Groundwater supply for Cape Town:

Low hanging fruit? What else are we missing?

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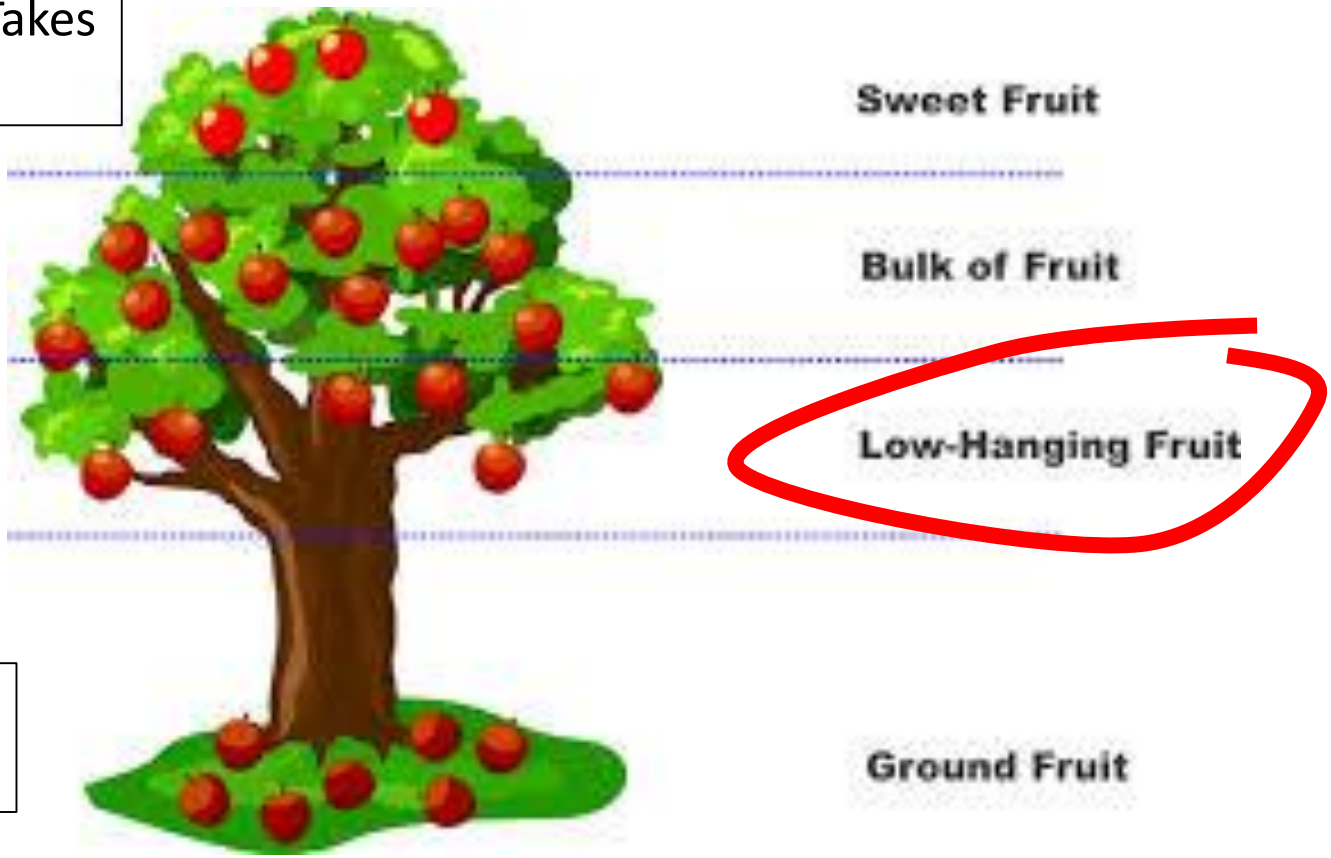
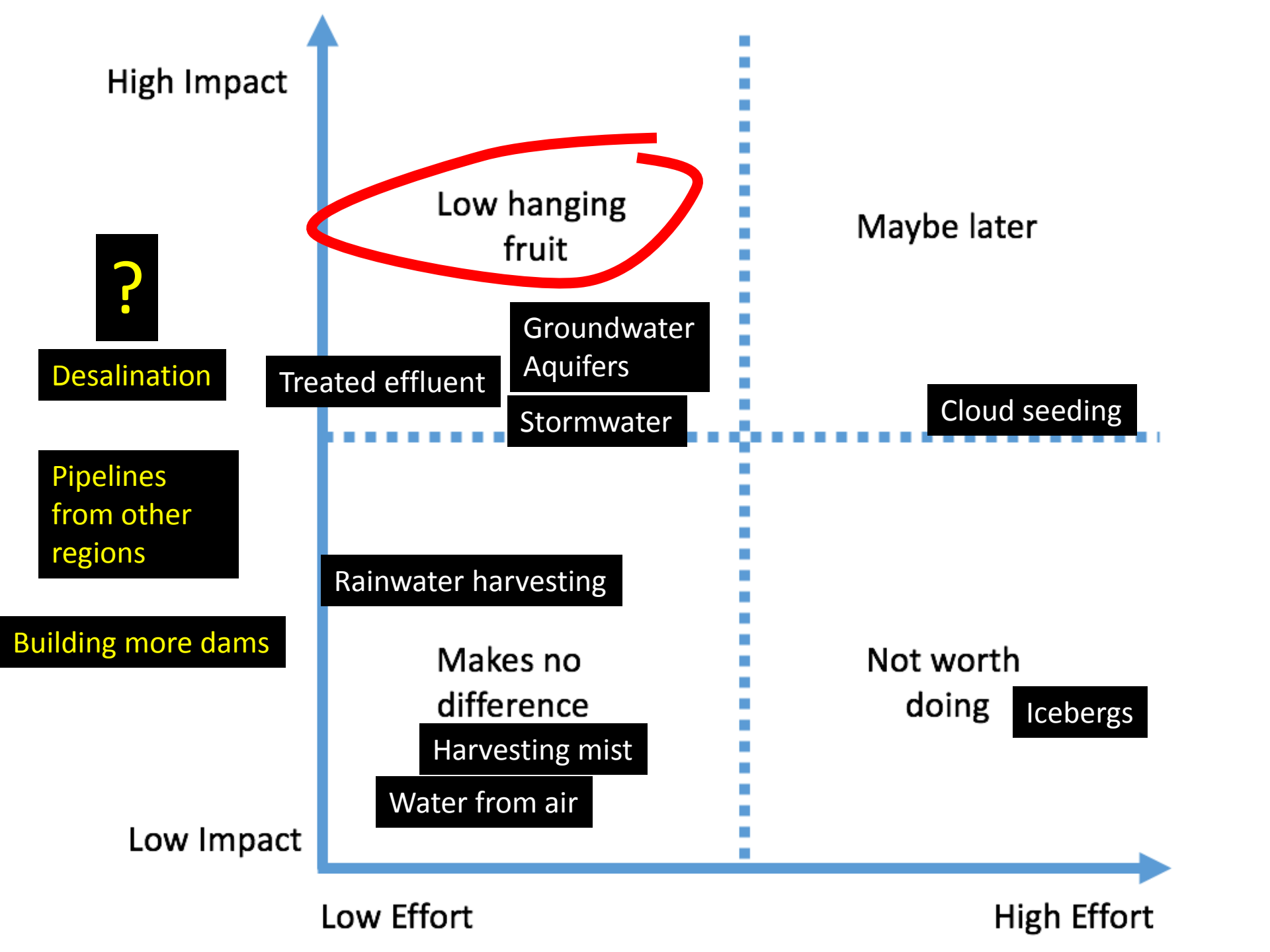
Huge effort.
Large investment. Takes time to get there

Requires more effort but has higher returns

Easier to achieve

Wasted opportunity
Business as usual?

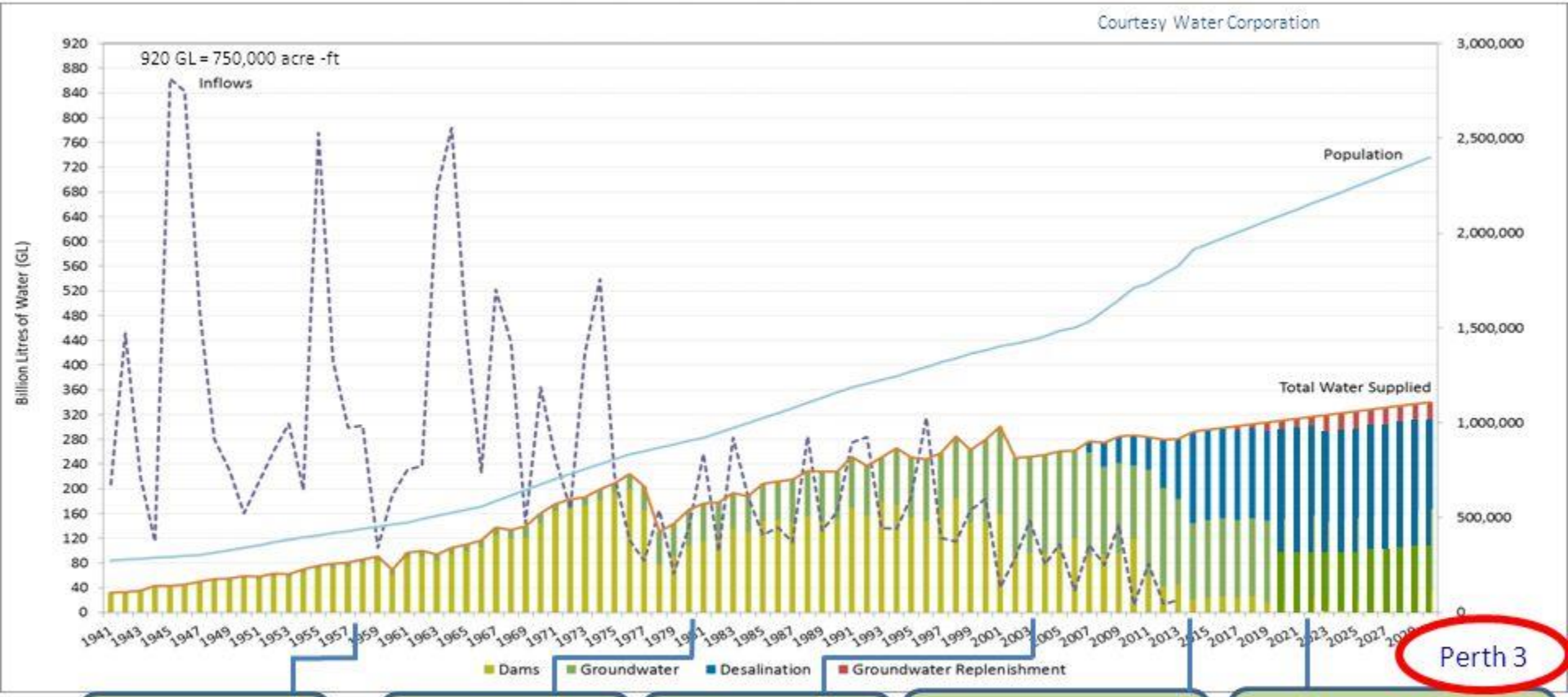



High Impact
Low hanging fruit
Maybe later
?
Desalination
Groundwater Aquifers
Treated effluent
Stormwater
Cloud seeding
Pipelines from other regions
Rainwater harvesting
Building more dams
Makes no difference
Not worth doing
Icebergs
Harvesting mist
Water from air
Low Impact
Low Effort
High Effort

