the required contaminant reduction.	Treatment plants must be selected and designed to achieve the required objectives. Specify clear objectives with respect to source water quality and variability to be treated, final water quality to be achieved, and contaminant reduction. Select reliable, proven technologies with a good track record of treating similar quality water for similar end uses. Engage the services of water treatment experts to assist in selection and design of treatment plant. Seek performance warranties from service providers with respect to plant performance in the specific situation. The supplier should provide explicit warranties with respect to plant performance in the specific circumstances.	Check the detailed specifications of the equipment provider's offer against required performance specifications. Check the equipment as supplied against specifications.

Table 5-4 (cont'd). Risks, controls and monitoring for water treatment systems*

Risks	Controls	Monitoring
The treatment plant is not installed and commissioned appropriately and does not provide the required contaminant reduction.	Treatment plants must be installed and commissioned correctly so that they are able to achieve the required objectives. This should include testing of all alarms, interlocks, corrective actions and calibration of equipment. Include proper installation and commissioning requirements as part of the supply contract. Engage the services of water treatment experts to assist in installation and commissioning of treatment plant. Seek performance warranties from service providers with respect to plant performance following installation and commissioning. Require suppliers to provide validation testing data to demonstrate individual treatment process unit's capabilities in reducing pathogens and chemicals, before selecting treatment system.	Perform validation testing of water emanating from the treatment system to prove that treated water meets desired quality objectives, before offering completion contract payments. Perform validation and testing of the individual treatment process units to demonstrate: • their capability in achieving the required water quality objectives • that on-line process monitoring is capable of detecting off-specification water in real-time. Implement quality control procedures to confirm that the system has been appropriately installed and commissioned.
The treatment plant is not operated and maintained appropriately and does not provide the required contaminant reduction.	Treatment plants must be operated and maintained correctly so that they are able to achieve the required objectives. Require the provision of an operating and maintenance manual, or similar, as part of the package that is provided with the plant. Engage the services of water treatment experts to assist in developing the operating and maintenance manual. Integrate the operating and maintenance requirements into reliable systems, such as Building Maintenance Systems and Computerised Maintenance Management Systems. Engage the services of specialist service providers in operating and maintaining the plant. Seek long-term performance warranties from service providers with respect to plant performance in the specific situation, if operated and maintained within a specific set of parameters. Provide certified competencies, and scheduled renewal of those competencies, relating to plant operation and maintenance for relevant personnel.	Undertake verification testing of the final water quality emanating from the treatment system, to prove that treated water continues to meet desired quality objectives. Record all operating and maintenance activities and report on completion against scheduled plans. At appropriate intervals, undertake checking and calibration of the instruments used to control the treatment systems. Undertake operational process monitoring of the treatment systems, ideally online and continuous, and ideally linked to automatic shut-down, to provide ongoing assurance of treatment efficacy and water safety.

Table 5-4 (cont'd). Risks, controls and monitoring for water treatment systems*

Risks	Controls	Monitoring
The treatment plant is bypassed and is not used to treat water.	Treatment plants must be in line and must not be bypassed. Avoid installations that make it possible to bypass the treatment plant; ensure that all water is treated. Tag and lock out any bypass valves to prevent accidental bypasses from occurring.	When making maintenance checks on the plant, confirm that bypass controls are in place and operating correctly.
Treatment plant fails	Use principles of failsafe design as far as practicable. Interlocked process control systems. Choice of more failsafe over less failsafe technologies.	Testing failsafe systems to check that they work as intended at commissioning, as part of routine checks at intervals, and following maintenance activities.

* **'Class A' water recycling schemes (recycled water derived from sewage or greywater at volumes of >5000 litres per day) need a higher level of risk management than that described in this table. Refer to Section 4 and Appendix A for more detail.**

5.15. Storage and plumbing systems

5.15.1. General requirements

The regulatory requirements for storage and plumbing systems are provided in Section 4. Note that:

- all plumbing works must conform to Part 12A of the *Building Act 1993* and the Plumbing Regulations 2008.
- warm water storage and distribution systems should be managed in accordance with the *Legionella* control requirements of the *Health (Legionella) Regulations 2001.*
- all signage must conform to AS1319-1994 *Safety Signs for the Occupational Environment.*

5.15.2. Risks to be managed

Stored water must be protected from re-contamination by hazardous substances, from deterioration over time and from siphonage into the potable water distribution system. It must also avoid causing problems with odour, spills and public and worker safety.

Distribution of both untreated and treated non-potable water needs to be carefully controlled. In some facilities there are multiple grades of water: drinking water, recycled water and rainwater and this may lead to confusion regarding the type of water flowing from specific fittings or through pipes. This risk can be managed through rigorous plumbing controls and signage in conjunction with ongoing awareness training.

Examples of the types of risks that can arise and approaches to managing these risks are provided in Table 5-5.

