

Storing and Treating Stormwater for Reuse Using Aquifers:

Research Objectives and
Outcomes of the ASTR
Demonstration Project



The Aquifer Storage Transfer & Recovery (ASTR) research and demonstration project has involved harvesting up to 200,000m³ per year of urban stormwater via an engineered wetland as part of the Parafield Stormwater Recycling Scheme.

The treated stormwater was then injected into a brackish aquifer. The recovered water has been used to supply the mixing tank of Mawson Lakes dual reticulation system and to irrigate nearby ovals.

This brochure provides an overview of the research conducted at the ASTR site between 2006 & 2009.

Key Publications

- Pavelic et al, 2004, Groundwater Modelling to Assist Well-Field Design and Operation for the ASTR Trial at Salisbury, CSIRO Land and Water Technical Report No. 27/04
- Swierc et al, 2005, Preliminary Hazard Analysis and Critical Control Points Plan – Salisbury Stormwater to Drinking Water Aquifer Storage Transfer and Recovery (ASTR) Project, CSIRO Land and Water Technical Report No. 20/05
- Dillon et al, 2008, A critical evaluation of combined engineered and aquifer treatment systems in water recycling, *Water Science and Technology* 57(5): 753-762
- Dillon et al, 2008, City of Salisbury's progress towards being its own drinking water catchment. In: Singapore International Water Week, Singapore, 23-27th June
- Page et al, 2008, Preliminary Quantitative Risk Assessment for the Salisbury Stormwater ASTR Project, CSIRO Water for a Healthy Country National Research Flagship report
- Kremer et al, 2009, Flow and Solute Transport Observations and Modelling from the First Phase of Flushing, Injection and Abstraction Operations at the Salisbury ASTR Site, CSIRO Water for a Healthy Country National Research Flagship report
- Page et al, 2009, Operational Residual Risk Assessment for the Salisbury Stormwater ASTR Project, CSIRO Water for a Healthy Country National Research Flagship report, 106 pp
- Toze et al, 2009, Decay of Enteric Pathogens in Urban Stormwater Recharged to an Aquifer using Aquifer Storage Transfer and Recovery, CSIRO Water for a Healthy Country National Research Flagship report

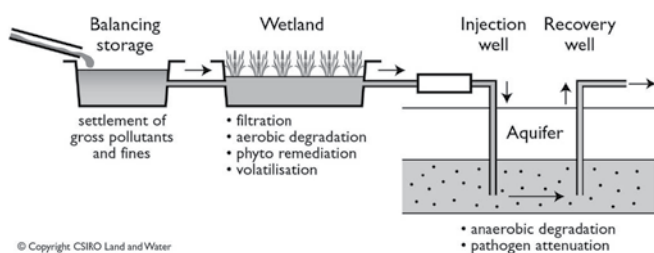


Research Needs and Objectives

With the growing demand for water, the increasing interest in the use of alternative water sources such as stormwater and treated wastewater, and the successful demonstration of Aquifer Storage and Recovery (ASR) technology, a research need was identified in 2005 to further demonstrate the potential application of natural treatment and storage of stormwater in aquifers.

The objective of the research was to demonstrate whether stormwater from urban catchments could be stored in aquifers and recovered to produce high quality water, with simple treatments in a multiple barrier approach. The research has been undertaken between 2006 and 2009 and encompassed the following activities:

- Aquifer characterisation – making use of hydrogeological information to design and operate the project
- Groundwater and geochemical modelling
- Risk-based management according to Australian Drinking Water & Water Recycling Guidelines
- Water quality monitoring incorporating passive samplers to detect trace organic compounds
- Determining the fate & attenuation of microbial pathogens
- Assessing the performance of wetlands for water quality improvement (eg for metals and suspended solids)
- Ecotoxicological assessment of stormwater & recovered water



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Site Location and Operation

The ASTR demonstration site is located within the City of Salisbury on the Northern Adelaide Plains in South Australia. The ASTR project draws water from the Parafield Stormwater Recycling Scheme, which is operated by the City of Salisbury. The total catchment area is 1,600 Ha and the water harvesting scheme area is 11.2 Ha. The majority of the land use within the catchment is residential, although it includes a light industrial area.

