Groundwater supply for Cape Town:
*Low hanging fruit? What else are we missing?*

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Wasted opportunity
Business as usual?

Easier to achieve

Requires more effort but has higher returns

Huge effort. Large investment. Takes time to get there
Groundwater
Aquifers
Treated effluent
Stormwater
Rainwater harvesting
Desalination
Pipelines from other regions
Building more dams
Low hanging fruit
Low impact
Treated effluent
Groundwater Aquifers
Stormwater
Rainwater harvesting
Makes no difference
Harvesting mist
Water from air
High impact
Cloud seeding
Maybe later
Not worth doing
Icebergs
High effort
Low effort
Agenda

- LEARNING FROM OTHER CITIES
- BOREHOLES AND WELL POINT ABSTRACTION
- CAPE FLATS AQUIFER
- MANAGED AQUIFER RECHARGE
- BACK TO BUILDING A WATER SENSITIVE CITY
  - WHAT ARE WE MISSING?
Perth Water Supply Security

920 GL = 750,000 acre-ft

Inflows

Population

Total Water Supplied

Billion Litres of Water (GL)

1958
92% Dams
8% G/water

1980
65% Dams
35% G/water

2004
38% Dams
62% G/water

2014
7% Dams
51% Desal
42% G/water
1% GWR

2022 Likely
0% Dams
65% Desal
24% G/water
11% GWR

Perth 3
Hydrological Cycle: groundwater flow

CSIR, 2003
Aquifers: Unconfined Vs Confined

- Confined aquifer
- Unconfined aquifer
- Confining unit
- Recharge area
- Water table
- Potentiometric surface
- Flowing artesian well
- Perched water table well
- Water table well
- Artesian well
- Ground surface
- Confining unit
• **Groundwater**: subsurface water in soils and rocks that is saturated

• **Aquifer**: a layer of rock or unconsolidated deposits that contain sufficient saturated material to yield significant quantities of water. An aquifer can be **Unconfined** or **Confined**.

  • **Unconfined Aquifer**: is an aquifer with a water table open to direct recharge and discharge from the ground surface. (No impeding overlying strata)

  • **Confined Aquifer**: is where groundwater is confined, under pressure, by overlying relatively impermeable strata
Artesian Flow
• Fractured rock - deep aquifer: water exists in the fractures of rock, e.g. Table Mountain Group Aquifer
**Springs**

- **Spring** – A location where groundwater is discharged from the ground
Springs

- **Spring** – A location where groundwater is discharged from the ground

![Diagram of springs](image)
• Groundwater contribution to streamflow are known as baseflow.

• Sometimes areas of discharge can also recharge groundwater (i.e. Cape Town)
Groundwater...Infinite Resource?

- Groundwater is renewable, but if usage is higher than the rate of recharge the aquifer and related ecosystem can be damaged.
Groundwater Problems

- Boreholes can change the direction of groundwater flow

- Risk of contaminants entering drinking water supply

- Contaminants can also adversely affect other users:
  - Industry: salinity.
  - Agriculture: Salinity, pathogens
Salt Water Intrusion

- Saltwater is more dense than freshwater so it stays below the fresh water table.

- Pumping and drawdown can cause saltwater influx into what would naturally be freshwater aquifer.
Boreholes / Wellpoints

- Depth to static water level
- Static water level
- Depth to pumping water level
- Drawdown
- Pumping water level
- Pumping level minus static level equals Drawdown.
Land Subsidence

- Over abstraction of groundwater from an aquifer can cause land subsidence.
Cape Flats Aquifer

From Adelena, S. et al (2010) see reading
• Cape Flats Aquifer unconfined sand aquifer deposited on top of impervious Malmesbury shale and Cape granite bedrock.

• Well studied since the 1980’s. CSIR conducted extensive testing.

• Tests concluded that the CFA Aquifer is a valuable resource.

• Sustainable yield of 18 million m³
Cape Town CBD

Cape Flat Aquifer
Example of Managed Aquifer Recharge

Schematic example of Managed Aquifer Recharge via injection or infiltration
Simulated mean groundwater head elevation (meters above sea level) for the Cape Flats 2000-2015
MAR potential for the Cape Flats Aquifer
The impact of land use change on the CFA, comparing the simulated mean groundwater recharge for the land use of 1983 (a) and 2013 (b)
MAR: water supply

Summary Table of the scenario descriptions for MAR at Philippi and Mitchells Plain

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 14</td>
<td>The artificial recharge of ‘stormwater’, during the winter months (infiltration and injection) increased volumes of stored water from 2 Mm³ to 10 Mm³.</td>
</tr>
<tr>
<td>Scenario 15</td>
<td>Equivalent summer abstraction and winter recharge rates using a conservative rate of approximately 15 ℓ. s⁻¹.</td>
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<tr>
<td>Scenario 16</td>
<td>Summer only abstraction at maximum pumping rates at 32 ℓ. s⁻¹ with no artificial recharge at the Philippi site.</td>
</tr>
<tr>
<td>Scenario 17</td>
<td>Double summer abstraction at approximately 32 ℓ. s⁻¹ and a conservative winter recharge rate of approximately 15 ℓ. s⁻¹ at the Philippi site.</td>
</tr>
<tr>
<td>Scenario 18</td>
<td>Summer only abstraction at maximum pumping rates at 32 ℓ. s⁻¹ with no artificial recharge at the Mitchells Plain site.</td>
</tr>
<tr>
<td>Scenario 19</td>
<td>Double summer abstraction at approximately 32 ℓ. s⁻¹ and a conservative winter recharge rate of approximately 15 ℓ. s⁻¹ at the Mitchells Plain site.</td>
</tr>
</tbody>
</table>
Some conclusions from the study

- MAR can improve the wellfield yield at Philippi resulting in a sustainable yield of approximately 10 Mm$^3$ per year without risking seawater intrusion.

- The total sustainable yield of MAR schemes for Mitchells Plain and Philippi is approximately 18 Mm$^3$ per year (potentially 50 MI per day)

- Current CoCT water demand is approximately 320 Mm$^3$ per year therefore about 5% of water could be used sustainably to supplement CoCT supply if MAR is properly managed.
Managed aquifer recharge in cities

[Diagram of managed aquifer recharge in cities, showing various components such as WWTP, infiltration devices, storage of stormwater or treated wastewater, and interactions with urban river and wetlands.]
New thinking: the CITY as a catchment
A Water Sensitive, liveable city

‘Water: conserve, value and enjoy’ -
What are we missing?
Rebuilding our cities as if water really mattered
Biofiltration pond alongside the Liesbeek: 1997
Bank full canal: 15 October 25mm / 3 hours?
Turning contaminated runoff from an informal settlement clean water without chemicals
What can we learn?

• Need to adapt much faster to water scarcity
• Improve the commitment to building water sensitive cities
• Change behaviour and management: Conserve, Value and Enjoy
• You don’t manage what you can’t measure
Some references of interest

S Adelana, Y Xu, P Vrbka (2010) A conceptual model for the development and management of the Cape Flats aquifer, South Africa, Water SA Vol 36 No 4

https://journals.co.za/content/waters/39/2/EJC134881
KEEP CALM
AND
SAVE WATER
WHILE WE HAVE IT

Courtesy of the UCT Water Task Team