AUGMENTING BULK WATER SUPPLY WITH PRIVATE BOREHOLE WATER: CAPE TOWN FEASIBILITY STUDY

ENSAfrican have contributed to legislative part

MAIN PROJECT TARGETS

- Identification of high yield groundwater areas
- Identification of 50-100 boreholes located in high yield groundwater areas on private land
- Review legislation looking for possibilities for the city to get access to groundwater and groundwater infrastructure on private land
- Definition of a generic roadmap for implementation of groundwater on private land

AGENDA

Desktop study

- Groundwater related data
- Identification of private boreholes
- High yield areas
- Identification of potential clusters of boreholes
- Business Cases

Site visits

Legislation

Roadmaps for implementation of private boreholes in bulk water supply

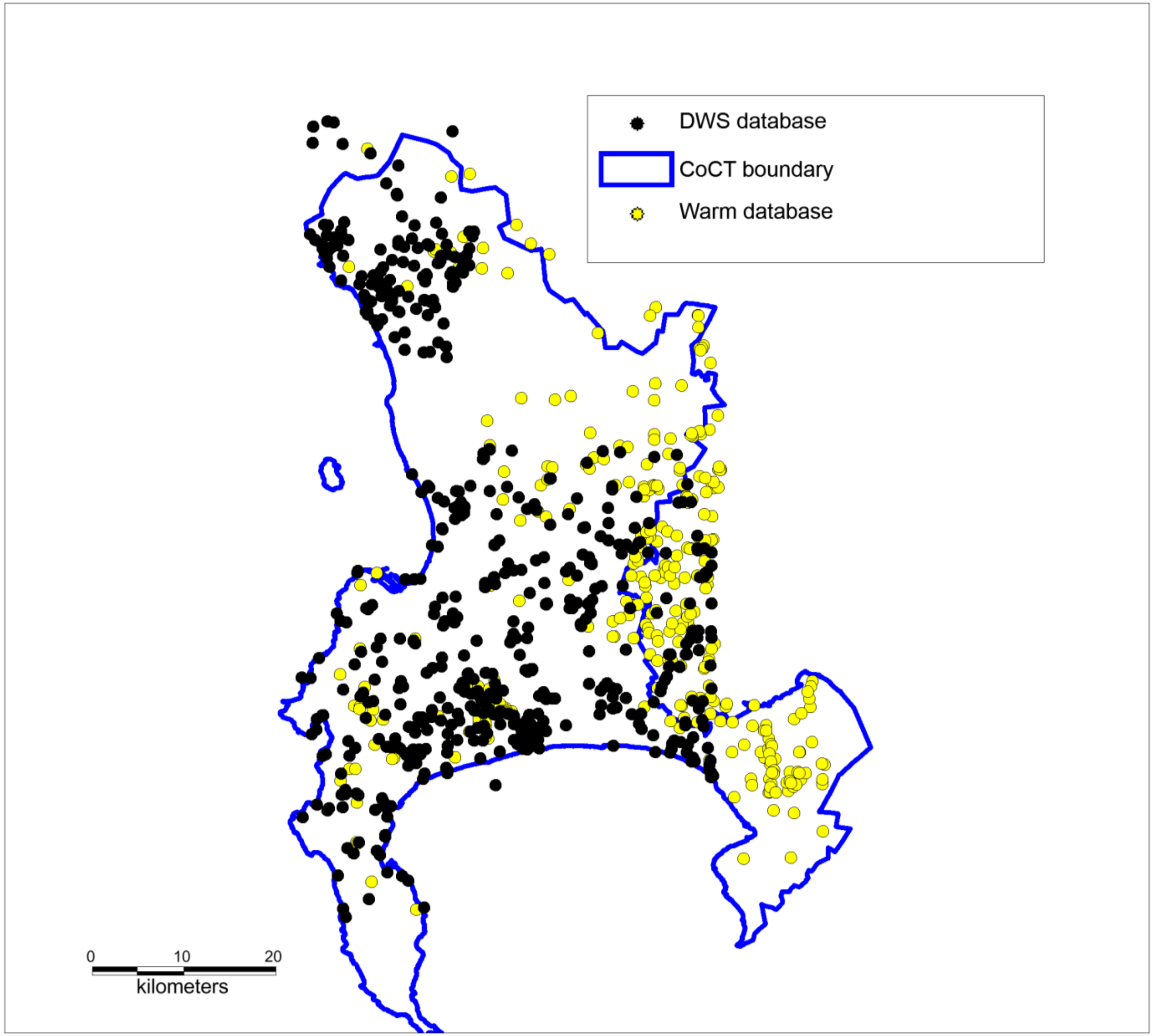
Recommendations

RAMBOLL

DATA – DESKTOP STUDY

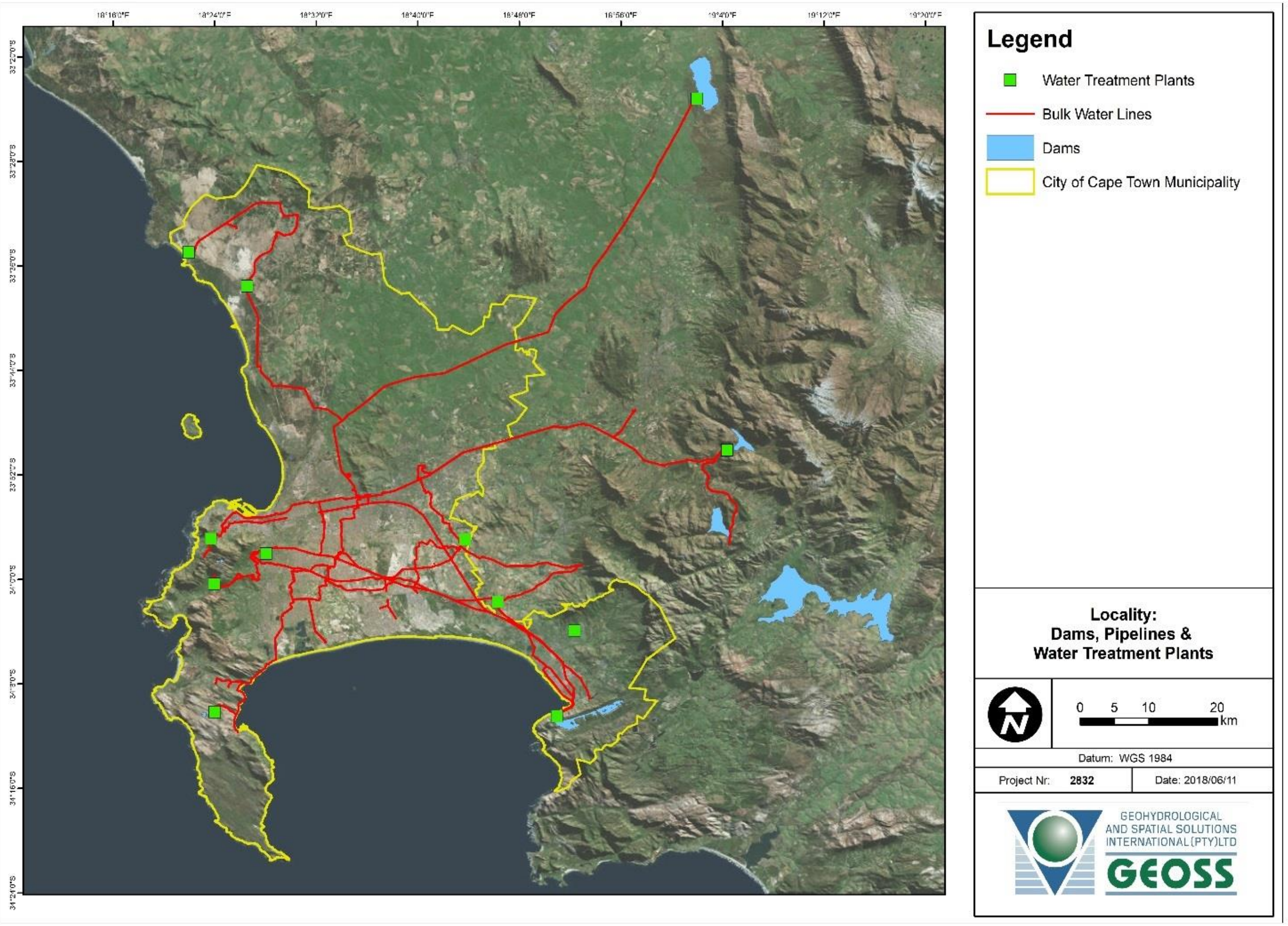
- Borehole information
  - DWS database
    - Wells with geological descriptions
    - Water quality
    - Pump test
  - Warm database
    - Register of boreholes with water use license
  - City of Cape Town
    - Addresses of Private boreholes
    - Bulk pipeline and water treatment plants
    - Property boundaries
    - Climate data
    - Hydrogeological reports (Umvoto etc.)

