

The Atlantis Water Resource Management Scheme: 30 years of Artificial Groundwater Recharge

Field Trip Guide to the Atlantis Water Resource Management Scheme

August 2010



The *Field Trip Guide to the Atlantis Water Resource Management Scheme* has been developed as a user-friendly reference guide that can be easily carried during a field visit to the Atlantis scheme in the Western Cape. This field guide highlights the different aspects of the integrated scheme such as storm water detention basins, water treatment works and the different artificial recharge basins. It provides background information on the different aspects of the scheme as well as directions and estimated visiting and travelling times from Cape Town.

This booklet is a stand-alone version of Appendix 2 of the main report, "*The Atlantis Water Resource Management Scheme: 30 years of Artificial Groundwater Recharge.*" The reference information for this main report is as follows:

Authors:

Gideon Tredoux (private consultant (formerly CSIR))
Julia Cain (Wide Eye productions)

Published by:

Department of Water Affairs
Private Bag X313
Pretoria
0001
Republic of South Africa
Tel: (012) 336-7500

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FIELD TRIP OVERVIEW: ATLANTIS WATER RESOURCE MANAGEMENT SCHEME (AWRMS)

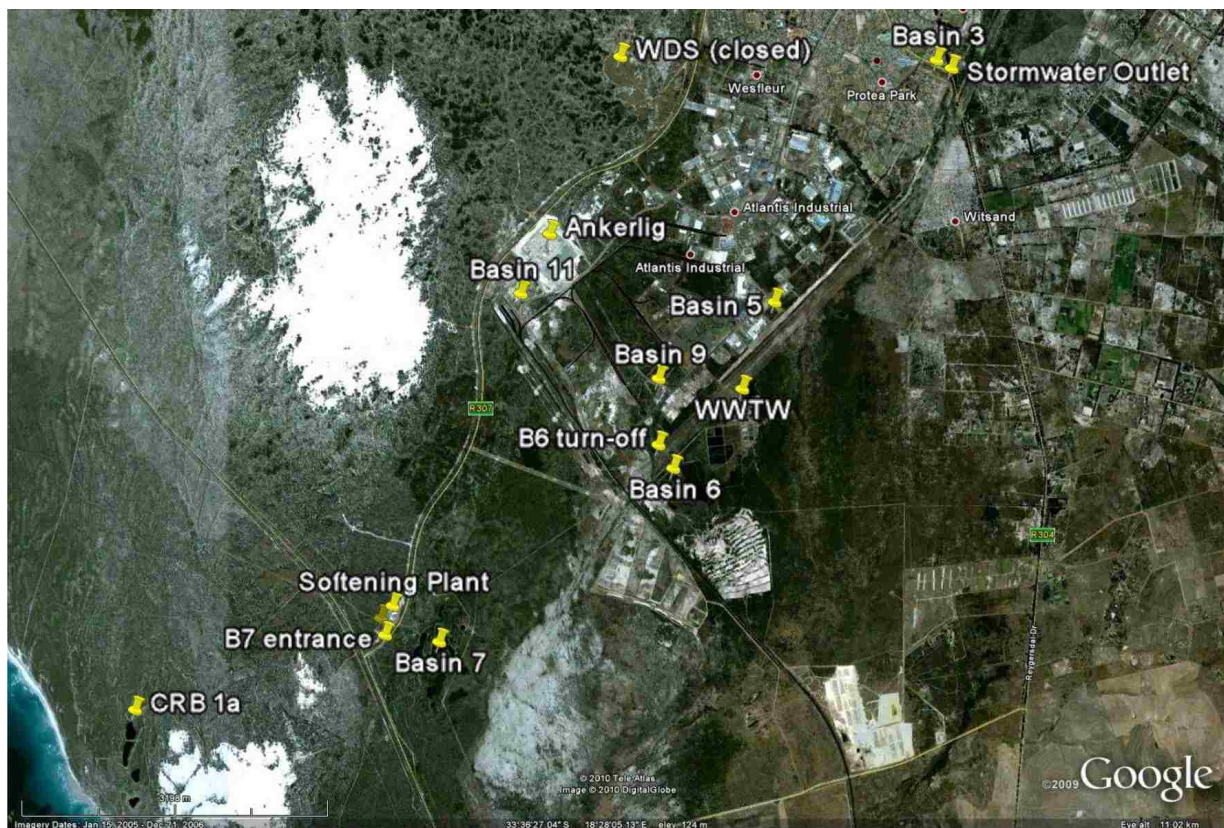
	SITES:	DESCRIPTION	TIME ESTIMATE
1	Basin 3: Domestic storm water detention basin	Residential storm water collection and groundwater transfer basin. Coordinates: 33.57532°S; 18.50303°E	10 minutes on-site
2	Wastewater Treatment Works	A key development of the ARWMS. Two parallel treatment works for (1) domestic wastewater and (2) industrial wastewater were developed and came on line in mid-1990s. Coordinates: 33.60579°S; 18.48141°E	5 minutes on-site
3	Basin 9: Industrial storm water detention basin	Industrial storm water collection basin that is also a reed bed. Neil Hare Rd turn off: 33.60492°S; 18.47399°E Basin 9 Inlet: 33.60405°S; 18.47197°E	10 minutes on-site
4	Basin 6: Silt reduction and holding basin	A basin that brings together all of the domestic storm water, most of the industrial storm water, and the treated domestic wastewater. It was modified in 1988 to also act as a silt reduction point. From Basin 6, the water flows to recharge Basins 7 and 12. Coordinates: 33.61188°S; 18.47416°E	15 minutes on-site
5 (a)	Softening Plant	City-operated weak base ion exchange groundwater Softening Plant that was built in 1986 largely to meet the water quality needs of industry but also to the advantage of domestic users. Coordinates: 33.62657°S; 18.44334°E	30 – 45 minutes visit: A tour of the plant by staff must be arranged in advance. (See contact details below).
5 (b)	Borehole	A borehole in the Witzand wellfield that abstracts groundwater, which is then treated in the nearby Softening Plant before being piped to the residential and industrial areas of Atlantis. Coordinates: 33.62719°S; 18.44113°E	15 - 20 minutes on-site visit, including walking time
6	Infiltration Basin 7	The main recharge basin for treated domestic wastewater and storm water runoff of the AWRMS. Water infiltrates down through the basin, up gradient of the main wellfield, and reaches the production boreholes in a period of 18 months to 2 years time. Basin 7 entrance: 33.62858°S; 18.44154°E	20 minutes on-site. This must be arranged in advance with CoCT's approval. A key to the gate must be obtained from the Softening Plant.
7	Coastal Recharge Basins	Coastal basins in Eskom-owned nature reserve that are recharged with treated industrial wastewater and storm water, as well as the regenerant brine from the Softening Plant. The water that infiltrates here, down gradient of the main aquifer, serves to raise the water table and prevent seawater intrusion into the main aquifer. Basin 1a inlet: 33.63554°S; 18.41335°E	30 – 45 minutes (including travel to/from Softening Plant). This trip is only permitted with advance approval from CoCT and a guide.
<i>Total on-site time including travel between sites</i>			3 – 4 hours
<i>Total time including return travel from Cape Town CBD</i>			5 – 6 hours