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



1958
92% Dams
8% G/water

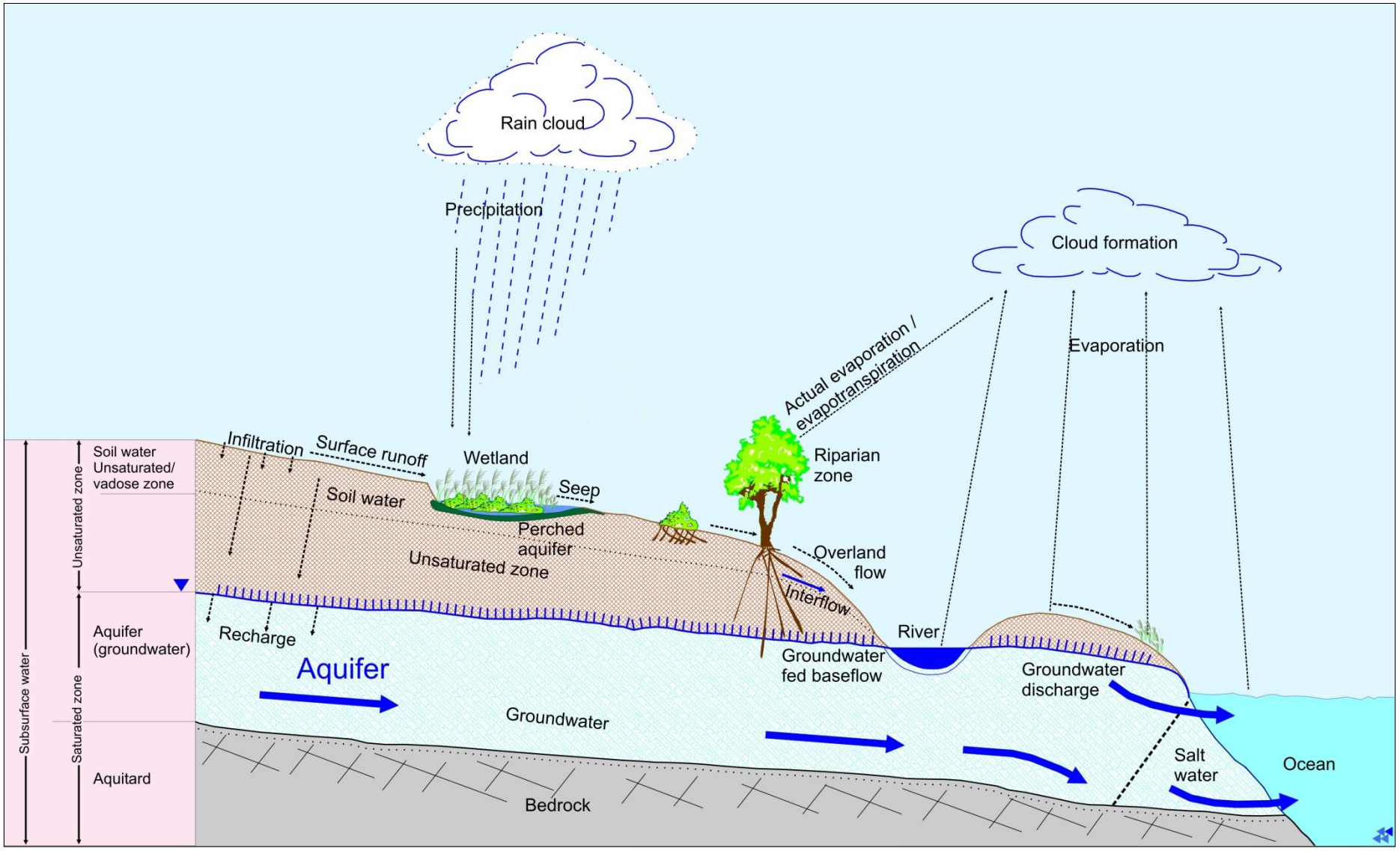
1980
65% Dams
35% G/water

2004
38% Dams
62% G/water

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

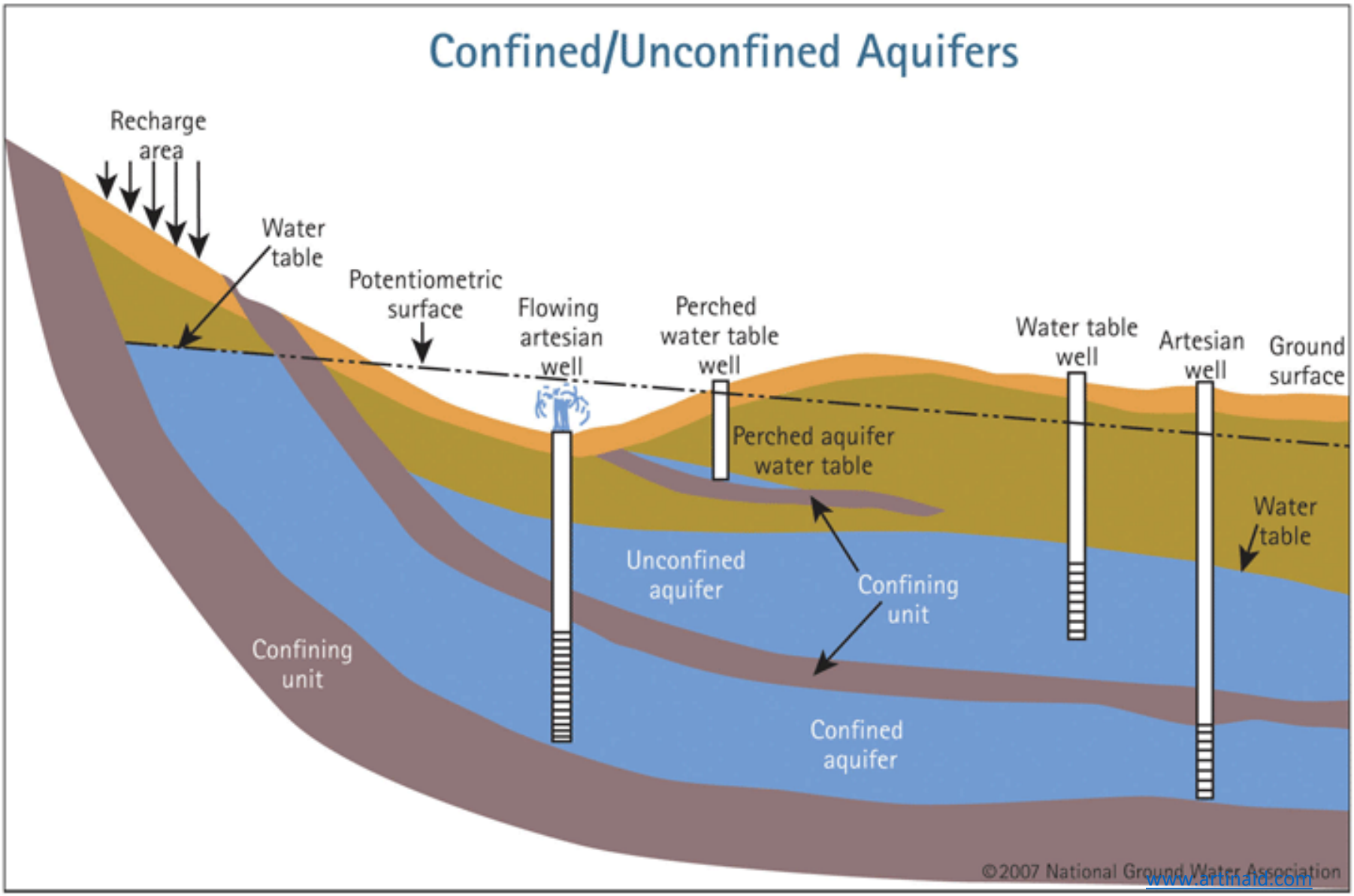
2022 Likely
0% Dams 65% Desal
24% G/water 11% GWR

Hydrological Cycle: groundwater flow



CSIR, 2003

Aquifers: Unconfined Vs Confined



- **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**.

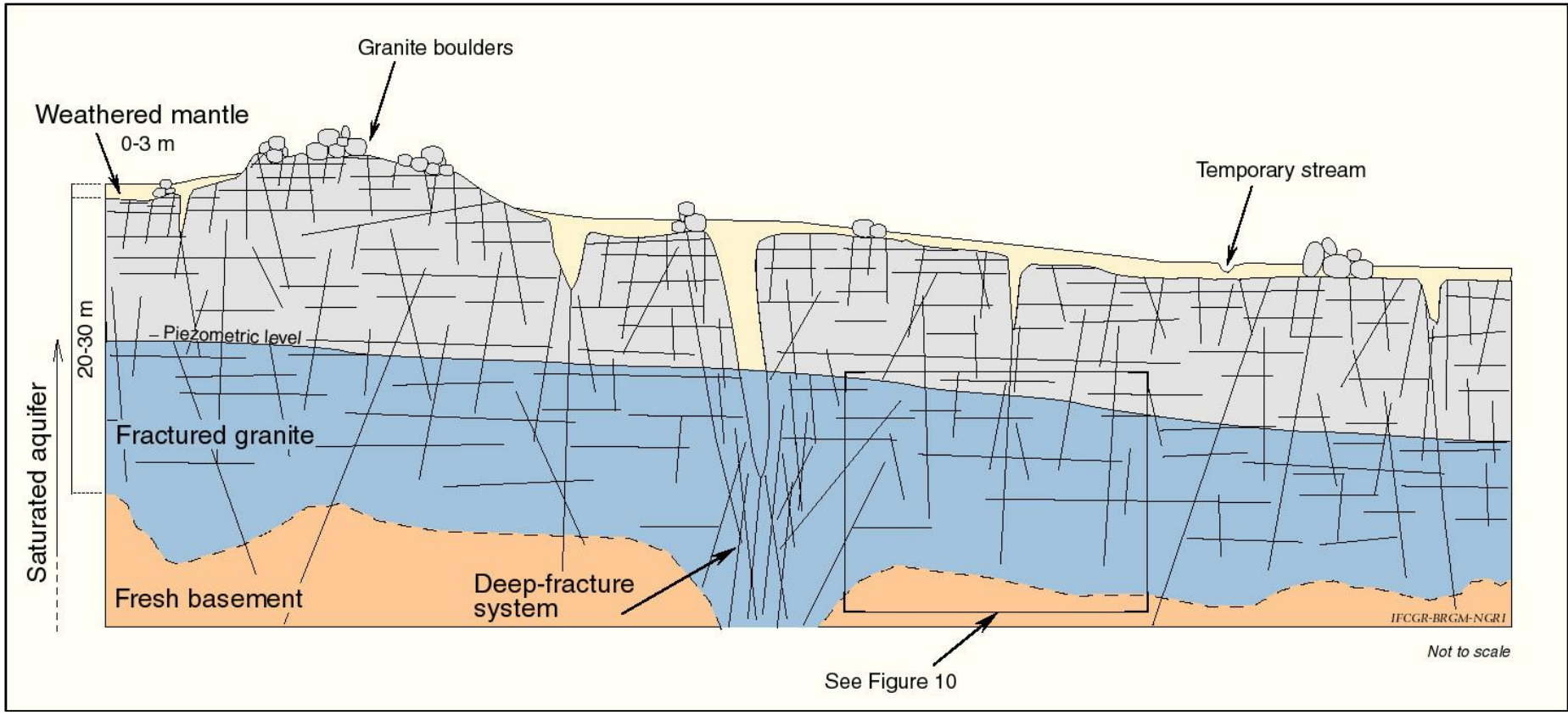
  - **Unconfined Aquifer:** is an aquifer with a water table open to direct recharge and discharge from the ground surface. (No impeding overlying strata)

  - **Confined Aquifer:** is where groundwater is confined, under pressure, by overlying relatively impermeable strata

