Retrospective on 10 years of risk-based guidelines for managed aquifer recharge

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HydSoc SA lunchtime webinar, Adelaide, 28 May 2020 –

Contents

- Australian MAR Guidelines 2009
- Australian Experience and Research
- Suggested updates for Australian Guidelines

For more information see open access journal paper (Feb 2020):

Dillon, P., Page, D., Vanderzalm, J., Toze, S., Simmons, C., Hose, G., Martin, R., Johnston, K., Higginson, S., and Morris, R., (2020). Lessons from 10 years experience with Australia's risk-based guidelines for managed aquifer recharge. MDPI J Water Special Issue "Managed Aquifer Recharge for Water Resilience" Water **2020**, 12, 537. https://www.mdpi.com/2073-4441/12/2/537

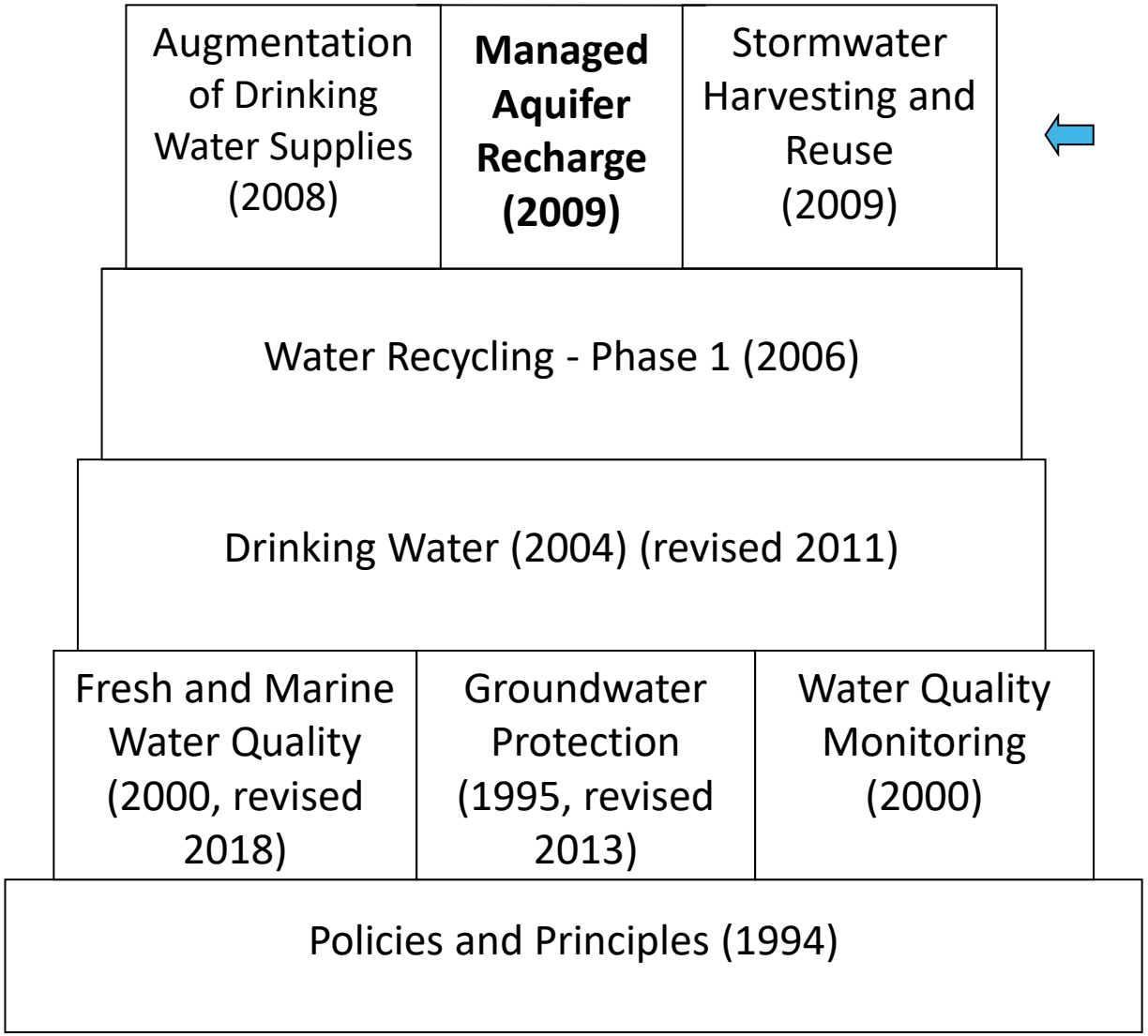
MAR policy matrix

Management Issue: / Resource:	**Quantity** Water and Storage Entitlements and Allocation *(Waterlines #38, 2011)*	**Quality** Human Health and Environment Protection *(**MAR guidelines**, NWQMS #24, 2009)*
Surface water	• Environmental flow requirements • Water allocation plans and surface water entitlements • Inter-jurisdictional agreements	• Catchment pollution control plan • Water quality requirements for intended uses • Risk management plan for water quality
