



# Brine streams

*Potential impacts and opportunities  
for the Water Industry*

*Presented by Dr Harry Grynberg*





## Funding

- SWF
- Co funding

Central Highlands Water, Wannon Water,  
GWMWater

- Collaborators

Above plus CSIRO, EPAV



## Overall Objective

*To conduct a review of the management practices of brine streams both in Australia and overseas and look at which management practices would best suit inland Victoria. The project will also identify major issues in the management of brine streams in Victoria.*

### What were our Sub-objectives?

- **Need 1:** Identify Issues Facing Inland Water Authorities on Brine Stream Disposal
- **Need 2:** Address Knowledge Gaps on Brine Stream Management
- **Need 3:** Evaluate Management Options
- **Need 4:** Knowledge Sharing and Collaboration
- **Need 5:** Quantify Major Water Customer's Salt Impact



# Methodology

- Information Gathering: Water Corporations
- Water Corporation Workshop - to identify common issues.
- Literature Review and Issues Paper  
Report on current management practices of brine streams and any social, economic and environmental issues and impacts identified from the introduction of brine streams in Australia and other regions of the world.
- Evaluate Management Practices  
Review each of the management practices using a TBL and identify management practices which may be suitable for inland Victoria.
- Industry forum  
Presentation of the findings from the project and promote discussion between Water Corporations in Victoria, EPA Industry.
- Final Report



## Why is Desalination Needed?

*On-going drought, trade waste discharges, and poor quality water supply has driven Water Corporations to investigate the use of desalination to mitigate these drivers.*

The major drivers for desalination are:

- Drought
- Trade Waste Discharge Quality
- Poor Water Quality



## Identifying the Issues

*This information was used to model the quantity and quality of reject streams produced by Reverse Osmosis (RO) treatment. The following aims were used when setting the model:*

- Provide a reliable, palatable, potable water supply with the use of RO.
- Improve the option for recycled water use with the removal of TDS using RO.

The outcome of the model enabled the identification of:

- Concentration and mass of salt which will need to be managed; and
- Increased demand in raw water requirements needed to satisfy the use of RO as a treatment technology.
- Information that can be used by the WA for planning purposes.



## Brine Management Options

Conventional methods typically used to manage brine streams include:

- Discharge to sewer;
- Deep well injection (typically oil & gas type geological formations);
- Evaporation ponds;
- Discharge to surface water; and
- Rapid infiltration (shallow subsurface disposal).



**Table 1 - Workshop Summary of Conventional Disposal Methods for each Location**

Management Option	Clunes	Arco	Maryborough	Edenhope	Nhill	Pt Fairy Water	Pt Fairy Recycled Water	Heywood	Mortlake
Discharge to Sewer	x	x	x	x	x	✓	✓	✓	✓
Deep Well Injection	✓	✓	✓	✓	✓	x	x	x	x
Evaporation Ponds	✓	✓	✓	✓	✓	x	x	✓	✓
Surface Water Discharge	x	✓	✓	x	x	✓	✓	✓	✓
Rapid Infiltration	x	x	x	x	x	x	x	x	x



## Beneficial and Non-traditional Uses

Beneficial and non-traditional uses are another means of prolonging the use of brine streams prior to ultimately disposing or managing the salt. In general, these uses include:

- Oil/Gas Well Field Injection
- Solar Ponds
- Land Application and Irrigation
- Zero Liquid Discharge
- Aquaculture
- Wetlands Creation and Restoration
- Constructed Wetland Treatment
- Others
- Stormwater and Wastewater Blending
- Feedstock for Sodium Hypochlorite Generation
- Dust Control and De-Icing
- Recreational Use – subset of wetland reuse and irrigation
- Transport of minerals



## Evaluation of the Brine Stream Management Options: Overview

Disposal option	Advantages	Disadvantages
Evaporation ponds	<ul style="list-style-type: none"> <li>• Considered to be the most likely management option, given technical feasibility.</li> <li>• Relatively simple technology used, with low capital, operation and maintenance costs (assuming land is available).</li> <li>• Can be used to manage a wide range of concentrations.</li> <li>• Particularly well-suited to arid climates.</li> </ul>	<ul style="list-style-type: none"> <li>• Can result in habitat and ecological risks (e.g. potentially to some waterbird species).</li> <li>• Can result in seepage to groundwater if the liner is inappropriate for the concentrate or if it is not adequately maintained.</li> <li>• Leakage could also adversely affect soil quality and vegetation.</li> <li>• May require the removal of vegetation.</li> </ul>



## Evaluation of the Brine Stream Management Options: Overview (cont)

Disposal option	Advantages	Disadvantages
Deep well injection	<ul style="list-style-type: none"> <li>• Does not require treatment of the brine and concentrate prior to disposal.</li> <li>• Potentially low environmental risk, if aquifer of similar salinity found.</li> <li>• Causes minimal (if any) adverse consequences for air quality.</li> </ul>	<ul style="list-style-type: none"> <li>• Costs can be exacerbated if multiple wells are required.</li> <li>• Potential for low quality brine to impact on intermediate aquifers.</li> <li>• Regulatory and approval requirements are untested.</li> <li>• Approval likely to be conditioned on a relatively onerous monitoring regime.</li> </ul>