Artesian Flow

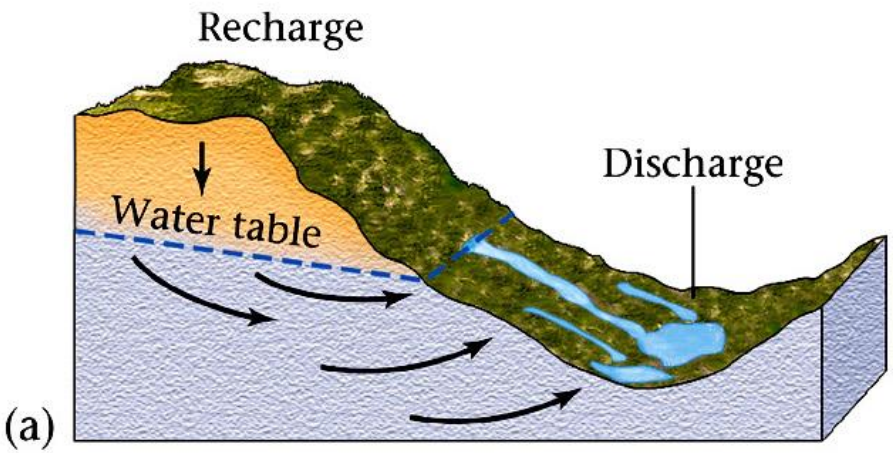
www.euwfd.com

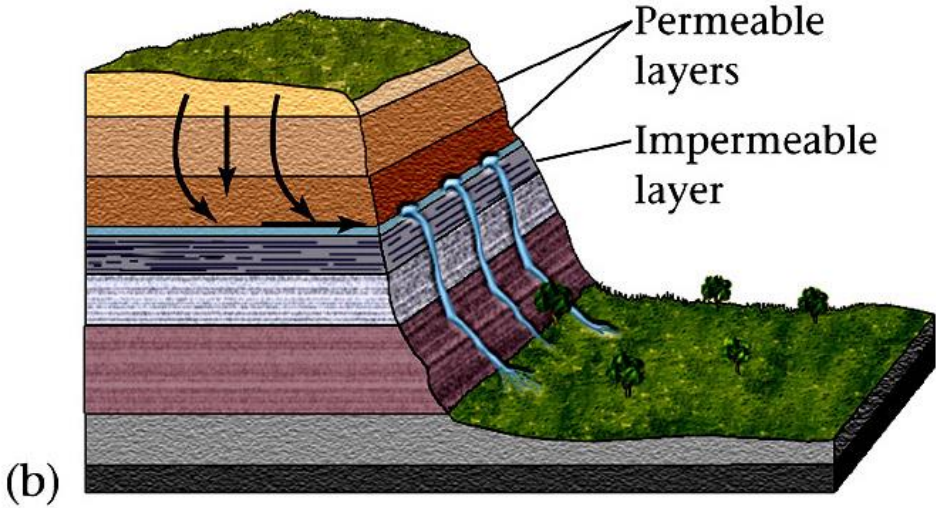
- **Fractured rock - deep aquifer:** water exists in the fractures of rock, e.g. Table Mountain Group Aquifer

