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Artificial Recharge newsletter #6

Groundwater Strategy 2010

Newsletter #6: Artificial Groundwater Recharge

The Department of Water Affairs and the Water Research Commission supported the development of an Artificial Recharge Strategy, completed in 2007. This newsletter summarises recent initiatives in artificial recharge as part of the roll-out of that strategy.

What Is Artificial Recharge?

Artificial recharge is the process whereby surface water is transferred underground to be stored in an aquifer. Underground water storage is an efficient way to store water because it is not vulnerable to evaporation losses and it is relatively safe from contamination.

Groundwater is an important source of water of water for many villages, towns, and agricultural enterprises across South Africa. It is reliable and sustainable provided its use is well managed. As water use requirements increase more demand is placed on aquifers and a number of different approaches have evolved whereby these can be topped up again, before they should empty and fail. The most common methods of artificial recharge involve either injecting surplus surface water into boreholes, or transferring water into spreading basins where it infiltrates the subsurface. Catchment rehabilitation can also enhance infiltration. Aquifers may be used as a way of storing and re-using recycled waste water.

An animation of this process can be viewed on the DWA website www.artificialrecharge.co.za

The main reasons for the implementation of artificial recharge in South Africa are:

- artificial recharge is usually far cheaper than conventional surface water schemes
- new surface water sources are not available
- the aquifer offers storage opportunity where surface storage is not possible
- existing groundwater supplies are over-utilised
- no further 'natural' local groundwater sources are available.

Some Existing Artificial Recharge Schemes

Atlantis (Western Cape): recharge using storm water and waste water

The town of Atlantis, with a population in excess of 60 000, is 50 km north of the centre of the City of Cape Town on the dry west coast.

The Atlantis Water Resource Management Scheme has successfully recharged and recycled water for almost three decades. On average approximately 7 500 m^3/d of storm water and wastewater is currently recharged, thereby augmenting the water supply by more than 2.7 million m^3/a. Approximately 30% of Atlantis' groundwater supply is augmented through artificial recharge.

***Photo 1:** Atlantis' main artificial recharge basin*

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Some principles for artificial recharge distilled from the above experience

1. Water must be available for recharge purposes.
2. There are a variety of water sources and techniques for recharging aquifers.
3. Artificial recharge becomes necessary where abstraction rates exceed natural recharge rates.
4. With artificial recharge an aquifer can deliver more water than it would under natural conditions, and this can be planned into system design and use.
5. The natural quality of groundwater is not always suitable for use. Saline groundwater can be diluted to acceptable fresh water standards through artificial recharge of aquifers.
6. Artificial recharge is a very useful way of storing and recycling treated water. The time water spends stored in the aquifer can bean important part of treatment.
7. By including artificial recharge in water resource planning, and using aquifers as storage reservoirs or dams, both local and national water storage capacity can be greatly increased.

Resources Available

DWA's artificial recharge website www.artificialrecharge.co.za:

This website contains all the resources listed below, links to other relevant websites and more information on artificial recharge. All new resources developed under DWA's roll-out of the artificial recharge strategy have been posted on the website.

Artificial groundwater recharge: Recent initiatives in South Africa (DWA, 2010): An illustrated report in easily readable booklet style discussing existing and identified potential artificial recharge schemes. This newsletter was largely drawn from this booklet.

Artificial Recharge Strategy: Version 1.3 (DWAF, 2007): This document is mostly a handbook on artificial recharge. It contains a wealth of information, including the types of schemes, details on the "success criteria",

Polokwane (Limpopo): storage of treated waste water

Polokwane has grown rapidly over the past decade with an estimated population in excess of 400000 and water requirements of about 12 million m^3/a. Whilst the city is largely dependent on surface supplies, groundwater, which is fed by infiltrating treated waste water and natural runoff, has been the saviour for the city in times of surface water shortages – especially during the 1992–1994 drought when groundwater supplied the bulk of the city's requirements.

The reliability of groundwater as a source is largely due to the artificial recharge of 3-4 million m^3/a of treated municipal wastewater infiltrated into the alluvial and gneissic aquifers. This water is used both by the municipality and by farmers for large-scale irrigation.

Photo 2: *Polokwane's artificial recharge water source - discharge of treated waste water from the final matuartion pond*

Williston (Northern Cape): pumping across groundwater compartments

Williston is a small town in the western Karoo relying on groundwater for its domestic supplies. Abstraction over the years has been in excess of natural recharge and groundwater levels have steadily declined. The aquifer is divided by an impermeable barrier and the levels in the adjacent "compartment" have not shown the decline evident in the pumped compartment.

A groundwater transfer scheme has been constructed to pump water from the one compartment to the other thus doubling the effective storage and recharge capacity available, with the total aquifer capacity now able to sustainably meet the towns needs.

