water & sanitation

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Water and Sanitation
REPUBLIC OF SOUTH AFRICA

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THE STATE OF WATER RESOURCES IN THE DROUGHT AFFECTED AREAS OF THE NAMAKWA AND PIXLEY KA SEME DISTRICT MUNICIPALITIES IN THE NORTHERN CAPE

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1 Introduction

It has been evident that global climate change will significantly affect the sustainability of water availability and supply in the coming decades for the Northern Cape. Inherently, the low level of rainfall and its variability and inconsistency have become more frequent in the last three decades and it has, in most instances led to recurring bouts of droughts in certain parts of the province, especially the western, northern and central parts of the Northern Cape.

Whilst there has been a return to normal rainfall patterns throughout most of South Africa, below average rainfalls are still being experienced in the western regions. In the Northern Cape this specifically translates to areas within the Namakwa and Pixley ka Seme District Municipalities.

The weather of the Northern Cape is typically that of desert and semi-desert areas. It is a generally hot and dry region with fluctuating temperatures and generally low rainfall. Evaporation levels exceed the annual rainfall which varies between 50 mm and 400 mm (the average annual rainfall over the Province is 202 mm). The western areas of the Province, which include Namaqualand, portions of Boesmanland, and small areas of the Green Kalahari, receive rainfall during the winter months (April to September). The central, northern and eastern parts of the Province receive rain primarily during the summer months (December to February).

2 Background

2.1 Climate

*Figure 1*below illustrates the average rainfall of the Northern Cape. In January, average afternoon temperatures range between 34°C and 40°C in the interior. Winter temperatures range between 5°C and 15°C. Frost occurs in the high-laying regions with snow occasionally falling in the Sutherland and Kamiesberg uplands region. The fog that blankets much of Namaqualand is a phenomenon that occurs frequently during the autumn months when onshore wind speeds are not strong enough to produce the turbulence that breaks up the fog. The fog is an important alternative source of moisture for the plants and various animal species and fulfils a vitally important function in the ecology of the Richtersveld.

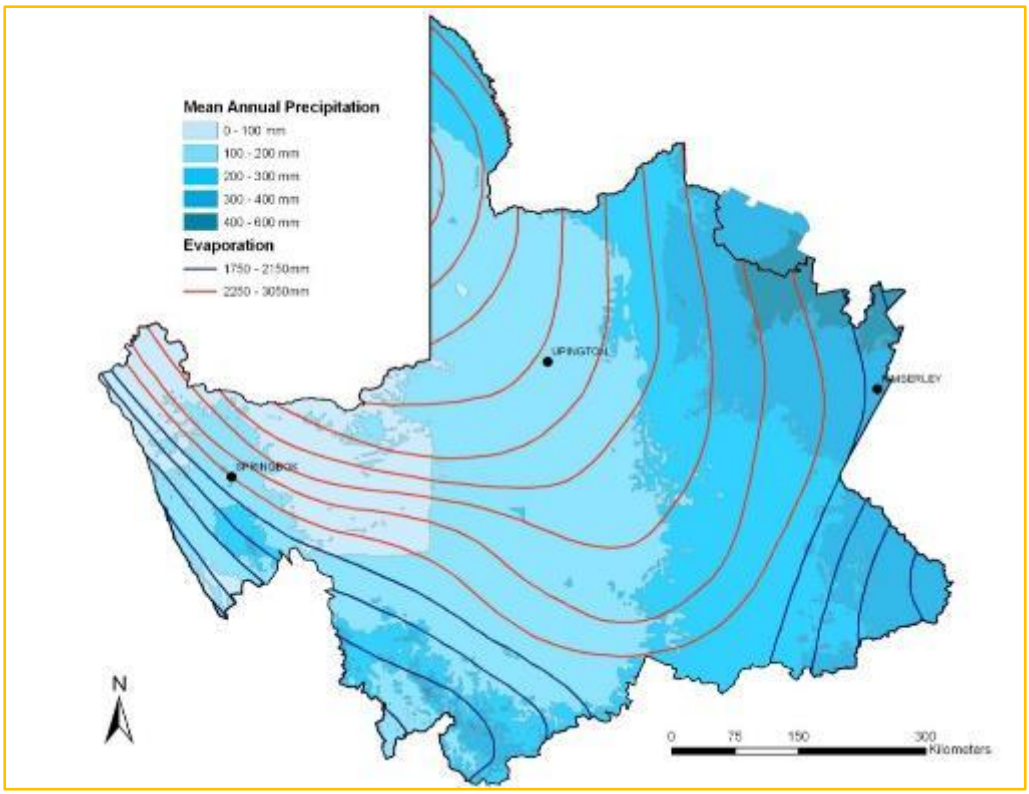

Figure 1: Rainfall of the Northern Cape (Source: DWS-NC)

2.2 Hydrology of the Northern Cape

The Northern Cape Province is the driest province in South Africa with an average annual rainfall of about 200 mm. The scarcity of water resources is a defining feature of this arid environment. The Orange River with its tributaries is the main source of surface water in the province. Ground water plays an important part in the region, especially in settlements far removed from the Orange River, however, the quality and quantity of ground water varies. The western part of the Northern Cape borders on the Atlantic Ocean and these marine resources play an integral role in the economy, environment and climate of the province.

Groundwater resources are particularly important in the Northern Cape with its high evaporation potential, and low and variable rainfall. There are thirteen groundwater regions within the provincial boundaries. A total of 280 communities in the Northern Cape are dependent on groundwater which affects 465 000 people, which is approximately 40% of households. A number of communities are utilising more than the recommended sustainable yield of groundwater resources. Twenty-six out of fifty-seven (where information is available) are utilising more than 80% of the resource potential. By utilising more than 80% of the resource, it becomes unsustainable.

2.3 The General State of Water Resources

In 2009, DWS compiled the Reconciliation Strategy (All Town studies). The studies gathered information about the bulk water balance situation of all towns in the country, to select the towns that are most in need of comprehensive strategies for reconciliation of water availability with future water requirements, and to identify the most appropriate series of interventions that will form part of such strategies. *Figure 2* gives a summary of the water statusfor each town as per the *All Town Studies*.The estimated water sustainability was compiled before the lower average rainfalls of the past few years; hence the situation has since deteriorated.

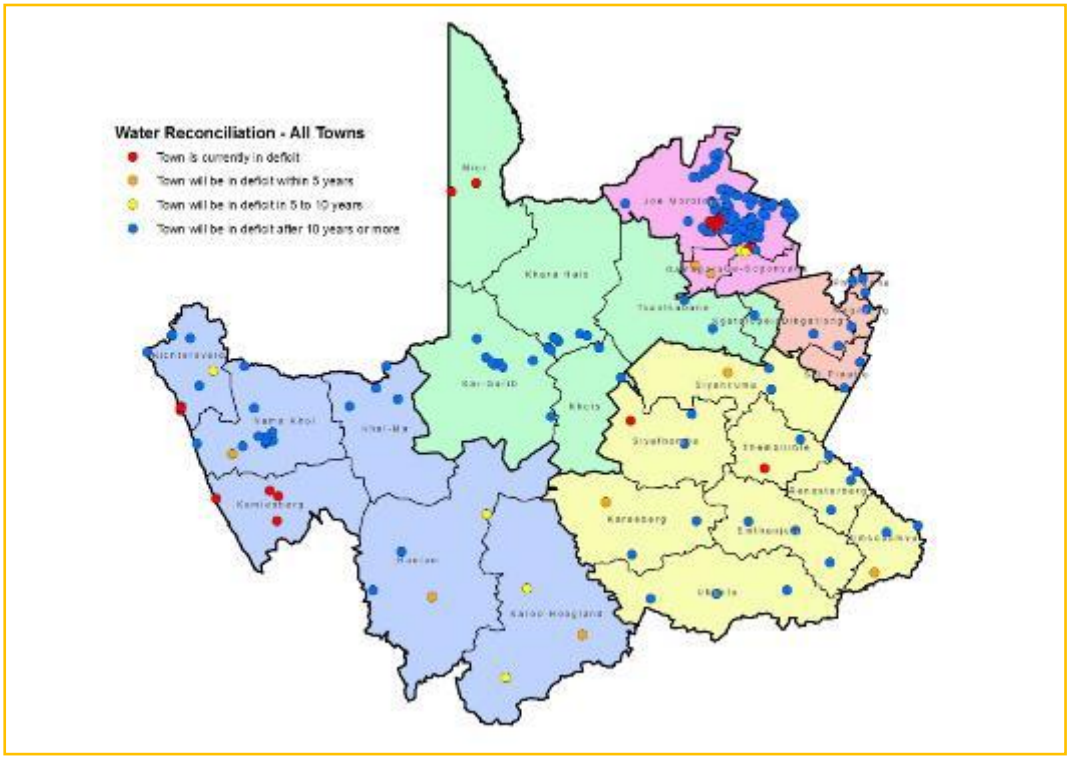

Figure 2: All town study of the Northern Cape (Source: DWS-NC)

As mentioned, groundwater resources are particularly important in the Northern Cape. Figure *3*below shows the trends in groundwater levels across the country from 30 August 2015 to 30 August 2017. The western and southern regions of the Northern Cape are of interest, showing decreases in groundwater levels. Particularly in the Richtersveld, Hantam, Karoo Hoogland and Kareeberg Locoal Municipalities.

