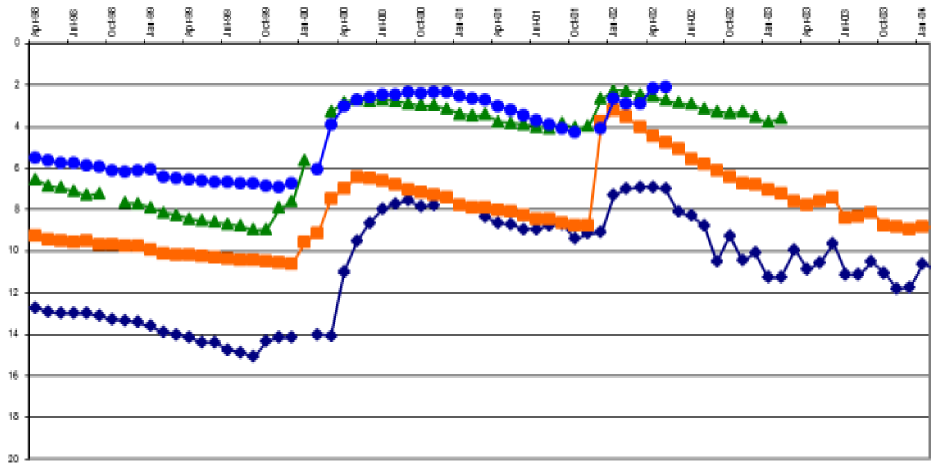
**LIMPOPO REGION**

# QUARTERLY STATUS REPORT ON GROUNDWATER LEVEL TRENDS

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**PLANNING AND INFORMATION**


**SEPTEMBER 2016**


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**SUMMARY**

The groundwater level status discussed in the report represent the situation on 30 June 2016, which is the end of the 3rd quarter of the hydrological year and midway through the dry season. Drought conditions resulting in very limited groundwater recharge since 2014 is evident, with a notable decline in water levels since then. Groundwater levels at 89.3% of monitoring stations are currently lower than the same time the previous year. Despite the two-year decline present at almost all monitoring stations, is the general status of the groundwater levels still considered to be healthy in most instances. Historical data indicates that current levels are generally still much above the critical levels reached in previous droughts such as the early nineties. If the dry conditions however persists for a prolonged period, the rate of decline will accelerate over time and the situation may become critical. Three areas of possible concern have been identified due to continuous declining water levels and an apparent lack of recharge during normal seasonal rainfall. An accurate assessment of the current status in these areas can unfortunately not be made as no long-term data in these areas is available.

Indications from current forecasts are that the probability for a better rainy season then the previous is good. Unfortunately forecasts show that heavy rainfall very early in the season is not a high probability.

Drying up of surface water resources such as streams and small dams, especially in rural areas is leading to more dependency on groundwater. As a result monitoring boreholes are being vandalised to be used as s source of water. This is achieved by dipping empty containers down the hole utilising the suspension ropes for the electronic loggers and hauling water from the borehole. Instruments are vandalised, stolen or dumped down the hole. In some instances pumps are installed in the monitoring boreholes. At formal groundwater supply schemes the tendency is to increase the abstraction from supply boreholes which lead to over abstraction and ultimately failing of boreholes.

The situation emphasise the importance of groundwater as alternative source but it can only be sustainable if managed properly.

## 1. BACKGROUND

The report reflects the status at the end of the third quarter of the hydrological year which is also midway through the dry season. Electronic groundwater level data was downloaded during July and August 2016 and processed in September

Groundwater level trends and comparison to previous levels are discussed per secondary drainage area.

The distribution of the monitoring network is illustrated by **MAP 1**.

## 2. GROUNDWATER LEVELS

The groundwater levels at some sites are directly impacted by nearby pumping. In calculation of averages for tables 1 and 2, data from stations directly affected by nearby abstraction were not included.

### 2.1 DIFFERENCE IN GROUNDWATER LEVELS; 1 APRIL TO 30 JUNE 2016 (TABLE 1)

Some stations indicating a rise in groundwater level are related to pumping and can not be considered to be a true reflection. Only 8.7% of stations with data for this period indicate an actual rise in groundwater level due to some very limited late recharge. Groundwater levels at 89.13% of the stations with data for this period have declined since the start of the dry season.

The distribution of monitoring stations with higher or lower groundwater levels is illustrated by **MAP 2**.

| 1 April to 30 June 2016 | |
|---|---|
| Total stations | 196 |

| | | |
|---|---|---|
| With data | 184 Stations | 93.9% |

| Water level | Number of stations | Average(m) | % |
|---|---|---|---|
| Down | 164 Stations | -0.62 | 89.13% |
| Up | 19 Stations | 0.54 | 10.33% |
| No change | 1 Stations | | 0.54% |
| No Data | 12 Stations | | |
| **Total** | **196** | | **100.00%** |

**TABLE 1**

### 2.2 DIFFERENCE IN GROUNDWATER LEVELS; 30 JUNE 2015 TO 30 JUNE 2016 (TABLE 2)

89.33% of the monitoring stations indicated lower water levels than that recorded the same time last year. The average decline is 1.5m. Six of the stations with higher water levels are due to pumping levels measured and only 7.3% actually indicate a true rise.

The distribution of monitoring stations with higher or lower groundwater levels is illustrated by **MAP 3**

| 30 June 2015 to 30 June 2016 | |
|---|---|
| Total stations | 196 |

| | | |
|---|---|---|
| With data | 178 Stations | 90.8% |

| Water level | Number of stations | Average(m) | % |
|---|---|---|---|
| Down | 159 Stations | -1.54 | 89.33% |
| Up | 19 Stations | 0.59 | 10.67% |
| No change | 0 Stations | | 0.00% |
| No Data | 18 Stations | | |
| **Total** | **196** | | **100.00%** |

**TABLE 2**

## 3 GROUNDWATER LEVEL TRENDS IN THE DIFFERENT SECONDARY DRAINAGE AREAS

The positions of monitoring stations used for discussion of trend graphs in each drainage is indicated on the relevant map for the drainage.

### 3.1 DRAINAGE AREA A4 (MAP 4)

Groundwater levels in the upper to middle reaches of the drainage generally indicate normal seasonal fluctuations over some years. Despite some recharge indicated in April 2016 is the limited recharge over the past two seasons clearly visible from the general decline since December 2014 **(GRAPH 1)**

In the lower reaches or discharge area of the drainage groundwater levels indicate little to no seasonal fluctuation. **(GRAPH 2)**

Despite this are groundwater levels generally stable with the exception of two stations in the north east of the drainage that are characterised by a constant decline in groundwater levels, as is also the case at some nearby stations in the adjoining A5 drainage area.

### 3.2 DRAINAGE A5 (MAP 5)

Groundwater levels in the upper reaches of the drainage indicate stable conditions with normal seasonal fluctuation. The current groundwater levels in this area represent a healthy status but the lack of recharge since 2014 can be seen from the declining trend since April 2014 (**GRAPH 3)**

In the lower reaches of the A5 drainage area the situation is not as favourable. Groundwater levels are continuously declining with little or no evidence of recharge for some years now. **(GRAPH 4**). This trend is also displayed at some stations in A4 and A6 drainage areas adjacent to this area.

### 3.3 DRAINAGE A6 (MAP 6)

Groundwater levels is still considered to reflect a good status despite the limited recharge the past two seasons (**GRAPH 5).** The graph represent the general groundwater level trends in most of the drainage area. The declining trend since 2014 can also be noted at the end of the graph.

It is also clear that periodic periods of rise and decline is normal. Compared to the historical levels displayed in the long-term, current levels are still healthy.

Groundwater levels at some stations in the north western part however are displaying a constant decline. The groundwater level time series of two of these stations are presented as an example **(GRAPH 6)**

### 3.4 DRAINAGE A7 (MAP 7)

The current status of groundwater levels in the A7 drainage in general, is considered healthy when compared with historical levels **(GRAPH 7)** The two-year decline since 2014 as discussed above is also, as in all drainages, present in the groundwater level trends but is currently still no reason for concern. The declining trend is illustrated by **(GRAPH 8)**

### 3.5 DRAINAGE A8 (MAP 8)

Groundwater levels in the A8 drainage are very stable and characterised by normal seasonal fluctuations. **(GRAPH 9).**
The groundwater level at A8 Mabvete however, indicate a constant decline and corresponds with trends displayed by a number of monitoring stations in the adjacent A9 drainage area.

### 3.6 DRAINAGE A9 (MAP 9)

Clear seasonal fluctuations can generally be noted at most stations in the upper reaches of the A9 drainage with the two-year decline also apparent here. **(GRAPH 10).** Seasonal fluctuations at some stations such as A9Tshidzivhe, A9Tswera and A9Vhurivhuri is very prominent indicating quick recharge followed by outflow. The groundwater levels at A9Mailaskop and A9Gondeni are impacted by nearby abstractions and indicate a declining trend similar to that displayed by groundwater levels in the lower reaches of the drainage.

The lower reaches of the Mutale River drainage is characterised by steady declining groundwater levels **(GRAPH 11).** Despite some recharge from 2012 to 2014, the decline still continues. The stations is highlighted in red on **(MAP 9)**

### 3.7 DRAINAGE B3

The groundwater level at only one of the four monitoring stations in this drainage is un-impacted and it is impossible to come to any conclusions on the status of groundwater in the drainage as a whole except that some areas are heavily impacted on. The groundwater status around Tuinplaas and Settlers has long been a matter of concern and continue to be so **(GRAPH 12).**

### 3.8 DRAINAGE B5 (MAP 10)

Some long-term data is available in this drainage and as with the A6 and A7 drainages, comparison of current and historical trends indicate a still healthy status**(GRAPH 13)**

### 3.9 DRAINAGE B7 (MAP 11)

Groundwater levels in this drainage indicate a stable condition with seasonal fluctuations around a mean. The current two-year decline in water levels is also very apparent. The groundwater level status is still considered to be healthy **(GRAPH 14)**

### 3.10 DRAINAGE B8 (Map 12)

Groundwater level trends in the northern part of the drainage drained by the Koedoes, Middle and Klein Letaba Rivers differ drastically from that in the southern part drained by the Great Letaba River.

A constant decline with very little to no seasonal fluctuation characterise groundwater levels in the northern part of the B8 drainage. Considerable rainfall in the 2012-2013 wet season did not have any apparent impact on the groundwater levels. Groundwater in this area may be at risk.**(GRAPH 15)**

Groundwater level trends in the southern part display stable conditions with regular seasonal fluctuations. The decline from 2014 onwards is prominent for station B8Mpagani (**GRAPH 16)**. Groundwater level status is also still considered to be healthy.

### 3.11 DRAINAGE B9 (MAP 13)

The four monitoring stations in the B9 drainage indicate an underlying very slow decline despite some seasonal fluctuations at B9Mukhomi and B9Maphophe. **(GRAPH 17)** This trend is somewhat similar to that displayed by groundwater levels in the adjoining B8 drainage but not as prominent.

## 4 RAINFALL

### 4.1 PERCENTAGE OF NORMAL RAINFALL; JULY 2015 TO JUNE 2016

**(FIGURE 1).** Complied from maps obtained from the South African Weather Services give clear indication of the low rainfall recorded in Limpopo for the past two seasons.

## 5 SEASONAL FORECASTS

Precipitation probability maps obtained from the United States Of America's National Oceanic and Atmospheric Administration web site http://www.cpc.ncep.noaa.gov/ can be viewed as **(FIGURE 2)**
The text provided on the figure is self explaining. Indications currently are of a more favourable rainfall outlook from December 2016 onwards

Rainfall probability forecasts compiled by the South African Weather Services also indicate more favourable conditions for above normal rainfall from December 2016 onwards **(FIGURE 3)**.

## 6 IMPORTANCE OF GROUNDWATER MONITORING AND RESOURCE MANAGEMENT

The impact from drought on water resources is sooner apparent than on groundwater. With the current state of dams in Limpopo below 50% of capacity the importance of groundwater, especially in rural settings, can not be ignored, but sustainable use of groundwater as with any resource, depends on sound management. Management of groundwater is based on proper monitoring of groundwater levels, quality and abstraction volumes.

### 6.1 THE RESULT OF LACK OF RESOURCE MANAGEMENT; B5 BYZONDERHEID 2 (GRAPH 18)

This is the 3rd consecutive report in which this example is included. The decline continues and is currently the most extreme case identified by the monitoring network. As the borehole where the abstraction took place has reportedly failed it may well be that the forced discontinuation of abstraction will result in some recovery of the water level. A good recharge event will however be needed for the aquifer to recover.

## 7 AREAS OF POSSIBLE CONCERN

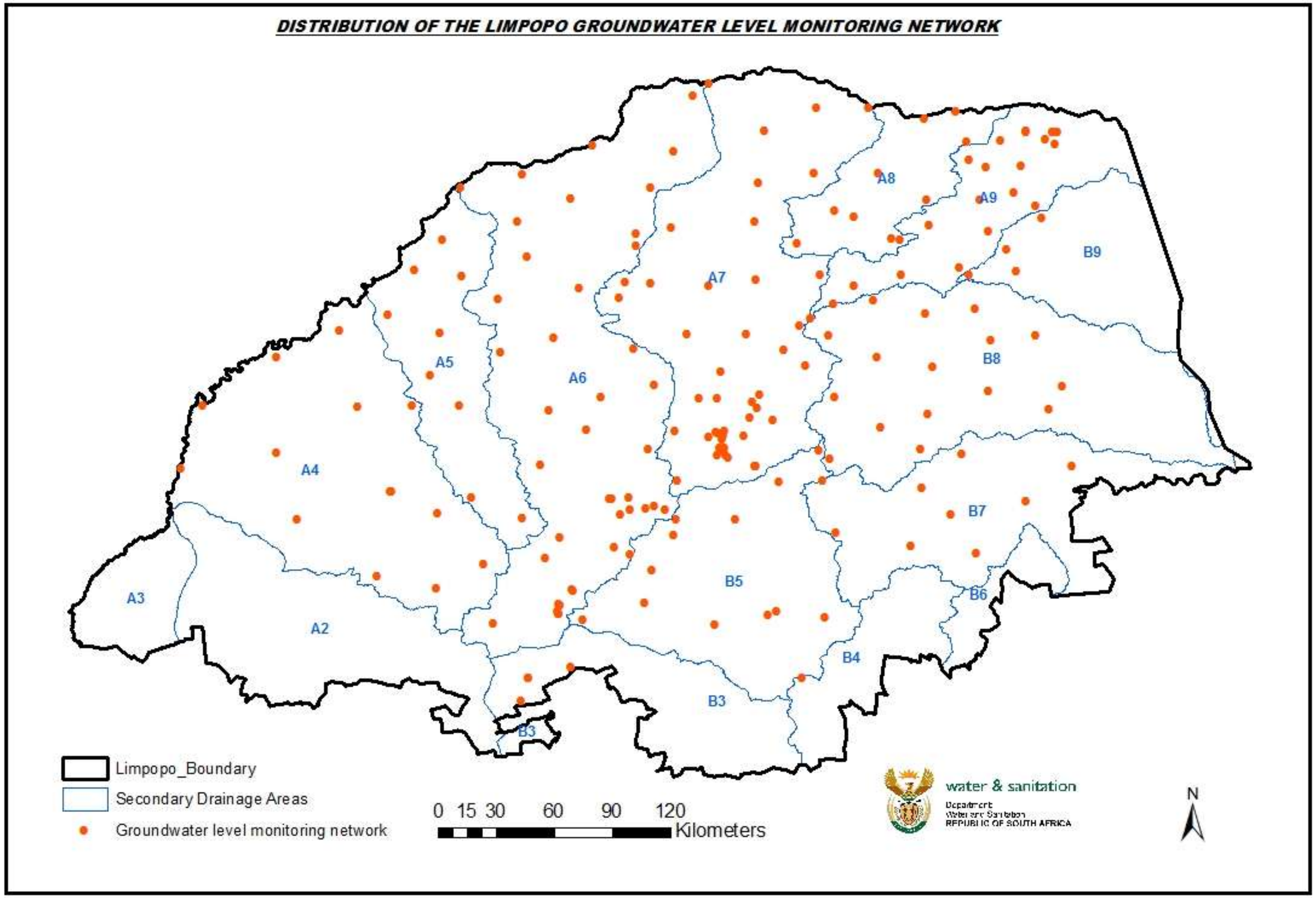
Three areas of possible concern if the drought persists have been identified from continuous declining groundwater levels and little to no indication of recharge. The monitoring stations in question are highlighted in red on (**MAP 14)**

## 8 ACKNOWLEDGEMENTS

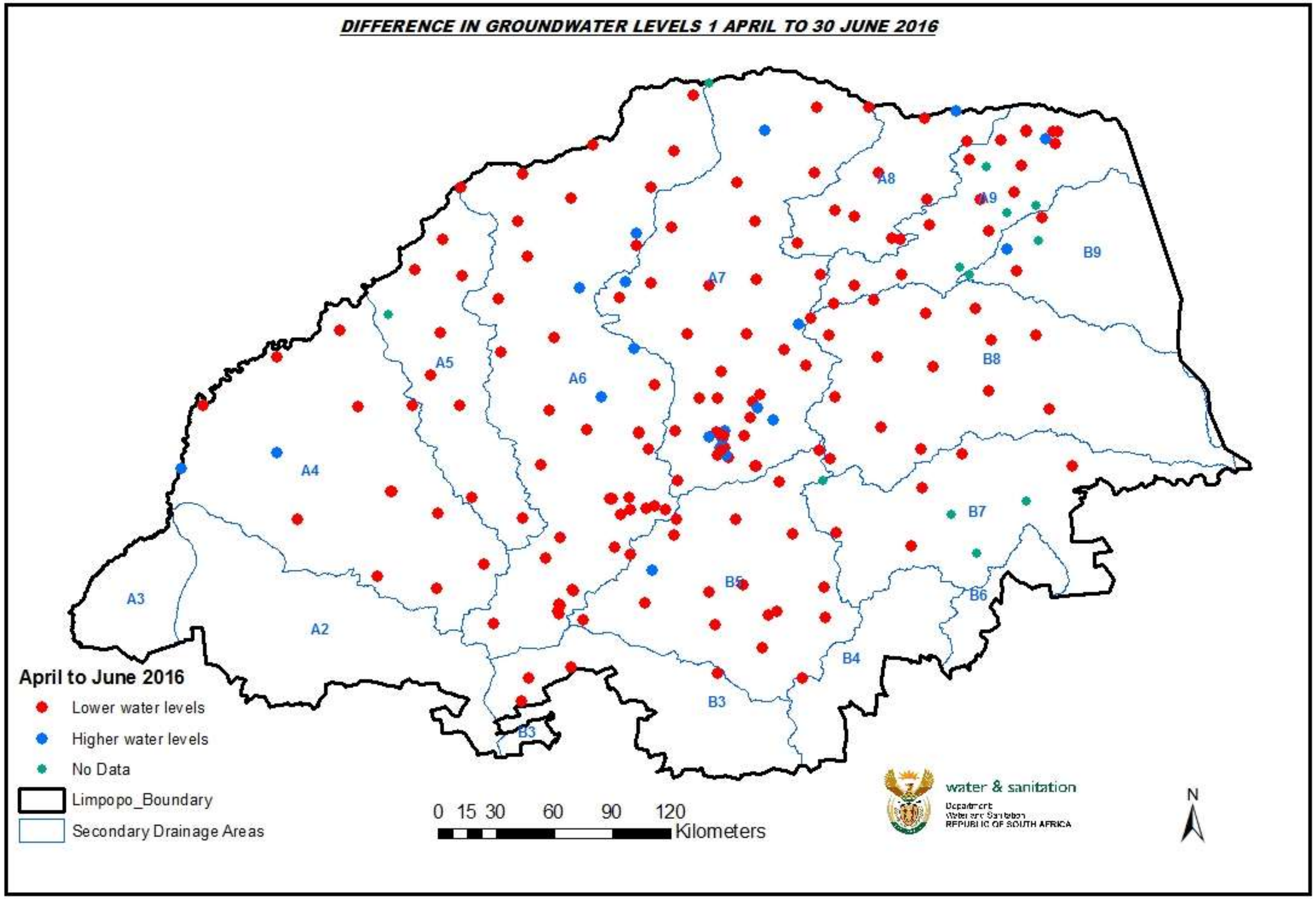
Percentage of normal rainfall: South African Weather Services: http://www.weathersa.co.za

Detail forecasts: South African Weather Services: http://www.weathersa.co.za

Precipitation probability forecasts: U. S government , National Oceanic and Atmospheric Administration: http://www.cpc.ncep.noaa.gov/

