



Discussion Paper

A Framework for Alternative Urban Water Supplies: Managed Aquifer Recharge (MAR)

December 2006



Our Water Our Future
A Victorian Government initiative





Department of Sustainability and Environment
Department of Human Services

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Foreword

Over recent years it has become increasingly clear that our current water use is not sustainable. Our rainfall is becoming less reliable. Victorians understand that we need to change the way we use and value water so we protect our supplies for future generations.

Victorian communities have responded quickly to our water challenges and have made many water savings through smarter, more efficient water use at home and at work.

As part of our ongoing efforts to address the wider water challenges we need to enable opportunities to recycle alternative water sources. In doing so, it is important that public health and environmental risk is well managed to maintain community confidence and support for water recycling.

Currently, the key water recycling regulatory and approval mechanisms for ensuring environmental and public health protection vary depending on the source of the water and the characteristics of the recycling scheme.

Under the Victorian Government White Paper *Our Water Our Future* Actions 5.42 and 5.43, the Environment Protection Authority (EPA) and the Department of Human Services (DHS) were required to undertake a review of the public health and environmental framework supporting alternative urban water supplies.

In February 2006, I released a discussion paper on the first phase of the review, which covered rainwater, stormwater, greywater and treated sewage.

This Discussion Paper presents results from the second phase of the review, and includes recommendations for the proposed regulatory framework supporting Managed Aquifer Recharge (MAR).

It forms the key document to be used in the consultation process designed to gather feedback from stakeholders and interested groups on the proposed regulatory framework recommendations.

The review of the public health and environmental framework, and the preparation of this Discussion Paper, were overseen by a steering committee comprising representatives from EPA, DHS and the Department of Sustainability and Environment (DSE). In addition, a working group provided detailed input into the risk assessment and development of management controls. The working group comprised representatives from EPA, DHS, DSE, Melbourne Water, Southern Rural Water, Goulburn Murray Water, Stormwater Industry Association of Victoria, City of Kingston and EPA (South Australia). Two specialists from CSIRO and URS also contributed to the working group. I thank these organisations and individuals for their input.

Your feedback on the proposed regulatory framework will play an important role in finalising a regulatory framework which effectively enables access to alternative water supplies while ensuring environmental and public health protection. I encourage all Victorians to participate in this important initiative to ensure that we work together to secure our water future.

John Thwaites
Minister for Water

The process of intentionally injecting or infiltrating water into an aquifer, and then extracting the water for use at a later date is known as Managed Aquifer Recharge (MAR).

Interest in using MAR to reduce the amount of reticulated water used in urban areas, is increasing.

As a result, there is a need to review Victoria's existing regulatory environment in relation to MAR.

This Discussion Paper forms part of the review and proposes recommendations for a new Regulatory Framework for the use of MAR schemes.

The Discussion Paper is divided into three parts:

PART A: About the Review

PART B: About Managed Aquifer Recharge

PART C: The Proposed Regulatory Framework.

Individuals and organisations are encouraged to provide feedback on Part C: the Proposed Regulatory Framework.

A glossary is contained in Section 4.1.

The risk assessment and regulatory review process have primarily focused on the use of MAR in water recycling in urban areas. However, the proposed framework should be applicable to all potential MAR schemes across the state.

Table of Contents

Part A: About the Review

1	The Need for a Review	1
2	Objectives of this Discussion Paper	2
3	How to Use this Document	3
4	Useful Information	4
4.1	MAR Terms and Definitions	4
4.2	Management Control Definitions	5
4.3	Regulatory Framework Definition	5
4.4	Roles and Responsibilities of Agencies	5
5	The Need for Consultation	6
5.1	Getting It Right for the Future	6
5.2	Who Might the Review Affect?	6
5.3	Should I Participate in Consultation?	6
5.4	How Feedback Will Be Considered	7
6	The Review Process	8

Part B: About Managed Aquifer Recharge

7	About Storing and Extracting Water from Aquifers	9
8	Managed Aquifer Recharge (MAR)	10
8.1	Types of MAR Schemes	10
8.2	Sources of Recharge Water	11
9	Using Aquifer Water	12
10	Understanding Hazards and Risk	13
10.1	What is a Hazard?	13
10.2	What is a Hazardous Event?	13
10.3	What is Risk?	13
10.4	What is Risk Management?	13
11	Potential Managed Aquifer Recharge Risks	14

Part C: The Proposed Regulatory Framework

12	Managing MAR Risks	15
12.1	Introductory Comments	15
12.2	Diagram: Recommended MAR Scheme Assessment Process	16
12.3	Explanatory Text: Recommended MAR Scheme Assessment Process	17
12.4	Risk Assessment Framework	18
12.5	Questions	20
12.6	Water Quality Prior to Injection	21
13	Victorian Regulatory Framework: A Summary	22
13.1	Licensing Groundwater Use	22
13.2	Groundwater Ownership	22
13.3	Groundwater Use and Protection	23
13.4	Groundwater Allocation Caps	23
13.5	Underground Disposal	23
13.6	Consent	23
13.7	Discharges to the Environment	23
13.8	Works Approval and Licensing Requirements	24
13.9	State Environment Protection Policy (Groundwaters of Victoria)	24
13.10	Groundwater Quality Objectives	25
13.11	Attenuation Zones	25
13.12	Local Drainage	25
13.13	Melbourne and Metropolitan Area	25
13.14	Developing Aquifer Storage and Recovery Opportunities in Melbourne, Technical Guidance for MAR 2006	25
13.15	White Paper – Our Water Our Future	25
14	Managed Aquifer Recharge Recommendations	26
15	All-of-Framework Recommendations	28

1

The Need for a Review

Victoria's prosperity depends on secure water supplies for our homes, farms, environment and industry.

Population growth, climate change and the need to ensure healthy river systems are all factors that demonstrate why the State needs new and better ways to secure water for the future.

The Victorian Government's White Paper, *Our Water Our Future*, is an action plan to enable smarter water use and management across the State.

Reducing the amount of water we use (saving water) is one way to protect the State's water supplies; another way is to store excess water resources for retrieval and use at a later date.

Water can be stored in aquifers – underground layers of material, such as rock or soil that allows water to pass through it.

The process of intentionally injecting or infiltrating water into an aquifer for storage, and then extracting the water for use at a later date is known as Managed Aquifer Recharge (MAR).

With increasing interest in MAR schemes, it is important that public and environmental health is protected and the health of aquifers is maintained for future generations.

There is now a need to review Victoria's existing regulatory environment in relation to MAR schemes to:

- support an appropriate regulatory framework to establish confidence and security in alternatives to reticulated drinking water;
- ensure public health and the environment are protected and community confidence is maintained in relation to the use of MAR;
- give Victorians access to comprehensive information and education about safe and sustainable MAR schemes; and
- create a system which is easy for Victorians to use, navigate and participate in.

The review of the Regulatory Framework for managed aquifer recharge forms a key part of actions 5.42 and 5.43 of the White Paper, *Our Water Our Future*, which requires EPA Victoria, in partnership with the Department of Human Services, to review the public health and environmental framework for alternative water sources. For each alternative water source, the review considers:

- The level of regulatory oversight that is needed;
- The most efficient approaches for assessing and approving the use of individual alternative water supplies; and
- The necessary reporting and auditing requirements so that the community retains confidence in the safety of alternative water supplies.

