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Atlantis Water Supply Scheme (AWSS) artificial recharge scientific and operational support

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Since the 1970s, the town of Atlantis, on the dry west coast of South Africa, has relied on an innovative process whereby wastewater and stormwater is transferred underground to be stored in an aquifer for future use. To ensure the long-term sustainability of the Atlantis Water Supply Scheme, an assessment of its operational and technological requirements was required.

WHAT IS MANAGED AQUIFER RECHARGE?

Managed Aquifer Recharge (MAR) is defined by the transfer of surface water underground and the subsequent storage in an aquifer, either via infiltration from basins/dams/ponds or through injection boreholes. In this way, water is stored during wet periods or when there is a surplus and abstracted during dry periods. Underground water storage is more efficient because it minimizes evaporation. In addition, water is relatively safe from contamination and the porous medium through which it infiltrates acts as a filter.

THE ATLANTIS WATER SUPPLY SCHEME

The town of Atlantis, with a population of 70,000, is located 50 km north of the City of Cape Town on the dry west coast of South Africa (**Figure 1**). The Atlantis Water Supply Scheme (AWSS) has been operational since the late 1970s (**Figure 2**). Treated domestic wastewater and storm water is diverted to large basins (**Figure 3**), it infiltrates into a sandy aquifer from where it is abstracted (Witzand and Silwerstroom Wellfields, **Figure 1**) and reused for municipal supplies. Approximately 30% of Atlantis' groundwater supply is augmented through artificial recharge.

SCOPE AND OBJECTIVES OF THE PROJECT

Management of the water sources and the aquifer is required to ensure future long-term sustainability. Support to the operational management of the AWSS, scientific inputs for the sustainability of the AWSS, monitoring requirements, training of staff and compilation of an operational manual, obtaining commitment from various City of Cape Town divisions, industries and users, the rehabilitation of boreholes and borehole clogging are some of the issues that are being addressed.