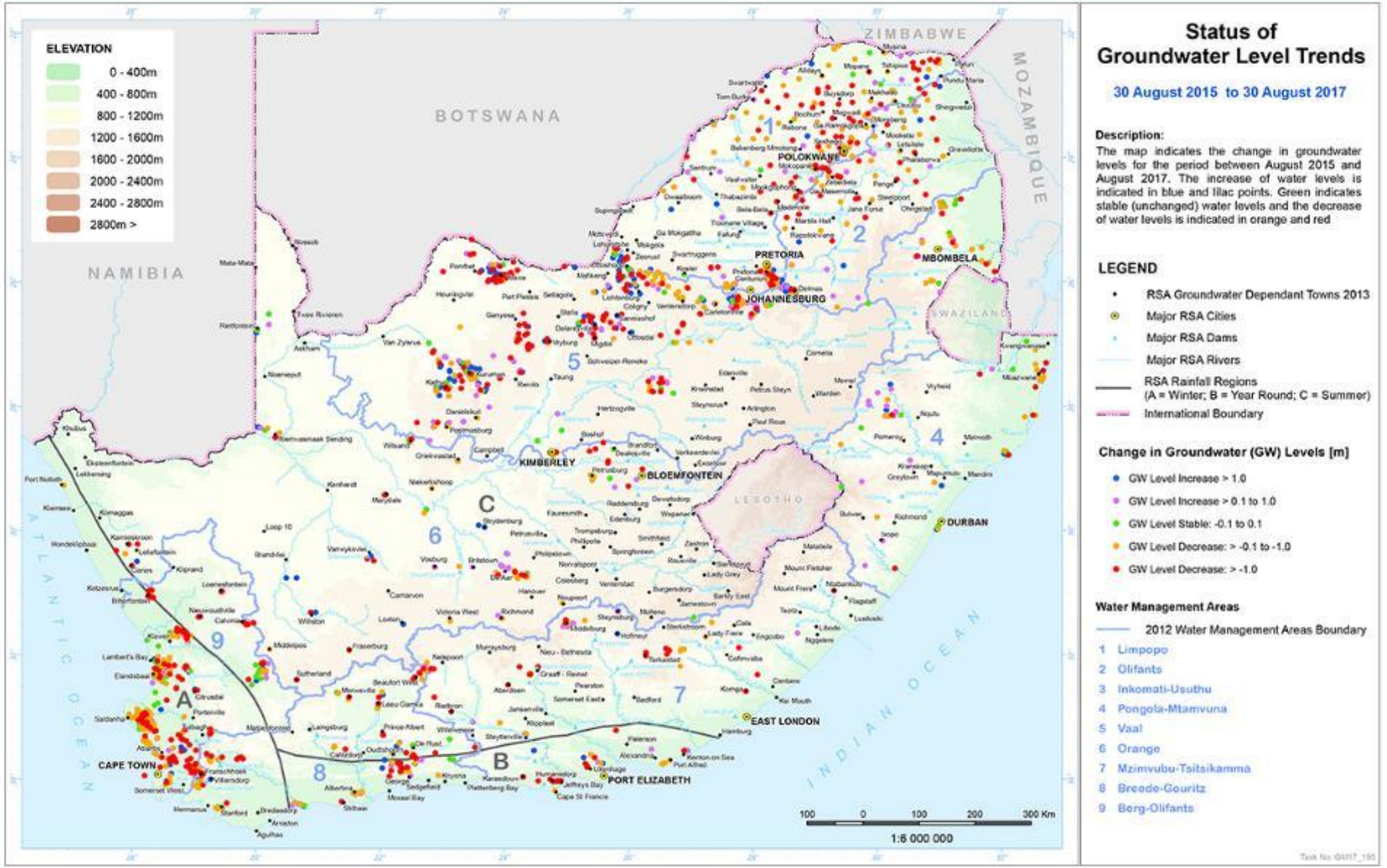

Figure 3: Status of Groundwater Level Trends – 30 Aug 2015 to 30 Aug 2017

2.4 Rainfall and Groundwater Levels

The 12-month Standardized Precipitation Index (SPI) categories for the period ending August 2017 is shown in *Figure 4*, whilst the 48-month SPI is shown in *Figure 5*.

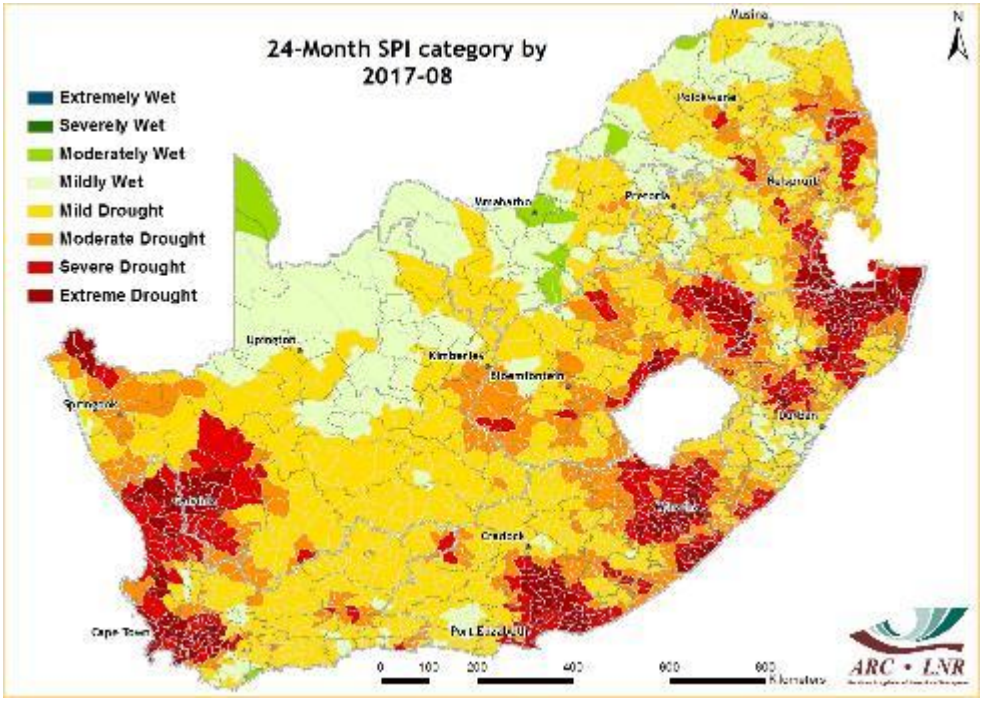

Figure 4: The 12-Month Standardized Precipitation Index (SPI) for the period ending August 2017 (Source: Agricultural Research Council)

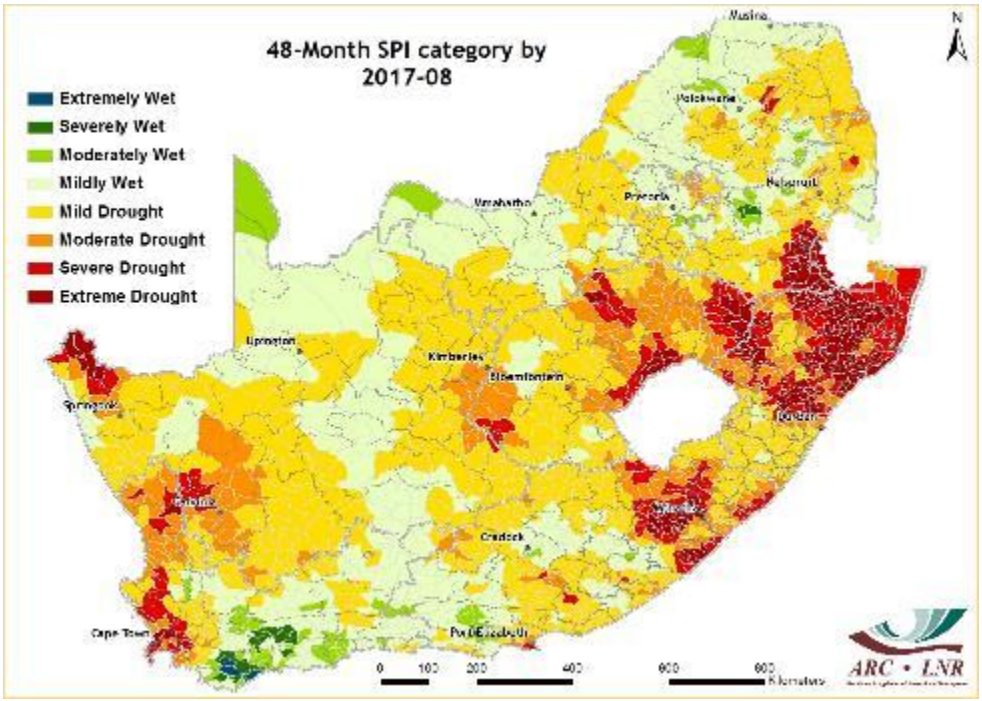

Figure 5:The 48-Month Standardized Precipitation Index (SPI) for the period ending August 2017 (Source: Agricultural Research Council)

Considering the above SPIs it is evident that drought conditions have been prevalent in the western parts of the Northern Cape for some time. Only when considering the normalized difference vegetation index (NDVI), given in Figure 6, does the impact of the drought in the south-eastern part of the Northern Cape also become clear. Decreased vegetation activity is thus observed in the western, south-western and south-eastern parts in the Northern Cape. This is in accordance with both the rainfall patterns (*Figure 4* and *Figure 5*) and the groundwater level trends (*Figure 3*).