Borehole information

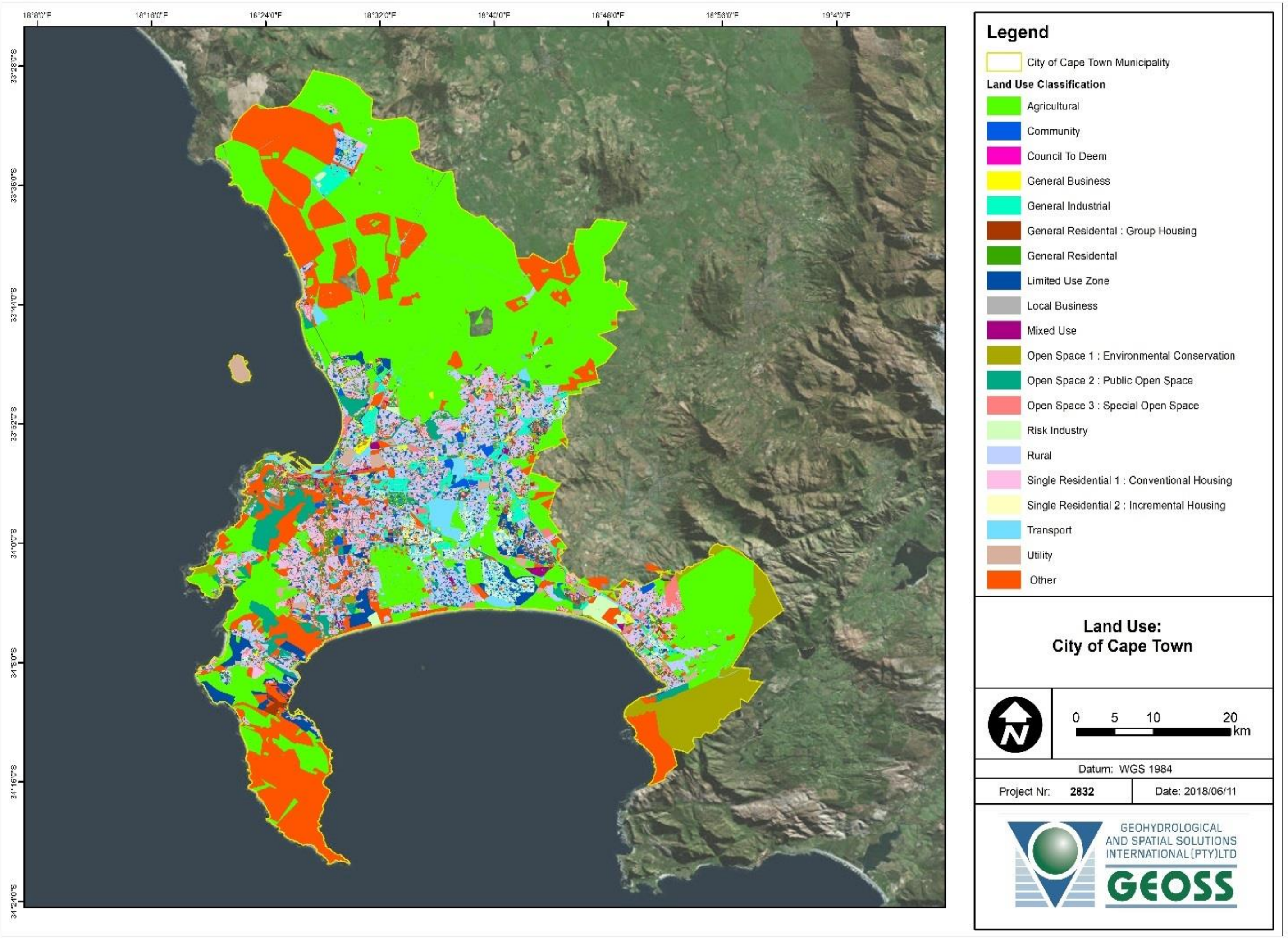


RAMBOLL

DAMS, WATER TREATMENT PLANTS AND BULK WATER PIPELINES

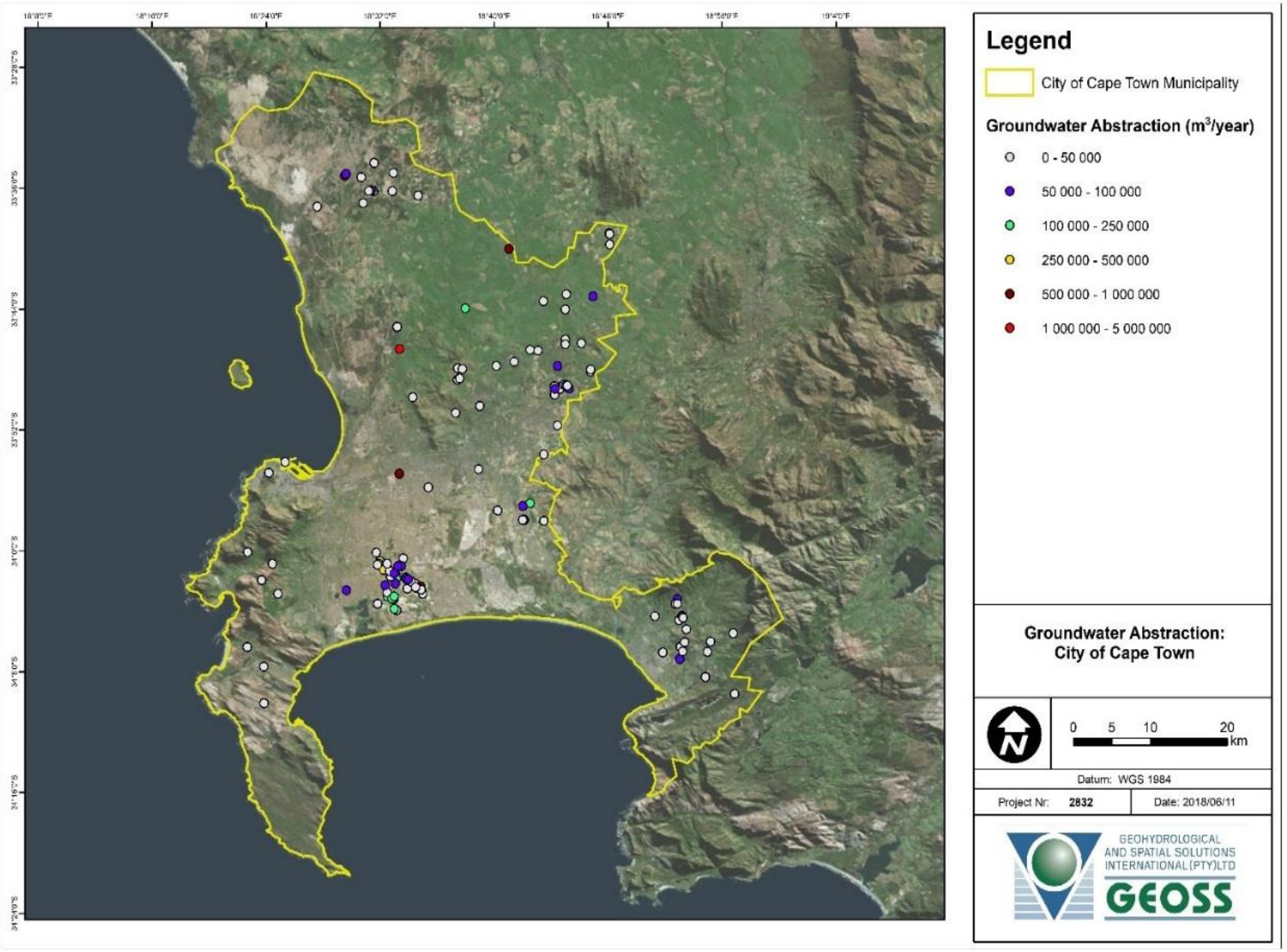


PROPERTY BOUNDARIES



RAMBOLL

GROUNDWATER ABSTRACTION – WATER USE LICENSE

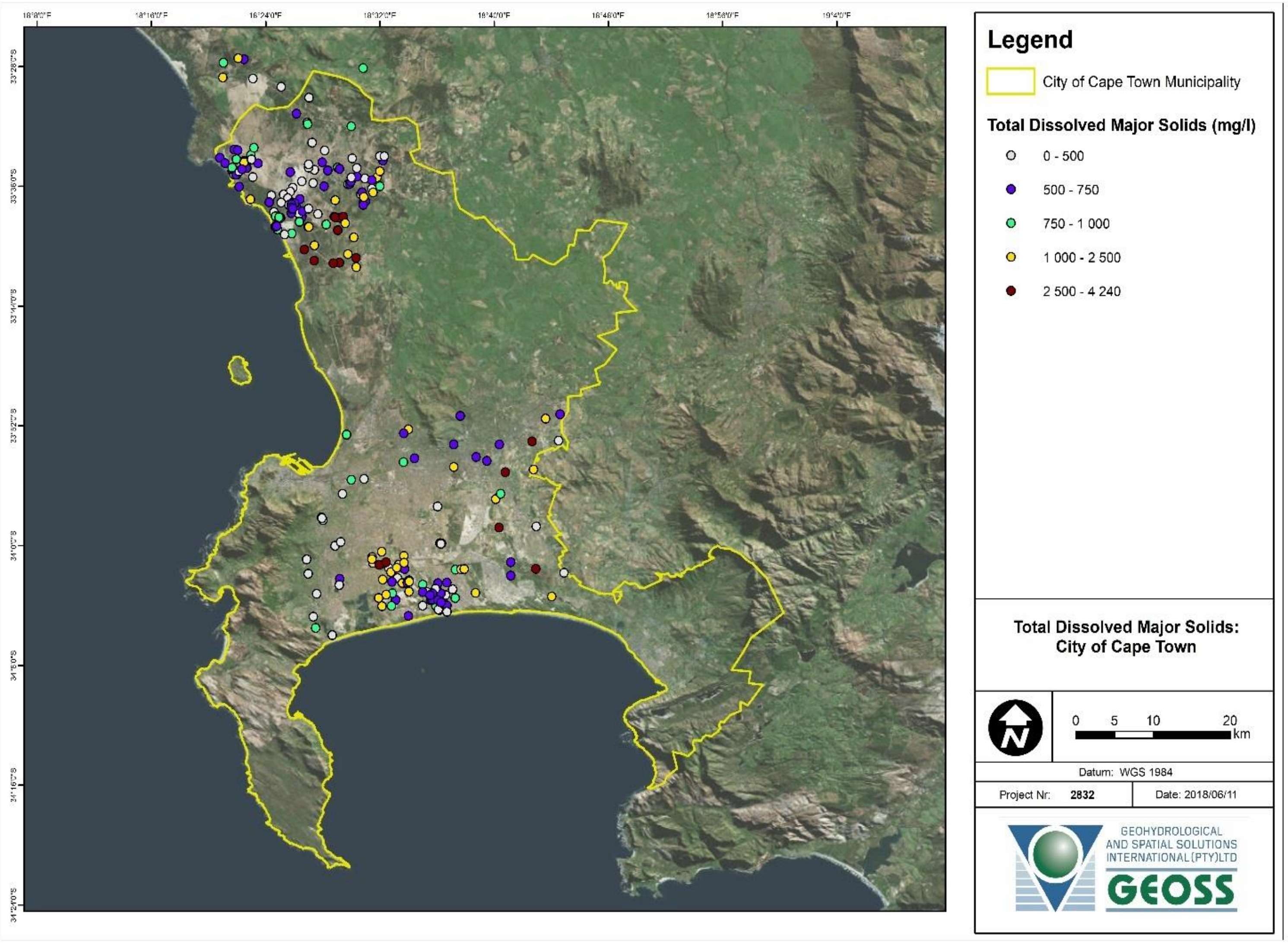


23 million cubic meter per year within Cape Town municipality based

10 million cubic meter per year at cape flats

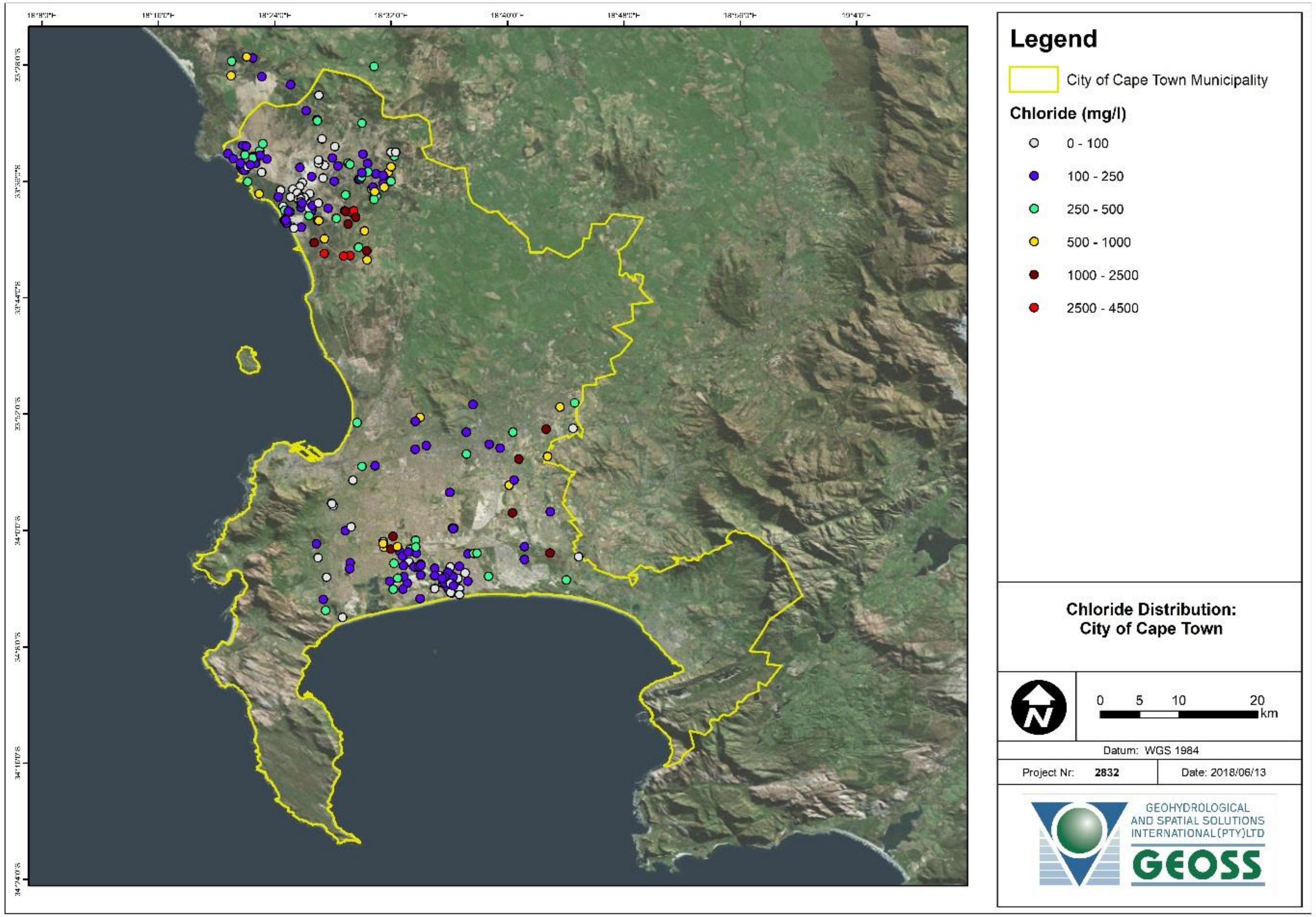
RAMBOLL

TOTAL MAJOR DISSOLVED SOLIDS



RAMBOLL

CHLORIDE


Legend
City of Cape Town Municipality
Chloride (mg/l)
0 - 100
100 - 250
250 - 500
500 - 1000
1000 - 2500
2500 - 4500
Chloride Distribution:
City of Cape Town
0 5 10 20
km
Datum: WGS 1984
Project Nr: 2832
Date: 2018/06/13
GEOHYDROLOGICAL AND SPATIAL SOLUTIONS INTERNATIONAL (PTY) LTD
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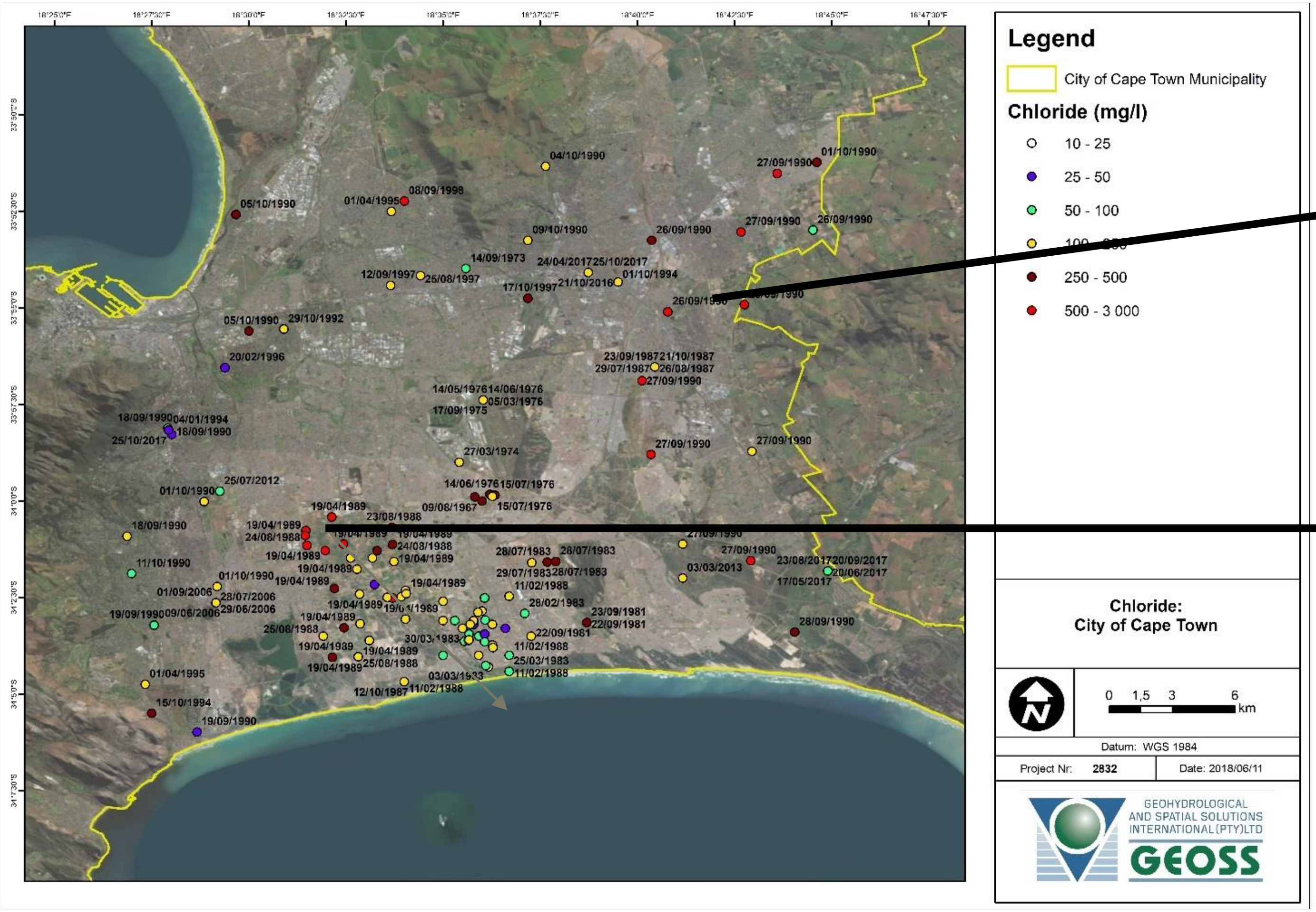
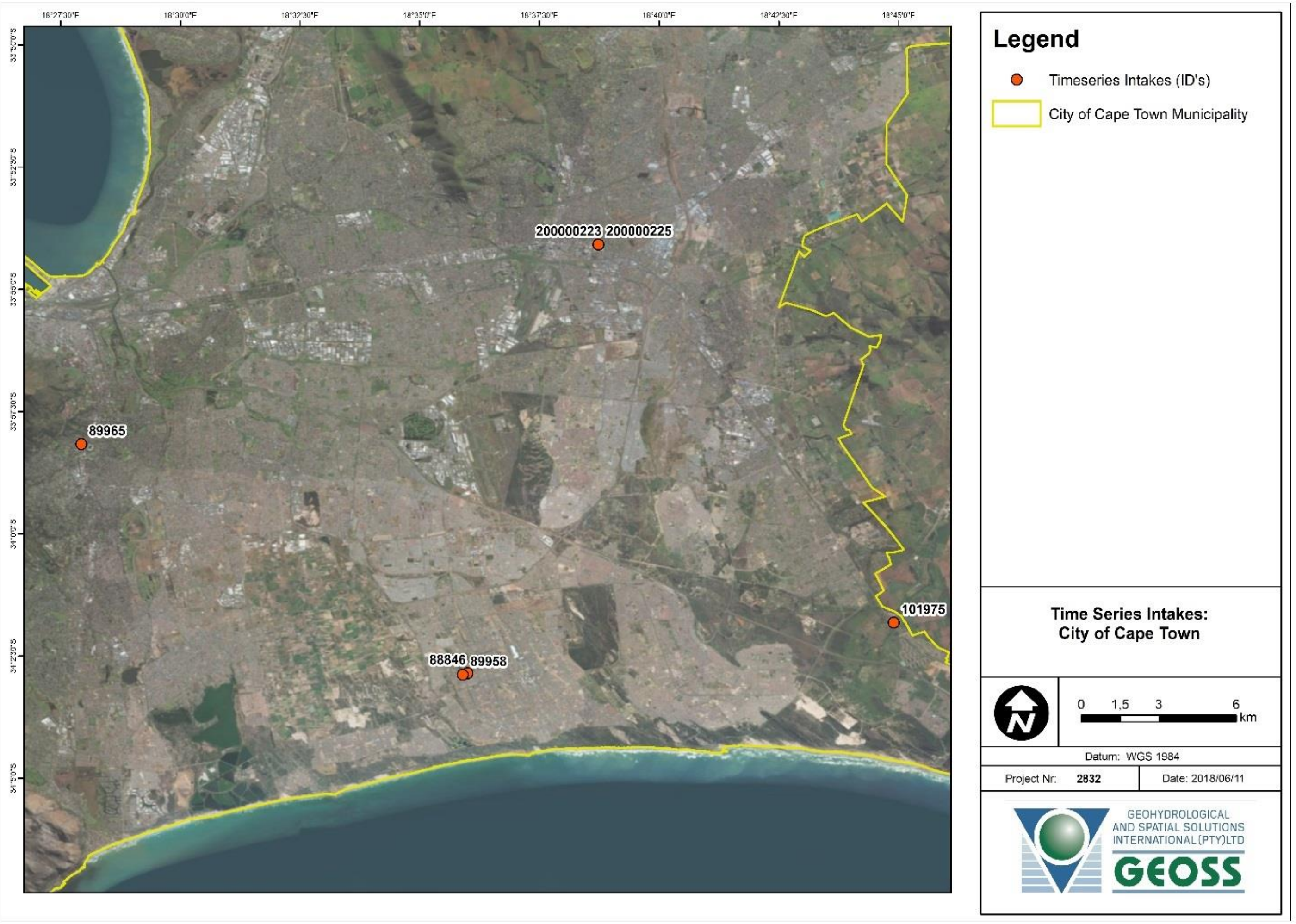
CHLORIDE – CAPE FLATS



Probably residual salty water

Irrigation

CHLORIDE TIMESERIES



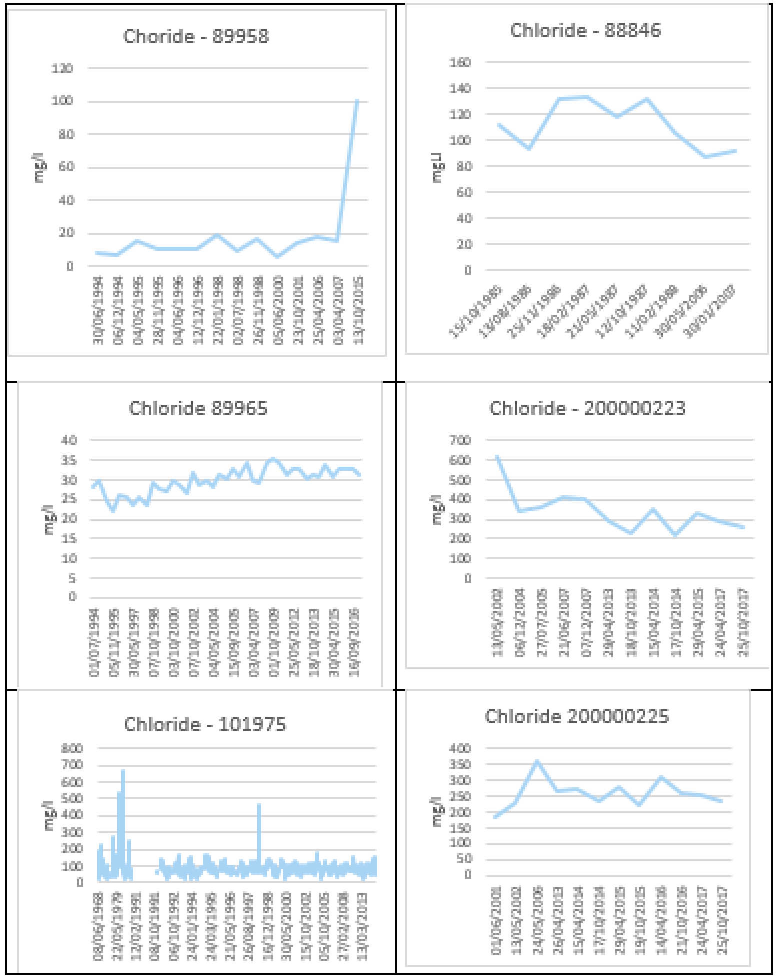
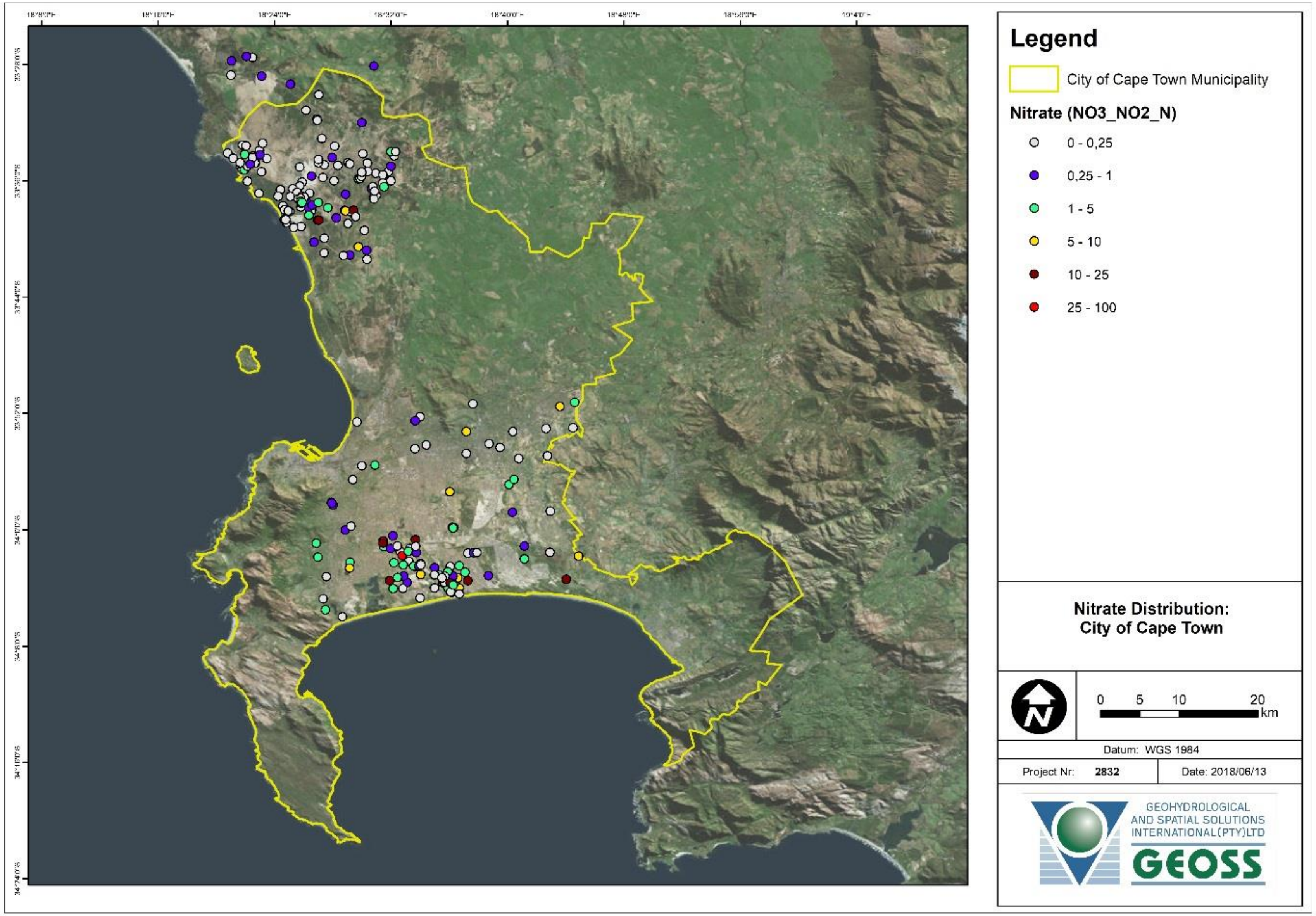