Table 5-5. Risks, controls and monitoring for storages and plumbing systems

Risks	Controls	Monitoring
Stored water flowing back through top-up/back-up system into the drinking water (or other higher grade) supply system, leading to drinking (or other sensitive use) of non-potable water.	Stored water must be prevented from flowing into the drinking water or other higher quality water supply system by including a registered air-gap or reduced pressure zone device (RPZD) certified as per AS2845.	Annual inspection as per AS 2845.
Connecting drinking water (or other higher quality water) fittings to non-potable water storages. Non-potable water distribution lines becoming cross-connected with drinking water (or other higher quality water) lines, leading to drinking (or other sensitive use) of non-potable water. Connecting drinking water (or other higher quality water) fittings to non-potable water lines.	Drinking water and sensitive water use taps and fittings must not be tapped into non-potable water lines. Non-potable water must be prevented from flowing into the drinking water or other higher quality water supply system. Prevent cross-connections in the design and construction of the plumbing system. Differential colouration of non-potable water and drinking water lines in accordance with relevant plumbing standards. Labelling to identify non-potable water lines. Permitting only licensed plumbers to undertake plumbing works within the premises. Providing an item in the Safe Work Method Statements or checkbox in the Job Safety and Environmental Analysis (JSEA) or other site induction program for plumbers and contractors that come onto the site. Explain that non-potable water is supplied and that any modifications to plumbing works need to be controlled for cross-connections. Maintaining accurate and up-to-date drawings, illustrating where non-potable water and other plumbing lines go. Maintaining a pressure differential so that the drinking water distribution system is always at higher pressure than the non-potable water distribution system. The non-potable water supply pump can have a pressure sensor that would detect, and alert system operators and/or shut down supply, in the event of a change in pressure in the non-potable water system indicative of a cross-connection to the drinking water supply.	Physical inspection of plumbing works after any plumbing modifications are carried out, with sign-off by nominated person attesting that works are carried out correctly. Physical inspection at programmed intervals to confirm there are no cross connection. Flow tests at regular intervals (annually, or following plumbing works), in which the water distribution system to a particular area is shut off and water fittings are run, to check that they only flow when the correct water supply system is in operation. Conductivity tests at regular intervals (annually, or following plumbing works), in which each water fitting is tested to check that the conductivity of the water matches the grade of water present. Check differential pressure and pump monitoring and control systems at appropriate intervals. Regularly calibrate. Dosing of colourants or other differentiators into the non-potable water system.
Excessive *Legionella* growth, leading to increased risks from legionellosis.	*Legionella* spp. levels must be kept low in situations where persons may become exposed to aerosols. Maintain water temperatures in storage tanks below 25°C (target below 20°C) or above 50°C, and/or maintain an adequate disinfectant residual. Prevent situations where persons may become exposed to aerosols of undisinfected water.	Regular checking, e.g. weekly, of disinfectant residuals and/or temperatures, including at water supply points representative of the longest residence times and highest temperatures.

Table 5-5 (cont'd). Risks, controls and monitoring for storages and plumbing systems

Risks	Controls	Monitoring
Algae growth, mosquito breeding or contamination from bird and animal droppings in open tanks, leading to health risks.	Design system to prevent algal growth. Outdoor tanks should be light-proof and covered. Openings/inlets to outdoor tanks should be protected with insect-proof mesh.	Regular checking of storage integrity.
Preventing scaling and/or corrosion.	There should be a fit-for-purpose match between the material from which all plumbing fixtures are made and the quality of the water to be carried and stored within those fixtures. Water treatment can be used to dose corrosion inhibitors or anti-scalants, as appropriate. Select plumbing materials that are tolerant to the water quality supplied.	Physical inspections of accessible system components to check for scaling or corrosion. Regular testing of water quality to check for corrosion products.
Preventing stagnation.	Water remains fit-for-purpose during storage and use and does not degrade, causing loss of residual disinfectant (if used), formation of odour or build-up of corrosion products. Maintaining regular turnover and flow of water within storage tanks and pipe work, e.g. every 24 hours for disinfected systems. The required frequency will depend on the water quality, storage material and nature of end use.	Regular checking of records for volume of water used and turnover achieved. Regular testing of water quality to confirm that water remains fit-for-purpose with respect to odour, appearance and disinfectant residual.
Non-potable water being ingested from taps leading to drinking (or other sensitive use) of non-potable water.	Persons must be made aware that an accessible non-potable water fitting, e.g. a tap or other accessible water supply point, contains water that is not suitable for drinking. Providing signage on non-potable water taps that illustrates pictorially, and states in words, that the water is not for drinking. Providing an item in the Safe Work Method Statements or checkbox in the Job Safety and Environmental Analysis (JSEA) or other site induction program for people coming onto the site. Explain that non-potable water is supplied, how non-potable water fittings are identified, and that non-potable water is not for drinking.	Physical inspection of signage at regular intervals (monthly, or following works) with proactive replacement of signs before they become faded, or as soon as practicable after damage has occurred.
Failure of signage to prevent non-potable water being ingested from taps leading to drinking (or other sensitive use) of non-potable water, for example inability to understand signage due to being too young, illiterate, unable to read English or mentally disabled.	Placing removable handles on taps to prevent accidental use of the water. Raising taps to a height that would make it difficult for young children to access the handle. Not putting taps in areas frequented by persons that may have difficulty understanding the requirements.	Physical inspection of controls at regular intervals (monthly, or following works).
Failure to consider the specific source and use risk factors.	Consider these items on a case-by-case basis. Refer Appendices.	Case-by-case basis.