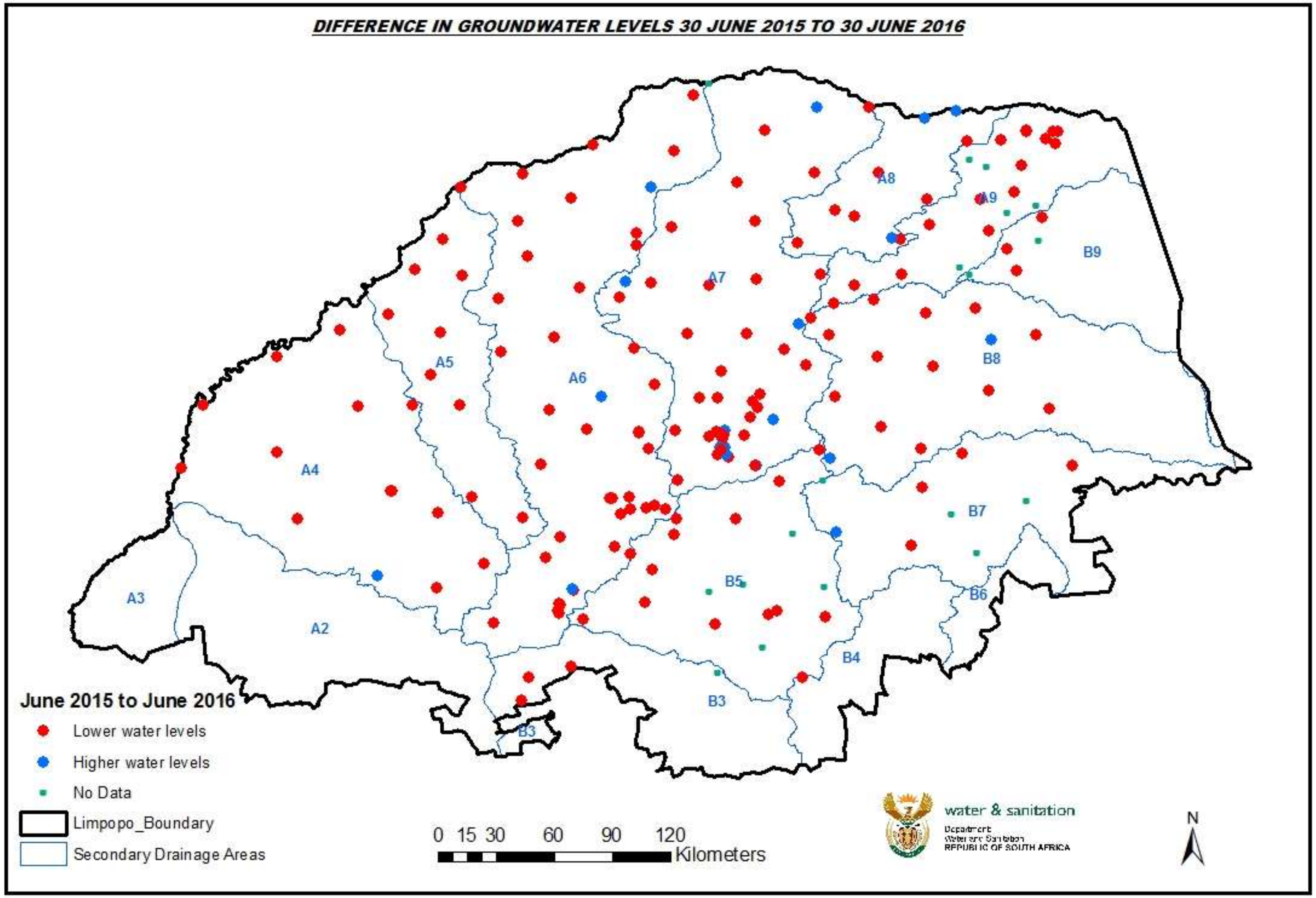

DISTRIBUTION OF THE LIMPOPO GROUNDWATER LEVEL MONITORING NETWORK
A2
A3
A4
A5
A6
A7
A8
A9
B3
B4
B5
B6
B7
B8
B9
Limpopo_Boundary
Secondary Drainage Areas
Groundwater level monitoring network
0 15 30 60 90 120
Kilometers
water & sanitation
N

**MAP 1**

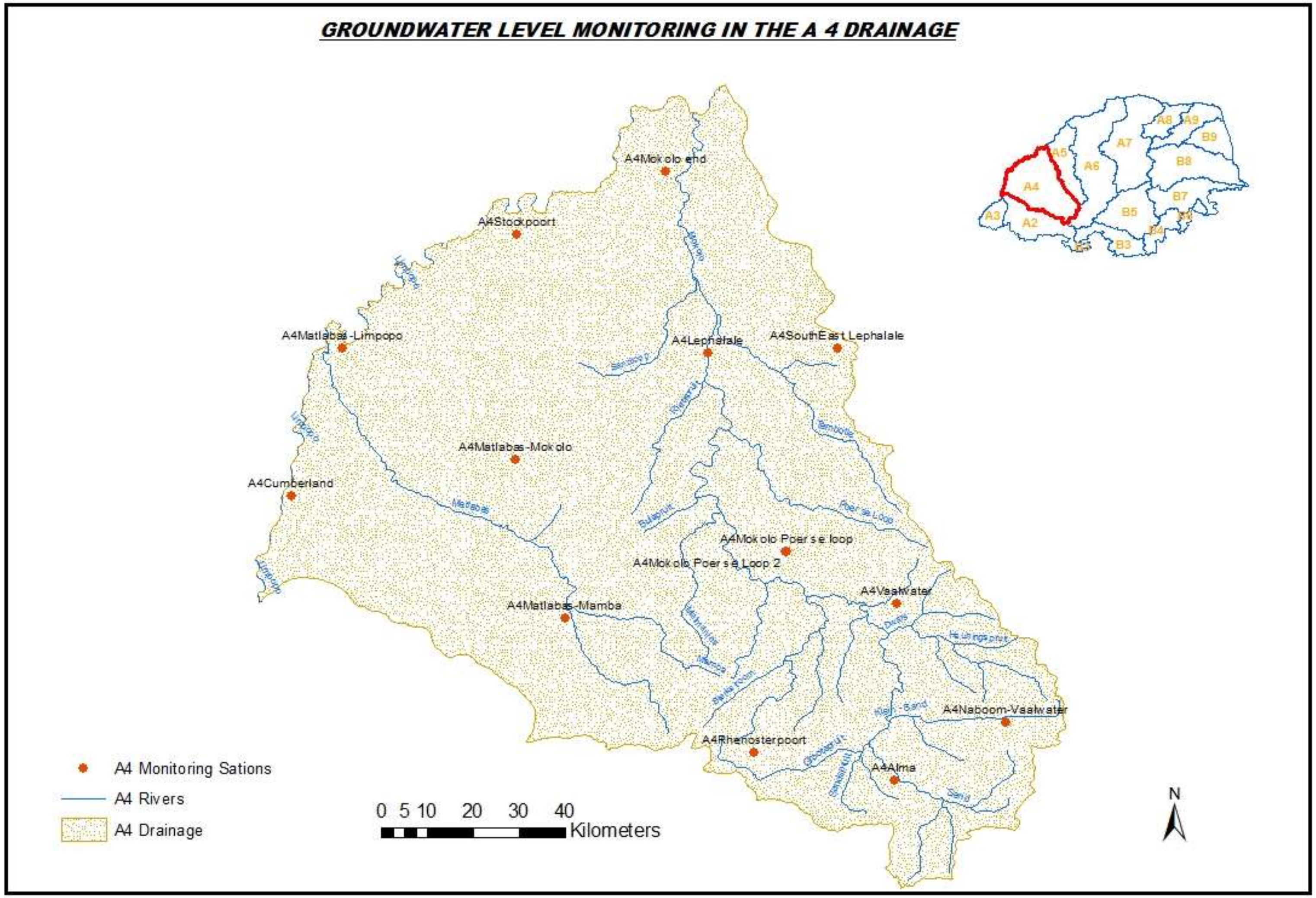


DIFFERENCE IN GROUNDWATER LEVELS 1 APRIL TO 30 JUNE 2016
A8
A9
B9
A7
A5
A6
B8
A4
B7
A3
B5
B6
A2
B4
B3
B3
April to June 2016
Lower water levels
Higher water levels
No Data
Limpopo_Boundary
Secondary Drainage Areas
0 15 30 60 90 120
Kilometers
water & sanitation
Department
Water and Sanitation
REPUBLIC OF SOUTH AFRICA
N


**MAP 2**

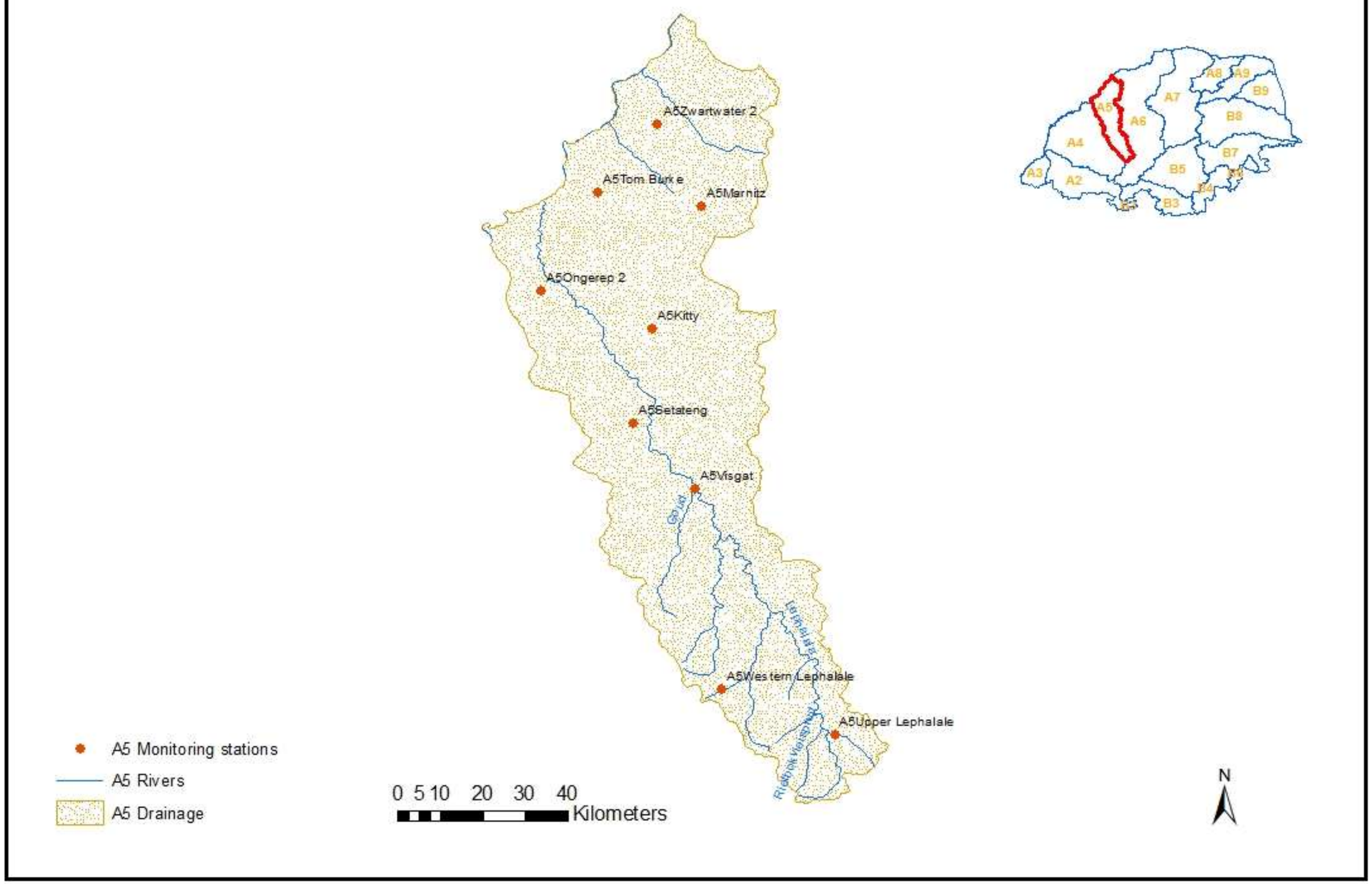

DIFFERENCE IN GROUNDWATER LEVELS 30 JUNE 2015 TO 30 JUNE 2016
A2
A3
A4
A5
A6
A7
A8
A9
B3
B4
B5
B6
B7
B8
B9
June 2015 to June 2016
Lower water levels
Higher water levels
No Data
Limpopo_Boundary
Secondary Drainage Areas
0 15 30 60 90 120
Kilometers
water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA
N

**MAP 3**

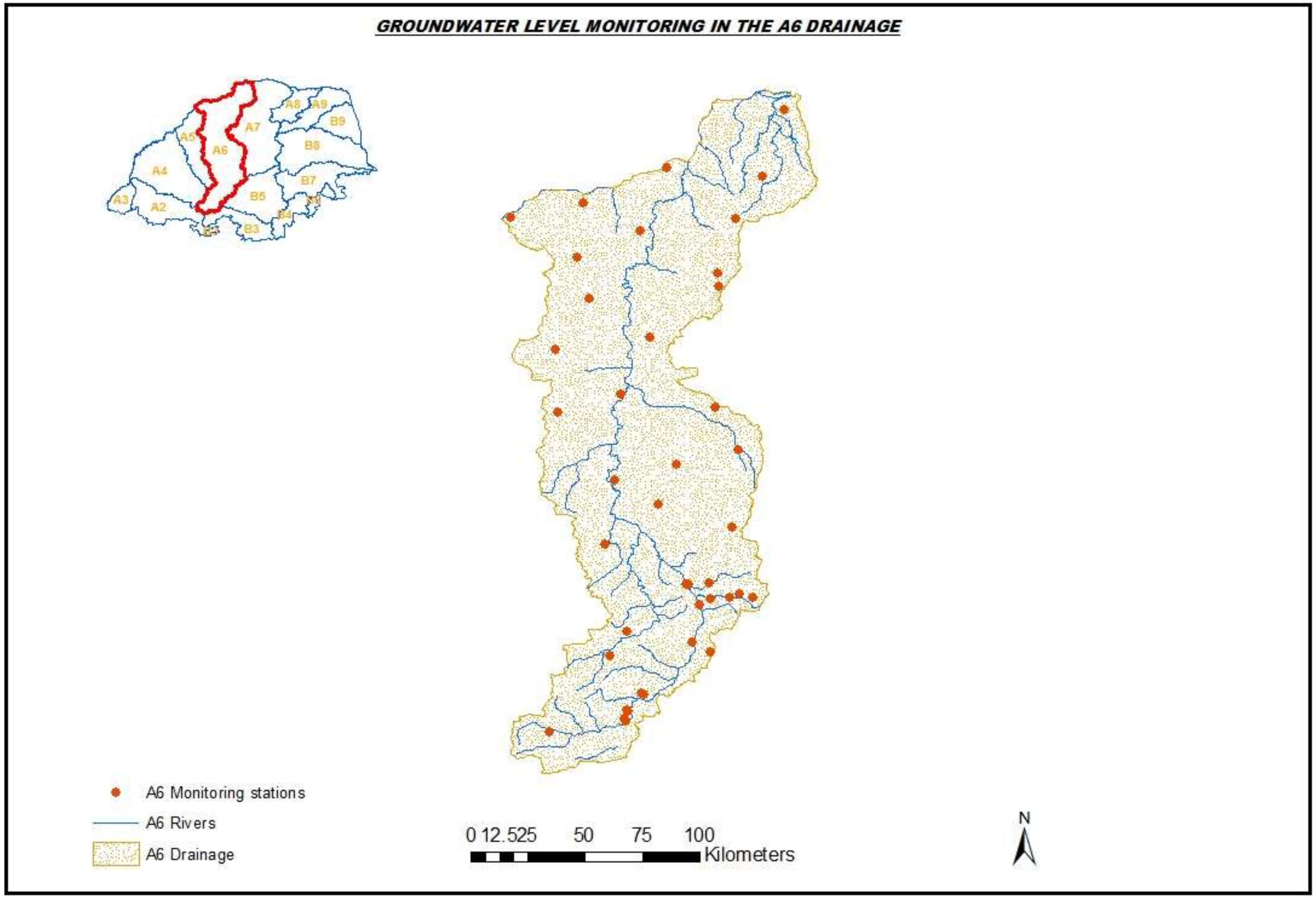

GROUNDWATER LEVEL MONITORING IN THE A 4 DRAINAGE
A4Mokolo end
A4Stockpoort
A4Matlabas-Limpopo
A4Lephalale
A4SouthEast Lephalale
A4Matlabas-Mokolo
A4Cumberland
A4Mokolo Poer se loop
A4Mokolo Poer se Loop 2
A4Vaalwater
A4Matlabas-Mamba
A4Naboom-Vaalwater
A4Rhenosterpoort
A4Alma
A4 Monitoring Sations
A4 Rivers
A4 Drainage
0 5 10 20 30 40
Kilometers
N

**MAP 4**

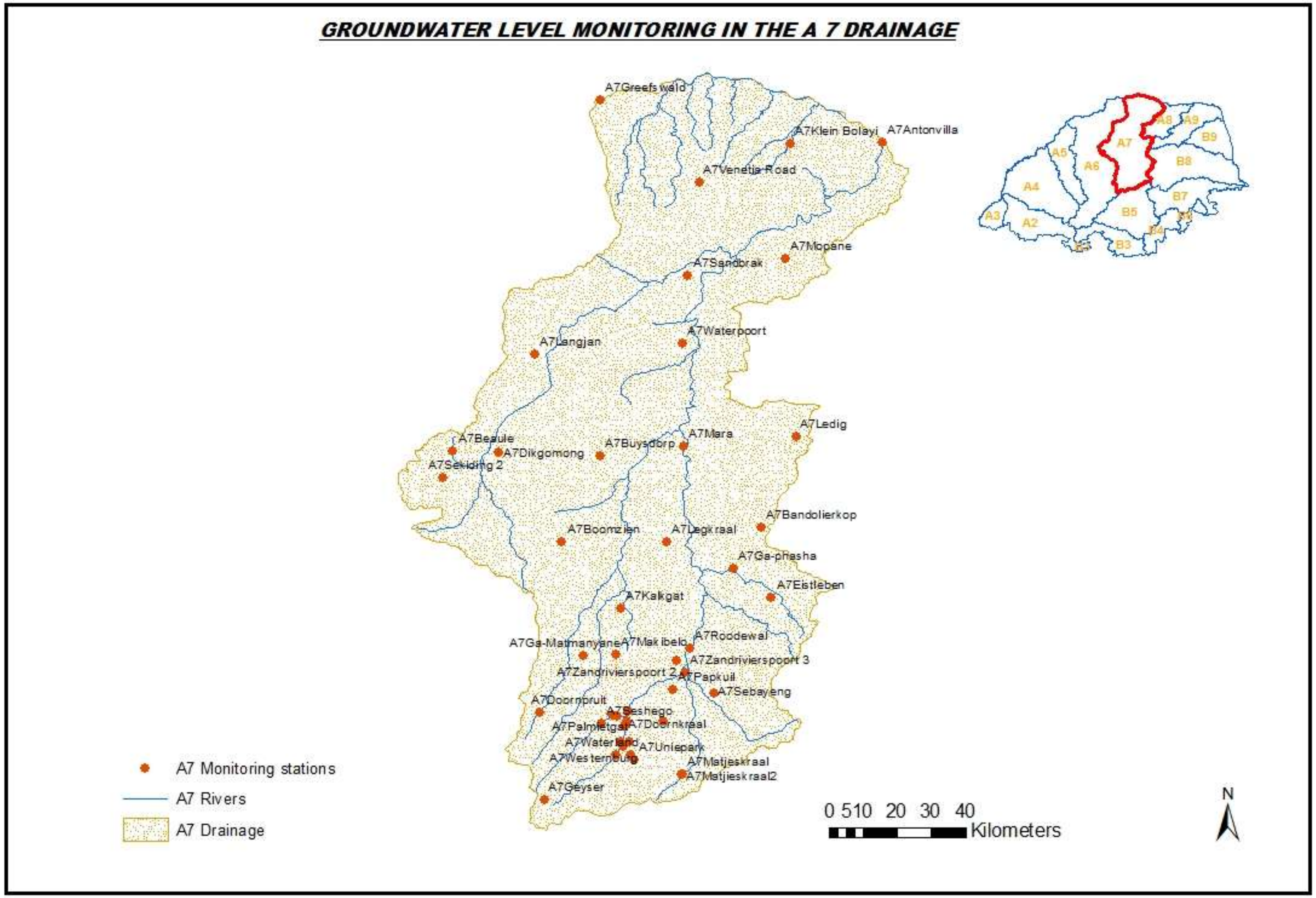
## GROUNDWATER LEVEL MONITORING IN THE A 5 DRAINAGE