Figure 8-4 Timeseries for Chloride

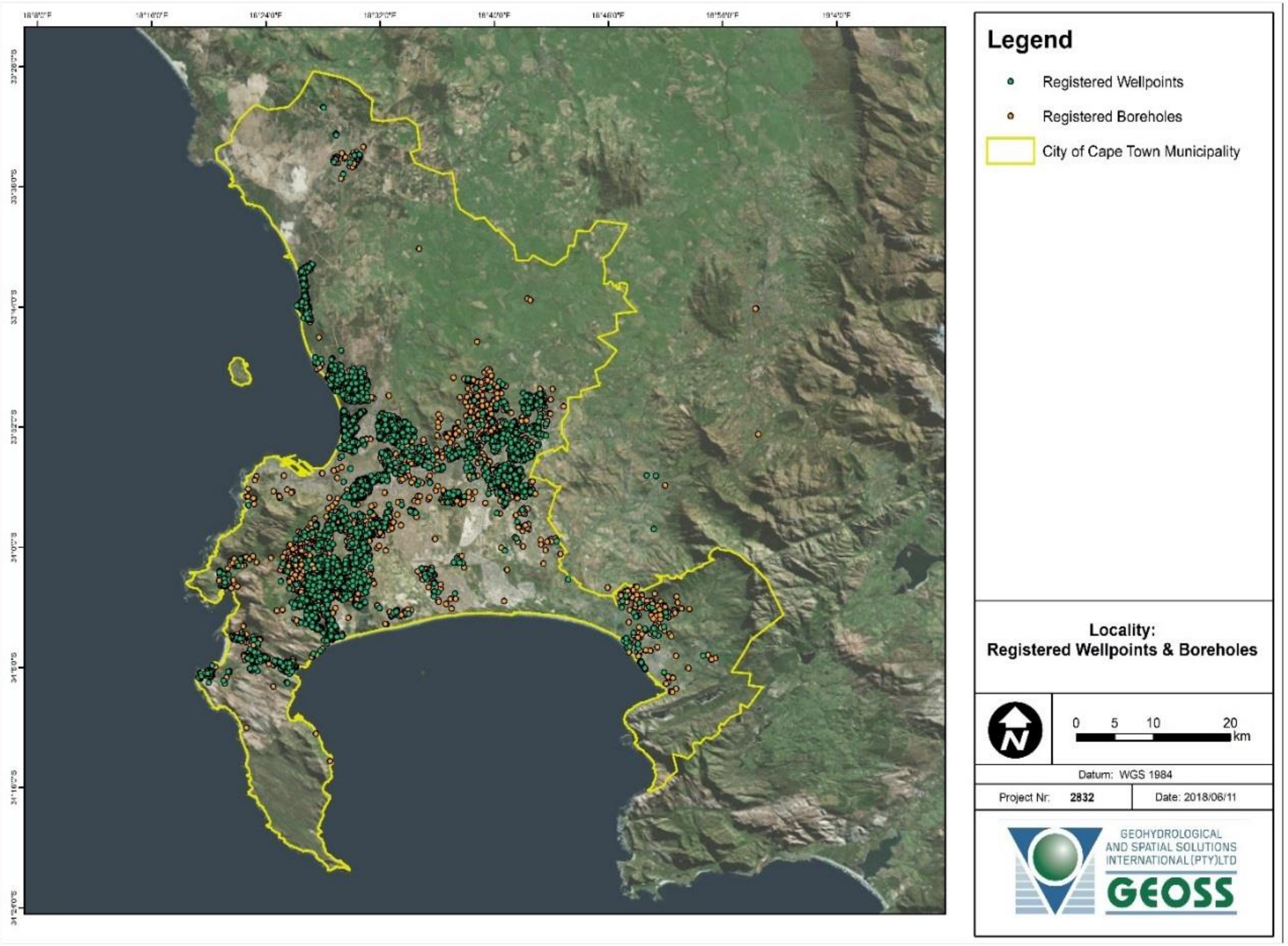
RAMBOLL

NITRATE



RAMBOLL

PRIVATE BOREHOLES AND WELLPOINTS

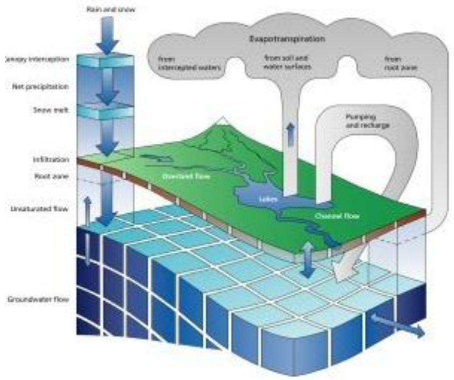


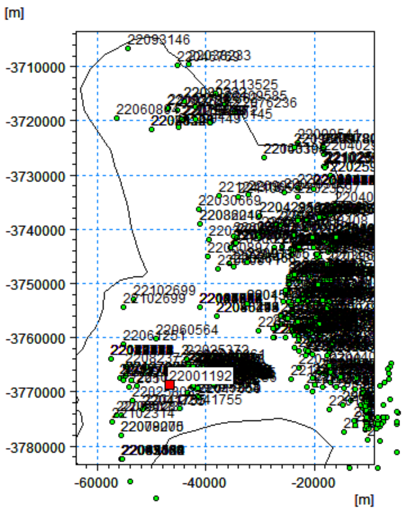
2997 Wellpoints

5161 boreholes

RAMBOLL

MODELLING

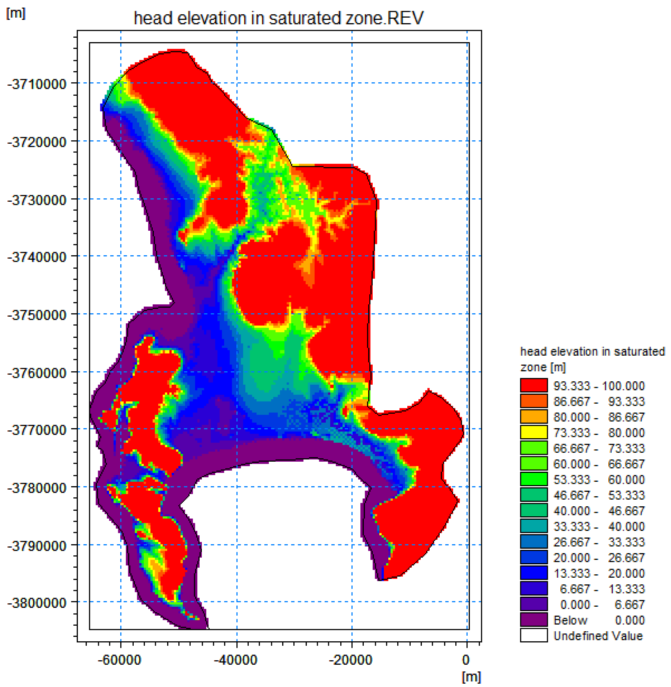


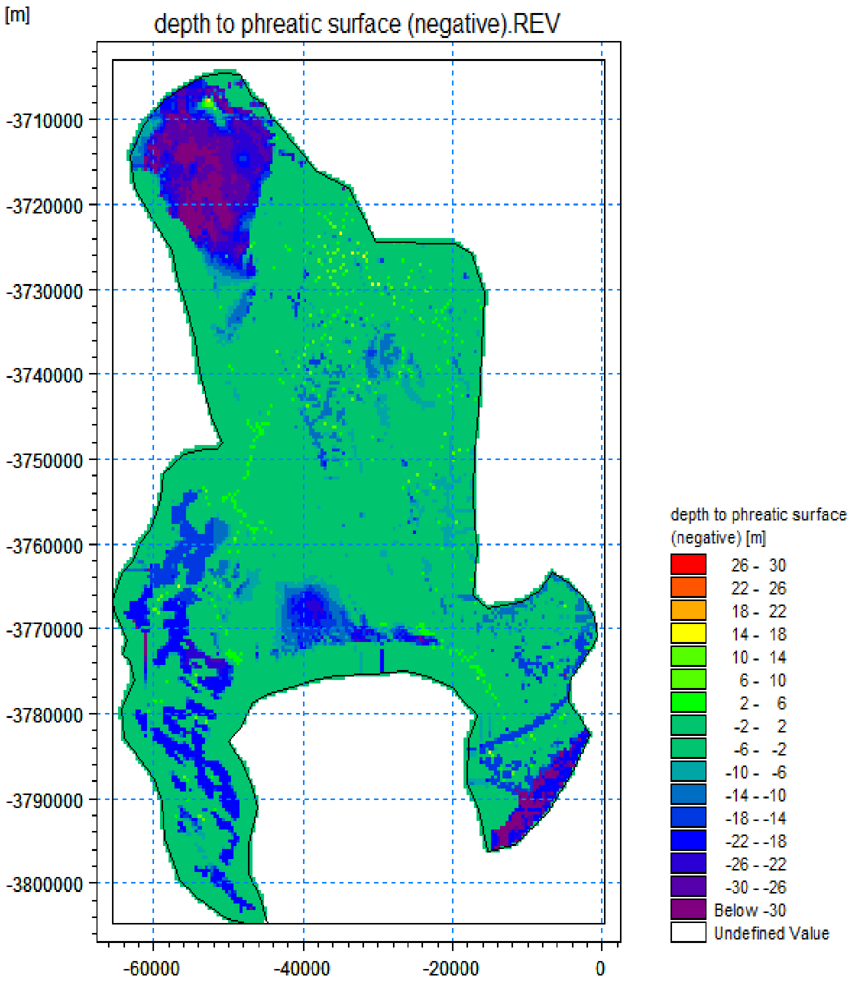


Well locations:

Other Well Data

	Well ID	X	Y		Level	Depth	Well Field
1	22000898	-46723.09	-3768602.08		11.01	50.00	OELOFVAN
2	22001192	-46723.09	-3768602.08		11.01	50.00	JJTERBLAN
3	22001316	-23972.00	-3748332.39		121.87	50.00	WAKJRDEN
4	22002468	-46723.09	-3768602.08		11.01	50.00	NEDERBUR
5	22007524	-41069.16	-3754299.73		24.40	50.00	BEOHLHOF



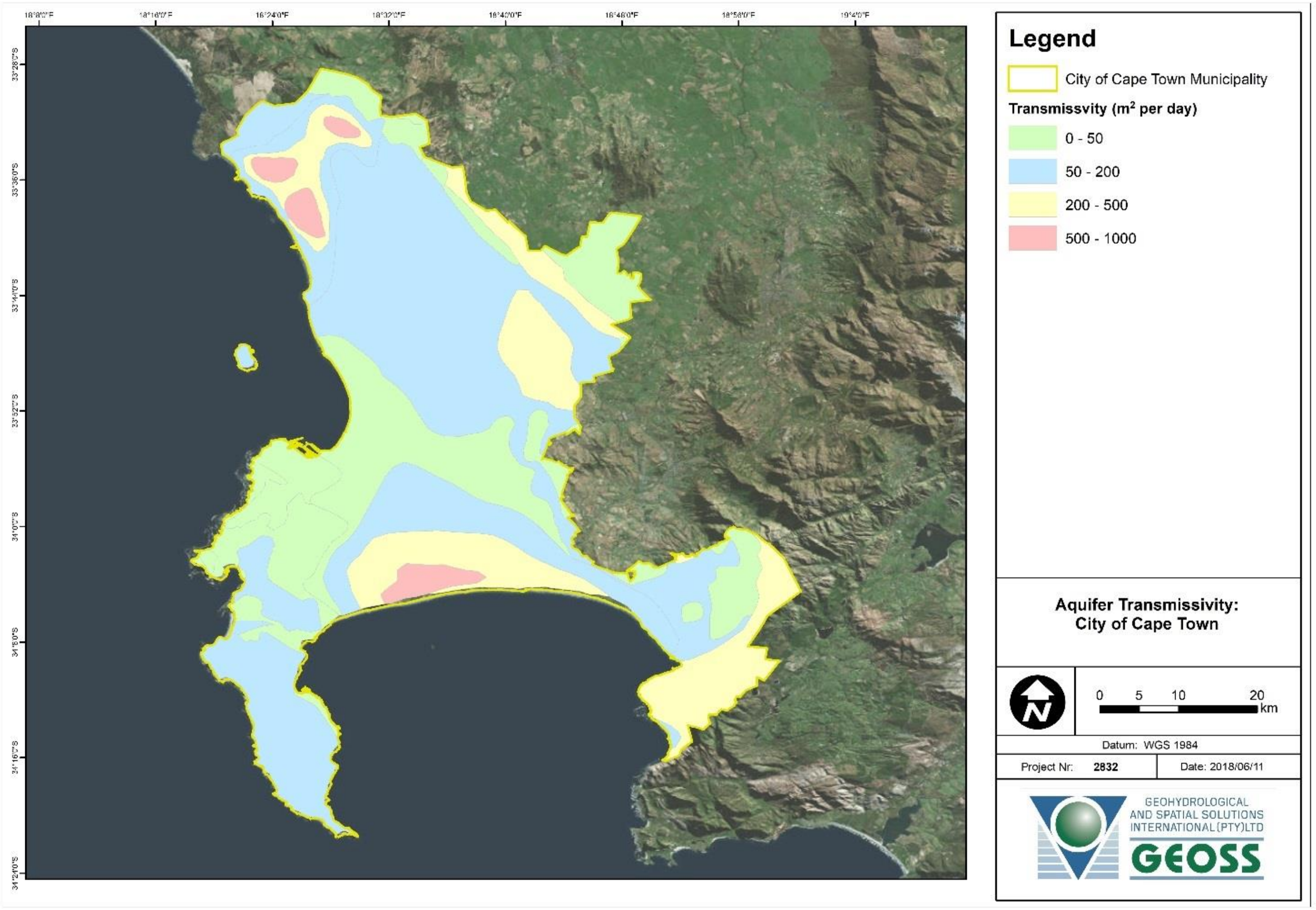


HIGH YIELD AREAS

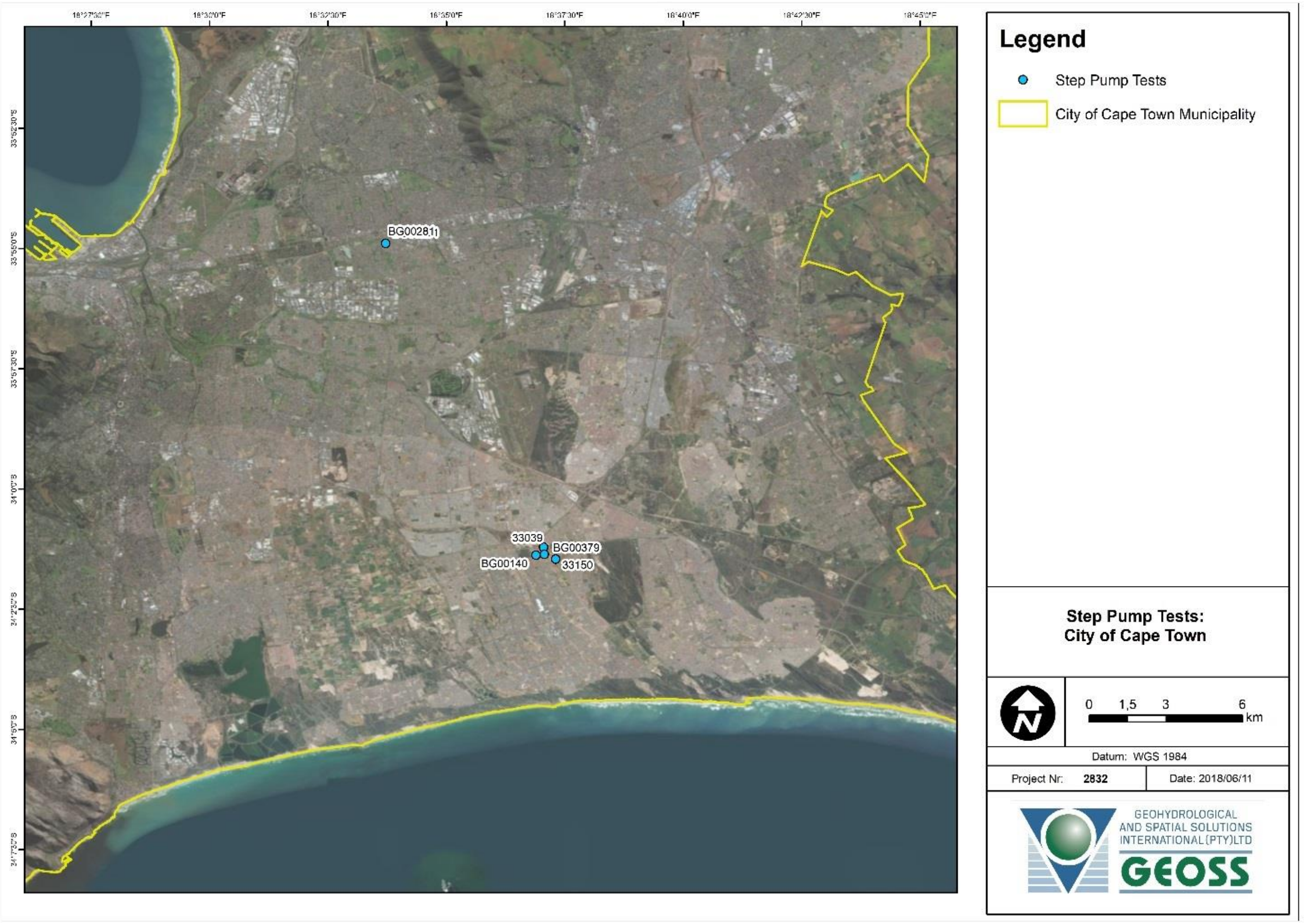
- Geological and hydrogeological maps
- Extent and thickness of aquifers
- Geological descriptions from wells
- Any available data from test pumps/borehole yields

- Supported from hydrological model
- Water quality

AQUIFER CLASSIFICATION



STEP PUMP TEST



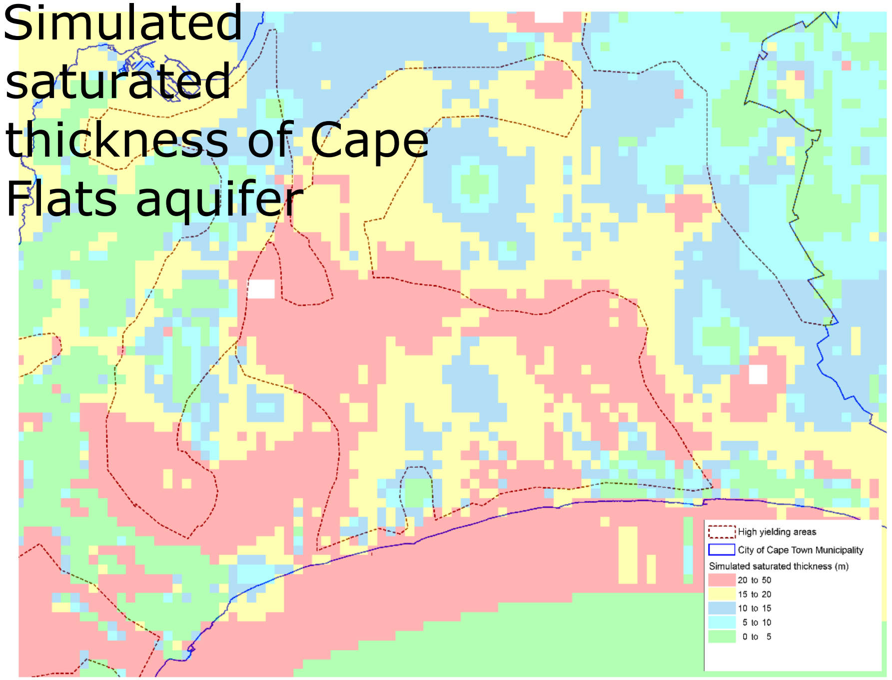
Hydraulic conductivities lie within the range from fine – medium sand

Limited access to pump test data have generally complicated the research

ID	Transmissivity (m2/s)	K m/s
BG00281	1.36e-3	7e-5
BG00140	2.33e-3	1e-4
33039		
33150	9.54e-4	4e-5