6. Useful contacts

Department of Health

Health risks associated with non-potable water supplies:

Environmental Health Unit
Tel: 1300 761 874
www.health.vic.gov.au/environment

Capital development and sustainability policy for HCF:

Capital Management Branch
Tel: 03 9096 2030
www.capital.dhs.vic.gov.au/capdev/
www.dhs.vic.gov.au/environment/

Environment Protection Authority

Regulatory approvals for sewage, greywater and some industrial water recycling:

EPA Information Centre
Tel: 03 9695 2700
www.epa.vic.gov.au

Plumbing Industry Commission

Standards and regulatory requirements for plumbing:

Tel: 1800 015 129
www.pic.vic.gov.au

References

ADWG (2004) Australian Drinking Water Guidelines National Health and Medical Research Council/Natural Resource Management Ministerial Council. Commonwealth of Australia, Canberra.

AGWR (2006) Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1). Natural Resource Management Ministerial Council, Environment Protection and Heritage Council and Australian Health Ministers Conference, Commonwealth of Australia, Canberra.

AGWR (2009) Australian Guidelines for Water Recycling (Phase 2) Stormwater Harvesting and Reuse. Natural Resource Management Ministerial Council, Environment Protection and Heritage Council and National Health and Medical Research Council, Commonwealth of Australia, Canberra.

Anaissie EJ, Penzak SR and Dignani MC (2002) Systematic Review of Water-related Nosocomial Infections. Arch. Intern. Med. 162:1483–1492.

AS/NZS 3500 National Plumbing and Drainage Code.

AS/NZS 2845 Water Supply—Backflow Prevention Devices.

AS 1319 Safety Signs for the Occupational Environment.

AS 1851:2005 Maintenance of Fire Protection Systems and Equipment.

DHS (2001) Developing Risk Management Plans for Cooling Tower Systems, Department of Human Services.

DHS (2007) Rainwater Use in Urban Communities—Guidelines for Non-drinking Application in Multi-residential, Commercial and Community Facilities, Department of Human Services.

DHS (2008) Cooling towers and recycled water, Department of Human Services.

DHS (2008) Guide for the completion of a Recycled Water Quality Management Plan for Class A water recycling schemes, Department of Human Services.

DHS Capital Development Guideline: Essential Engineering Services—Risk Management http://www.capital.dhs.vic.gov.au/capdev/AssetPropertyManagementOperations/EssentialEngineeringServices/

EPA (2003) Guidelines for Environmental Management: Use of Reclaimed Water, Environment Protection Authority Victoria.

EPA (2005) Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes—Health and Environmental Risk Management, Environment Protection Authority Victoria.

EPA (2008) Guidelines for Environmental Management: Code of Practice—Onsite Wastewater Management, Environment Protection Authority Victoria.

EPA (2009) Industrial Water Reuse Guidelines, Environment Protection Authority Victoria.

Hrudey SE and Hrudey EJ (2004) Safe Drinking Water: Lessons from Recent Outbreaks in Affluent Nations. ISBN: 1 84339 042 6 London, UK: IWA Publishing.

Lodder WJ, Vinje´ J, Van De Heide R, De Roda Husman AM, Leenen EJTM and Koopmans MPG (1999) Molecular Detection of Norwalk-Like Caliciviruses in Sewage. Appl. Environ. Microbiol. 65:5624–5627.

PIC (2009) Fire Sprinkler Water Conservation Project—Guide to Fire Sprinkler System Water Saving, Plumbing Industry Commission, Victoria.

Appendices

A. Best practice guidelines for water reuse and recycling

Industrial wastewater

Industrial Water Reuse Guidelines

Environment Protection Authority 2009
Available from www.epa.vic.gov.au/publications/ or contact the EPA on 03 9695 2700.

Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1)

Natural Resource Management Ministerial Council, Environmental Protection and Heritage Council, Australian Health Ministers Conference 2006
Available from www.ephc.gov.au.

Cooling towers and recycled water

Department of Human Services 2008
Available from www.health.vic.gov.au or contact the Environmental Health Unit, Department of Health on 1300 761 874.

Rainwater

Rainwater Use in Urban Communities: Guidelines for Non-drinking Applications in Multi-residential, Commercial and Community Facilities

Department of Human Services 2007
Available from www.health.vic.gov.au or contact the Environmental Health Unit, Department of Health on 1300 761 874.