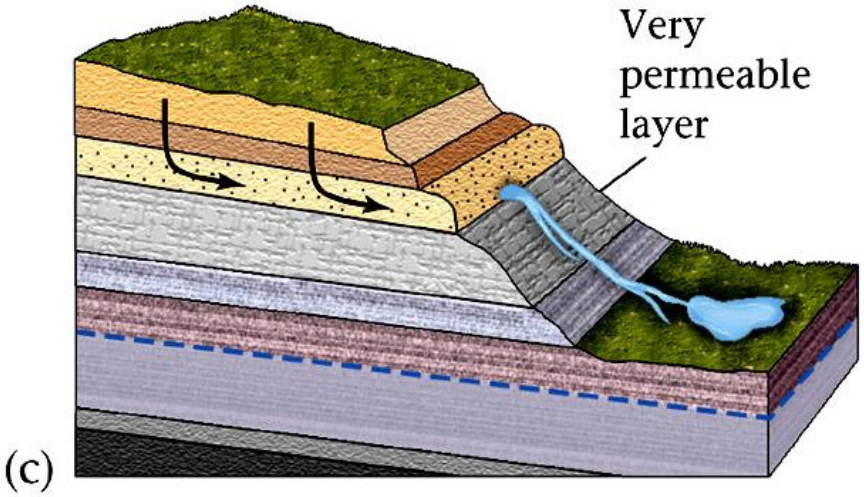


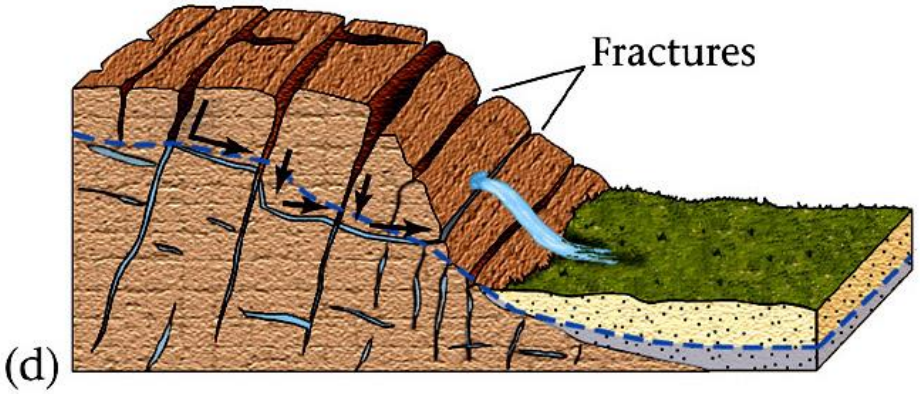
Springs

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







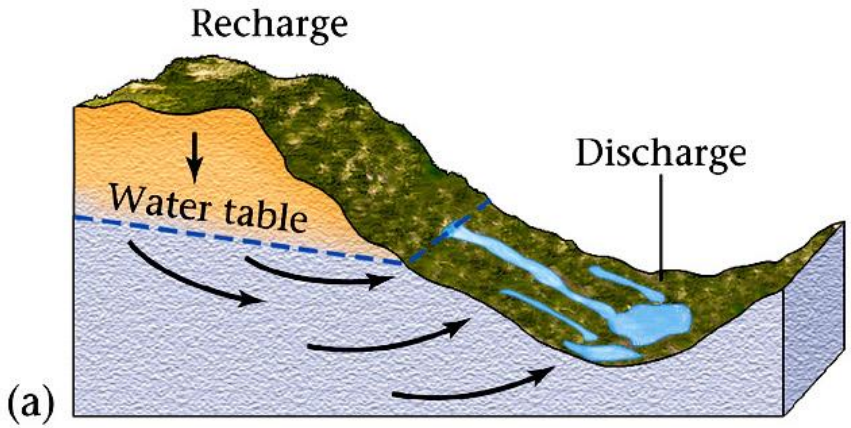


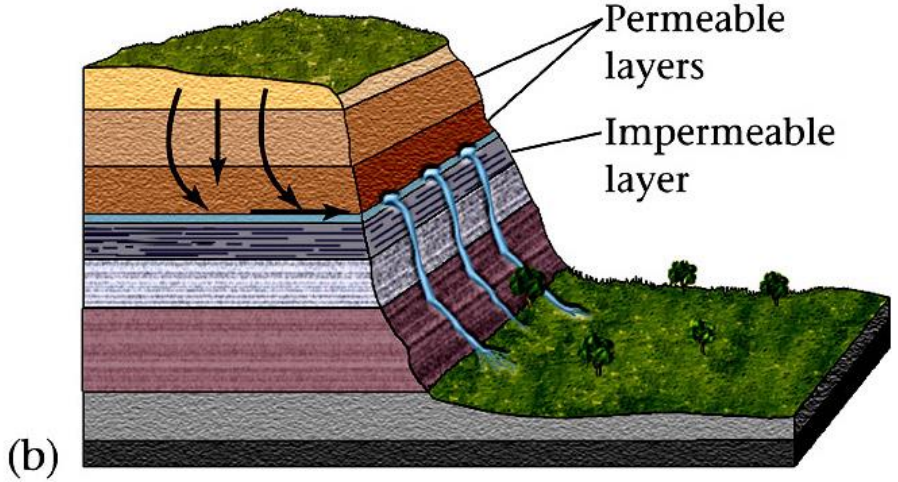

SPRINGS
WAY
WEG

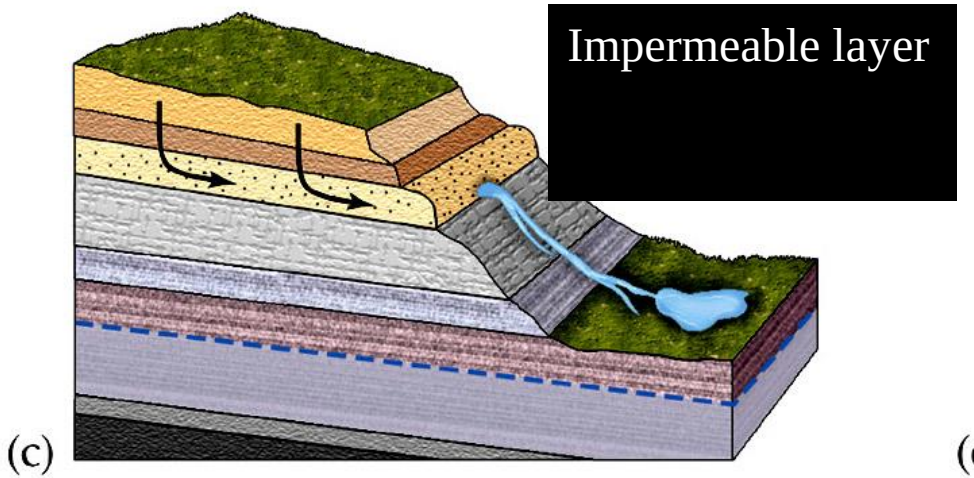

25L
per person per fill

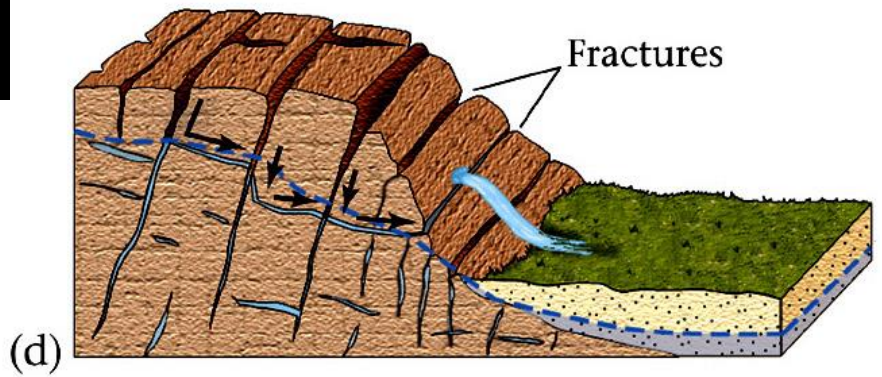
Springs

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

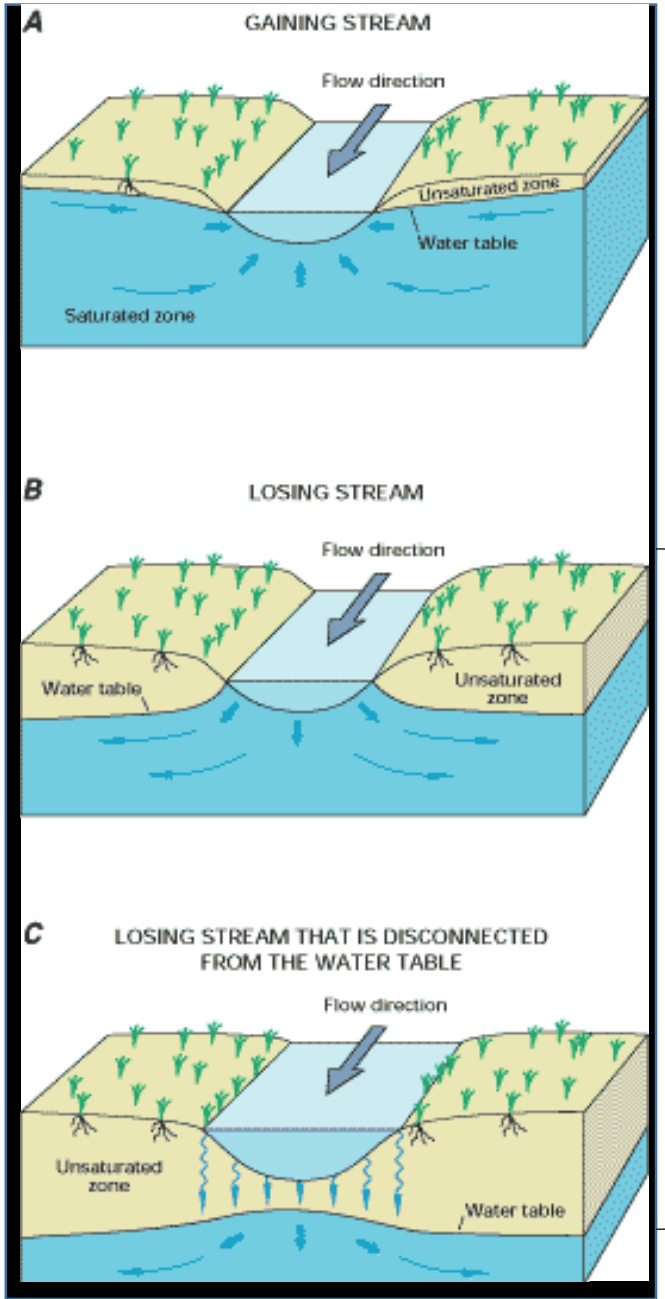








Recharge and Discharge



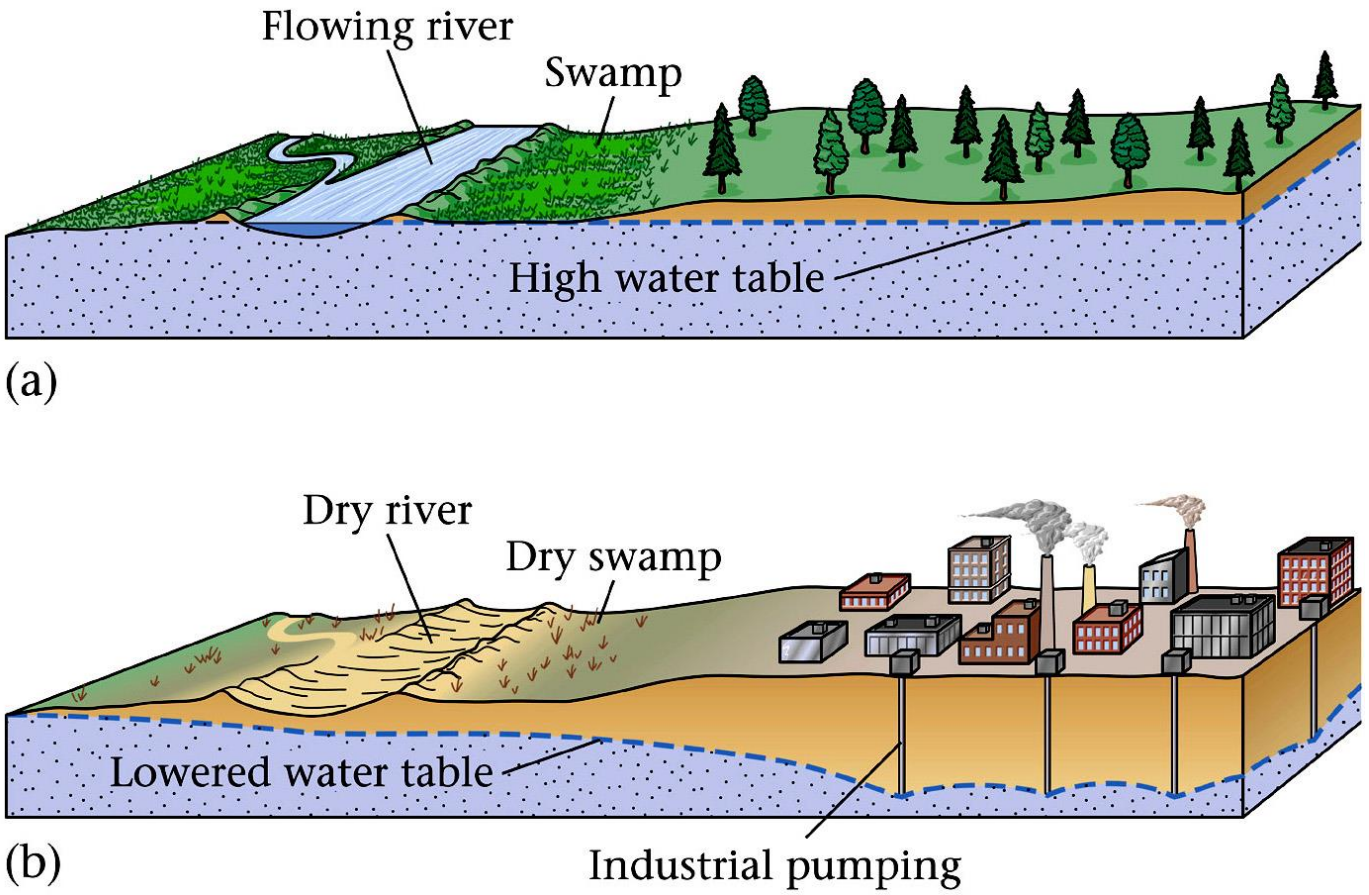
Winter

Summer

- Groundwater contribution to streamflow are know as baseflow.
- Sometimes areas of discharge can also recharge groundwater (i.e. Cape Town)

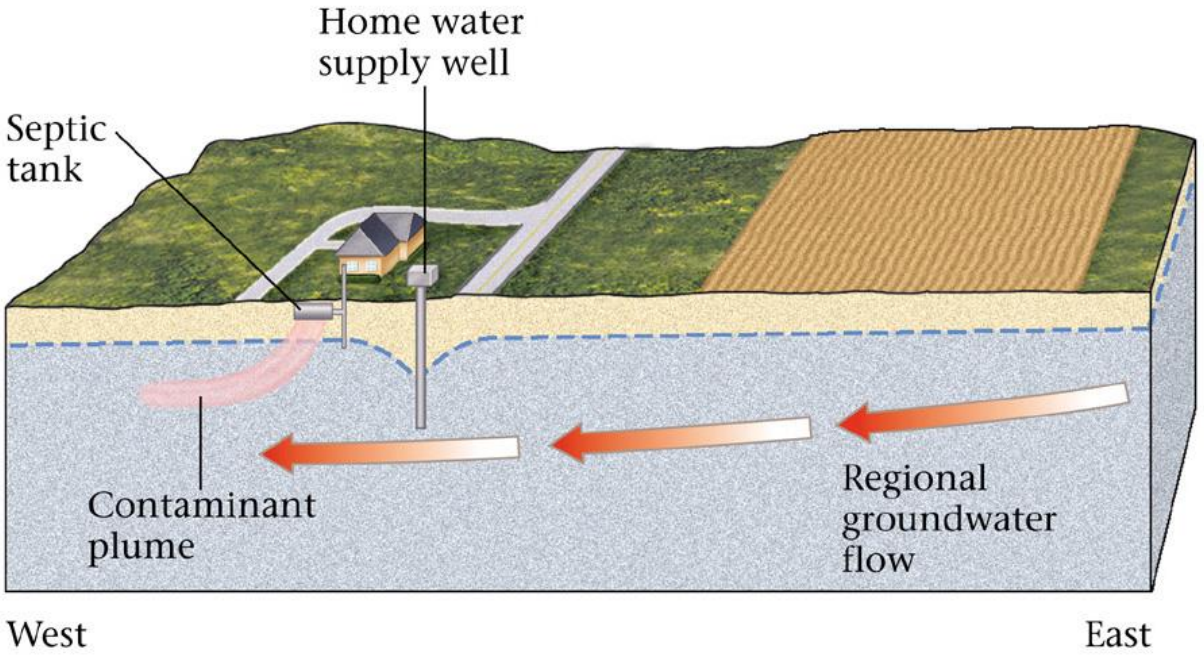
Groundwater…Infinite Resource?

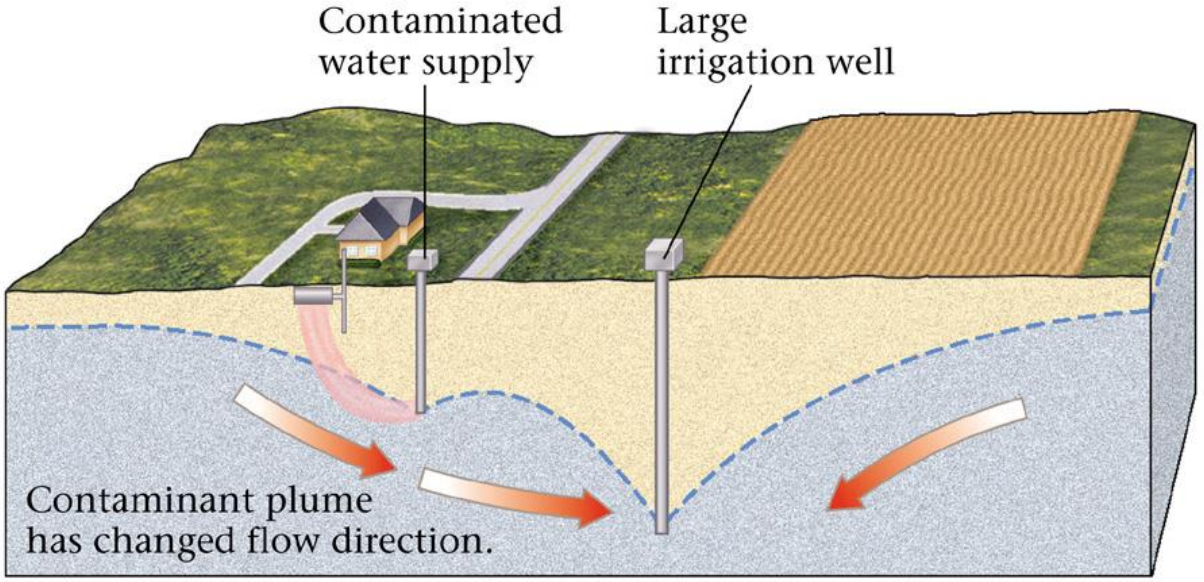
- Groundwater is renewable, but if usage is higher than the rate of recharge the aquifer and related ecosystem can be damaged.