After harvesting, the stormwater is injected and stored at a depth of 160-180 m within the tertiary T2 aquifer of the Port Willunga Formation. This confined limestone aquifer is naturally brackish and has a low-moderate permeability.

The well field encompasses six production wells spaced at 50 m in a quadrilateral configuration. In routine operation the outer four wells are used to inject wetland treated stormwater and the two inner wells are used to recover stored water from the aquifer. An initial flushing phase with injection into the inner wells was needed to freshen the storage zone within the aquifer. The concept of separating recharge and recovery wells allows for sufficient residence time and travel distance in the aquifer for it to operate as a natural biofilter. This provides extra water treatment during its storage in the aquifer and provides greater operational control of pathogen attenuation in the aquifer.

Researchers were able to predict changes in the quality of recovered water during storage by using FeFlow computer simulations of groundwater flow and salinity. Predictions were made for recovery efficiency under various operating strategies accounting for dry, average and wet years.

The following recharge and recovery cycles have occurred:

- 373 ML injected into the two inner wells between September 2006 and June 2008
- 30 ML injected into the four outer wells between September 2008 and June 2009
- 53 ML recovered from the inner wells between February and April 2009

Subsequent recovery and recharge is occurring at the site.

Research Outcomes

The research undertaken at the ASTR site has been focused on understanding the recoverability of recharged water and the water quality improvements of harvested, injected and recovered stormwater. A series of water quality monitoring sites were established at the Parafield Stormwater Recycling facility and at the ASTR site. Analytes included trace organic chemicals, microbial pathogens, inorganic chemicals, nutrients, physico-chemical parameters and suspended solids. Maximal, residual, organic chemical and quantitative microbial risk assessments were also undertaken.

Many water samples were collected throughout the project. Furthermore, passive sampling and conventional sampling was undertaken for organic compounds. Of the analyses of more than 350 trace organic species, only 32 were detected by passive samplers and none of these exceeded drinking water guideline values at the exit end of the reedbed. Simazine was the only compound detected by conventional sampling and appears to be the main micropollutant of concern.

Although no human pathogens were found in the source water, the rate of natural die-off of pathogens in the reedbed and aquifer was measured using in-situ pathogen attenuation chambers for a range of pathogens including bacteria, viruses and protozoa. Die-off rates were determined by changes in concentration with time. The rate of die-off of bacterial pathogens was fast (ie in the order of days) but *Cryptosporidium* and rotavirus were less predictable and died off more slowly. To achieve an acceptable low level of risk according to Australian Water Recycling Guidelines, ultraviolet light and chlorination disinfection has been recommended.

The native groundwater and stormwater both contain iron concentrations in excess of drinking water aesthetic guideline values at the ASTR site. Recovered water did not reveal mobilisation of iron or arsenic in the aquifer. However, recovered water did contain iron near guideline levels and on occasions exceeded the aesthetic limit for colour (which can cause iron staining). The results, therefore, suggest that iron removal treatment is needed.

The project has demonstrated that recovered water at the ASTR site generally meets the Australian Water Recycling Guidelines without further treatment. However, further research is needed to test the robustness of the concept and to engage with the community concerning the desirability of this source of water for various uses, to explore options for harvesting and use of stormwater (alone and in combination with other waters) and to assess impacts of its use on water distribution systems.

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ASTR & Reclaim Water

The research project is known in Australia as ASTR. ASTR also formed the Australian case study site of a European Union (EU) research project known as Reclaim Water (www.reclaim-water.org) - "Advances in water reclamation technologies for managed aquifer recharge". The Reclaim Water project ran from 2005-2008 and involved 19 partners which represented 12 countries from western and eastern Europe, China, Mexico, Israel, South Africa and Singapore. The project encompassed seven case study sites, including ASTR, and several partners conducted laboratory studies.

Collaboration

The ASTR project has been coordinated and managed by United Water and involves the following partners who have contributed funding and in-kind expertise:



Government Support

The ASTR project was proudly supported by:



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The Government of South Australia through the Premier's Science and Research Fund;



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