Groundwater	• Groundwater plan & entitlements allocated • Groundwater-dependent ecosystems • Demand management • Capacity and entitlement for additional storage in the aquifer • Transfer of entitlements from MAR operations • Inter-jurisdictional agreements	• Groundwater quality protection plan for recharged aquifer • Water quality requirements for intended uses of groundwater • Risk management plan for water quality assurance beyond attenuation zone

Australian MAR Guidelines (2009)

- Based on established **WHO** and NWQMS **risk management** approach
- Addresses **all** recharge methods, types of source waters, aquifers and end uses
- Accounts for **biogeochemical reactions** within the soil and aquifer
- Allows for an **attenuation zone** for demonstrably sustainable passive treatment within the subsurface
- Requires **staged development** of new projects and monitoring to demonstrate that risk management is effective
- Is focused on water quality for health and environmental protection, but requires that firstly viability is demonstrated – availability of source water and entitlement to access it, capacity to store and recover water without adversely impacting on existing groundwater users and groundwater dependent ecosystems
- Gives advice on clogging and recovery efficiency

National Water Quality Management Strategy



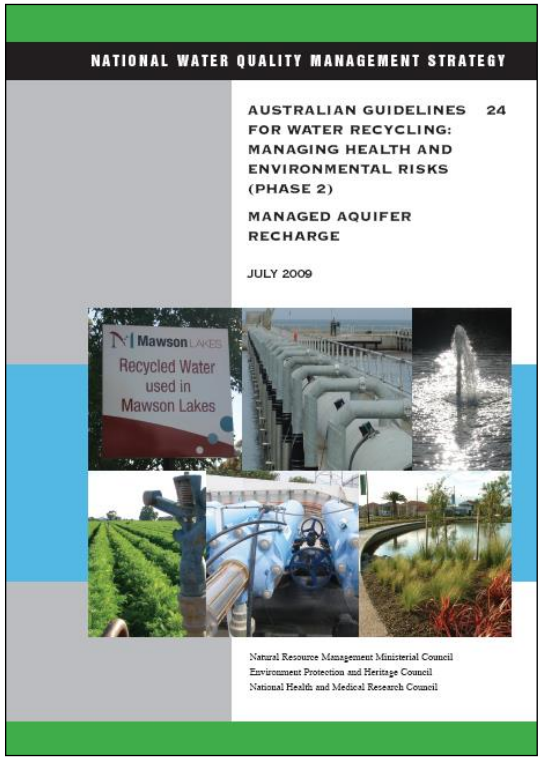
Water Recycling Phase 2

Australian Government
National Water Commission

National Research FLAGSHIPS
CSIRO

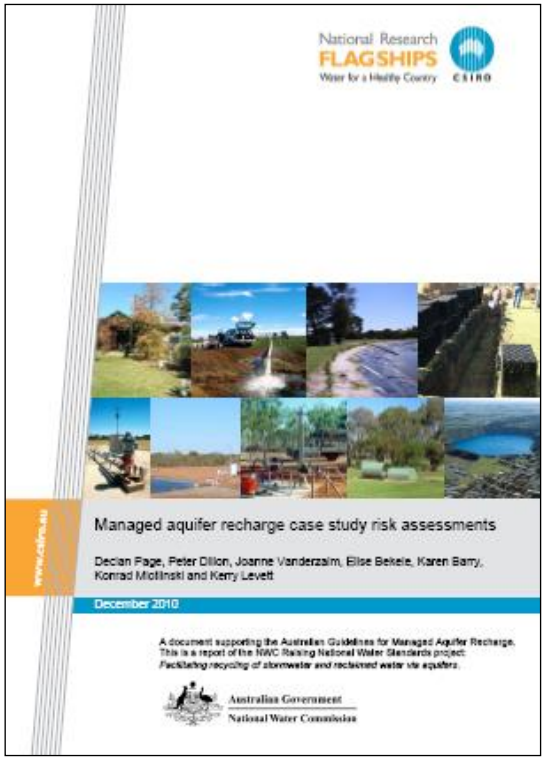
MAR Guidelines for health and environment protection

