Storage goes underground

ONE of the biggest problems with reusing wastewater is that the supply is most plentiful when it's needed least. Storing suburban stormwater and treated effluent from wet months for drier times is a major challenge.

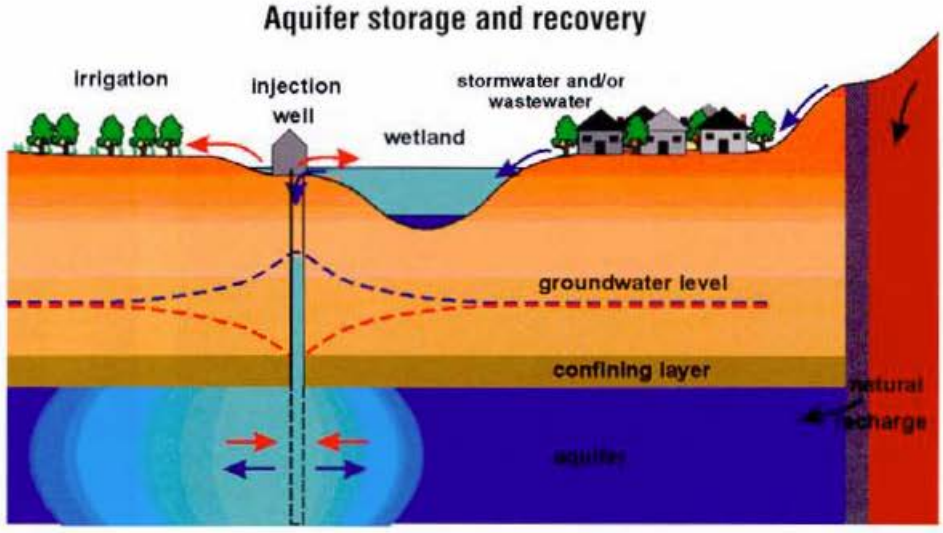
In Adelaide the CSIRO Division of Water Resources, in association with the Centre for Groundwater Studies, is taking part in a plan to capture and treat stormwater and sewage effluent (wastewater) at times of high flow, then to store the recycled water deep underground in existing aquifers until needed. The main research challenge is to guard against contaminating the aquifers with chemicals and microorganisms.

Stormwater and wastewater quality can be improved in wetlands or basins, and through further treatment in the aquifer. Many of the physical, chemical and microbiological processes occurring in these systems are the focus of scientific study. Just as important to the use of aquifers for water reclamation, however, is the development of guidelines under which the process can be managed sustainably.

Central to developing such guidelines has been research by the division's Dr Peter Dillon and Paul Pavelic. In a report published this year, they reviewed a number of studies on stormwater and wastewater quality and compared the data with established standards for the water's potential reuse. They also reviewed the efficiency of wetlands in removing contaminants, and the fate of contaminants in aquifers.

What did they discover? . . . That when it comes to water reclamation, nothing is simple!

Treatment requirements depend on the range and concentrations of contaminants present, the type of aquifer, and the beneficial uses of the recovered water. These are specific to each aquifer-recharge site.



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What goes down the drain

Stormwater and wastewater contain a range of contaminants that can be categorised as suspended solids, oxygen-demanding materials, nutrients, heavy metals, microorganisms, trace organics, or gross solids. The concentrations of these contaminants must be reduced to acceptable levels before the water can be injected into aquifers. But because stormwater and wastewater are from different sources, the range and concentrations of contaminants they contain differs too. For example, levels of suspended solids generally are much higher in stormwater than in wastewater. Suspended solids content is important in aquifer recharge systems as it causes clogging in injection wells. In contrast, total dissolved solids and nitrogen concentrations usually are higher in wastewater than in stormwater. These are two factors that can render wastewater unfit for drinking.