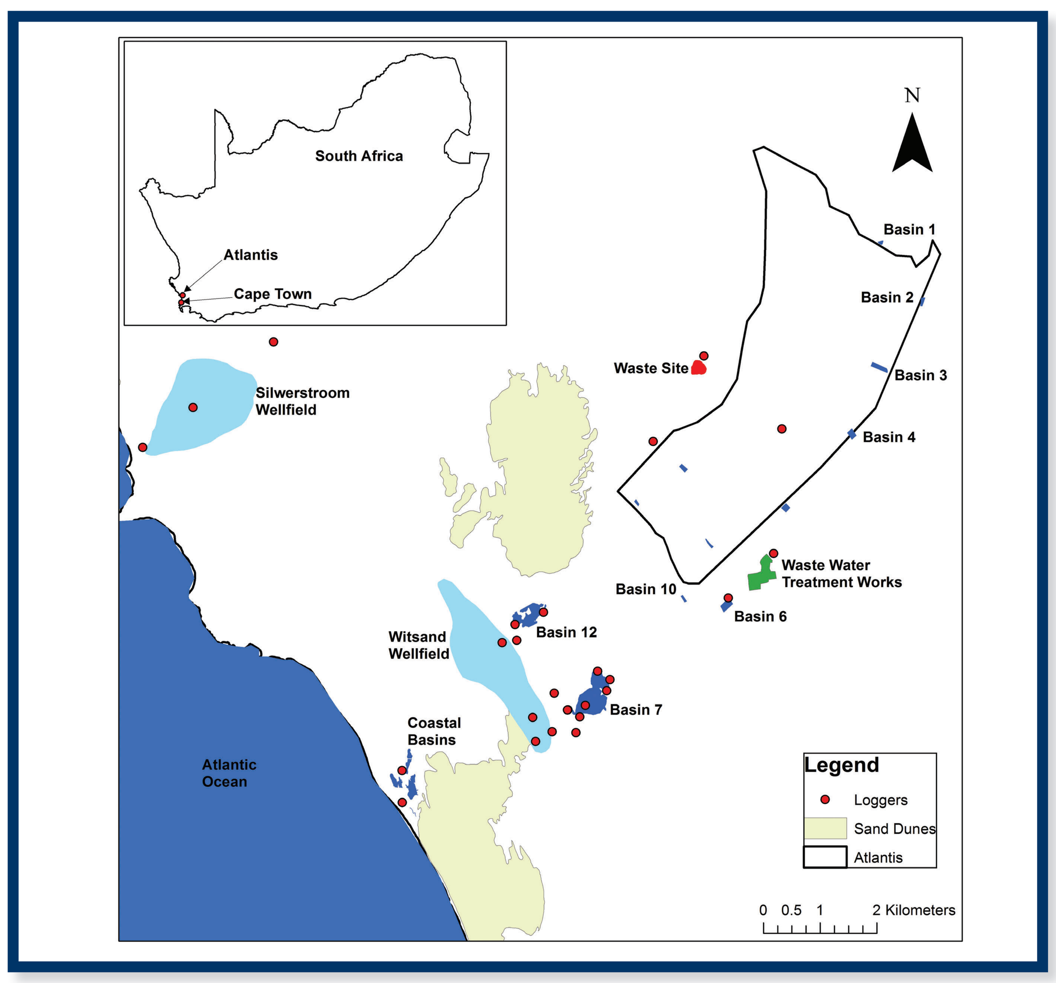

Figure 1: The location of Atlantis and outline of the AWSS. Storm water is collected in Basins 1, 2, 3 and 4. Treated domestic wastewater and storm water passes through the reed bed in Basin 6, and it is conveyed into recharge Basins 7 and 12. Industrial storm water is discharged separately via Basin 10 to the Coastal Basins. These basins also serve to dispose of treated industrial wastewater and prevent oceanic salt water intrusion. A water softening plant is located in the vicinity of Basin 12. Unvegetated sand dunes are efficient natural groundwater recharge areas

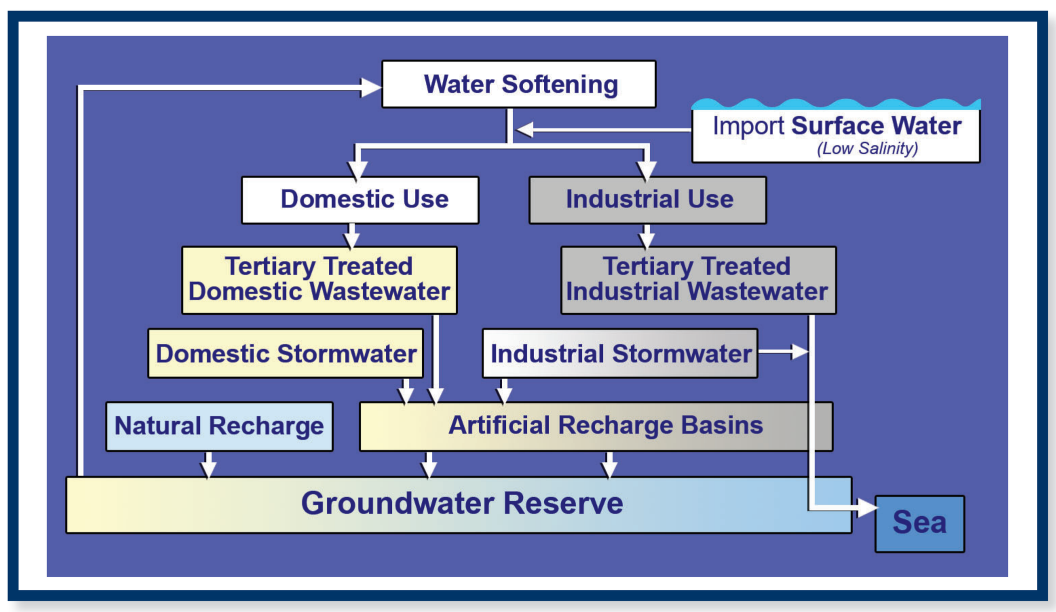

Figure 2: Operational scheme of AWSS

GROUNDWATER RESOURCE

A network of sensors was established in order to log hourly groundwater levels and water quality (electrical conductivity) at key locations (**Figure 1**) and determine the sustainability of groundwater abstraction. In the past decade, most of the abstraction occurred from the Witsand wellfield (1.50 $Mm^3 a^{-1}$ on average per year compared to 0.12 $Mm^3 a^{-1}$ at Silwestroom). Decrease in abstraction over time occurred due to the availability of water from the Voëlvlei dam and borehole fouling caused by hydrochemical and biogeochemical reactions involving Fe.

Figure 3: Artificial recharge Basin 12

WATER QUALITY

Water is sampled and analysed regularly at key locations in the system. **Figure 4** illustrates the benefits of the system in terms of water purification. Dissolved organic carbon (DOC) and electrical conductivity (EC) decrease along several sampling points from the domestic waste water treatment (WWT) works to the final chlorination plant for drinking water.