Stormwater

Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) Stormwater Harvesting and Reuse

Natural Resource Management Ministerial Council, Environmental Protection and Heritage Council, National Health and Medical Research Council 2009
Available from www.ephc.gov.au.

Greywater (≤5,000 litres per day)

Guidelines for Environmental Management: Code of Practice—Onsite Wastewater Management

Environment Protection Authority 2008
Available from www.epa.vic.gov.au or contact the EPA on 03 9695 2700.

Sewage or greywater (>5,000 litres per day)

Guidelines for Environmental Management: Use of Reclaimed Water

Environment Protection Authority 2003

Guidelines for Environmental Management: Dual pipe water recycling schemes—Health and environmental risk management

Environment Protection Authority 2005

Both are available from www.epa.vic.gov.au or contact the EPA on 03 9695 2700.

Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1)

Natural Resource Management Ministerial Council, Environmental Protection and Heritage Council, Australian Health Ministers Conference 2006
Available from www.ephc.gov.au

Guide for the completion of a Recycled Water Quality Management Plan for Class A water recycling schemes

Department of Human Services 2008
Available from www.health.vic.gov.au or contact the Environmental Health Unit of the Department of Health on 1300 761 874.

B. Risk Management Plan template and guidance note

It is best practice to use a RMP as a tool to help bring together all of the elements relating to risk assessment and risk management for the water recycling scheme.

There is not a single correct way to set out a water recycling RMP. These are examples of RMP approaches suitable for a water reuse or recycling scheme:

- Recycled water quality management plans such as *Guide for the completion of a Recycled Water Quality Management Plan for Class A water recycling schemes 2008* http://www.health.vic.gov.au/environment/downloads/guide_rwqmp.pdf
- Risk management plans for Legionella control such a the *Guide to Developing Risk Management Plans for Cooling Tower Systems November 2001* http://www.health.vic.gov.au/environment/downloads/fullrmp.pdf
- Food safety programs http://www.health.vic.gov.au/foodsafety/bus/templates/index.htm such as *Codex Alimentarius Hazard Analysis and Critical Control Point* (HACCP) or Australian Standard AS ISO 22000:2005 http://infostore.saiglobal.com/store/
- Generic approaches such as *Australian Standard AS/NZS 4360:2004 Risk Management* http://infostore.saiglobal.com/store/
- Drinking water quality management plans such as those consistent with the RMP requirements of the *Safe Drinking Water Act 2003* and Safe Drinking Water Regulations 2005 http://www.health.vic.gov.au/environment/water/d-wateract.htm.

The **more complex the water recycling scheme, the more detail required in the RMP.** A simple scheme usually involves a relatively low risk source, such as uncontaminated process water or roofwater, and probably requires little or no treatment. A complex scheme using a contaminated source, such as greywater, involves relatively sophisticated engineered treatment systems and may require specific local government or state government approval. It should be noted that this RMP template should be used for process water only. For other water sources such as rainwater, stormwater, sewage and greywater, refer to existing guidance as outlined in Figure 4-1.

For schemes identified as Class A sewage or greywater recycling schemes, implement a detailed RMP in accordance with the EPA *Guidelines for Environmental Management: Dual Pipe Recycling Schemes 2005,* and meet the relevant regulations. That same guidance can be used for other, lower risk schemes, but it is not mandatory.

The following section of the document provides a template to illustrate the type of information that should be in a RMP for process water.

Project details and commitment

Clearly summarise and specifically identify the water reuse or recycling scheme for which the RMP is being prepared. Be absolutely clear as to where the non-potable water system is and who is responsible for ensuring the correct management of risks and for operating the system.

Item	Details
Organisation name	
Property street address/location	
Position and name of person accountable for management of risks	
Position and name of contact person for the water reuse or recycling scheme (if different from above)	
Operational contact telephone—business hours	
Operational contact telephone—after hours and during emergencies	
Alternative contact details—after hours and during emergencies (fax, telephone numbers and pagers for one or more backup persons)	
RMP document file no, reference number and version	
Date of this version of the RMP	
Name and position of person who prepared this version of the RMP	
Name and position of person who approved this version of the RMP (if different from above)	
Signature of person who approved this version of the RMP	

Include a statement of commitment to the project, noting how the scheme will be maintained into the long term.

Managing risks associated with water reuse and recycling schemes in HCF should be a commitment made by the CEO and Board. The commitment must transcend simple cost analysis and must be a genuine long-term commitment to good sustainable environmental and health risk management. As highlighted in Section 3 it is important that justification for a project considers the potential water savings, risks and cost.

Formal and regulatory context example template

Identify the relevant regulations and formal requirements that apply to your particular scheme.