To arrange a tour of the Softening Plant and to arrange permission to visit Recharge Basin 7 and the coastal recharge basins: Contact Mr John Charles, Manager: Atlantis Water Scheme Utility Service – Bulk Water (john.charles@capetown.gov.za), or Mr Paul Wyngaard, Senior Superintendent (paul.wyngaard@capetown.gov.za), in Atlantis on 021 577 5000 /2 /3 /4.

INTRODUCTION

The town of Atlantis is located 50 km north of the centre of the City of Cape Town on the dry west coast. It has a population of approximately 57,000 people and presently forms part of the metropolitan area of Cape Town.

Initially prompted by the need to find an alternative to marine wastewater discharge, Atlantis began recharging its wastewater into its sandy soils in the late 1970s. With the recognition that the natural groundwater yield of the aquifer was not sufficient to meet the long-term needs of the town, the focus shifted to *recycling* water and *recharging* the aquifer. The addition of storm water to the recharge system was a major development, as was the eventual separation of domestic and industrial effluent that was done in order to allow recharge of the highest quality water in the areas of the greatest importance. Currently, treated domestic effluent, all of the domestic storm water, and most of the industrial storm water is used for recharging the aquifer upgradient of the wellfields into two retention basins. Industrial effluent, some of the industrial storm water, and the regenerant brine of the Softening Plant are diverted to the coast downgradient of the main aquifer to coastal recharge basins in order to raise the water table and prevent seawater intrusion into the main aquifer. The overall scheme is referred to as the Atlantis Water Resource Management Scheme (AWRMS) (refer Google image below).



Google Map overview of the Atlantis Water Resource Management Scheme.