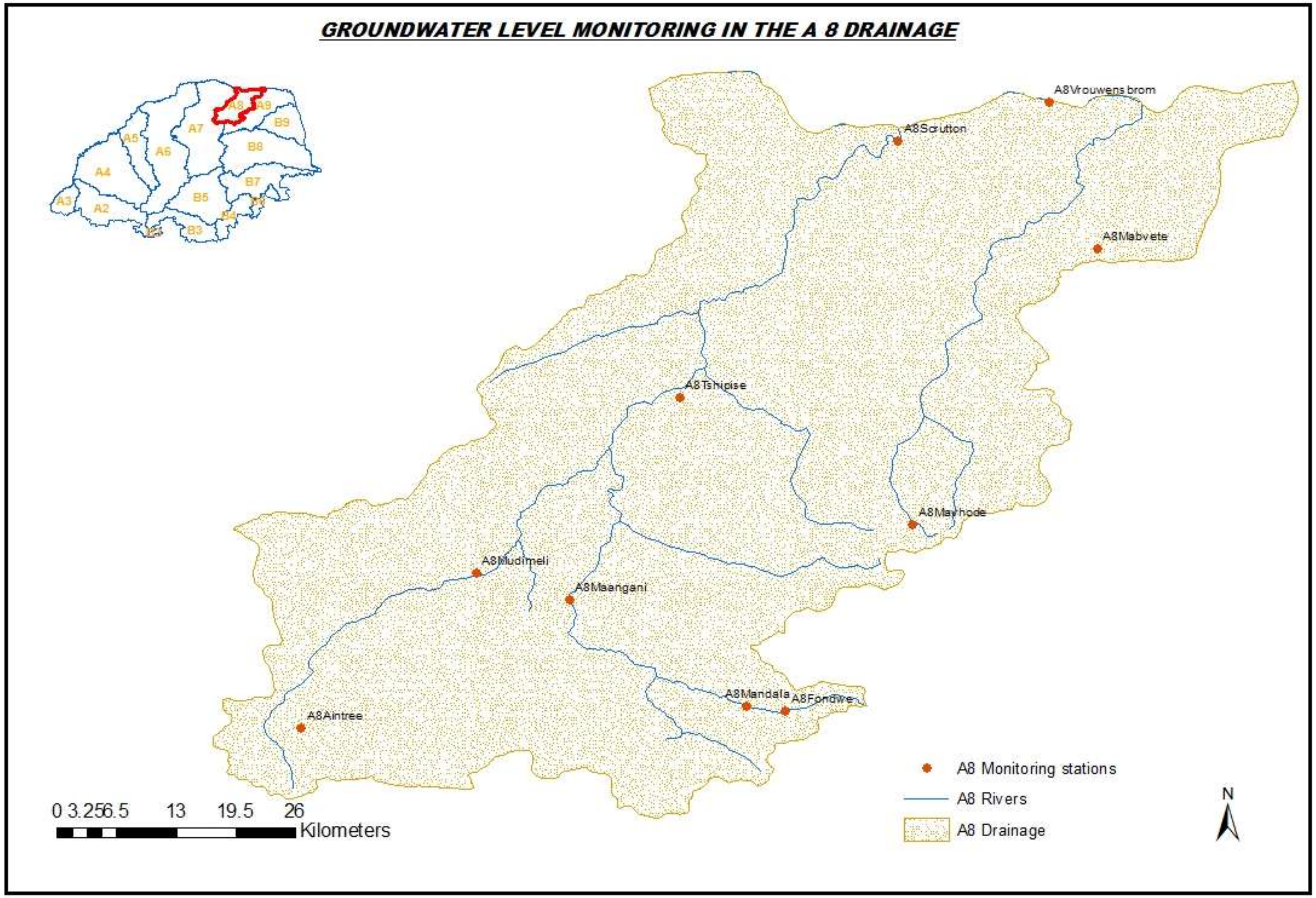

**MAP 5**


GROUNDWATER LEVEL MONITORING IN THE A6 DRAINAGE
A6 Monitoring stations
A6 Rivers
A6 Drainage
0 12.525 50 75 100
Kilometers
N

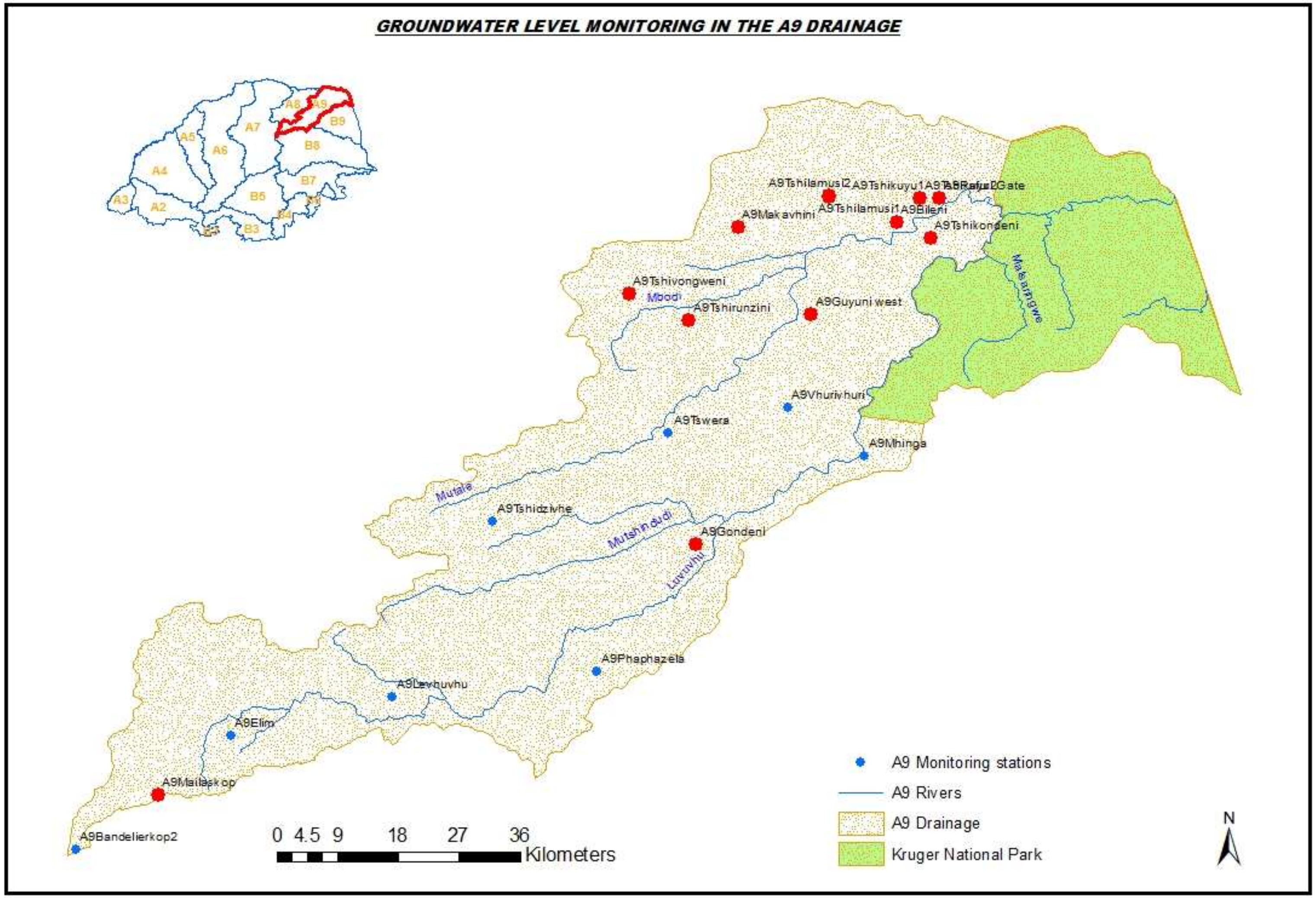
**MAP 6**


GROUNDWATER LEVEL MONITORING IN THE A 7 DRAINAGE
A7Greefswald
A7Klein Bolayi
A7Antonvilla
A7Venetia Road
A7Mopane
A7Sandbrak
A7Waterpoort
A7Langjan
A7Ledig
A7Beaule
A7Dikgomong
A7Buysdorp
A7Mara
A7Sekiding 2
A7Bandolierkop
A7Boomzien
A7Legkraal
A7Ga-phasha
A7Eistleben
A7Kalkgat
A7Roodewal
A7Ga-Matmanyane
A7Makibelo
A7Zandrivierspoort 3
A7Zandrivierspoort 2
A7Papkuil
A7Sebayeng
A7Doornpruit
A7Seshego
A7Palmietgat
A7Doornkraal
A7Waterland
A7Uniepark
A7Westernburg
A7Matjeskraal
A7Matjieskraal2
A7Geyser
A7 Monitoring stations
A7 Rivers
A7 Drainage
0 510 20 30 40
Kilometers
N
A8
A9
A7
B9
A5
A6
B8
A4
B7
A3
A2
B5
B3
B4

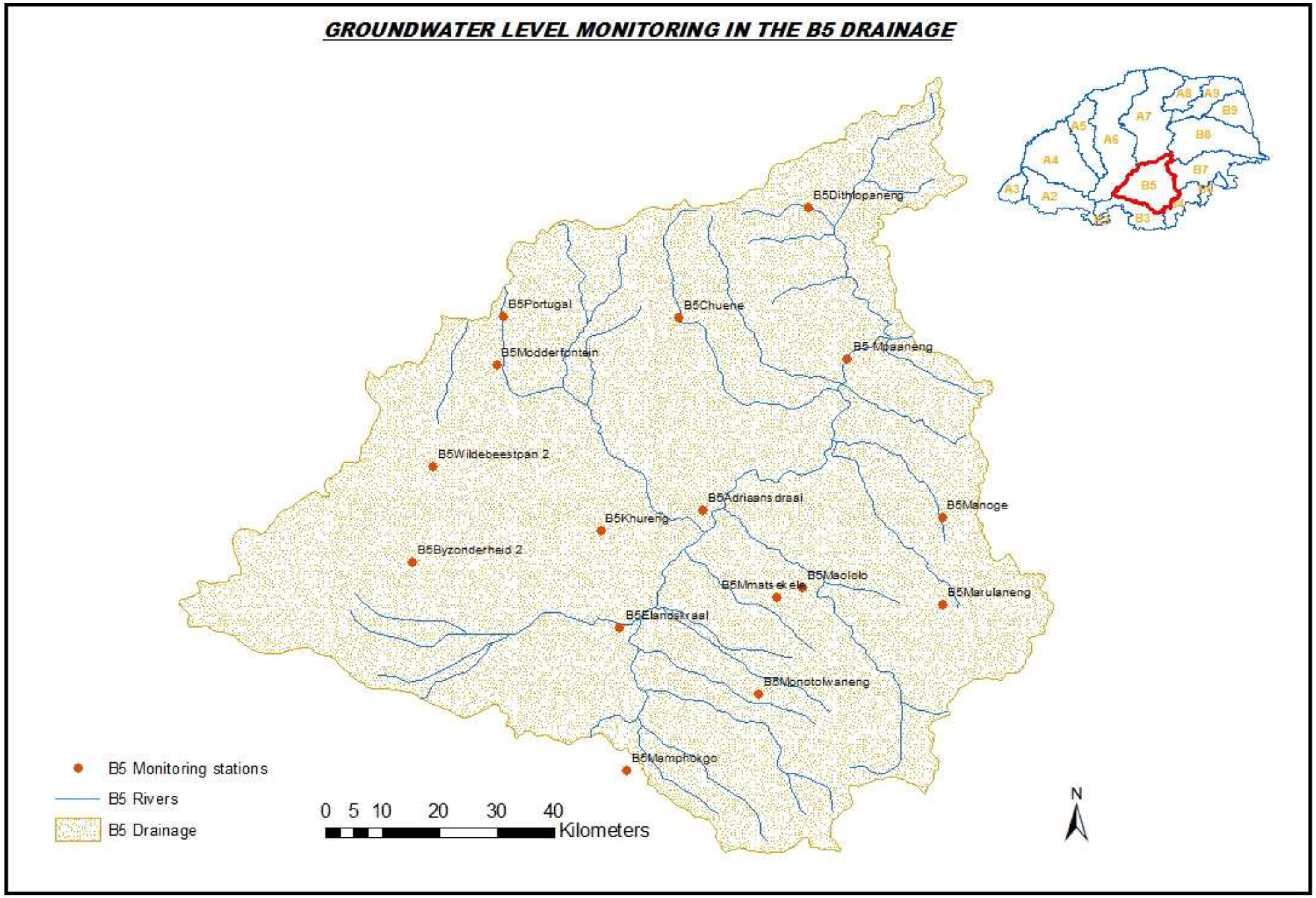
**MAP 7**


GROUNDWATER LEVEL MONITORING IN THE A 8 DRAINAGE
A8Vrouwens brom
A8Scrutton
A8Mabvete
A8Tshipise
A8Mayhode
A8Mudimeli
A8Maangani
A8Mandala
A8Fondwe
A8Aintree
A8 Monitoring stations
A8 Rivers
A8 Drainage
0 3.256.5 13 19.5 26
Kilometers
N

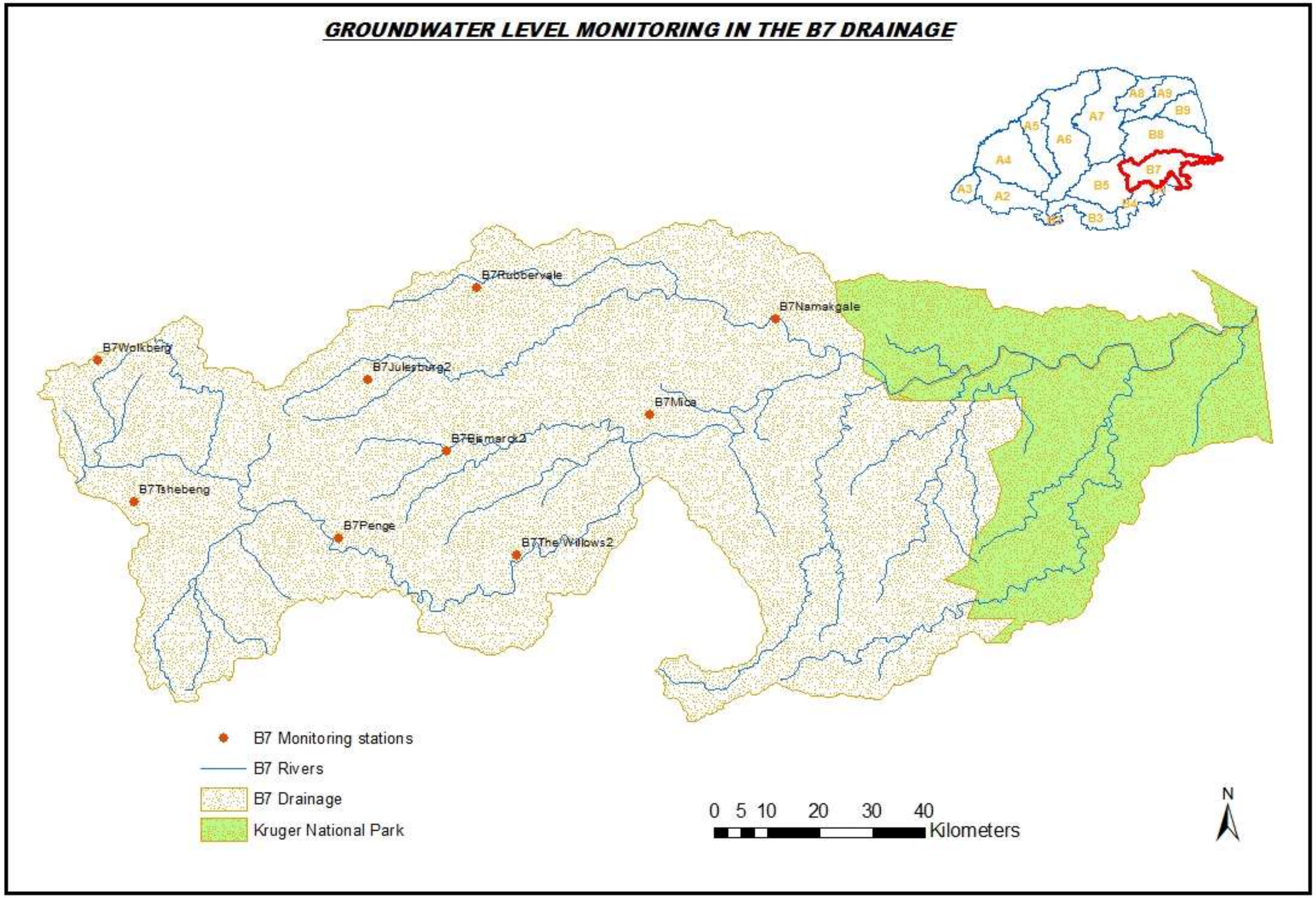
**MAP 8**


GROUNDWATER LEVEL MONITORING IN THE A9 DRAINAGE
A8
A9
B9
A7
A5
A6
B8
A4
B7
B5
A3
A2
B3
A9Tshilamusi2
A9Tshikuyu1
A9Tshilamusi1
A9Bileni
A9Makavhini
A9Tshikondeni
A9Tshivongweni
Mbodi
A9Tshirunzini
A9Guyuni west
A9Vhurivhuri
A9Tswera
A9Mhinga
Mutale
A9Tshidzivhe
Mutshindudi
A9Gondeni
Luvuvhu
A9Phaphazela
A9Levhuvhu
A9Elim
A9Mailaskop
A9Bandelierkop2
0 4.5 9 18 27 36
Kilometers
A9 Monitoring stations
A9 Rivers
A9 Drainage
Kruger National Park
N

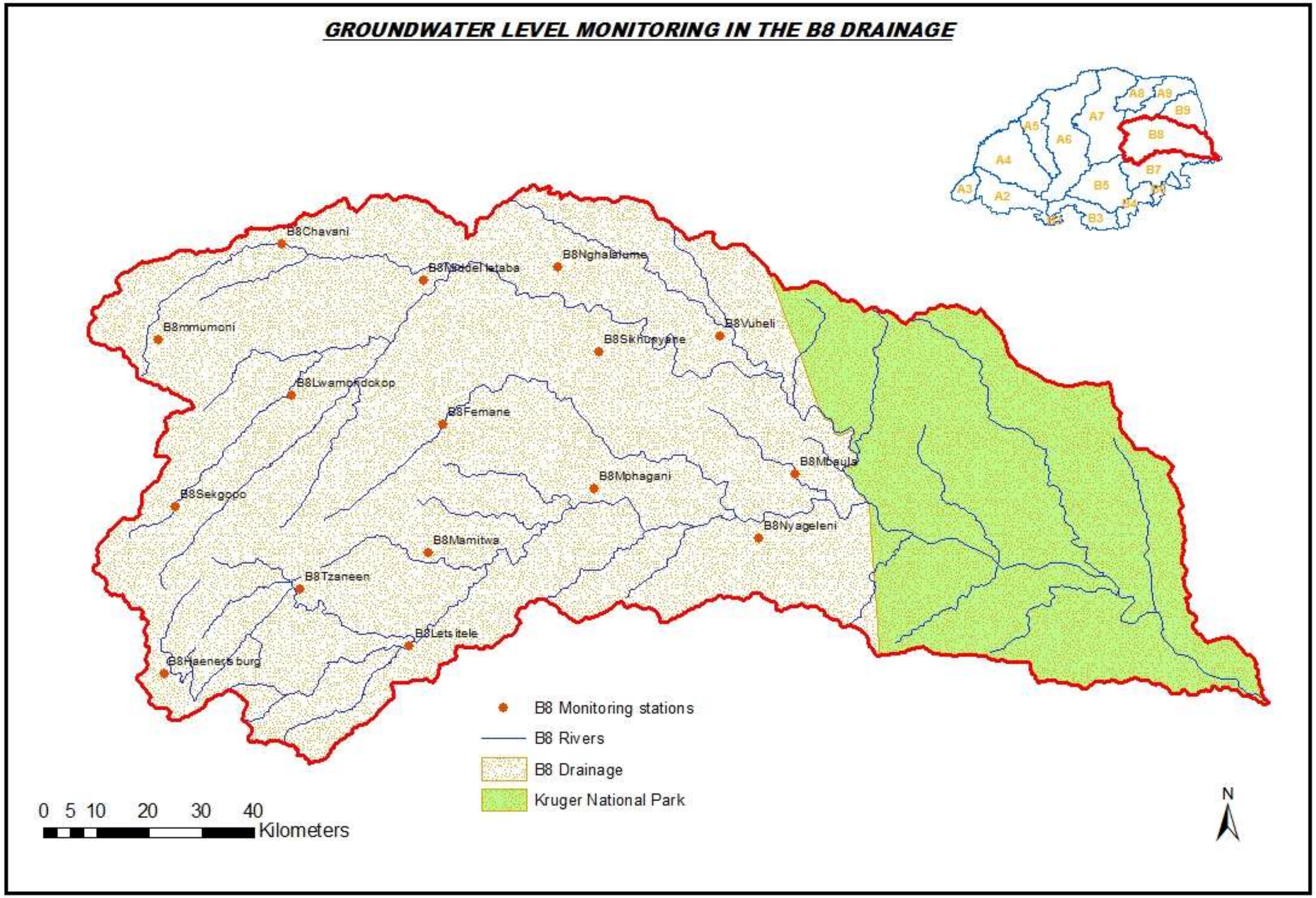
**MAP 9**


GROUNDWATER LEVEL MONITORING IN THE B5 DRAINAGE
B5Dithlopaneng
B5Portugal
B5Chuene
B5Modderfontein
B5 Mpaaneng
B5Wildebeestpan 2
B5Adriaans draai
B5Manoge
B5Khureng
B5Byzonderheid 2
B5Maclolo
B5Mmats ek ele
B5Marulaneng
B5Elandskraal
B5Monotolwaneng
B5Mamphokgo
A8
A9
B9
A5
A7
A6
B8
A4
B7
A3
A2
B5
B3
B5 Monitoring stations
B5 Rivers
B5 Drainage
0 5 10 20 30 40
Kilometers
N