Groundwater Problems

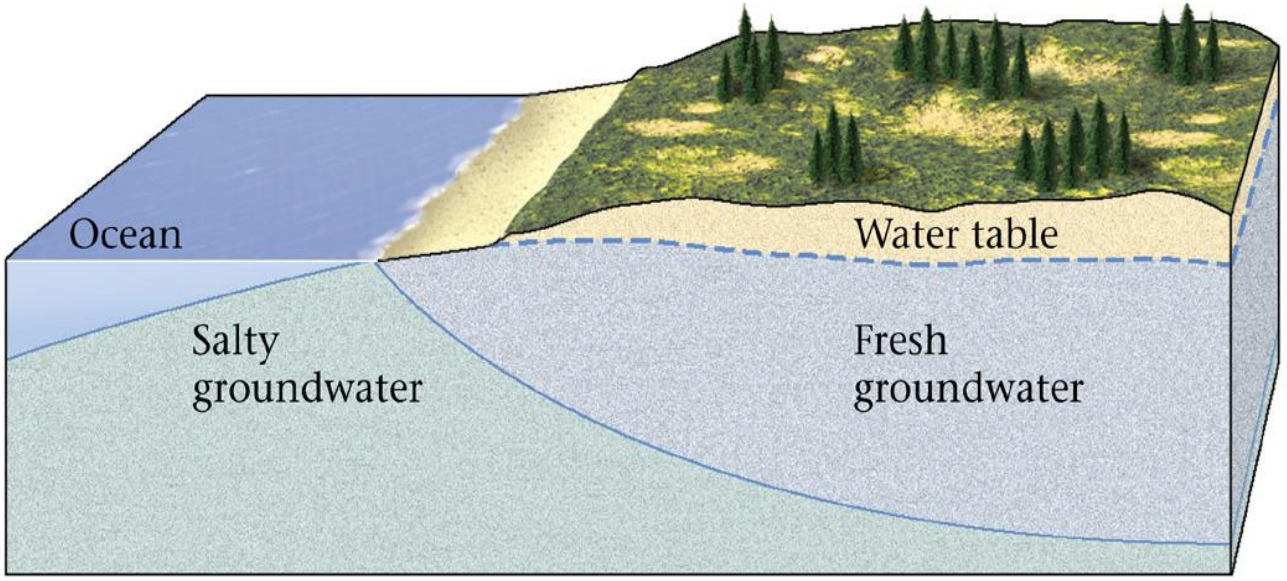
- Boreholes can change the direction of groundwater flow
- Risk of contaminants entering drinking water supply
- Contaminants can also adversely affect other users:
  - Industry: salinity.
  - Agriculture: Salinity, pathogens



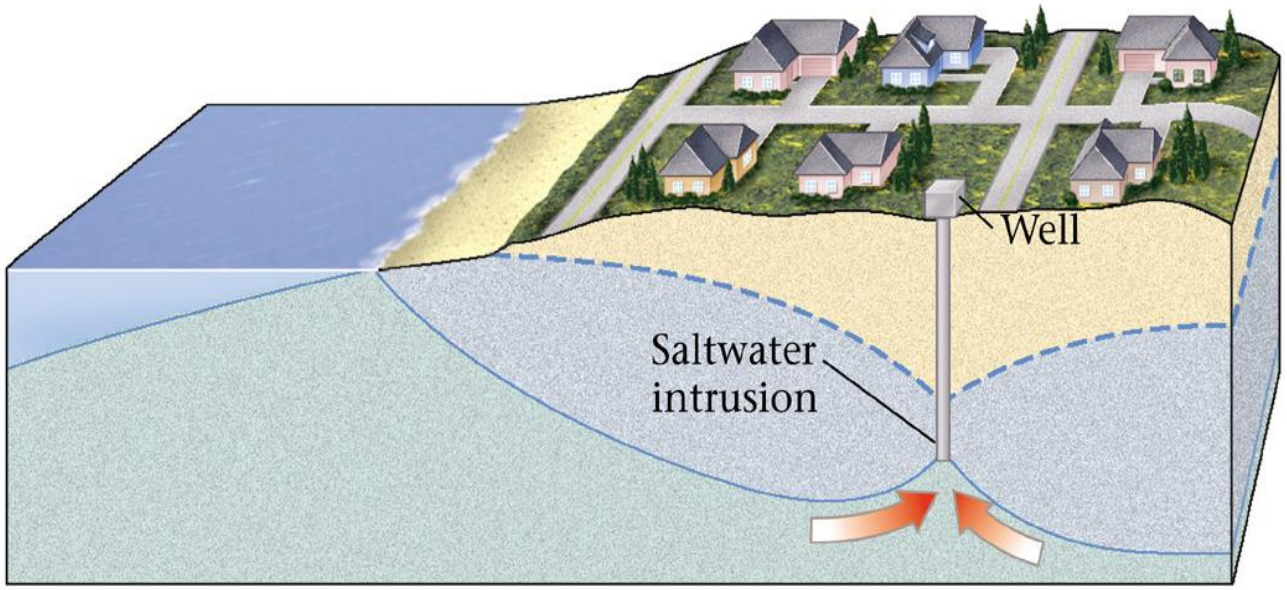


Salt Water Intrusion

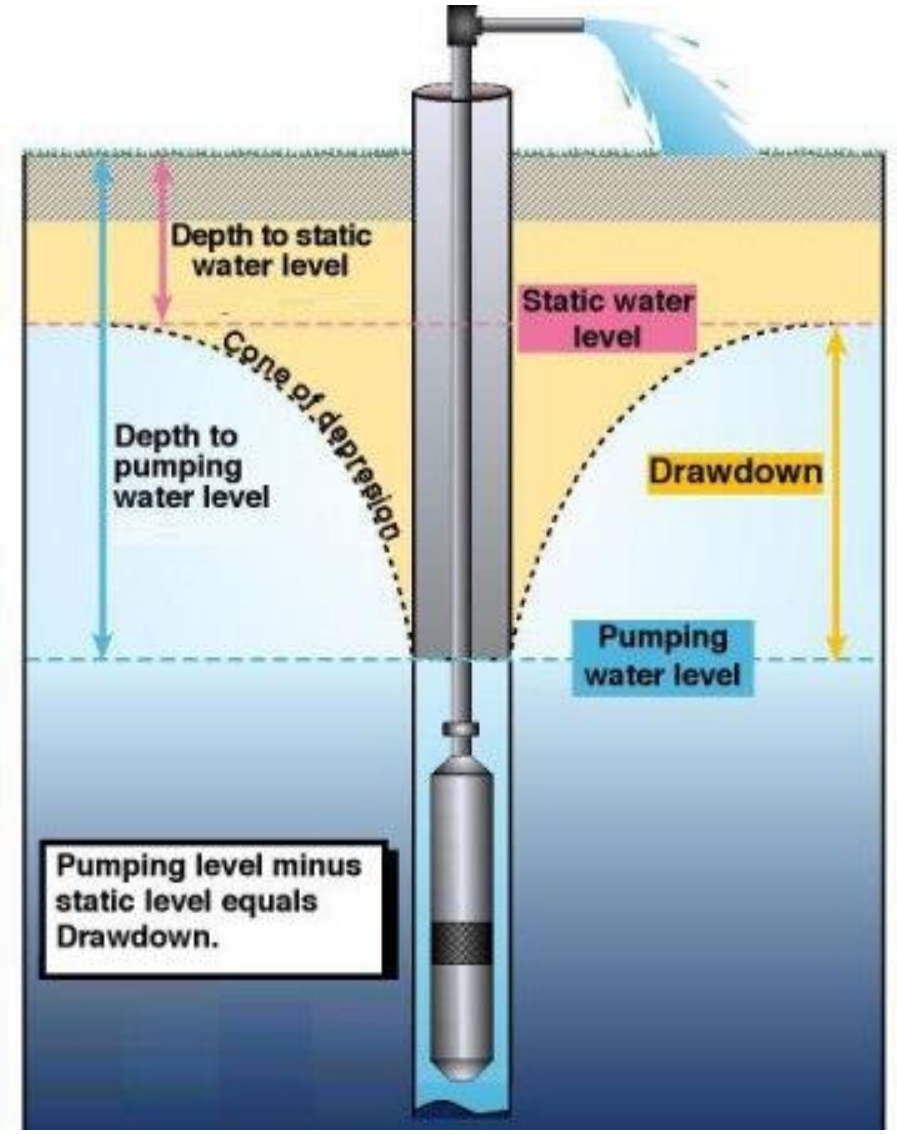
- Saltwater is more dense than freshwater so it stays below the fresh water table



- Pumping and drawdown can cause saltwater influx into what would naturally be freshwater aquifer