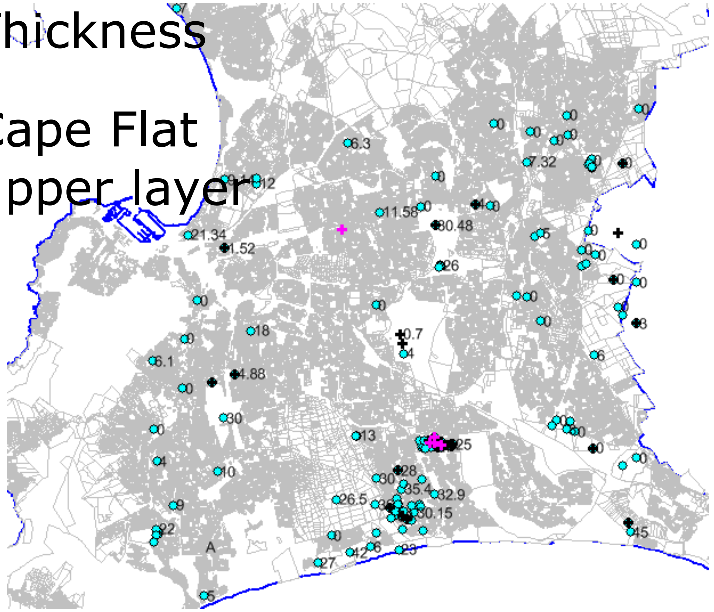
RAMBOLL

Simulated saturated thickness of Cape Flats aquifer

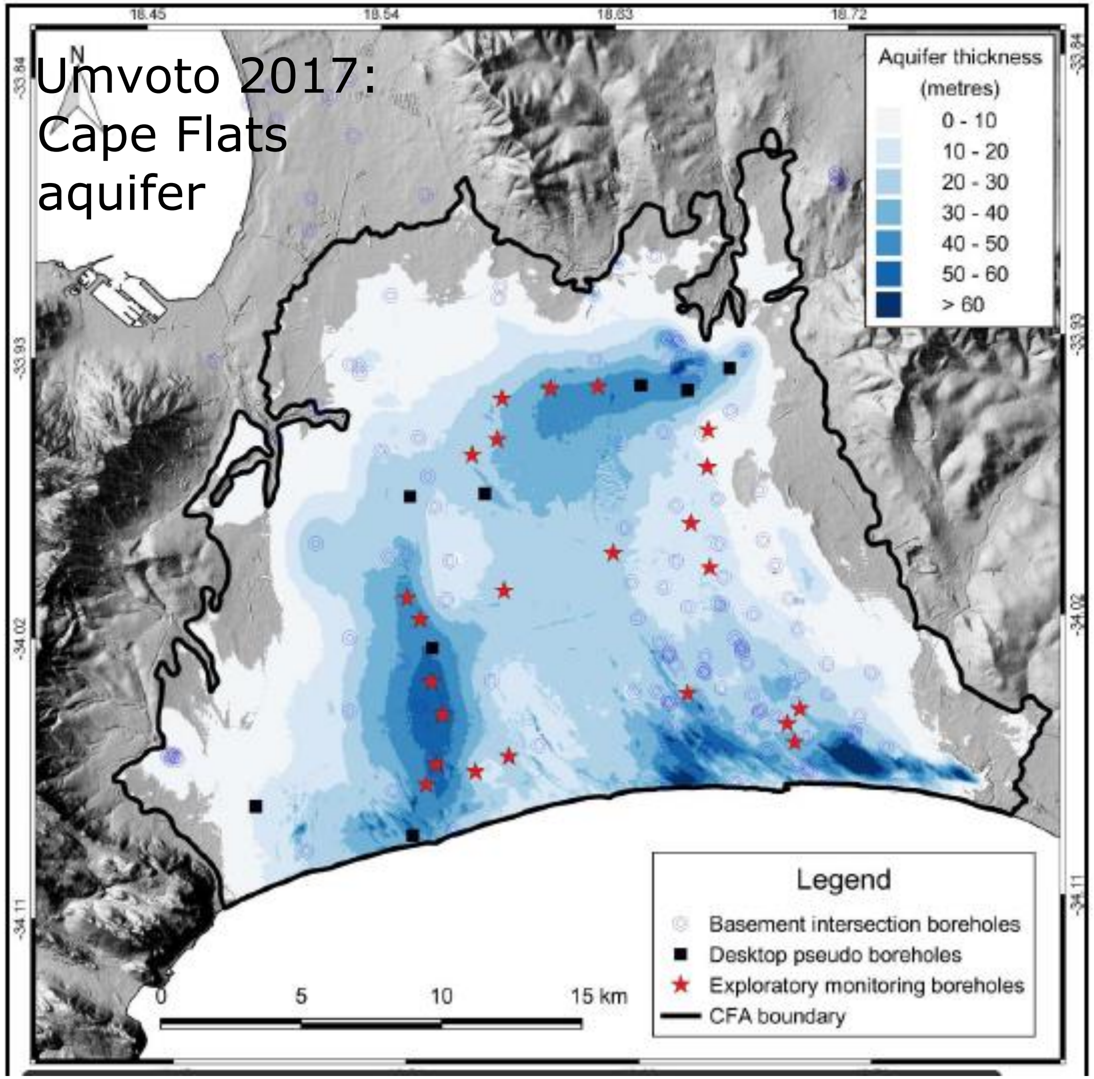


Thickness

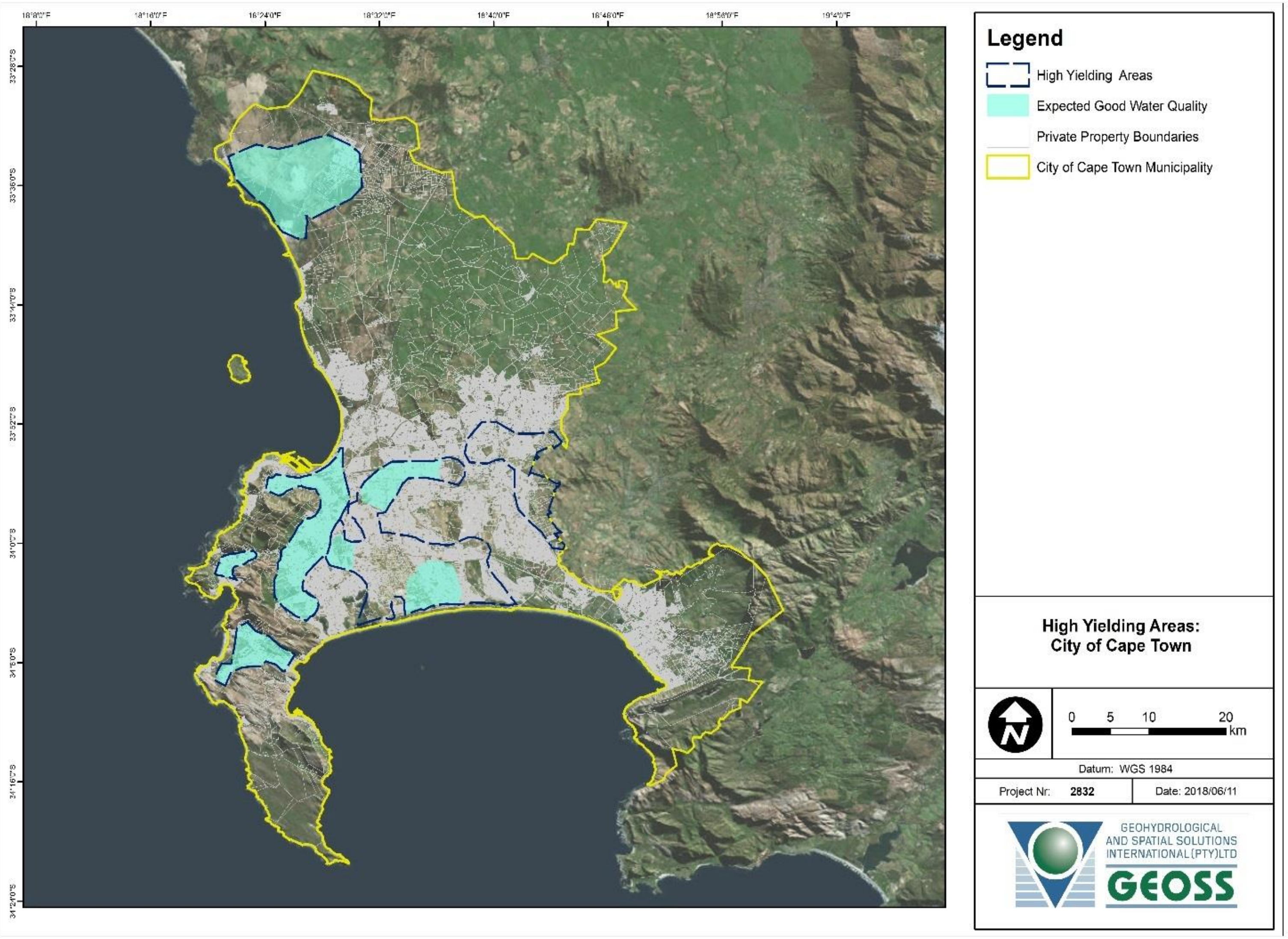
Cape Flat upper layer



Umvoto 2017: Cape Flats aquifer



POTENTIALLY HIGH YIELDING AREAS



TARGET AREAS

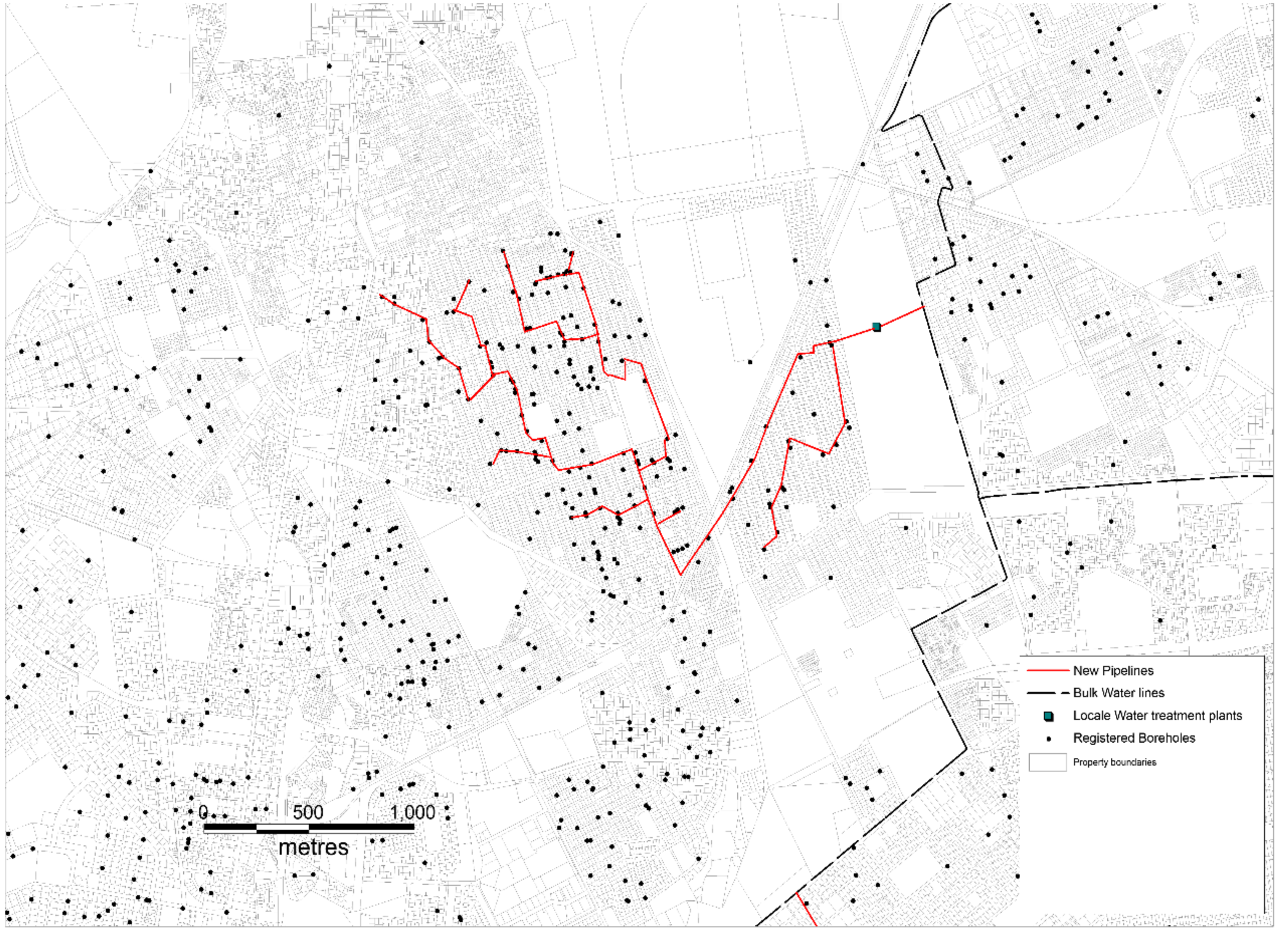
-Mitchells plain

-Newland area

-Plumstead

-Atlantis

IDENTIFICATION OF POTENTIALLY GOOD CLUSTERS OF BOREHOLES



-focused on boreholes and not wellpoints

-focused on clusters on potentially high yielding areas

-focused on clusters located close to water pipelines

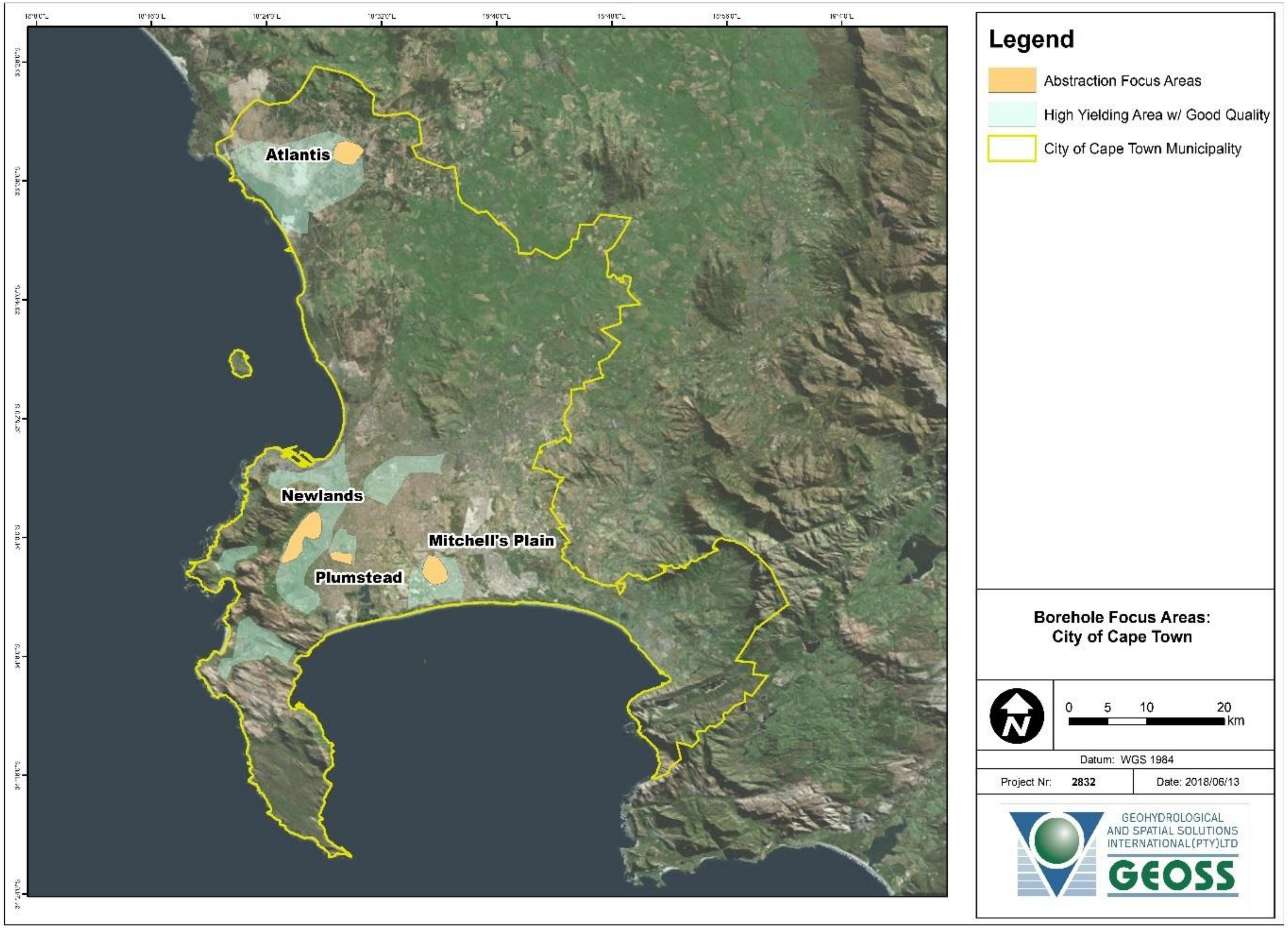
-made some business cases for implementation of clusters in water supply

BUSINESS CASES - BASIC PRICES

Level of contamination	Cost category	Costs and production capacities
No significant contamination: basic chlorination	Operating Costs	<R0.50/kl
Iron and manganese contaminated groundwater	Capital Costs	~ R3.5 million/MLD
	Operating Costs	~ R2.50/kl
Saline/brackish water	Capital Costs	~ R10 million - 15 million/MLD
	Operating Costs	~ R12 - R20/kl

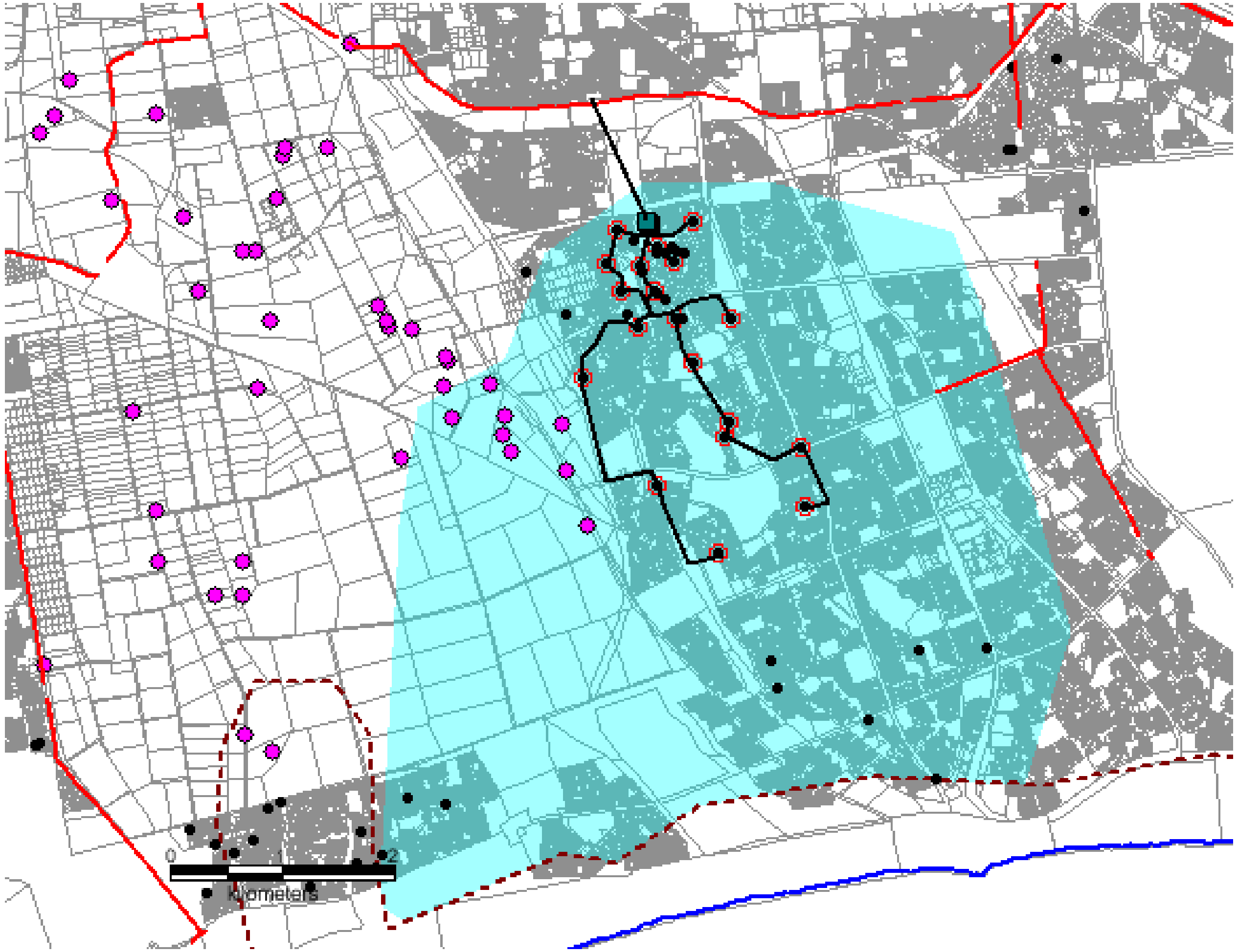
Pipelines: 4000 rand pr. meter

MITCHELLS PLAIN



RAMBOLL

MITCHELLS PLAIN



-High yielding area

-based on step pump test transmissivity 80-100 m2/day

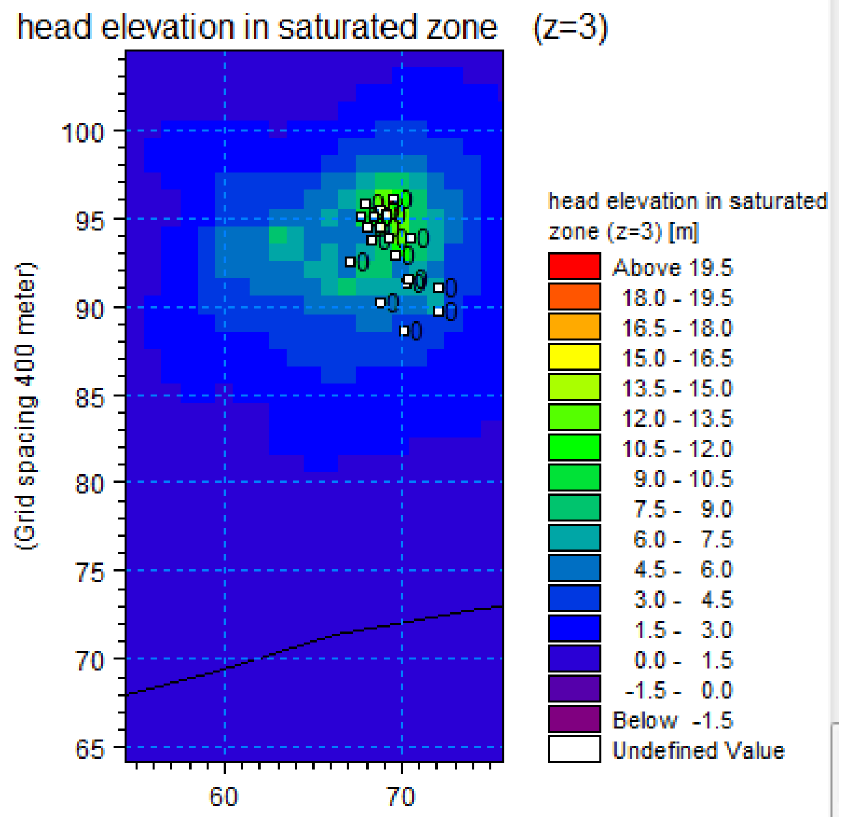
-general good water quality but needs iron and manganese treatment

-19 boreholes

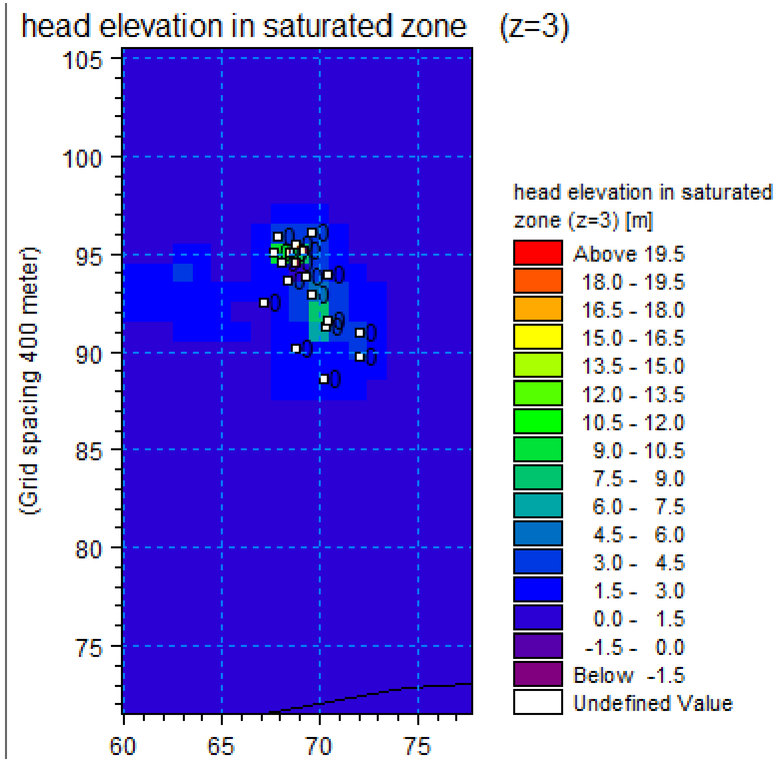
RAMBOLL

MITCHELLS PLAIN

Drawdown 2.8 million m3 per year



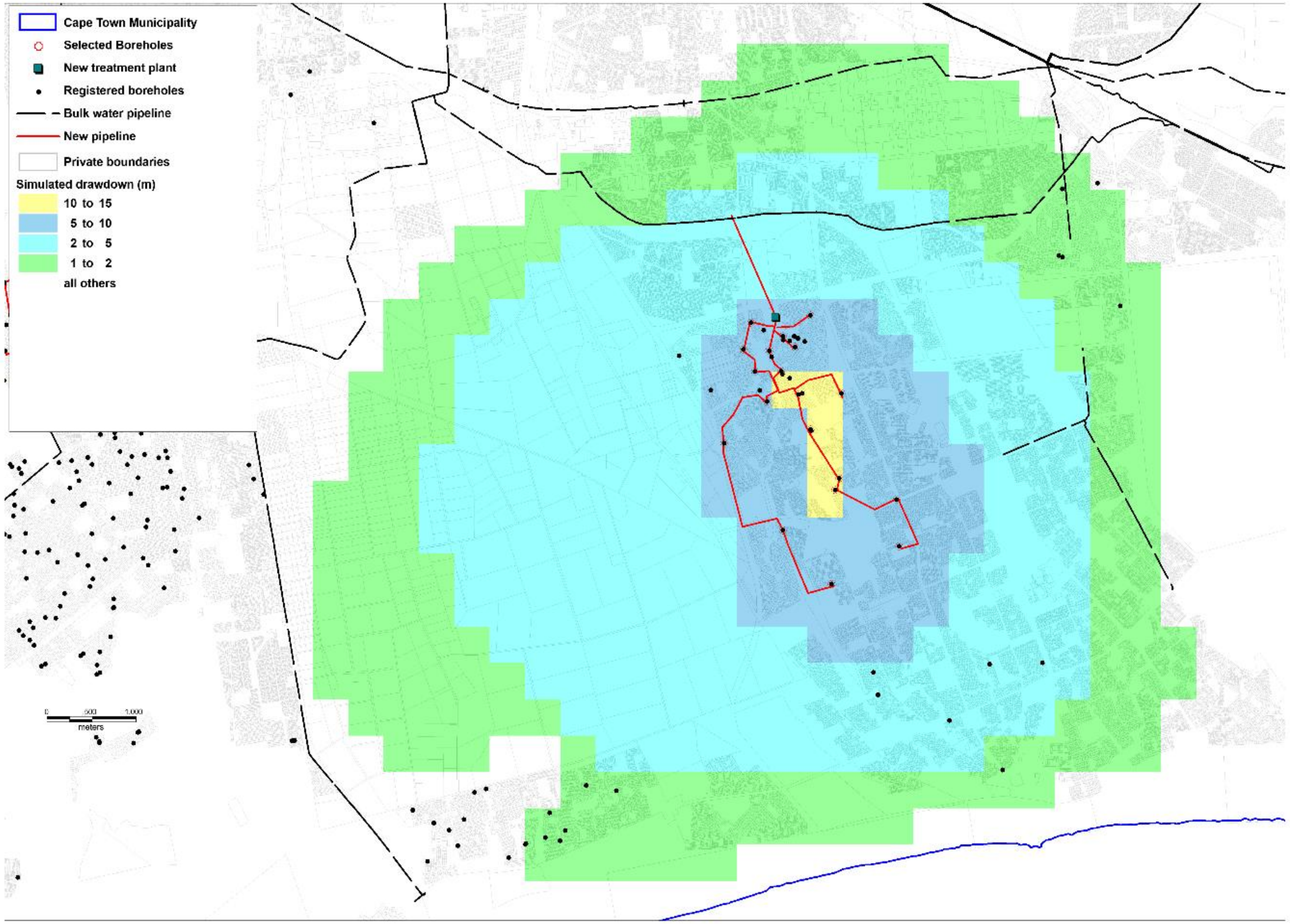
Drawdown 2 million m3



Estimated potential 2.3 million m3 per year

RAMBOLL

MITCHELLS PLAIN – PUMPING 2 MILLION M3 PER YEAR



MITCHELLS PLAIN – COSTS

Mitchells Plain	abstraction (m3 per year)	Capital cost (rand)		Operating Cost
	2005602	Treatment	3500000	5014005
		Pipelines	40320000	
		Pumps		
		Connection of pump		
		Total rand	43820000	5014005
		Rand/m3	21.84880151	2.5