Jurisdiction	Formal requirement	Relevance to this scheme
National	List any national guidelines or regulations that apply to this scheme. Examples might be plumbing codes, materials codes, trade practices legislation and national recycling guidelines.	Explain how these instruments are relevant to this scheme.
State	List any state guidelines or regulations that apply to this scheme. Examples might be plumbing regulations, fair trading legislation and state recycled water guidelines and regulations.	
Local	List any local laws that apply to this scheme. Examples might be requirements for council approvals for specific installations.	
Site	List any site-specific requirements that apply to this scheme. Examples might be requirements to meet operating contracts or HCF building environmental and safety requirements.	

System analysis and management example template

Concisely describe the key features of all non-potable water supply systems. Every system is unique, so specifically document each system.

System analysis and management involves understanding the entire recycling system, the hazards and events that can compromise water quality and the controls and monitoring necessary for risk minimisation.

The process should begin by describing and mapping the system, followed by a detailed assessment of potential risks and controls. It specifically considers:

- Water sources and uses
- Water treatment
- Storage and plumbing systems.

System description
Water source: • Describe where the water is collected. • Categorise the source of the process water. ***Intended use and exposures to non-potable water:*** • Describe intended use for non-potable water—toilet flushing, irrigation etc. • Identify how persons and any sensitive environments at HCF might become exposed—consuming irrigated vegetables, inhaling aerosols from cooling systems etc. ***Inadvertent exposures to non-potable water:*** • Describe potential non-intended or accidental uses of the non-potable water (e.g. children might fill water bottles with the water and drink it). • Identify how persons and any sensitive environments at HCF might become exposed (e.g. water running off site). ***Process summary:*** • Describe how the source water is collected. • Identify how source water quality is controlled at the point of collection (through controls on what can be discharged to the collection point). • Identify if treatment is necessary for the intended use. Explain how the source process water is treated to become recycled water and identify operational monitoring requirements. • Identify where and how the source water and recycled water is stored. • Describe how the source water and recycled water is transported. • Describe how recycled water is supplied to the point of use. • Identify how exposure is controlled at the point of use (through signage or other means). • Explain how water is supplied if the recycled water supply needs to be shut off (e.g. through potable back-up systems with registered air gaps). • Explain how any contaminated recycled water entering the distribution system is safely discharged. • Describe plumbing controls to prevent cross-connections between drinking water supply and recycled water supply. • Describe what materials are used for all water collection surfaces, pipes, pumps, tanks and other items that come into direct contact with the recycled water. • Specifically name any treatment systems—include process type, manufacturer, local supplier/reseller, brand, series and model number. • Specifically identify any chemical used in the recycled water process—chemical name, grade, brand and supplier details. • Check whether or not any parts of the system allow the water to reach temperatures above 20°C (relevant to assessing risks associated with Legionella spp. and related bacteria). ***System details:*** • Identify the document names, versions, file references, dates and custodians for the principal technical drawings, design and operations and maintenance documentation pertinent to the system.

System process flow diagram example template

A simple block diagram should be prepared for the scheme. Show the source, storage, treatment, distribution and use components, water flow direction, bypasses and alternative routings, as well as potable water connections and top-ups. Examples are included in Figure 5-2 and Figure 5-3.

Risk management plan team

The RMP should be developed using a team and peer workshop approach, involving a body of expertise covering system design, operation, maintenance and relevant technical expertise. The peer group that undertakes the risk assessment and develops the RMP should jointly attest to the veracity of the finalised summary and management plan and should be named in the RMP.

Name	Position	Organisation	Expertise	Role in RMP	Contact details	Signature of endorsement of the RMP

Risk management table

Prepare a summary of the risks posed by the specific scheme, identifying how those risks are managed. Risks and controls should be described for each process step indicated in the process flow diagram, as well as for the total system. The risk management table should identify that all significant foreseeable risks have been considered and that all risks have been reduced to acceptable, low levels by the control measures that are in place. The following tables provide a format for capturing the type of information required.

Process step	Risks	Controls	Monitoring
Identify the process step at which this risk can arise	How can contamination be introduced? How can processes involved in the removal of contamination become compromised? What potentially harmful microbial, chemical or physical characteristic could occur in the water?	What process or procedure is used to prevent or mitigate the risk, to reduce it to acceptable levels? How can the hazardous event be prevented? How can any hazards introduced be reduced to acceptable levels?	What process performance indicator is used to show that the control measure is operating within specification to reduce risks to acceptable levels? How is the process control indicator measured? Clarify the 'what, how, where, when and who' of monitoring. What is the response if the process control indicator reveals that the process is trending out of control?

Verification

A verification program is a body of objective evidence showing conformity of the recycled water to requirements. Verification is based on monitoring.

