Australian Water Recycling Centre of Excellence

GOYDER INSTITUTE FOR WATER RESEARCH

MANAGED AQUIFER RECHARGE

Workshop summary

A report prepared by Aither for the Australian Water Recycling Centre of Excellence and the Goyder Institute for Water Research

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Summary

On Thursday 6 March the Australian Water Recycling Centre of Excellence (AWRCOE) and the Goyder Institute for Water Research held a forum on Managed Aquifer Recharge (MAR) research. The aim of the forum was to inform stakeholders of the latest research being undertaken in relation to MAR, and to discuss the adoption of research into policy and practice.

Specifically, the forum involved short briefings from research project leaders along with facilitated workshop sessions in order to:

- establish the status of MAR in Australia
- present the latest research results
- define issues for proponents, regulators and policy makers
- inform future management of MAR
- consider the need for revision of national MAR guidelines
- identify pathways for research adoption
- recognise gaps and opportunities for future investment.

The presentations and workshop sessions were well attended, with close to 40 representatives from research organisations, local government, state government agencies, regulators, utilities, consulting firms and private industry.

Following presentations from research leaders on the current state of MAR research and uptake, four workshop sessions were aimed at answering the following questions:

- What is it that we hope to achieve with MAR?
- Who are MAR users and what are their information or research needs?
- How do current projects meet these needs and what gaps exist?
- How can project outputs or outcomes be better linked to and inform user needs?

These sessions stimulated robust discussion from participants on a range of matters related to current MAR research and level of uptake, and future pathways for the adoption of research into policy and practice. Detailed notes of these discussions are summarised at Appendix A, with the main messages arising from these discussions being:

- Australia has a world leading position in both MAR research and implementation – with a sizeable portion of the published studies in the field originating from Australia as a result of the successful implementation of some significant trials and operational schemes. At different scales and sites, MAR has proven to be technically feasible and economically viable, cost effective, and, importantly, accepted by communities. Many knowledge gaps have been filled by research projects and trials over the last decade.
- Despite these achievements, it is generally accepted that MAR has yet to realise its full potential by way of its contribution to efficient and effective water management – including not having made a substantial contribution to major water supply augmentations, or a substantial

impact at the national level. Research has generally been government led. This may contribute to the evident disconnect between research, commercial or industry opportunities and decision making.

- More work is required to demonstrate the value of research and implementation undertaken so far, and to align completed and potential future research with both policy and commercial opportunities. There is a gap for the relevant group to act as a champion for MAR and custodian of existing MAR research and knowledge, who can also act as a broker between researchers and policy makers and continue to facilitate and improve the involvement of utilities and private industry.
- In addition, there is a strong case for coordinated effort to articulate the full range of costs and benefits of MAR alongside other options. Despite substantial amounts of research being undertaken to date, we are yet to clearly articulate how MAR compares to the range of other future water supply options, including at a national level. This includes bringing government, utilities and the private sector into a conversation about the respective costs and benefits in different locations and scenarios.
- A national business case for MAR could help capture our current knowledge, provide a vehicle for improved dialogue between MAR researchers and end users, and clearly present the respective costs and benefits of MAR alongside other options. Developing this business case presents a significant opportunity to realise a return on investment from research to date, leverage existing knowledge, increase involvement of the utility and private sectors, and realise opportunities for MAR uptake in a range of sectors and markets, including urban, rural and regional, resources, and at an international level.

The remainder of this short report further summarises outcomes from the workshop, including a summary of the current status of MAR research and implementation; participants' overarching views of future outcomes sought for MAR and supporting research; areas for future work that might contribute to realising those outcomes; and suggestions on potential roles for researchers, policy makers, industry and brokers.

Webcast

A webcast was produced from the Adelaide workshop and is available on the AWRCOE website: www.australianwaterrecycling.com.au . It comprises eight presentations by MAR research managers on the following subjects:

- Policy, viability and opportunities for aquifer recharge schemes
- Managed aquifer recharge and stormwater use options
- Bolivar recycled water aquifer storage and recovery project
- Governance issues for MAR in South Australia
- Adelaide Plains groundwater study
- Recycled water for heavy industry and preventing seawater intrusion
- Perth Ground Water Replenishment Trial
- MAR communication products and networks

1 MAR research and implementation

There has been significant progress in the development and implementation of Managed Aquifer Recharge (MAR) schemes in Australia over the past 10 to 15 years. This has been both supported and enabled by a substantial body of research investment and output.

While MAR has existed in Australia in some form for much longer than this (some examples date from the 1960's), the unprecedented drought conditions of the early 2000's and associated commitments by governments to water reform have driven increased levels of interest in MAR from a range of stakeholders.

Interest in the potential of MAR as a viable water supply option is reflected in the increasing number of trials or active schemes now in operation, and research output that has answered many questions in relation to its feasibility.