ATLANTIS

Atlantis
Newlands
Mitchell's Plain
Plumstead
Legend
Abstraction Focus Areas
High Yielding Area w/ Good Quality
City of Cape Town Municipality
Borehole Focus Areas:
City of Cape Town
0 5 10 20
km
Datum: WGS 1984
Project Nr: 2832
Date: 2018/06/13
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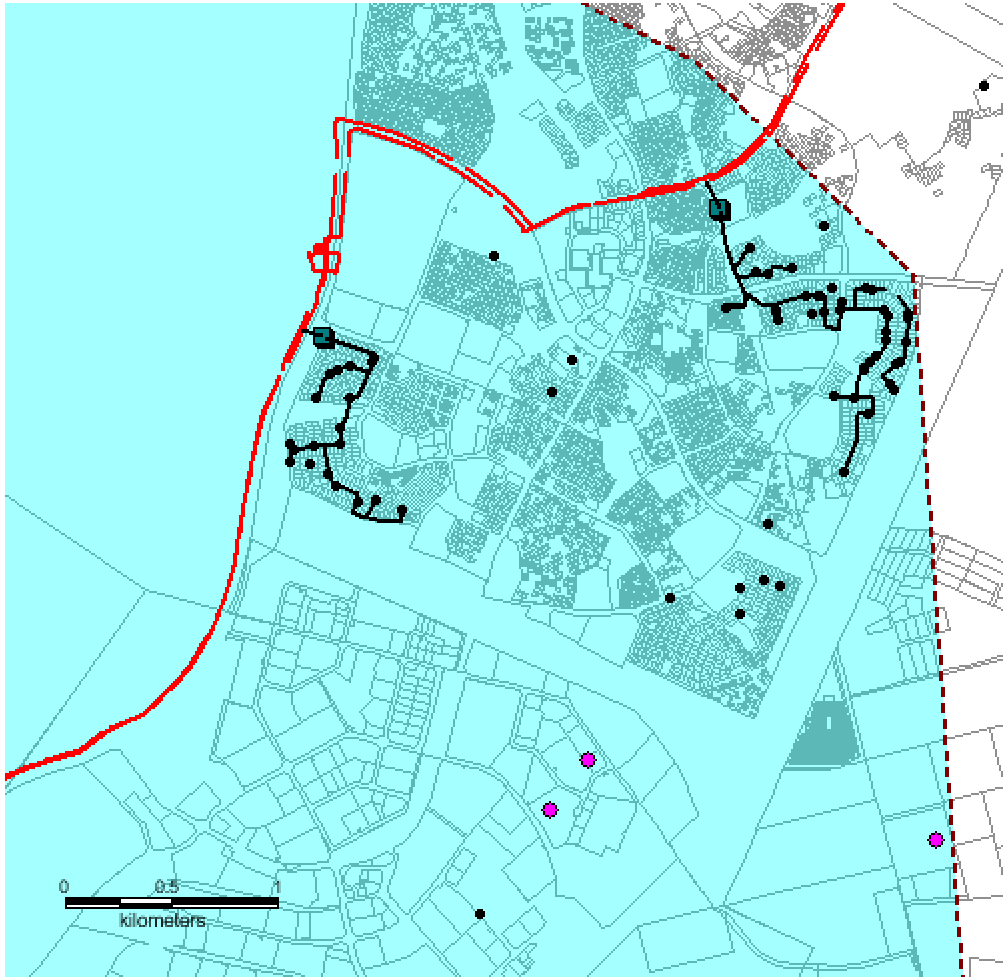
ATLANTIS



-Potentially high yielding area

-general good water quality but needs iron and manganese treatment

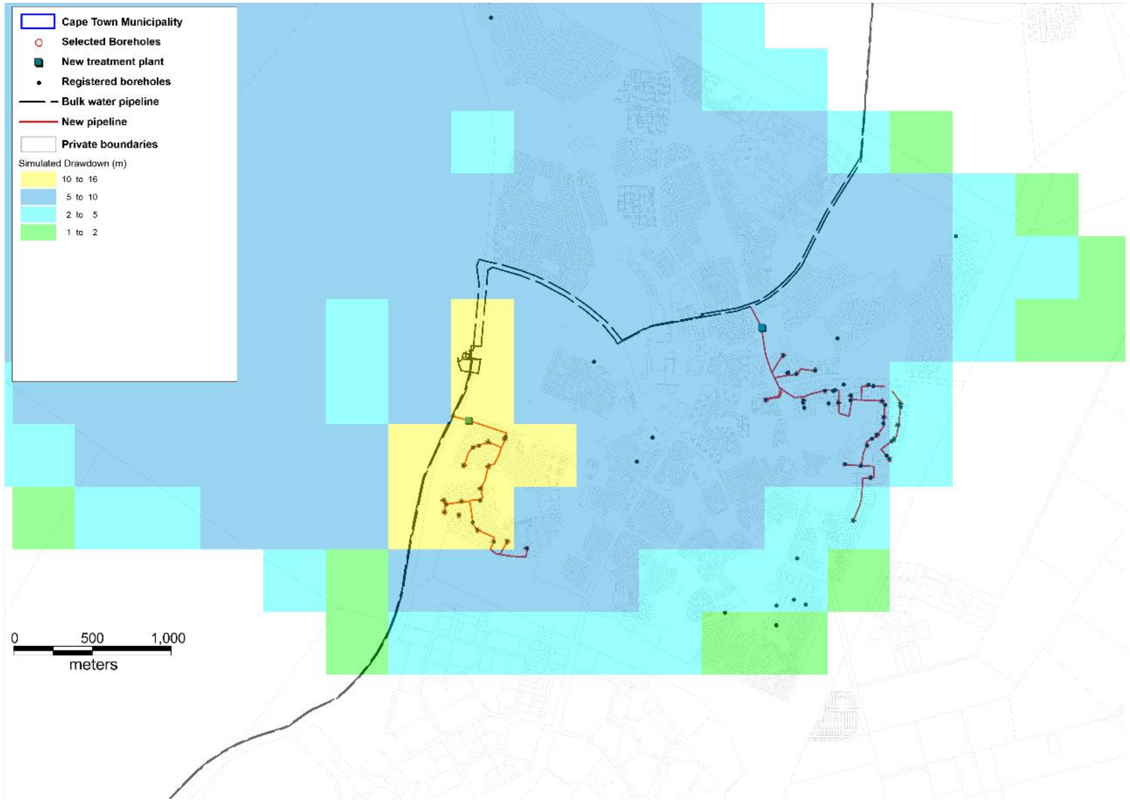
-35 boreholes (based on site visits it is wellpoints)

-no local transmissivity available

-2 separate water treatment plants

RAMBOLL

ATLANTIS – ABSTRACTION 0.35 MILLION M3 PER YEAR



Pumping limited because of shallow wellpoints

Could be a potential area if new boreholes are developed

But conservative Transmissivity used

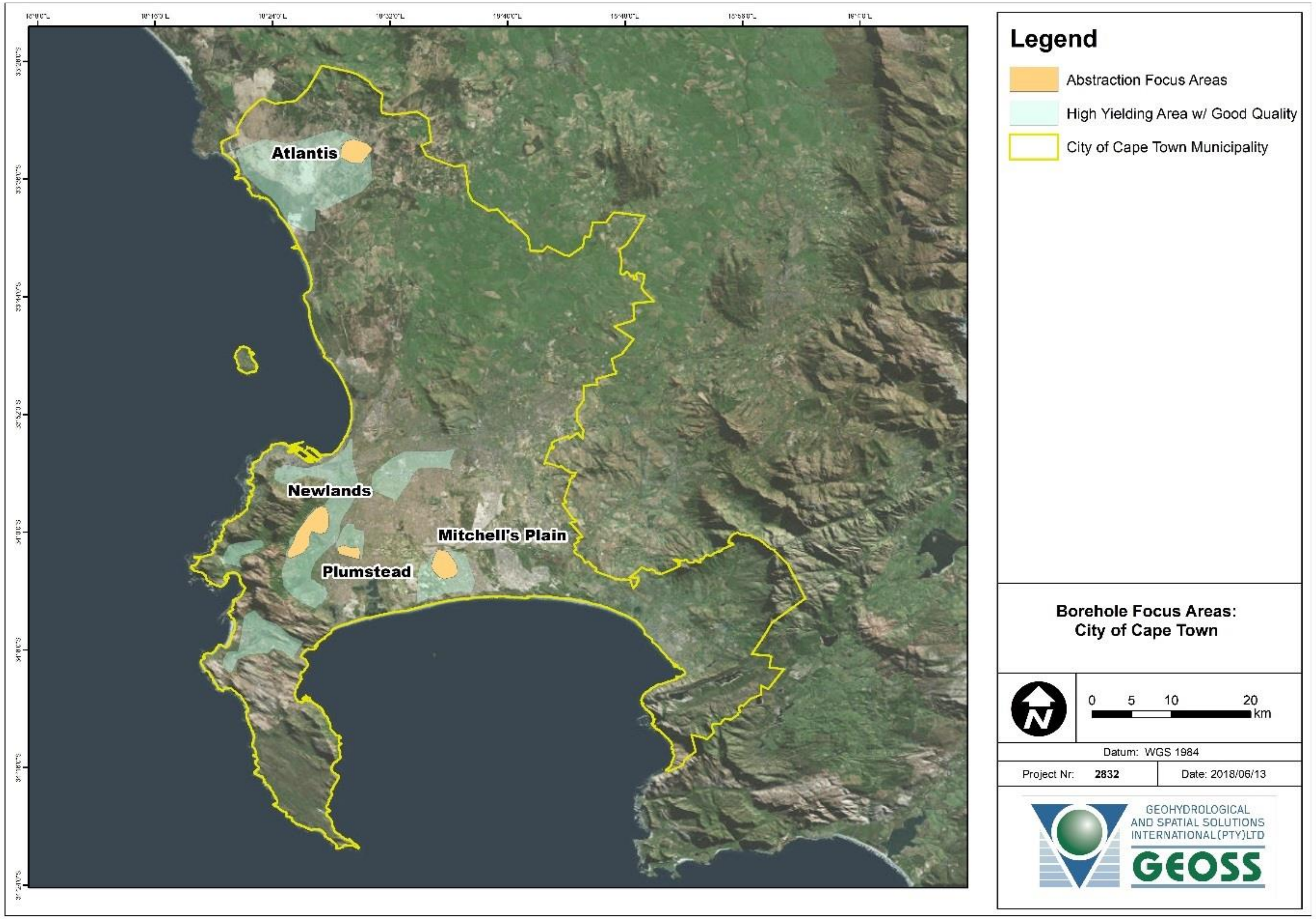
Hydraulic conductivity 1e-5 m/s), Transmissivity 25 m2/day

ATLANTIS – COSTS

Atlantis	abstraction (m3 per year)	Capital cost (rand)		Operating Cost Rand
	350000	Treatment	3500000	875000
		Pipelines	15600000	
		Pumps		
		Connection of pump		
		Total rand	19100000	875000
		Rand/m3	54.57142857	2.5

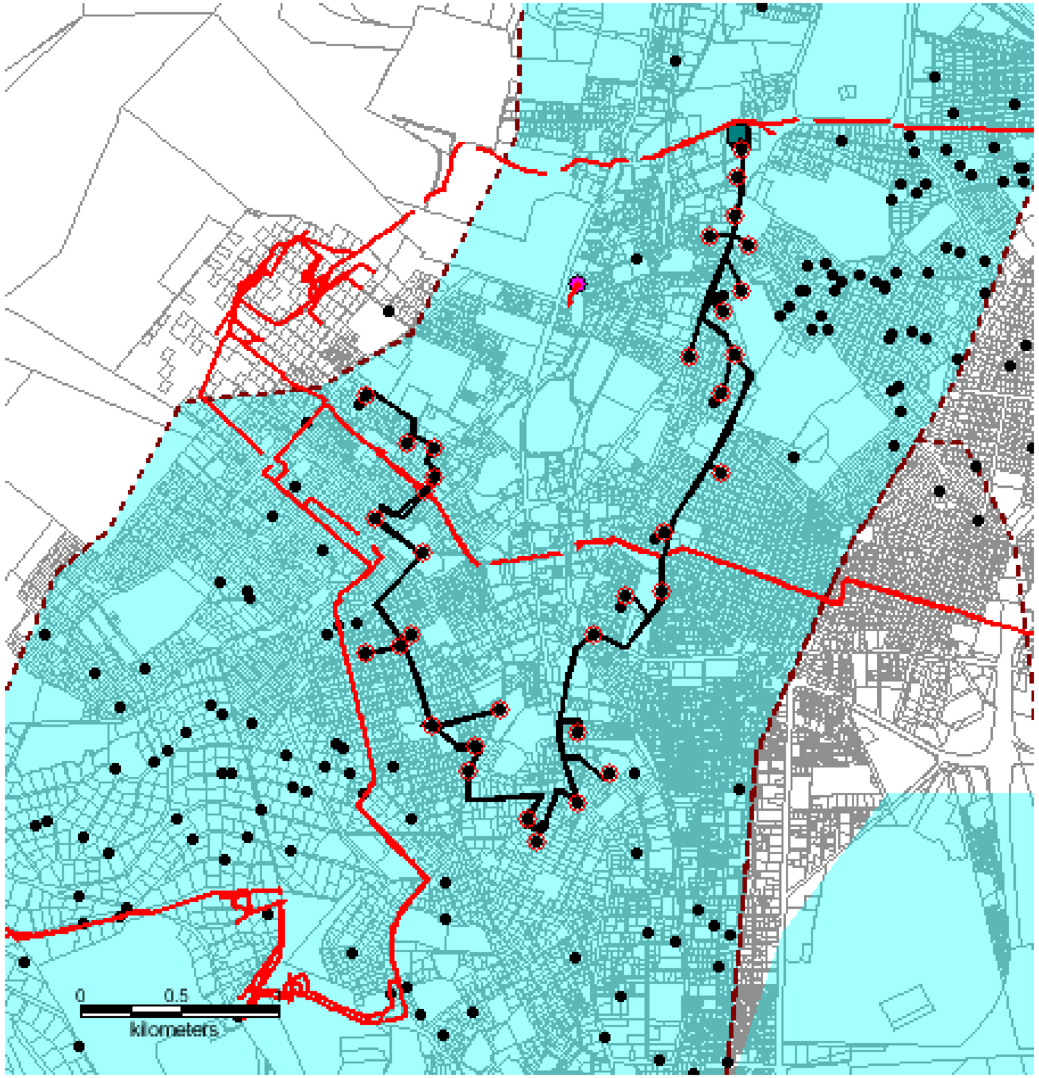
Uncertain because locale value of transmissivity is needed

NEWLANDS



RAMBOLL

NEWLANDS



Newlands area

- Border of the mountains

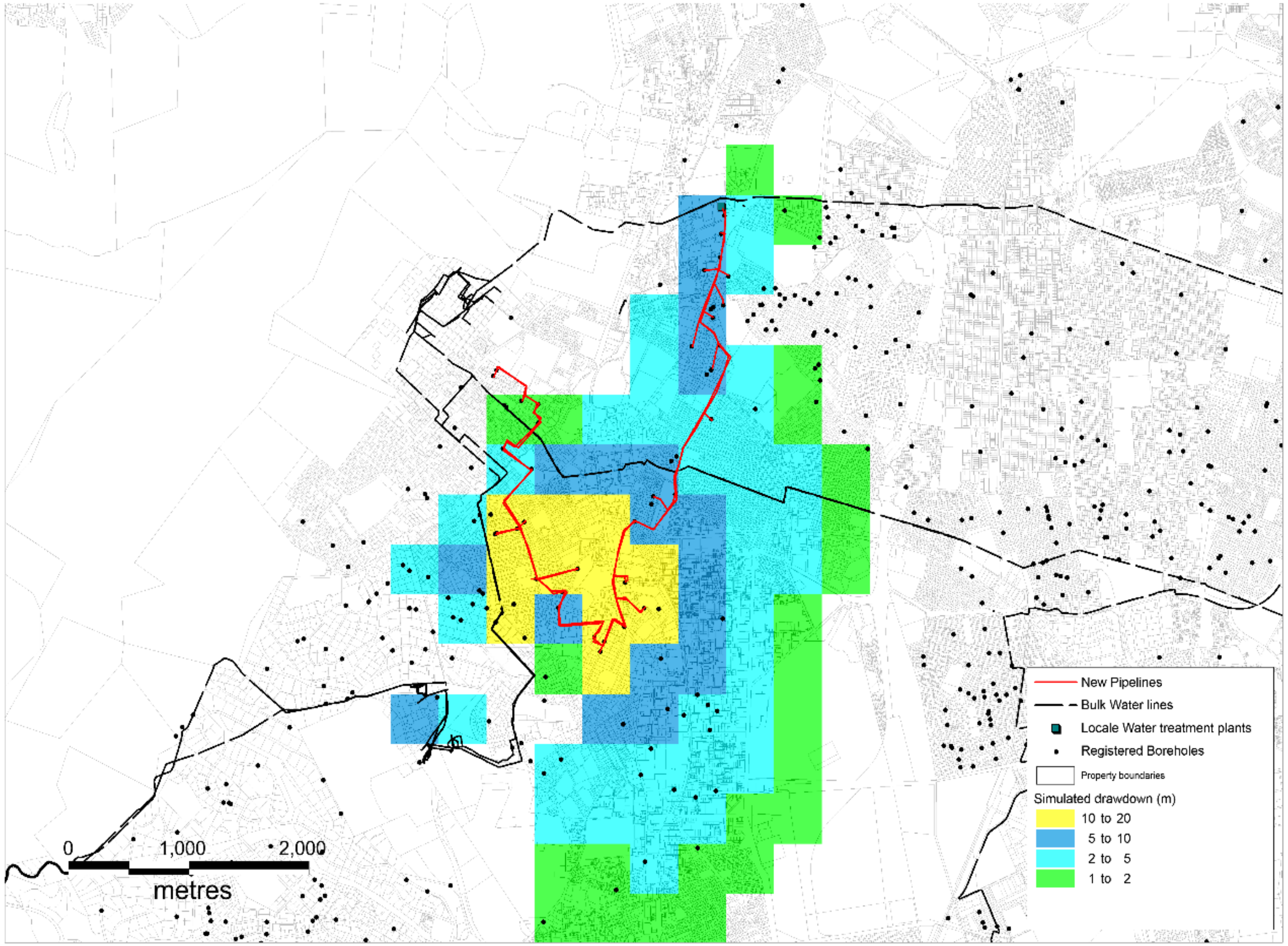
- Springs in the area with good water quality

-34 boreholes

-no local transmissivity values available

RAMBOLL

NEWLANDS – ABSTRACTION 1.5 MILLION M3 PER YEAR



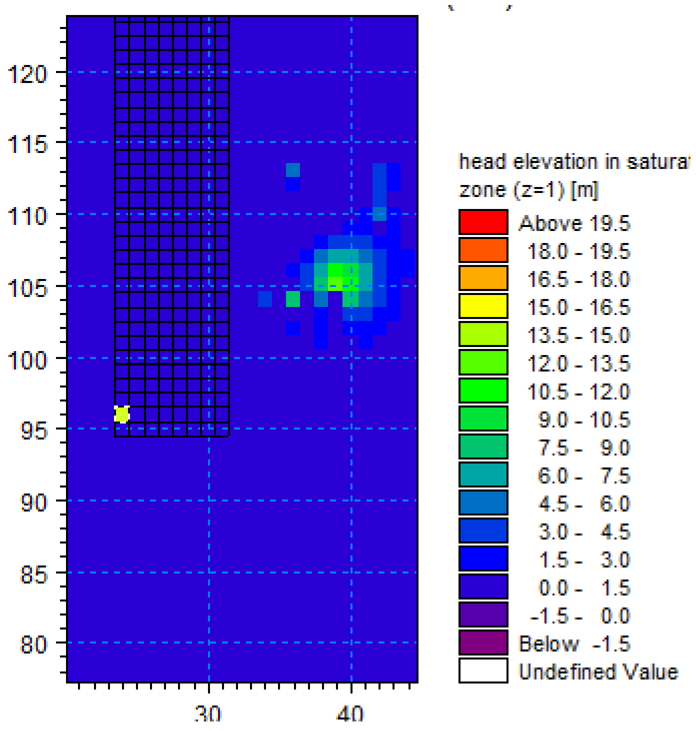
Potential high yielding area

But conservative Transmissivity used

(hydraulic conductivity 1e-5 m/s) Transmissivity 25 m2/day

RAMBOLL

NEWLANDS – ABSTRACTION 2 MILLION M3 PER YEAR



Potential high yielding area

Transmissivity 75 m2/day

NEWLANDS – COSTS

Newlands	abstraction (m3 per year)	Capital cost		Operating Cost
	1550000	Treatment		775000
		Pipelines	38764000	
		Pumps		
		Connection of pump		
		Total rand	38764000	775000
		Rand/m3	25.00903226	0.5