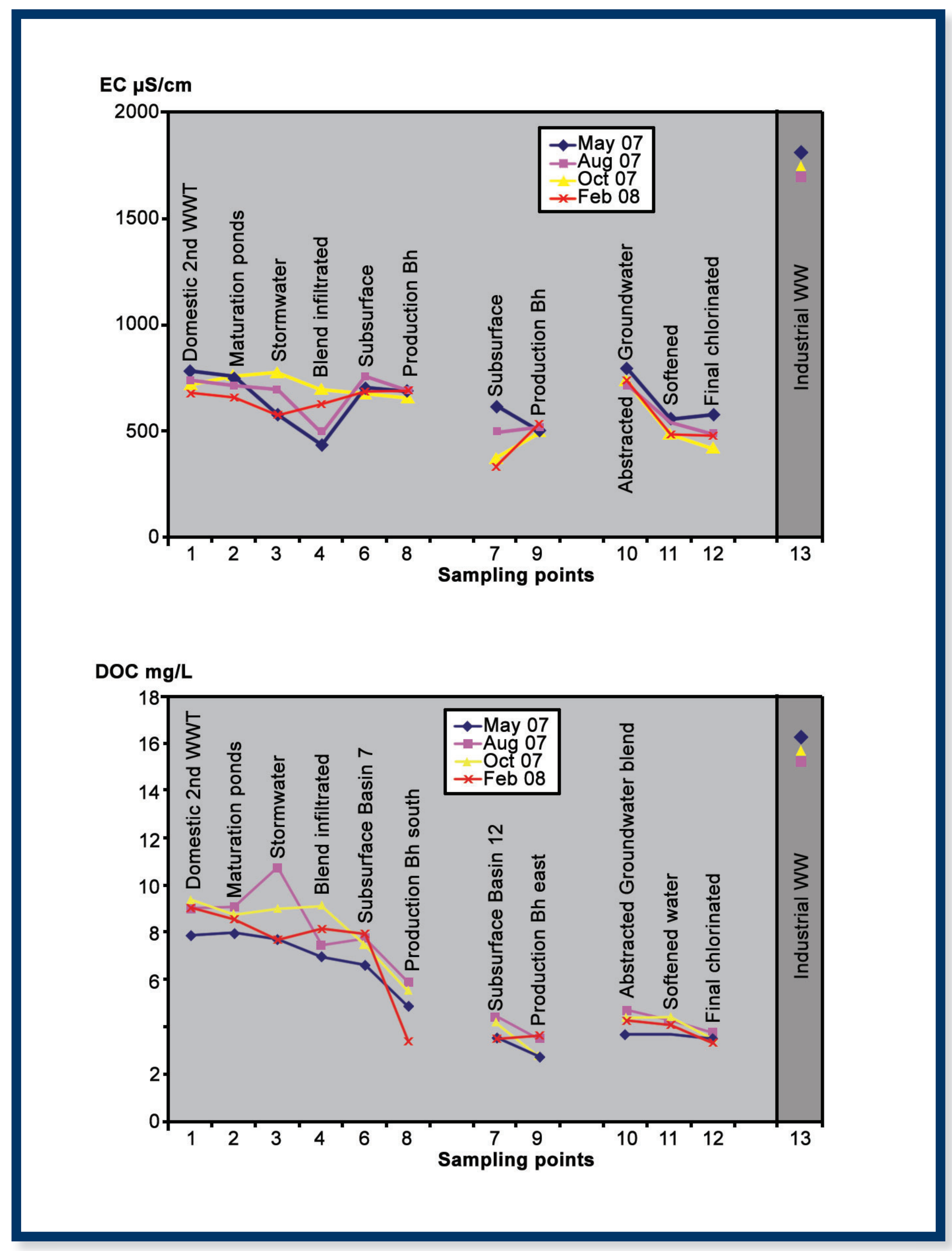

Figure 4: Dissolved organic carbon (DOC) and electrical conductivity (EC) along several sampling points in the AWSS. Industrial waste water (WW) concentrations are shown as reference.

Table 1: Identification of risks in the AWSS, their frequency and severity

Severity \ Occurrence	Very unlikely (1)	Remote (2)	Occasional (3)	Probable (4)	Frequent (5)
Very high (5)		Industrial waste water spill/breakage of transportation pipeline Over-pumping (retention time disturbed) Integrity of soil			
Critical (4)		Breakage/leakage of softening brine effluent transportation pipeline Disinfection failure			
Major (3)		Recovery breakdown	Chemical spill/ industrial spill/illegal discharge	Bacterial regrowth Production borehole failure/pump breakages	Hard rain/floods and peak storm water events
Moderate (2)			Domestic WWTP Effluent transportation leakage/breakage		Biofilm in distribution system and reservoirs/ storage tanks Power failure/bad performance by WWT plant
Minor (1)				Failure of softening plant	

RISK ASSESSMENT

Qualitative and quantitative risk analyses of the system were carried out in order to identify, assess and manage risks to the drinking water supply source. **Table 1** provides a summary of the qualitative risk analysis. The quantitative risk analysis indicated negligible risks from microbiological and emerging contaminants.

CONCLUSIONS

The hydrogeological resource assessment indicated that currently the contributions from both wellfields are well below their production potential. The artificial recharge scheme is beneficial in terms of water purification and reduction in costs for water treatment, and the subsurface storage of water. Future monitoring to ensure that the final water is free of pharmaceutical compounds is recommended. All data are used in scenario modelling to assess the long-term sustainability of the system and potential risks.

ACKNOWLEDGEMENTS

The project was funded by the City of Cape Town (2011 to current) and the European Union (2007 – 2009) through the FP6 RECLAIM WATER project.

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