AQUIFER STORAGE AND RECOVERY
A NEW RESOURCE

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ABSTRACT

Managed aquifer recharge (MAR) is the controlled infiltration or injection of water into an aquifer. Infiltration methods can include infiltration ponds or trenches and a variety of other types of infiltration techniques, whereas injection is carried out using a bore (injection well) or series of bores.

Aquifer Storage & Recovery (ASR) is a type of MAR, whereby water is injected via a well during times when water is available, and recovery of the water from the same well during times when it is needed. Generally, injected water is stored in the aquifer for a period of time before being recovered again.

ASR has the potential to enable the better utilisation of water resources that are currently under-utilised such as storm water and recycled water. Subject to suitable geology, ASR can provide large volumes of storage with small surface infrastructure footprints.

Barwon Water is investigating the use of ASR for water storage and has programs in place to assess the viability of aquifers in the Anglesea area over the next 2 years, along with studies into aquifers closer to Geelong for this purpose. Barwon Water sees ASR as a way of increasing the flexibility of supply options as part of an overall water supply strategy for the region.

1.0 INTRODUCTION

Barwon Water provides a water supply system to the city of Geelong and surrounding region with a population of over 250,000. Up to 80% of the Geelong region's supply is traditionally derived from the Barwon River catchment with the remainder from the Moorabool River catchment. In recent times due to prolonged dry periods, up to 40% of Geelong's potable water supply has come from the Barwon Downs aquifer. With climate change continually having an impact on the amount of water able to be harvested from surface water storages, and ultimately groundwater resources – new ways of utilising resources have had to be considered. This is where Aquifer Storage and Recovery is being investigated to see what benefits we may be able to achieve utilising this as a 'new resource'.

2.0 DISCUSSION

2.1 What is ASR?

ASR is a type of Managed Aquifer Recharge whereby water is injected into the ground and recovered from the same bore at a later time when required. The aquifer is used as a large underground storage facility in times when surface water storages may be full and additional water is required to be stored for prolonged dry periods.

Depending on the end-use, the injected water may be sourced from stormwater, recycled water or excess surface water. Typically the water is stored in the aquifer for a period of time which in-turn provides additional treatment of the stored water by way of pathogen die-off.

2.2 How does ASR work?

ASR works by the injection of water into the ground by a series of injection bores. These injection bores are much like normal groundwater extraction bores and look much the same on the surface as a typical bore.

The most suitable types of ground for successful ASR requires a coarsely graded material, typically gravel or sandy in nature, confined between harder, more impervious material such as clay or bedrock. This allows the injected water to be contained within a confining layer of suitable material and not allowed to escape or flow away. The injected water forms a reservoir "bubble" around the injection well with some blending of water with natural groundwater at the extremities of the bubble.