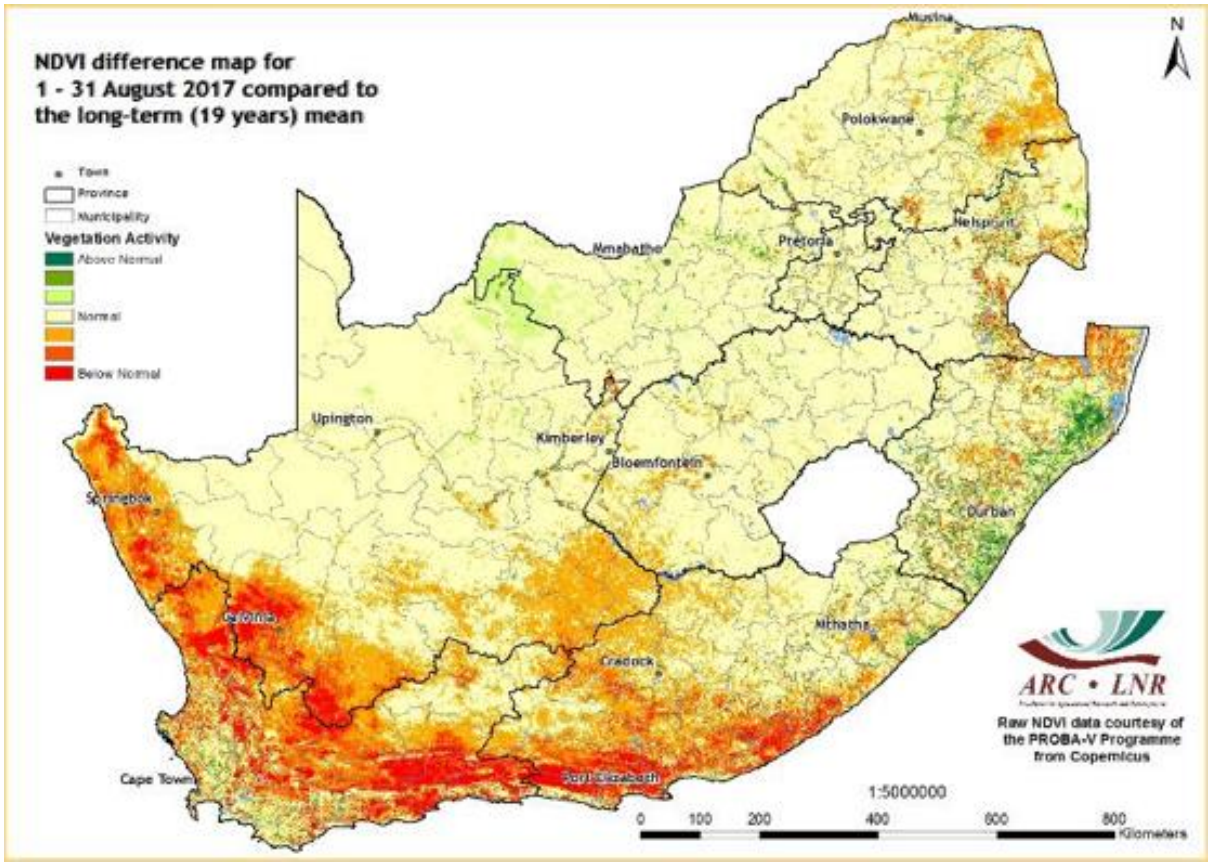

Figure 6: The Normalized Difference Vegetation Index for August 2017.

The seasonal outlook for rainfall is shown in *Figure 7*. According to the South African Weather Service (SAWS), The forecasting system is currently very uncertain on a specific direction of rainfall during mid spring; however, there are strong indications that wetter conditions can be expected from late spring and early summer. This is however only expected to be significant for the summer-rainfall areas of South Africa.

Higher than average rainfalls are expected for the western and north-western regions of the northern cape. The south-eastern region is only expected to receive above-average rainfall during late summer. It should be noted that the level of uncertainty is high and as mentioned

above, the level of rainfall is only expected to be of significant value in summer rainfall areas. Hence, little improvement in groundwater levels is expected.

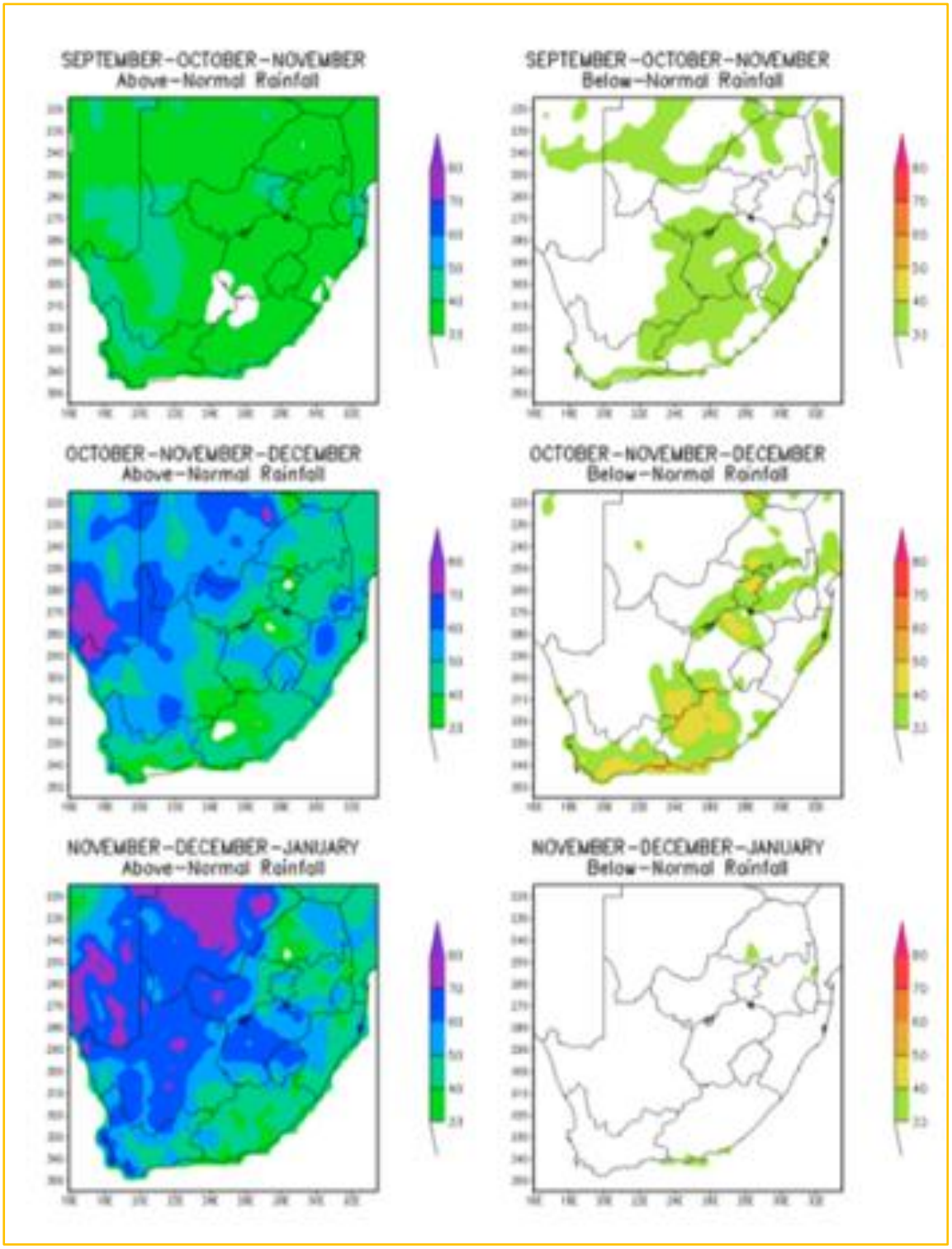

Figure 7: Climate Forecast for Summer 2017

3 The State of Water Resources and Interventions in the Drought Affected Areas

3.1 Pixley ka Seme District Municipality

3.1.1 Kareeberg Local Municipality

3.1.1.1 Vanwyksvlei

Vanwyksvlei has the most severe water supply problems in the Kareeberg municipality. The town has 453 households. Currently the town is suppled with water from five (5) boreholes. Three (3) boreholes are located at Smouskolk, one (1) at Waverley and the remainingone (1) is called Soutgat. There are four(4)additional boreholes located next to the Vanwyksvlei dam that are not in use due to the brackish nature of the water.Currently the municipality does not have the funds to buy membranes for the desalination plant in Vanwyksvlei.