2

Objectives of this Discussion Paper

The objectives of this Discussion Paper are:

- To inform interested Victorians about the review of the Regulatory Framework for MAR schemes.
- To assist Victorians in providing feedback on the proposed Regulatory Framework by providing information in an easy-to-read format and clear instructions for participation in consultation.
- To generate feedback on the proposed Regulatory Framework contained in Part C, in order to identify recommendations which need further consideration and areas of acceptance.



3

How to Use this Document

Although at some points there is a need to use technical language, wherever possible this Discussion Paper has been written in a style that enables all stakeholders to participate in the consultation process.

Interested stakeholders are invited to:

- **Read** this paper, focussing on the earlier sections first as they provide useful information about the context for the review and developments to date.
- **Seek further information if required:** The *Managed Aquifer Recharge Technical Report* – which informed this Discussion Paper – is available to all stakeholders seeking more detailed technical information.

The report is available:

- at www.epa.vic.gov.au; or
- by phoning: **03 9821 4895**.

- **Respond to the questions provided in Part C: The Proposed Regulatory Framework. The following channels are available to provide feedback on Part C – The Proposed Regulatory Framework.**

- **Workshops:** During February 2007, workshops will be held with stakeholders to gather feedback on the Discussion Paper. Victorians interested in participating in a workshop should contact **03 9821 4895** to register their interest and to locate the workshop nearest them.
- **Written Feedback:** Victorians can also provide written feedback without attending a workshop. It is important that written feedback clearly identifies which question is being responded to. Written feedback must be submitted by Friday 16 March, 2007 via:
 - e-mail: feedback@bcg.com.au; or
 - post:
Managed Aquifer Recharge Discussion
Paper Feedback
13/499 St Kilda Road
Melbourne VIC 3004

Should you require further assistance, please contact **03 9821 4895**.

4

Useful Information

4.1 MAR Terms and Definitions

Below are some common terms used in this Discussion Paper.

Aquifer

An aquifer is an underground layer of water-bearing permeable rock, or unconsolidated materials (gravel, sand, silt, or clay) from which groundwater can be usefully extracted using a water well.

Aquitard

An aquitard is a zone within the earth that restricts the flow of groundwater from one aquifer to another. An aquitard can sometimes, if completely impermeable, be called an aquiclude or aquifuge. Aquitards are comprised of layers of either clay or non-porous rock with low hydraulic conductivity.

Attenuation

Attenuation is the combination of physical, chemical and microbiological processes that reduce the concentration, mass or toxicity of pollutants.

Beneficial Use

A use of the environment or any element or segment of the environment which is conducive to public benefit, welfare, safety, health or aesthetic enjoyment and which requires protection from the effects of waste discharges, emissions or deposits or of the emission of noise.

Extracted Water

Water taken out of an aquifer for use.

Greywater

All household wastewater excluding that derived from the toilet and urinals.

Groundwater

Any water contained in or occurring in a geological structure or formation or an artificial landfill.

Inherent Risk

The probability that without intervention, an adverse outcome will occur in a person, group of people, plants, animals and/or the ecology of a specified area that is exposed to a particular dose or concentration of a hazardous agent.

Managed Aquifer Recharge

In the context of this Discussion Paper, Managed Aquifer Recharge is the intentional recharge of water into an aquifer either by injection or infiltration and recovery by planned extraction.

Rainwater

Water collected directly from roof run-off.

Recharge Water

Water injected or infiltrated into an aquifer.

Recycled Water

Water that has been derived from sewage, greywater, stormwater or industrial water and treated (where necessary) to a standard that is appropriate for its intended use.

Residual Risk

The probability that following the implementation of risk management controls, an adverse outcome will occur in a person, group of people, plants, animals and/or the ecology of a specified area that is exposed to a particular dose or concentration of a hazardous agent.

Reticulated Drinking Water (Potable Water)

Drinking water supplied to a site by a water authority through a network of pipes.

Sewage

Any waste containing human excreta or domestic wastewater

Stormwater

Urban surface water runoff most commonly captured from rain events

Sustainability

The capacity of the aquifer to sustain the MAR without degradation or impacts on other users.

4.2 Management Control Definitions

Management controls are used to control the use of alternative water sources and vary depending on the level of risk posed.

Management controls need to be viewed as part of a spectrum, where interventions are proportional to the level of risk posed, with education to control low inherent risk at one end and explicit regulation to control higher inherent risk at the other end.

Education

Information made available either proactively (e.g. a guideline sent directly to stakeholders) or passively (e.g. a brochure available for collection from Government agencies or downloading from a website).

Regulation

Requirements and restrictions for the operation and management of specific activities and/or premises which are legally enforceable and carry appropriate penalties for non-compliance. The spectrum of regulation options is broad, ranging from notification of an activity and compliance with guidelines, through to assessment and approval and licensing requirements.

4.3 Regulatory Framework Definition

The term “regulatory framework” is used broadly to include the hierarchy of potential management controls including Acts, regulations, guidelines, education etc.

4.4 Roles and Responsibilities of Agencies

The key Victorian agencies with responsibilities related to MAR schemes are:

EPA Victoria

EPA administers the *Environment Protection Act 1970* and State environment protection policies including the *State environment protection policy (Groundwaters of Victoria)* and is responsible for developing, implementing and enforcing environmental guidelines including those for the development of safe and sustainable water recycling schemes.

Department of Human Services

The Department of Human Services (DHS) administers the *Health Act 1958* and is responsible for the enhancement and protection of the health and well being of all Victorians.

Department of Sustainability and Environment

The Department of Sustainability and Environment (DSE) is Victoria’s lead government agency responsible for promoting and managing the sustainability of the natural and built environment. The DSE oversees the administration of the *Water Act 1989*, the *Water Industry Act 1994*, the *Catchment and Land Protection Act 1994* and the *Planning and Environment Act 1987*.

Water Authorities

Water Authorities supply water and sewerage services and may have other roles such as waterway management, drainage or floodway management functions. Rural water authorities are of particular relevance to MAR activities, as they have responsibility for bulk water supply, including the management, control and licensing of groundwater.

Local Councils

Local councils are responsible for planning, protecting public health and the environment within their municipalities. Many local councils have responsibility for drainage functions under the *Water Act 1989*.

Catchment Management Authorities (CMAs)

Under the *Catchment and Land Protection Act 1994* (the CaLP Act), Victoria is divided into 10 regions each with its own CMA. The CMAs apply a whole of catchment approach to ensuring the protection and restoration of land and water resources, the sustainable development of natural resource based industries and the conservation of our natural and cultural heritage. CMAs also administer permits for works on waterways under the *Water Act 1989*.

Plumbing Industry Commission

The Plumbing Industry Commission (PIC) enforces standards and regulatory requirements for all regulated plumbing work.

5

The Need for Consultation

5.1 Getting It Right for the Future

The Regulatory Framework will have a life span of many years and as a result, it is important at the outset to create a *quality* framework which:

- Is well-designed and well administered;
- Avoids overlap and duplication with existing regulation;
- Ensures participation in, and where appropriate consistency with, national initiatives
- Provides flexibility to adapt to emerging technologies and community behaviour; and
- Provides for periodic review to ensure it continues to meet the needs of Victorians in line with contemporary behaviours and best practice.

To achieve this, it is important to hear – through consultation – the views of Victorians and others who will be affected by new regulations or changes to existing regulation, to ensure the best possible Regulatory Framework is developed.

5.2 Who Might the Review Affect?

There is a range of stakeholders who might be affected by the review of the current Regulatory Framework. They can be described as:

- Proponents and users/customers of MAR schemes;
- Designers, installers, operators and maintainers of MAR schemes;
- Regulators and authorities responsible for overseeing the use of MAR schemes; and
- Environmental peak bodies and related interest groups.