Australian MAR guidelines (2009)



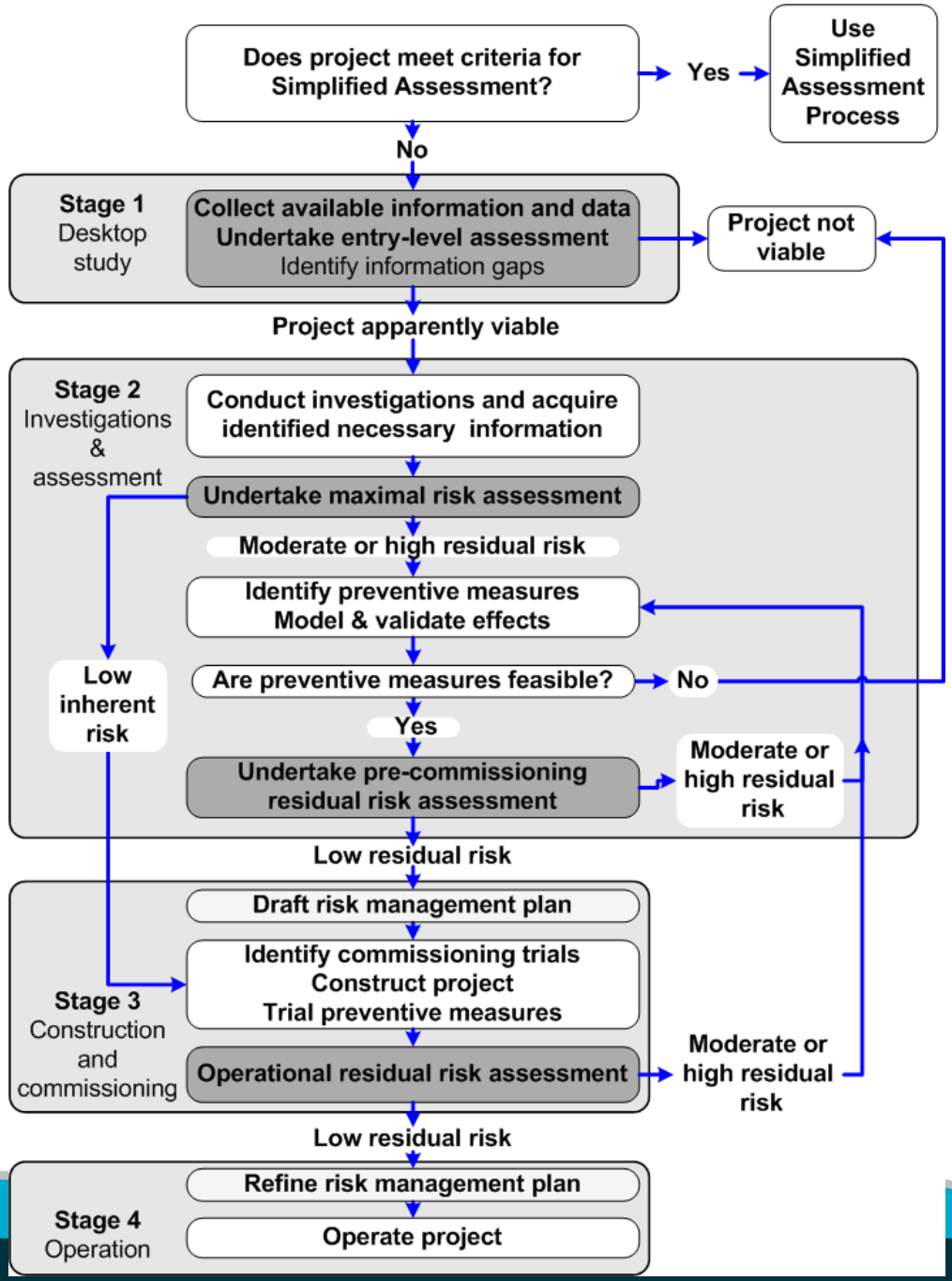
NRMMC, EPHC, NHMRC (2009). Australian Guidelines for Water Recycling, Managing Health and Environmental Risks-Managed Aquifer Recharge. NWQMS Document 24, 237p. http://www.environment.gov.au/resource/national-water-quality-management-strategy-australian-guidelines-water-recycling-managing-1