In January 2016 there was sufficient rainfall to fill Vanwyksvlei dam.A request was forwarded to the municipality to make use of this opportunity to pump out the brackish boreholes and recharge them with fresh water from the dam, sadly this was not achieved. In 2015, water was trucked from the Saaipoort aquifer to provide water to the town.Since then the municipality has not had sufficient funds to continue with this and water has only been provided for two (2) to five (5) hours per day.

Currently, DWS has drilled five (5) artificial recharge boreholes (as shown in *Figure 8*) at Smouskolk,all of whichwas very successfuland the targeted aquifers was reached. The water levelsare 22 meters at Smouskolk and 19 meters at Soutgat. During the summer of 2016/17 the water levels were 19meters at Smouskolk and 26meters at Soutgat.

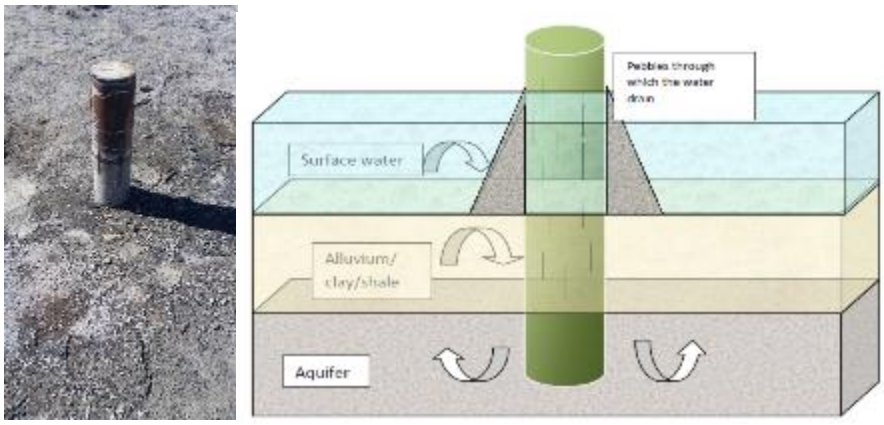

Figure 8: Left: An artificial recharge borehole at Smouskolk. Right: Operation of an artificial recharge borehole.

Iron Bacteria is another problem encountered in many Karoo towns. This is also the case at Smouskolk, where bacteria areblocking the water flow in the two (2) boreholes. DWS suggested that the boreholes be cleaned out; however, the municipality declined the offer, as the infrastructure around the boreholes would have to be broken down to allowa drill to clean the borehole.

Figure 9: Iron Bacteria in the boreholes at Smouskolk.

3.1.1.2 Carnarvon

Carnarvon abstracts its water from a well field in the town's dam and the supply is supplemented from Saaipoort. Currently the water supply is under stress as there was very little to no rainfallduring the 2016/17 summer season. The town's dam which recharges the boreholes has been dry for the past three(3) years. The groundwater levels rose incrementally over the winter due to decreased waterdemand; however, it is expected that water levels will drop again in summer,stressing the system further.

Two(2)artificial recharge boreholes (*Figure 10*) are being planned for the dam in Carnarvon similar to those drilled at Smouskolk. Two(2) additional boreholes will also be drilled on allotted ground. DWS also suggested that the town equip four(4) boreholes that were drilled in 2014 by SRK to augment the supply. Currently Saaipoort is being pumped 24/7 to help supply water to Carnarvon. At Saaipoort, six(6) artificial recharge boreholes and three(3) production boreholeswill be drilled to supply water to the suggested pipeline. Prosopis trees (*Figure 11*)present a significant problemat Saaipoort. Eradication of these trees will relieve some of the strain on the groundwater supply.

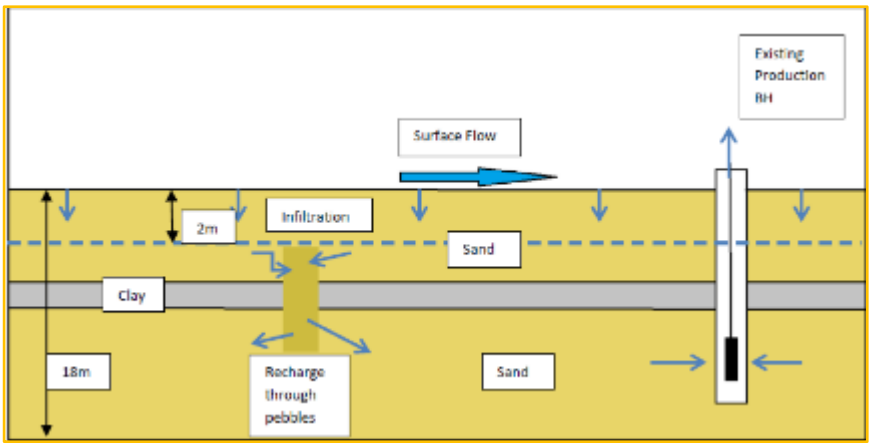

Figure 10: Schematic representation of artificial recharge boreholes at Saaipoort.

Figure 11: Prosopis trees growing at Saaipoort.

3.2 Namakwa District Municipality

3.2.1 Hantam Local Municipality

The HantamLocal Municipality is the most troubled by the drought as most of the towns are dependent on winter rainfall, which was little to none during the past season. Only Brandvlei is located within the summer rainfall area and is expected to receive increased rainfall during the summer as mentioned earlier. The Hantam Local Municipality is the most proactive municipality and have been supplying DWS with weekly updates on the water status in all its towns.

3.2.1.1 Nieuwoudtville

Seven (7) boreholes supply water to Nieuwoudtville. It was requested that water restrictions be implemented due to little winter rainfall and the fact that Nieuwoudtville will also have to supply water toe Loeriesfontein during summer.

In 2009 most of the boreholes' water levels were between 80-120m.In 2013 pine trees near the boreholes were cut down and the water levels rose to between 50-70m. Because there was little to no rain, the dam that always recharges the boreholes are empty and the boreholes' water levels are expected to decrease over the course of summer. It is suggested that Loeriesfontein mainly be supplied by borehole Nt12 over the summer, as was done in the past. Monitoring of the boreholes must continue to be done daily and the boreholes must not be over pumped. This is especially true for boreholes Nie 4 and G00303NC, as they show a linear decline.