The Atlantis Water Resource Management Scheme has successfully recharged and recycled water for almost three decades. It is estimated that on average, approximately 7500 m³/d of storm water and wastewater is currently recharged up gradient of the well field, thereby augmenting the water supply by more than 2.7x10⁶ m³/a (i.e. approximately 25 - 30% of Atlantis' groundwater supply is augmented through artificial recharge). Some 4000 m³/d higher salinity industrial wastewater is treated and discharged into the coastal basins down gradient of the well field close to the ocean.

The AWRMS provides a local South African example of a cost-effective artificial recharge solution that has been proven over time, successfully supplying water to both the residential and industrial areas of Atlantis for nearly 30 years. A renewal of careful management of the water sources and aquifer is now required to ensure its future long-term sustainability.

THE ROUTE

1. Basin 3: Residential storm water collection (33.57532°S; 18.50303°E)

Directions: Basin 3 is located within Atlantis town. The inlet can be seen from the corner of Reygersdal Dr. and Kerria Ave.; the outlet is at the diagonally opposite corner of the basin in Acacia Crescent. To get here, take the N7 from Cape Town travelling north; take the R304 exit to Atlantis. Follow the R304 into Atlantis, past the informal settlement area on the left, into the town (the R304 turns into Regersdal Dr.). At the first little circle turn left into Kerria Ave and then left into Acacia Crescent. If you park at the end of the road (before it turns to the right), and climb up the embankment, you will see the concrete outlet structure (see Google image below).

Time required: ~10 minutes.



Google Map view of surroundings of Storm water Basin 3.

Basin 3 is a part of the storm water management system (i.e. artificial recharge does not happen at this site). It is a detention basin and its purpose is to collect water from that area of residential Atlantis from storm events and to slow down peak flow (by spilling into the basin and seeping back into the canal when the peak flow subsides) – it is thus a ‘dry pond’ i.e. it is not designed to retain water, simply to slow it down. This regulated flow is then taken by pipeline to Basin 6, from which it is then piped to Basin 7 for artificial recharge.

Basin 3 works as an initial ‘polishing’ stop (i.e. settling out sediment); it allows some recharge; and in the dry season it is used as a sports field because grass continues to grow on it. It was thus designed (and works) as a multi-function area, providing public open space, play space, and storm water detention.



Basin 3: Storm water inlet.



Basin 3: Low level flow channel.



Basin 3: Storm water outlet.