The application of MAR has expanded from early beginnings in agriculture, to stormwater, mining and resources, and recycled water – with increasing diversity in end uses, including potable end use in some locations. In 2008, MAR contributed 45 Gigalitres (GL) to irrigation supplies and 7 GL to urban water supplies. In that year, five states and territories had operational MAR projects and two states had investigations underway. More specifically:

- In South Australia (SA), investment in stormwater aquifer storage and recovery (ASR) has been substantial, with an estimated 30 individual stormwater MAR schemes now in existence processing approximately 8 GL of water (with up to 23 GL capacity). Trials have also demonstrated the feasibility of using aquifer storage transfer and recovery (ASTR) for drinking water purposes.
- In Western Australia (WA), a significant recycled water MAR trial has been proceeding at the Beenyup Water Recycling Plant, which injects water into the Leederville aquifer. The government has approved the trial for full scale production by 2016 with around 7 GL of water to be processed, and which will ultimately involve potable use.
- In Victoria (Vic), City West Water has completed pre-feasibility studies into broadscale MAR and has further investigations due for completion in 2015.
- Pre-feasibility studies have been completed in Penrith and Blacktown (New South Wales (NSW)), Gawler (SA), Broadmeadows (Vic), Orange (NSW), Brisbane (Qld), Mackay (Qld), several locations in suburbs west of Melbourne (Vic), and the Murray drainage area (WA).
- The mining sector is increasingly using MAR to reinject brackish or saline water from dewatering processes as a means of better managing this water and providing for future supply.

Investment into MAR research has intensified in recent years, with Australian researchers and projects suggested as being world leaders in the field and producing a large proportion of research output on the topic. For example:

- The National Water Commission has invested over $1.6 million to develop MAR guidelines, feasibility studies, case studies, policies and toolkits.
- The Goyder Institute for Water Research has invested over $2 million in the Managed Aquifer Recharge and Stormwater Use Options (MARSUO) project, with an additional $4.8 million from

the National Water Commission, CSIRO and Water Research Australia to support this research. Additional investment of approximately $8.3 million in related research areas such as investigating the capacity of the Adelaide Plains groundwater system, water sensitive urban design and optimisation of water source mixes at a city scale, as well as the ownership of different water sources.

- The Australian Water Recycling Centre of Excellence (AWRCOE) and industry partners have invested $3million to expand MAR into other regions and to use with recycled water for heavy industry near Perth.

Research has now answered many important questions related to technical feasibility, as well as some of the social and economic considerations of MAR. For example:

- There is now a strong understanding of both the pre-requisites for, and technical feasibility of different types of MAR schemes for a range of water sources, aquifer types, and end uses.
- Investment in trials and associated research has fundamentally proven the concept.
- There is now a high degree of confidence around the health and environmental implications of MAR schemes.
- Water quality changes are now known and validation has been completed for a number of different source waters and treatment types.
- Progress has been made on improving economic and other assessment techniques for MAR schemes, as well as in relation to community attitudes and consultation processes.
- A wide range of documentation and publications now exist that provide a sound evidence base and understanding of MAR, for a range of audiences.
- Various tools and products have been produced to assist decision makers and others – including the establishment of national guidelines, risk assessment tools and evaluation tools.
- There is strong community support for MAR schemes where certain standards of community consultation and engagement have been achieved.

While there have been significant developments and achievements in both implementation and research, researchers, policy makers and practitioners have expressed the view that MAR has not yet reached its full potential.

This view was confirmed by participants at the workshop, who suggested that MAR uptake has been fragmented, and is either perceived as or may actually represent a 'cottage industry'. Some suggested that MAR has in some cases been crowded out by inferior or higher-cost options. These perceptions or realities may be informed or driven by a range of factors, including changing drivers or potential barriers to adoption. For example, participants in the workshop suggested that:

- MAR has generally not been demand driven; past drivers have included drought, local government innovation, and flood mitigation, but these drivers have changed more recently.
- Poorly structured regulatory arrangements are creating perverse incentives in some cases – including subjecting highly similar techniques to different regulatory arrangements.
- There are inconsistencies in guidelines or standards between jurisdictions.

- Property rights and pricing matters remain unresolved in many jurisdictions.
- There is a lack of transparency around costs and benefits in comparisons of MAR with other supply sources or management solutions.
- Inconsistent approaches have been taken to project evaluation and risk assessments that have reduced the chances of adoption.

While it was not the purpose of the workshop to assess the extent to which these or other barriers may be withholding MAR from achieving its potential, their discussion in the context of MAR research revealed potential opportunities for future work and raised the possibility of improvements at the interface between research and policy or decision makers in government or industry.

2 Future outcomes sought for MAR

The gap between MAR's potential and its actual realisation highlights the need to (re)consider what stakeholders would like MAR to achieve, including what future outcomes are sought in terms of implementation or research. The substantial investments and achievements to date reinforce the need for this consideration.