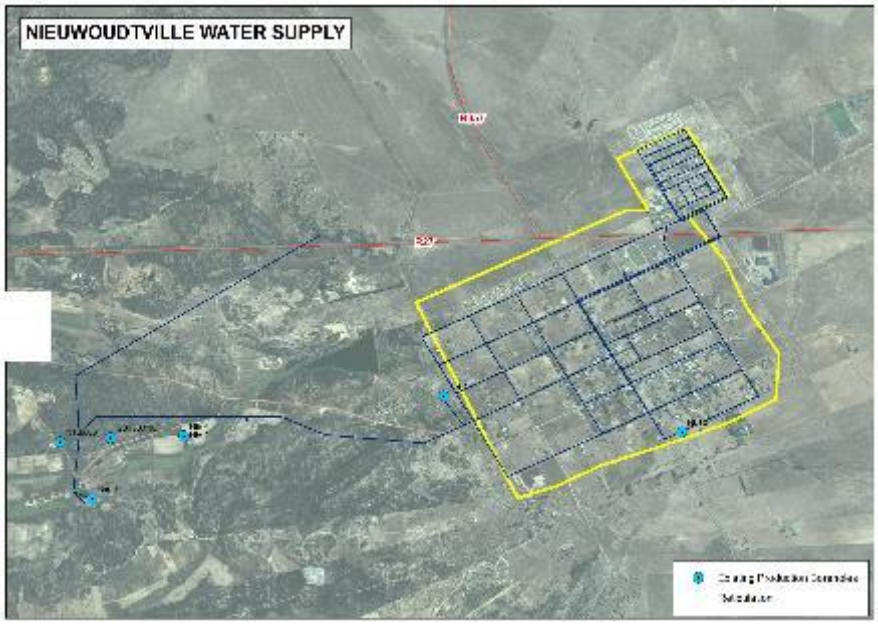

Figure 12: Nieuwoudtville Water Supply

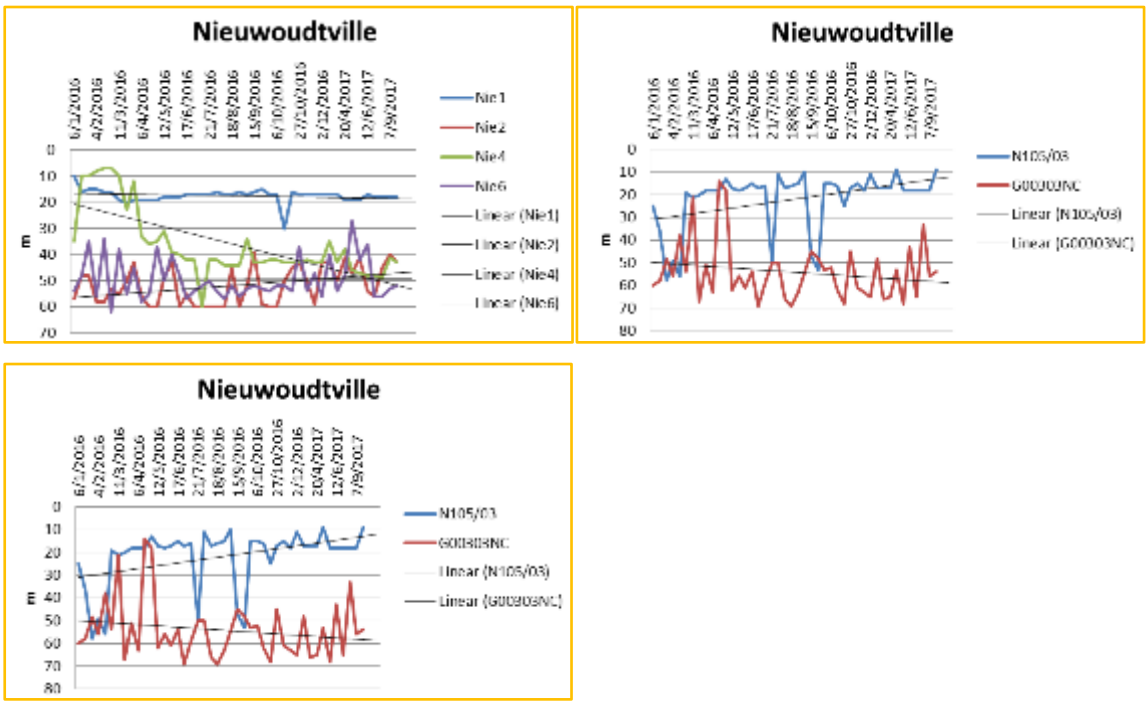

Figure 13: Borehole water levels in Nieuwoudtville.

3.2.1.2 Loeriesfontein

To supply Loeriesfontein, water was trucked for 42months at a cost of R12 million from Nieuwoudtville, which is located 70km away.Additional boreholes have been drilled, but is also 40km away from the town. A desalination plant is being built at a cost of R140 million to treat high salinity groundwater from these boreholes. The required pipeline is not expected to be completed by summer and trucking of water from Nieuwoudtville will have to commence again. Artificial recharge boreholes will also be drilled in three (3) dry dams as is indicated on the map.

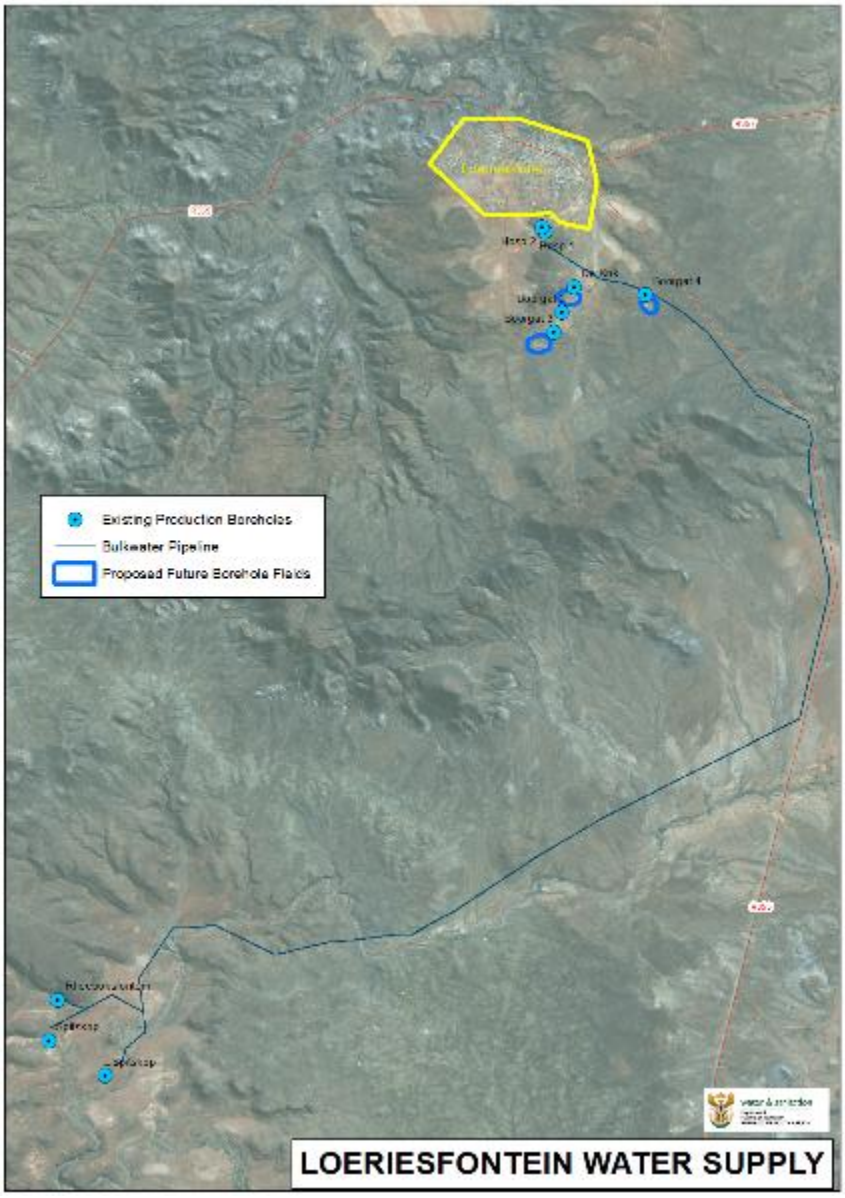

Figure 14: Map detailing the water supply of Loeriesfontein.