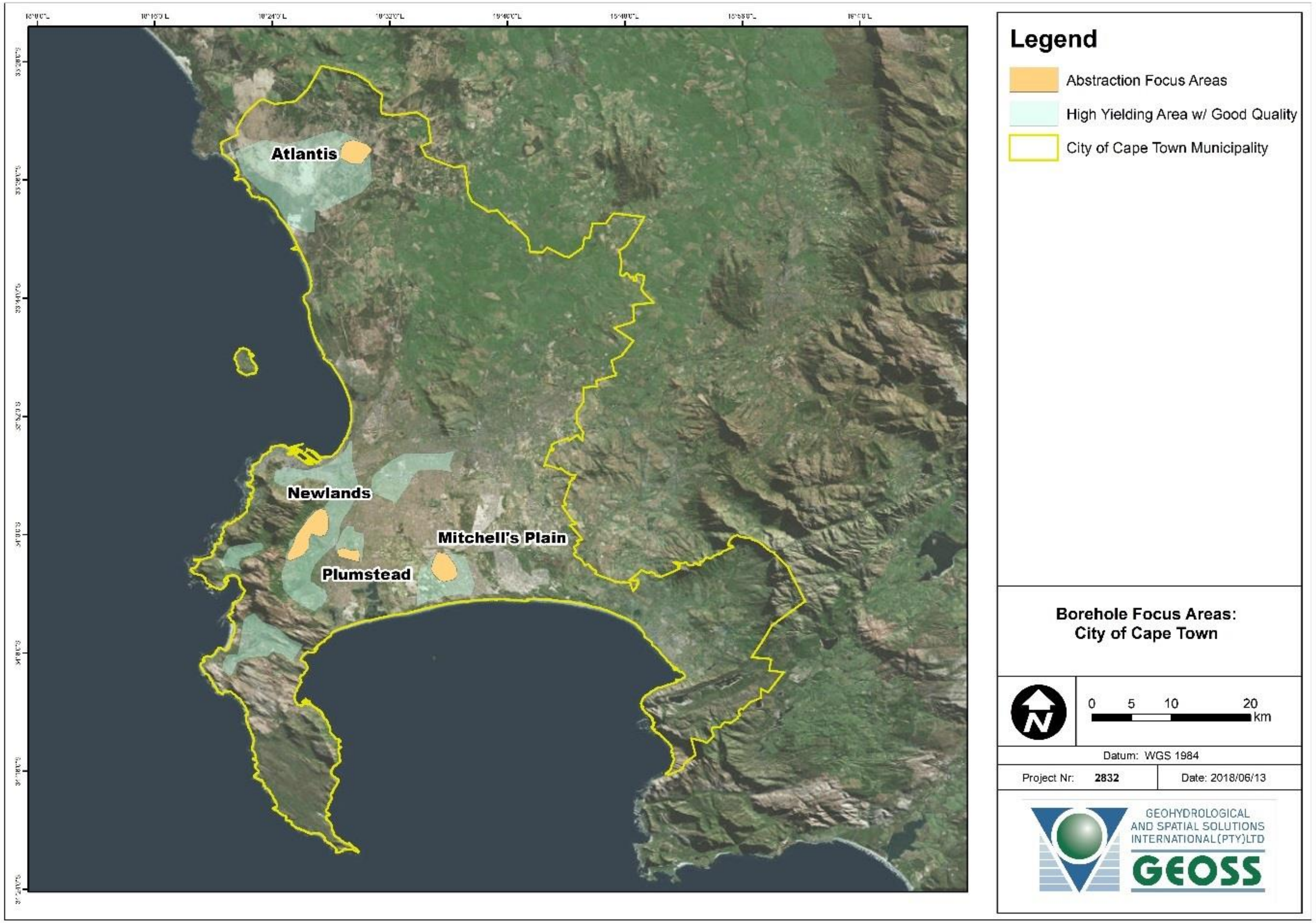
Newlands	Abstraction (m3 per year)	Capital cost		Operating Cost
	2000000	Treatment		1000000
		Pipelines	38764000	
		Pumps		
		Connection of pump		
		Total rand	38764000	1000000
		Rand/m3	19.382	0.5

Uncertain because locale value of transmissivity is needed

Operating cost low because only simple treatment is expected

RAMBOLL

PLUMSTEAD


Atlantis
Newlands
Mitchell's Plain
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Abstraction Focus Areas
High Yielding Area w/ Good Quality
City of Cape Town Municipality
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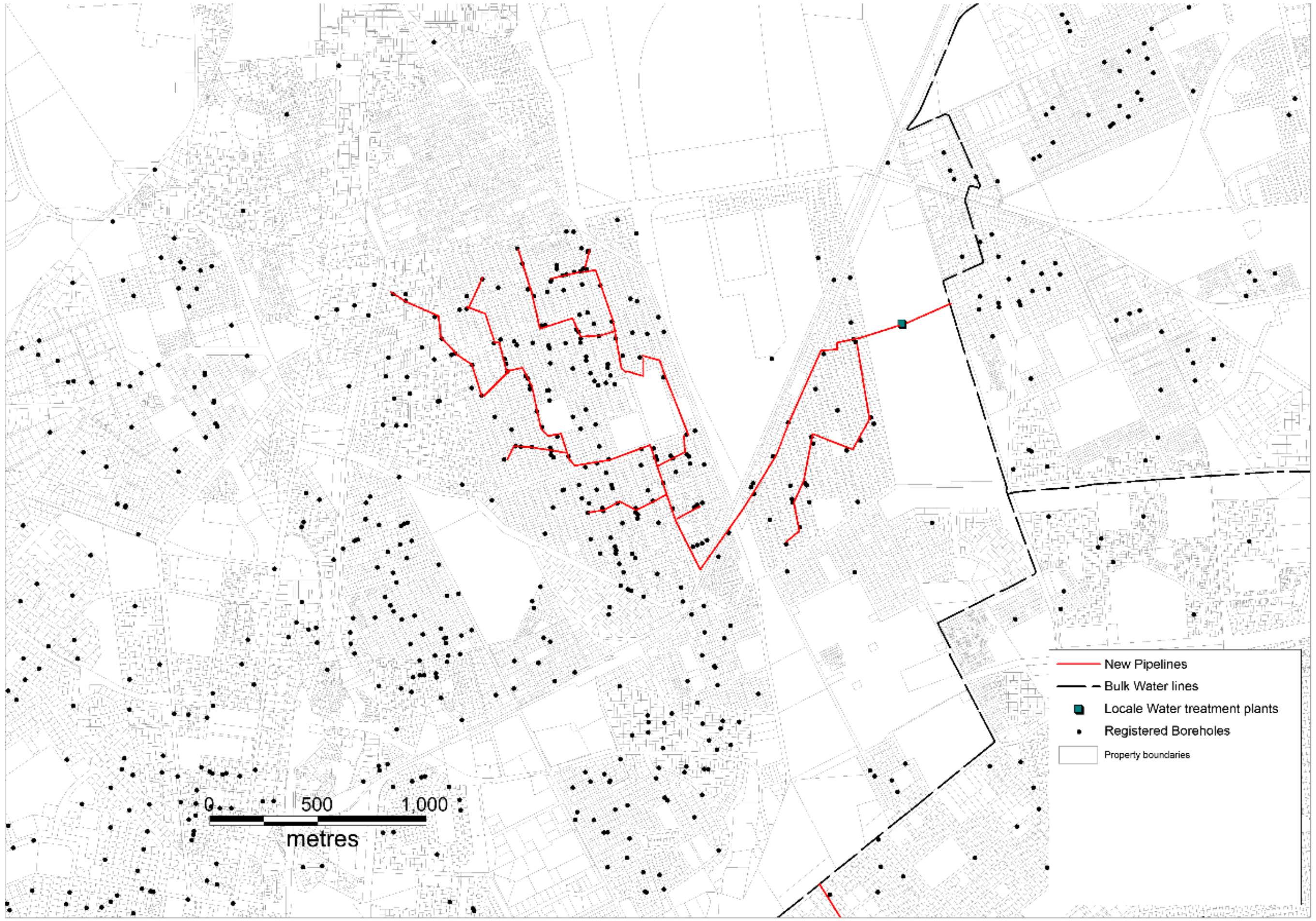
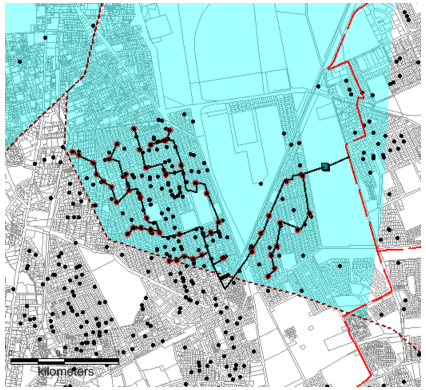
PLUMSTEAD



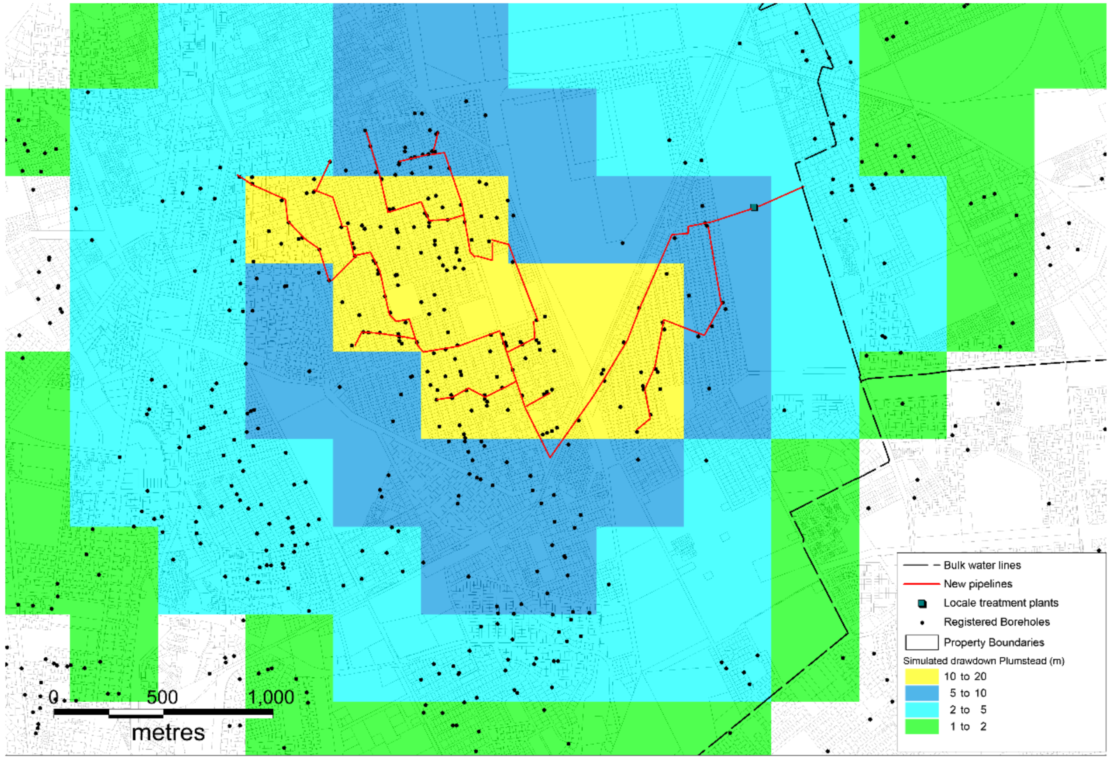
-Potentially high yielding area, gravel deposits located close by

-34 boreholes

-no local transmissivity available



PLUMSTEAD 1.2 MILLION M3 PER YEAR



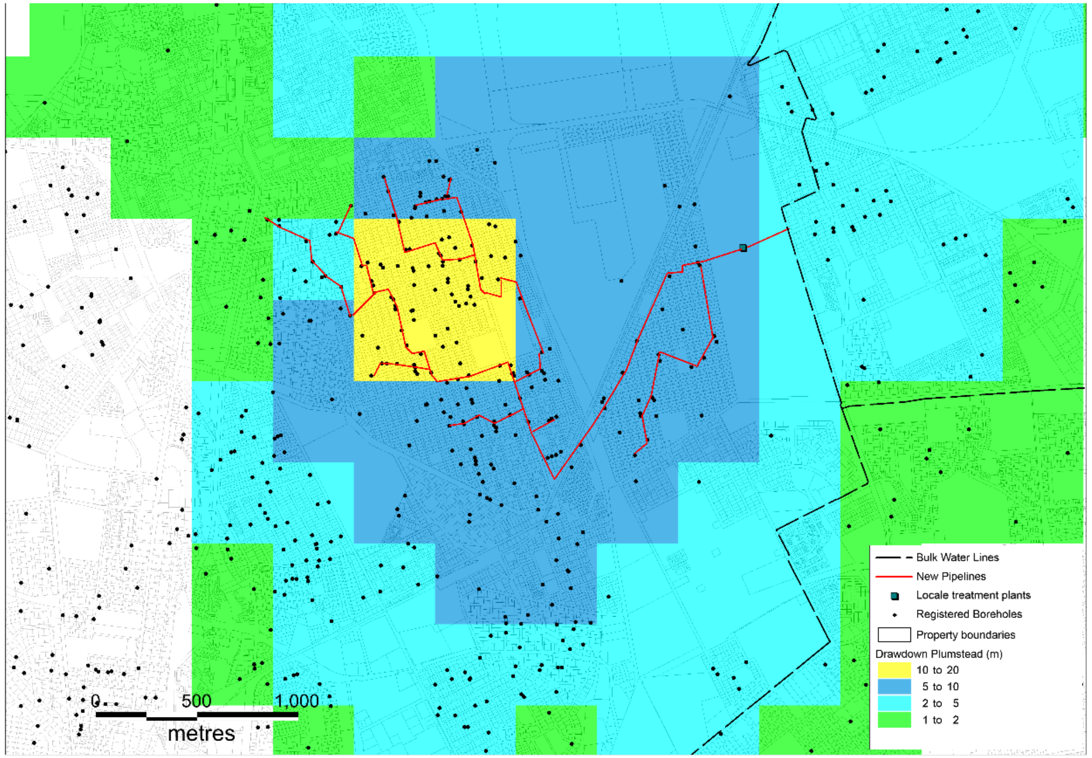
hydraulic conductivity value 0.00009 m/s, Transmissivity 150 m2/day

-more than 300 boreholes and wellpoints in the area which means that amount of Schedule 1 water is very high (more than 1 million m3 per year)

-not much available water left

RAMBOLL

PLUMSTEAD 2.9 MILLION M3 PER YEAR



(hydraulic conductivity 0.0002 m/s, Transmissivity 325 m2/day)

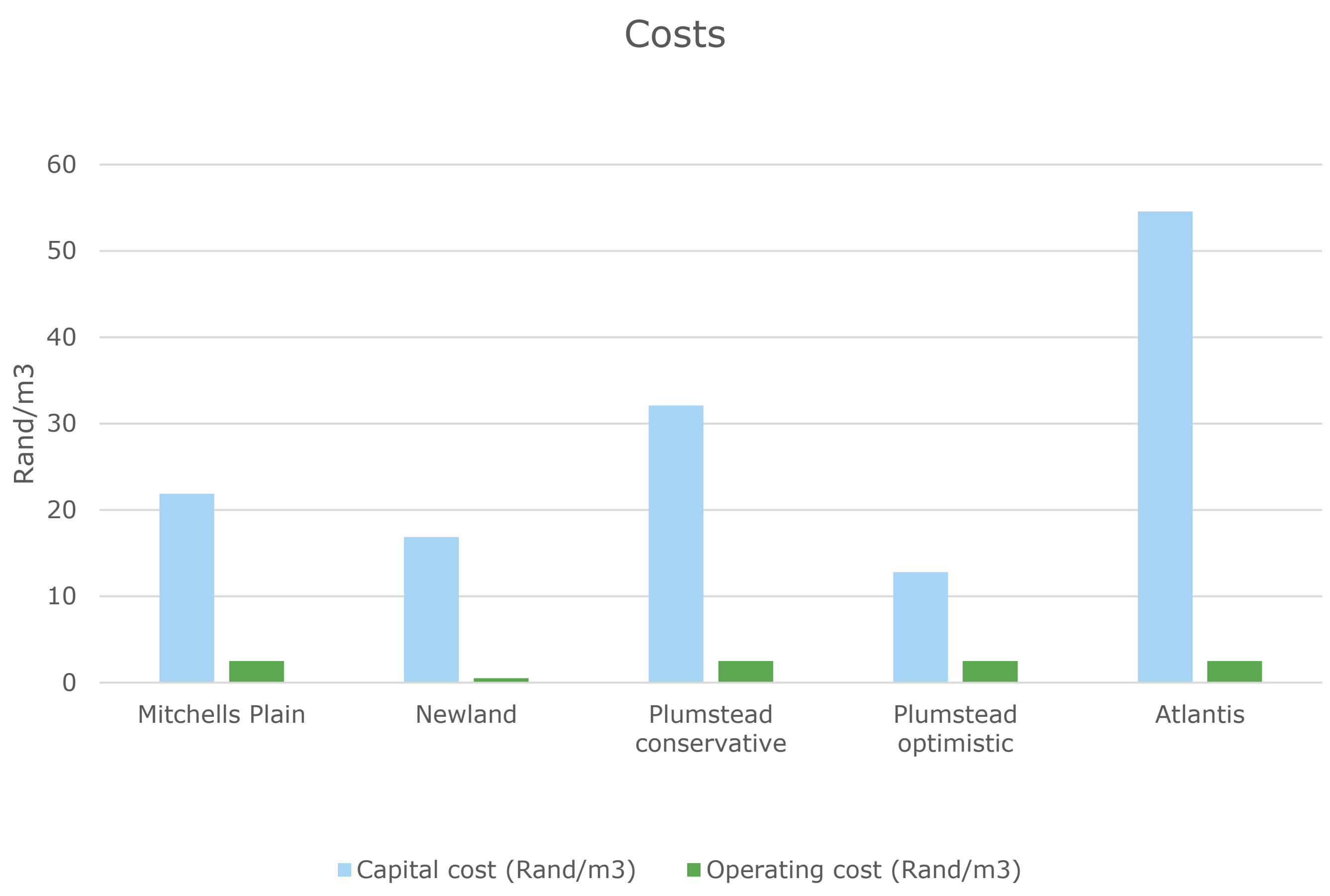
So good potential if coarse grained deposits are present

PLUMSTEAD – COSTS

Plumstead	Abstraction (m3 per year)	Capital cost		Operating Cost
	1200000	Treatment	3500000	3000000
		Pipelines	35000000	
		Pumps		
		Connection of pump		
		Total rand	38500000	3000000
		Rand/m3	32.08333333	2.5

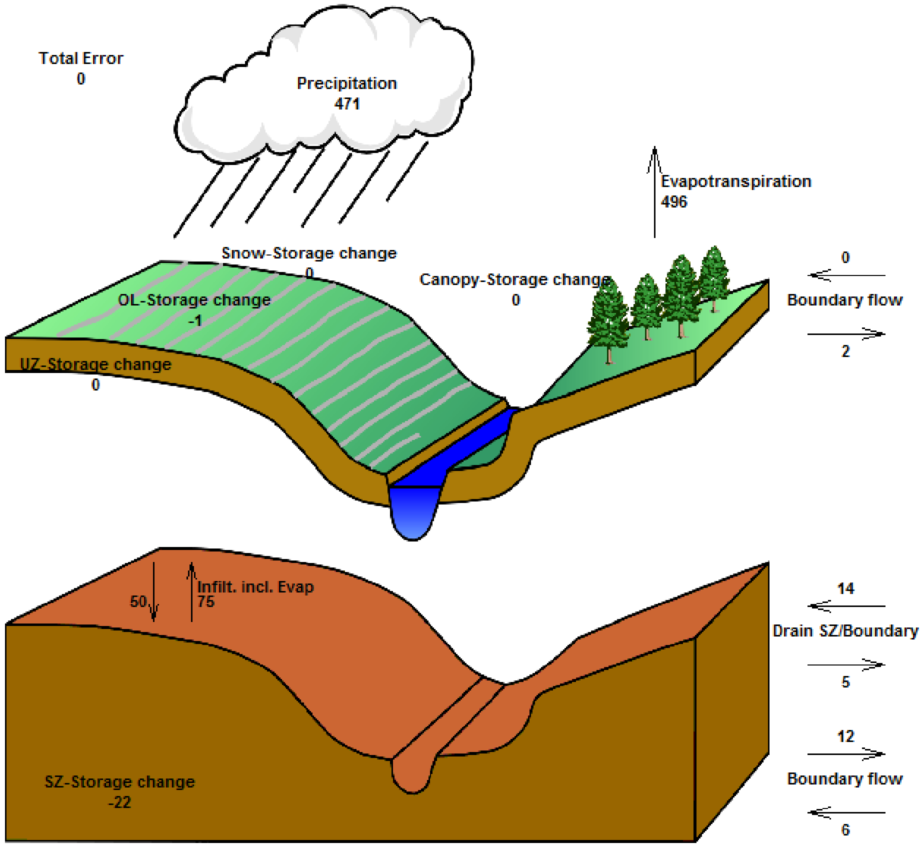
Plumstead	Abstraction (m3 per year)	Capital cost		Operating Cost
	2900000	Treatment	3500000	7250000
		Pipelines	33624000	
		Pumps		
		Connection of pump		
		Total rand	37124000	7250000
		Rand/m3	12.80137931	2.5