The workshop sessions revealed that participants firmly believe in both the feasibility and viability of MAR. In broad terms, it appears that researchers, practitioners and policy makers believe MAR can (and maybe should) play a substantial role in the future, especially if the full range of benefits it can provide are more widely understood and accepted.

In terms of MAR implementation, participants generally wanted to ensure that MAR is assessed accurately and consistently, and is able to compete on equal terms with other supply options; reflecting a view that in the past, MAR has often not been assessed in this way. Participants generally did not believe MAR should be promoted for its own sake. For example, it was suggested that in the future, MAR should:

- be widely accepted as an alternative water supply option – including in urban, regional, rural, and industry applications, for a variety of sources and MAR techniques
- be promoted or marketed for equal consideration with other options, rather than in its own right
- be compared on equal terms with other options – including having its full range of benefits understood, quantified and accepted
- have more active demonstrations that show the range of different types and scales of implementation options that are possible
- have greater industry support and involvement – including more participation by the private sector and commercial operators.

In terms of MAR research, participants acknowledged that many key technical questions have been answered, and that in the future, research may need to take on a different focus. It was suggested that the outcomes of past research need to be embedded into future decision making to ensure its value is realised. For example, it was suggested that in the future, research should:

- be well planned and targeted at remaining critical gaps or opportunities
- be based on funding mechanisms that enable more collaborative and user-driven research
- include social science and policy coordination elements, and better link traditional science research with policy and decision makers in government and industry.

A range of areas for potential future research were also identified by participants, these are outlined in the following section.

3 Realising outcomes – areas for future work

To achieve the desired outcomes noted above, further work could be undertaken. However, as was acknowledged by participants in the workshop, investment in MAR research is likely to have peaked, and given the current fiscal constraints of most governments, additional commitments may not be forthcoming in the near future.

Despite this, future opportunities may be presented by industry, utilities and current scheme operators as they seek to optimise the supply and delivery of water (thereby containing costs and price increases),. In addition, it is likely that opportunities will be presented as the private sector looks to gain greater participation in the water industry.

The workshop sessions suggested that areas for future work are related to:

- consolidating outcomes of recent research investments and embedding this into private and public decision making processes, as well as addressing remaining institutional or policy matters
- undertaking future research in targeted areas aimed at addressing remaining knowledge gaps in, and barriers or constraints to, wider adoption of MAR.

To leverage the existing body of work and ensure value is generated from it, as well as any future work, the outcomes of the workshop sessions suggest we need to:

- Continue efforts to connect research with policy and practice, to ensure users or beneficiaries are aware of the research and able to easily draw on it.
- Embed the outcomes of past research into considerations of decision makers, such as in integrated water supply and urban land use planning frameworks.
- Ensure there is custodianship of the body of research and 'corporate knowledge' generated through MAR research projects or trials.
- Implement institutional arrangements that support greater private sector involvement (e.g. 3rd party access, legislation or regulations to support ownership or competition).
- Harmonise or ensure more consistent regulation – including between different types of regulation and across jurisdictions.
- Develop integrated water plans across a range of sources of supply that include optimisation between sources.
- Resolve any skills, training and capacity issues associated with MAR implementation or ongoing operation.

To address remaining knowledge gaps, barriers or constraints, the outcomes of the discussions suggest we need to:

- Develop consistent approaches to assessments for MAR schemes – including standardised approaches to valuation and risk assessment.
- Improve understanding of the economics associated with MAR – including externalities and methods to ensure MAR projects can be assessed consistently and accurately compared to other options.

- Improve understanding of social drivers, impacts and interactions – including improved engagement frameworks, and education of customers and communities.
- Improve understanding and quantification of non-monetary benefits – including positive externalities, and the economics associated with MAR more generally; such as externalities and methods to assess MAR projects consistently and accurately against other options.
- Develop roadmaps for regulatory frameworks, such as flow charts of regulations for each state and for each water source.
- Improve understanding of where MAR is possible versus demand location.
- Better understand large-scale versus localised or decentralised approaches.
- Clarify property rights, pricing and entitlement issues in certain jurisdictions – including those associated with recovery and transfer.
- Understand the broader impacts of MAR schemes on larger aquifers and interaction between different MAR schemes.
- Undertake validation for pathogen, bacteria and nitrogen removal; develop improved validation protocols; and reduce the time and cost associated with validation.
- Determine accurate life-cycle costs – including ongoing operations and maintenance.
- Develop case study compendiums.
- Better understand natural (aquifer) treatment performance and benefits, and improve understanding of clogging in MAR schemes.

4 Who does what?

The various areas of future work noted in the section above suggest an ongoing role for researchers, policy and decision makers, industry (private or public, utilities and others), and importantly research brokers. In an increasingly constrained fiscal environment, all stakeholders will need to ensure their efforts are increasingly targeted in order to achieve desired outcomes.