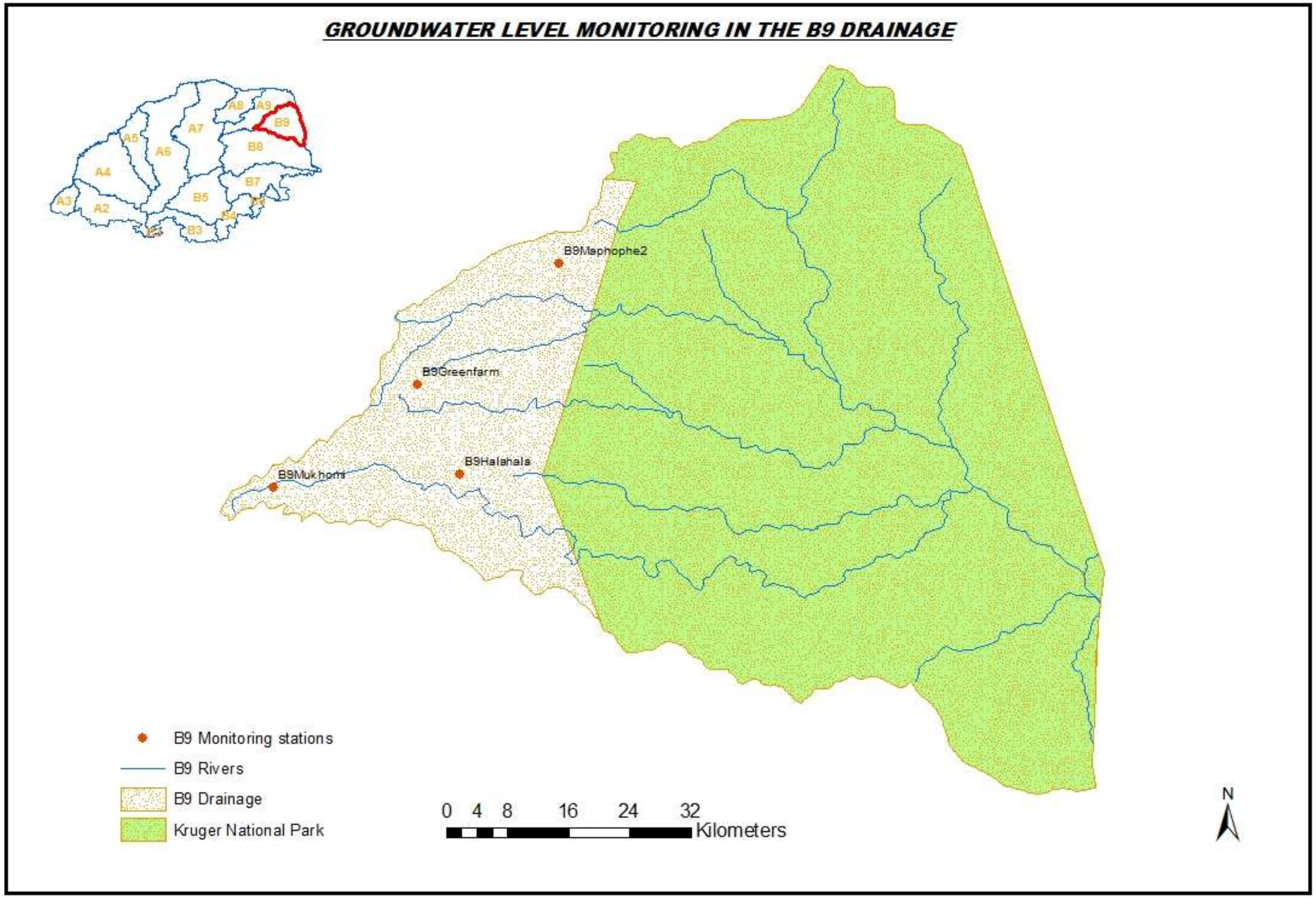
**MAP 10**


GROUNDWATER LEVEL MONITORING IN THE B7 DRAINAGE
B7Rubbervale
B7Namakgale
B7Wolkberg
B7Julesburg2
B7Mica
B7Bismarck2
B7Tshebeng
B7Penge
B7The Willows2
A8
A9
B9
A7
A5
B8
A6
A4
B7
A3
A2
B5
B3
B7 Monitoring stations
B7 Rivers
B7 Drainage
Kruger National Park
0 5 10 20 30 40
Kilometers
N

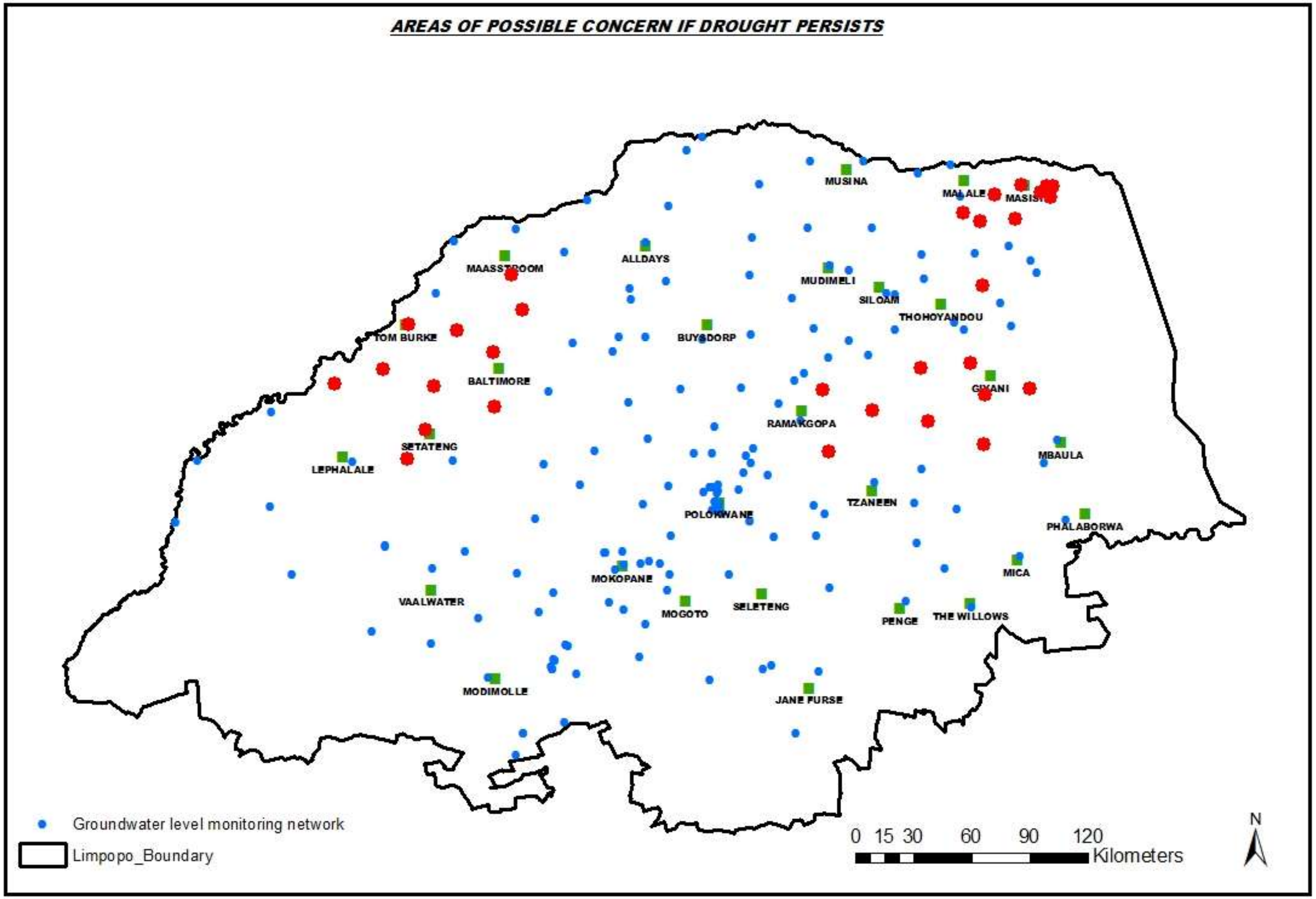
**MAP 11**


GROUNDWATER LEVEL MONITORING IN THE B8 DRAINAGE
B8Chavani
B8Nghalalume
B8mmumoni
B8Vuheli
B8Femane
B8Mphagani
B8Mbaula
B8Sekgopo
B8Nyageleni
B8Mamitwa
B8Tzaneen
B8Letsitele
B8Haenertsburg
B8 Monitoring stations
B8 Rivers
B8 Drainage
Kruger National Park
0 5 10 20 30 40
Kilometers
N
A3
A2
A4
A5
A6
A7
A8
A9
B9
B8
B7
B5
B3

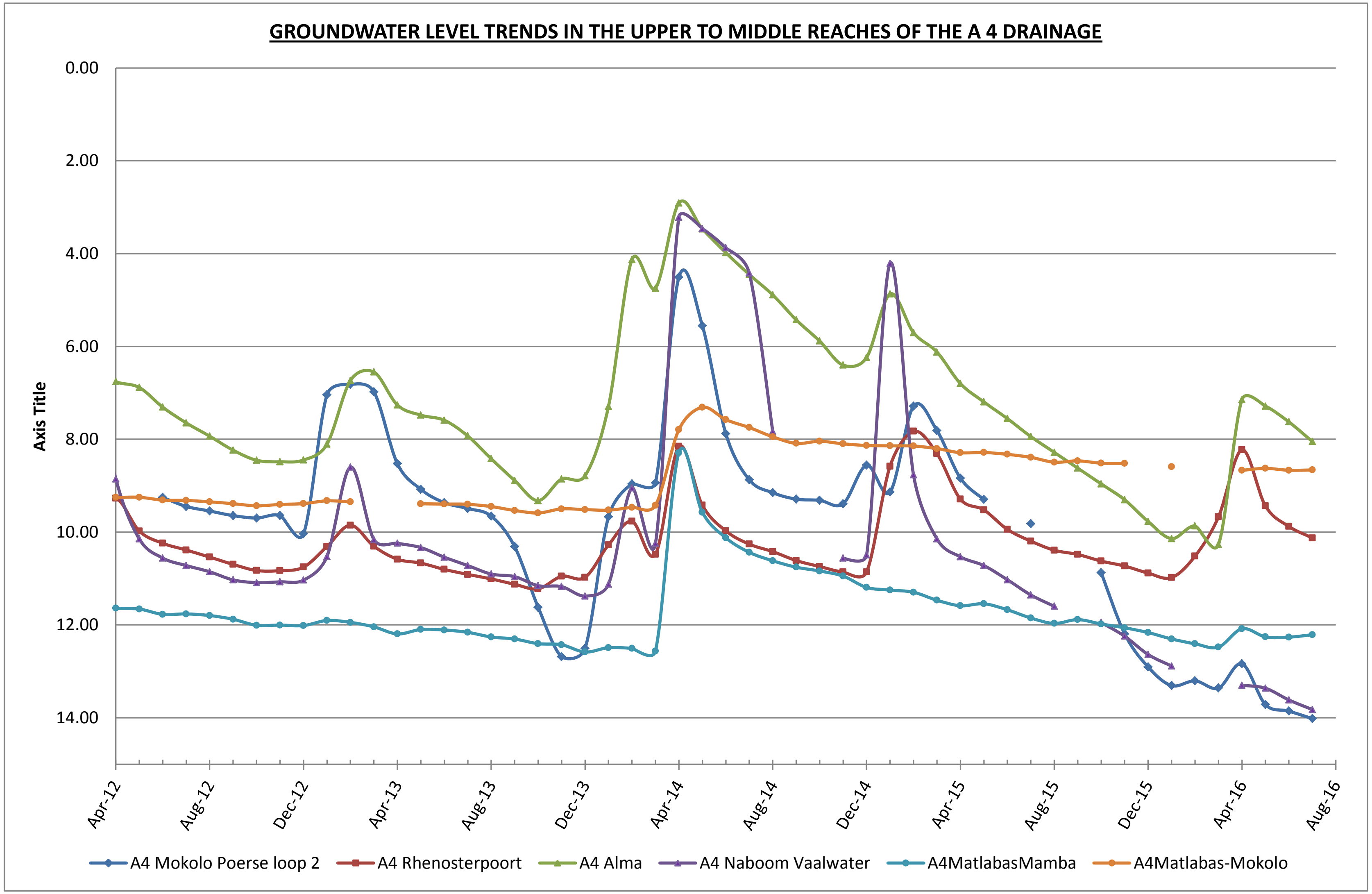
MAP 12


GROUNDWATER LEVEL MONITORING IN THE B9 DRAINAGE
A2
A3
A4
A5
A6
A7
A8
A9
B9
B8
B7
B5
B3
B9Maphophe2
B9Greenfarm
B9Halahala
B9Mukhomi
B9 Monitoring stations
B9 Rivers
B9 Drainage
Kruger National Park
0 4 8 16 24 32
Kilometers
N

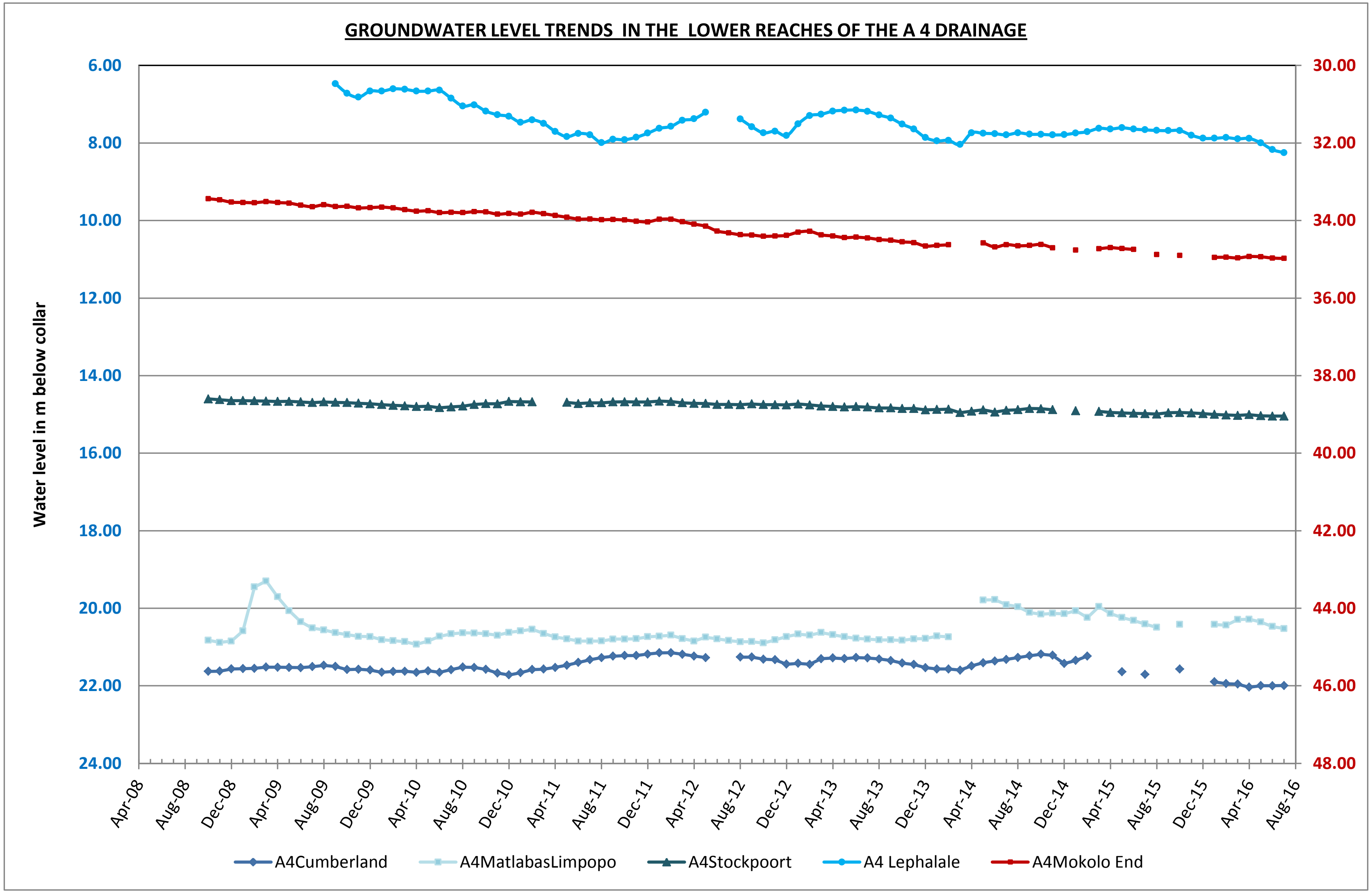
**Map 13**


AREAS OF POSSIBLE CONCERN IF DROUGHT PERSISTS
MUSINA
MALALE
MASISI
ALLDAYS
MAASSTROOM
MUDIMELI
SILOAM
THOHOYANDOU
TOM BURKE
BUYSDORP
BALTIMORE
GIYANI
RAMAKGOPA
SETATENG
LEPHALALE
MBAULA
TZANEEN
POLOKWANE
PHALABORWA
MICA
MOKOPANE
VAALWATER
MOGOTO
SELETENG
PENGE
THE WILLOWS
MODIMOLLE
JANE FURSE
Groundwater level monitoring network
Limpopo_Boundary
0 15 30 60 90 120
Kilometers
N