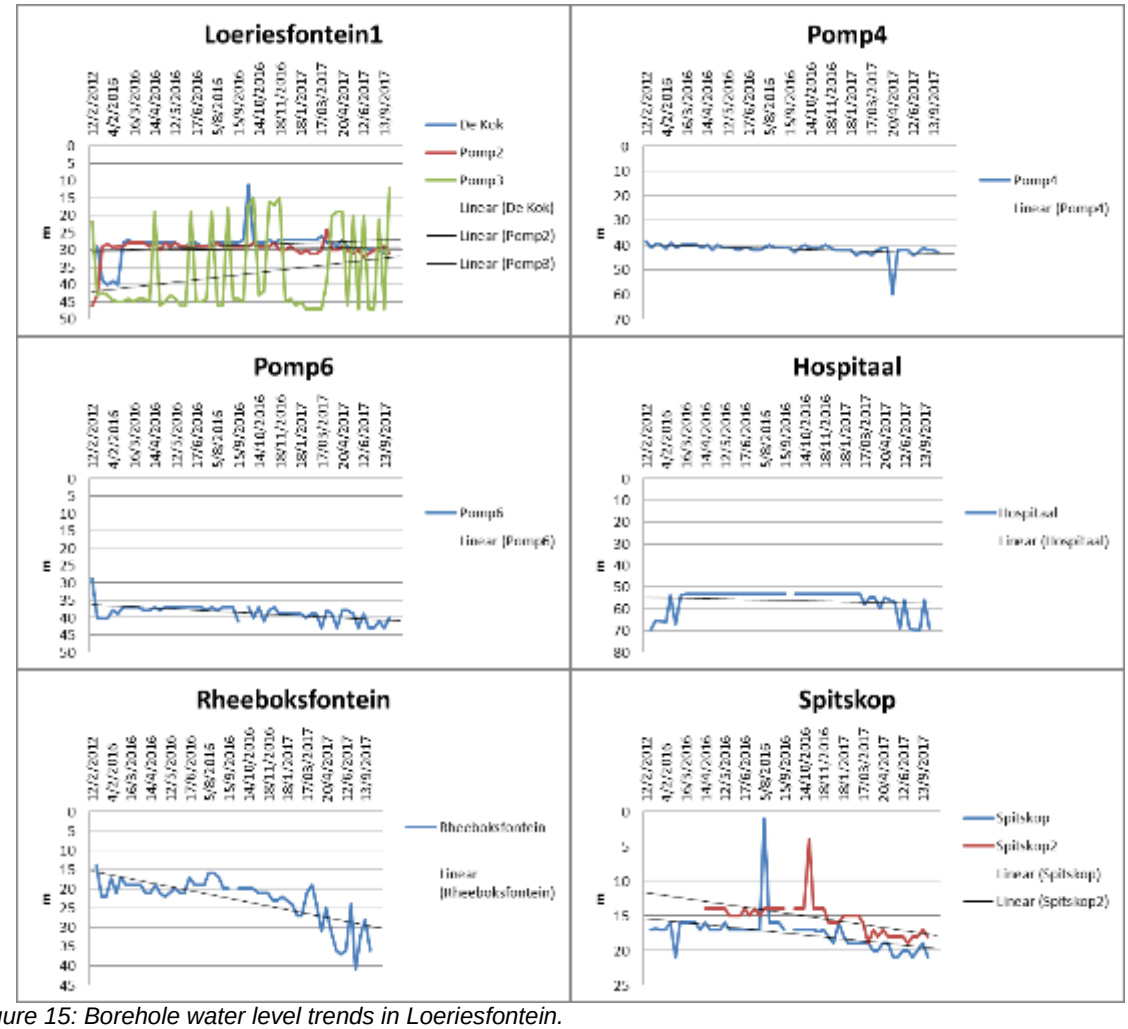

Figure 15: Borehole water level trends in Loeriesfontein.

3.2.1.3 Brandvlei

The water supply is currently sufficient in Brandvlei; however, the state pipeline from Romanskolk has severely deteriorated. It was requested that the municipality preventatively issue water restrictions.

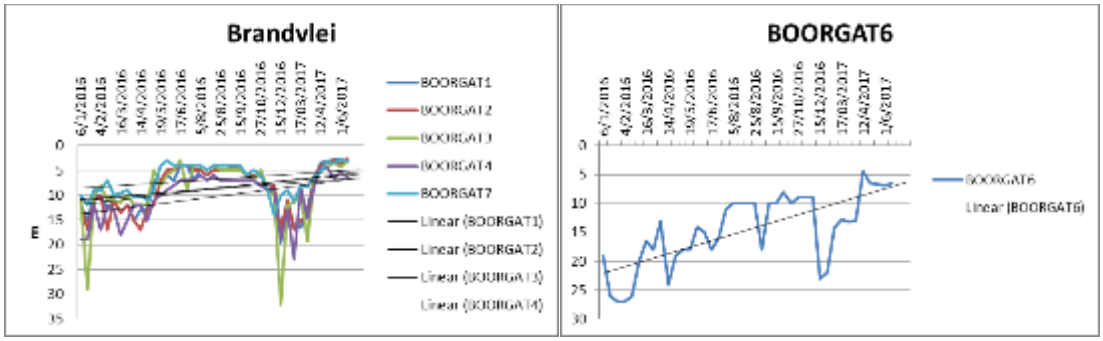

Figure 16: Borehole water level trends in Brandvlei.

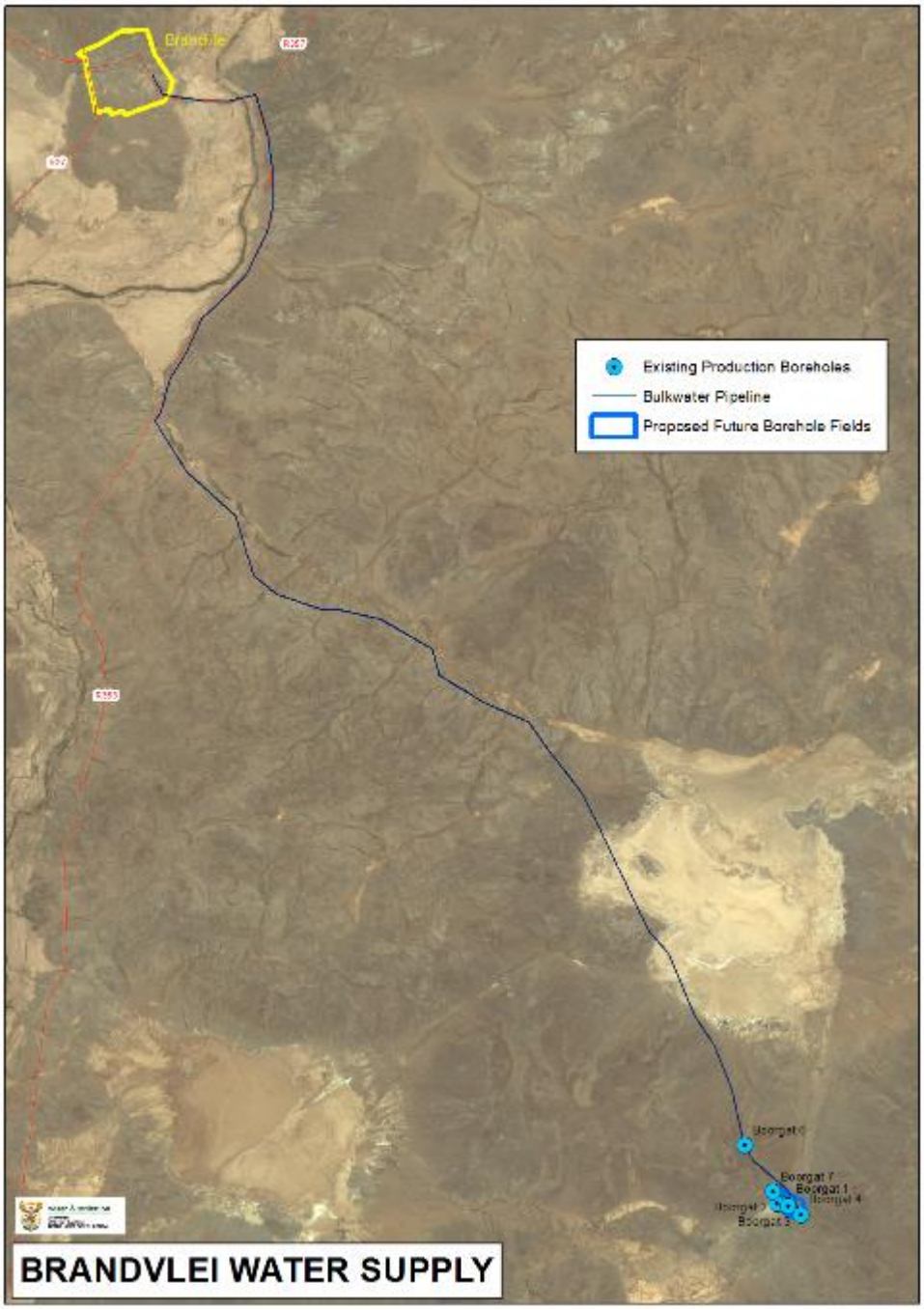

Figure 17: Brandvlei Water Supply

3.2.1.4 Calvinia

Since 2015, Calvinia has received very little rainfall. The town is dependent on a dam and have seven (7) boreholes to supply water. Due to little or no rainfall in the preceding season, the dam ran dry in November 2016. In June 2017 the dam and its catchment received 40mm of rain and the dam level increased to 4meters. Hence, the boreholes were switched off to recover from the continued pumping. The dam is currently on 1.55m/2.7% and will possibly last until the end of October 2017.

Currently the boreholes in Calvinia are being pump tested and the pumped water is being placed into the system for use. On the map in Figure 18, two(2) drilling sites are indicated, the one is an artificial recharge site and at the other the blue gum trees would have to be cut down to see whether sufficient water can be located. There is also a suggested pipeline on the map for to artificially recharge borehole G39973 when the dam is overflows. This borehole has a large capacity and will also assist in preventing excessive evaporation from the dam.