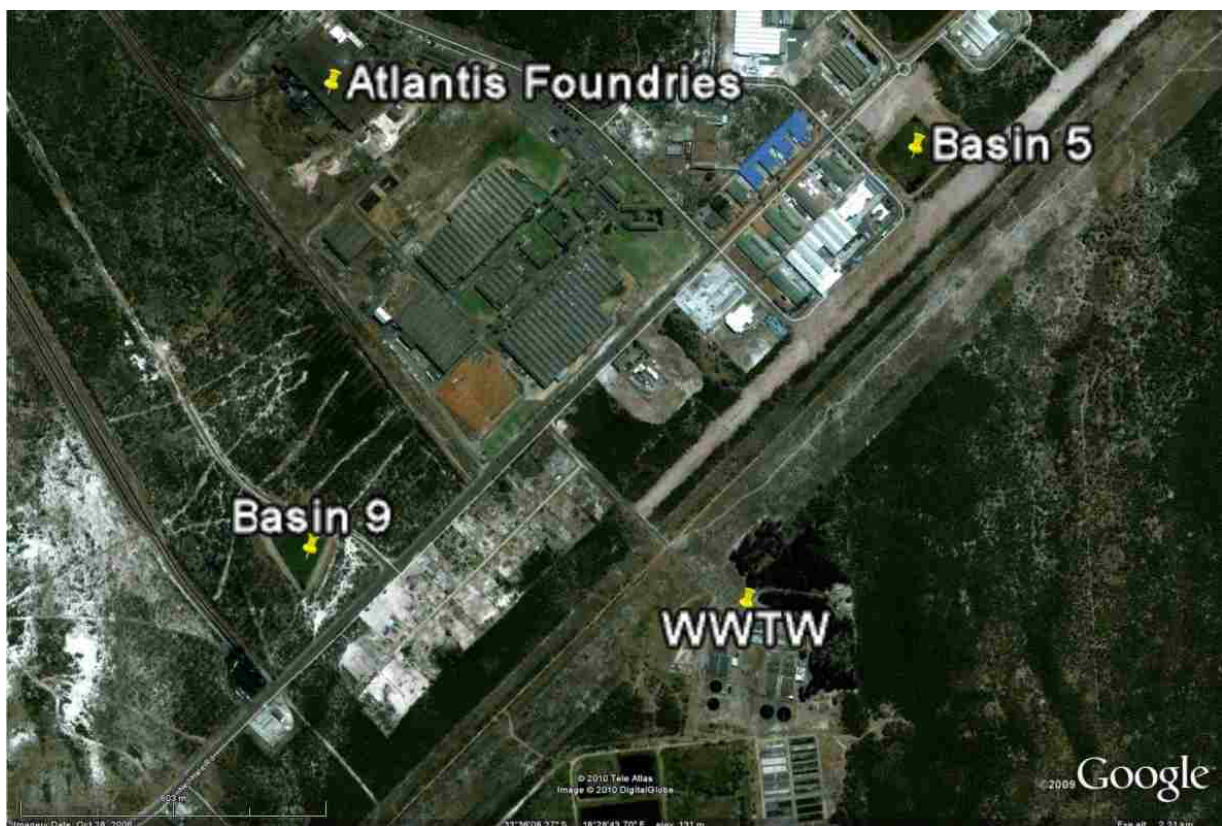


Basin 3: Storm water outlet.

2. Wes-Fleur Domestic and Industrial Wastewater Treatment Works (WWTW)

From Acacia St., turn left into Kerria and drive to the end of this road. Turn left into Charel Uys Dr, and then left into Neil Hare Rd (at this point there is a road sign that says R304/N7/Cape Town/Malmesbury). Drive through the industrial area continuing with Neil Hare Rd (and not turning left towards the R304/N7). You will pass Basin 5 on your left at the traffic circle (optional stop – see notes below). Continue on Neil Hare Rd; after the rise in the road, look for an immediate left into Perkins Rd. This leads to the WWTWs. Facing the WWTW, the plant on the right hand side treats industrial wastewater only, and the one on the left hand side treats domestic wastewater only (refer Google image below). (Coordinates: 33.60579°S; 18.48141°E)

Time required: 5 minutes (if not visiting inside facilities). If you wish to visit inside the facility, an advance arrangement with the Manager: Jacques Basson on 021 577 2411 must be made.



Google Map of WWTW, Basin 5 and Basin 9 area.

By 1986, water quality concerns about the inclusion of the industrial wastewater in the artificial recharge system resulted in the development of a 2nd parallel wastewater treatment plant. This enabled domestic wastewater and industrial wastewater to be treated separately, and the effluent from each to be distributed independently. The effluent from the domestic wastewater plant is diverted into the artificial recharge system (i.e. it goes to Basin 6 en route to Basin 7). The effluent from the industrial wastewater plant was initially diverted to the Donkergat River, and then later (and currently) diverted to the coastal recharge basins. Both treatment works use natural processes i.e. activated sludge processes based on micro-organisms breaking down waste. Anything very noxious would kill these organisms and thus cannot be put into the system.

Storm water (via Pond 10) emanating from the noxious trade area goes into the treated waste flow from the industrial treatment works (and then on to the coastal recharge basins).



Industrial Wastewater Treatment Works.



Entrance to Wes-Fleur Wastewater Treatment Works with domestic WWTW in background.

Basin 5: Storm water detention basin (optional stop): Basin 5 is a storm water detention basin that was modified into a wet pond so that reeds would grow. This was done by installing an outflow control valve so that outflow would occur only after the pond had filled up. This pond receives approximately half the storm water flow from the south-western part of the industrial area excluding the noxious trade area. The storm water it receives may carry dye and salts illegally discharged into the storm water system. The reeds are very useful for removing suspended solids from the water. The reeds need to be harvested as required so that they don't grow too thick and impede the flow. The groundwater in this area is more saline as it is located closer to the shale. This pond drains to Basin 6 for further polishing and blending with domestic effluent before it goes on to Basin 7 and Basin 12 for artificial recharge. (Basin 5 along Neil Hare Rd: 33.59661°S; 18.48518°E)

3. Basin 9: Industrial storm water detention basin (33.60405°S; 18.47197°E)

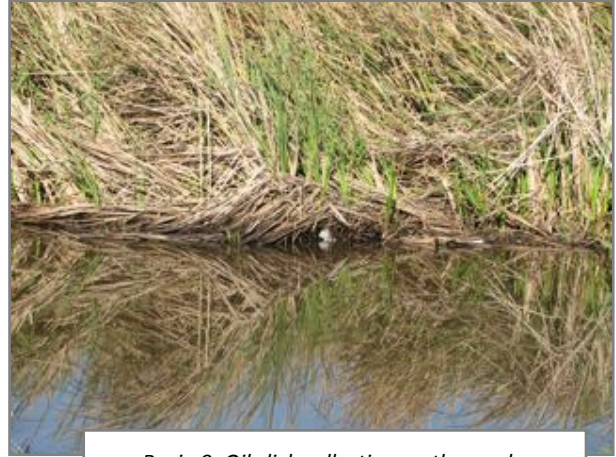
Return to Neil Hare Dr from the WWTW, turning left on this road. Go about 300m and turn into your first right, which is a smaller road with no name (33.60492°S; 18.47399°E). After about 200 m you will see Basin 9 on the left hand side (see Google image above).