Boreholes / Wellpoints

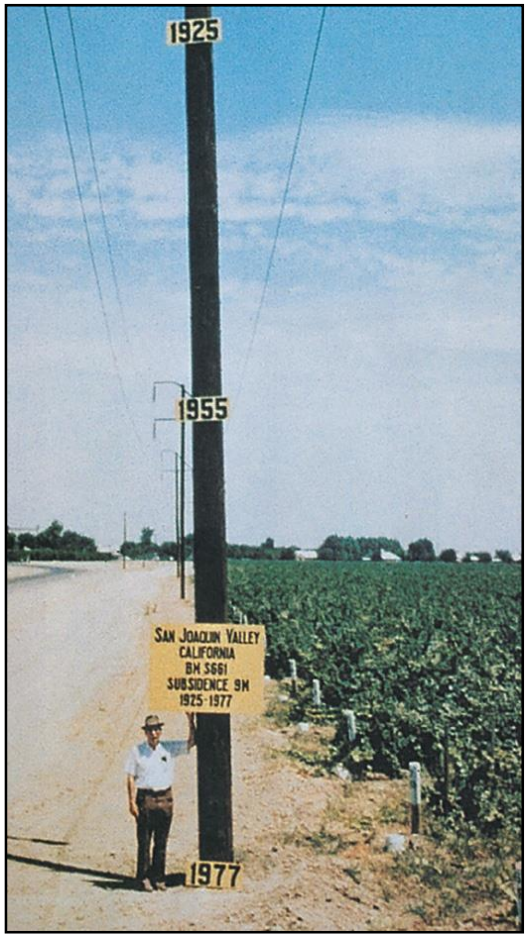


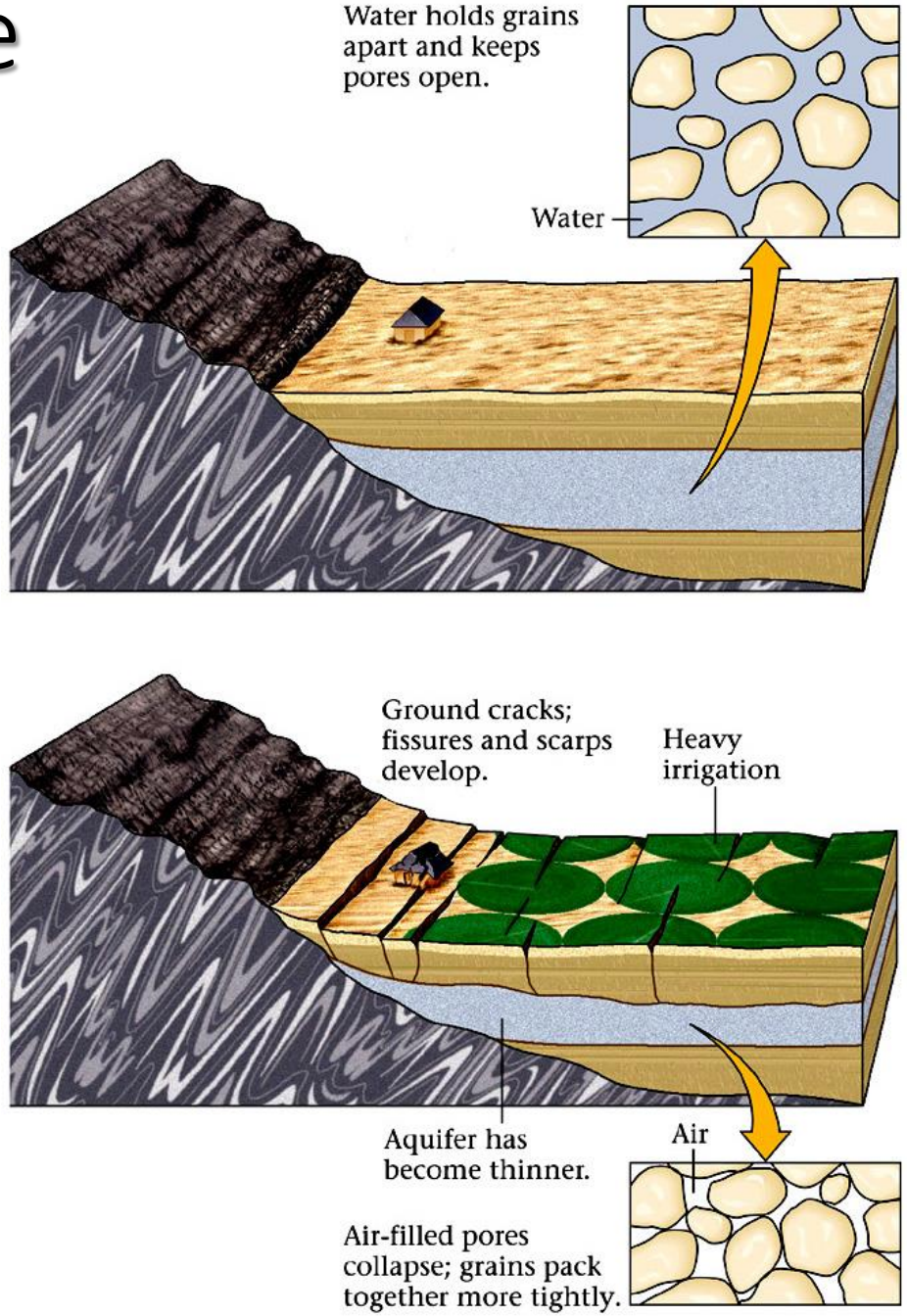
www.wellcore.co.za

www.pumpexpress.co.uk

Land Subsidence

- Over abstraction of groundwater from an aquifer can cause land subsidence





Cape Flats Aquifer

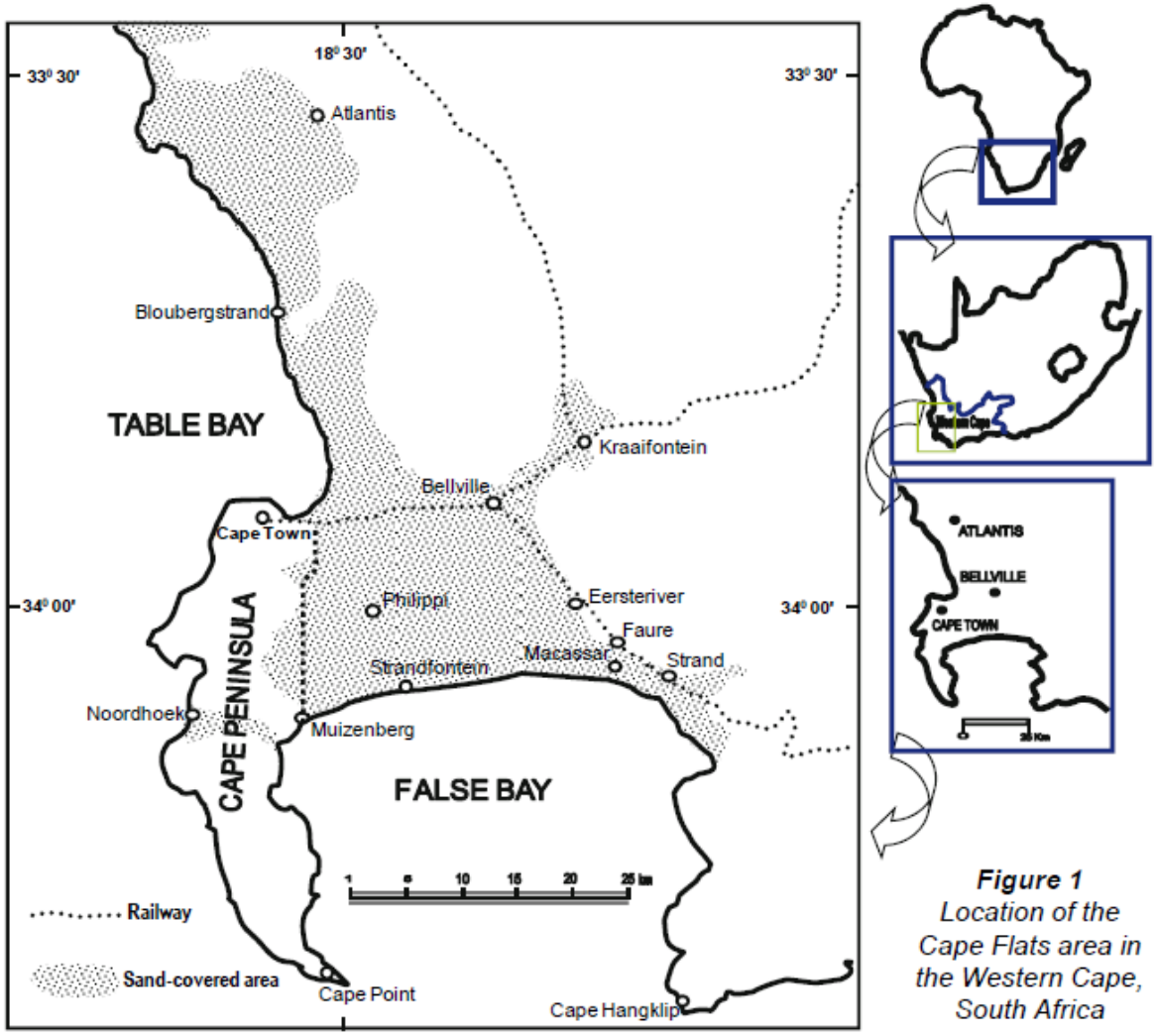


Figure 1
Location of the Cape Flats area in the Western Cape, South Africa

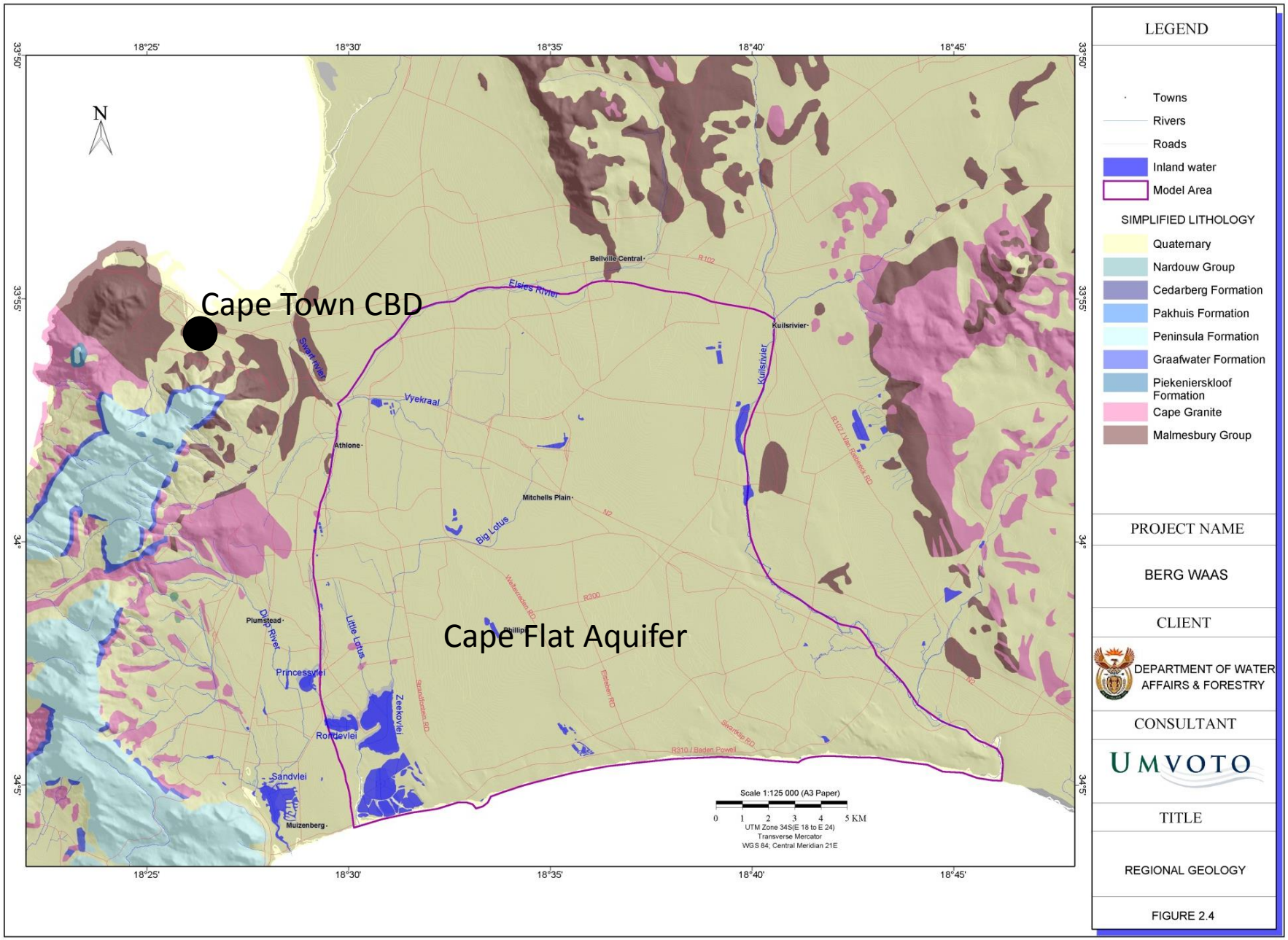
From Adelena, S. et al (2010) see reading

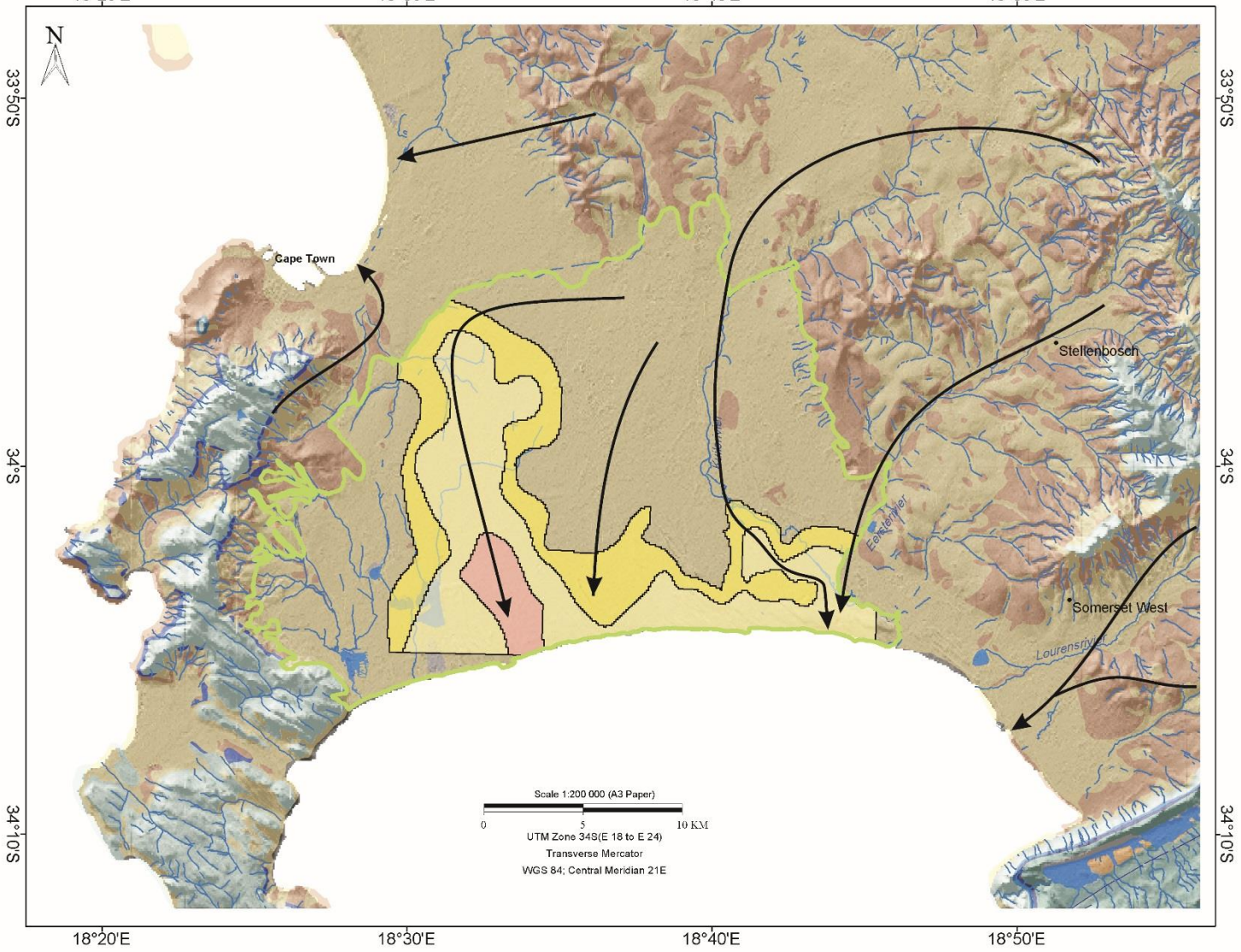
- Cape Flats Aquifer unconfined sand aquifer deposited on top of impervious Malmesbury shale and Cape granite bedrock.