For researchers there are some important areas of work still to be undertaken, but this work will need to strategically target remaining gaps. It is also important that researchers continue to improve lines of communication with end users – especially policy and decision makers in both government and industry – to improve understanding and awareness of research outcomes and increase the chances of adoption. In summary researchers need to:

- be conscious of users demands or needs – including understanding their strategic direction and key drivers
- continue improving knowledge adoption activities and embed these into research projects
- continue improving communication such that research is readily understood by intended users.

In a similar way to researchers needing to understand the drivers and information demands of actual or potential users of MAR, policy and decision makers need to improve communication of their needs to the research community. This includes clarifying exactly what the key questions or knowledge gaps are that need to be addressed. Policy and decision makers need to:

- help researchers understand the policy environment and strategic direction of agencies or governments, and how this informs the work required
- improve engagement with the research community and work to clarify what information they require.

To support the further development and uptake of MAR, policy and decision makers also have a role in:

- addressing policy, institutional and regulatory constraints that may be inhibiting uptake of MAR; such as those listed in Section 3 above
- undertake work to formally embed the substantial body of research and other corporate knowledge related to MAR in decision making frameworks so that MAR is readily considered when developing future supply augmentation or water management options
- consider supporting the business case for wider adoption of MAR and work to better understand how to optimise different sources of supply including MAR.

There is an important, and currently under realised, role for the utility and private sector in linking MAR research and policy to practice. At the same time, tight government fiscal conditions mean there is opportunity and interest in enabling greater private sector involvement across the economy, including in water issues. This presents opportunities for innovation, research and development, and implementation to occur outside traditional government funding models.

However, further work is required to realise these opportunities. For example:

- Industry needs to play an increased role in identifying and developing opportunities, understanding demand, and working with policy makers, regulators and researchers to help realise opportunities.
- The private sector can contribute financial backing, and work with proponents and investors to identify opportunities for investing in or managing new or existing MAR schemes.
- Industry could highlight the constraints it faces in bringing capital investment to MAR (or reflect on lessons learnt from private investments already made), and assist policy makers, regulators and researchers understand and subsequently deal with these constraints.
- Industry could undertake greater investment in research and development associated with MAR to ensure research efforts are specific and demand driven, and assist the research community and policy makers deal with intellectual property issues that might support greater investment.
- Industry could explore optimisation options and opportunities for cost savings or improvements in service levels using MAR.

The above points, and the broader outcomes of the workshop suggest there is an important and ongoing role for research and knowledge brokers. This is especially important given the challenges identified in the workshop centred on connecting research with both public and private policy and decision making. Looking to the future, research brokers could:

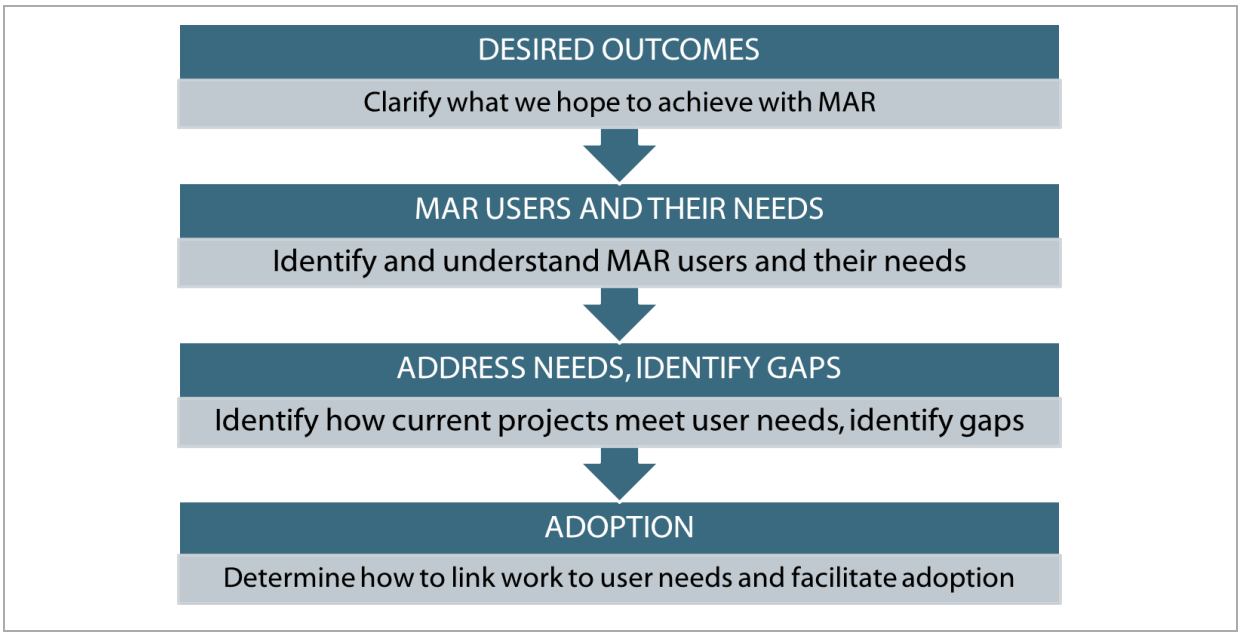
- continue brokering; particularly in terms of understanding the needs (demands) of users, and ensuring the research effort is focused on those needs
- continue to improve engagement and knowledge adoption activities, and facilitating dialogue between actual or potential end users and the research community
- aggregate and communicate research outcomes to non- research audiences and users; particularly in ensuring primary research is understood and drawn on by users
- drive improved connections between the research community and private industry – including to help facilitate private investment in MAR research and development
- lead the development of the national business case for MAR
- consider their role in acting as the custodian of existing MAR research outcomes and outputs, and helping to ensure this is reflected in future decision making.