Time required: 10 minutes

Basin 9 receives the remaining storm water from the south-western part of the industrial area of Atlantis (excluding the noxious trade area) and thus forms part of the storm water management system. Its purpose is to collect water from the industrial area from storm events and to slow down peak flow i.e. it is a 'detention' basin. Note that this water is often noticeably oily and more contaminated than the residential storm water. It also receives dirtier industrial storm water than Basin 5 as it drains the area with heavy industries. This pond was designed and is operated as a "wet" pond. The reeds growing in this basin were encouraged to grow for quality improvement and assist in further slowing down this storm water, as well as breaking down organic matter from the industrial run-off. While dark water flows into this pond, clear water exits from this basin and flows to Basin 6 where it joins both the cleaner residential storm water run-off, as well as the much cleaner treated domestic wastewater, before continuing to Basin 7 for the purposes of artificial recharge. Ideally, the Basin 9 outflow should be diverted away from Basin 6 and not used as part of the flow for recharging Basin 7.



Basin 9: Industrial storm water detention.

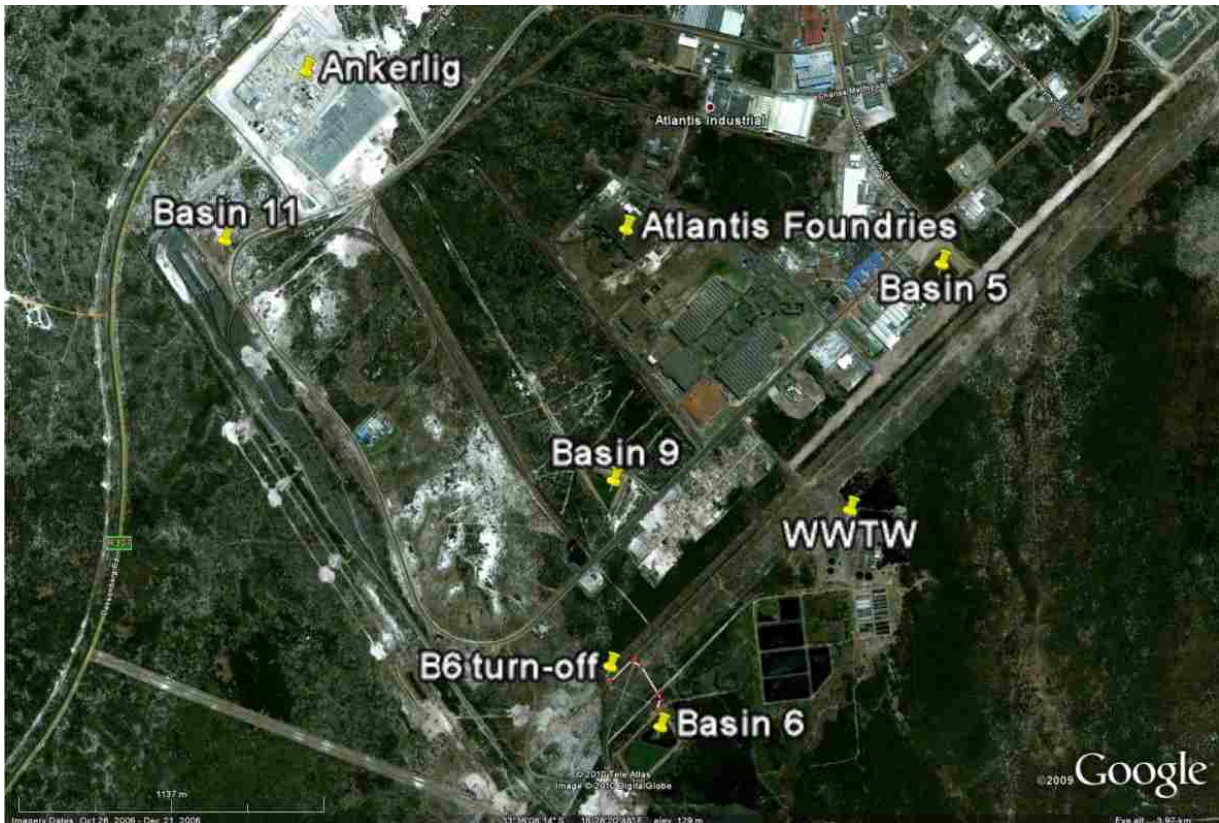


Basin 9: Oil slick collecting on the reeds.