All stakeholders are invited to provide feedback through consultation.

5.3 Should I Participate in Consultation?

Key stakeholders representing all of the groups mentioned above, are being actively consulted; however, anybody interested in providing feedback is welcome to do so through the channels provided in Section 3.



5.4 How Feedback Will Be Considered

All feedback will be incorporated into a report which will inform actions 5.42 and 5.43 of the *White Paper – Our Water Our Future*, as it relates to managed aquifer recharge (which incorporates aquifer storage and recovery) in water recycling.

Action 5.42 states that:

EPA Victoria, in partnership with the Department of Human Services, will review the public health and environmental framework supporting alternative urban water supplies, including recycled water, greywater, stormwater and rainwater. For each alternative water source, the review will consider:

- the level of regulatory oversight that is needed;
- the most efficient approaches for assessing and approving the use of individual alternative water supplies; and
- the necessary reporting and auditing requirements so that the community retains confidence in the safety of alternative water supplies.

Action 5.43 states that:

EPA Victoria will work in partnership with the Department of Human Services to build from the existing *Guideline for Environmental Management: Use of Reclaimed Water* (EPA, 2003) and establish a broad suite of guidance for alternative water supplies.

The guidelines will establish water quality standards and appropriate management controls to expand the use of alternative supplies, including:

- the use of recycled water in urban third pipe networks;
- the use of recycled water to provide environmental flows for waterways;
- the use of greywater in individual households;
- the use of stormwater for urban recycling;
- the use of aquifer storage and recovery in water recycling; and
- the use of industrial waste water for industrial and urban recycling.

Additional consultation and/or communication with Victorians is anticipated during implementation of actions 5.42 and 5.43.

6

The Review Process

To ensure this Discussion Paper provides high quality advice and recommendations to manage the potential public health and environmental risks associated with the use of MAR, a Working Group was created to bring together technical and industry expertise. The Working Group included representatives from the following organisations.

- Department of Sustainability and Environment
- Department of Human Services
- Environment Protection Authority
- Southern Rural Water
- Goulburn Murray Water

- Melbourne Water
- Stormwater Industry Association of Victoria
- EPA (South Australia)
- City of Kingston

In addition, two specialists from CSIRO and URS provided detailed technical input to the Working Group.

The process of reviewing the existing regulatory framework for MAR includes the steps outlined below. The process of seeking feedback on this Discussion Paper is one of the steps.



7

About Storing and Extracting Water from Aquifers

For the purpose of this Discussion Paper, aquifers are considered as an underground storage medium, which can be used to store water.

Water can be transferred from the surface to an aquifer via a bore or by infiltration through the ground surface.

During storage water quality may improve as a result of attenuation.

The stored water can be extracted for use at a later date via a bore either at the point of injection or elsewhere in the aquifer.



8

Managed Aquifer Recharge (MAR)

Water can be extracted from an aquifer and used in many ways depending on the quality of the water. Aquifers can have high quality water due to naturally occurring filtration caused by the rock materials in the aquifer structure.

Water can also be intentionally injected or infiltrated into an aquifer to replenish water taken from the aquifer or to store water for use at a later date. This is commonly referred to as 'recharging the aquifer'. The water used is commonly referred to as 'recharge water'.

The process of intentionally injecting or infiltrating water into an aquifer, and then extracting the water for use at a later date is known as Managed Aquifer Recharge.

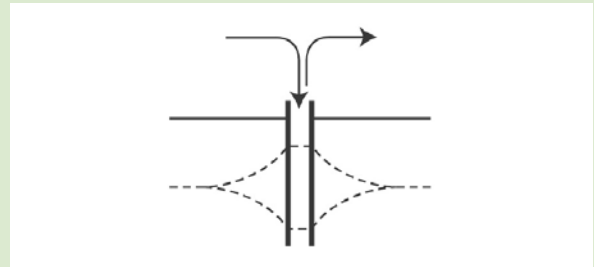
The term Managed Aquifer Recharge or MAR, is widely used in Australia and is consistent with internationally accepted terminology.

There are many MAR techniques which can be used to inject or infiltrate water into an aquifer and then retrieve it.

8.1 Types of MAR Schemes

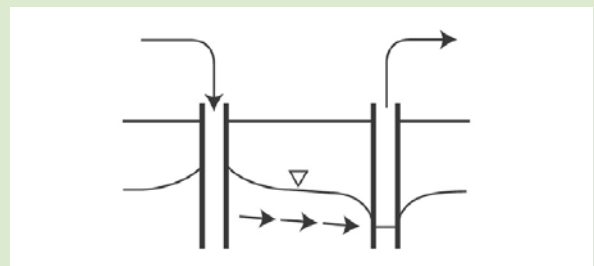
Specific definitions of the MAR techniques that this review focuses on are provided below. These are derived from *Future management of aquifer recharge*¹, and modified where relevant.

- **Aquifer Storage and Recovery (ASR)** is the injection of water into a well for storage and recovery from the same well.

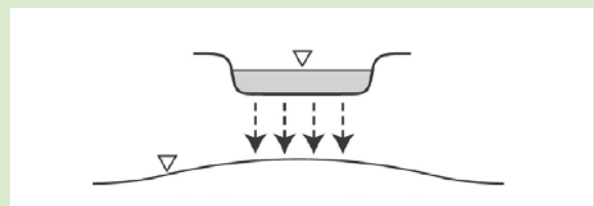


- **Aquifer Storage Transfer and Recovery (ASTR)** is injection of water into a well for storage and recovery from a different well.

The aquifer can provide additional treatment of injected water in suitable circumstances where sustainability can be ensured.

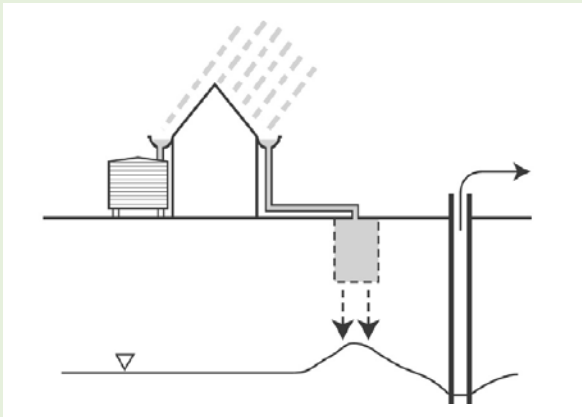


- **Infiltration Ponds:** Ponds constructed usually off-stream where surface water is diverted and allowed to infiltrate (generally through an unsaturated zone) to the underlying unconfined aquifer

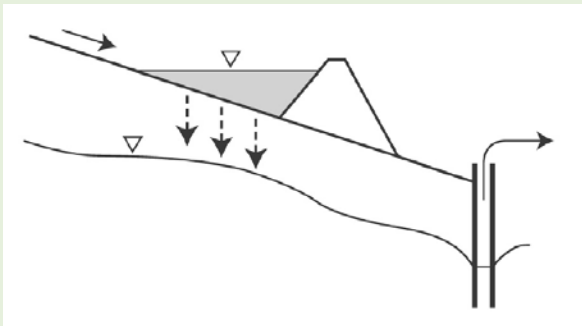


¹ Dillon, P. (2005). Future management of aquifer recharge. *Hydrogeology Journal* 13 (1): 313–316.

- **Rainwater Harvesting:** Roof runoff is diverted into a well or a trench filled with sand or gravel and allowed to percolate to the water-table where it is collected by pumping from a well.