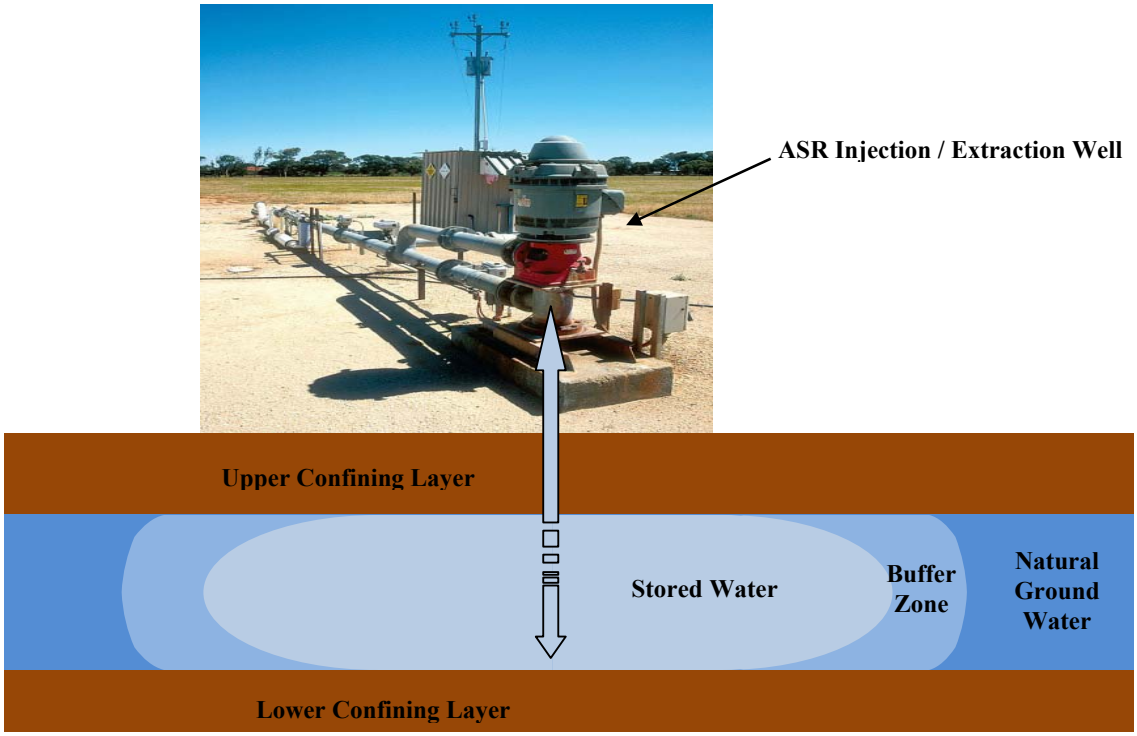

Figure 1: ***Typical ASR Well Arrangement***

Depending on the type of ground conditions, a number of injection wells may be required to allow a sufficient injection rate and achieve the required storage volume. In such cases, injection bubbles may overlap with each other to form a single large reservoir of injected water around the wells. Injected water will need to be of sufficient quality so as to meet environmental requirements associated with mixing of groundwater, prevent degradation of the aquifer and potential "leaking" of the aquifer to surface water systems.

When the injected water is required, the injection wells become extraction wells to extract the stored water out of the ground for its intended use. Groundwater observation bores would be used to monitor the effect of water injected into the ground and again when the water is extracted.

2.3 What are the benefits of ASR?

ASR has a number of benefits over traditional surface water type storages. These benefits include:

- Potentially large storage volumes with minimal surface footprints and no evaporation losses
- Ability to provide an additional level of treatment through pathogen die-off over a period
- Generally lower infrastructure cost to construct in relation to similar sized surface storage
- Minimal environmental impact compared to large surface water storages

ASR provides an alternative storage for water that may have traditionally been "wasted' through lack of storage opportunities. Recycled water is a potentially continuous supply of water that currently has limited options to store large volumes for bulk use. Whilst most of it may have a market for use during the drier months for irrigation, watering etc, during winter this market subsides and excess recycled water would not normally be stored and subsequently wasted. Stormwater similarly would normally be available during wetter months when not required, as well as typically falling in short, heavy bursts during summer where most would run off to waste. Stormwater retarding basins in combination with ASR would provide an opportunity to harvest this previously unutilised resource.

2.4 Barwon Water ASR Research

With the realisation of stormwater and recycled water as a valuable resource, Barwon Water has begun investigations into how the technology could be utilised to provide a "new" water source and integrated into its supply system. Barwon Water recognises that to combat climate change, a diverse range of water supply options is required to meet demand.

A number of sites have been identified as potential ASR sites in the Geelong region with various end-use options being considered. These sites include the new Armstrong Creek growth corridor to the south of Geelong, the Batesford quarry area and adjoining Fyansford development area to the West of Geelong and the Jan Juc aquifer system to the south west of Geelong.

Initial investigations centre on the Jan Juc aquifer system, just to the north of Anglesea. This area was chosen as significant information about the ground conditions already exist in the area and is known to contain suitable aquifer material. The area has two aquifers, an upper aquifer – which is the target aquifer for the investigations, and a lower aquifer – which will be accessed by the soon to be completed Anglesea Borefield. The Anglesea Borefield will provide up to 7,000 ML/a of water to the Geelong supply system from the end of 2009. The upper and lower aquifers in this area are separated by an almost impermeable layer, known as an aquitard.

The aim of the investigations in the Jan Juc aquifer is to determine the ability and suitability of the aquifer to store sufficient quantities of water to be considered for further development. The studies will determine any potential environmental impacts and provide an analysis on the potential for full scale implementation.