Case study applications (2010)

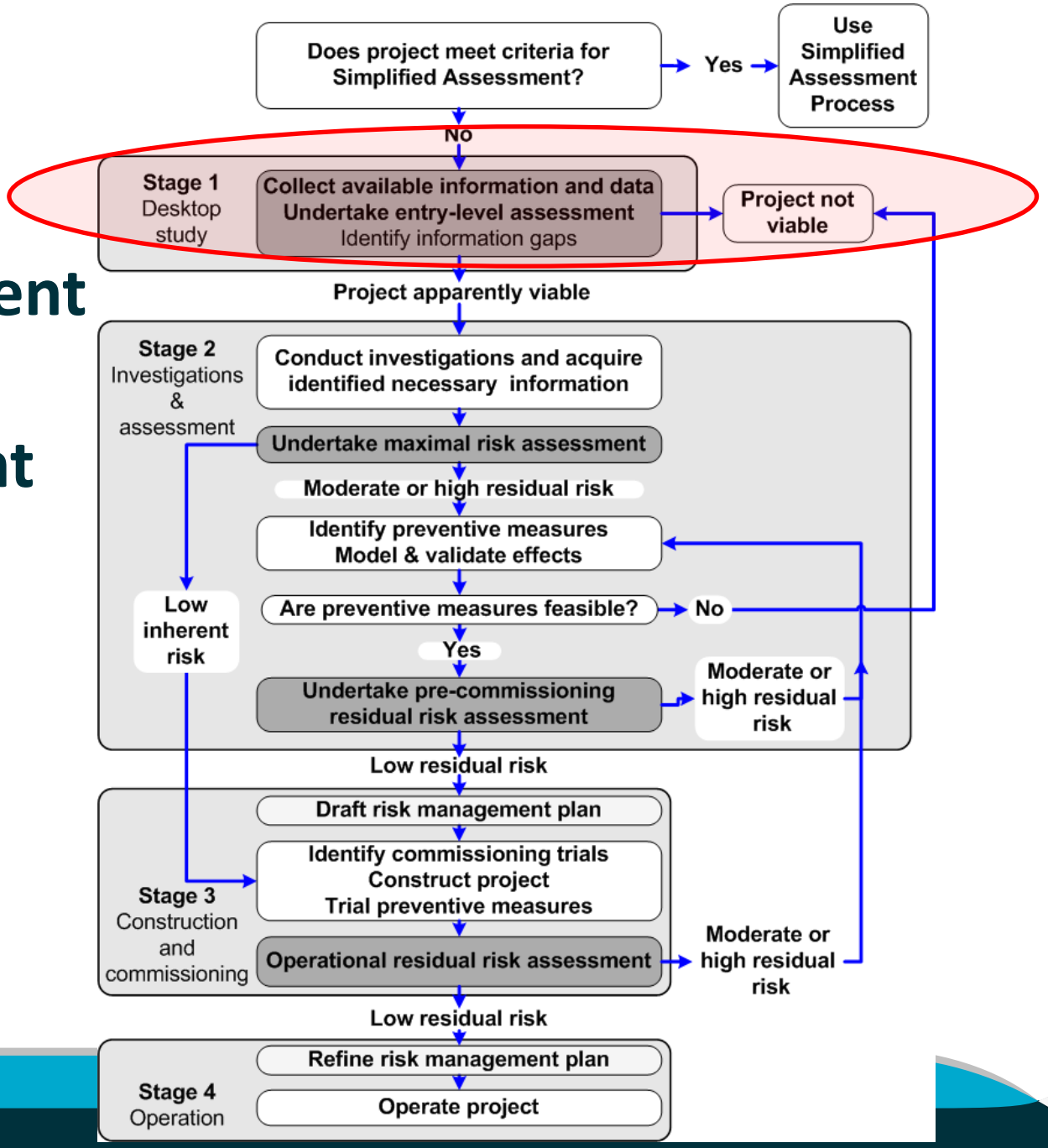


Page, D., Dillon, P., Vanderzalm, J., Bekele, E., Barry, K., Miotlinski, K. and Levett, K. (2010). Managed aquifer recharge case study risk assessments. CSIRO Water for a Healthy Country Flagship Report, Dec 2010, 144p. http://www.clw.csiro.au/publications/waterforahealthycountry/2010/wfhc-MAR-case-study-risk-assessments.pdf