- 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 m^3**


Cape Town CBD
Cape Flat Aquifer
N
18°25'
18°30'
18°35'
18°40'
18°45'
33°50'
33°55'
34°
34°5'
Bellville Central
Elsies River
Kuilsrivier
Vyekraal
Athlone
Mitchells Plain
Big Lotus
Little Lotus
Princessvlei
Plumstead
Rondevlei
Zeekovlei
Sandvlei
Muizenberg
R102
N2
R300
R310 / Baden Powell
Scale 1:125 000 (A3 Paper)
0 1 2 3 4 5 KM
UTM Zone 34S(E 18 to E 24)
Transverse Mercator
WGS 84; Central Meridian 21E
LEGEND
Towns
Rivers
Roads
Inland water
Model Area
SIMPLIFIED LITHOLOGY
Quaternary
Nardouw Group
Cedarberg Formation
Pakhuis Formation
Peninsula Formation
Graafwater Formation
Piekenierskloof Formation
Cape Granite
Malmesbury Group
PROJECT NAME
BERG WAAS
CLIENT
DEPARTMENT OF WATER AFFAIRS & FORESTRY
CONSULTANT
UMVOTO
TITLE
REGIONAL GEOLOGY
FIGURE 2.4



LEGEND

- Towns
- Rivers
- Hydrotects
- Cape Flats Model area

Bedrock Elevation (mamsl)

- -20_-30
- 0_-20
- 10_0

SIMPLIFIED LITHOLOGY

- Quaternary
- Pre_Cape
- Nardouw Group
- Cedarberg Formation
- Pakhuis Formation
- Peninsula Formation
- Piekenierskloof Formation
- Graafwater Formation
- Post_TMG
- Dam

Flow paths

PROJECT NAME

BERG RIVER MODEL STUDY

CLIENT

DEPARTMENT OF WATER AFFAIRS

CONSULTANT

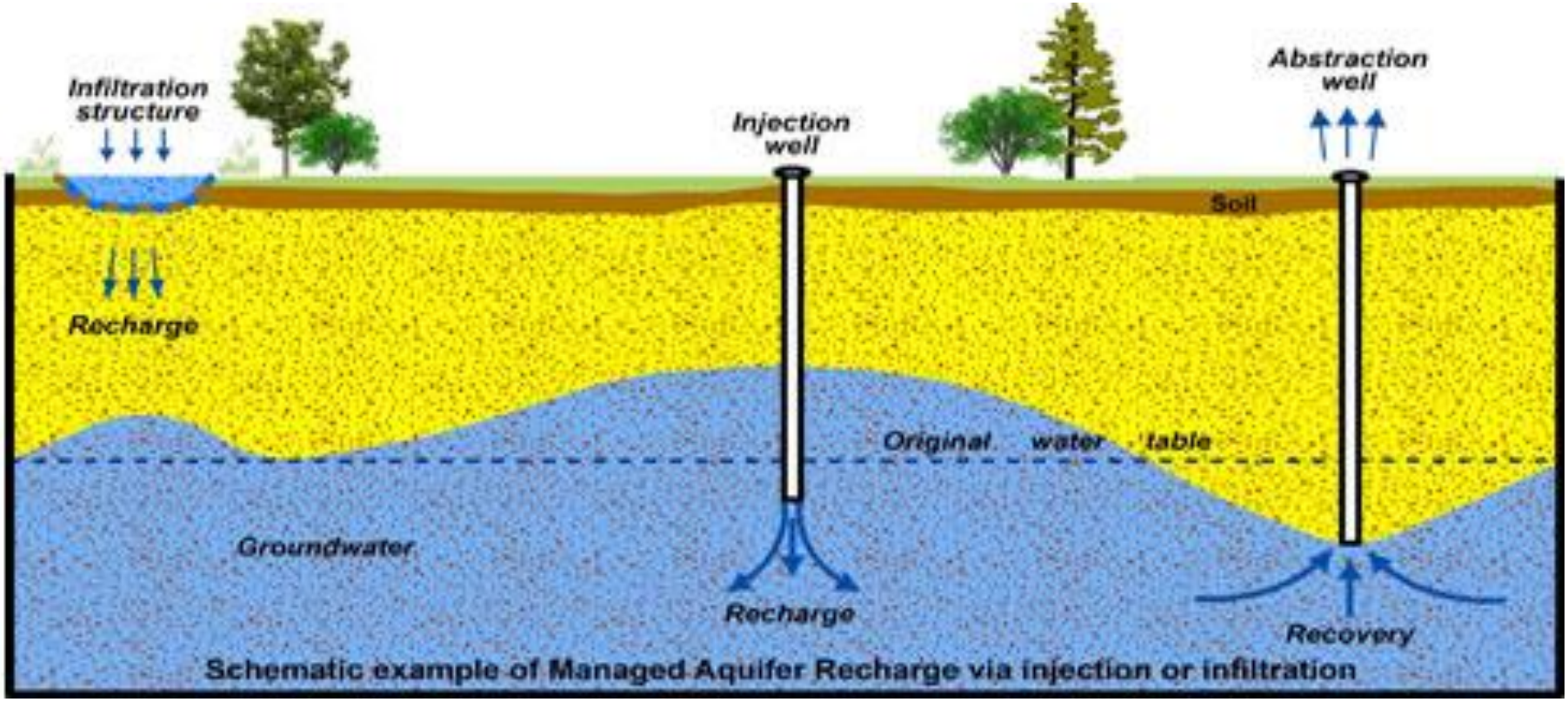
UMVOTO

TITLE

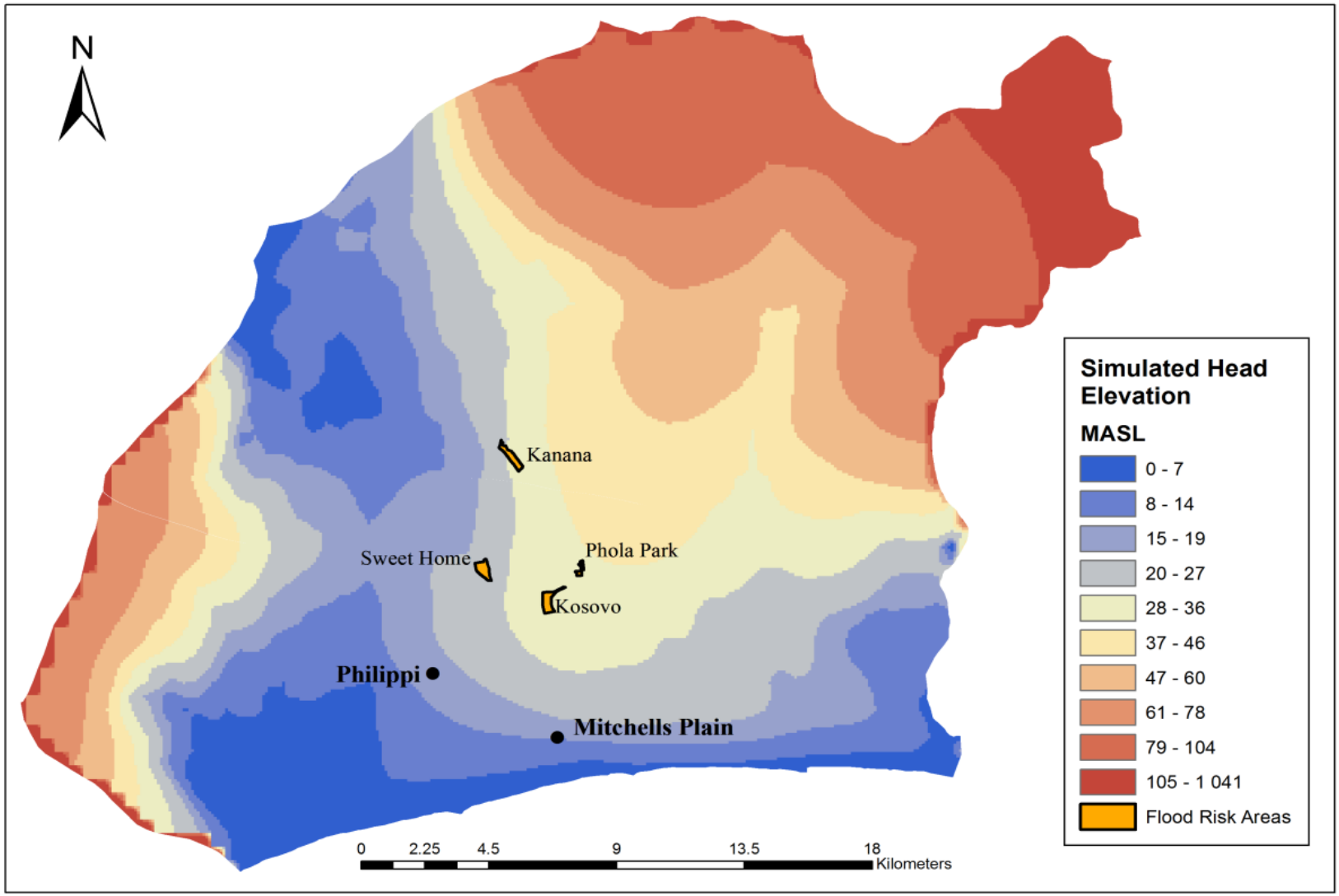
CAPE FLATS CONCEPTUAL MODEL (VOLUME 3)