4. Basin 6: Silt reduction and holding basin (33.61188°S; 18.47416°E)

Directions: Return to Neil Hare Dr and turn right. Go south on Neil Hare Rd through the industrial area of Atlantis for less than 1 km. Turn into your first left onto a small tar road (just before the MSA building on your left). The tar soon turns to gravel; travel approximately 100m on the gravel and then (33.61088°S; 18.47220°E) take the left track (staying left), take the first turn to the right about 80 m further until you arrive at Basin 6 (refer Google image below).

Time required: 15 minutes



Google Map showing the WWTW and several basins in the industrial area.



The car (returning from Basin 6) shows where to turn to get onto the track that leads to Basin 6 (coordinates: 33.61088°S; 18.47220°E).

Basin 6 acts primarily as a silt reduction unit for peak flow reduction of storm water. Because Atlantis is built on sand, the storm runoff collects significant volumes of sand which needs to be settled out prior to diversion to the infiltration (recharge) basins. Basin 6 is divided in half and the first half is a key component of the management system of the AWRMS as it is used for final 'polishing' (i.e. removing sediments). It brings together water from several different sources: (1) all the residential storm water; (2) most of the industrial storm water; and (3) the treated domestic wastewater (i.e. effluent from the domestic wastewater treatment plant). Basin 6 thus receives water from Basins 2, 3, 4, 5, and 9. The water reaches the second half of the basin by flowing over an embankment. The whole basin serves as a reed bed. When the water leaves Basin 6, it then flows to Basin 7 for the purpose of artificial recharge.

Note that the following basins do not drain to Basin 6: Basin 8 located north of the Ankerlig Power Station has not yet been built; Basin 10, which drains the noxious trade area and groundwater that is high in sulfate, is diverted to the coastal recharge basins; and Basin 11 drains into the field to the south-west of the Atlantis railway station.



Basin 6: Storm water inlet with entrance covered to prevent children playing inside.



Basin 6: Inlet from treated domestic effluent (centre) and large diameter inlet from storm water collection system (right).

5. (a) Softening Plant (33.62657°S: 18.44334°E)

Directions: Return to Neil Hare Rd from Basin 6 and turn left. This takes you through the noxious trade area of the Atlantis industrial area. Pass the large Pro Meal factory and pass under the train bridge. As the road curves right, note Basin 11 on your left (coordinates: 33.59714°S; 18.45698°E; optional stop – see notes below). Take your first left towards the R307 (direction Cape Town / Darling), which will take you past the side boundary of the Eskom Ankerlig Power Station. At the t-junction, turn left onto the R307 (direction Cape Town and Table Mountain), called Dassenberg Drive. Note the non-vegetated white dunes some distance to the right. These dunes are important for the natural recharge of the aquifer. Drive approximately 4.5 kms on the single lane highway. Turn right into the gate of the Witzand Water Treatment Plant and Pump Station to sign in and park.



En route to Softening Plant.

Time required: Optional depending if the group is to be received by staff from the Softening Plant (also see Google image below).

Contact Mr John Charles (Manager: Atlantis Water Scheme Utility Service – Bulk Water) 021 577 5000 /2 /3 /4 - john.charles@capetown.gov.za or Mr Paul Wyngaard (Senior superintendent) 021 577 5000 /2 /3 /4 - paul.wyngaard@capetown.gov.za.



En route to Softening Plant: Eskom Ankerlig Power Station.



Google Map showing relative locations of the Softening Plant, Basin 7 and the Coastal Recharge Basins.



Softening Plant Office Block.

The Softening Plant was put in place in 1986 in order to supply a consistent quality of water to the various users to the standard defined by what is now called SANS 241 regarding the quality of potable water. This standard states that the maximum water hardness allowed is 200 mg/L as calcium carbonate. The natural level of hardness from the Witzand wellfield ranges from 200 – 275 mg/L as calcium carbonate. The Softening Plant treats groundwater abstracted from the boreholes that supply Atlantis. In view of the natural salinity of the water a weak base ion exchanger was selected, which actually reduces the total salinity somewhat. The water is softened to give the required quality before it is piped to the residential and industrial areas of Atlantis for domestic and industrial use. Bypassing of part of the flow is possible to retain a low level of hardness in the final water.