Stages in project development and risk assessment



Stages in project development and risk assessment



Stage 1- Entry Level Assessment

Viability assessment (5 questions):

- Ongoing water demand *
- Access to source of water *
- Suitable aquifer *
- Space for capture/treatment
- Capabilities to operate

Degree of difficulty assessment (14 questions):

- 8 basic questions on water quality
- Proximity to others; aquifer capacity *
- Fractured, karstic or reactive aquifer *
- Similarity to successful projects, management capability
- Planning requirements

* DEW has prime capability

Stage 2: Key hazards in source water, groundwater and aquifer materials for MAR projects

Guidelines	Hazard
5.1	Pathogens
5.2	Inorganic chemicals
5.3	Salinity and sodicity
5.4	Nutrients
5.5	Organic chemicals
5.6	Turbidity/particulates
5.7	Radionuclides
5.8	Pressure, flow rates, volumes and levels
5.9	Contaminant migration in fractured rock & karstic aquifers
5.10	Aquifer dissolution and aquitard and well stability
5.11	Impacts on groundwater (dependent) ecosystems
5.12	Greenhouse gases

For each hazard, guidelines document :

- Effect of hazard on public health and environment
- Source or cause of hazard
- Management of hazard
- Tables of :
  - Acceptance criteria at each stage of risk assessment
  - Preventive measures
  - Validation monitoring
  - Verification monitoring
  - Operational monitoring

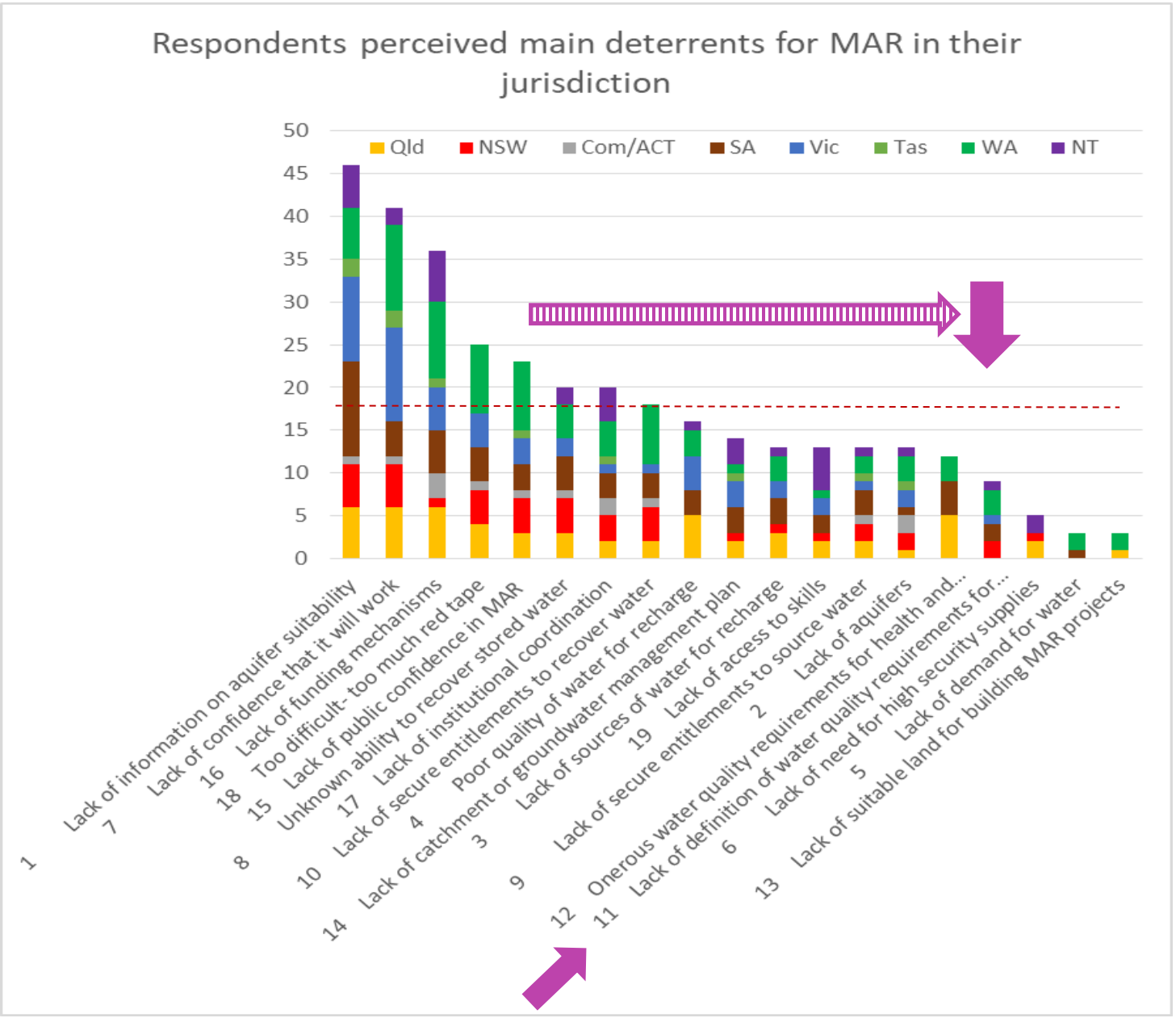
What has happened since?