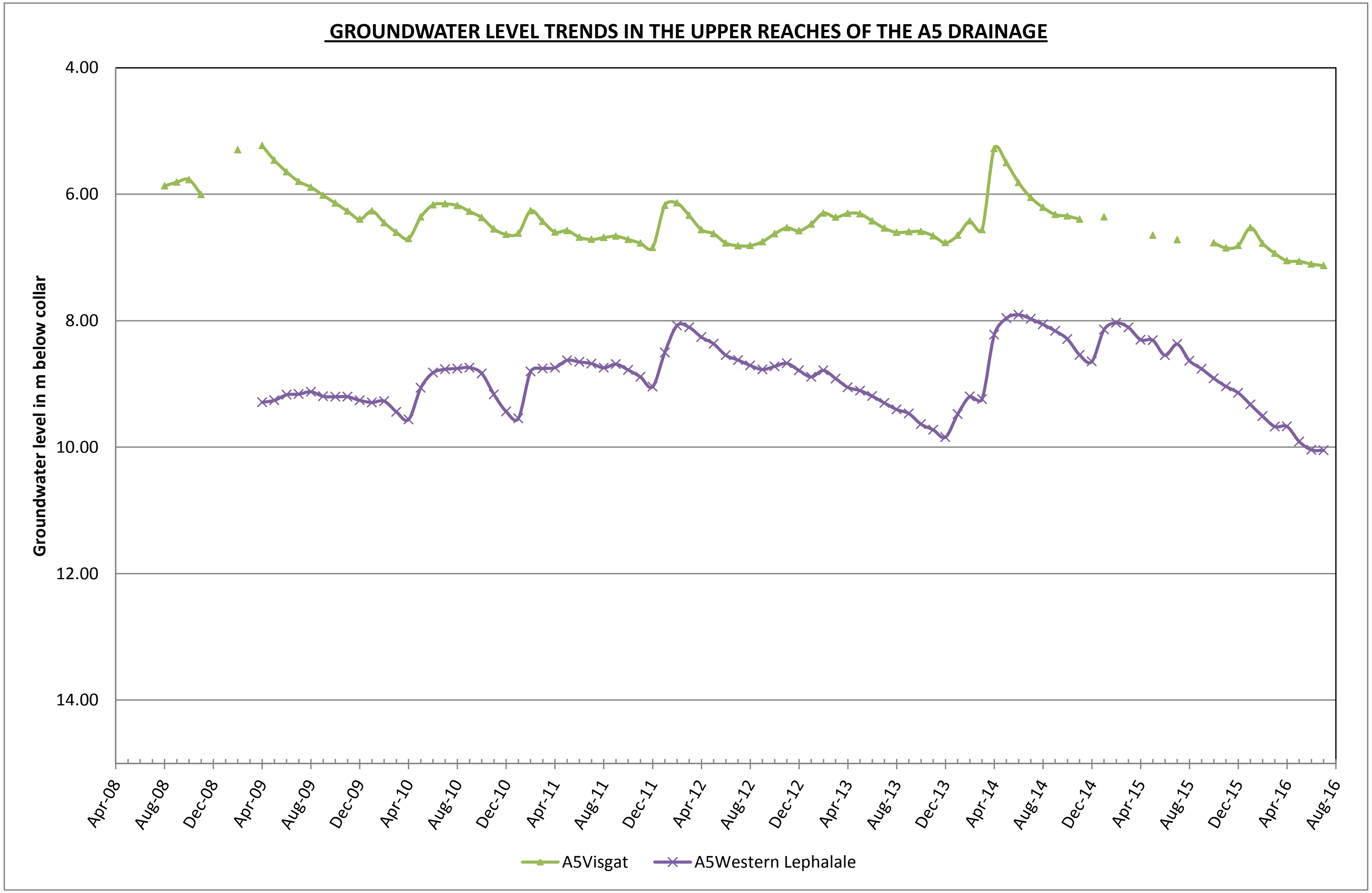
**MAP 14**


GROUNDWATER LEVEL TRENDS IN THE UPPER TO MIDDLE REACHES OF THE A 4 DRAINAGE
Axis Title
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
Apr-12
Aug-12
Dec-12
Apr-13
Aug-13
Dec-13
Apr-14
Aug-14
Dec-14
Apr-15
Aug-15
Dec-15
Apr-16
Aug-16
A4 Mokolo Poerse loop 2
A4 Rhenosterpoort
A4 Alma
A4 Naboom Vaalwater
A4MatlabasMamba
A4Matlabas-Mokolo

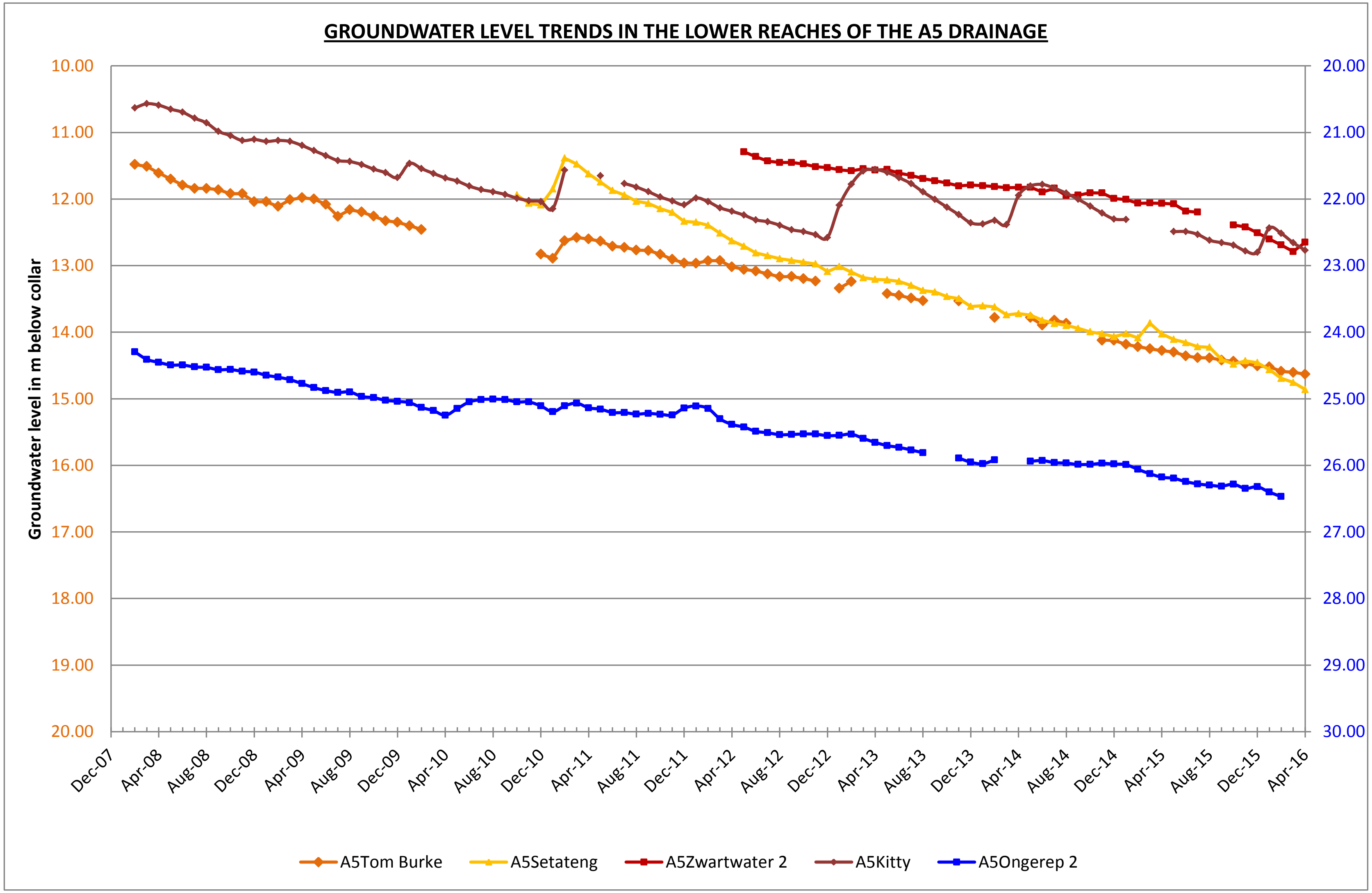
**GRAPH 1**


GROUNDWATER LEVEL TRENDS IN THE LOWER REACHES OF THE A 4 DRAINAGE
Water level in m below collar
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
30.00
32.00
34.00
36.00
38.00
40.00
42.00
44.00
46.00
48.00
Apr-08
Aug-08
Dec-08
Apr-09
Aug-09
Dec-09
Apr-10
Aug-10
Dec-10
Apr-11
Aug-11
Dec-11
Apr-12
Aug-12
Dec-12
Apr-13
Aug-13
Dec-13
Apr-14
Aug-14
Dec-14
Apr-15
Aug-15
Dec-15
Apr-16
Aug-16
A4Cumberland
A4MatlabasLimpopo
A4Stockpoort
A4 Lephalale
A4Mokolo End

**GRAPH 2**

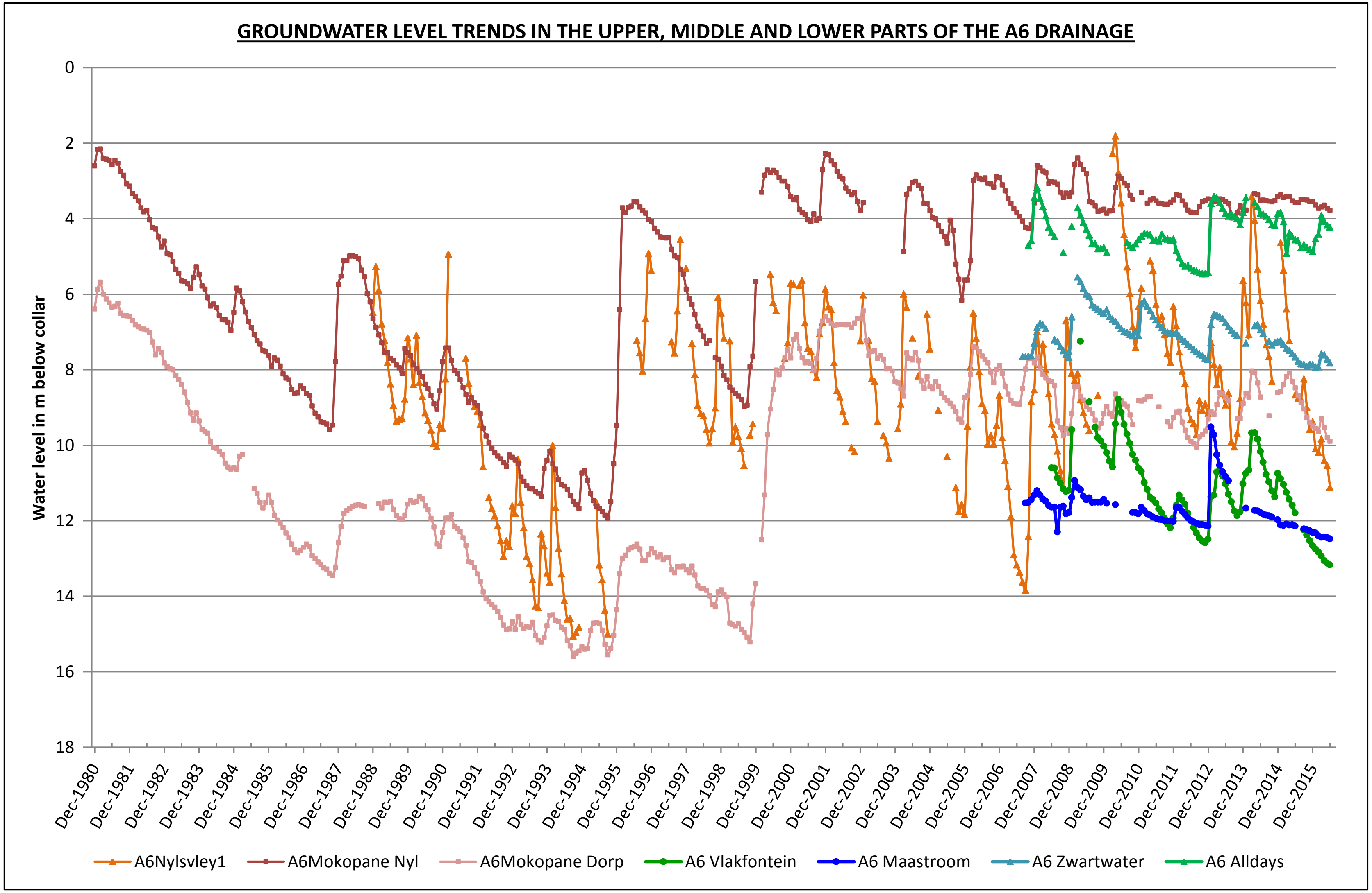

GROUNDWATER LEVEL TRENDS IN THE UPPER REACHES OF THE A5 DRAINAGE
Groundwater level in m below collar
4.00
6.00
8.00
10.00
12.00
14.00
Apr-08
Aug-08
Dec-08
Apr-09
Aug-09
Dec-09
Apr-10
Aug-10
Dec-10
Apr-11
Aug-11
Dec-11
Apr-12
Aug-12
Dec-12
Apr-13
Aug-13
Dec-13
Apr-14
Aug-14
Dec-14
Apr-15
Aug-15
Dec-15
Apr-16
Aug-16
A5Visgat
A5Western Lephalale

**GRAPH 3**

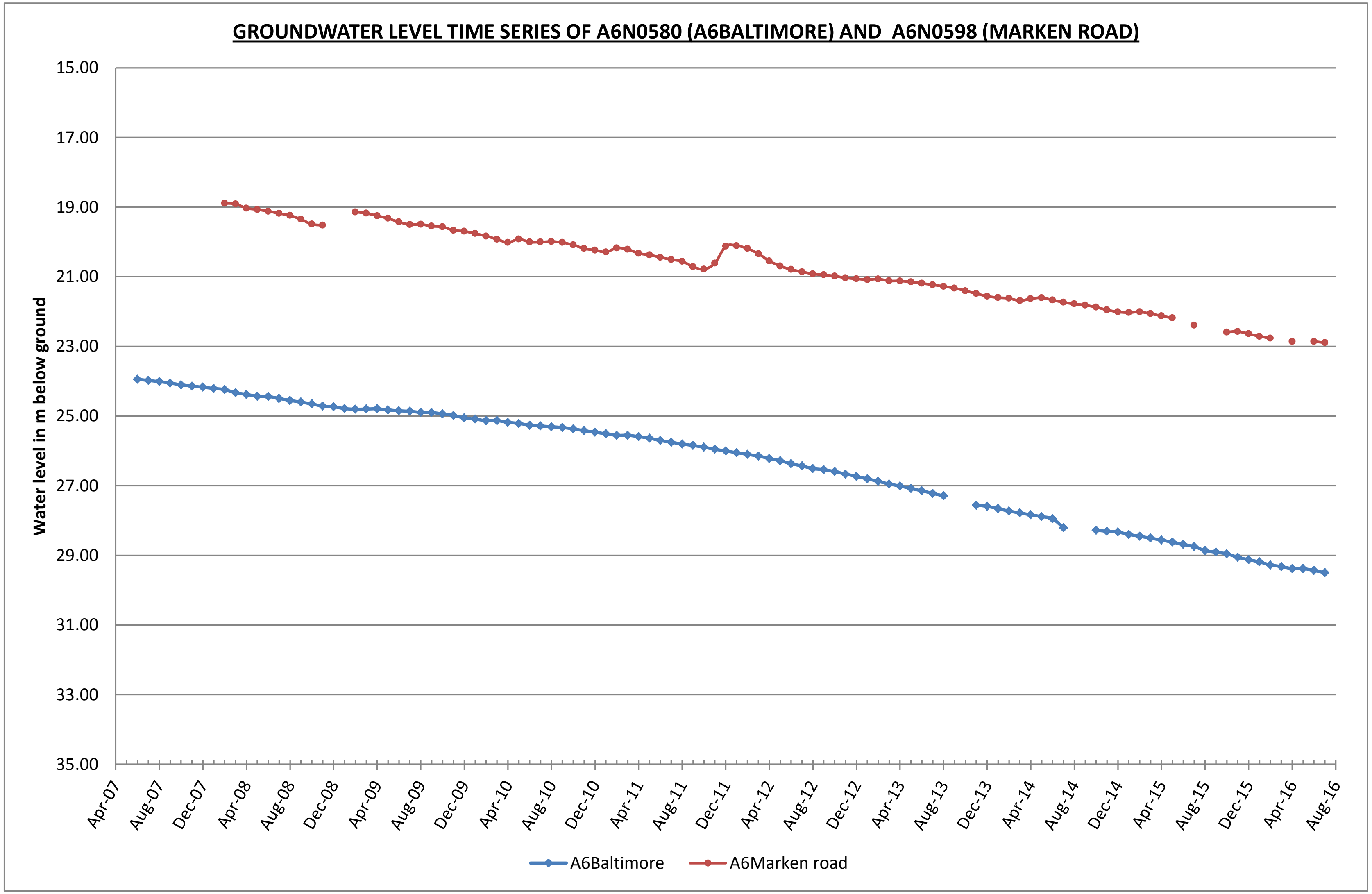


GROUNDWATER LEVEL TRENDS IN THE LOWER REACHES OF THE A5 DRAINAGE
Groundwater level in m below collar
10.00
11.00
12.00
13.00
14.00
15.00
16.00
17.00
18.00
19.00
20.00
20.00
21.00
22.00
23.00
24.00
25.00
26.00
27.00
28.00
29.00
30.00
Dec-07
Apr-08
Aug-08
Dec-08
Apr-09
Aug-09
Dec-09
Apr-10
Aug-10
Dec-10
Apr-11
Aug-11
Dec-11
Apr-12
Aug-12
Dec-12
Apr-13
Aug-13
Dec-13
Apr-14
Aug-14
Dec-14
Apr-15
Aug-15
Dec-15
Apr-16
A5Tom Burke
A5Setateng
A5Zwartwater 2
A5Kitty
A5Ongerep 2

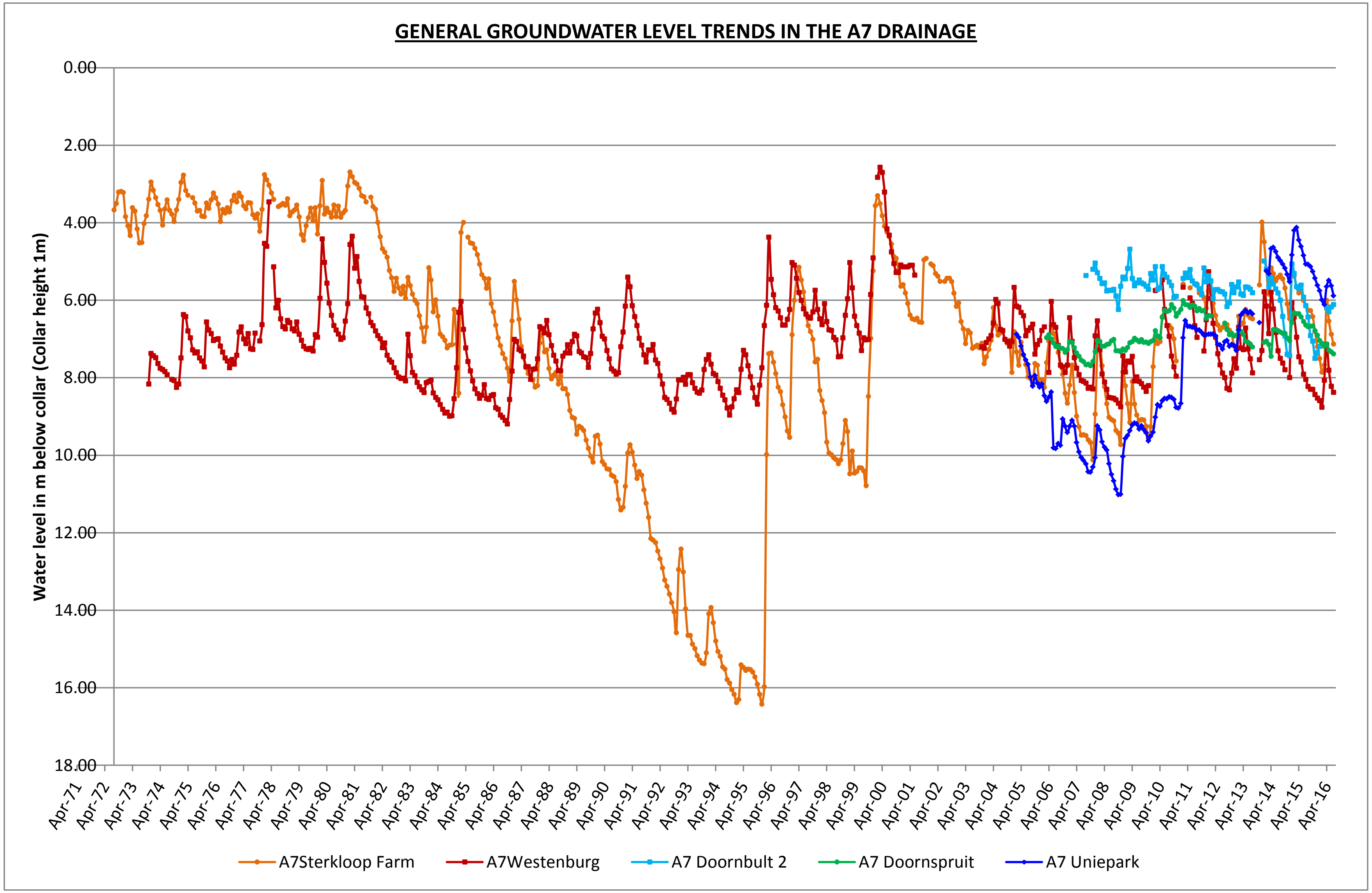

**GRAPH 4**


GROUNDWATER LEVEL TRENDS IN THE UPPER, MIDDLE AND LOWER PARTS OF THE A6 DRAINAGE
Water level in m below collar
0
2
4
6
8
10
12
14
16
18
Dec-1980
Dec-1981
Dec-1982
Dec-1983
Dec-1984
Dec-1985
Dec-1986
Dec-1987
Dec-1988
Dec-1989
Dec-1990
Dec-1991
Dec-1992
Dec-1993
Dec-1994
Dec-1995
Dec-1996
Dec-1997
Dec-1998
Dec-1999
Dec-2000
Dec-2001
Dec-2002
Dec-2003
Dec-2004
Dec-2005
Dec-2006
Dec-2007
Dec-2008
Dec-2009
Dec-2010
Dec-2011
Dec-2012
Dec-2013
Dec-2014
Dec-2015
A6Nylsvley1
A6Mokopane Nyl
A6Mokopane Dorp
A6 Vlakfontein
A6 Maastroom
A6 Zwartwater
A6 Alldays