5 Appendix A – Workshop session results

5.1 Overview

The overall approach to the workshop practical sessions was outlined to participants (Figure 1 below). The overview from the panel session set the scene before the workshop sessions, which included: working towards a vision and objectives for MAR in the context of current status; explicitly defining MAR users and their needs; identifying how current projects and research are meeting these needs and any gaps; and confirming how to ensure existing or future work is linked to user needs and adopted. The following sections summarise the results of the four activities undertaken on the day.

Figure 1. Workshop sessions overview



Source: Aither

5.2 Desired outcomes and vision for MAR

5.2.1 Overview

The aim and purpose of this session was to:

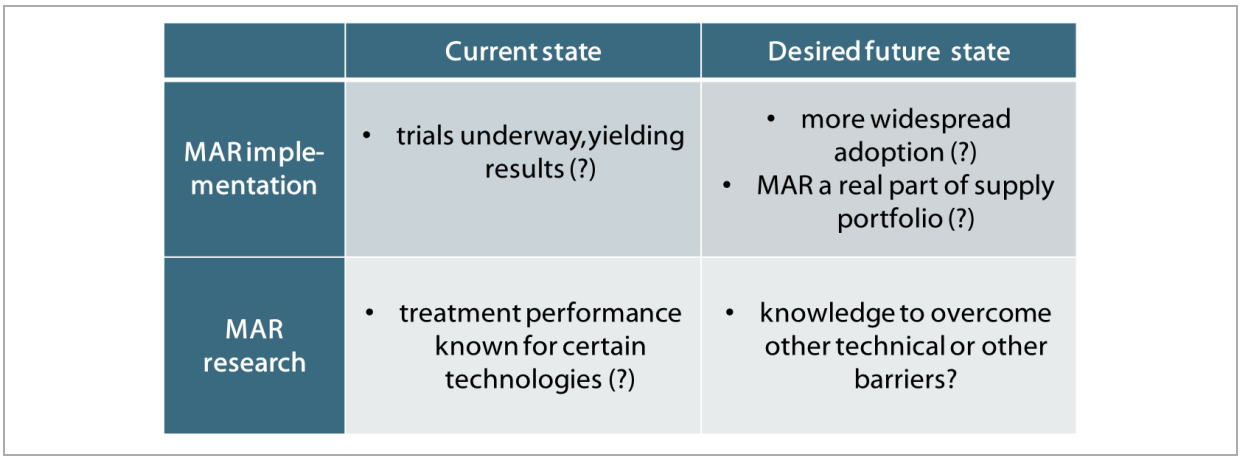
- determine what success looks like in the context of where we are now
- workshop desired outcomes for MAR and MAR research, leading to a vision statement.

Activities for the session were as follows:

- A small group discussion was undertaken with groups reporting back.
- Groups were asked to populate a four-box matrix on MAR implementation and MAR research against current circumstances and desired future outcomes (see Figure 2 over page).

A vision statement activity was canvassed but time limitations prevented this from proceeding.

Figure 2. Example of current and future state of MAR implementation or research



Source: Aither

5.2.2 Results

A summary of the responses of the four groups is provided in Table 1 and 2 below and over page.

Table 1. MAR implementation: current and future state

Current state	Desired future state
• Fragmented uptake nationally • Utility supply cost arrangements not transparent • Cottage industry (perception and/or reality) • Short operational history – some uncertainty and doubt • Inconsistent guidelines or standards • Poorly structured regulatory arrangements – out of step with research • Lack of marketing based on end users • Stormwater ASR dominant, recycled uptake lower • Training for operators – opportunities are available • Trials happening – long enough for assessments of efficiency and effectiveness to be undertaken • Returning value – capacity could be expanded • Optimisation now possible – how equipment performs • Strong community support, but risk of loss of market as industries adjust (e.g.	• Level playing field, mainstream accepted alternative water supply option • Variety of sources and MAR techniques • Recognition of all benefits of MAR –triple bottom line, enviromental, economic and social • Equal comparisons, including standardised assessment & approach • Considered in rural and regional as viable option • Skills & capacity issues addressed • More demonstrations – including type and scale of uses showing benefits • Supported by industry • Property rights clear and resolved • Increased 3rd party operators providing fit for purpose schemes • Streamlined regulations • Better commercial involvement, incentives, opportunities – from take & pay to commercial environment (improved contracts, different operating arrangements) • Enablers of this, e.g. WIC Act(s) – 3rd party access & commercial viability from source to end use • Training improved, MAR study unit implemented in