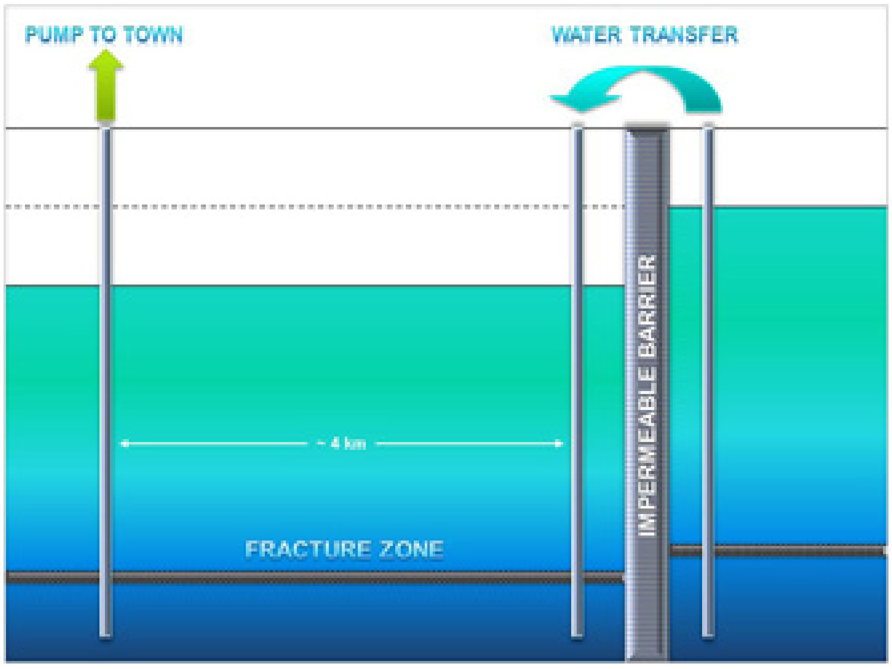

Image 3: *Williston's groundwater transfer scheme*

Kharkams (Northern Cape): Opportunistic recharge

Kharkams is a small village in the semi-arid Namaqualand region that depends solely on groundwater from a granitic aquifer. Surface runoff, whenever it rains, is now directed into the aquifer that had the lowest yielding of the village's three production boreholes.

This has had the effect of tripling the borehole's yield and bringing the salinity of the water from virtually undrinkable (electrical conductivity of 300 mS/m) to good quality drinking water

authorisation and regulatory issues and the Artificial Recharge Strategy.

Potential Artificial Recharge Areas in South Africa (DWA, 2009): This report identifies potential recharge areas, identifies a number of places where artificial recharge should be considered, describes conceptual plans for artificial recharge at a few sites, and gives an artificial recharge assessment of WMA 19. The methodology for the WMA 19 study is written up in detail and can be used as an example or template for WMA-scale studies.

A check-list for implementing successful artificial recharge projects (DWA, 2009): This brief report covers: Artificial recharge project stages; the Pre-feasibility study check list; and the Feasibility study check list

The Atlantis Water Resource Management Scheme (DWA, 2009): This report describes the history, planning, implementation and operation of the Atlantis scheme that has been in operation for nearly 30 years. Linked to this are a lecture on the scheme and field trip guide.

Artificial Recharge lecture and lecture notes: A lecture with lecture notes has been prepared for academic institutions. The lecture covers all key points on artificial recharge.

Acknowledgements

Photographs 1,2,4,5,& 7-10 in this newsletter were taken by Dr Ricky Murray (Groundwater Africa).

Photograph 6 were taken by Lucas Smith.

All photographs are used with permission.

Your feedback

Your inputs on this topic, or any other aspect related to the future of Groundwater in South Africa, would be much appreciated.

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(<100 mS/m). The surface runoff water used for this artificial recharge would otherwise be lost to evaporation and evapotranspiration.

This scheme demonstrates the value of opportunistic artificial recharge in semi-arid areas, even if it is only practised here on a small scale. Unfortunately a lack of basic maintenance of the sand filter has resulted in the scheme not operating optimally over the past few seasons

Photo 4: *Kharkams' in-stream sand filter. Water is led from here to the injection boreholes.*

Windhoek (Namibia): Water banking

Windhoek has a water requirement of 21 million m³/a. Most of this comes from three dams but some is sourced from a quartzite aquifer and from reclaimed water (fully treated recycled water).

Photo 5: *One of Windhoek's injection boreholes*

The cost saving through the use of artificial recharge to increase its assurance of supply is significant for the city. Surface water transfer from the Kavango River was estimated at R1.79 billion in comparison to the R242.5 million for the artificial recharge scheme.

In this case artificial recharge takes the form of water banking, with surface water is "banked" in the aquifer as security against droughts. This allows for the dams to be used at greater risk levels, as security lies in sub-surface storage where evaporation and aquifer losses are negligible.

The overall aim of the scheme is for the aquifer to be able to supply virtually the entire city's current use when it is full, and then for it to be able to be rapidly and fully recharged afterwards.