Routine testing of recycled water is required at appropriate intervals to verify that the water meets set quality specifications. The verification testing program should be tailored according to the nature of the source and the use. In general:

- Verification testing should seek to demonstrate the absence of (or presence at tolerable levels of) hazards that might foreseeably be present in the recycled water. If the recycled water is highly unlikely to contain a particular substance, there may be no need for verification testing to prove its absence. The risk assessment should be used to identify substances that need to be tested.
- Verification determinands relating to acute-acting hazards, such as microbial quality testing for *E. coli,* are required at more frequent intervals.
- Verification determinands relating to slow-acting hazards, such as heavy metals, are required less frequently.

Item to be verified	Verification monitoring	Corrective action	Records
Identify what needs to be specifically verified to prove that the RMP is effective.	Describe the monitoring required to verify that the RMP is effective. Include the 'what, where, how, who and when' of monitoring.	Describe response when problems are indicated by the verification monitoring.	Identify how records are kept of the verification records, so that these are available for audit and review.

Supporting elements

For a risk management system to remain effective it is important that details are provided on supporting programs such as:

- maintenance schedule
- supplier assurance program
- employee awareness training and certification
- validation
- research and development
- documentation and reporting
- evaluation and audit
- review and improvement
- communication
- regular reporting to Management, including CEO and board

Further information on each of these components is provided below.

Maintenance Schedule

The maintenance schedule should specifically address every item relating to managing non-potable water quality risks. Each item identified in the RMP as requiring inspection and maintenance needs a pre-defined and scheduled maintenance program. The nature and frequency of these activities need to be appropriate in order to prevent the failure of control processes. A suitable maintenance scheduling system would be the Computerised Maintenance Management System (CMMS), already in place at many HCF.

In particular the schedule should consider the checking, cleaning, calibration and maintenance of process control equipment used to monitor significant risks. The technical adequacy of this schedule needs to be proven as part of the RMP.

A suitable maintenance schedule should contain the following key features:

- pre-determined maintenance and inspection tasks and their frequency over the lifetime of the system or asset
- tasks and frequencies based on good information, such as supplier instruction or experienced and expert judgement
- the ability to generate work orders or instructions, to alert staff or contractors to the need to complete inspection and maintenance tasks
- authorisation of personnel qualified to undertake maintenance works
- records of who undertakes the specified task and on what date
- the ability to provide an audit trail to provide evidence of maintenance carried out over time.

Supplier assurance program

Suppliers of chemicals, materials and plant and equipment should provide evidence that their goods are fit for purpose. Evidence could include documentation relating to quality assurance systems and warranties for specific items. Treatment systems in particular should be validated as being fit for the purpose of treating the specific water source to meet the intended use of the non-potable water. These assurances and warranties should be described in the RMP.

Employee awareness and training

Employees

Whenever additional and/or revised processes and operational practices are planned to be implemented, an assessment of the training needs of staff involved is to be undertaken. Where required, suitable training is to also be provided and this training should be kept current through updates. Following completion, the effectiveness of the training may need to be assessed through competency assessment processes.

Training can be tailored to specific applications; such as where suppliers train users in equipment operation, or can be generic; such as Certificate Level II, III or IV TAFE training in water and wastewater treatment and water quality management.

Contractors

In addition it is important that plumbing works be undertaken by appropriately trained, registered, experienced, insured and licensed plumbers. Training and induction must also be provided to new personnel and contractors on site before they are given responsibility for tasks relating to non-potable water quality management.

Validation, research and development

A specific technical summary is required that attests to the validity of the technical basis of the assumptions made in the RMP. The validation summary should cover items such as:

- the ability of the treatment process to reduce pathogenic microorganisms to tolerable levels, given the source, intended use and under the specific operational conditions *in situ.*
- the assumptions used in undertaking the risk assessment and risk management plan, in particular the assumptions relating to the process control limits set for the control of significant risks.

Documentation and reporting

Documentation required to support the RMP is likely to include:

- a map of the site illustrating areas where non-potable water is collected, stored, treated and used.
- plumbing system diagrams indicating all non-potable water and drinking water plumbing in the areas:
  - from which non-potable water is sourced
  - through which non-potable water is transported and stored
  - to which non-potable water is supplied.

  The diagram should indicate any inter-connections, bypasses or other features as well as the locations of controls such as backflow prevention devices and air gaps. The diagrams should specifically identify the location of the water catchment area, plumbing systems and all connected fittings.
- supplier warranties, operations and maintenance manuals, standard operating procedures and any other relevant documentation describing the water treatment system and its capabilities.
- Materials Data Safety Sheets (MSDS) and other relevant documentation describing the chemicals used and their specifications, in particular any quality assurance and quality control documentation relating to those chemicals.
- Job Safety and Environmental Analysis (JSEA) requirements.
- Standard Operating Procedures (SOP), Work Instructions (WI), Safe Work Methods Statements (SWMS) or similar documentation should be available for all procedures that are required to manage risks as identified in the RMP.

Review

The review process is the final element of the framework and is required to ensure that the identified risks are being adequately managed and opportunities for improvement are identified. It consists of two components:

- evaluation and audit.
- review and improvement.