**GRAPH 5**

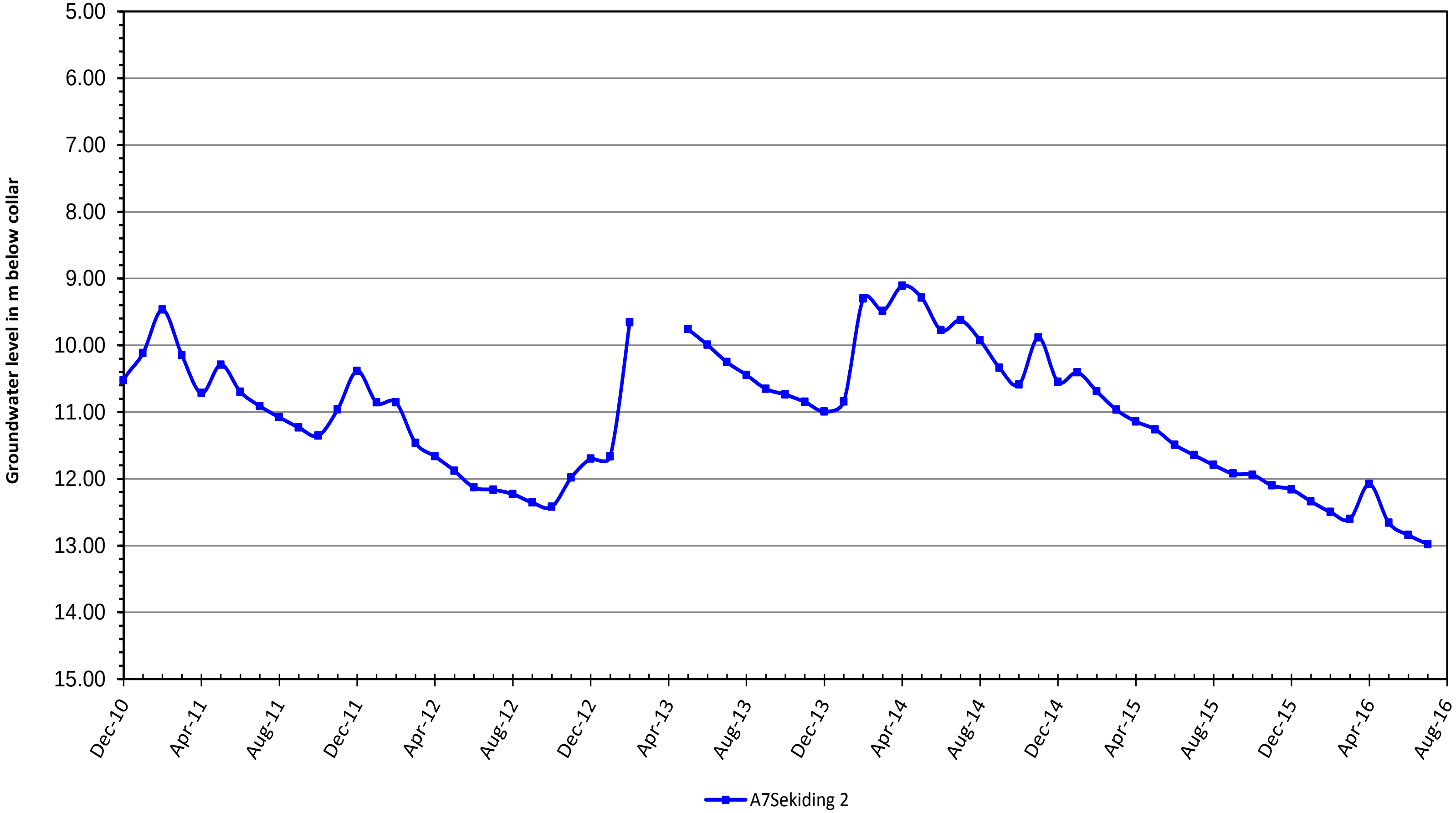

GROUNDWATER LEVEL TIME SERIES OF A6N0580 (A6BALTIMORE) AND A6N0598 (MARKEN ROAD)
Water level in m below ground
15.00
17.00
19.00
21.00
23.00
25.00
27.00
29.00
31.00
33.00
35.00
Apr-07
Aug-07
Dec-07
Apr-08
Aug-08
Dec-08
Apr-09
Aug-09
Dec-09
Apr-10
Aug-10
Dec-10
Apr-11
Aug-11
Dec-11
Apr-12
Aug-12
Dec-12
Apr-13
Aug-13
Dec-13
Apr-14
Aug-14
Dec-14
Apr-15
Aug-15
Dec-15
Apr-16
Aug-16
A6Baltimore
A6Marken road

**GRAPH 6**

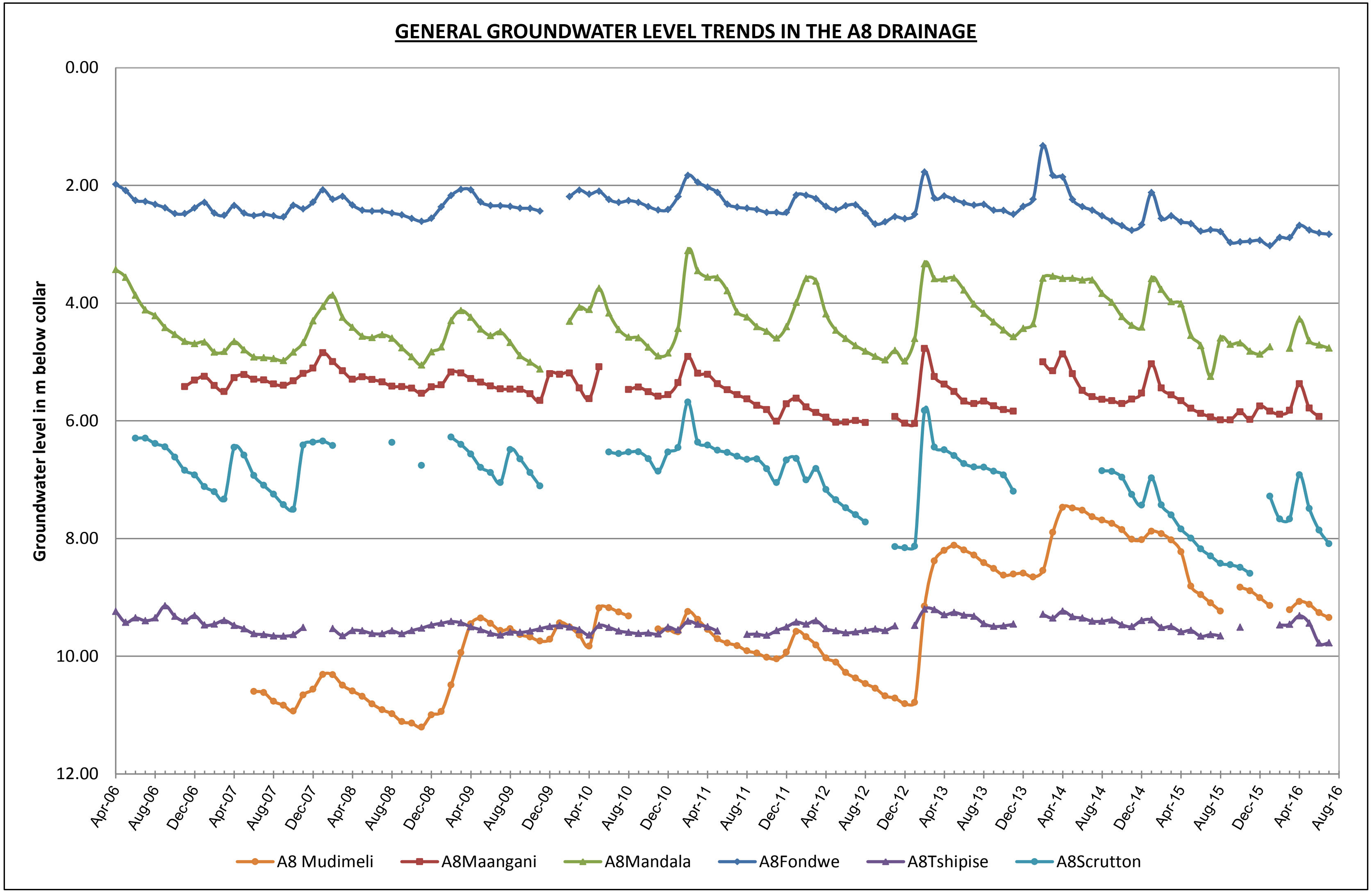

GENERAL GROUNDWATER LEVEL TRENDS IN THE A7 DRAINAGE
Water level in m below collar (Collar height 1m)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
Apr-71
Apr-72
Apr-73
Apr-74
Apr-75
Apr-76
Apr-77
Apr-78
Apr-79
Apr-80
Apr-81
Apr-82
Apr-83
Apr-84
Apr-85
Apr-86
Apr-87
Apr-88
Apr-89
Apr-90
Apr-91
Apr-92
Apr-93
Apr-94
Apr-95
Apr-96
Apr-97
Apr-98
Apr-99
Apr-00
Apr-01
Apr-02
Apr-03
Apr-04
Apr-05
Apr-06
Apr-07
Apr-08
Apr-09
Apr-10
Apr-11
Apr-12
Apr-13
Apr-14
Apr-15
Apr-16
A7Sterkloop Farm
A7Westenburg
A7 Doornbult 2
A7 Doornspruit
A7 Uniepark

**GRAPH 7**

## GROUNDWATER LEVEL TREND AT A7 SEKIDING 2

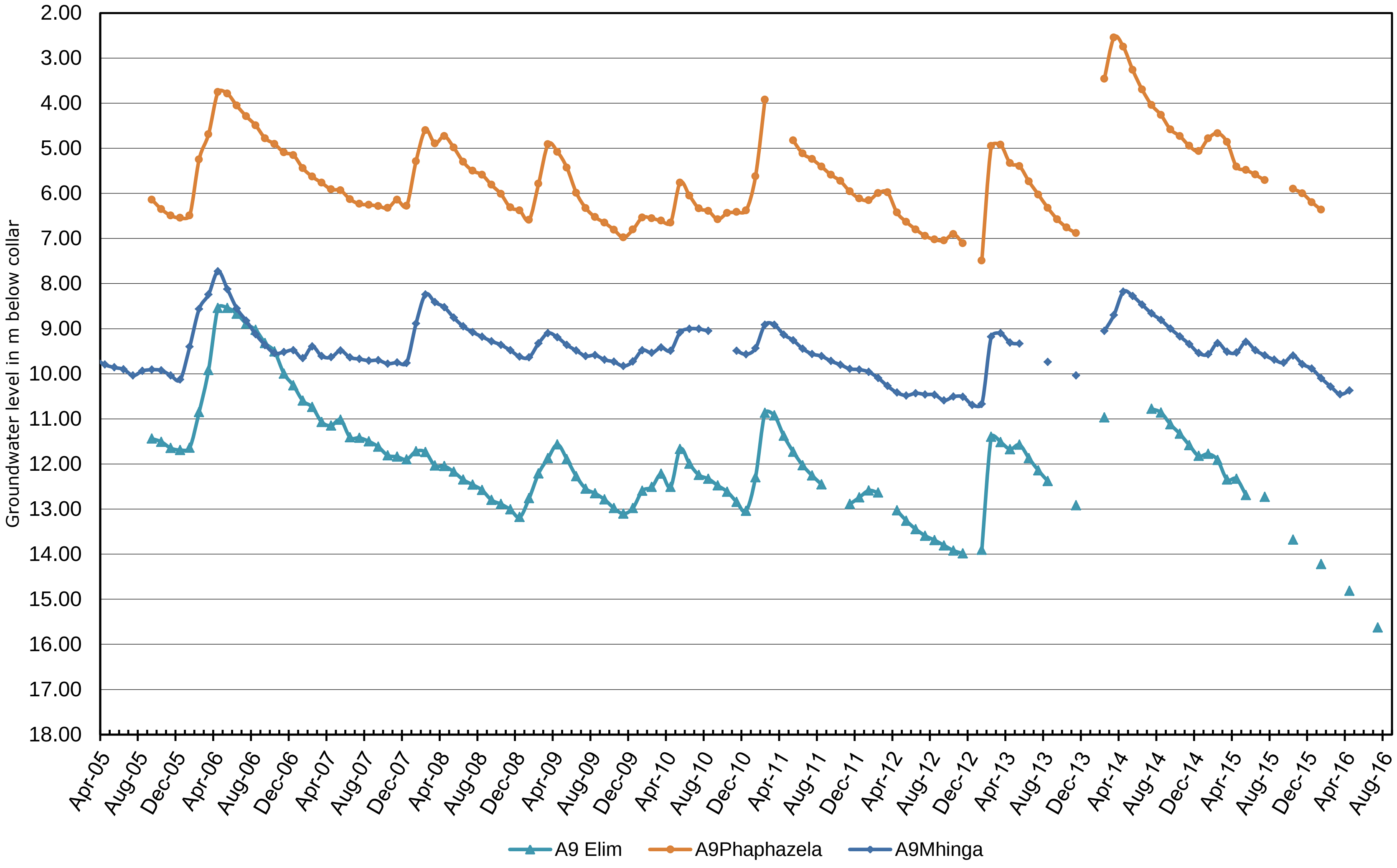



**GRAPH 8**

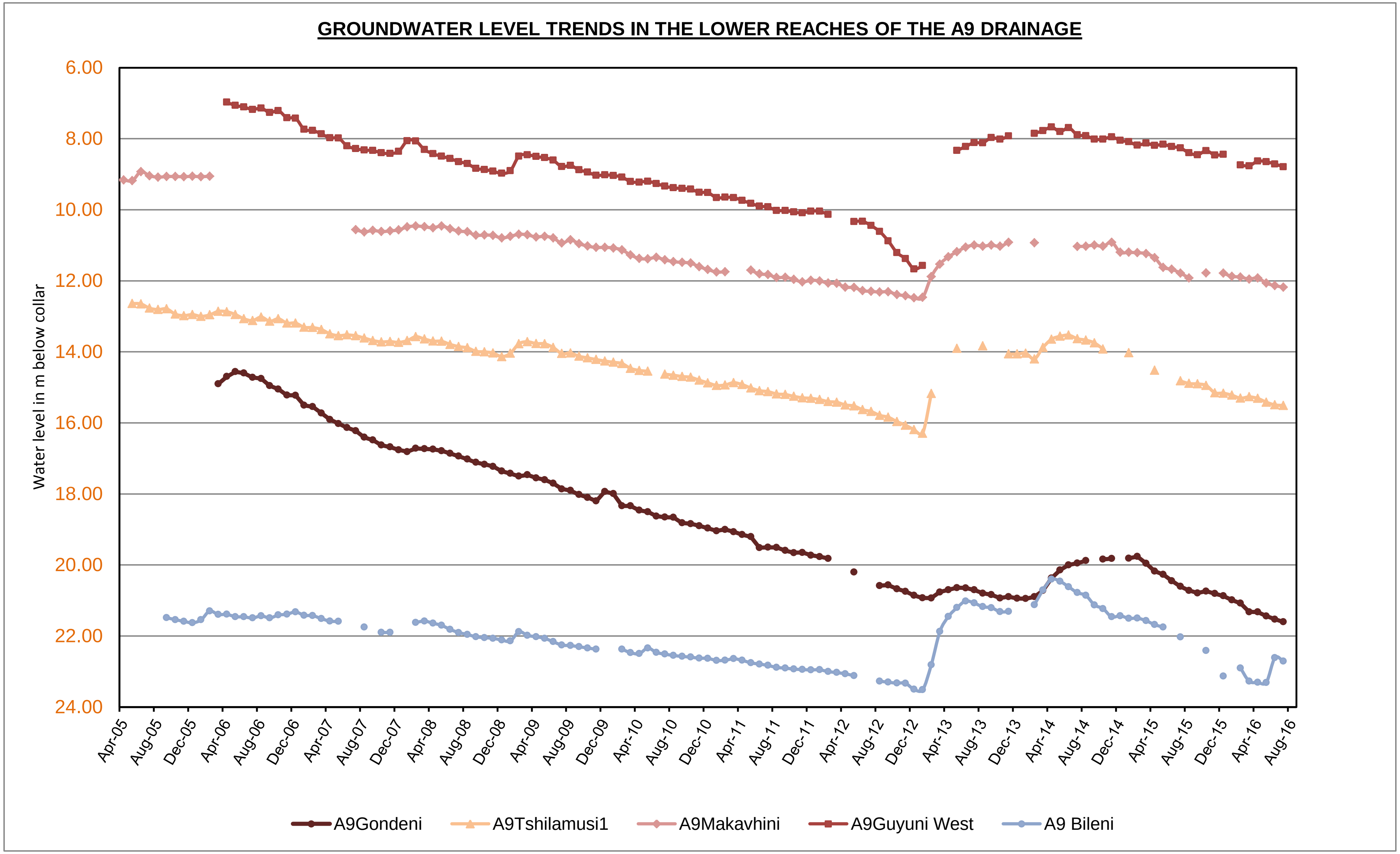

GENERAL GROUNDWATER LEVEL TRENDS IN THE A8 DRAINAGE
Groundwater level in m below collar
0.00
2.00
4.00
6.00
8.00
10.00
12.00
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Aug-08
Dec-08
Apr-09
Aug-09
Dec-09
Apr-10
Aug-10
Dec-10
Apr-11
Aug-11
Dec-11
Apr-12
Aug-12
Dec-12
Apr-13
Aug-13
Dec-13
Apr-14
Aug-14
Dec-14
Apr-15
Aug-15
Dec-15
Apr-16
Aug-16
A8 Mudimeli
A8Maangani
A8Mandala
A8Fondwe
A8Tshipise
A8Scrutton