Omarauru River Delta (Namibia): Storing desert floods underground

The artificial recharge scheme in the Omaruru River Delta (Omdel) in Namibia consists of the Omdel Dam and a series of infiltration basins in the riverbed 6 km down-stream.

The main impoundment serves as a silt trap and, after settling, the water is allowed to flow along the riverbed to the infiltration basins constructed of alluvial material.

Over 50% of desert flood waters (9 million m^3) have been recharged through this opportunistic infiltration scheme in the two flood events since its construction.

The aquifer provides water to the coastal towns of Walvis Bay, Swakopmund and Henties Bay, as well as the Rössing mine.

Photo 6: *One of Omdel's infiltration basins*

Using Artificial Recharge To Increase Aquifer Potential

There are a number of significant and exciting new developments in the field of artificial recharge. **Sites that show promise for the implementation of artificial recharge in increasing aquifer potential, include:**

Photo 7: *Langebaan's borehole injection test*

Langebaan Road Aquifer for Saldanha Bay: Storing surplus winter flows

In this scheme water would be transferred from the Berg River during winter, when demand is low and there is surplus surface water, and injected into the Langebaan Road Aquifer. A test has already injected 76 000 m³ into the sandy confined aquifer.

Prince Albert: Topping up the aquifer

The water demand in Prince Albert in the Karoo increases threefold over the summer months from about 1 000 to 3 000 m³/day. Sources are from mountain water and from boreholes in a sandstone aquifer. These boreholes are used to capacity to bridge the summer months. The mountain water is supplied via a furrow and the idea is to divert this water into the aquifer during the winter when the furrow is being cleaned. This would add 120 000 m³ to the aquifer for use during the summer. Borehole injection tests are planned for 2010.

***Photo 8:** Injection testing in Prince Albert*

Plettenberg Bay: Pre-treatment and storage of seasonal water

Most of Plettenberg Bay's water comes from the Keurbooms River, but the town also relies on groundwater abstraction from the quartzite aquifer, especially during summer when requirements increase to over 300 000 m³/month and borehole water levels drop by tens of metres.

***Photo 9:** Borehole injection test in Plettenberg Bay*

Artificial recharge using surplus winter surface water, treated prior to borehole injection at the time of low demand, would rapidly replenish the aquifer and provide a back-up volume of treated surface water underground for use during summer. This treated water in the aquifer can be used with minimal further disinfection when needed in summer. This takes pressure not only off supplies, but also off the water treatment works over the critical demand period. The artificial recharge option is currently being considered together with other water supply options.

Calvinia: Banking water for emergency supplies

The town of Calvinia in the western Karoo has the potential to store 100 000 m^3 as a back-up supply in a highly mineralised and permeable sub-surface compartment similar in shape to Kimberlite pipes. Treated surface water from the Karee dam can be transferred to this compartment for safe storage. The water cannot be lost, since the permeability of the surrounding formations is very low and only the municipality has an abstraction borehole.

Because of the mineralised nature of the host rock, the recharged and abstracted water is not suitable for human consumption and would need to be blended with the dam water prior to use. For this reason the scheme has not been in operation. Similar water quality problems could result from storing fresh water in disused mines.

***Photo 10:** Injection boreholes in Calvinia*

The Kathu Aquifer: Storing mine water

Water levels in the wellfield area of the Kathu Aquifer in the Northern Cape have dropped by over 20 m in 27 years and there is a general decrease in water levels of about 0.7m/a. This trend could be stopped or reversed by injecting water into the areas where the water table is depressed.

The only available water source is groundwater from Khumba Mine. Although much of this water is used in the mining operation, any surplus could be transferred to the Kathu Aquifer. An artificial recharge pre-feasibility study has been undertaken for Sishen Iron Ore Company (Pty) Ltd.

National Potential For Artificial Recharge

A nationwide assessment of potential artificial recharge areas has been conducted as part of DWA's artificial recharge strategy. Favoured areas are those with high aquifer permeability. Maps for each Water Management Area can be downloaded from the DWA artificial recharge website. A more detailed assessment has been conducted for the Olifants/Doorn WMA.

More ideas for implementation:

There are lots of possibilities. **Here are some prospects:**

Vivo / Dendron. More infiltration dams, and borehole injection, would help with declining water levels. But where would the water come from?

Lephalale. Borehole injection to optimise aquifer storage and use in meeting growing requirements.

Vanrhynsdorp. Water could be transferred out of the Olifants Doring system during the winter and stored in the over-utilised Vanrhynsdorp aquifer.

Hermanus. Diversion and infiltration of urban runoff to meet growth in urban requirements.

Springbok Flats. Importation and storage of water sourced from seasonal or even occasional surpluses elsewhere.

Middle Letaba. Use of the aquifer as additional storage for irrigators.

Kenhardt. Aquifer could be used to store Orange River water.

Cedarville Flats. Storage of Mzimvubu River water.