Evaluation and audit

The RMP is to be audited and included in the scope of the Operational Risk Register audited at HCF as part of the Victorian Managed Insurance Assessor risk audits to ensure conformity with the Australian Council of Healthcare Standards framework.

Audits should be undertaken either by experienced internal HCF staff or suitably experienced external auditors. These external auditors may include those with expertise in auditing water-related risk management, for instance:

- Department of Human Services approved *Legionella* Risk Management Plan auditors (www.health.vic.gov.au/environment/legionella/risk-plans.htm).
- Department of Human Services endorsed Drinking Water Quality Management System *Safe Drinking Water Act 2003* auditors (www.rabqsa.com/search.html).
- Chartered Professional Engineers working in recycled water quality management and with auditing qualifications (https://fwas.engineersaustralia.org.au/rpsearch/home.jsp).
- Victorian Managed Insurance Assessor risk auditors, possibly supported by suitable technical experts if required.
- Auditors approved by EPA Victoria for relevant categories of environmental auditing (www.epa.vic.gov.au/envaudit/auditors.asp).

Audit findings should be reported to the CEO and Board of the HCF.

The audit is to cover all aspects of the RMP, with a particular focus on system operation and the performance of the maintenance processes required to manage identified health risks. Attention should also be given to treatment systems and the means used to avoid cross-connections and inappropriate tap-ins within the plumbing system.

Audit frequencies are to be defined by the inherent risk of the selected system. In determining an appropriate frequency for the scheme, it is important to consider the source water and its contaminants, the intended uses, and the potential risk of cross connection. Low-risk schemes involving use of uncontaminated process water for low-exposure uses could be potentially be audited at a lesser frequency than high risk schemes.

Review and improvement

The RMP should be checked over and reviewed at least annually, to ensure that it is still accurate and to identify areas for improvement.

Community involvement and communication

Communication should inform affected persons of the water reuse or recycling processes that are in place. Communication can be important to assist in gaining acceptance of the water conservation initiative, as well as assisting with risk management. In the latter case, similar to the way that training is used to inform operators, whenever additional or revised processes and operational practices are planned to be implemented, appropriate communication mechanisms may need to be developed to inform any persons that could potentially affect, or be affected by, the non-potable water system.

Importantly, a communication plan must de developed to inform relevant personnel whenever the water quality falls outside the control limits set in the RMP. This form of communication would normally involve an incident response leading to the non-potable water supply being immediately shut off until the situation had been safely resolved, with any contaminated water being discarded to waste.

Roles and responsibilities

The RMP needs to set out clearly who is responsible for developing, reviewing, and endorsing or approving the RMP and the recycling project. The RMP should document which regulations are relevant and how they have been complied with.

C. Scheme checklist

Scheme proponents are encouraged to use this checklist to ensure all of the elements relating to risk assessment and risk management for the scheme have been implemented.

Element	Component	Action	☑
Commitment to responsible use and management	Responsible use of water	Involve agencies (i.e. stakeholders) with responsibilities and expertise in the protection of public health.	
		Ensure that design and management of the scheme is undertaken by agencies and operators with sufficient expertise.	
		Consider establishment of an independent advisory panel for high risk sources.	
		Ensure that the scheme complies with the relevant legislation and guidelines.	
		Identify, assess and manage the risks posed by the supply.	
		Ensure the scheme is implemented in accordance with the risk management plan.	
		Monitor, report and audit the scheme.	
	Regulatory and formal requirements	Identify and document all relevant state and federal legislation, regulations, Australian Standards and other government policy.	
		Ensure management and other scheme stakeholders are aware of and comply with the regulatory requirements.	
		Identify governance requirements specific to agencies, designers, installers, operators, maintainers, owners and users.	
		Review requirements periodically to reflect any changes.	
	Partnerships and engagement of stakeholders	Establish partnerships with relevant agencies and organisations to support effective management of the scheme.	
		Identify other stakeholders affecting, or affected by, decisions or activities related to the use of water.	
		Develop appropriate mechanisms and documentation for stakeholder commitment and involvement.	
	Recycled water policy	Develop a recycled water policy endorsed by senior management.	
		Ensure the policy is visible and is communicated, understood and implemented by relevant stakeholders.	