**GRAPH 9**

## GROUNDWATER LEVEL TRENDS IN THE UPPER REACHES OF THE A9 DRAINAGE

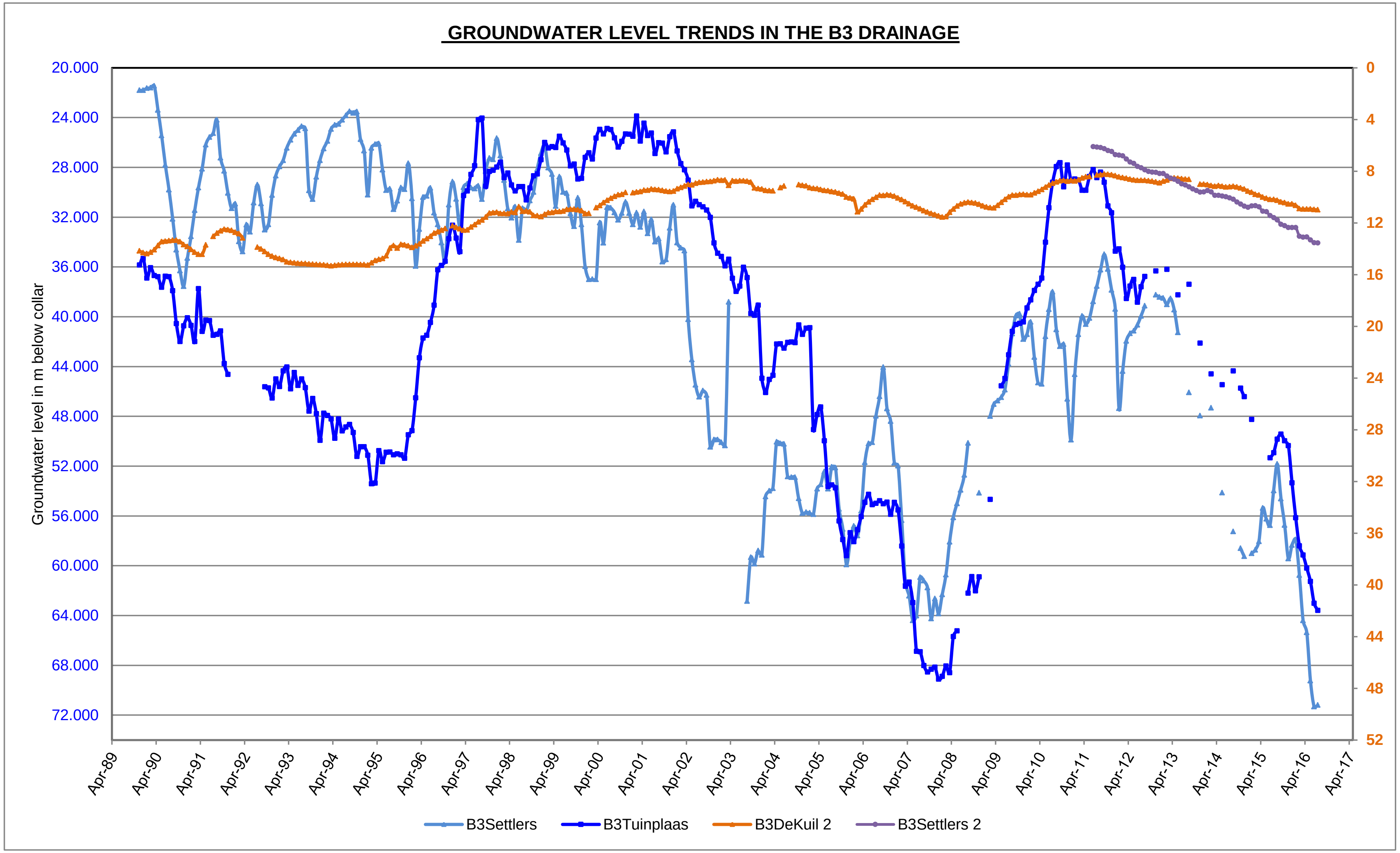



**GRAPH 10**

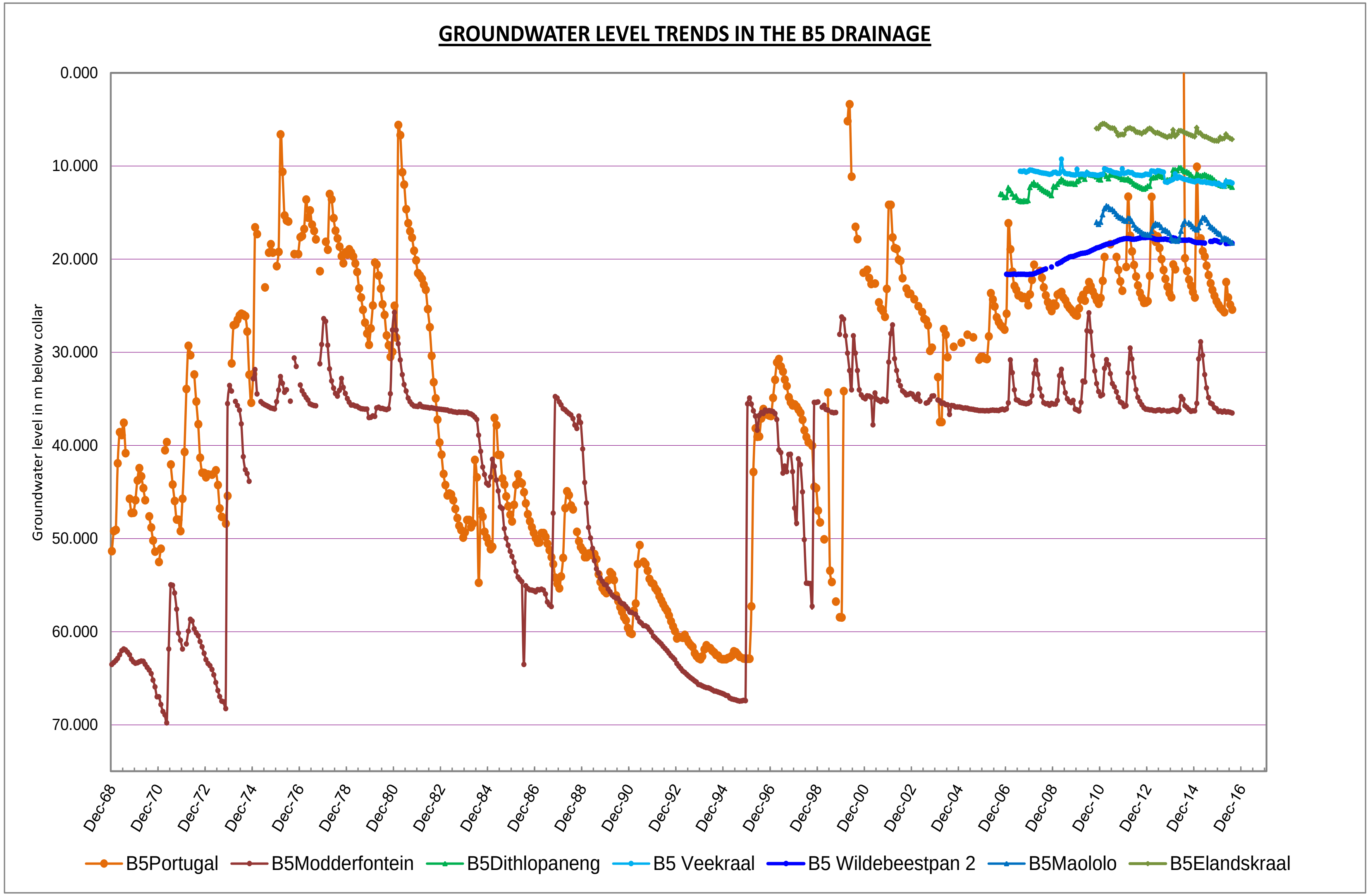


GROUNDWATER LEVEL TRENDS IN THE LOWER REACHES OF THE A9 DRAINAGE
Water level in m below collar
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Aug-08
Dec-08
Apr-09
Aug-09
Dec-09
Apr-10
Aug-10
Dec-10
Apr-11
Aug-11
Dec-11
Apr-12
Aug-12
Dec-12
Apr-13
Aug-13
Dec-13
Apr-14
Aug-14
Dec-14
Apr-15
Aug-15
Dec-15
Apr-16
Aug-16
A9Gondeni
A9Tshilamusi1
A9Makavhini
A9Guyuni West
A9 Bileni

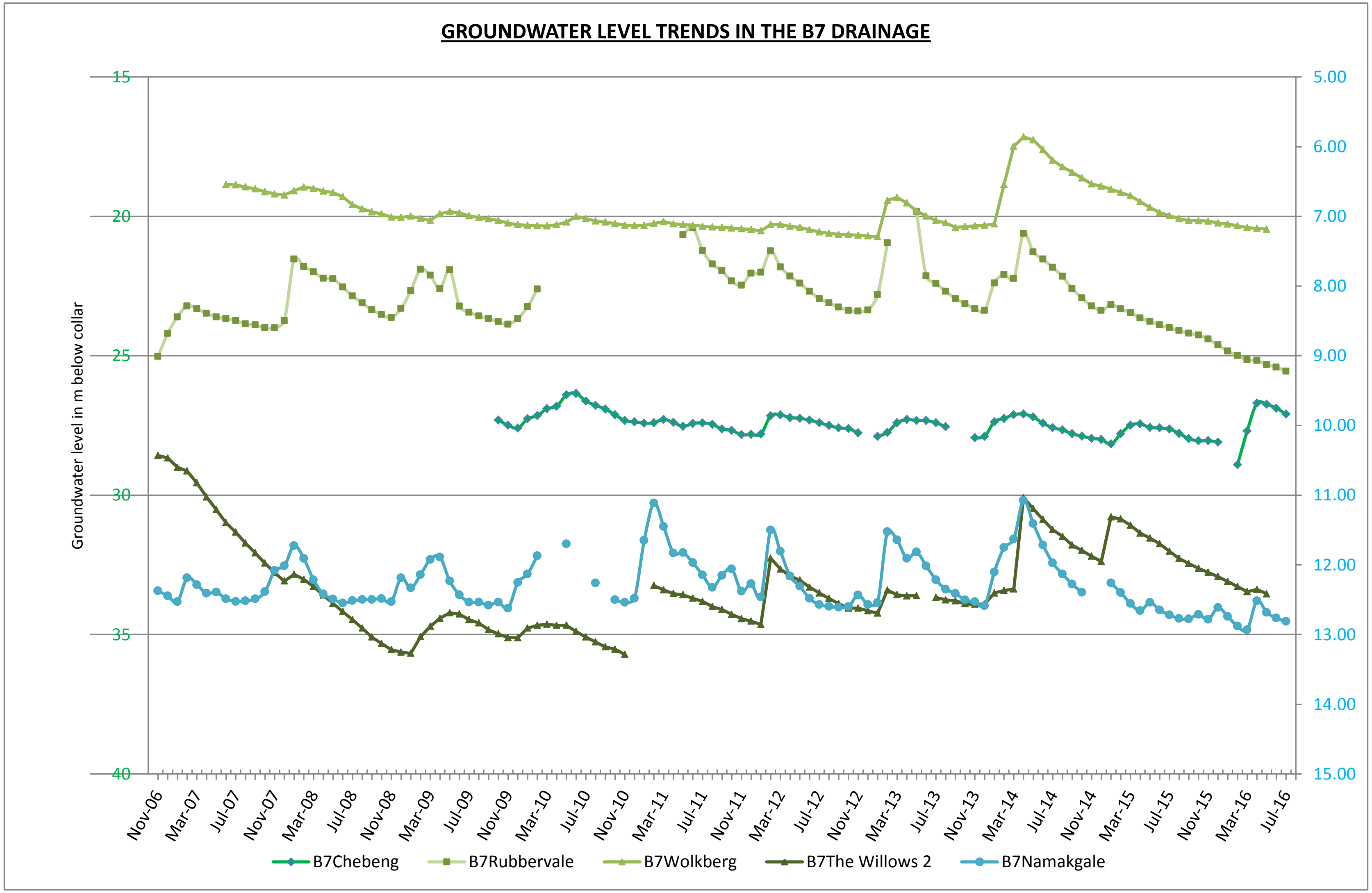

**GRAPH 11**


GROUNDWATER LEVEL TRENDS IN THE B3 DRAINAGE
Groundwater level in m below collar
20.000
24.000
28.000
32.000
36.000
40.000
44.000
48.000
52.000
56.000
60.000
64.000
68.000
72.000
0
4
8
12
16
20
24
28
32
36
40
44
48
52
Apr-89
Apr-90
Apr-91
Apr-92
Apr-93
Apr-94
Apr-95
Apr-96
Apr-97
Apr-98
Apr-99
Apr-00
Apr-01
Apr-02
Apr-03
Apr-04
Apr-05
Apr-06
Apr-07
Apr-08
Apr-09
Apr-10
Apr-11
Apr-12
Apr-13
Apr-14
Apr-15
Apr-16
Apr-17
B3Settlers
B3Tuinplaas
B3DeKuil 2
B3Settlers 2

**GRAPH 12**

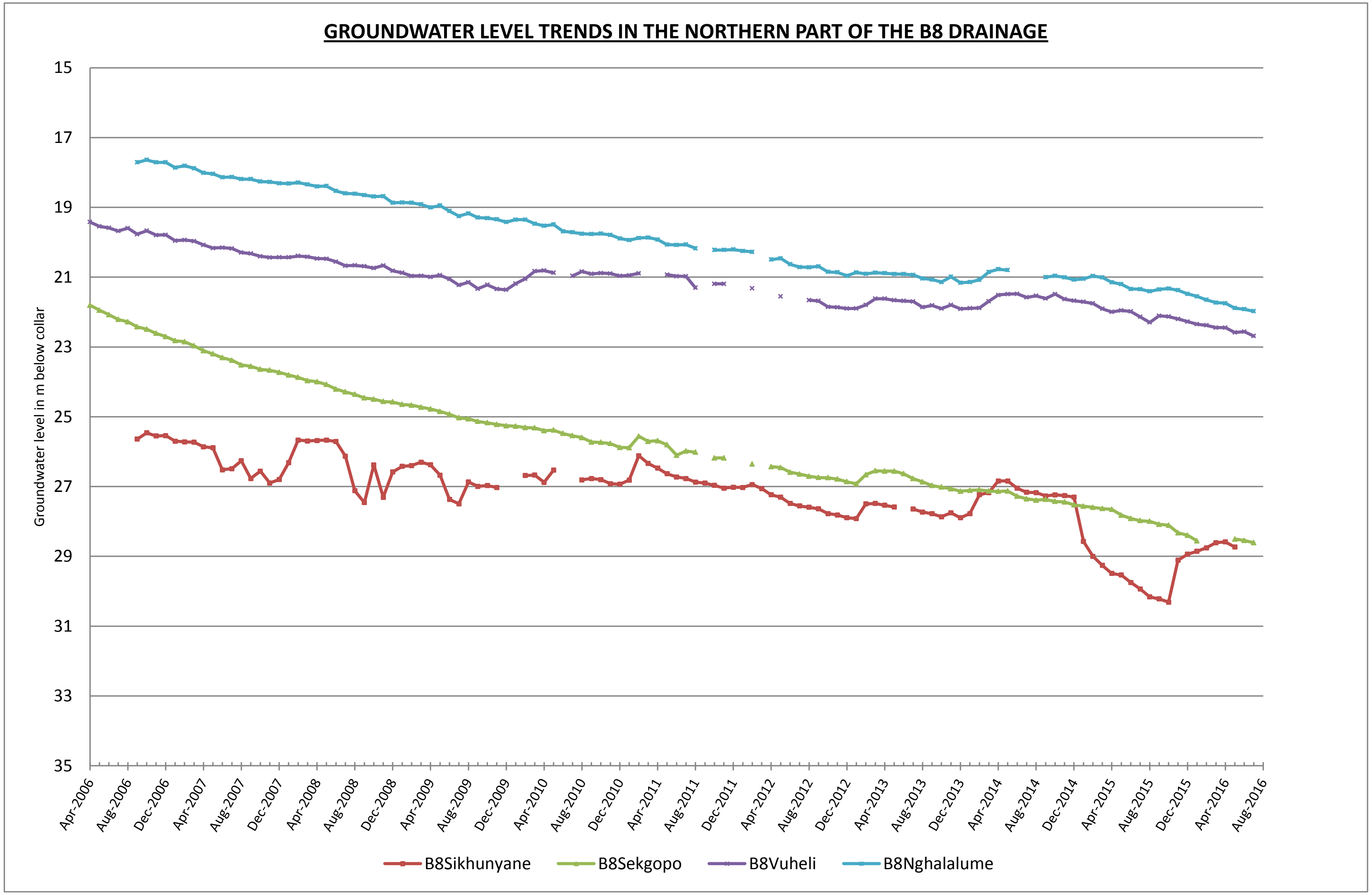

GROUNDWATER LEVEL TRENDS IN THE B5 DRAINAGE
Groundwater level in m below collar
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
Dec-68
Dec-70
Dec-72
Dec-74
Dec-76
Dec-78
Dec-80
Dec-82
Dec-84
Dec-86
Dec-88
Dec-90
Dec-92
Dec-94
Dec-96
Dec-98
Dec-00
Dec-02
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
B5Portugal
B5Modderfontein
B5Dithlopaneng
B5 Veekraal
B5 Wildebeestpan 2
B5Maololo
B5Elandskraal

**GRAPH 13**

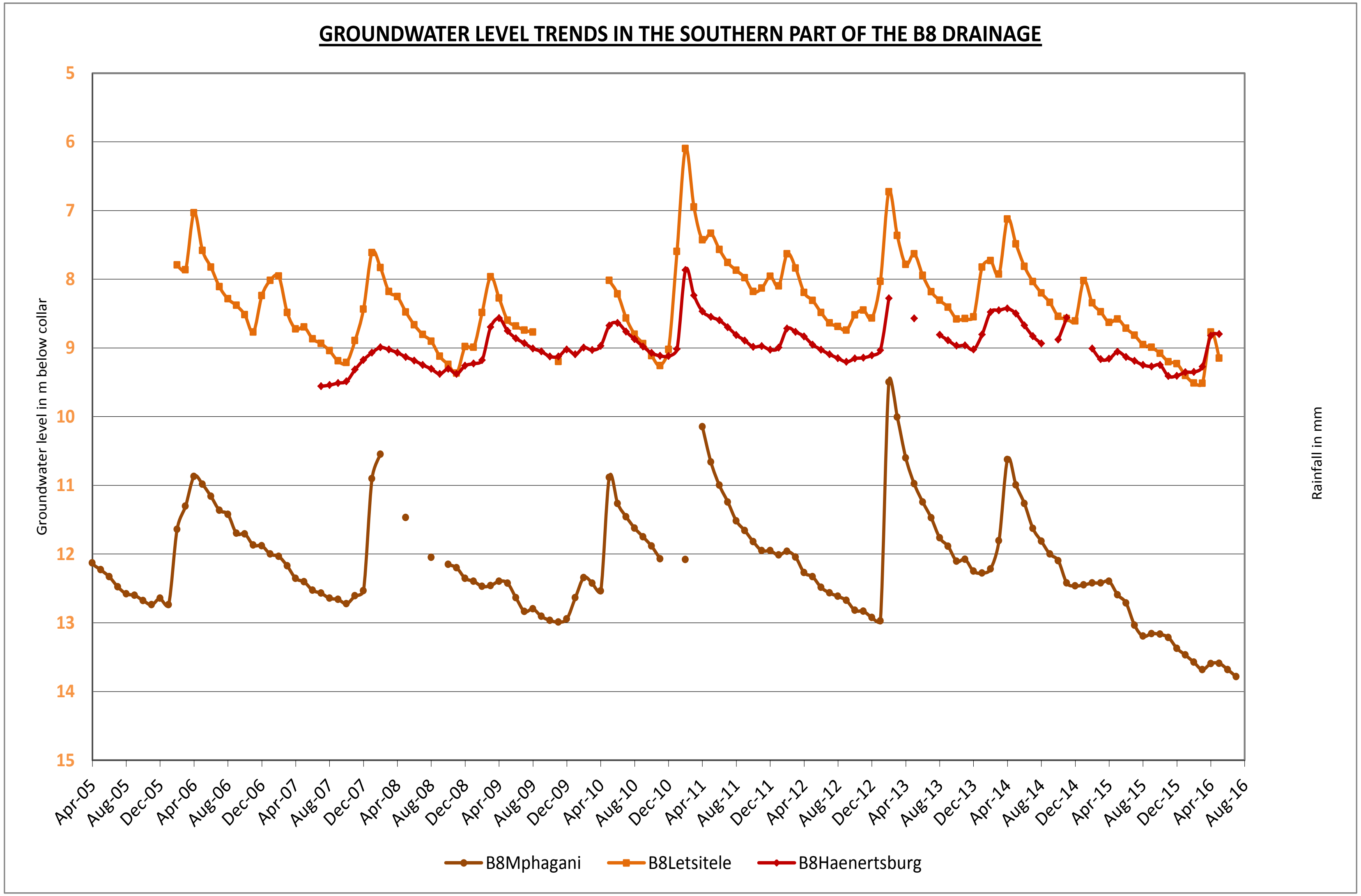


GROUNDWATER LEVEL TRENDS IN THE B7 DRAINAGE
Groundwater level in m below collar
15
20
25
30
35
40
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
Nov-06
Mar-07
Jul-07
Nov-07
Mar-08
Jul-08
Nov-08
Mar-09
Jul-09
Nov-09
Mar-10
Jul-10
Nov-10
Mar-11
Jul-11
Nov-11
Mar-12
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
Jul-15
Nov-15
Mar-16
Jul-16
B7Chebeng
B7Rubbervale
B7Wolkberg
B7The Willows 2
B7Namakgale