## Evaluation of the Brine Stream Management Options: Overview (cont)

Disposal option	Advantages	Disadvantages
Zero Liquid Discharge (ZLD)	<ul style="list-style-type: none"> <li>• Brine streams processed faster than evaporation ponds.</li> <li>• Fewer holding ponds required, therefore less land to be purchased.</li> <li>• Reduced risk of pond leakage.</li> <li>• High quality water vapour by-product that can be used for other purposes</li> </ul>	<ul style="list-style-type: none"> <li>• Requires significant energy input.</li> <li>• Costs are relatively high.</li> <li>• High energy requirements.</li> <li>• Potential for significant volumes of Greenhouse Gas emissions.</li> </ul>



## Evaluation of the Brine Stream Management Options: Overview (cont)

Disposal option	Advantages	Disadvantages
Wind-aided intensified evaporation (WAIV) ponds	<ul style="list-style-type: none"> <li>• Reduced overall land footprint compared to traditional evaporation ponds.</li> <li>• Size of evaporation ponds tends to be smaller.</li> </ul>	<ul style="list-style-type: none"> <li>• No known tests of WAIV being conducted in Australia.</li> <li>• Costs tend to be higher than traditional evaporation ponds.</li> <li>• Potential for salt drift.</li> <li>• Can result in habitat and ecological risks (e.g. potentially to some waterbird species).</li> <li>• Can result in seepage to groundwater if the liner is inappropriate for the concentrate or if it is not adequately maintained.</li> </ul>



## Approach to TBL

*The triple bottom line focuses corporations not just on the economic value they add, but also on the environmental and social value they add – and destroy. At its narrowest, the term ‘triple bottom line’ is used as a framework for measuring and reporting corporate performance against economic, social and environmental parameters (Elkington 1980).*



## Methodology

- Reviewed WA TBL methodologies
- Qualitative Multi Criteria Analysis
- Identification of issues
- Workshop of issues and ranking
- Used ranking criteria as follows:



**Rank Descriptions (Financial)**

Rank description	Rank
Expensive (total cost > \$2,000/ML)	
Moderately expensive (total cost: \$1,501 - \$2,000/ML)	
Relatively inexpensive (total cost: \$1,000 - \$1,500/ML)	

**Rank Descriptions (Environmental and Socio-economic)**

Rank description	Rank
Always problematic with complex mitigation measures	
Occasionally problematic with moderate mitigation measures	
Rarely problematic with simple mitigation measures	



# Option Assessment Summary

Criteria	Evaporation ponds	Deep well injection	Zero liquid discharge (ZLD)	Wind-aided intensive evaporation
<b>Financial</b>				
Total cost (\$/ML, based on 3.79 ML/day)			High operating costs owing to energy requirements	Moderate operating costs owing to capital and land requirements
<b>Environmental</b>				
Water receptors (e.g. aquatic species and habitat)		Ecological risks are low, unless it fails and discharges to surface water		
Air receptors (e.g. birds, insects and air quality)	Some concentrations may contain constituents that pose a hazard to avian receptors.			Some concentrations may contain constituents that pose a hazard to avian receptors.
Land receptors (e.g. plants, animals and habitat)				
GHG emissions		Owing to energy requirements	Owing to energy requirements	
Noise			Because mechanical equipment is used	
<b>Socio-economic</b>				
Health (potential effect on human health)		Potential for migration to potable water supplies.		
Visual amenity (facility's effect on human amenity)	Relatively large area of land required		Infrastructure can be obtrusive	Reduced area of land required, but infrastructure may be more obtrusive
Public acceptance (likelihood of public opposition).		Because of risk to groundwater	Because of energy consumption	Potential for salt draft
Regulatory requirements/approval		Unknown regulatory environment	But may be more problematic because of high GHG emissions	Marginally more assessment required for approval than evap. Ponds



## Conclusions fro MCA

- Traditional evaporation ponds are the least problematic.
- ZLD is potentially the most problematic owing to its high energy requirements, which has flow on implications for the cost and potentially the public acceptance of this option.
- Deep well injection, requires accompanying regulatory and approvals process
- WAIV ponds have potential to create a number of adverse human and environmental effects, relative to traditional evaporation ponds.
- mitigation measures are available for all of the areas of concern,
- estimating these using cost data requires site specific assessment



## Forum outcomes (at which MCA was presented)

- EPA is aware of the growing trend to desalinate brackish/saline water
- EPA is currently reviewing policies and guidelines
- EPA highlighted the issue that these alternative disposal schemes will need a high level of investigation, assessment and review
- Evaporation ponds are the traditional and most obvious disposal option.
- There was consensus among those present at the forum on the importance of planning.
- Consideration of aquaculture as a possible 'disposal' option was also raised at the forum, as well as the importance of trying to harness excess heat/energy from other industries when siting desalination plants. Recovering salts as by-products was also raised by CSIRO, however this is not considered to be a viable option at this point in time, for brine streams.



## The way forward

*It is recommended that the next stage in the investigation of brine disposal be the selection of a specific site, development of specific site parameters and the application of the TBL to that site.*

*This will provide valuable information on the relative costs and benefits of each disposal option.*



## Acknowledgements

SWF: Simon Lees

URS Team: Scott Wright, Vanessa Lenihan, Chris Sprott, Lili Pechey, Bryan Chadwick

Water Authorities: Paul Atherton (GWMW), Jason McGregor (CHW), Ben Pohlner (WW)

EPA: Stephen Lansdell

CSIRO: Dr Hal Aral