- **Percolation Tanks:** Harvesting of water in storages built in temporary basins where water is detained and infiltrates through the base to enhance storage in unconfined aquifers and is extracted down-valley for town water supply or irrigation.



8.2 Sources of Recharge Water

There are many possible sources of recharge water – that is, water injected or infiltrated into an aquifer.

However, to protect the quality of existing groundwater and the existing aquifer, many recharge waters may require some level of treatment.

Possible sources of recharge waters are provided below.

- Recycled Water
- Rainwater
- Stormwater
- Greywater
- Sewage
- Industrial Water

9 Using Aquifer Water

Water extracted from aquifers can be used in a variety of ways, depending on the quality of the water extracted.

Potential uses of water extracted from an aquifer are outlined below.

- Drinking
- Food preparation
- Personal washing
- Laundry trough
- Swimming pool/spa
- Washing machine (with dedicated washing machine taps)
- Outdoor use (for washing cars, outdoor surfaces, outdoor recreation, and use in ornamental water features)
- Toilet flushing
- Crop irrigation (surface and subsurface)
- Landscape irrigation (surface and subsurface)
- Fire protection
- Heating/cooling systems
- Construction
- Dust suppression
- Industrial processes (e.g. cooling, material washing)



10

Understanding Hazards and Risk

Risk-management is a process used to direct efforts to mitigating risks to an acceptable level. In discussing risk management, it is important to distinguish between hazards and risks.

10.1 What is a Hazard?

A hazard is the capacity of an agent (e.g. biological, chemical, physical) to have adverse consequences to public health or the environment¹.

10.2 What is a Hazardous Event?

A hazardous event is an incident that can lead to an exposure of the hazard to humans or the environment.

10.3 What is Risk?

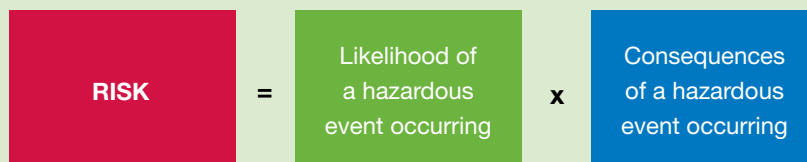
Risk is the likelihood of the hazardous event occurring and causing harm to the exposed population or environment.

10.4 What is Risk Management?

Risk management aims to reduce both the likelihood of a hazardous event occurring, and the consequences of that event.

Effective risk management involves the following.

1. Identifying potential human health and environmental hazards.
2. Identifying potential hazardous events.
3. Assessing the level of risk.
4. Reducing the risk to a level acceptable to the community.



¹ Modified from Department of Health and Ageing and enHealth Council, (2002), *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards*.

11

Potential Managed Aquifer Recharge Risks

Identifying and managing potential MAR risks will ensure the protection of public health and the environment as well as ensuring the health and quality of aquifers is maintained for future generations.

In determining the risk associated with MAR schemes a number of factors need to be considered including:

- variable source water quality;
- variable source water availability;
- quality of groundwater;
- beneficial uses (existing and potential) of groundwater and hydraulically connected surface waters;
- catchment type and uses (including landfills, contaminated sites, industrial activities, agricultural activities, sewer design and integrity of sewer infrastructure, density and integrity of septic systems);
- treatment required prior to recharge;
- aquifer characteristics (including type, thickness and extent, porosity and hydraulic conductivity, transmissivity, storativity, dispersivity);
- available storage capacity of the aquifer and depth to water table (if confined aquifer);
- compatibility of recharge water with groundwater;
- possible biogeochemical interactions within the aquifer;
- quality of the water extracted;
- intended uses;
- treatment required prior to use;
- continuity of use;
- variable demand for the extracted water;
- the potential for an increased pressure head and its impact on aquitard and adjacent wells;
- the potential for an increased risk of flooding or adverse impact on local foundations;
- the potential for a negative impact on surface water quality and quantity; and
- the potential for a negative impact on downstream environmental flow.

Due to the variability of the factors associated with different stages of a MAR scheme and the resulting complexities, a generic risk assessment is not practical. It is recommended that a case-by-case assessment be undertaken for each proposal.

12 Managing MAR Risks

12.1 Introductory Comments

In this section, we propose a framework for assessing the viability of potential MAR schemes and managing potential risks.

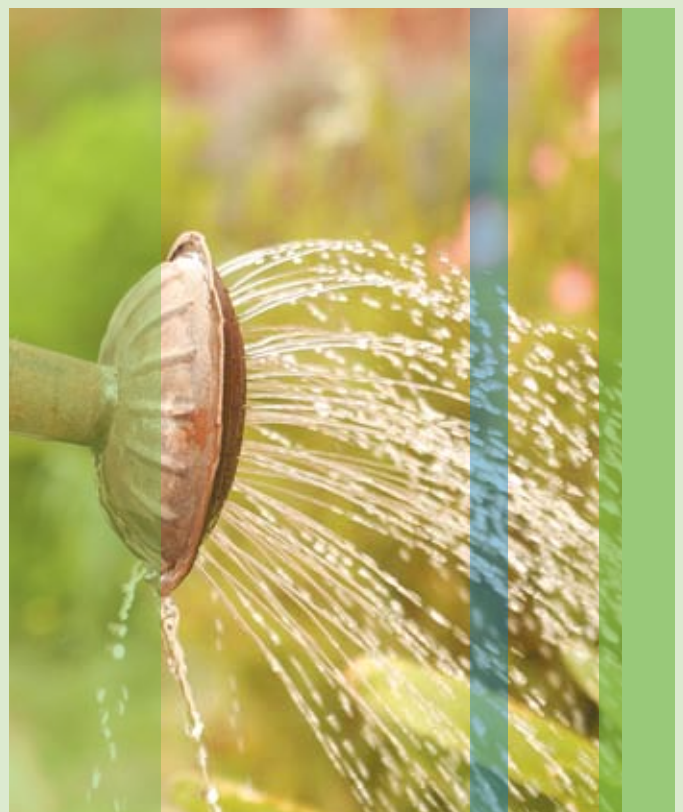
The framework is designed to ensure long-term aquifer sustainability and that public and environmental health risks associated with different stages of MAR schemes are identified and reduced to acceptable levels.

As identified in Section 11, irrespective of whether the source water is above or below the *SEPP (Groundwaters of Victoria)* quality objectives, the variability and complexities associated with different MAR schemes means that a generic risk assessment approach is not practical.

It is therefore recommended that a case-by-case assessment be undertaken for each potential MAR scheme.