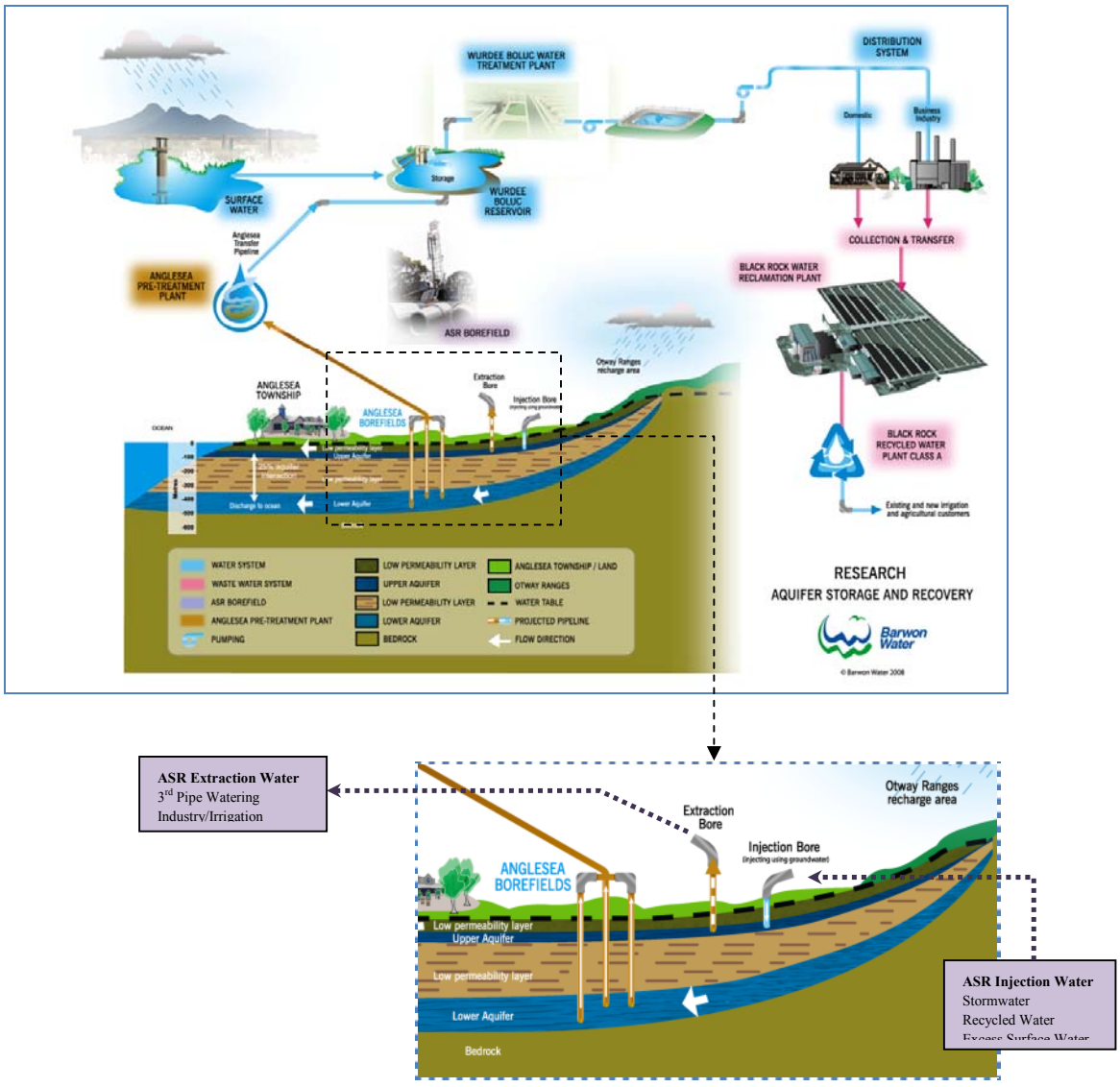

Figure 2: ***Hypothetical ASR Concept***

The ASR research project is jointly funded and supported by the Department of Sustainability and Environment and comprises a four-staged approach to determining the suitability of the aquifer:

- **Stage 1 – Preliminary Aquifer Characterisation** whereby six observation bores are drilled to a depth of approximately 120m and a short-term pump test is conducted at each bore to determine aquifer transmissivity and initial water quality.
- **Stage 2 – Detailed Hydraulic Assessment.** A production bore is drilled to a depth of approximately 120m and a seven day pump test conducted to determine aquifer performance. A further three observation bores drilled to monitor aquifer behaviour during pump test.
- **Stage 3 – Aquifer Modelling & Conceptual Design**. A computer model is generated from information gained from Stages 1 & 2 to allow aquifer behaviour

to be modelled under various operating scenarios.

- **Stage 4 – Injection Trial and Feasibility Analysis.** A 7-28 day injection trial whereby water is injected into the aquifer to test the behaviour of the aquifer and the injected water. From the injection trial data, design and costing of a preliminary injection borefield and assess the feasibility of the project.

2.5 Future Directions

A number of possibilities exist for the use of ASR as a new water source for Geelong. For each of the three sites identified for research into ASR, potential injection source water may be derived from:

- Class A recycled water
- Stormwater
- Excess surface water

With potential end-use of extracted water being:

- 3rd pipe use for garden watering, toilet flushing etc
- Industry or irrigation (sports grounds, golf courses etc)

Pending the outcome of the research trials and upgrade of the Black Rock Water Reclamation Plant, ASR has the potential to provide a significant resource. With up to 16,000 ML/a of recycled water potentially available, ASR could provide the means to utilise this precious resource in the future.

3.0 CONCLUSION

ASR is a concept that has been successfully implemented in Australia and the United States, with the potential to provide the same benefits of water supply diversity and security to the Geelong region. Several potential options exist in the Geelong area to utilise this technology, with research into available aquifers being conducted to determine their viability.

The Barwon Water research project will determine the feasibility of the technology in the Geelong region including the Jan Juc aquifer system and the Armstrong Creek and Batesford/Fyansford development areas. The research may lead to the improved utilisation of this alternative water resource and reduced reliance on more traditional water harvesting methods.

4.0 ACKNOWLEDGEMENTS

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