Laboratory facilities are on-site at the Softening Plant and the water is tested at three stages: the blended raw water received from the borehole network; the softened water that has been sent through the ion exchange process; and the final blended water of both softened and raw water.

Staff at the Softening Plant offer tours of the facilities to school children and visitor groups if arranged in advance.



Water softening plant: water level monitoring.



Raw groundwater blending tank at Softening Plant.



Waste acid pond: backwash brine from regeneration process (right); dilution water from borehole (back right); disposal pipeline suction (black pipe).



Basin 11

Basin 11: Industrial storm water detention basin (optional stop): Basin 11 collects industrial storm water, primarily run-off from the nearby large Eskom plant. The water from this basin is discharged into the field to the south of the railway line where it will naturally recharge. (Coordinates: 33.59714°S; 18.45698°E).

(b) Borehole G30966 (33.62719°S; 18.44113°E)

Directions: One of the many production boreholes can be seen on the west (sea) side of the Softening Plant's enclosure. If you walk up the road that turns to the left on entering the Softening Plant area, you will see the borehole outside the fence.

Time required: 15 - 20 minutes (including walking time)

Borehole G30966 is dedicated to irrigation onsite and regeneration waste dilution to prevent precipitation of calcium sulphate in the brine pipeline from the Softening Plant.



Peter King, Rodney Bishop and John Charles at Borehole G30966.

With regards to the production boreholes, they pump into a network of pipes that feed into the raw water blending tank at the Softening Plant where the water is analysed for certain parameters. Depending on the results, a certain percentage of the flow is pumped through the ion exchange units, then the de-gassing unit and then blended with the balance of the raw water to achieve the desired hardness of 175 mg/L. This water is then pumped up to holding reservoirs for the residential and industrial areas of Atlantis.



De-gassing chamber.

There are various operational problems associated with the use of multiple production boreholes. Characteristics of groundwater and surface water are completely different and require different abstraction and treatment processes. Borehole clogging has been one of the main issues with the AWRMS over the years. The boreholes have lost efficiency over time, and this is likely due to them being operated at too high rates. When pumped at too high a rate, the water levels in and around the boreholes drop too much, which allows for the ingress of oxygen into the borehole and the gravel pack and the aquifer around the borehole that can result in iron-related borehole clogging problems. This can be minimised (but not eliminated) by limiting the water level draw down by decreasing the pumping rates and increasing the pumping hours. Effective management, monitoring, and regular rehabilitation programmes are key to the success of multiple production borehole schemes.



A. Hön sampling the clogging material on the borehole pump.

6. Basin 7 (main recharge basin): (entrance coordinates: 33.62858°S; 18.44154°E)

*Directions: A key that is kept at the Softening Plant is needed to enter the gate that leads to Basin 7. From the Softening Plant, turn right into the R307 and continue for 200 m until you see a gate/track on your left hand side (you will need to have the key to the gate). Drive to the end of the track, then onto the embankment passing alongside the Basin on the left, to see the **splitter box** (33.62730°S; 18.45206°E). On the way back, note the **stilling basin**, and then continue back for good views of Basin 7.*



Basin 7: Parking spot and viewpoint.

Time required: 20 minutes

Basin 7 is the main recharge basin of the Atlantis WRMS. A second basin, Basin 12, where the natural groundwater quality is better than at Basin 7, was added in 1994. It receives the highest quality recharge water (mainly in winter). Basin 7 is fed by Basin 6 and thus receives the final effluent from the domestic wastewater treatment plant, all the residential storm water, and most of the industrial storm water.

About 80 m above the inlet to Basin 7, the *splitter box* (33.62730°S; 18.45206°E) is designed to separate episodic storm water peak flow that is of better quality (i.e. less saline) to Basin 12 (the 2nd recharge basin), and perennial poorer quality storm water baseflow (more saline than peak flow) and treated domestic wastewater into Basin 7.

The stilling basin is designed to allow measurement of the inflow over the weir but it also gives an additional opportunity for any sediment to settle out.

Basin 7 is a natural depression with two built embankments. The location of the main recharge basin was thus based on topographical considerations and not on infiltration rates i.e. the water flow to Basin 7 is based on gravity, but note that higher infiltration rates would have been gained if the basin had been built on the top of the dunes.



Recharge Basin 7.

Two key issues with recharge schemes are thus the following:

- 1) Infiltration rate (i.e. the speed at which the water will go into the ground): In a continuous recharge situation, this is governed by the **hydraulic gradient** away from the basin.
- 2) Water quality: The quality of the water being infiltrated into a recharge basin is a critical concern that requires close monitoring.