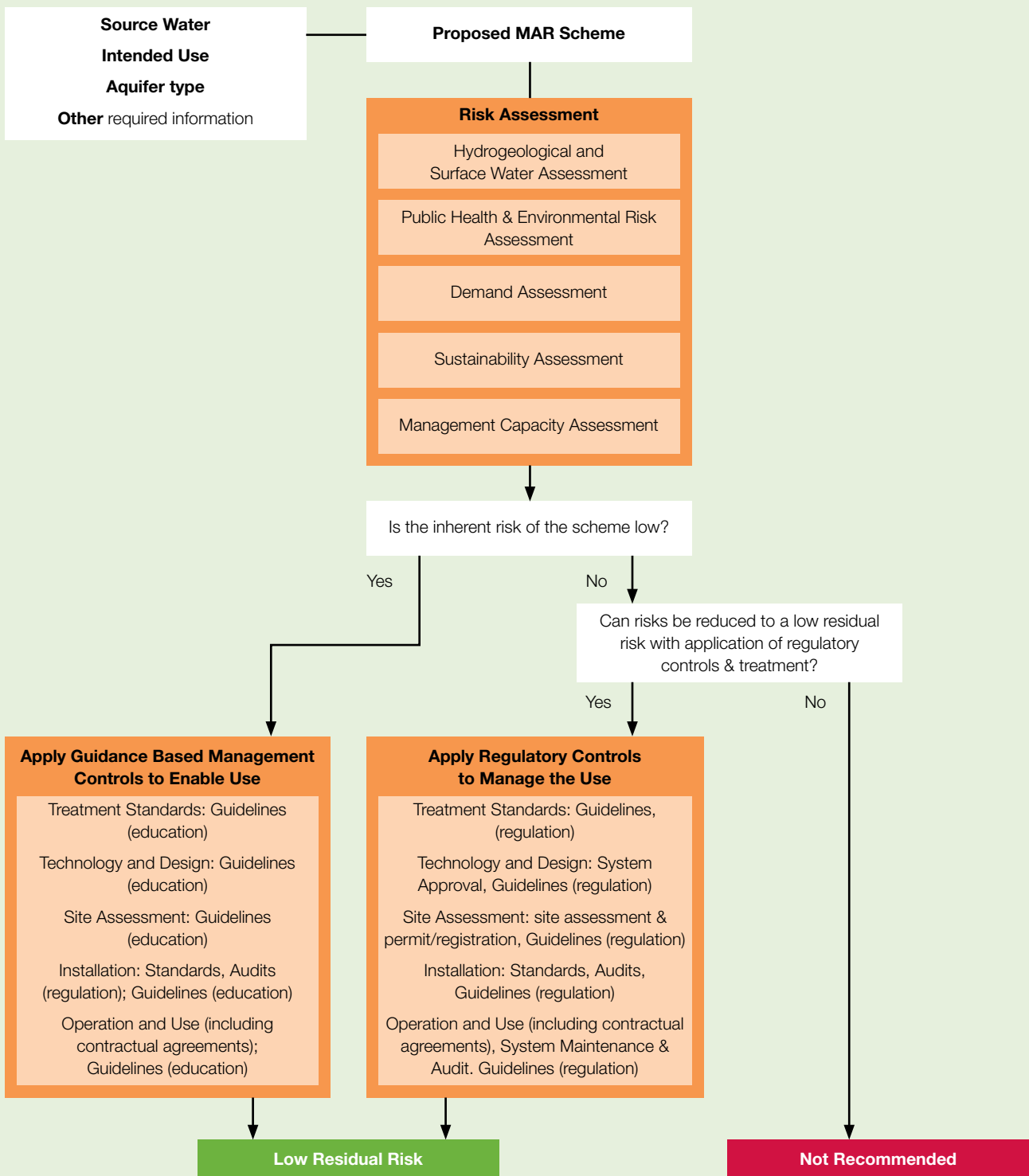
The level of regulatory control required for each MAR scheme will depend on:

- the risks associated with the quality of the recharge water;
- the quality of the extracted water; and
- the aquifer characteristics and its beneficial uses.



12.2 Diagram: Recommended MAR Scheme Assessment Process

The recommended framework for assessing the public health and environmental aspects of MAR schemes is described in the following diagram.



12.3 Explanatory Text: Recommended MAR Scheme Assessment Process

The recommended steps for assessing individual MAR schemes are outlined in the following pages.

12.3.1 Step 1: Undertake Risk Assessment

A risk assessment is recommended for each MAR scheme to ensure that:

- the aquifer and its beneficial uses are protected, and the aquifer is suitable for the proposed scheme;
- there is a demand for extracted water (including obtaining ongoing commitments);
- the scheme is sustainable, using a Triple Bottom Line framework;
- proponents and operators have the capacity to manage the scheme; and
- water extracted is safe for use.

Section 12.4 provides more detail about assessing each component, which is to be commensurate with the overall complexity and level of risk posed by the scheme.

Guidance needs to be developed to provide the methodology to determine human health and environmental standards for MAR schemes. However, the *National Guidelines for Water Recycling: Managing Health and Environmental Risks* provides a model for such guidance.

12.3.2 Step 2: Determine Level of Risk

Where it is determined that the inherent risk of the scheme is low, it is recommended that guidance based management controls be used to enable the scheme and result in a low residual risk.

Where it is determined that the inherent risk of the scheme is not low, a further judgement needs to be made to determine whether a low residual risk can be achieved with the application of regulatory controls. If a low residual risk can be achieved, it is recommended that the scheme comply with regulatory controls described in step 3 below.

Where residual risks cannot be reduced to a low level, it is recommended that the scheme not proceed.

12.3.3 Step 3: Apply Controls

The level of regulatory control of MAR schemes is to be proportionate to the risk involved. The regulatory framework recommended requires MAR scheme proponents to comply with:

- source water and extracted water treatment standards and treatment system design standards;
- site assessment and permit/registration requirements;
- installation standards; and
- system operation and use management plans.

It is recommended that the regulatory framework include and be supported by detailed technical guidance setting out the expectations of the risk assessment process, directions about assessing the risk levels (particularly about how to determine when the inherent risk may be deemed to be low) and details of management control requirements.

The management controls for system operation would include:

- ongoing monitoring ensuring sustainability of the scheme, providing information where necessary to the relevant authority to allow continuation of the scheme;
- (if attenuation within the aquifer is used for treatment purposes) the necessary monitoring and reporting requirements including delineating any part of the aquifer within which attenuation is occurring, and the need for a plan of remedial actions in cases where monitoring indicates attenuation is not as anticipated.

12.4 Risk Assessment Framework

This section outlines the proposed risk assessment for MAR schemes. As in South Australia, the risk assessment would be a requirement of a MAR licence application and take the form of an environmental management plan.

The risk assessment would address the following components:

- hydrogeological and surface water assessment;
- human health and environmental risk assessment;
- demand assessment (including obtaining commitments);
- sustainability assessment using a Triple Bottom Line framework; and
- management capacity assessment.

The risk assessment must not only consider the health and environmental risks associated with the end use, it must also consider the risks of impact on the aquifer. As such the risk assessment must also determine:

- the level of treatment required for source water prior to recharge of the aquifer;
- the level of treatment required for the extracted water prior to distribution for the intended uses; and
- the impact on the aquifer and its beneficial use, particularly where attenuation within an aquifer is considered;

The following section outlines the key elements to be considered under each component of the risk assessment. The level of rigour in assessing each component would vary depending on the MAR scheme and would be commensurate with the overall complexity and the potential risks posed by the scheme.

12.4.1 Hydrogeological and Surface Water Assessment

The key elements to be considered as part of the Hydrogeological and Surface Water Assessment are:

- aquifer physical and chemical characteristics (including beneficial uses);
- available storage capacity of aquifer;
- existing or potential uses of groundwater and hydraulically connected surface waters;

- groundwater level, flow direction, head gradient and quality trends;
- depth to water table (if aquifer is unconfined);
- aquifer recharge and discharge mechanisms;
- source water, volume (and availability), water quality (and variability), level of pre-treatment required;
- proposed method of introducing source water to aquifer;
- biogeochemical compatibility of source water with the aquifer and biogeochemical interactions within the aquifer;
- uncertainty in aquifer properties;
- extent of the 'area of influence' of the MAR scheme (level and quality) potentially based upon fate and transport modelling;
- proposed method of extraction;
- quality of the extracted water (constituents, variability, and proportion of introduced supply source);
- likely timeframe for equilibrium conditions to be achieved;
- impact of increased pressure head on aquitard;
- impacts on existing users, surface water quality and quantity and environmental flows;
- risk of adverse impact on local foundations (heave/subsidence etc.);
- risk of flooding;
- compatibility with the existing water management arrangements and groundwater management plans; and
- if attenuation within an aquifer for treatment purposes is considered, the long-term impact of this on the aquifer and quality of the recovered water.