Further to these variations, each supply of stormwater and wastewater differs from the next. The sources of contaminants in urban stormwater include atmospheric deposition on catchment surfaces; road-surface accumulation; construction activity; industrial runoff; animal wastes; decaying vegetation; chemicals applied to lawns and gardens; septic tank seepage; litter spills and overflow. The types of land-use practised in a given catchment therefore will affect the quality of its stormwater.

Wastewater in urban areas is made up of municipal sewage, industrial waste, and in some cases stormwater overflows and groundwater inflows. Wastewater quality is determined by the quality of the water supply, the relative contributions of these sources, and by its level of treatment.

Another factor affecting the treatment requirements of stormwater and wastewater bound for aquifer recharge is how the reclaimed water will be used.

The review by Pavelic and Dillon revealed that stormwater and secondary-treated wastewater may in some situations be successfully injected into aquifers to create irrigation and livestock water supplies, subject

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to adequate pretreatment in wetlands and detention basins. But such waters are not suitable for direct injection into aquifers to generate drinking water supplies without additional pretreatment.

What about wetlands?

In some situations, particularly where reclaimed water will be used for irrigation or livestock, artificially-constructed wetlands can be the best option for treatment and storage of wastewater and stormwater bound for aquifers.

Contaminant removal processes that operate in these systems include sedimentation, uptake by macrophytes and algae, adsorption onto sediments, chemical transformations in the water column or sediments, filtration through plants, microbial die-off and infiltration through sediments.

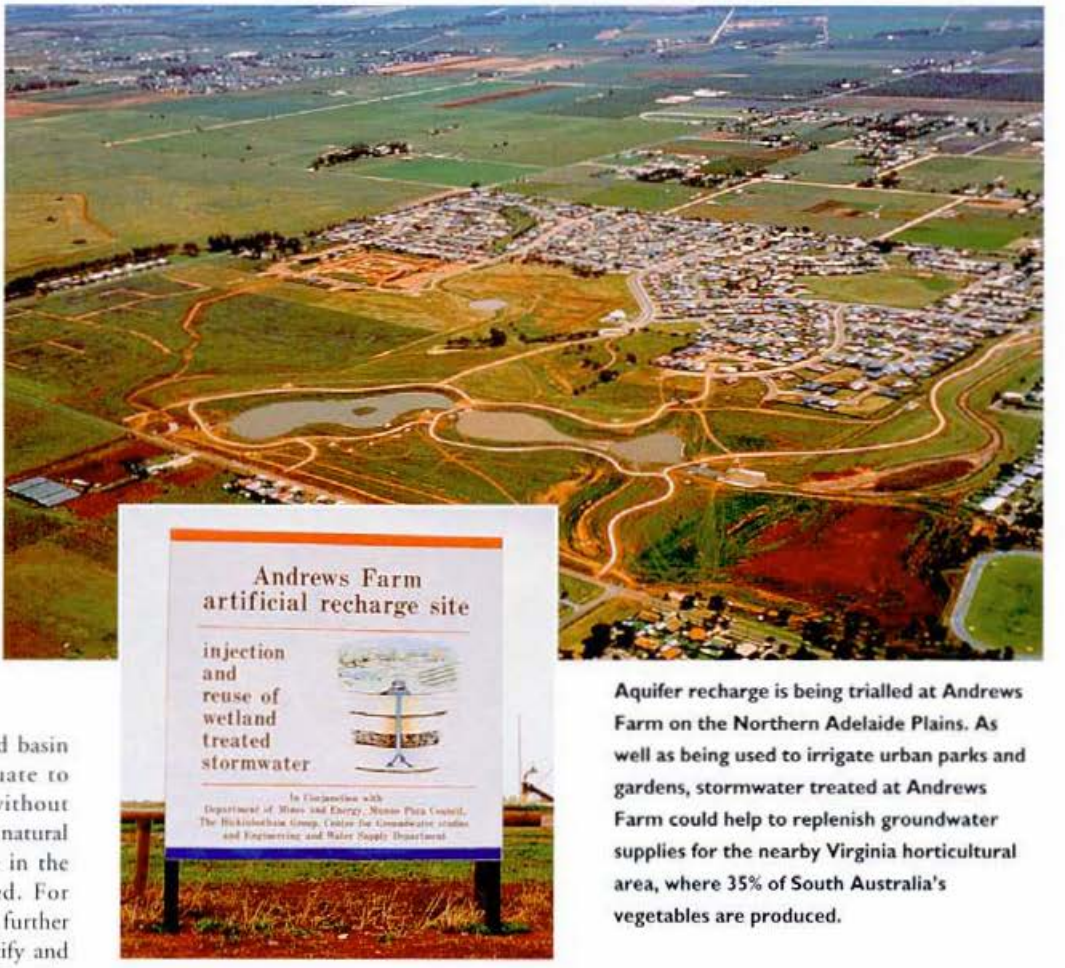
The average level of wetland and basin performance, however, is inadequate to produce drinking water supplies without further treatment. In such instances, natural attenuation processes that take place in the aquifer itself need to be considered. For example, Pavelic and Dillon say that further study is needed to characterise, quantify and predict rates of microbial degradation in aquifers if chemical disinfection (and disinfection by-products) are to be avoided.