In the case of Atlantis, the rate of infiltration decreased over the years in Basin 7. Additionally, Atlantis grew and hence there was increased run-off from the developed area. Also, new boreholes were developed on the inland side of the West Coast road. To address this situation, a decision was made to develop a 2nd recharge basin (Basin 12).

Additionally, during the period that the industrial wastewater treatment works was being built, all wastewater went through the domestic WWTW. Because there were concerns about using this water for artificial recharge, this combined effluent was discharged into the Donkergat River. During this period, Basin 7 could be dried out. Once it was dried out in the summer of 1989 when storm water flow was limited and also diverted to the Donkergat River, a front-end loader was used to scrape away the bottom layer of sediment (mud, debris and other matter that accumulates and slows down the infiltration process) and this improved infiltration dramatically once it was put back into use. (This was the only time Basin 7 has been dried and scraped out in its 20+ years of operation. Ideally, this should be done every 15 years under the present conditions). Note that during the time that Basin 7 was bypassed, 3500 megalitres was lost to the artificial recharge system. This resulted in a significant drop in water levels in the Witzand area and adversely affected the rate of clogging in the boreholes.

Both Basin 7 and Basin 12 recharge the aquifer at a rate of about 1.5 to 2.5 Mm³/a.

With regards to water quality, a guiding principle of the AWRMS from its inception has been that the recharge water must be of the same or better quality than the water in the aquifer that is being recharged. These concerns (ie the presence of persistent organic compounds, colour and heavy metals in the industrial wastewater together with the higher salinity) led to the separation and diversion away from Basin 7 of the treated industrial wastewater.

7. Coastal Recharge Basins (33.63554°S; 18.41335°E)

Directions: From the Softening Plant turn right onto Dassenberg Dr / R307; travel 0.5km to the t-junction and turn right on to the R27; travel 0.6kms to the gate of the Eskom nature reserve on the coastal side (you will need the key from the Softening Plant). Once inside the gate, turn right following the fence line; pass various boreholes. At the "Trail's End" rest spot, follow the dirt track left-ish. Follow the winding dirt road in the direction of the 'bird' trail signs. After 3.1km's continue straight (off the bird trail) to immediately stop and see the inlet of coastal basin 1a.

To continue on, return to following the bird trail signs to the coast. When the bird trail turns off the dirt road to a walking trail, continue on the road, which will loop around smaller, empty basins.

On the return, turn right when you reach the t-junction with mountain bike signs; then left at the t-junction with a "30" sign; keep right after this and then you will be back to the bird trail you came in on (continue against the direction of the bird signs to return to the gate).

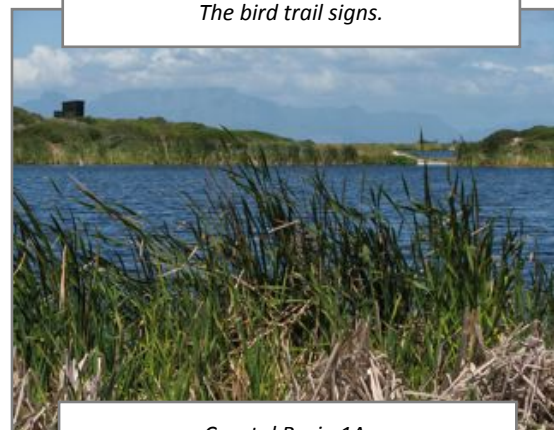
Time estimate: 30 – 45 minutes including driving from Softening Plant

These coastal recharge basins are recharged with treated industrial wastewater from the industrial wastewater treatment works; the Softening Plant waste; and storm water from the noxious trade area (via Basin 10).

Early in the development of the AWRMS, it was determined that the industrial effluent was not of adequate quality to be used for artificial recharge of the main aquifer. Parallel treatment works were thus established so that the industrial wastewater could be treated separately and disposed of independently. While the industrial effluent was initially diverted to the Donkergat River, further innovations to the AWRMS consisted of developing the coastal recharge basins and redirecting the industrial effluent there. The purpose of these recharge basins is to raise the water table in the area and prevent seawater intrusion into the main aquifer. These basins also provide a safe means for disposing diluted backwash from the water Softening Plant, treated effluent from the industrial wastewater plant and storm water from the noxious industrial area.



The bird trail signs.



Coastal Basin 1A.

A positive side effect from these recharge basins is that the groundwater level upstream of the coastal recharge basins has risen. Eskom also sees the bird life that developed around the coastal recharge basins as a plus point for the nature reserve.

Return the keys to the Softening Plant and then return to Cape Town on the R307, connecting to the R27.