12.4.2 Human Health and Environmental Risk Assessment

Risk assessment:

- identification of hazards associated with source water, storage, pre-treatment, introduction to the aquifer, the aquifer, geochemical reactions in the aquifer, recovery of water, recovered water, post-recovery treatment, infrastructure (injection/infiltration, extraction, treatment, distribution),
- assessment of risks associated with each hazard; and
- quantification of risks.

Identification of controls:

- identification of controls which need to be in place to reduce risks to acceptable levels; and
- quantification of risks assuming control options adopted (accounting also for the possible failure of the control options adopted).

Operation and maintenance requirements:

- operation, maintenance, monitoring and reporting plan for the proposed scheme to demonstrate regulatory compliance; and
- site security.

12.4.3 Demand Assessment

The key elements to be considered as part of the Demand Assessment are:

- proposed end uses;
- cost compared to other supply sources;
- user preparedness to pay (based upon market research);
- provision of net replenishment of aquifers or environmental flow benefits;
- customer supply agreements, or similar, to demonstrate demand (volume and quality) for the supply of recovered water including likely variability in the demand (daily and seasonally);
- relevant contractual agreements for water use; and
- likelihood of MAR scheme to succeed commercially.

12.4.4 Sustainability Assessment

The key elements to be considered as part of the Sustainability Assessment are:

- impact upon the aquifer and its beneficial uses (including long-term impact on the aquifer if attenuation within an aquifer for treatment purposes is considered);
- impact on existing and potential uses of groundwater, surface water quality and quantity, and environmental flows;
- environmental benefits and costs of using the source water compared to existing management arrangements;
- environmental benefits and costs of supplying the recovered water to end users compared with other supply sources such as reticulated potable water;
- impact on existing water diversions, farm dam approvals, and groundwater management areas;
- continued availability of the supply source;
- likelihood of recharge and recovery continuing in accordance with the original proposal in a sustainable manner;
- greenhouse gas emissions in relation to existing or alternative supplies;
- predicted noise levels;
- contingency measures for potential problems including environmental & public health risks, variability in source water availability and supply of recovered water;
- social impacts on the community and local amenity.

The Department of Sustainability and Environment (2003) *Draft Guidelines for Planning and Reporting of Recycled Water Programs* could provide a useful model for evaluating social impacts on the community and sustainability through Triple Bottom Line (TBL) assessments.

12.4.5 Management Capacity Assessment

The key elements to be considered as part of the Management Capacity Assessment are:

- demonstrated management capacity to ascertain that the scheme proponent has the resources, financial capacity and experience to ensure that the scheme operates sustainably over its full lifecycle;
- assurance on the responsibility for operation and maintenance of the scheme; and
- requirement of legally binding management arrangements, particularly regarding private sector schemes.

12.4.6 Additional Information

Other information required for the risk assessment of MAR schemes would include:

- title details of proponent's property and a map showing the precise location of the scheme;
- rights to access water source for recharge and to extract water from the aquifer;
- arrangements for transfer of entitlements from rechargers to users where appropriate;
- catchment type and uses including landfills, contaminated sites, industrial activities, agricultural activities, sewer design and integrity of sewer infrastructure, density and integrity of septic systems; and
- potential interconnectivity of surface and groundwater systems.

The risk assessment framework for MAR schemes will be further developed in consultation with stakeholders in the next phase of the project, when the technical details are developed for the regulatory framework.

12.5 Questions

Please consider the following questions.

Question 1

Does the assessment process set out in the diagram in Section 12.2 present any potential issues or challenges?

Question 2

In your opinion, what should constitute a MAR scheme with low inherent risk?

Question 3

Do the proposed guidance based management controls for low inherent risk MAR schemes present any potential issues or challenges?

Question 4

Do the proposed regulatory management controls for MAR schemes which are not low inherent risk present any potential issues or challenges?

Question 5

Are there any other management controls which should be applied to MAR Schemes?

12.6 Water Quality Prior to Injection

As mentioned in Section 12.4, the proposed risk assessment framework will ensure consideration of the requirements of a MAR scheme in order to ensure the sustainability of the aquifer and its beneficial uses, and the suitability of the recovered water for the intended uses. This section presents further information in relation to the treatment and standards required for source water prior to recharge, in other states and countries, and provides the opportunity to suggest the requirements that should be in place in Victoria.

Examples of source water types and treatment used:

- South Australia – stormwater with pre-treatment can be used as recharge water;
- Western Australia – secondary and tertiary treated wastewater can be used to recharge aquifers such that the water extracted would not require extra treatment;
- Florida, USA – source water must be treated to drinking water standards (at the well-head) prior to recharge; and
- Arizona, USA – surface water from the Colorado River and treated wastewater effluent can be recharged to an aquifer provided that the water quality meets drinking water standards as measured at a specified distance from the injection well.

Question 6

In your opinion, what should be the standard for water quality prior to injection into a MAR scheme?

13

Victorian Regulatory Framework: A Summary

To aid the introduction of the management framework proposed in Section 11, an analysis of existing regulation and guidance was undertaken to determine where changes need to be made and where new regulation or guidance needs to be created.

A summary of the Regulatory Framework in Victoria is provided below. The Regulatory Frameworks of South Australia, Western Australia, Florida and Arizona (in the USA) were also reviewed to determine the gaps in the existing Victorian regulatory environment and identify best-practice legislation.

The detailed Regulatory Framework review of Victoria, South Australia, Western Australia, and Florida and Arizona (in the USA), is available in the complete *Managed Aquifer Recharge Technical Report* upon which this Discussion Paper is based.

Individuals seeking more detailed information should refer to the *Technical Report* available at www.epa.vic.gov.au.

The existing regulatory framework for MAR schemes in Victoria is described in the following pages.



13.1 Licensing Groundwater Use

Under the *Water Act 1989* rural water authorities have been delegated the responsibility for licensing the taking and use of groundwater in Victoria.

Division 2 of Part 4 of the *Water Act 1989* makes provision for licences to take and use water. Such a licence may be required for the collection of water (and storage of water) prior to its introduction into an aquifer.

A licence will also be required to drill a bore (section 67).

13.2 Groundwater Ownership

Groundwater is defined within the Act to mean “any water occurring in or obtained from an aquifer and includes any matter dissolved or suspended in any such water”. Once introduced into an aquifer, water becomes groundwater as defined by the *Water Act*.

Under the Act, the recharged water is “groundwater” once in the aquifer, with the Crown retaining all its usual rights to that water.

Under the *Water Act 1989*, the Crown owns and controls all water, except where the Act provides individuals with rights over water. As a result, most actions in relation to water require some form of licence or permit.

However, a proponent of MAR is likely to require a degree of certainty in relation to the ability to recover the recharged water that may not currently be provided for in the *Water Act 1989*. The *Water Act 1989* does not allow for priority rights, to either a portion or all of the recharged groundwater, to a proponent that establishes and operates a MAR scheme.

To this end, this Discussion paper will help to inform any associated groundwater allocation processes (see Section 14 – Recommendation 2). Groundwater allocation in relation to MAR schemes would be made pursuant to the *Water Act 1989* as amended from time to time.