New developments

Artificial recharge by injection in Australia is in its infancy. Although widely practised internationally, especially in the United States, Israel and the Netherlands, only a handful of such studies are known in Australia, with at least as many in the planning stages in Adelaide alone.

One experimental site is a housing development called Andrews Farm on the Northern Adelaide Plains. CSIRO scientists are working with the developer, Hickinbotham Homes, and with Mines and Energy SA hydrologists, to test the performance of a system to detain and treat stormwater in a detention basin before injection into a limestone aquifer for reuse. They are also investigating sustainability aspects such as well clogging, and the fate of contaminants in groundwater.

The trials at Andrews Farm are part of a broader initiative by Hickinbotham Homes to establish over the next 20 years housing for up to 70 000 people in 10-15 nodal villages. The company's plan is to treat and reuse water locally, rather than add to the 200 million cubic metres of stormwater and 100 million cubic metres of secondary-treated sewage effluent that is discharged annually to St Vincent Gulf.



Aquifer recharge is being trialled at Andrews Farm on the Northern Adelaide Plains. As well as being used to irrigate urban parks and gardens, stormwater treated at Andrews Farm could help to replenish groundwater supplies for the nearby Virginia horticultural area, where 35% of South Australia's vegetables are produced.

According to Dillon and Pavelic, the long-term aim of the aquifer recharge research is to allow opportunities for developing water resources that would otherwise have been foregone. As well as being used to irrigate urban parks and gardens, stormwater treated at Andrews Farm could help to replenish groundwater supplies for the nearby Virginia horticultural area, where 35% of the State's vegetables are produced.

This industry uses 18 million cubic metres of groundwater a year, but its size is restricted by the natural rate of groundwater replenishment. Over-exploitation results in falling groundwater pressures and increasing salinities, as has been found in the past and is now stabilised by restricting groundwater use.

'The Andrews Farm experiment is testing both the feasibility and the sustainability of the aquifer recharge operation,' Pavelic says. 'The overall aim is to utilise waters which are currently just being wasted, but to do it in a manner which is sustainable.'

It's an experiment that has succeeded in its objectives. To date it has recharged more than 100 000 cubic metres of fresh water to the aquifer for later irrigation. Otherwise the water would have run off to the ocean.

Draft guidelines for the injection of stormwater and wastewater, developed specifically for Australia, have been recently released. The guidelines build on groundwater protection policies contained in the National Water Quality Management Strategy and allow for the treatments that aquifers provide, and the acquisition of groundwater quality data which will enable sustainable rates of contaminant attenuation in aquifers to be quantified.

Comments on the draft guidelines are welcome. Copies are available from Paul Pavelic, Centre for Groundwater Studies, CSIRO Division of Water Resources, PMB 2 Glen Osmond, SA 5064, (08) 303 8700, fax (08) 303 8750, email: pcp@adl.dwr.csiro.au.

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