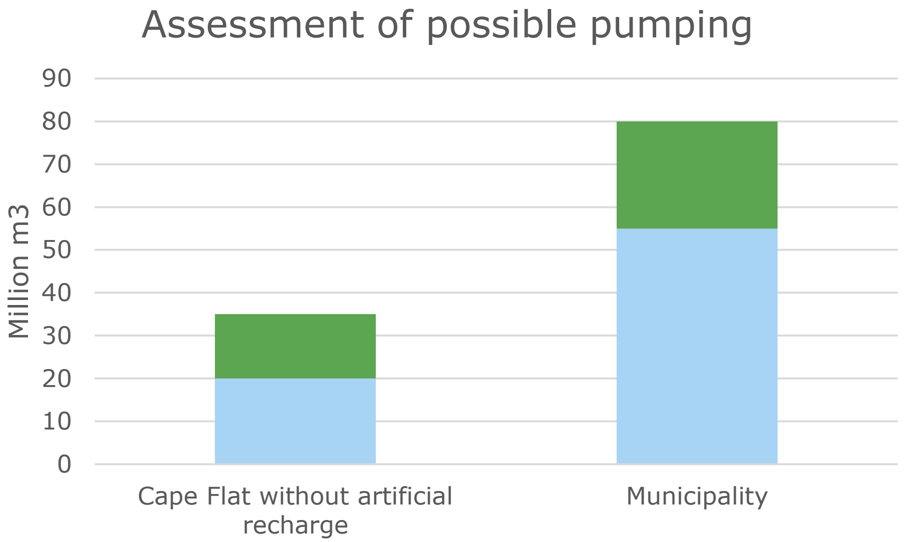
PRELIMINARY ESTIMATES OF COSTS, MICHELL'S PLAIN PROBABLY MOST CERTAIN



RAMBOLL

WATER BALANCE OUTPUT FROM PRELIMINARY MODEL WITHOUT PUMPING, DRY YEAR 2017

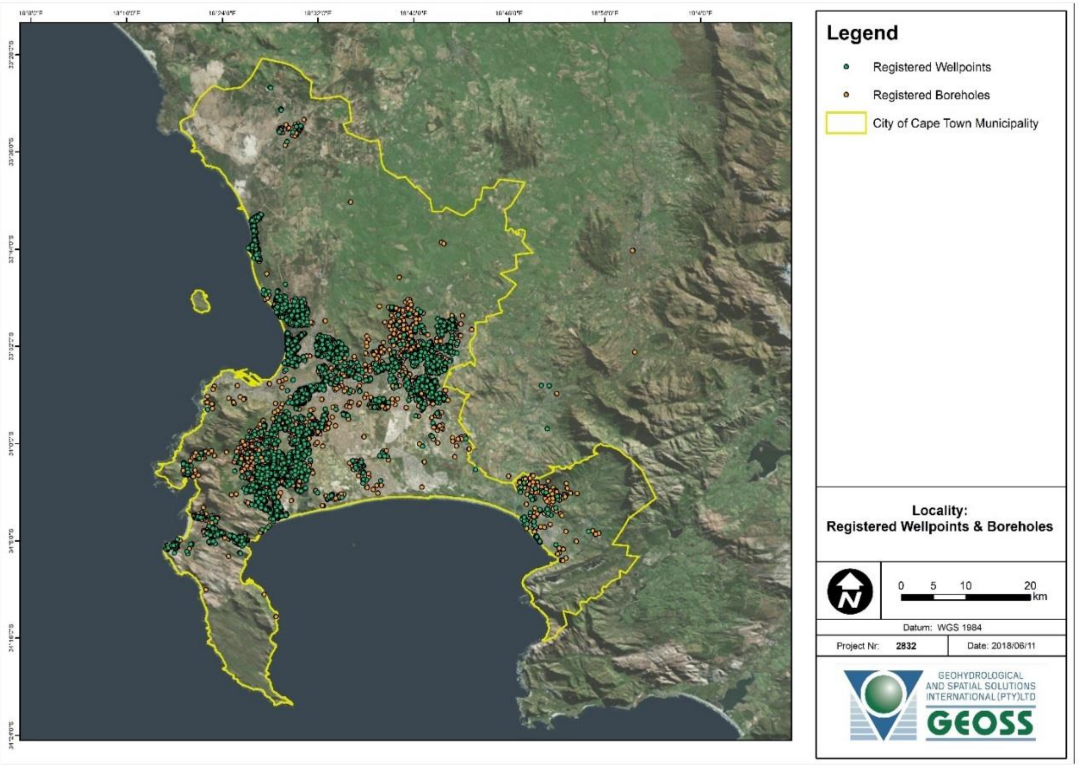


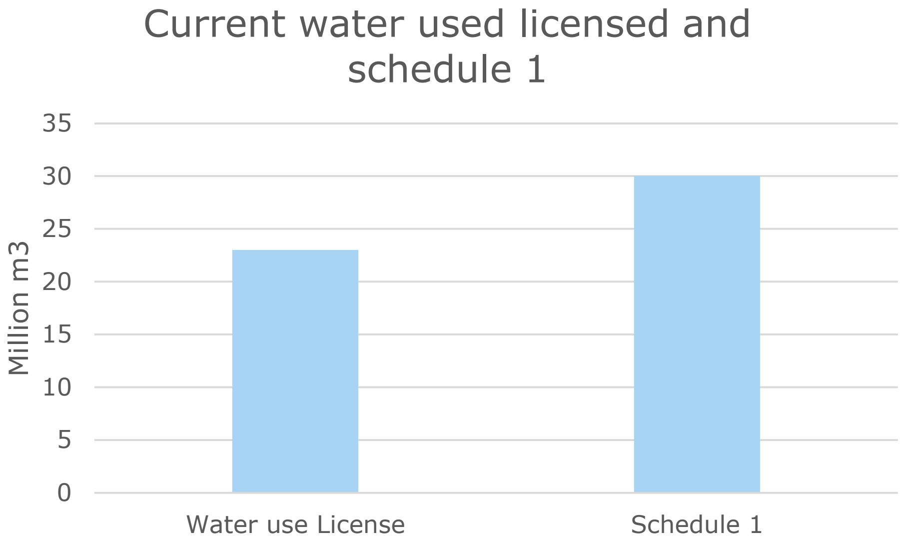


I Denmark pumping is generally sustainable when pumping max. 30-50 % of the recharge to the groundwater within a watershed or catchment area

RAMBOLL

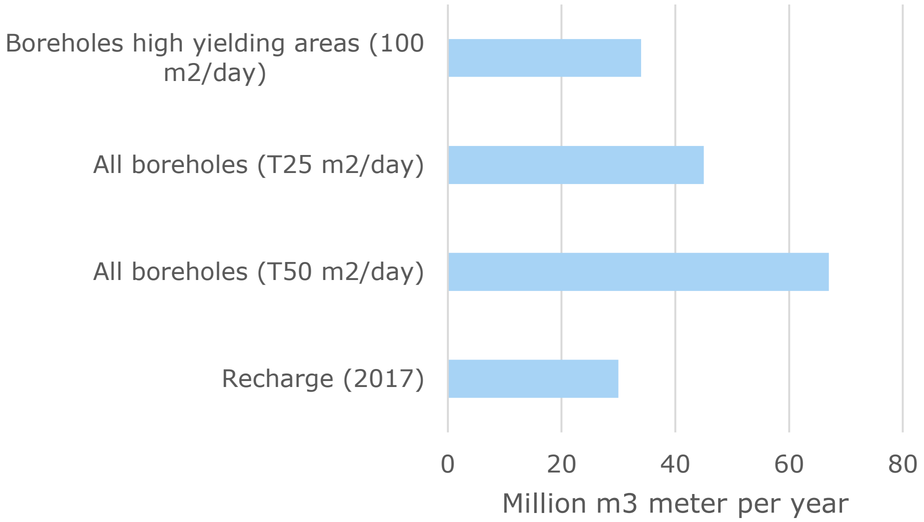
POTENTIAL ABSTRACTION FROM PRIVATE BOREHOLES

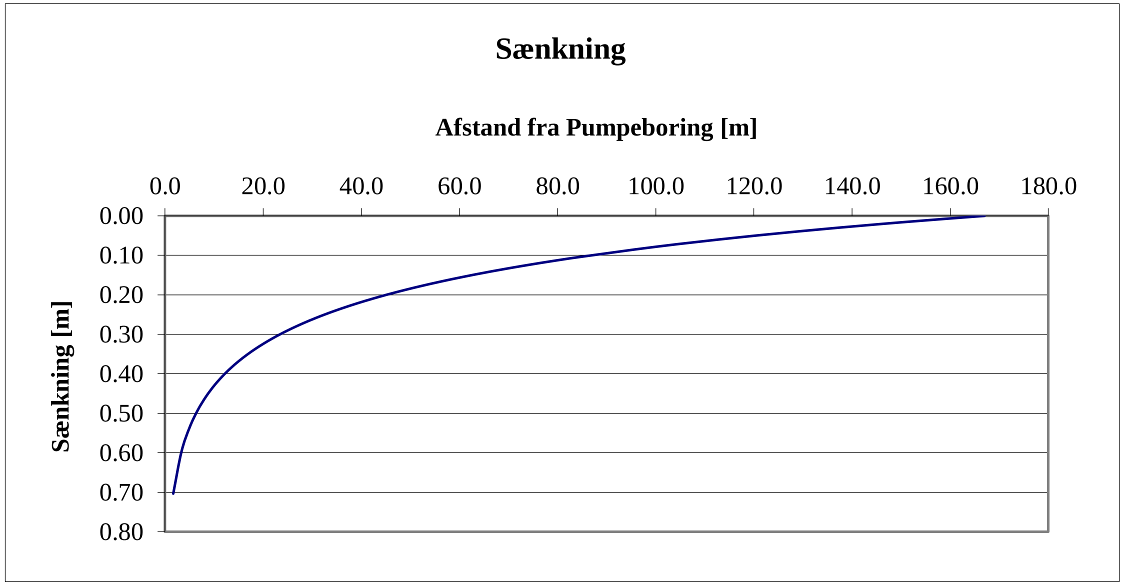




To estimate total amounts is difficult because locale transmissivity has to be measured and incorporated in calibrated and validated model in accordance with accepted standards. Moreover borehole designs are not known

POTENTIAL ABSTRACTION FROM 5161 PRIVATE BOREHOLES (NOT WELL POINTS)





SITE VISITS

-Bishops court/Newland
-Mitchells Plain
-Atlantis
-Plumstead

Learning from the site visits:
-access can be difficult to achieve
-we saw some useful boreholes in Newland area (diameter 120 mm) and several springs in the area indicating there is plenty of water
-In Atlantis we got access to several boreholes but they turned out to be very shallow wellpoints (PVC plastic tube)

LEGISLATION

Memorandum from ENSafrican

First a step 1 for securing a water use Entitlement. ENSAfricans recommendations is that The City first identify the Private boreholes that it intends to use for groundwater abstraction, as well as those private properties that it would like to develop boreholes on to access underlying aquifers. Once it has this information it will be able to determine the general authorised amount of groundwater available in terms of the General Authorisation Notice. If the aggregate generally authorised amount of groundwater is sufficient, no water use licence will be required. However, the City will need to register its intended water use. If the generally authorised amount of water is insufficient, the City will either need to approach the DWS to procure that it need to secure a water use licence is dispensed with or prepare a consolidated single water use licence application and submit this to the DWS for consideration on an expedited basis so that a water use licence may be granted to the City to use water found underground on land not owned by the City. If consent from the owner of the land is not forthcoming, the City will need to motivate to the DWS that there us good reason to grant the water use licence in the context of the severe drought being experienced in the region.

LEGISLATION

Memorandum from ENSafrican

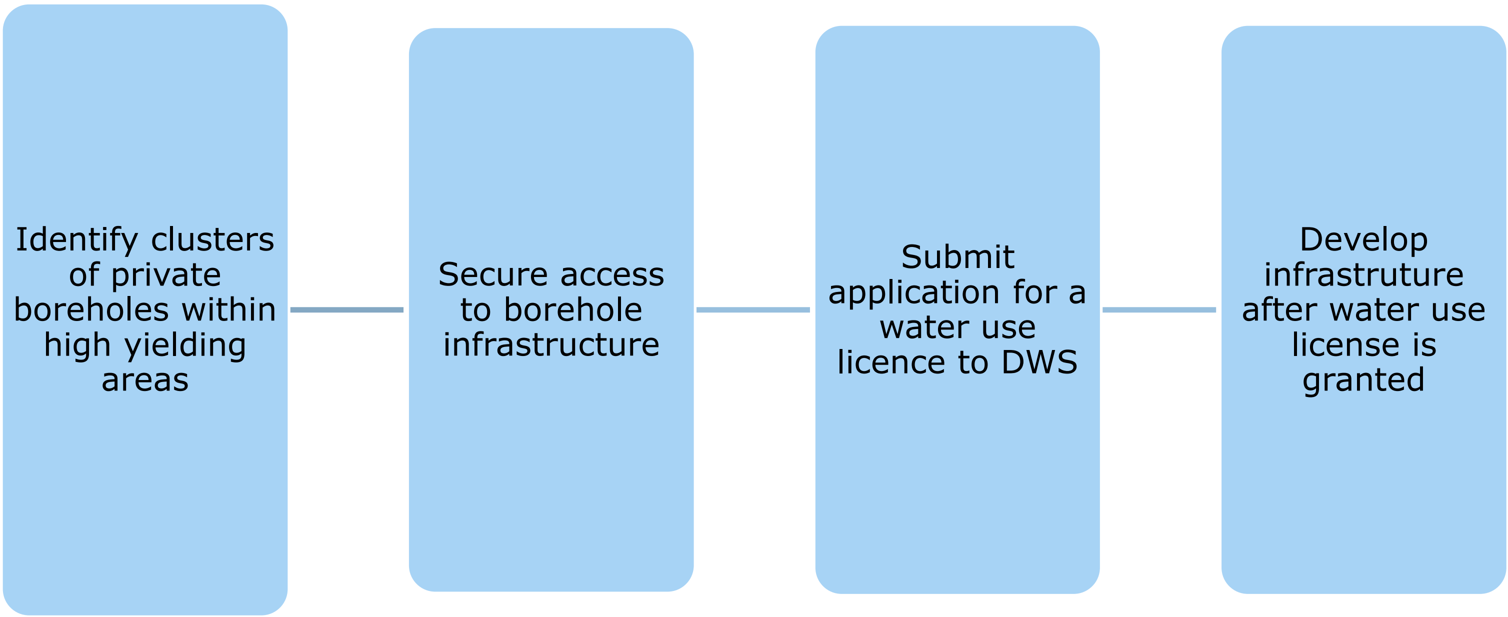
Thereafter a step 2 for securing access to the Borehole infrastructure. Once a water entitlement has been granted to the City by the DWS, the next step for the City to secure access to the borehole infrastructure, where this already exists. This may be achieved by way of private agreements for the acquisition of the borehole infrastructure with a related agreed servitude of access. If it is more practical to do so, it is also possible for the DWS to acquire the borehole infrastructure and transfer it to the City. However, from a practical point of view, when dealing with 20,000-40,000 boreholes this may be difficult to achieve, depending to a large extent on the timeframes for implementation of the proposed project by the City. A potentially more efficient approach would be for the City on the expropriation procedure in the Expropriation Act read together with its immovable Property By-Law to gain temporary access to the borehole infrastructure. The City may be able to rely on PAJA to dispense with certain procedures if it is reasonable and justifiable in the circumstances to do so. However, the City would need to tread wearily to as to strike the right balance between expediency and the recognition of the principles of just administrative action. Ultimately the Court will decide the compensation to be paid by the City. An alternative expropriation proceeding is for the City to apply to court for a servitude of aqueduct in terms of Schedule 2 of the NWA. Ultimately, the court will make a determination on the compensation to be paid to each landowner for the servitude over their land to allow the City to access the borehole.

One of the challenges approaching a new area, is that the exact amount of groundwater that can be pumped from the area is not known in detail (both from the aquifer and the existing boreholes).

Therefore, the landowners must be approached first for securing of access to the borehole infrastructure – and to investigate for both aquifer properties (Transmissivity) and borehole designs:
-the depth of the borehole and intake
-the diameter of the borehole
-Borehole yields
-current pump-setup
-the depth to the groundwater table

When the areas potential has been estimated an application for a water licence can be submitted to DWS.

ROADMAP 1 FOR IMPLEMENTATION OF PRIVATE BOREHOLES



ROADMAP 2 FOR IMPLEMENTATION OF PRIVATE BOREHOLES

Identify potential high yielding areas

Identify cluster of boreholes close to distribution grid

Estimate potential groundwater ressource within area

Preliminary contact to DWS to secure possible water use entitlement

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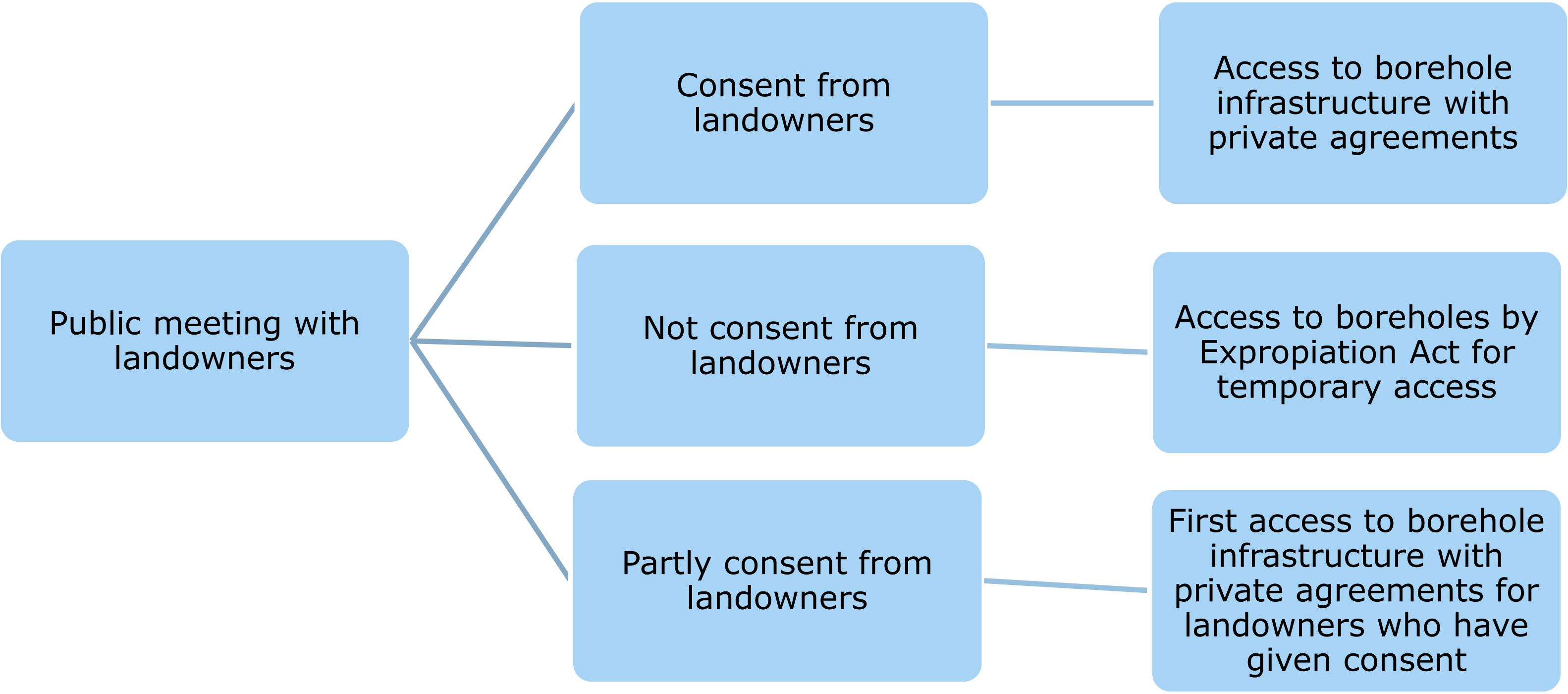
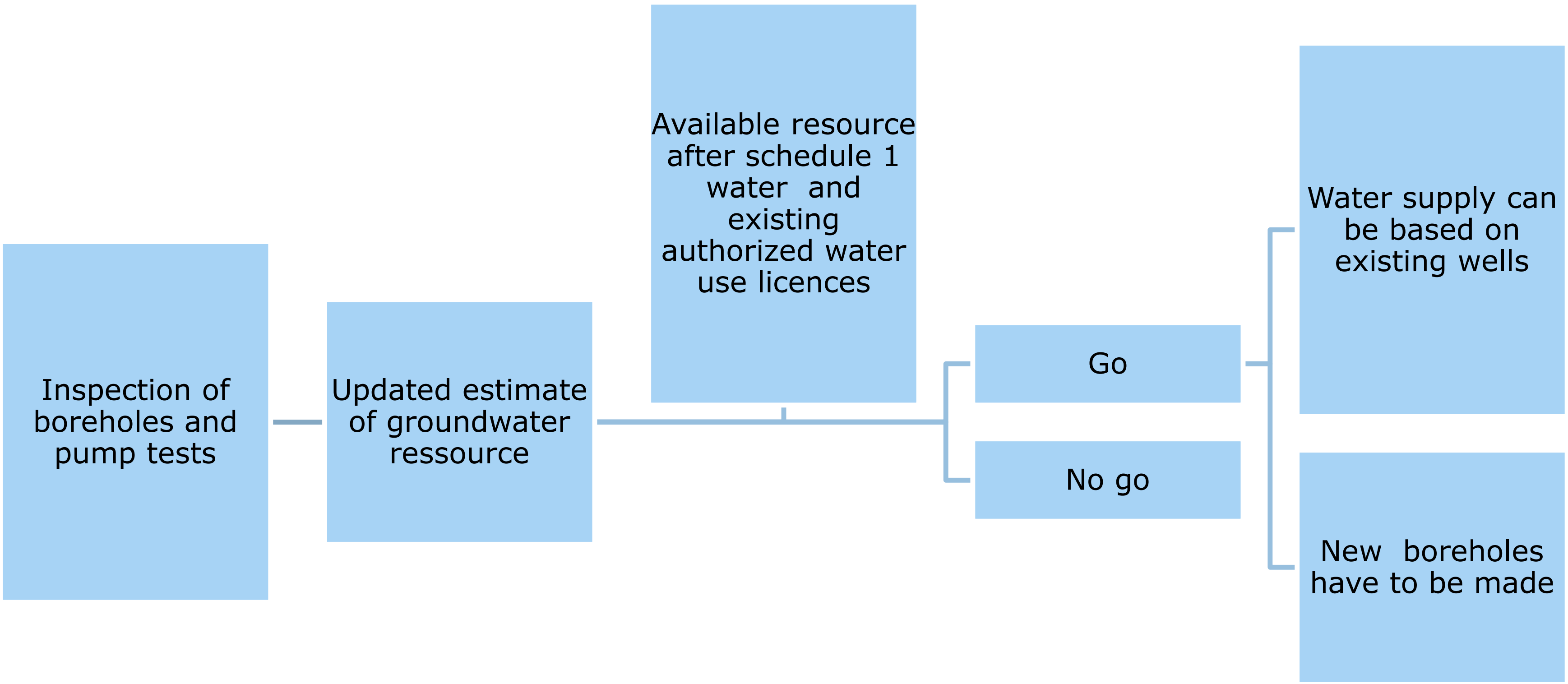
ROADMAP 3 FOR IMPLEMENTATION OF PRIVATE BOREHOLES