Current state	Desired future state
Holden) • Current drivers: drought, local government innovation, flood mitigation (not demand driven)	water industry certificate • Terminology and communications improved – marketing of MAR • Better understanding of externalities • No marketing for inappropriate use, but marketing for equal consideration (prudent, meets needs) • Vested interests don't influence outcomes • Transparency in pricing

Table 2. MAR research: current and future state

Current state	Desired future state
• Opportunistic • Providing confidence for regulators and community • Water quality changes known • Guidelines in place • Net benefits technique available for economic assessment • World leading, leading publications, internationally regarded • Dominated by well injection techniques • Technology, documentation, publications • Strong science base for validation and understanding MAR	• Planned • Education and engagement of customers • Impacts of variations understood • Understanding of aquifer treatment performance or benefits (below ground) • Decision support systems – help to step through assessment of viability • Proof/validation for pathogens, bacteria, and nitrogen • Externalities quantified • People considering water supply operate in a consistent framework – economic, social, environmental costs • Consistent or harmonised regulations (current regulations across human health and environment a barrier, economic regulations counter to benefits on health/environment) • Validation technology particularly for potable end uses is improved, need to lower costs • Risk assessment inconsistencies (delivery versus other risks, project assessment inconsistencies) • Greater coordination and collaboration in financially constrained environment • Funding mechanism to enable more collaborative research that is user driven • Improved understanding of clogging (primary technical impediment for ASR) • Science better linked to/informing policy • Greater role for social science, policy coordination • Mapping

5.3 MAR research users and their needs

5.3.1 Overview

The aim and purpose of the session was to:

- identify and understand MAR user groups and their needs from MAR research.

The activity for the session involved:

- a broad group discussion to identify users (e.g. policy makers, regulators, industry etc.)
- outlining some of the decisions they are taking around water
- considering the information they require to inform those decisions (see Figure 3 below).

Figure 3. Example of MAR users and their needs

	e.g. Utility	e.g. Regulator
Decision making	• Supply augmentation • Options assessment	• Safety, economic efficiency, environmental impacts
Information needs	• Evidence option is superior (lower cost, better performance), political and community acceptance	• Evidence risks mitigated, economically viable, environmentally sound

Source: Aither

5.3.2 Results

Users identified

A range of actual or potential users of MAR or MAR research were identified, which included:

- health, environmental or economic regulators
- state government agencies
- financiers
- utilities
- private sector
- local councils
- politicians, ministers, governments
- urban and land use planners
- communities
- customers – residents, commercial/industrial, primary producers, resources/mining
- research community.

Groupings and information needs

To aid in the process of understanding decision making and information needs, users were grouped into the following themes:

- policy and regulator decision makers
- owners
- customers.

The decision making and information needs of these groups is summarised in Table 3 below.

Table 3. Decision making and information needs

Policy & regulator	Owners	Customers
• Validation of natural treatment • Contexts for individual schemes (skills & tools to understand impacts of individual schemes, impacts of number of schemes on broader aquifer) • Longer term decisions – cumulative impact & benefit • Policy and research need to update one another, requirements better articulated • Need for multi-disciplinary input & coordination • Sustainability of ownership • Last resort service provider problem – issue for private investment • Confusion around regulators, non-drinking water approvals framework • Quantifying and understanding externalities (communicating also)	• Different valuation approaches – CBA, TBL, etc. • Understanding of costs • Demand for product • Skillsets • Advice • Roadmap for regulatory framework • Independent advice for utilities • Lifecycle costs – long term operations and maintenance • Realistic risk analysis and risk mitigation – due to low number of existing schemes	• Talking to/selling the benefits – e.g. drought, parks and gardens • Confidence in security of supply from MAR • Understanding how much it costs • Demonstrating that it works • Understanding non-monetary benefits • Understanding changes in value associated with schemes • Engagement frameworks – agreed approaches to consultation • Life cycle costs (where customer/owner the same) • Customers need cost transparency

5.4 Linking MAR research and user needs

5.4.1 Overview

The aim and purpose of this session was to:

- identify research and other knowledge or products that are helping meet user needs
- identify where gaps exist.

The activity for this session involved a small group session that was scribed and reported back to the main group. It included discussions about:

- how current projects or outputs meet user needs
- what gaps exist.

Figure 4. Example of linking MAR research with user needs

Policy maker		Regulator		Etc.
What needs are being met and how	*What gaps exist*	*What needs are being met and how*	*What gaps exist*	
• Project A provides info. B to inform need 3	No knowledge or information on need 1,2	Etc.	..	.