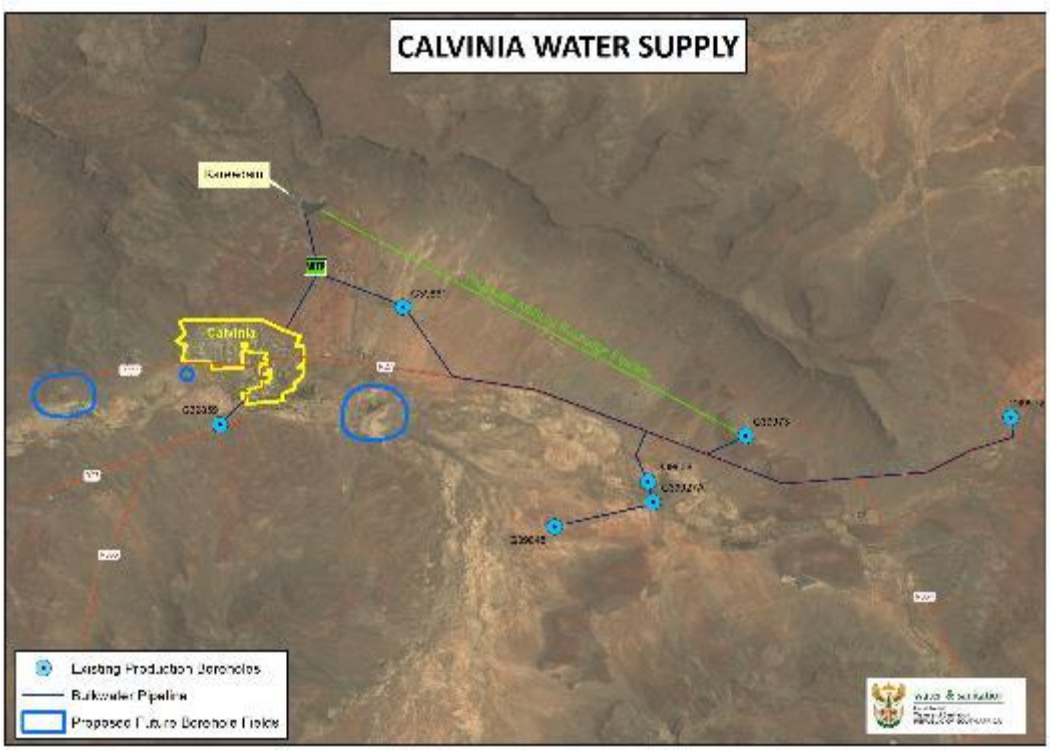

Figure 18: Calvinia Water Supply

From Figure 20, it can be seen when pumping of the boreholes commenced and stopped. It should also be noted that there was a slight increase in the water levels of all the boreholes in May 2016.This was due to a flood that occurred in Sutherland when the Vis and Renoster rivers went into flood. It is also suggested that the, when it rains, water run-off water from the mounted be captured via canal and returned to the dam. Fog nets can be used to aid in the collection of additional water.

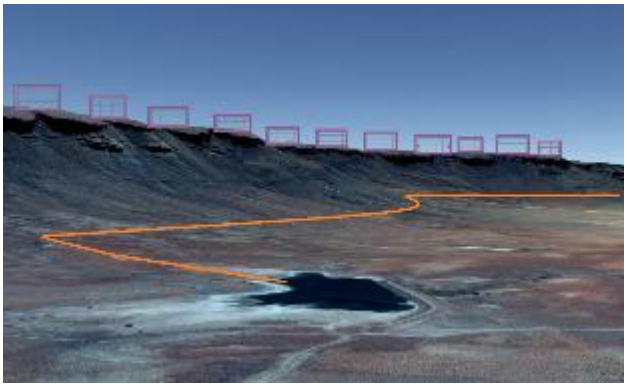

Figure 19: Fog nets on the Hantam mountain, with a canal to transport the collected water.

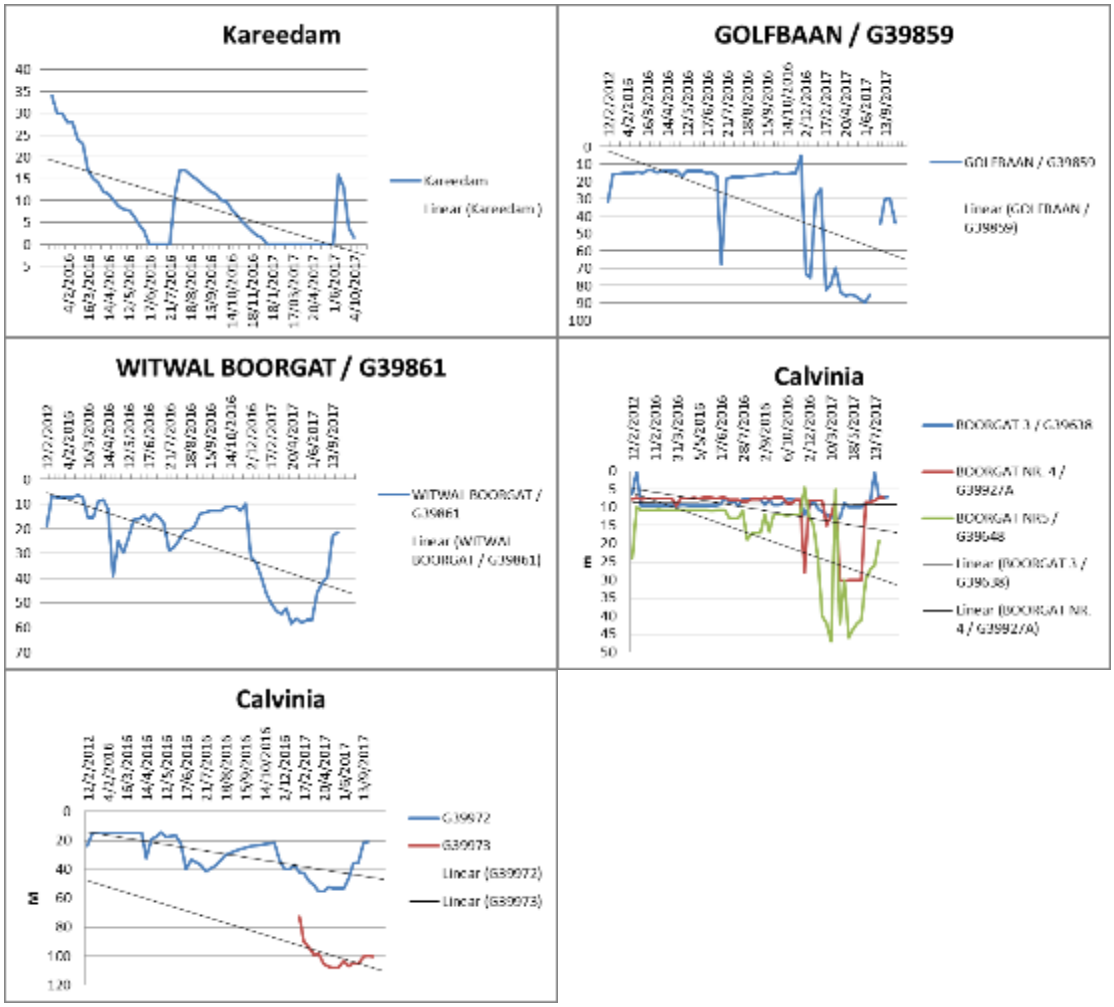

Figure 20: Water level of the Karee Dam and boreholes in Calvinia.

3.2.2 Karoo Hoogland Local Municipality

3.2.2.1 Williston

Williston haven't had sufficient rain for the past four (4) years. Currently there are three (3) boreholes being monitored. In 2015 the boreholes almost collapsed due to over-abstraction. The problem was addressed and the water levels have since remained constant. That being said, water cuts were implemented during the summer of 2016, where the town only had

six(6) hours of water per day to manage the effects of the drought. Should sufficientrainfall not occur this year, the same measures will be implemented. In 2013 SRK drilled new boreholes to augment the water supply. It is planned that these boreholes will be equipped in this financial year.

3.2.2.2 Fraserburg and Sutherland

Currently the strained water supply in Fraserburg and Sutherland is managed well. In Fraserburg boreholes are being alternated to allow for recovery. Whilst in Sutherland only two (2) boreholes are being used. Two (2) additional boreholes can be equipped when needed. One of the boreholes in Sutherland dropped from 1 to 14 meters during this year; however, this is a repeat of last year's events. The water supply of the town remains unaffected.

3.2.3 Nama Khoi

3.2.3.1 Buffelsrivier and Komaggas

The Buffelsrivier aquifer has a safe yield of 823 200m^3/a, whilst the Komaggas aquifer's safe yield is 174287m^3/a. This gives a combined value of 997 487m^3/a, which should be adequate for both communities. The water level data given in the tables below was collected on 14 September 2017 and indicates that the aforementioned recommendations should be halved if the aquifers are expected to be able to provide water until the next rainfall season.