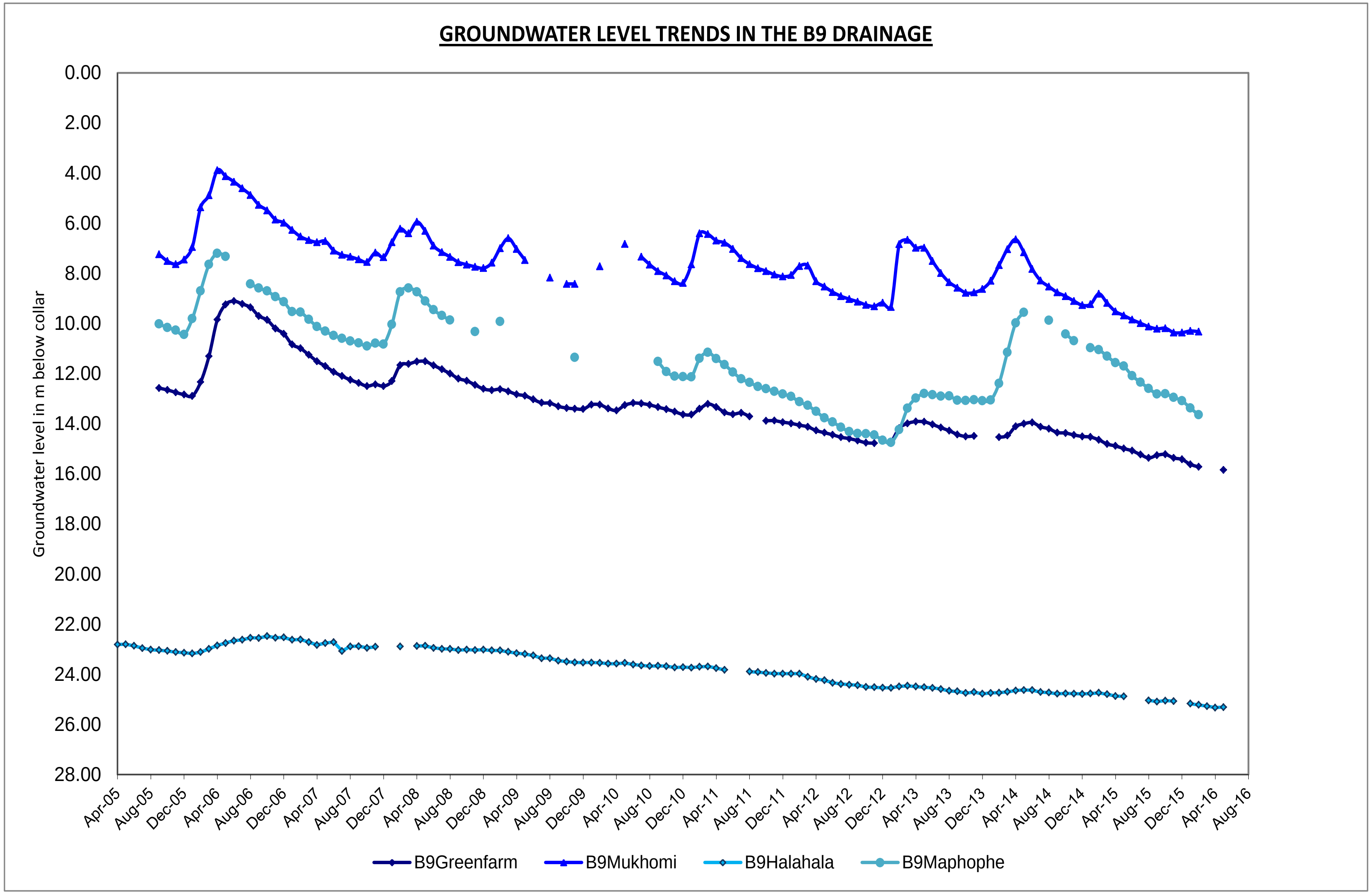

**GRAPH 14**


GROUNDWATER LEVEL TRENDS IN THE NORTHERN PART OF THE B8 DRAINAGE
15
17
19
21
23
25
27
29
31
33
35
Groundwater level in m below collar
Apr-2006
Aug-2006
Dec-2006
Apr-2007
Aug-2007
Dec-2007
Apr-2008
Aug-2008
Dec-2008
Apr-2009
Aug-2009
Dec-2009
Apr-2010
Aug-2010
Dec-2010
Apr-2011
Aug-2011
Dec-2011
Apr-2012
Aug-2012
Dec-2012
Apr-2013
Aug-2013
Dec-2013
Apr-2014
Aug-2014
Dec-2014
Apr-2015
Aug-2015
Dec-2015
Apr-2016
Aug-2016
B8Sikhunyane
B8Sekgopo
B8Vuheli
B8Nghalalume

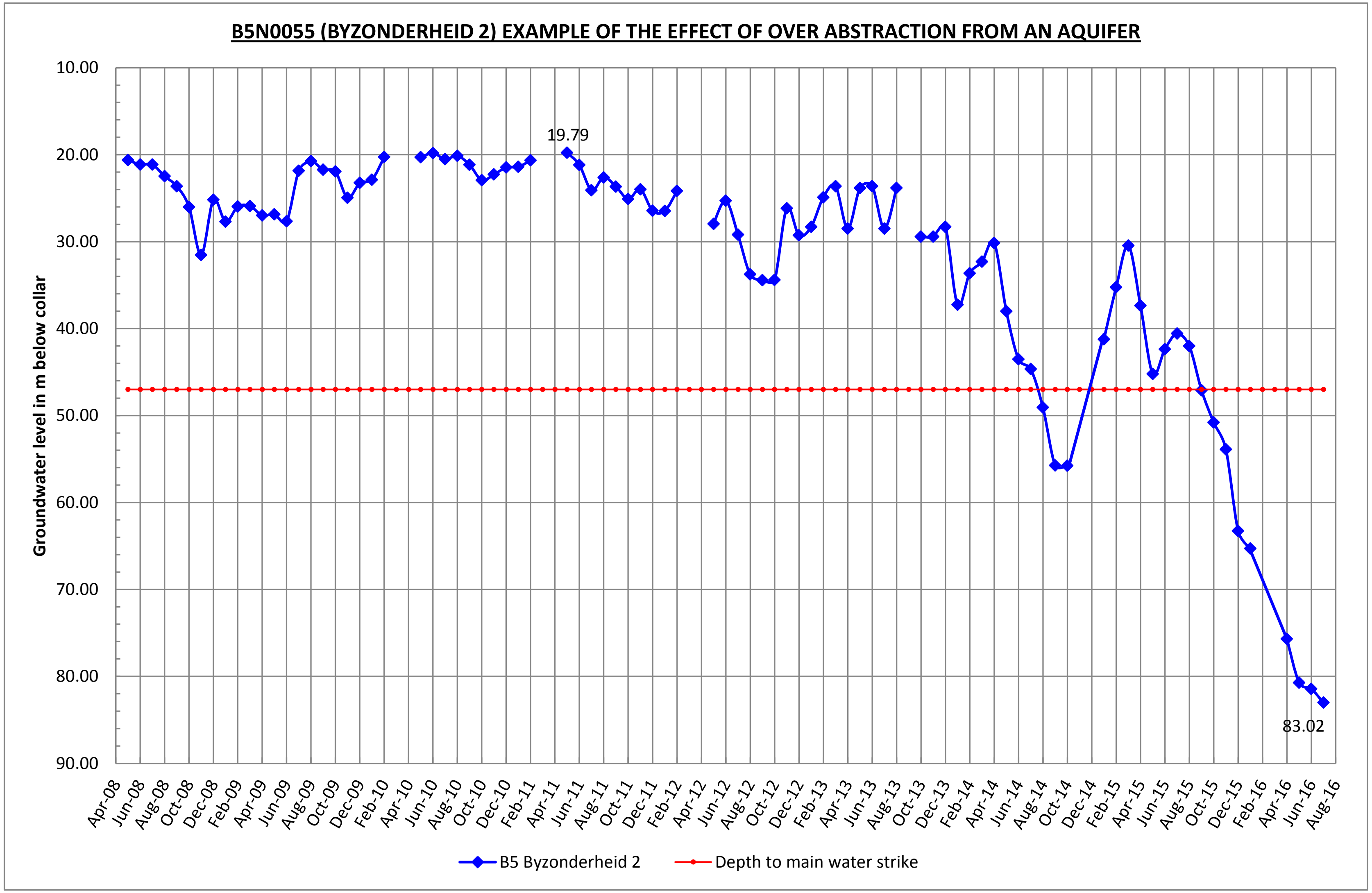
**GRAPH 15**


GROUNDWATER LEVEL TRENDS IN THE SOUTHERN PART OF THE B8 DRAINAGE
Groundwater level in m below collar
Rainfall in mm
5
6
7
8
9
10
11
12
13
14
15
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Aug-08
Dec-08
Apr-09
Aug-09
Dec-09
Apr-10
Aug-10
Dec-10
Apr-11
Aug-11
Dec-11
Apr-12
Aug-12
Dec-12
Apr-13
Aug-13
Dec-13
Apr-14
Aug-14
Dec-14
Apr-15
Aug-15
Dec-15
Apr-16
Aug-16
B8Mphagani
B8Letsitele
B8Haenertsburg

**GRAPH 16**

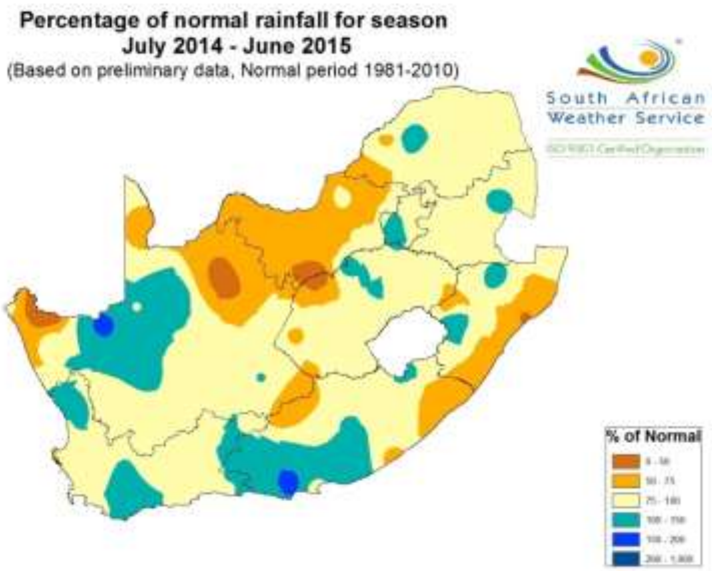

GROUNDWATER LEVEL TRENDS IN THE B9 DRAINAGE
Groundwater level in m below collar
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
26.00
28.00
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Aug-08
Dec-08
Apr-09
Aug-09
Dec-09
Apr-10
Aug-10
Dec-10
Apr-11
Aug-11
Dec-11
Apr-12
Aug-12
Dec-12
Apr-13
Aug-13
Dec-13
Apr-14
Aug-14
Dec-14
Apr-15
Aug-15
Dec-15
Apr-16
Aug-16
B9Greenfarm
B9Mukhomi
B9Halahala
B9Maphophe

**GRAPH 17**



B5N0055 (BYZONDERHEID 2) EXAMPLE OF THE EFFECT OF OVER ABSTRACTION FROM AN AQUIFER
Groundwater level in m below collar
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
19.79
83.02
Apr-08
Jun-08
Aug-08
Oct-08
Dec-08
Feb-09
Apr-09
Jun-09
Aug-09
Oct-09
Dec-09
Feb-10
Apr-10
Jun-10
Aug-10
Oct-10
Dec-10
Feb-11
Apr-11
Jun-11
Aug-11
Oct-11
Dec-11
Feb-12
Apr-12
Jun-12
Aug-12
Oct-12
Dec-12
Feb-13
Apr-13
Jun-13
Aug-13
Oct-13
Dec-13
Feb-14
Apr-14
Jun-14
Aug-14
Oct-14
Dec-14
Feb-15
Apr-15
Jun-15
Aug-15
Oct-15
Dec-15
Feb-16
Apr-16
Jun-16
Aug-16
B5 Byzonderheid 2
Depth to main water strike


**GRAPH 18**


Percentage of normal rainfall for season
July 2014 - June 2015
(Based on preliminary data, Normal period 1981-2010)
South African
Weather Service
% of Normal

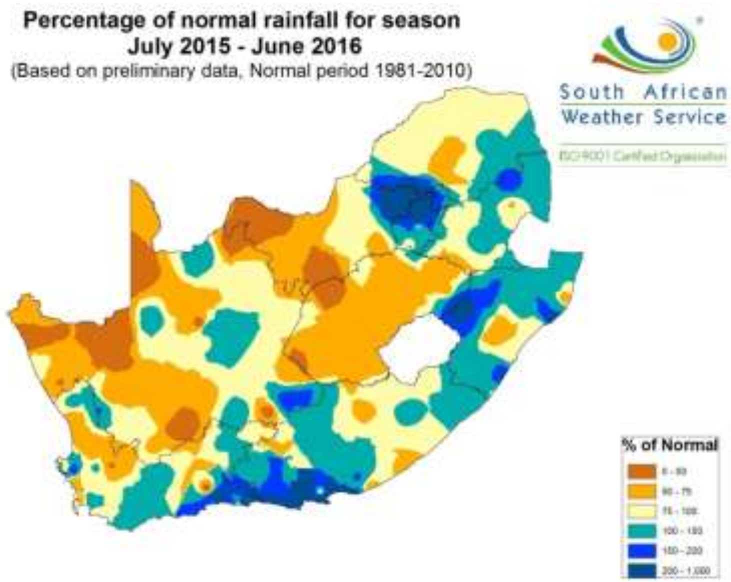

Percentage of normal rainfall for season
July 2015 - June 2016
(Based on preliminary data, Normal period 1981-2010)
South African
Weather Service
% of Normal

**FIGURE 1**

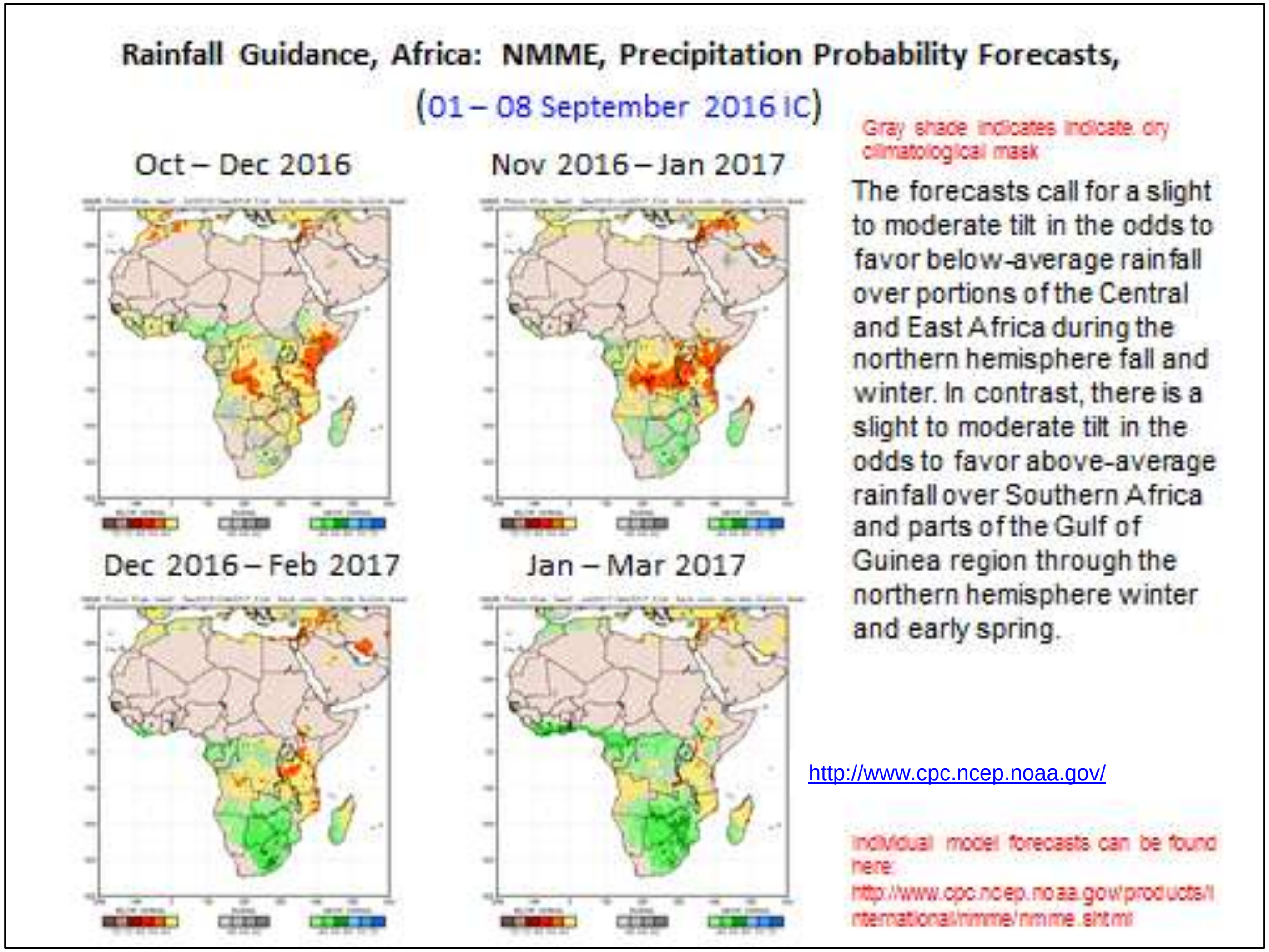
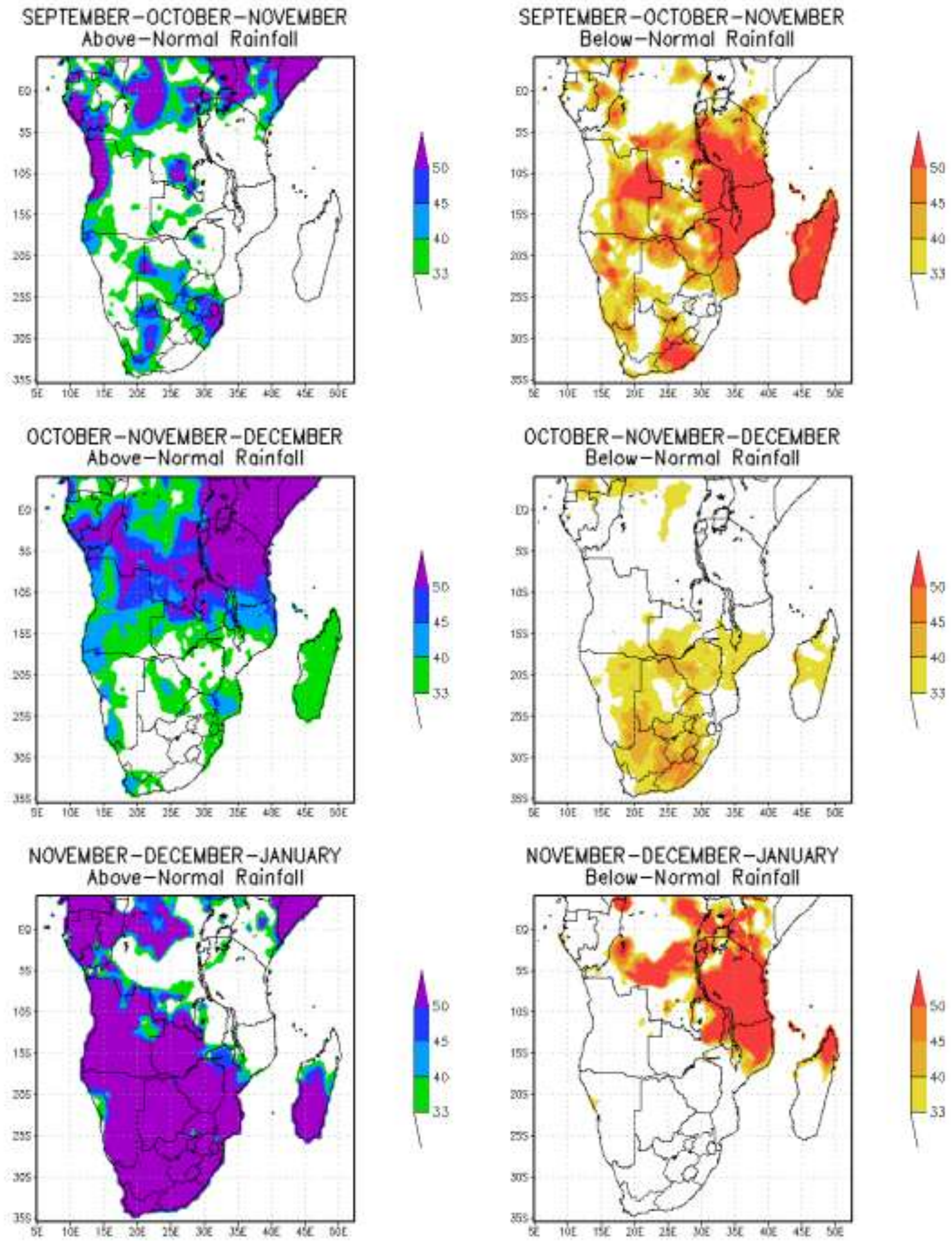

Rainfall Guidance, Africa: NMME, Precipitation Probability Forecasts,
(01 – 08 September 2016 IC)
Gray shade indicates indicate dry climatological mask
Oct – Dec 2016
Nov 2016 – Jan 2017
Dec 2016 – Feb 2017
Jan – Mar 2017
The forecasts call for a slight to moderate tilt in the odds to favor below-average rainfall over portions of the Central and East Africa during the northern hemisphere fall and winter. In contrast, there is a slight to moderate tilt in the odds to favor above-average rainfall over Southern Africa and parts of the Gulf of Guinea region through the northern hemisphere winter and early spring.
http://www.cpc.ncep.noaa.gov/
individual model forecasts can be found here:
http://www.cpc.ncep.noaa.gov/products/international/nmme/nmme.shtml

**FIGURE 2**




South African Weather Service CSIR The International Research In for Climate and Society

**FIGURE 3**