Source: Aither

5.4.2 Results

Results from the activity are summarised by user group in Tables 4, 5 and 6 below and over page.

Table 4. Policy and decision makers

Needs being met	Gaps
• Evidence base • Health and environment understanding, confidence provided (e.g. EPHC, NHMRC, NRMMC • Community attitudes ok, but maybe not for new sources • Some externalities understood • Entitlement policy framework (partly addressed) • Process understanding • Guidelines • Technical aspects for current schemes	• Validation of natural treatment (microbiological, geochemical, emerging contaminants) • Measurement techniques (e.g. infectivity measures) • Regulation could be done more economically and efficiently • WSUD – potential inconsistent or inappropriate disposal of SW • Grey areas in regulation around WSUD of other new policies • Externalities • Demonstrating community acceptance to ministers etc • Flow chart of regulations for each state, for each water source (WA non-drinking water flowchart examples) • Risk assessment • Knowledge for guidelines update • Revised climate predictions • Science communication knowledge transfer • Sustainability of ownership & last resort service provider issue

Needs being met	Gaps
• Climate predictions	• Clarity around lead regulator • Access to latest peer reviewed science • Appreciation of regulators drivers/perspective

Table 5. Owners

Needs being met	Gaps
• Technical feasibility, aspects related to current schemes • Baseline operational economics, economic evaluation • Operation understanding (in some areas) • Limestone aquifers and stormwater ASR – knowledge of costs ok, technical knowledge also ok • Wherever trials have been undertaken – simplified, knowledge available to others • Guidelines	• Technical feasibility for some schemes or source waters, emerging techniques and/or end uses • Continuous monitoring • Scenarios, better understanding of demand • Understanding of new markets • Sensitivity to scenarios e.g. climate change, levels of development, pricing • Operation (maintenance economics and life cycle costs (short operating history) • Wherever the market is young and emerging • Capability and skills gaps in some locations • New aquifer types and sources – pre feasibility needs • Cheat sheet for pre-feasibility check • Risk analysis lookup • Roadmap to navigate regulatory system • Commercial opportunities • Costs and benefits, and methods for assessment • Tools for assessing option, benefits, return on investment • Case study compendium • Scalable application to maximise value

Table 6. Customers

Needs being met	Gaps
• Community information, in some areas • Public awareness & engagement • (Driver) groundwater resource assessment/ availability	• Terminology • Knowledge of benefits & suitability • MAR with CSG, reinjection • Limitations and opportunities in rural and regional communities – irrigation agricultural users • Confidence in security of supply • Public engagement especially new applications • Price security • Frameworks/toolbox • Cost/quality and reliability issues • Benefits of schemes • Risk minimisation • Responsibilities (if any)

5.5 Adoption pathways and future directions

5.5.1 Overview

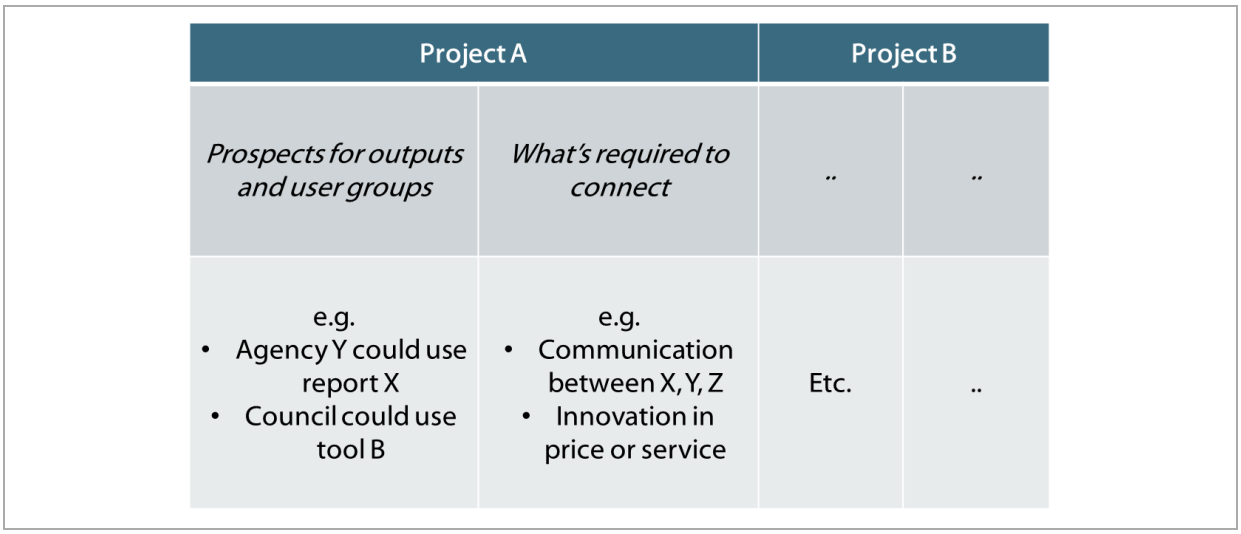
The aim and purpose of the session was to:

- identify what is required to ensure research, knowledge and tools are linked with and respond to user needs
- identify any other constraints or issues to address in the context of adoption

The activity involved small groups based on one (or two) MAR projects per group, with discussion and reporting back on the following topics:

- Specific prospects for project in terms of outputs and user groups.
- Examples of success if adoption has occurred.
- What's required to connect project with users.