Table 1: Komaggas Aquifer Water Levels

Borehole	Latitude	Longitude	Water Level 1998	Water Level Current	Condition
KG 4	29.80322	17.49299	-22	-18.44	Collapsed 33m
KG 102	29.80331	17.4989		-20.02	Collapsed 20m
KG 106	29.8028	17.49708	-17	-40.99	
KG 2	29.79887	17.49708	-33		
KG 100	29.79121	17.49954	-28		
KG 108	29.7887	17.50171	-25	-96.69	
KG 107	2978832	17.50171	-30	-63.58	
KG 109	29.79246	17.50724			

Table 2: Buffelsrivier Aquifer Water Levels

Borehole	Latitude	Longitude	Water Level 1998	Water Level Current	Condition
BH7A	29.7488	17.6367		-10.31	Bad
BH7B	29.74867	17.6364		-9.68	Bad
KG 118	29.73623	17.62882		Dry	Bad
BHA	29.71282	17.6014		??	Bad

It is recommended that the storage capacity at Buffelsrivier should be investigated by a qualified professional. It seems if there is not enough storage capacity to provide Buffelsrivier while water is being pumped to Komaggas. The reserviors are also placed to far down river and it seems that a reservior near the abstraction area will improve the water supply to both communities.

Spektakel mine can be considered for additional water. The volumes that were abstracted by OCC for Nigramoep mine previously are: October 1995: 39 249m^3, November 1995: 46 067 m^3 December 95: 45649m^3. The water from the mine is acidic; however, work by Dr. Robert Hansel from UFS on the OCC mines suggests that it may be possible to combine the Buffelsrivier aquifer water with the water from the Spektakel mine to achievewater that is fit for human consumption. An alternative option is the pipeline from Goodhouse to Kleinsee. The Nama Khoi LM is not in favor of this option due to the condition of the line.

3.2.4 Richtersveld

Currently, water restrictions are in place in Port Nolloth, whilst Eksteenfontein and Lekkkersing are experiencing water shortages. The Richtersveld LM requested bids for the drilling of production boreholes at Eksteenfontein and Lekkersing.

Lekkersing, Eksteensfontein are completely dependent on groundwater whilst Port Nolloth has four boreholes which is complemented with a pipeline from Alexander Bay

3.2.4.1 Eksteensfontein

Eksteensfontein has three (3) production boreholes that lie on the same aquifer approximately eighty meters apart. These boreholes were pump-tested in 2010/2011 by Barry Cronje. Thus far the pump test results could not be obtained, but currently the boreholes are over exploited. Borehole 1 is being pumped with 4 minute intervals, while

boreholes 2 and 3 are also not pumped correctly. None of the flow metres work and thus it is not possible to measure the volume water that is being abstracted.

It is recommended that a new borehole or boreholes be drilled to supplement the current well field. Boreholes must be drilled to east of the community in Stinkfontein. This group consists of quartzites and ground water quality and quantities are better than to the west. The current three boreholes must be tested again; this can be done by DWS personnel since the boreholes are equipped with electrical submersible pumps. It is advised that these pump tests be done in winter when the water consumption is lower and a reserve can be established before the tests commence. Since the current reservoirs were constructed the town has expanded and some houses are on the same height as the reservoirs and hence receive no water as soon as shortages occur.

3.2.4.2 Lekkersing

Lekkersing has two production boreholes, the third collapsed some time ago. The borehole with the best yield is a ZQM station but cannot be used to its full capacity as a brick was thrown into it and hence the pump can't be placed at the correct level. According to Des Visser, who did the monitoring of the Namaqualand in the nineties and early two-thousands, if only two boreholes are pumped the safe yields of the boreholes will be exceeded.

It is recommended that the ZQM borehole and collapsed boreholes replaced with new ones. The pipeline from the collapsed borehole to Lekkersing has not been used for more than 10 years and will probably have to be replaced.

3.2.4.3 Port Nolloth

The volume of water abstracted from the well field is unknown. According to Seward (GH3538) 2500m^3/d is available. He and Pike (GH1290) indicate that a possible other well field can be developed at Seemansrus for the following reasons:

- It is near the current well field
- It is not in the same aquifer
- Approximately 960m^3/d is available with a water quality between 250 and 350mS/m

4 Drought Interventions and Mitigation Measures

4.1 Infrastructure Development

The table below gives a summary regarding the drought mitigation measures that have been implemented in the Northern Cape.

Table 3: Drought Interventions and Mitigations Implemented Throughout the Northern Cape

Province	Interventions				
	Planned	**Done**	**Spent R'000**	**To Continue (2017/8)**	**Funding**
Northern Cape		25 boreholes drilled 51 boreholes refurbished Boreholes connected. Pipelines extended Water Treatment Works	R 10 268 R 34 405	Number of boreholes R 13 303 Upgrading bulk water supplies. R 22 000	DWS DoRA

Table 4: Drought Interventions and Mitigations Needed Throughout the Northern Cape

No	DM/LM	Town	Households	Problems	Interventions				2017/18 Funding
					Planned	**Achieved**	**Continuing**	**Spent R'000**	
1	**Namakwa Hantam**	Loeriesfontein	3971	Almost all boreholes dry.	Tankering from Nieuwoudtville	Water restricted to 4 hours per day	Yes		Loeriesfontein BWS RBIG 50 426 000 WSIG 4 000 000
2					Equip & Connect boreholes	Temporary pump main done	More boreholes	R 6 800	
3		Calvinia		Empty Karee Dam, Boreholes drying up.	Geohydrological study	None	Yes		
4					Equip & connect boreholes	None	Now ZNC168		

No	DM/LM	Town	Households	Problems	Interventions				2017/18 Funding
					Planned	Achieved	Continuing	Spent R'000	
5		Brandvlei		Lack of groundwater	Upgrading bulk supply	None	Now ZNC169		
6	**Namakwa Karoo Hoogland**	Willeston	850	Lack of groundwater	Equip, connect & power for boreholes	None	Now ZNC142		WSIG R 4 000 000
7	**Namakwa Kammiesberg**	Spoegrivier	322	Very few boreholes, all stressed	Equip and connect boreholes	None	Now ZNC138		WSIG R 4 000 000
8					3 boreholes	3 x Drilled	Done	R 1 455	Drilling division (DWS)
9		Klipfontein		Very few boreholes, all stressed	Equip and connect boreholes	None	Yes		
10	**Namakwa Richtersveld**	Eksteensfontein	1656	Almost all boreholes dry.	Drill 3 boreholes, equip & connect	None	Now ZNC137		WSIG R 6 000 000
11		Lekkersing		Almost all boreholes dry.	Drill 3 boreholes, equip& connect	None			
12	**PixleKaSeme Kareeberg**	Vanwyksvlei	453	Groundwater stressed and of poor quality.	Refurbish desalination plant	None	Yes		RBIG 30 000 000
13					Carting water from Carnavon (70km)	Done	Yes		
14					Bulk pipeline				
15	**PixleKaSeme Kareeberg**	Victoria West		Local dam dry, lack of groundwater	Development of Boreholes	None	Now ZNC153		WSIG R4 000 000

No	DM/LM	Town	Households	Problems	Interventions				2017/18 Funding
					Planned	Achieved	Continuing	Spent R'000	
16	**John TaoloGaetsewe Joe Morolong**	Laxey		Lack of water	Refurbishment of boreholes	2 x new boreholes done (?)	Yes	R 3 430	WSIG funding
17					Purchasing Water Trucks	Done		R 7 669	
18	**John TaoloGaetsewe Joe Morolong**	Several		Current supply not meeting demand.	Drill 8 new & refurbish 35 boreholes			R 1 742 MIG R 13 679 WSOG R 7 551 MWIG	
19					Extensive tankering		Yes		Funded by LMs
20	**John TaoloGaetsewe Ga-Segonyana**	Several		Current supply not meeting demand.	Drill 3 new & refurbish 6 boreholes	Done		R 2 451 WSOG R 1 663 MWIG ? WSIG	
21					Kalahari East Pipeline Extention				RBIG 1 700 000
22					Water Treatment Plant				

4.2 Water Conservation Recommendations

Letters recommending water restrictions be put in place, was sent to Hanta, Karoo Hoogland and Kareeberg Municipalities on the 29th of September, with the following recommendations:

1. The watering of gardens and washing of cars with hoses should be prohibited.
2. The filling of municipal or private swimming pools should be discouraged.
3. Should the rainfall still be less than 200 mm, stricter water restrictions are recommended.
4. Should the drought conditions continue, the water supply to the town can also be halved by the municipality by closing the supply line to the town.
5. All water leaks and burst pipes should be attended to immediately.
6. If water reservoir levels are constantly below 20%, it is recommended that water be provided to the town for only 5 hours a day, e.g. 2 hours in the morning and 3 hours in the evening.

5 Conclusion

Proper water management is needed, which includes timely water restrictions.Despite many attempts to get financial assistance for drought relief, no support was given to the Northern Cape. This is troubling since the NC Disaster Management Unit expects DWS to manage the drought situation.

Municipal preparedness regarding drought is lacking and most municipalities lack Drought Disaster action plans. Water abstraction monitoring of boreholes in municipalities is also not done with sufficient commitment. The lack of standby pumps and boreholes further exacerbates water shortages. It is thus vital to increase municipal preparedness, especially in these regions which are prone to droughts.