ROADMAP 4 FOR IMPLEMENTATION OF PRIVATE BOREHOLES



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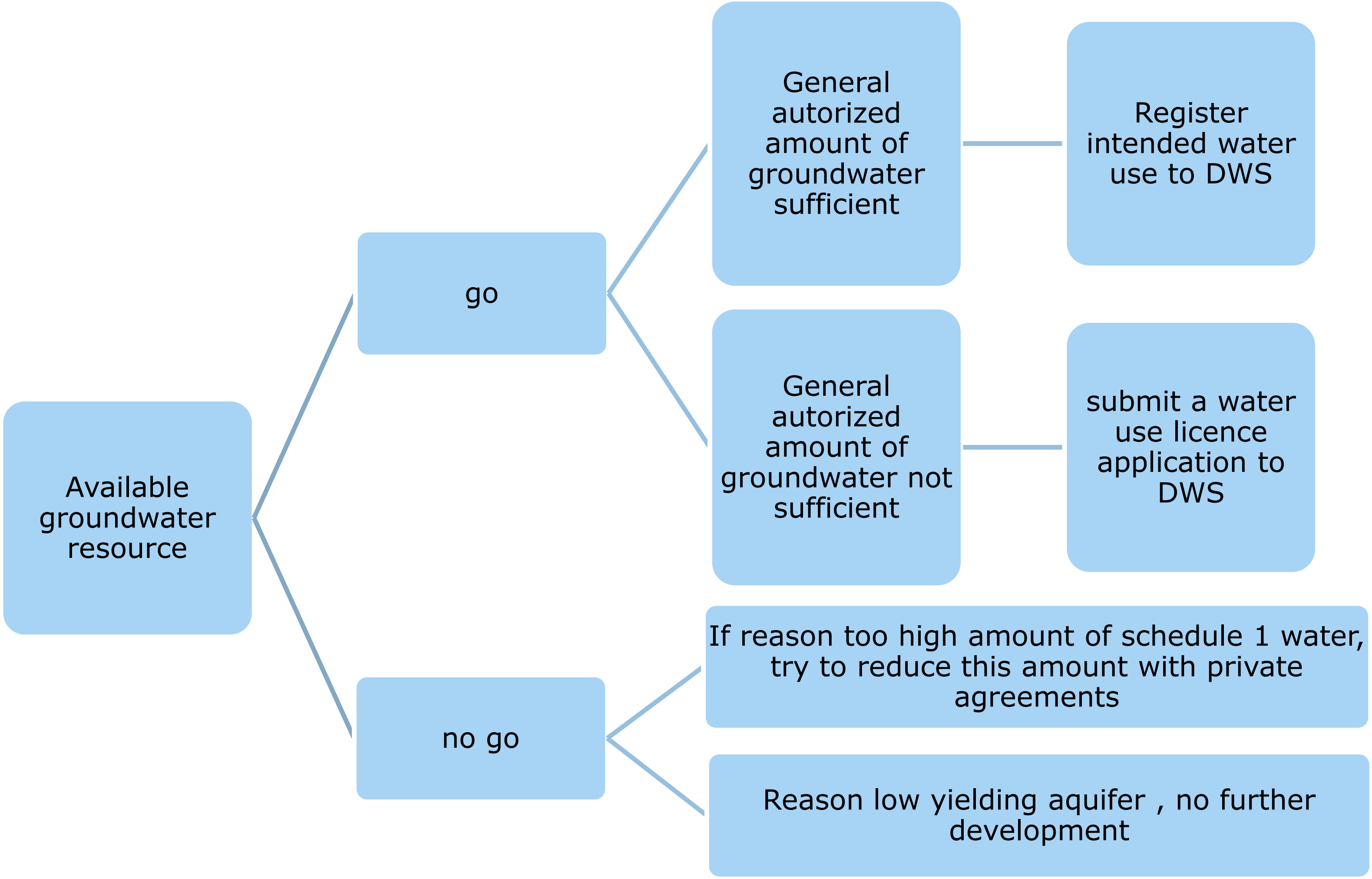
ROADMAP 5 FOR IMPLEMENTATION OF PRIVATE BOREHOLES



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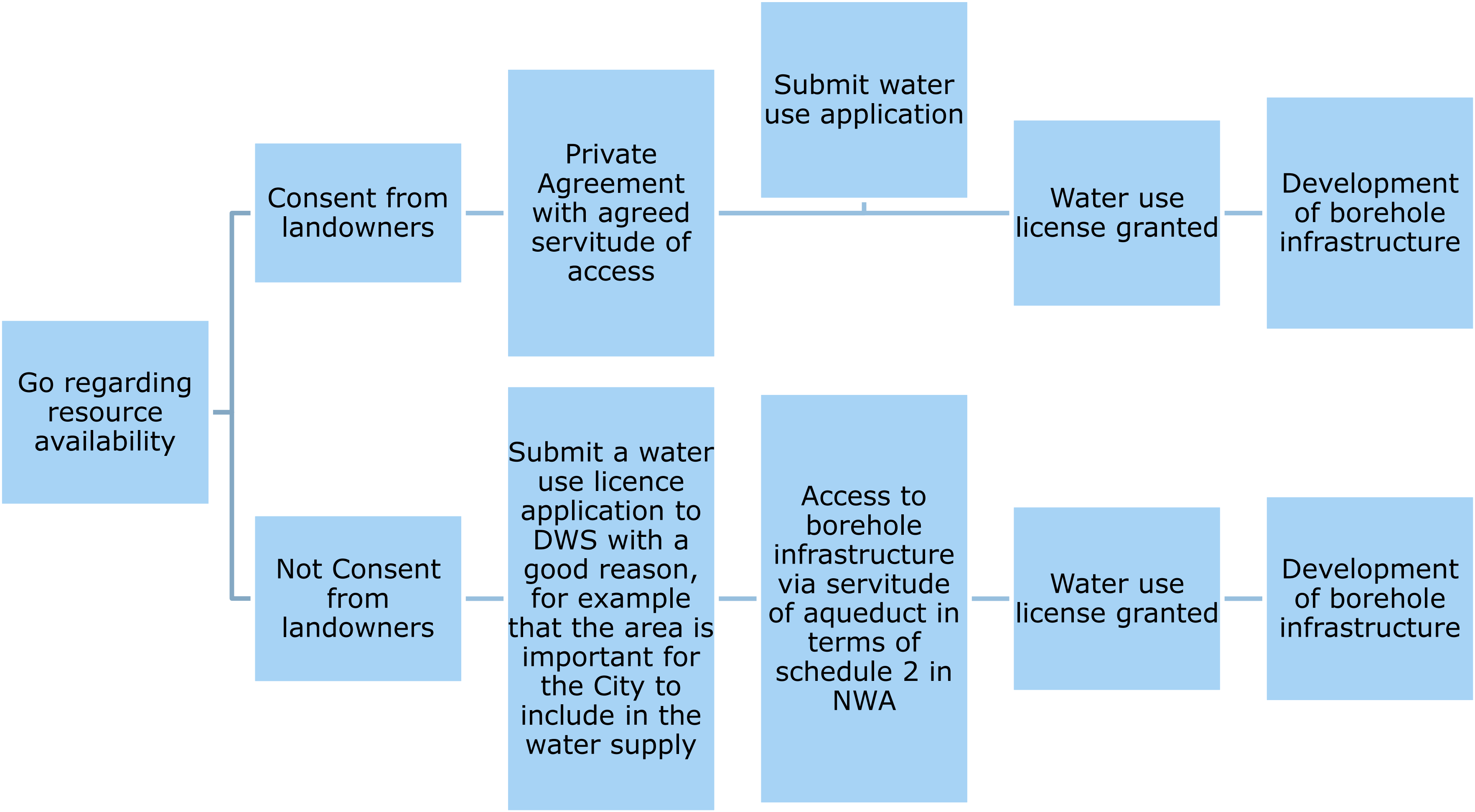
ROADMAP 6 FOR IMPLEMENTATION OF PRIVATE BOREHOLES



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RECOMMENDATIONS

-Make a pilot study for implementation of private boreholes in one of the areas

-establish one accepted hydrological model for the whole municipality

-start comprehensive monitoring programs (Hydraulic heads and water quality)

-Estimate sustainable yield based on monitoring and modelling, how much of the groundwater recharge can be pumped with regards to water quality and other relevant topics as impact on wetlands

-Synchronic head maps

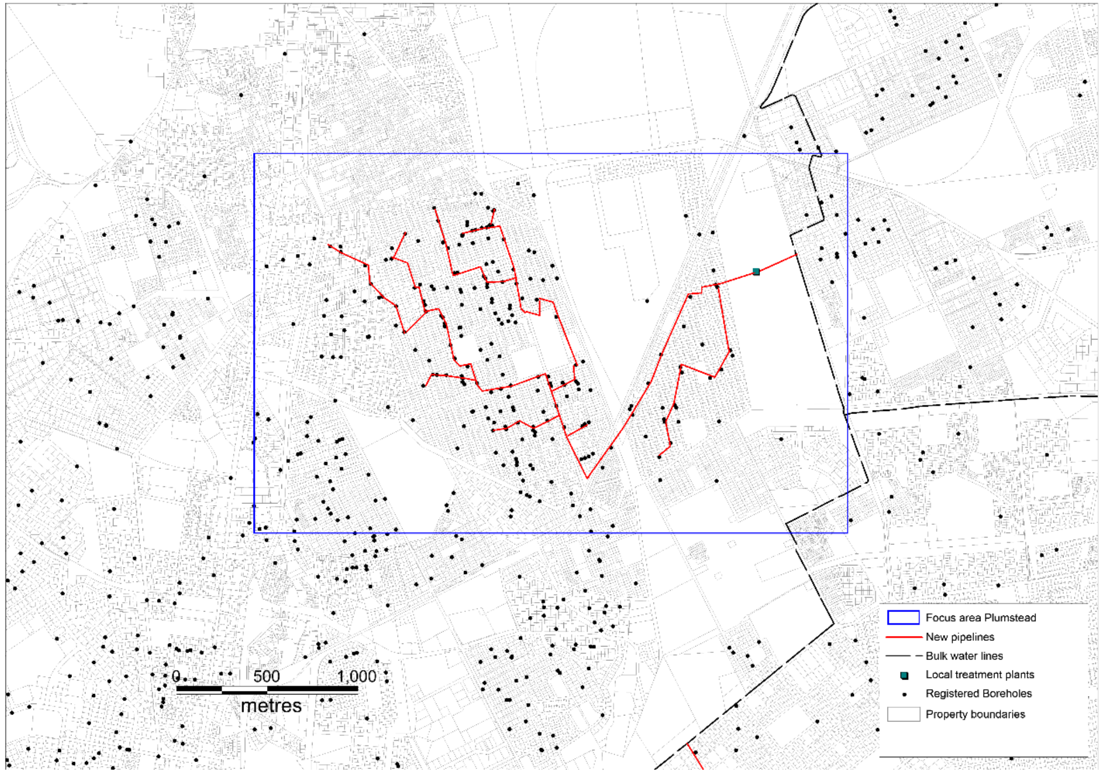
-Local collection and infiltration of rainwater in suburbs to increase the groundwater recharge

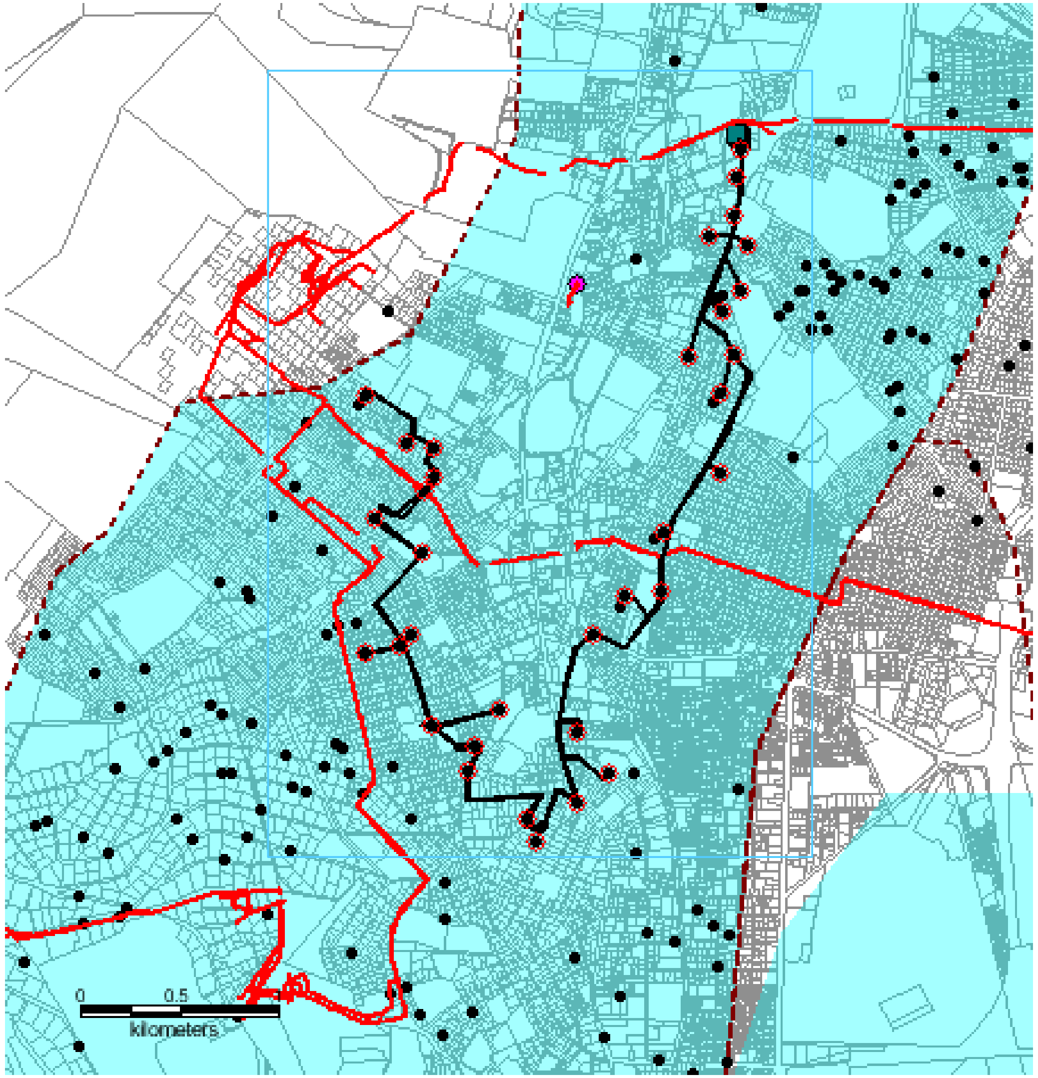
PILOT STUDY

1. Preliminary contact to DWS to secure possible water use entitlement
2. Secure access to borehole infrastructure (start with public meeting)
3. Estimate potential groundwater ressource within area
4. Submit application for a water use license
5. Develop required infrastructure after license is granted
6. Operate after manage-ment measurements

PILOT STUDY – INITIAL MAPPING OF BOREHOLES

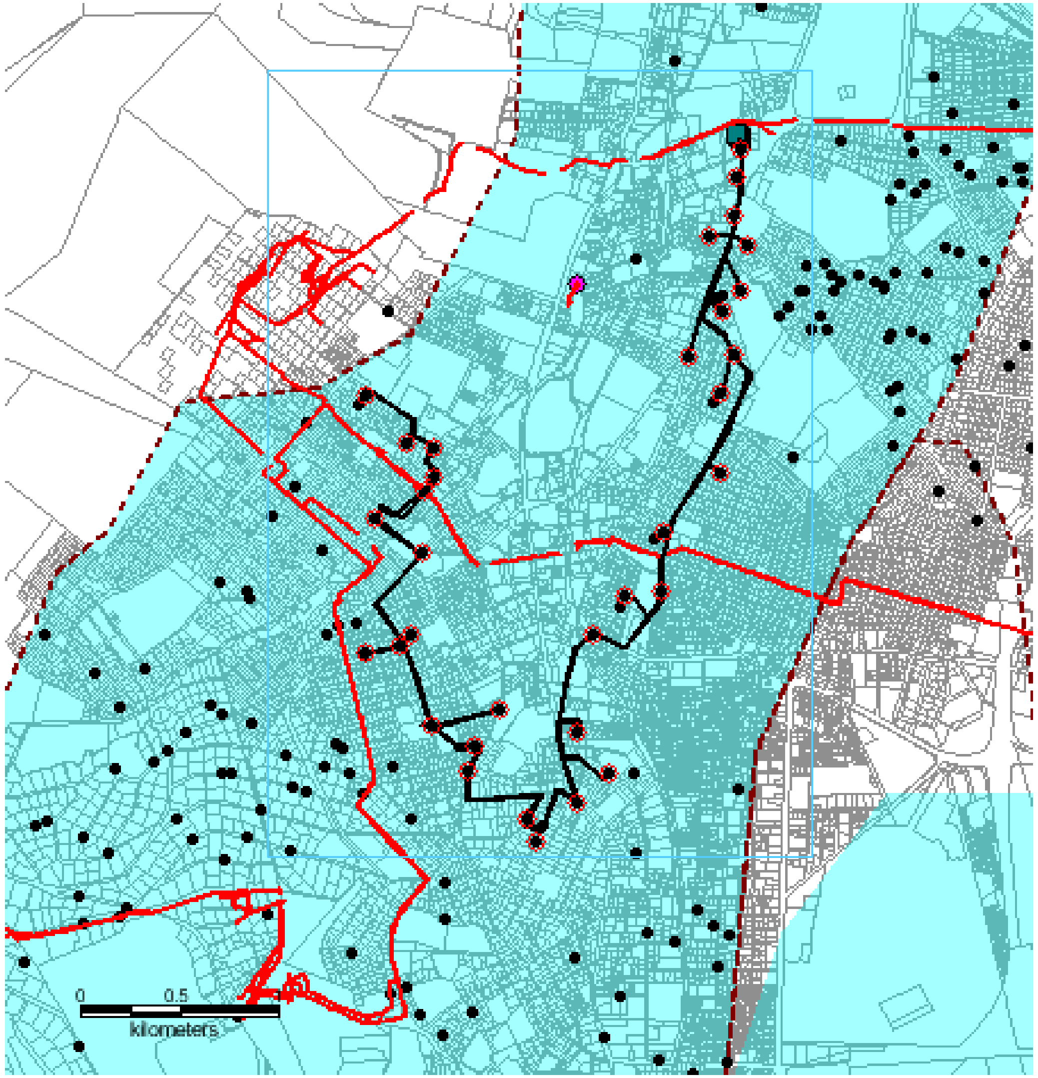
-the depth of the borehole and intake
-the diameter of the borehole
-current pump-setup
-the depth to the groundwater table





PILOT STUDY – DESIGN OF PUMP TESTS

-step pump test in a selected number of boreholes
Based on initial inspection
-a long term pump test with constant discharge
-water quality analysis from pumping well at start and end of pump test
-Estimation of sustainable yield with assist from modelling
-Determination of required distribution of Boreholes
-Supplementary yield tests
-Required pump setup for each borehole
-Determination of management measurements
-Submission of water use licence to DWS
-Private agreement with a servitude of access, negotiation of compensations
-Development of required infrastruture



PILOT STUDY –MANAGEMENT MEASURES

-Determination of maximal drawdowns from the pumping in:

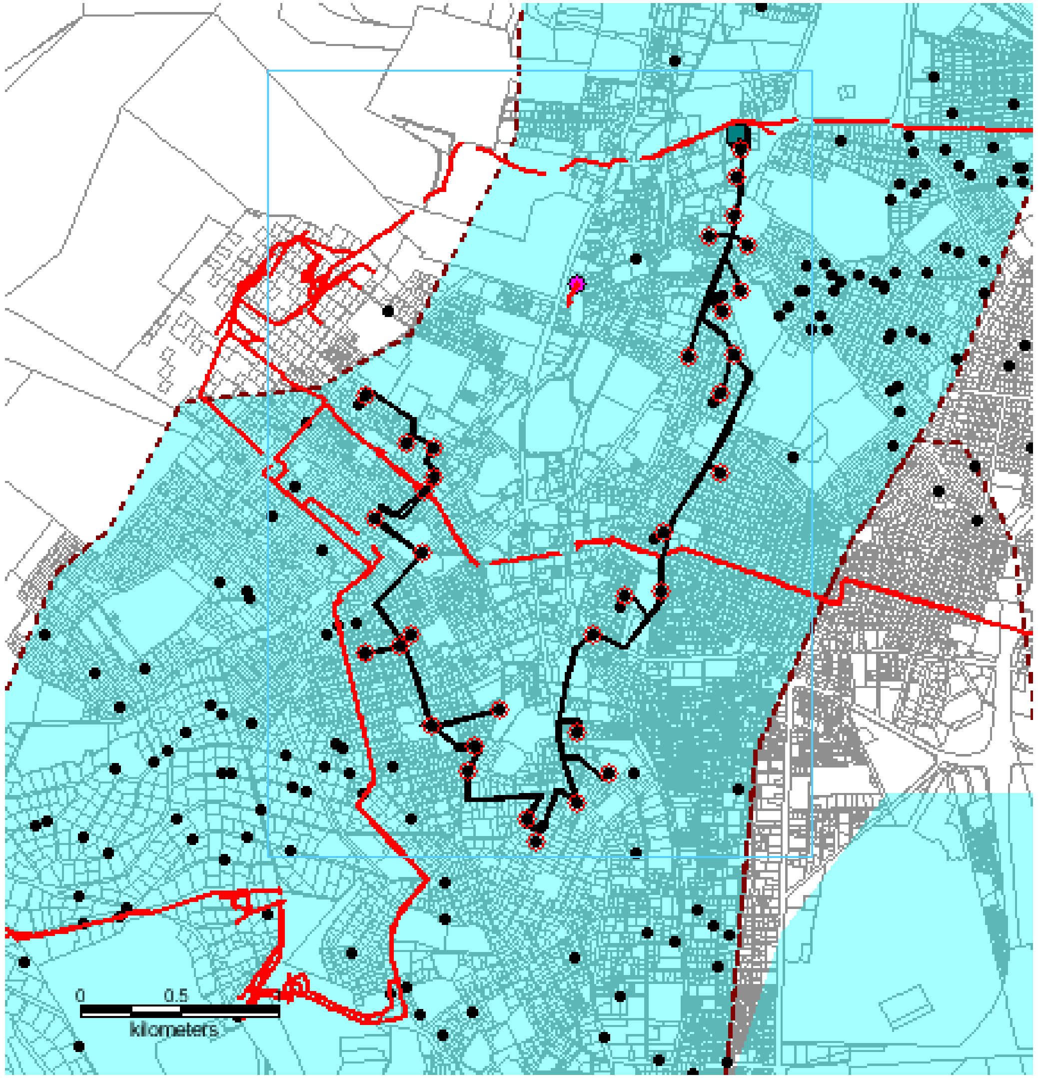
-pumping boreholes

-neighbouring boreholes

-near high classified wetlands

-other important topics for example to prevent intrusion of seawater

-management measures based on models and Implemented in monitoring programs



RAMBOLL

THANKS FOR YOUR ATTENTION