13.3 Groundwater Use and Protection

Section 22A of the *Water Act* 1989 provides that the Minister may, by Order, declare the total volume of water, whether surface water, groundwater or both, which may be taken in an area. This is described as the Permissible Consumptive Volume.

Section 27 of the *Water Act* 1989 provides for the Minister to declare an area to be a water supply protection area (WSPA). The area may be declared to be a WSPA for the protection of groundwater resources in an area or the surface water resources in the area, or both.

The *Water Act* 1989 requires the preparation of a management plan for a WSPA to make sure its water resources are managed in an equitable manner and to ensure the long term sustainability of those resources.

13.4 Groundwater Allocation Caps

In many groundwater areas it is not possible to obtain a groundwater allocation as allocations are capped under a water supply protection area groundwater management plan or through the Permissible Consumptive Volume. If it is thought necessary to amend this regime to encourage proponents of MAR schemes, a possibility may be to provide an exemption for recharge schemes or to amend the groundwater management plan.

13.5 Underground Disposal

Section 76 of the *Water Act* 1989 outlines the power of the Minister to approve underground disposal. A person may apply to the Minister for approval to dispose of any matter underground by means of a bore. The Minister may approve the application subject to conditions or refuse to approve the application and specify the reasons for refusal.

If, in the Minister's opinion, the disposal would cause the pollution of groundwater or be detrimental to the aquifer or bore or interfere with the function of the bore as a state observation bore, the Minister must refuse the application.

Any disposal to an aquifer would also need to comply with Clause 20 of the *State environment protection policy (Groundwaters of Victoria)*.

Additionally, Section 3(2) of the *Environment Protection Act* 1970 states that where the provisions of the *Environment Protection Act* are inconsistent with any provisions of any other Act (e.g., the *Water Act* 1989), the *Environment Protection Act* provisions will prevail.

13.6 Consent

It is an offence to do anything without the consent of the relevant Authority that may interfere with a waterway or interfere with any drainage regime.

Rather, the proponent has the same rights as other licence holders and hence must apply for a licence to extract in the same way as others must and may be subject (under some WSPA groundwater management plans) to a reduced annual allocation in drought conditions.

13.7 Discharges to the Environment

The *Environment Protection Act* 1970 (EP Act) provides a legislative framework for the protection of the environment in Victoria.

Under the EP Act discharges to the environment must be managed so that they do not adversely affect the receiving environment (for example, land, surface water or groundwater).

The EP Act allows for the creation of State Environment Protection Policies (SEPPs) and Industrial Waste Management Policies (IWMPs) which in turn may set requirements related to discharge or reuse.

The *SEPP (Groundwaters of Victoria)* is relevant to MAR proposals. In particular, clause 20 of that SEPP deals directly with the direct discharge of waste to an aquifer (see section 13.9 below for more details).

Where groundwater is extracted from an aquifer for use, then the requirements of the *SEPP (Waters of Victoria)*, which provides water quality objectives for surface waters, apply.

13.8 Works Approval and Licensing Requirements

The *Environment Protection (Scheduled Premises and Exemptions) Regulations 1996* outline the premises and activities that are scheduled and therefore require works approval and/or licensing under the *Environment Protection Act 1970*.

The Regulations also provide for exemptions from these works approval and licensing provisions for certain (otherwise scheduled) activities and premises. Included in the list of exemptions is “an effluent reuse scheme or activity” that is undertaken in a manner acceptable to the Authority.

While the use of sewage is captured as a scheduled activity within the regulations, the use of other source waters including rainwater and stormwater is not a scheduled activity.

Depending on the source and quality of the water to be injected, EPA has the capacity to implement other control measures, such as a Pollution Abatement Notice if a MAR scheme did not satisfy the definition of a “scheduled premises”.

If the MAR scheme utilises “sewage effluent” it could be treated as a scheduled premises as per Table A, Clause 1(d) of the *Environment Protection Scheduled Premises and Exemptions Regulations*. This clause states “Premises on or from which sewage (including sullage) effluent, exceeding a design or actual flow rate of 5 000 Litres per day, is discharged or deposited” are classified as being scheduled.

13.9 State Environment Protection Policy (Groundwaters of Victoria)

The *Environment Protection Act 1970* provides for State Environment Protection Policies (SEPPs) that identify beneficial uses to be protected through the setting and attainment of environmental objectives.

Pollution of Groundwater

The goal of the *SEPP (Groundwaters of Victoria)* is to maintain and where necessary improve groundwater quality sufficient to protect existing and potential beneficial uses of groundwater throughout Victoria.

The SEPP requires that all practicable measures be undertaken to prevent pollution of groundwater.

In addition, clause 20 of the SEPP provides that: “There must not be any direct discharge of waste to any aquifer by means of a bore, underground mine workings, infiltration basin, evaporation basin or other similar structures, except for the purpose of –

- (1) Aquifer recharge, irrigation drainage, backfilling of underground mine workings with tailings, or stormwater disposal, where the relevant protection agency is satisfied that the groundwater quality objectives of this policy specified in Table 3 will be met, and there will be no detriment to any beneficial use of groundwater, land or surface water; or
- (2) Groundwater remediation projects involving the injection of uncontaminated water or re-treated water to the aquifer, where the authority is satisfied that –
 - (a) the groundwater quality objectives specified in Table 3 will be met at the completion of the project; and
 - (b) there will be no detriment to any beneficial use of groundwater, land or surface waters beyond the boundaries of the premises on which the project is being conducted.”

Clause 20 does not specifically address the concept of MAR, but does have relevance for any proposed MAR schemes.

Recommendation 6 in Section 14 suggests the amendment of *SEPP (Groundwaters of Victoria)* to include a clause specific to MAR and particularly to address the concept of attenuation for treatment purposes.

13.10 Groundwater Quality Objectives

The most fundamental matter to be considered is whether the groundwater quality objectives specified in the SEPP will be met.

The SEPP identifies water quality and total dissolved solids (TDS) parameters for a range of groundwater “segments”. Segments are determined by reference to the groundwater’s TDS. The higher the TDS, the fewer the beneficial uses. For example, potable water supply is a beneficial use of groundwater with a TDS of less than 1 000 mg/L.

The environmental impacts of a proposed MAR scheme will be closely considered against the SEPP requirements for beneficial uses and associated groundwater quality objectives.

13.11 Attenuation Zones

Clause 17 of the SEPP deals with “attenuation zones”. An attenuation zone is an area where some or all of the water quality objectives set out in Table 3 need not be achieved. Attenuation zones can only be designated for landfills receiving municipal wastes, wastewater irrigation, ash ponds and evaporation basins incorporated in Government approved salinity management plans.

MAR schemes are not covered as the policy currently stands. Currently the policy does not recognise the concept of “attenuation” within an aquifer for treatment purposes as may be expected in some MAR schemes.

13.12 Local Drainage

To the extent that a MAR proposal interacts with local drainage, it will be necessary for the proponent to obtain the consent of and work with the local drainage authority (identified as local councils under the *Water Act 1989*).

13.13 Melbourne and Metropolitan Area

Under the *Melbourne and Metropolitan Board of Works Act 1958* Melbourne Water has waterway management, floodway and drainage management functions as well as water storage responsibilities within the Melbourne metropolitan area.

Under this Act it is necessary for a MAR proponent to obtain the consent of Melbourne Water for any proposal within the Melbourne metropolitan area which may impact upon waterways, floodways, and drainage.