Period	Total	Infiltration systems				Recharge wells			
		Rivers	Aquif-ers	Urban storm-water*	Recycled water	Rivers	Aquif-ers	Urban storm-water	Recycled water
1961-1970	79	10		69					
1971-1980	144	40		104	0	0			
1981-1990	185	53		130	0	2		0	0
1991-2000	213	53		156	0	2		2	0.2
2001-2010	257	53	3.5	182	0.6	0.1	0	17	0.2
2011-2015	410	53	3.5	208	1.8	0.1	113	29	1.5

Perth, Melb, Adl, Cbr

Perth

Pilbara WA, Surat Qld



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Australian survey in 2015

Total number of respondents = 134, total responses = 343, ave. number of responses per category = 18.

Factors identified to assist MAR implementation

1. maps showing the availability of suitable aquifers
2. local demonstration projects and information sharing
3. **guidelines on MAR to protect health & environment**
4. water allocation policies that account for MAR
5. holistic water resources planning
6. institutional capabilities

Experience to inform Guideline enhancements

- An NCGRT survey on MAR in Australia in 2015 (134 respondents)
- Tribunal ruling in 2017 on reinjection into a geothermal aquifer
- Responses since 2015 to the detection of PFAS in stormwater ASR
- Reinjection of coal seam gas associated water into a fresh aquifer
- Reinjection of dewatering water from iron ore mines
- Injection of recycled water into aquifer supplying city drinking water
- Failure to invest in MAR in an alluvial aquifer in NSW due to lack of confidence (at high cost)
- Cumulative impacts of ASR schemes causing 3rd party wells to overflow
- Unmanaged urban stormwater infiltration and potential for waterlogging and pollution

Research to inform GL enhancements

- deep well injection of brines from oil wells in USA suggests that fluid injection between 2km and 4km in depth may be inducing seismicity
- improved methods to assess the sources and fate of pathogens recharged to aquifers to allow improved public health risk assessment.
- improved genomics techniques to allow ecological impacts on aquifers and their connected ecosystems to be determined with higher reliability and reduced cost (in 2018 update of ANZECC Water Quality Guidelines)
- Also Australian Guidelines for Groundwater Quality Protection were updated in 2013, and as these were a foundation for the MAR Guidelines, consideration of the effects of changes are warranted.

MAR Guidelines are working

The Guidelines have streamlined and given certainty to approvals for MAR.

No known failure of projects due to inadequacy of GLs but some cases of inadequacies of water entitlement policy or of GLs not being followed.

States where GLs are in use have progressed in MAR implementation

States where MAR GLs are **not** in use have **not** progressed in MAR implementation.

The changes suggested based on experience are minor but important.

Suggested changes to Aust MAR Guidelines

- **Add temperature as a "hazard**" - in geothermal and open well ATES applications, and for explicit consideration in contaminant removal processes
- Incorporate advances in scientific knowledge with respect to fate of pathogens and organic chemicals, ecosystem monitoring methods, fluid-injection induced seismicity, and clogging processes
- Improved advice to operators on the effects of non-isothermal conditions on wellbore hydraulics
- Further elaboration of project closure requirements is suggested.

Policy recommendations:

- Include cumulative impacts in policy considerations
- Determine a pragmatic approach to encourage WSUD (infiltration for greening and stormwater flow reduction) while preventing excess recharge and groundwater contamination.
- Change commonwealth government funding processes to allow appropriate investigations before final design, costing, and construction

Thank you

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