FIGURE 1.3

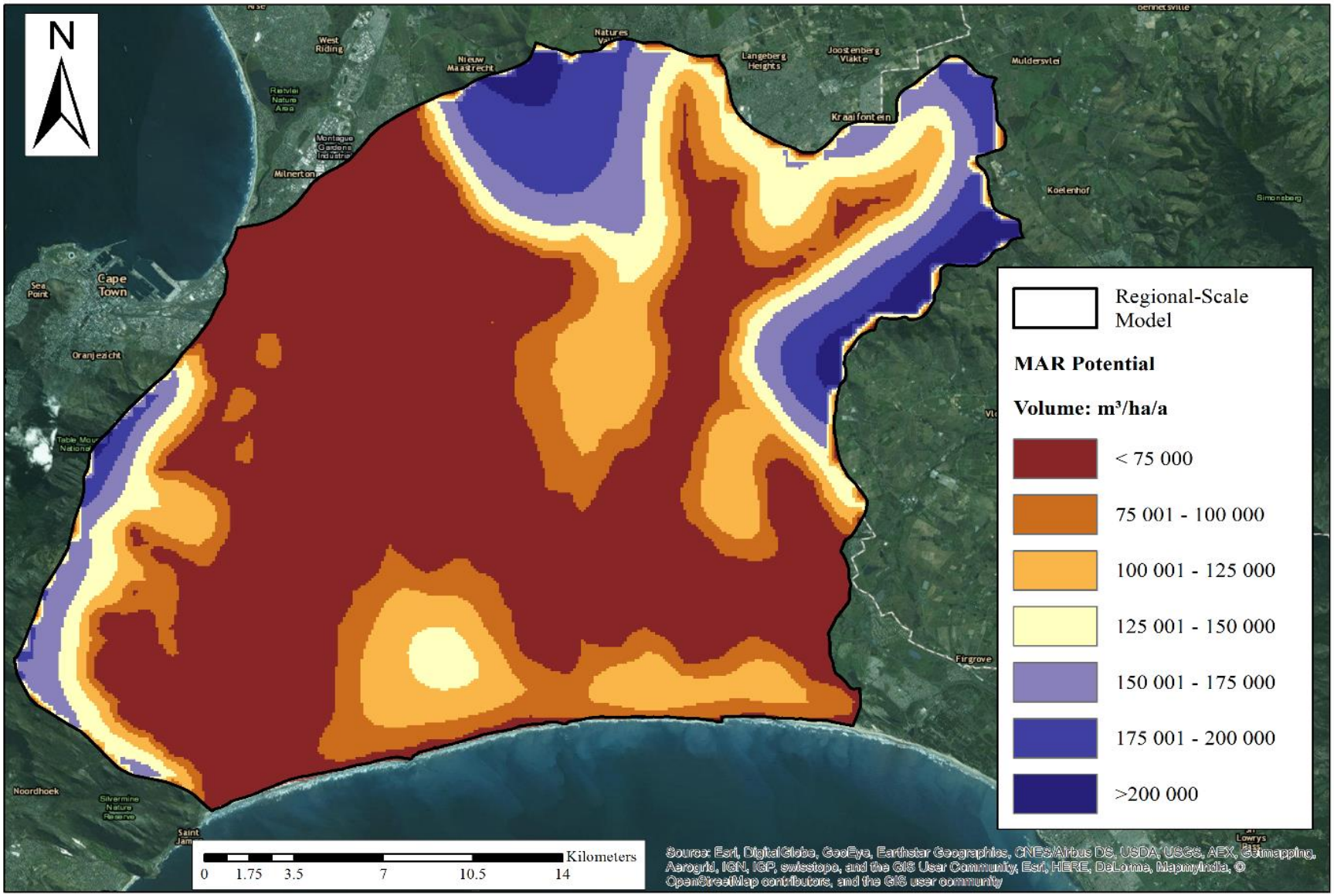
Example of Managed Aquifer Recharge



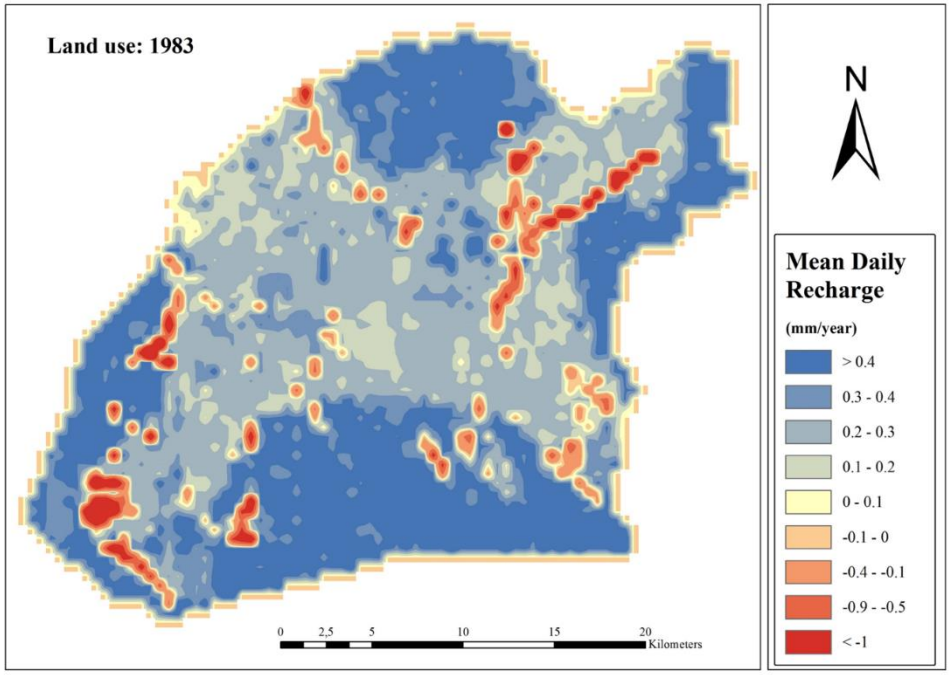
Simulated mean groundwater head elevation (meters above sea level) for the Cape Flats 2000-2015



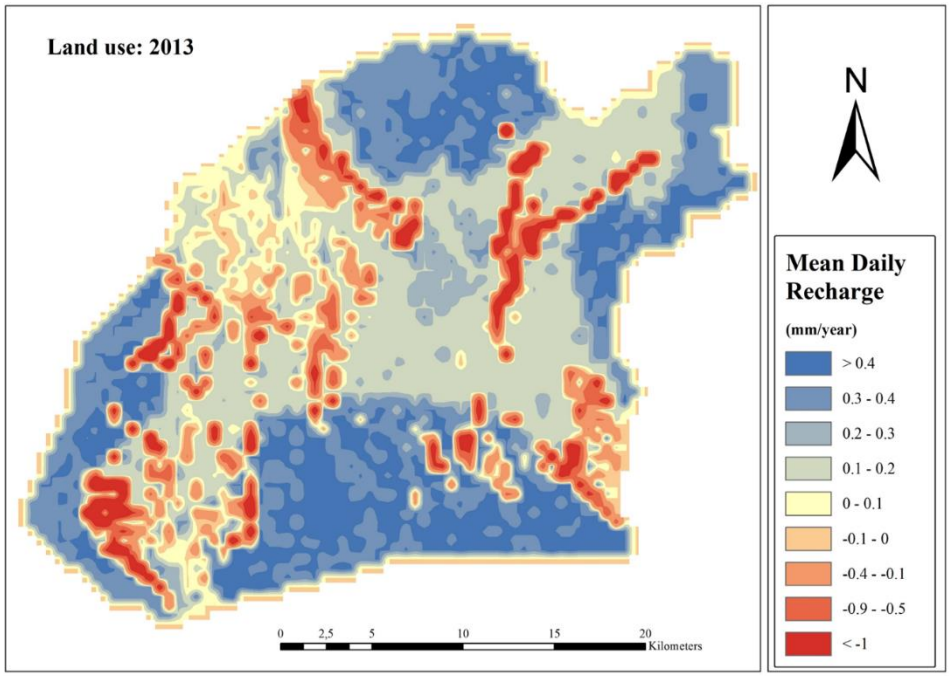
MAR potential for the Cape Flats Aquifer



a)



b)



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

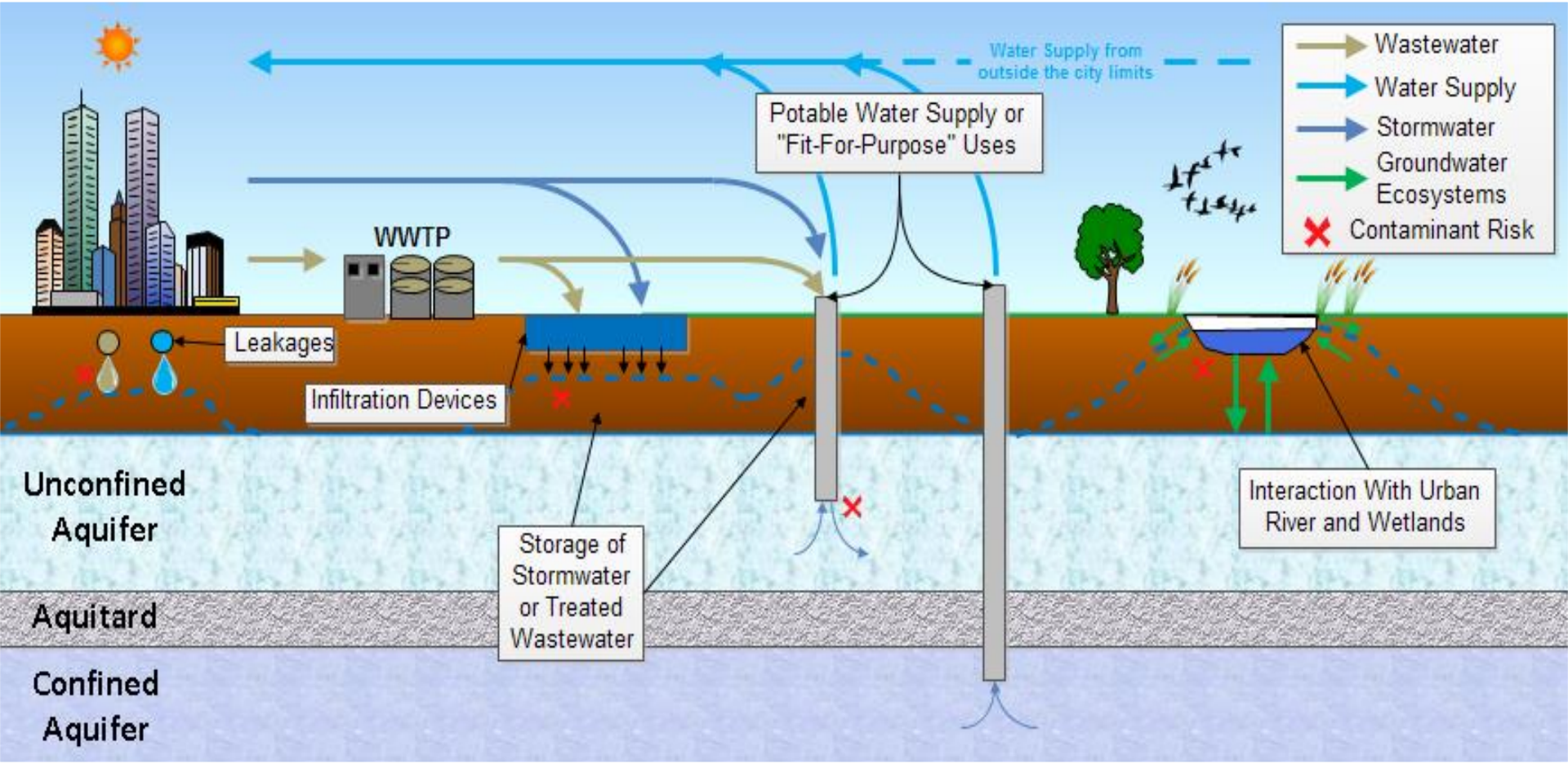
Summary Table of the scenario descriptions for MAR at Philippi and Mitchells Plain

Summary of scenario descriptions	
Scenario 14	The artificial recharge of 'stormwater', during the winter months (infiltration and injection) increased volumes of stored water from 2 Mm^3 to 10 Mm^3.
Scenario 15	Equivalent summer abstraction and winter recharge rates using a conservative rate of approximately 15 $\ell.s^{-1}$.
Scenario 16	Summer only abstraction at maximum pumping rates at 32 $\ell.s^{-1}$ with no artificial recharge at the Philippi site.
Scenario 17	Double summer abstraction at approximately 32 $\ell.s^{-1}$ and a conservative winter recharge rate of approximately 15 $\ell.s^{-1}$ at the Philippi site.
Scenario 18	Summer only abstraction at maximum pumping rates at 32 $\ell.s^{-1}$ with no artificial recharge at the Mitchells Plain site.
Scenario 19	Double summer abstraction at approximately 32 $\ell.s^{-1}$ and a conservative winter recharge rate of approximately 15 $\ell.s^{-1}$ at the Mitchells Plain site.

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 Ml 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



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://www.ajol.info/index.php/wsa/article/view/58423

C.D. Ruben Aza-Gnandji , Yongxin Xu , C.D. Ruben Aza-Gnandji and Jonathan Levy (2013) Salinity of irrigation water in the Philippi farming area of the Cape Flats, Cape Town, South Africa *Water SA Vol 39 No 2*
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