13.14 Developing Aquifer Storage and Recovery Opportunities in Melbourne, Technical Guidance for MAR 2006

The document *Technical Guidance for ASR: Developing Aquifer Storage and Recovery (ASR) Opportunities in Melbourne* (Dillon and Molloy; 2006) was developed under the Smart Water Fund. It provides guidance for projects intended to store water below ground for subsequent reuse for drinking water supplies, irrigation, industrial uses, and ecosystem support.

The Guidelines only apply to aquifer storage and recovery (ASR) and aquifer storage transfer and recovery (ASTR) with drinking water, stormwater, reclaimed water and groundwater. The Guidelines do not address injection or infiltration from water bodies and recovery from trenches and surface bodies.

Despite not having any formal status, this document may provide a significant resource with respect to any new guidance to be developed for MAR.

13.15 White Paper – Our Water Our Future

The Victorian Government’s White Paper *Our Water Our Future* establishes the principle that groundwater abstraction should not interfere with river flow.

Action 5.34 states that “the Government, water authorities and local government will investigate the potential for aquifer storage and recovery for Melbourne.”

14

Managed Aquifer Recharge Recommendations

There is a need to create a regulatory framework to facilitate safe and sustainable use of MAR in water recycling. To achieve this aim, the following changes to existing Victorian legislation and guidelines in relation to the management of environmental and health risk are recommended.

The recommendations are proposed for discussion and have been designed to facilitate use of MAR in water recycling.

- 1) Establish a head of power in legislation to provide for MAR schemes, which:
 - allows for roles and responsibilities to be clearly identified and assigned;
 - ensures certainty for MAR schemes by providing a legal framework protecting the entitlements of the proponents;
 - ensures proposed MAR schemes undergo appropriate assessment/approval (initial and ongoing) and comply with guidance;
 - allows for a single mechanism for initial and ongoing approval in relation to MAR schemes (including construction of works, injection to the aquifer and extraction of recharged water) where possible; and
 - specifies appropriate referral mechanisms for approvals.
- 2) Provide appropriate input to any groundwater allocation review process to ensure adequate consideration of:
 - The nature and extent of entitlements of water injectors and water used for MAR schemes and recoverable volume. This may require:
 - amendments to the Water Act to give priority entitlements to injected water to operators of MAR schemes;
 - provision that existing rights to water can coexist with entitlements to injected water;

- entitlements to be expressed as a percentage of the water injected;
 - clarification of entitlements to recharge and entitlements to recover and use groundwater from MAR schemes; and
 - provision to trade and transfer as appropriate.
- Allocation limits. This may require consideration of the water injected into aquifers for reuse when establishing allocation limits. Possible options for resolution are:
 - amend the Water Act to allow allocation limits to take into account water injected into aquifers;
 - express entitlements as a share; and
 - amend groundwater management plans.
 - Provision of mechanisms to ensure that any approved MAR scheme undertakes recharge and recovery in accordance with the original proposal in a sustainable manner, i.e. schemes do not become waste disposal activities.
 - Provision of a mechanism to account for other related environmental issues, including interaction with surface water systems and groundwater dependent ecosystems.
- 3) Ensure that the existing MAR schemes and/or the potential for future MAR schemes are incorporated when developing or reviewing relevant water management planning processes and documents.
 - 4) Develop guidance for MAR. The guidelines should:
 - specify the need for a feasibility assessment of each MAR scheme proposal;
 - provide a risk assessment framework to deal with the wide variation of risks associated with MAR schemes and provide a level of assessment proportionate to the risks involved; and

- provide a risk assessment framework for MAR schemes addressing:
 - public health and environmental aspects;
 - hydrogeological and surface water assessment;
 - capacity of the applicant to manage the scheme;
 - demand assessment (including obtaining commitments and ongoing demand); and
 - demonstration of sustainability through Triple Bottom Line (TBL) assessments.

Where appropriate, existing non-regulatory guidance and guidance from other jurisdictions should be utilized in developing Victorian guidance for MAR.

The assessment framework should:

- address risks associated with pre-recharge (water sources, storage, treatment etc), recharge (via an injection well, infiltration basin etc.), aquifer (type, impact zone, residence time etc.), recovery, and post-extraction (treatment, distribution, use etc.).
- consider groundwater surface water interaction.
- consider impacts on groundwater dependent ecosystems.
- include auditing and monitoring requirements. The frequency and rigour of monitoring and auditing requirements should be commensurate with the risk.
- advise on contractual arrangements between proponents of MAR schemes and the intended users.
- include standards and performance criteria that are transparent for decision making purposes.

- 5) Resolve appropriate approval authority or authorities.
- 6) Amend SEPP (Groundwaters of Victoria) to include a clause specific to MAR. This should:
 - address the concept of attenuation for treatment purposes and other possible impacts associated with MAR; and
 - require MAR scheme proponents to designate the area of impact of MAR schemes including the area of attenuation where appropriate.
- 7) Allow for research and development within approval mechanisms.
- 8) Develop a mechanism to collect and assess monitoring data from MAR projects to allow assessment of long-term effects.

Question 7

Do the proposed recommendations for MAR present any potential issues or challenges?

Question 8

Are there any other aspects of MAR which you would like considered?



15 All-of-Framework Recommendations

Although this Discussion Paper focuses on MAR, the Regulatory Frameworks for a number of other alternative water sources (rainwater, stormwater, greywater, sewage and industrial water) are also currently being reviewed.

It is possible that an organisation wishes to recharge an aquifer with rainwater, stormwater, greywater, sewage or industrial water. In this situation, it is important that the Regulatory Frameworks for all alternative water sources are integrated and managed effectively.

The following general recommendations are proposed for all water sources.

1. Ensure integration between the Regulatory Frameworks of each alternative water source where possible.
2. Ensure participation in, and where appropriate consistency with, national initiatives.
3. Ensure that the Regulatory Framework provides for the trial and adoption of new and innovative technologies.
4. Develop mechanisms to determine the impact of alternative water source uptake throughout the water cycle, including consideration of relevant management plans at the local, regional and state level.
5. Develop a mechanism to allow for data collection of alternative water source usage to assist with assessment of water cycle impacts.
6. Determine the most appropriate institutional and administrative arrangements given the adoption of the proposed Regulatory Framework.
7. Ensure that the Regulatory Framework takes account of the resourcing capacity and capability of the agencies responsible for administering the framework.
8. Develop a unified system to inform new owners and occupiers (resulting from change of ownership or tenancy) of existing alternative water systems and the maintenance requirements.
9. Develop guidance documents expressing a hierarchy for the best and lowest risk uses of alternative water sources for a range of common scenarios.
10. Establish mechanisms to provide for the assessment of long-term impacts on the environment from alternative water source usage.
11. Develop and implement a communication strategy to promote the guidance and Regulatory Framework for all alternative water sources.

Question 9

Do the proposed all-of-framework recommendations present any potential issues or challenges?

Question 10

Are there any other recommendations which should guide this review?

The following channels are available to provide feedback on Part C – The Proposed Regulatory Framework.

Workshops: During February 2007, workshops will be held with stakeholders to gather feedback on the Discussion Paper. Victorians interested in participating in a workshop should contact **03 9821 4895** to register their interest and to locate the workshop nearest them.

Written Feedback: Victorians can also provide written feedback without attending a workshop. It is important that written feedback clearly identifies which question is being responded to. Written feedback must be submitted by Friday 16 March, 2007 via:

- e-mail: feedback@bcg.com.au; or
- post:
Managed Aquifer Recharge Discussion
Paper Feedback
13/499 St Kilda Road
Melbourne VIC 3004

Should you require further assistance, please contact **03 9821 4895**.