Element	Component	Action	☑
Assessment of the recycled water system	Sources of reuse or recycled water	Conduct a water audit to identify water conservation, reuse and recycling opportunities.	
		Select lowest risk or best quality water available for the intended reuse or recycling.	
		Identify intended and unintended routes of exposure, receiving environments, endpoints and effects.	
	Recycled water analysis	Assemble pertinent information and document key characteristics of the scheme to be considered.	
		Assemble a team with appropriate knowledge and expertise.	
		Construct a flow diagram of the system from the source to the application or receiving environments.	
		Periodically review the reuse/recycled water system analysis.	
	Assessment of water-quality data	Assemble historical data about source water and identify gaps and assess reliability of data.	
		Assess data to identify trends and potential problems.	
	Hazard identification and risk assessment	Undertake a risk assessment including identification and documentation of hazards and hazardous events for each component of the system (source, collection, treatment, storage, distribution, and end-use).	
		Estimate qualitatively and quantitatively the level of human and environmental health risk for each hazard and hazardous event.	
		Determine significant risks and document priorities for risk management.	
		Evaluate the major sources of uncertainty associated with each hazard and hazardous event, and consider actions to reduce uncertainty.	
Preventive measures for recycled water management	Preventive measures for recycled water management	Identify and document existing and additional preventive measures and strategies for each significant risk.	
	Critical control points	Identify critical control points and establish mechanism for operational control.	
		Document critical control points, critical limits and target criteria.	

Element	Component	Action	☑
Operational procedures and process control	Operational procedures	Identify and document all procedures in an operations manual required for all processes and activities applied with the recycled water system.	
	Operational monitoring	Develop protocols for operational monitoring parameters and criteria, and routine analysis of results.	
		Document monitoring protocols into an operational monitoring plan.	
	Corrective action	Establish and document procedures for corrective action to control excursions in operational parameters.	
		Test corrective actions.	
		Establish rapid communication systems to deal with unexpected events.	
	Equipment capability and maintenance	Ensure the equipment is adequately designed and provides sufficient flexibility and process control.	
		Establish a program for regular inspection and maintenance of all equipment, including monitoring equipment.	
	Materials and chemicals	Establish documented procedures for evaluating materials, chemicals are suppliers.	
Verification	Recycled water quality monitoring	Determine the physical, chemical or microbial characteristics to be monitored.	
		Determine the points at which monitoring will be undertaken.	
		Determine the frequency of monitoring.	
	Monitor the integrity of the distribution system	Implement a quality management system to ensure the integrity of all plumbing works, covering design, commissioning, operation and maintenance phases.	
		Establish and implement a testing program for control devices that prevent cross-connections (e.g. devices that measure differential pressure and backflow prevention).	
	Application site and receiving environment monitoring	Determine characteristics to be monitored and the points at which monitoring will be undertaken.	
	Documentation and reliability	Establish a sampling plan for each characteristic, including the location and frequency of sampling, ensuring that the monitoring is representative and reliable.	
	Satisfaction of users of recycled water	Establish an inquiry and response program for uses of recycled water, including appropriate training of response personnel.	
	Short-term evaluation results	Establish procedures for the short-term review of monitoring data and satisfaction of users of recycled water.	
		Develop a reporting mechanism where required.	
	Corrective responses	Establish and document procedures for corrective responses or feedback from users.	
		Establish a rapid communication system.	

Element	**Component**	**Action**	☑
Management of incidents and emergencies	Communication	Define communication protocols with the involvement of relevant agencies and prepare a contact list of key stakeholders.	
		Develop a public and media communication strategy.	
	Incident and emergency response protocols	Define potential incidents and emergencies and document procedures and response plans with the involvement of relevant agencies.	
		Train employees and regularly test emergency response plans.	
		Investigate and incidents or emergencies and revise protocols as necessary.	
Operator and contractor awareness and training	Operator, contractor and end user awareness, involvement and training	Develop mechanisms and communication procedures to increase operator, contractor and end user awareness and participation.	
		Ensure that operators, contractors and users maintain the appropriate experience and knowledge by providing adequate training opportunities and resources.	
		Document all training undertaken.	
Involvement and awareness	Consultation with users of recycled water and the community	Assess requirements for effective involvement and develop a strategy for consultation with users and the community.	
	Communication and education	Develop an active two-way communication program to inform users of impacts and benefits of appropriate and inappropriate uses.	
Validation, research and development	Validation of processes	Validate processes and procedures to ensure hazards are controlled effectively.	
		Revalidate processes when changes are made or variations in conditions occur.	
	Design of equipment	Validate the design of new equipment and infrastructure to ensure continuing reliability.	
	Research and development	Review studies and research to increase understanding and inform possible improvements to the system.	
Documentation and reporting	Management of documentation and records	Develop a document and record management system and ensure employees have access and are trained it its use.	
		Periodically review documents.	
	Reporting	Establish procedures for effective internal and external reporting.	
		Produce an annual report aimed at users, regulatory authorities and other stakeholders.	

Element	Component	Action	☑
Evaluation and audit	Long-term evaluation of results	Collect, evaluate and report long-term data to assess performance and identify problems.	
	Audit of recycled water quality management	Establish procedures for internal and external audits and communication of audit outcomes.	
Review and continual improvement	Review by senior managers	Senior managers review the effectiveness of the management system and evaluate the need for change.	
	Recycled water quality management improvement plan	Develop a recycled water quality management improvement plan.	
		Ensure that the plan is communicated and implemented, and that improvements are monitored for effectiveness.	

State Government Victoria

Department of Health