Figure 5. Example of adoption exercise



Source: Aither

5.5.2 Results

Three groups chose to analyse the MARSUO project and one group considered Australian Groundwater Technologies. These are both summarised in Table 7 below and dot point summary over page.

Table 7. MARSUO

Prospects	What's required to connect
• Technical – risk assessment & management • Cost-benefit analysis • Knowledge gaps addressed • Increased end-use options for stormwater • Proof of concept for potable • Academic publications • Goyder reports • Risk management plan • Get information into policy & regulatory agencies (better mechanisms, more time)	• Key messages at different levels (condensed technical reports, layman's versions • Web-based communication • Policy change (potable use) • Natural treatment understanding • Steering committee representation (correct) • Summary documentation, different reports for different groups • Relationship development • Communication, education • Maintain corporate knowledge • Embed in state planning framework documents • Enduring policy document or framework • Planning regulations • Champions to inform partners, people not on SC • Communities of practice • Industry awareness • Briefings (eg AWA), or roundtables with policy advisors, boards, local government • MAR Hub – strengthen industry support & connections

Prospects	What's required to connect
	• Building into training • Establish and monitor capability • Written support (from for e.g. AWA, SIA, IAH, LG, NHMRC) • Water safety experts panel • Engagement with groups that can take it up

Australian Groundwater Technologies

- cost/cost model, cost and pricing (Council recycle scheme)
- customer connected
- extension of knowledge service – especially rural and regional and private sector role
- private applied science model
- understanding how we recognise private IP and disseminate this
- P/E / consultant – extension service – MAR hubs?
- CRC/WRA model of industry 'buy in' to research
- understanding how we link private industry.

Citation:

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For information on this report:

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Goyder Institute for Water Research

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5.5.3 Participant List

Name	Position	Organisation
Andrew Wilkins	Senior Engineer	SA Water
Anthony Knapton	Senior Groundwater Modeller	NT Government / CloudGMS Pty Ltd
Ashok Sharma	Principal Reserach Engineer	CSIRO Land and Water
Brenton Curtis	Strategic Asset Manager	Unley City Council
Bruce Naumann	Manager	Salisbury Water
Damien Moloney	Contract Consultant	Goyder Institute for Water Research
Danni Haworth		Australian Groundwater Technologies
David Cunliffe	Principal Water Quality Adviser	SA Health
David Pezzaniti	Research Engineer	University of South Australia
Declan Page	Team Leader, Water Recycling	CSIRO Land and Water
Don Alcock	Knowledge Adoption Manager	AWRCOE
Don McFarlane	Research Scientist	CSIRO - Flagship Coordinator – WA
Greg Claydon	Exec. Director, Science and Planning	Department of Water, WA
Jim Cox	Principal Scientist	SARDI
Joanne Vanderzalm	Research Scientist	CSIRO Land and Water
John Radcliffe	Chair, Research Advisory Committee	AWRCOE
Julia Grant	Executive Director, Water and Climate Change Branch	Department of Environment, Water and Natural Resources
Karen Rouse	Urban Water Theme Leader	CSIRO Land and Water
Mark O'Donohue	CEO	AWRCOE
Matthew Sanderson	Asset/Project Engineer Officer	Unley City Council
Melinda Burton	Manager Urban Water Planning	Department of Water (WA)
Michele Akeroyd	CEO	Goyder Institute for Water Research
Mike Donn	Research Projects Officer	CSIRO
Neil Power	Director, State Research Coordination Goyder Institute	Department of Environment, Water & Natural Resources
Paul Smith	Urban Water Manager	National Water Commission
Peter Dillon	Leader, Sustainable Water Systems	CSIRO Land and Water
Rino Trolio	Branch Manager Wastewater	Water Corporation
Robert Virtue	Principal Hydrogeologist	GHD Pty Ltd
Rudi Regel	Recycled Water Specialist	SA Water
Russell Martin	General Manager	Australian Groundwater Technologies
Ryan Gormly	Consultant	Aither
Saeed Torkzaban	Senior Research Scientist	CSIRO Land and Water
Stephen Parsons	Senior Hydrogeologist	SKM
Steve Spencer	Business Development Manager, Urban Water Theme	CSIRO Land and Water
Sue Keay	Program Manager R&D	AWRCOE
Tavis Kleinig	Senior Hydrogeologist	EPA (SA)
Will Fargher	Director	Aither